LEMMON VALLEY MASTER HYDROLOGY

RENO, NEVADA

Prepared

March 2005

For:

Matrix Engineering
Reno, Nevada

Under the Direct Supervision of:

CHARLES D. ANDERSON, Nevada RCE No. 11518

Schaaf & Wheeler
CONSULTING CIVIL ENGINEERS

100 N. Winchester Blvd., Suite 200
Santa Clara, CA 95050
(408) 246-4848
FAX (408) 246-5624

INTRODUCTION

Properties located between Military Road and Lemmon Valley Drive in Reno-Stead, Nevada are planned to be improved with residential, commercial and industrial development. This master planning effort is to quantify ultimate one-percent discharges throughout the area to facilitate flood protection and storm drain design. This work will also serve as a basis for the Letter of Map Revision (LOMR) process to remove those areas currently shown as flood prone during a base flood (100-year) event with a Zone A designation on the currently effective Flood Insurance Rate Map for Washoe County. The City and County have also requested an analysis of flow volume impacts due to proposed development during a 100-year, 24-hour design storm. This master plan builds on previous LOMRs recently issued by FEMA.

HYDROLOGIC ANALYSES

In a December 17, 1996 letter, FEMA conditionally approved a hydrologic model of the Lemmon Lake watershed affected by proposed development. Hence this model has been used as a basis for all subsequent hydrologic analyses.

Estimates of runoff in Lemmon Valley are based on the Soil Conservation Service (SCS) Unit Hydrograph model. Software employed to perform the computational work is the U.S. Army Corps of Engineers' HEC-1 program. The SCS model is a lumped-parameter type of model which uses a rainfall pattern and depth of rainfall as basic input. The rainfall-runoff relationship is established using the SCS Curve Number (CN) technique, which models the retention of excess precipitation as a function of land use, soil type, ground cover, and antecedent moisture conditions (i.e. soil saturation resulting from previous rainfall).

Each watershed's response to excess precipitation (runoff) is defined by the SCS non-dimensional unit hydrograph. Watershed characteristics that influence the unit hydrograph are generally measurable in the field (or more precisely, from quadrangle mapping). Precipitation information has been taken from the NOAA water atlas for Nevada, and previously determined intensity-duration-frequency relationships for the Reno area. Infiltration is modeled by a "curve number", which is estimated using SCS guidelines and published soil surveys. To improve model reliability, curve numbers have been calibrated to nearby, similar watersheds with gaged streamflow records. Readers requiring a more detailed description of the hydrologic model used in the original CLOMR are referred to *Peek's Lemmon Valley Property: Hydrologic and Hydraulic Analyses* prepared by Schaaf & Wheeler in March 1996.

To facilitate the present master plan, the following revisions have been made to the 1996 model:

1. Existing Conditions Discharge: The watershed is modeled under existing land use conditions, but with the completed Flood Control Channel "C" in place. This model was used as the basis for the recently approved LOMR submittal.

2. Ultimate Conditions Discharge: Proposed flood control channels are sized to carry base flows with ultimate estimated discharges based on proposed land uses from City of Reno and Washoe County Horizon 2020 zoning criteria. Development types and densities for build-out within Lemmon Valley have been provided by Matrix Engineering.

Urbanization

To model the effect of existing and ultimate development in the watershed, base curve numbers are used in conjunction with the percentage of impervious area in the sub-basin. Impervious areas refer to pavement (e.g. roads and parking lots), driveways, sidewalks, and building footprints that eliminate the surface infiltration of runoff into the ground. Urbanization tends to increase the peak rate and volume of runoff; all other factors (such as rainfall) being equal.

Existing urbanization was previously estimated for the original CLOMR submittal from aerial photographs and quadrangle mapping by computing the percentage of a given basin covered by impervious surfaces. Low density residential areas are assumed to have an impervious area of one-third the gross acreage; high density development and commercial or industrial areas are assumed to be 80 percent impervious. Special areas such as large parking lots or lakes are assumed to be 100 percent impervious.

Urbanization for ultimate build-out conditions is estimated from general plan land use zoning and development guidelines now in place at the City of Reno and Washoe County (Horizon Year 2020). Figure 1 shows land use categories with superimposed hydrologic model watersheds. (Based on presently available information, the urbanized model assumes that development will not significantly affect existing topography. That is, grades will not change to the point where drainage sub-basin boundaries are changed.) Basin imperviousness for each significant land use classification is also included. Figure 2 presents SCS Hydrologic Soil Group classifications from NRCS STATSGO together with the superimposed watersheds. Most of the drainage area to Lemmon Lake is made up of Type "B" and "C" soils which are generally classified as soils with low to moderate infiltration rates when wetted (silt loams, loams, sandy clay loams with infiltration rates between 0.05 and 0.3 inch per hour). Table 1 presents the percent impervious used for each land use category and Table 2 summarizes the results of an Arcview merge of land use information with those imperviousness percentages.

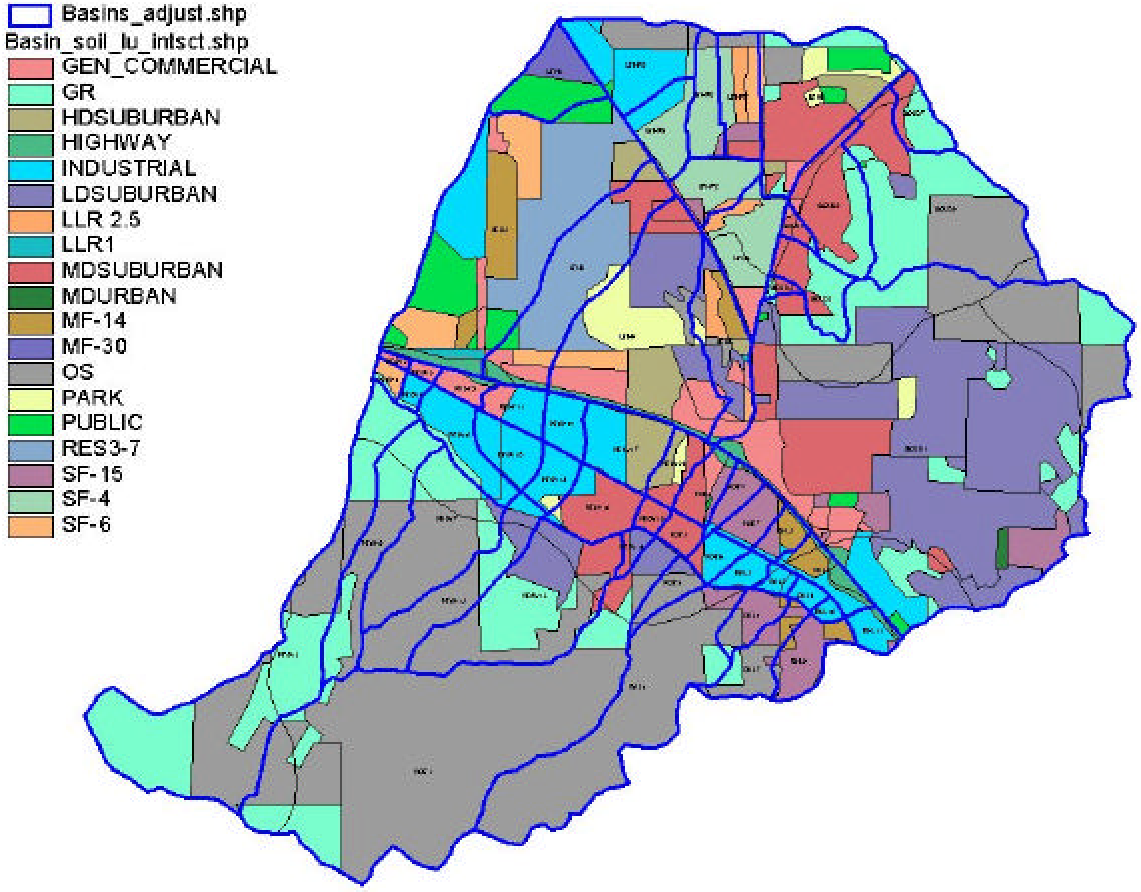

Figure 1. Horizon 2020 Land Uses in Lemmon Valley Watershed

Landuse	Percent Impervious
GR	0.2
LDSUBURBAN	10
MDSUBURBAN	25
RES1-3	25
RES-3-7	40
RES7-21	60
RES21+	75
SF-15	60
PARK	20
GEN_COMMERCIAL	80
INDUSTRIAL	80
HIGHWAY	98
NEIG_COM_OFFICE	85
OS	30
PUBLIC	60
TOUR_COMMERCIAL	80
MF-14	60
MF-30	75

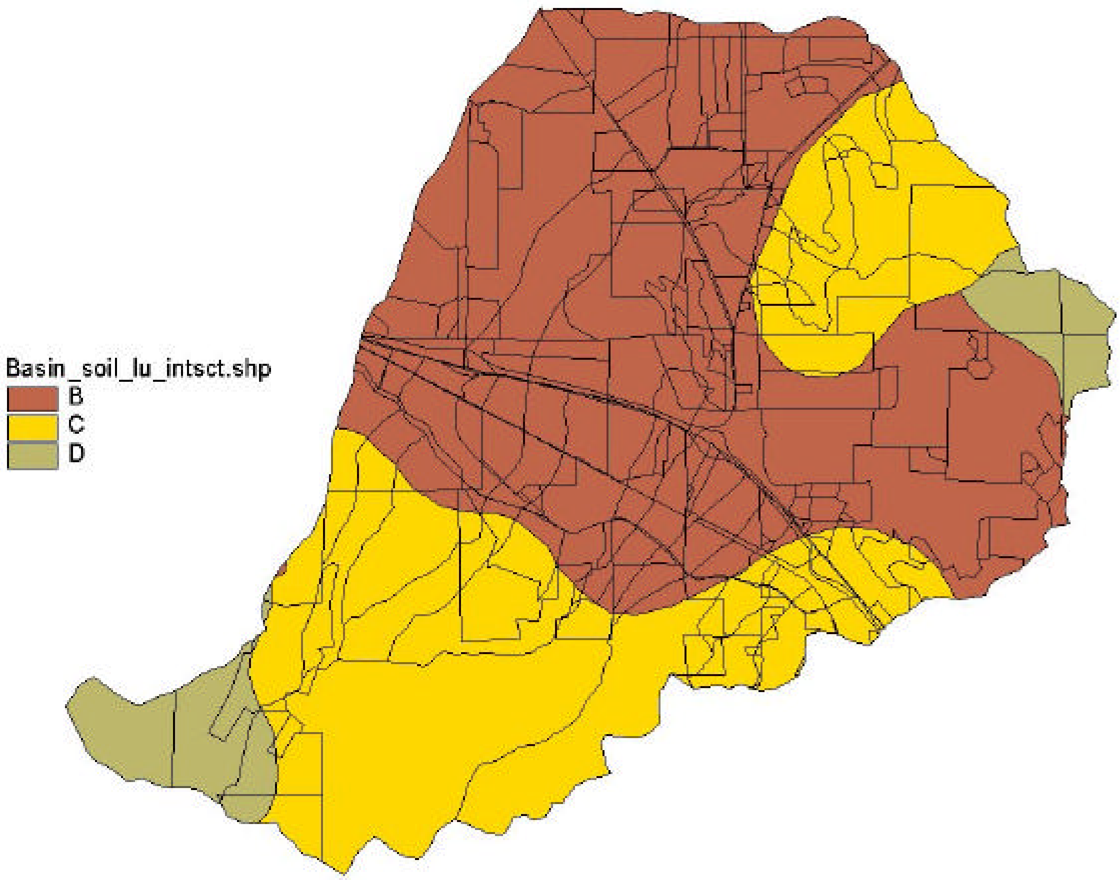

Figure 2. SCS Soil Types from NRCS STATSGO

Muskingum's method has been used to route hydrographs toward the watershed outlet (Figure 3). Muskingum's "K" parameter is estimated as the travel time in hours based on an average velocity of five feet per second for improved channels, with an "x" value (which weighs pure translation versus attenuation of the flood wave) of 0.4 to be consistent with the base model.

It should be noted that the developed conditions model assumes that existing storage areas and diversions behind Western Pacific Railroad crossings are maintained intact since this area is designated as "General Rural" and significant land use changes are not anticipated. The model has also incorporated planned and existing detention basins within the Sky Vista development. All other areas within the Lemmon Lake drainage basin are assumed to develop without detention.

These are somewhat conservative assumptions, but they are made since more detailed information regarding future development within the watershed is lacking.

Table 1. Ultimate Planned Urbanization of Lemmon Lake Watershed

	CLOMR		Arcview
Basin ID	Natural CN	Basin % Impervious	Ultimate Basin % impervious
GOLD1	77	15	18
GOLD2	73.9		16
GOLD3	72.3	5	11
GOLD4	73.5	20	27
GOLD5	69.4	22	17
GOLD6	74.5	5	4
GOLD7	72.8	1	8
LEM1	69.3		78
LEM2	74.5	12	58
LEM3	74.7	2	45
LEM4	78.4	2	40
LEM5	74.5		34
LEM6	66.7	1	49
LEM7A	69	1	55
LEM7B	69	1	60
LEM7C	69	1	47
LEM7D	69	1	46
LEM7E	69	1	33
LEM8	66.1	38	33
PEAV1	77		34
PEAV10	77		80
PEAV11	77		80
PEAV12	80.9		6
PEAV13	77		74
PEAV14	77.7	2	80
PEAV15	83.1	3	5
PEAV16	77	13	33
PEAV17	80.8	1	77
PEAV18	79.5	10	17
PEAV19	78.3		24
PEAV2	77		73
PEAV20	80.3	14	45
PEAV3	79.3		0
PEAV4	77		69
PEAV5	77		77
PEAV6	80.3		0
PEAV7	79.9		1
PEAV8	77	1	69
PEAV9	77		83
POE1	82.8		1
POE2	77	7	24
POE3	77	18	51
POE4	77	1	64
POE5	83.7		3
POE6	77		70
POE7	77	1	63
RAL1	84.8		3
RAL10	87	2	79
RAL11	87	5	82
RAL2	78.4		79
RAL3	77	44	65
RAL4	81.2		41
RAL5	79.5	5	79
RAL6	81.1	20	78
RAL7	81.5		20
RAL8	83.7	5	81
RAL9	87	25	58

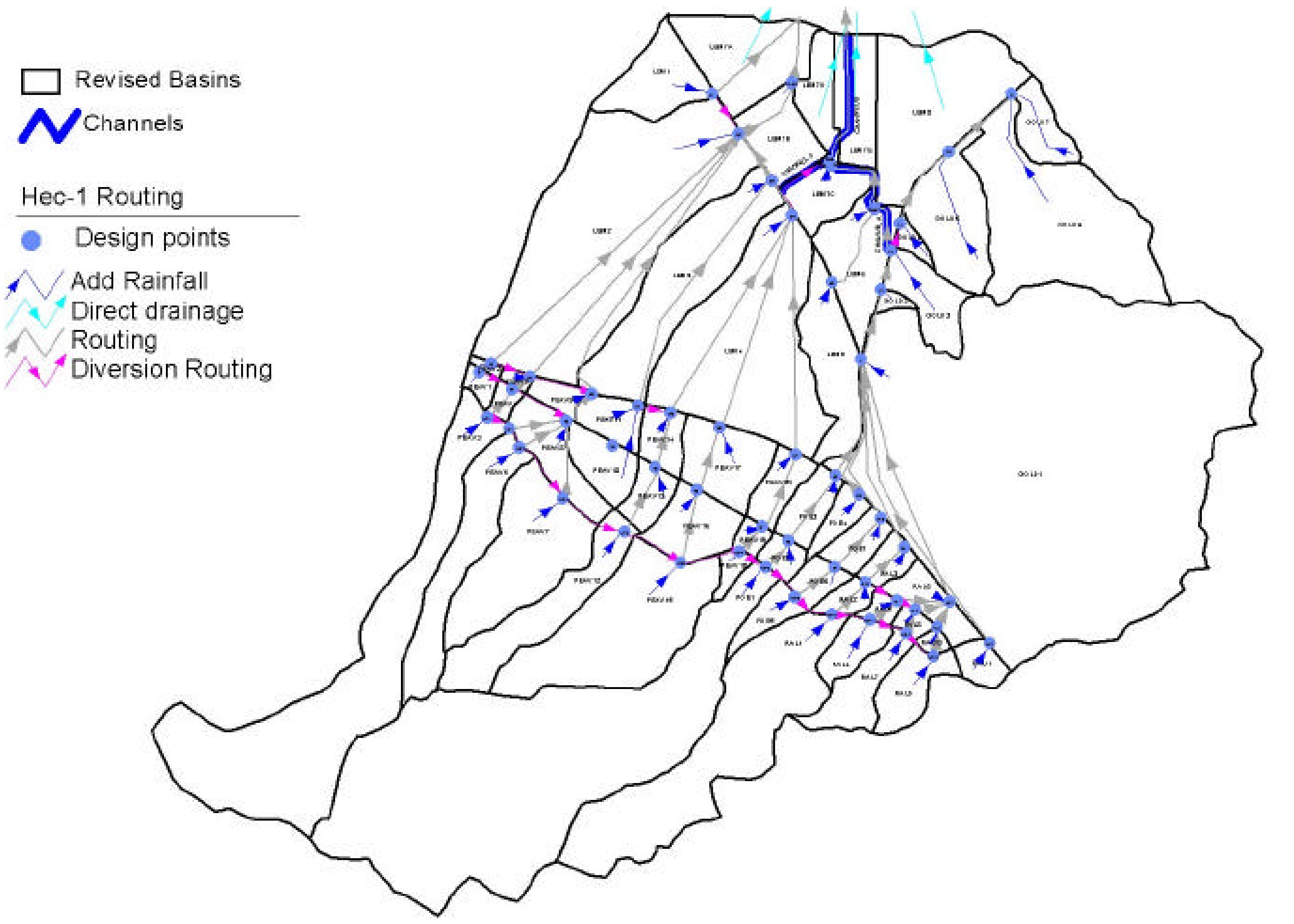

Figure 3. Basin Routing in HEC-1

Peak 100-year Discharges

Table 2 summarizes estimated peak 100-year discharge rates at points of interest, referenced to Figure 4. FEMA discharges for the CLOMR submittal and ultimate build-out discharges for design are listed.

Table 2. Estimated 100-Year Discharges for Flood Protection Design

Location	ID	100-Year Discharge (cfs)	
		Existing (CLOMR)	Ultimate Build-Out
Sage Point Channel at Military Road	M2	1,100	1,550
Sage Point Channel at Lear Boulevard	LEAR	1,110	1,600
Military Road Ditch D/S Channel C Culvert	M3	100	170
Military Road Ditch at Sage Point Channel	M2	250	420
Channel C U/S Military Road	M4	1,070	1,350
Channel C D/S Military Road	C	970	1,210
Peek 1 Channel / Storm Drain	M5	50	80
Lemmon Drive at (E) Culvert	L1	1,480	1,530
Lemmon Drive at Channel A	L3	1,490	1,540
Lemmon Drive D/S Channel A	L3	310	330
Channel A at Lemmon Drive	A	1,180	1,210
Channel A D/S Peek 1 Drain	A2	1,220	1,330
Channel B	B	2,030	2,400

Increase in Runoff Volume

In addition to increasing peak discharge *rates*, urbanization also increases peak runoff *volume*. The City of Reno and Washoe County have requested that additional volume be created to offset increased volume due to basin urbanization during a 100-year, 24 hour storm. This volume may be created using retention basins (not detention basins) above Lemmon Lake, or by adding volume to Lemmon Lake below elevation 4920 (the 100-year water surface elevation). For either option, only the volume created above the average seasonal high groundwater table may be considered.

As shown on the following tabulation, excavating approximately 92,000 cubic yards of material (either in retention basins or below the 4920 contour contiguous to Lemmon Lake) will mitigate the increase in runoff volume caused by planned improvements to the subject properties. Oversizing Channel "B" near its terminus with the lake is one possibility.

The hydrologic model has been used to estimate required mitigation volumes attributable to the Peek and Crest developments (Figure 4):

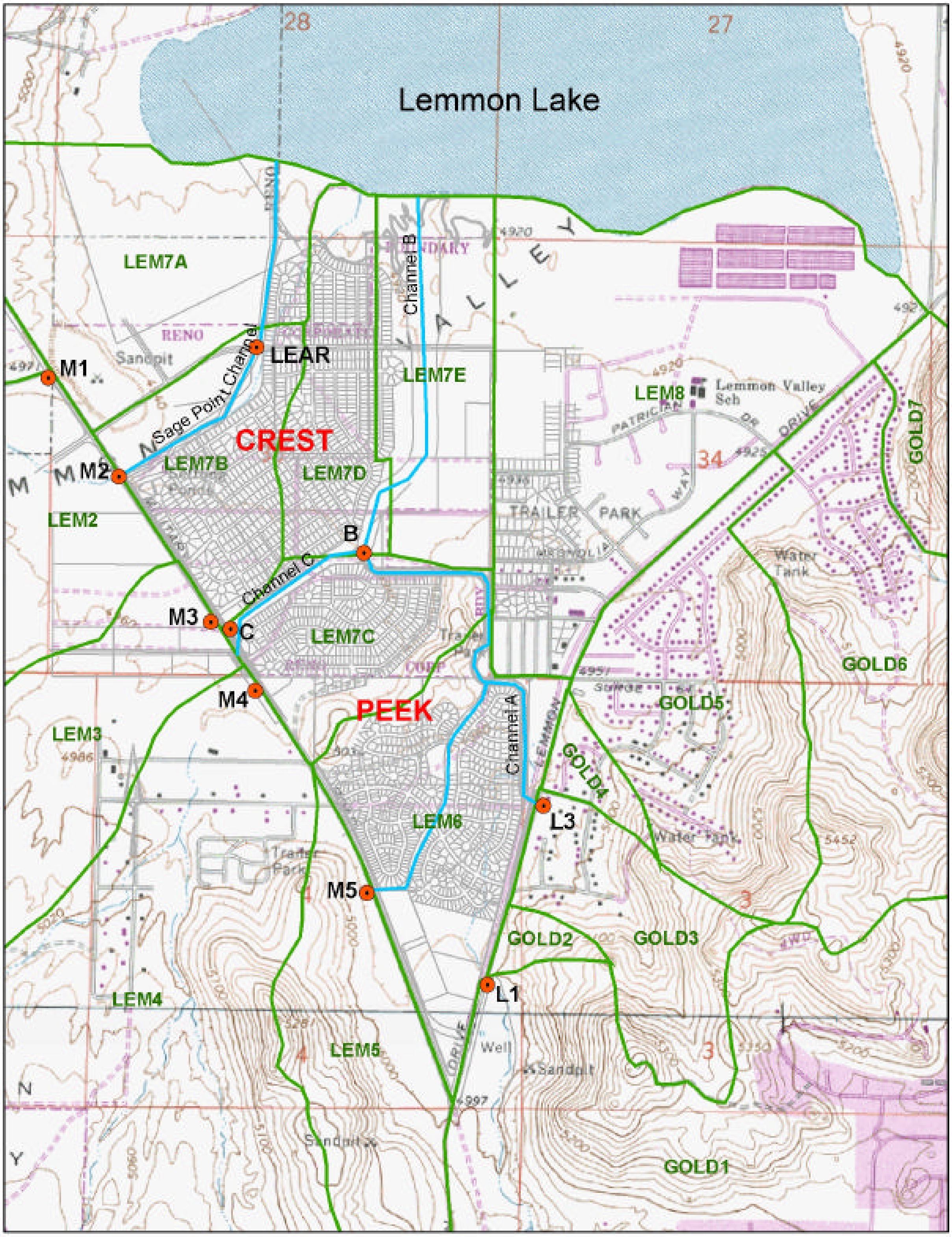

Figure 4. Hydrologic Identification

ADDITIONAL VOLUME

Peek 1	35 acre-feet
Crest	22 acre-feet
	57 acre-feet

HYDRAULIC ANALYSES AND DESIGN

For this master plan, normal depth calculations have been used to provide preliminary channel designs for Channel "A" and Channel "B" (Table 3). To prevent erosive velocities, Channel A should be lined with rock riprap (Manning's n = 0.035) or a grout-filled fabric revetment system similar to the one used for Channel C (n = 0.050).

Grout-filled Fabric Revetment on Channel C

Detailed designs for Channel "C" and its culvert at Military Road using the U.S. Army Corps of Engineers HEC-RAS program have been approved by FEMA for a discharge at the culvert entrance of 1,070 cfs. Under existing conditions topography immediately upstream of Military Road suggests that about 100 cfs in overbank flow is not captured by the culvert, but rather, flows along its historic path to the north next to the west side of the road. Discharge estimates provided in Table 2 assume that this situation continues, and future urbanization causes a slight increase in flows along the west side of Military Road toward Sage Point Channel. Since a roadside ditch is necessary, it may make sense to account for the Channel C overflows and design conveyance facilities for the total discharge. Alternatively, HEC-RAS backwater calculations demonstrate that Channel C and the Military Road culvert are sufficient to safely contain the entire 1,350 cfs design discharge without spill down the west side of Military Road. To achieve this, a containment berm or intercepting channel is needed to funnel storm runoff into the Military Road culvert. Private property issues have prevented this type of funnel from being designed or constructed to date.

Similarly, roughly 300 cfs is expected to flow down the median of Lemmon Drive unless future measures are taken to intercept this runoff. Table 3 presents preliminary channel configurations for both cases.

Table 3. Preliminary Channel Design Alternatives

Channel / Condition	Flow (cfs)	Manning's "n"	Flow Depth (feet)	Bottom Width (feet)
Sage Point Channel (2:1 sideslopes, S=.005)	1,600	.035	5	30
			6	20
		.050	5	45
			6	30
Channel A w/ Upstream Spill (2:1 sideslopes; S=.006)	1,330	.035	5	25
			6	15
		.050	5	35
			6	20
Channel A w/o Upstream Spill (2:1 sideslopes; S=.006)	1,530	.035	5	30
			6	20
		.050	5	40
			6	25
Channel B w/o Upstream Spills (3:1 sideslopes; S=.006)	2,400	.080	5	110
			6	80
Channel B w/ Upstream Spills (3:1 sideslopes; S=.006)	2,820	.080	5	130
			6	95