Technical Drainage Study

Update

Flying Cloud Casino at Buena Vista Rancheria

Prepared for:
Steelman Partners
3330 West Desert Inn Road
Las Vegas, Nevada 89102

Prepared by:
Kimley-Horn and Associates, Inc.
2080 East Flamingo Road
Suite 210
Las Vegas, NV 89119-5178

February 2009
KHA Project #092467011

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I. General Site Information

A. Introduction

This report is an Update to the Technical Drainage Study for the Flying Cloud Casino at Buena Vista Rancheria, located at the Buena Vista Rancheria in Amador County, California. The site plan has changed slightly since the previously submitted study was approved. The proposed project is approximately 35 acres in size and consists of a casino building, parking garage and driveway access to Coal Mine Road. In this study, the pre-development condition is mentioned as the existing condition. The post-development condition is mentioned as the proposed condition.

B. Project Site

Location of Property

The proposed Flying Cloud Casino is located southeast of the intersection of Coal Mine Road and Buena Vista Road in Buena Vista. A Site Location Map and a Vicinity Map are provided as **Figures 1** and **2** in **Appendix A**. The project is located within Section 19, Township 5 North, Range 10 East, M.D.M., Amador County, California.

Description of Property

The existing site features several old shed and concrete building foundations with dirt roads and power lines crossing the site. Site vegetation consists of large oaks and other trees with a moderate growth of grasses and weeds. The general topography shows the high point of the site on the southern boundary, with contours sloping from south to north.

General Project Description and Proposed Land Use

The proposed site development consists of a casino building with an underground garage and a concrete parking structure. Perimeter retaining walls and site utilities including water, sanitary sewer and storm drain will also be included with the project.

C. Hydrology Methodology

Peak Storm Runoff

Peak storm runoff was estimated using the rational method described in Appendix A of the *Erosion & Sediment Control Guidelines for the Developing Areas of the Sierra 1981* (Guidelines, see **Appendix C**) acquired from Amador County Public Works. Peak storm runoff was estimated for the project site in the existing and proposed conditions.

The equation for the Rational Method is:

$$Q = CIA$$

Q = Peak Discharge [cfs]

C = Runoff Coefficient (from Table 1 in the Guidelines)

I = Average rainfall intensity [in/hr] for a duration equal to the time of concentration, T_c

A = Area [ac]

The time of concentration time (T_c) was calculated using the equation shown in the Guidelines:

$$T_C = \left(\frac{11.9L^3}{H}\right)^{0.38}$$

T_c = Time of Concentration Time [hr]

L = Length of longest watercourse through watershed [miles]

H = Elevation difference along longest watercourse [ft]

Per a phone conversation with Mr. Roger A. Stuart at Amador County Public Works, the minimum time of concentration used was 15 minutes.

The average rainfall intensity for the project site was determined as 20 inches based on the Average Annual Rainfall exhibit in the Guidelines. The 25- and 100-year average rainfall intensities were determined based on Figure 2 in the Guidelines using the obtained average annual rainfall and the T_c value.

Design Hydrographs

Design hydrographs were determined using the storm peak runoff calculated from the rational method described above, the time base of the hydrograph, T_b, and the time to peak of the hydrograph, T_p as outlined in the Guidelines. Using T_b and T_p and the peak flow, triangular hydrograph ordinates were determined. The equations for T_b and T_p are as follows:

$T_b = 2.67\ T_p$ and $T_p = 0.6\ T_c$

Where,

T_b = Time base of hydrograph [hr]

T_p = Time to peak of hydrograph [hr]

These oridinates were entered into the U.S. Army Corps of Engineers HEC-1 software. HEC-1 was used to route the runoff hydrographs through the wetland in the existing conditions model and the proposed underground storage and the wetland in the proposed condition model. The hydrology calculations for both the existing and proposed conditions are provided in **Appendix B**.

II. Existing Drainage Conditions

A. Existing Drainage Patterns

In existing conditions, surface runoff within the project site generally drains south to north. Runoff from the offsite and onsite watersheds follows the natural contours and is conveyed to two downstream discharge points: the existing wetlands located at the northwest corner of the project site, and the existing natural stream line along the northeast boundary of the project site.

Existing basins were delineated from USGS quadrangle topographic maps and available field survey data. **Table 1** provides a summary of the existing conditions runoff in the 25- and 100- year storm events. **Appendix A** provides the Existing Conditions Drainage Map and **Appendix B** provides the Rational Method calculations.

Table 1. Existing Conditions Runoff by Subbasin

Subbasin ID	Area [ac]	25-Year Storm [cfs]	100-Year Storm [cfs]
ON1E	22.3	18.7	21.1
ON2E	10.3	8.6	9.7
ON3E	2.7	2.3	2.6
OFF1	7.1	6.0	6.7
OFF2	19.5	16.4	18.4
OFF3	4.7	3.9	4.4
OFF4	4.7	3.9	4.4

The existing wetlands on the northwest corner of the property act as a detention basin. Basins OFF2, OFF3, and ON1E currently drain to the wetlands. The wetlands are drained by an existing 18-inch corrugated metal pipe (CMP) culvert conveying runoff from the property. Stage-storage-discharge calculations are provided in **Appendix B**.

III. Proposed Drainage Conditions

A. Proposed Drainage Pattern

The proposed drainage pattern of the onsite basins changes slightly from existing conditions. A portion of basin ON2E is included in ON4D and ON5D in the proposed condition and drain to CP2 rather than CP1. As a result, ON2D is substantially smaller than ON2E and the resulting discharge from the site at CP1 is less in proposed conditions than existing. With the exception of this, the proposed site design maintains existing drainage patterns.

B. Proposed Underground Detention System

To match post development runoff to existing conditions during the 100-year event, an underground storage system was designed to detain the increase in flows from the developed condition. Per ADS Technical Note 2.120, the Abt & Grigg Method was used to determine the detention storage required for the underground detention system. The Abt & Grigg method measures the difference between the runoff volume resulting from the rainfall event and the outflow capacity of the outlet. The calculations for the Abt & Grigg method can be found in **Appendix B**.

The underground detention system is made up of a network of high density polyethelene (HDPE) storm pipe. The network is interconnected and will have a single 12-inch outfall pipe. An orifice plate was added to the invert of the outfall pipe to detain the outflow from the detention basin. Once the basin fills to capacity an overflow pipe will be engaged to drain the excess. The outfall pipe connects to a water quality unit designed as a first flush device. The water quality unit has an internal network of velocity reducing weirs. The weir network will allow sediment, trash and oil to dissipate from the storm runoff. The discharge pipe of the water quality unit crosses north under the casino driveway and discharges onto existing ground. A riprap apron has been designed to reduce outlet velocities and protect against erosion. Supporting calculations can be found in **Appendix B.**

C. Hydraulic Analysis

Hydraulic analyses of proposed onsite storm drains were conducted using StormCAD. Three systems were modeled, the first originating at the southwest corner of the site, collects roof drainage from the casino, adjacent parking garage, and the onsite water/wastewater treatment plant. The second system originates in the northeast corner of the site and collects runoff from the casino roof, perimeter access road, and landscaped areas. Lastly, two drop inlets in the casino driveway prior to Coal Mine Road collect street runoff. All three systems drain to the proposed underground storage facility. Results of the StormCAD model are included in **Appendix B.**

There is an existing natural channel on the western boundary of the site that conveys runoff from the southwest north to the wetlands. A culvert has been designed to convey that runoff and the runoff from ON-7 under the entrance drive to the north. A riprap apron has been designed to reduce outlet velocities and protect against erosion. Calculations are included in **Appendix B.**

D. Proposed Runoff Summary

Table 2 provides a summary table of the proposed conditions runoff in the 25- and 100- year storm events. **Appendix A** provides the Proposed Conditions Drainage Map and **Appendix B** provides the Rational Method calculations.

Table 2. Proposed Conditions Runoff by Subbasin

Basin ID	Area [ac]	25-Year Storm [cfs]	100-Year Storm [cfs]
ON1D	15.6	13.1	14.8
ON2D	4.7	3.9	4.4
ON3D	2.6	2.2	2.5
ON4D	10	14.4	16.2
ON5D	1.3	1.4	1.6
ON6D	1.1	0.9	1.0
OFF1	7.1	6.0	6.7
OFF2	19.5	16.4	18.4
OFF3	4.7	3.9	4.4
OFF4	4.7	3.9	4.4

Additionally, a peak flow of 0.4 cfs of treated effluent will discharge to the proposed storm drain from the onsite water/wastewater treatment plant. **Table 3** provides a comparison of pre- vs. post-development runoff conditions.

Table 3. Pre- vs. Post-Development Runoff Comparison

Concentration Point	25-Year Storm			100-Year Storm		
	Existing	Proposed	Change	Existing	Proposed	Change
CP1	14.6	9.9	-4.7	16.4	11.2	-5.2
CP2A[1]	3	3	0	3	3	0
CP3	6.2	6.1	-0.1	7.0	6.2	-0.8

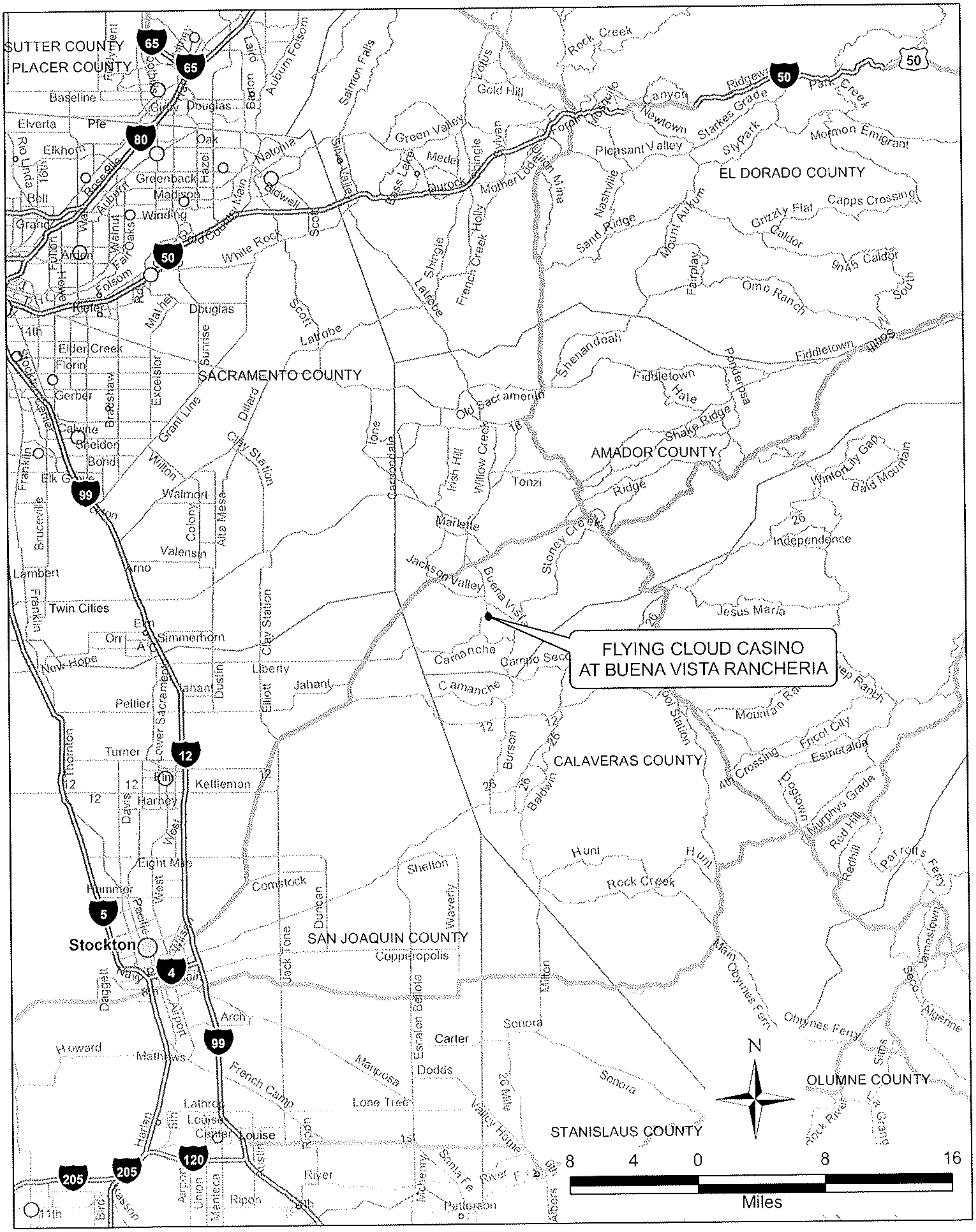
Concentration point CP2A is located downstream of CP2 at the northwest corner of the site. The discharge outfall point from the wetlands at this location is through the existing 18-inch storm drain. Although there is slightly more runoff going into the wetlands due to the proposed subbasin configurations, the wetland has more than enough capacity to accommodate the increase. Therefore, the amount of discharge from the site is not increased.

IV. Conclusion

The proposed Flying Cloud Casino at Buena Vista Rancheria site development meets the criteria of Amador County. Post-developed runoff does not exceed pre-developed conditions.

Appendix A
Figures

- Site Location Map
- Site Vicinity Map
- Offsite Drainage Map
- Existing Conditions Drainage Map
- Proposed Conditions Drainage Map



Kimley-Horn and Associates, Inc.

FIGURE 1: SITE LOCATION MAP

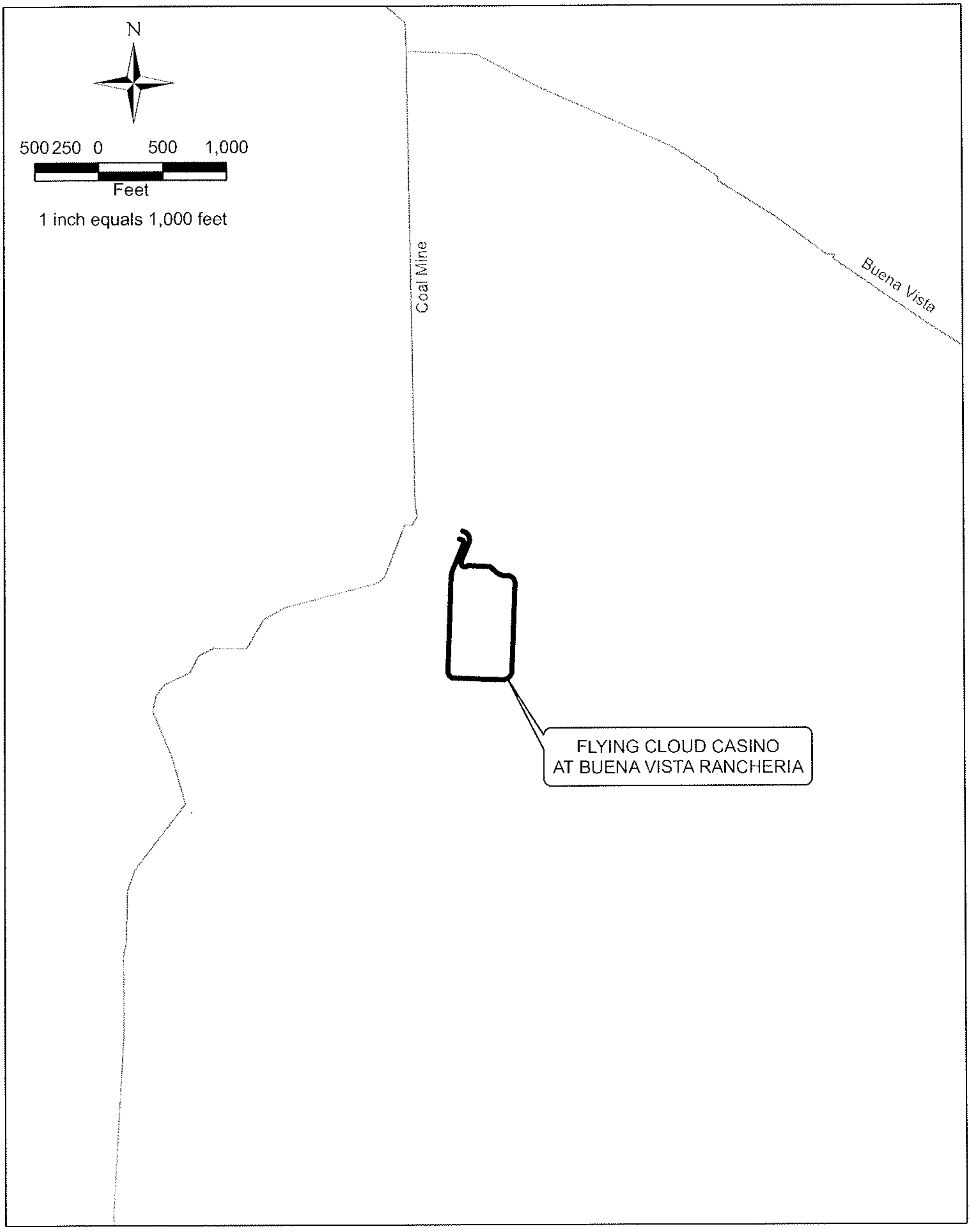


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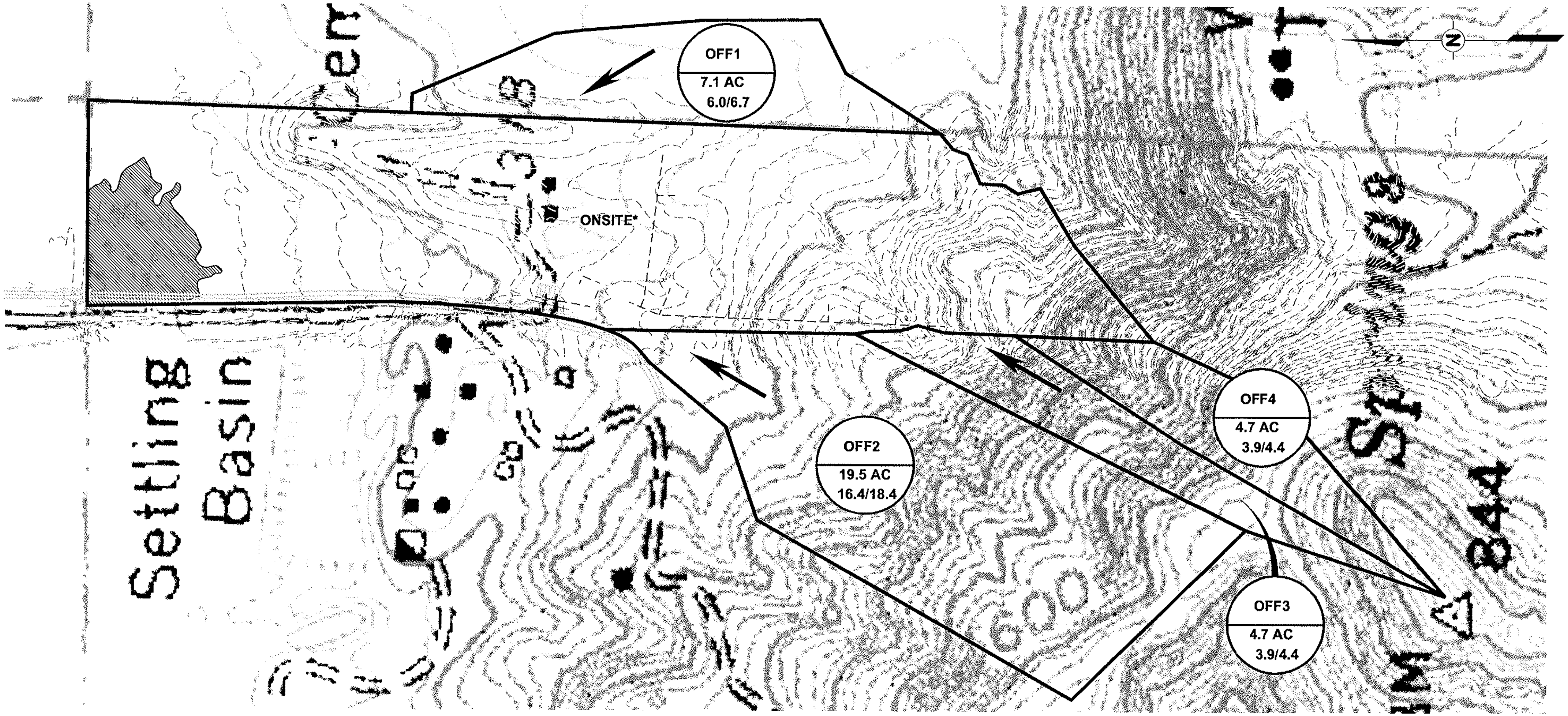
FIGURE 2: SITE VICINITY MAP



LEGEND

DIRECTION OF FLOW

BASIN BOUNDARY

OFF1 — BASIN NAME

7.1 AC — AREA

6.0/6.7 — Q_{25}(CFS)/Q_{100}(CFS)

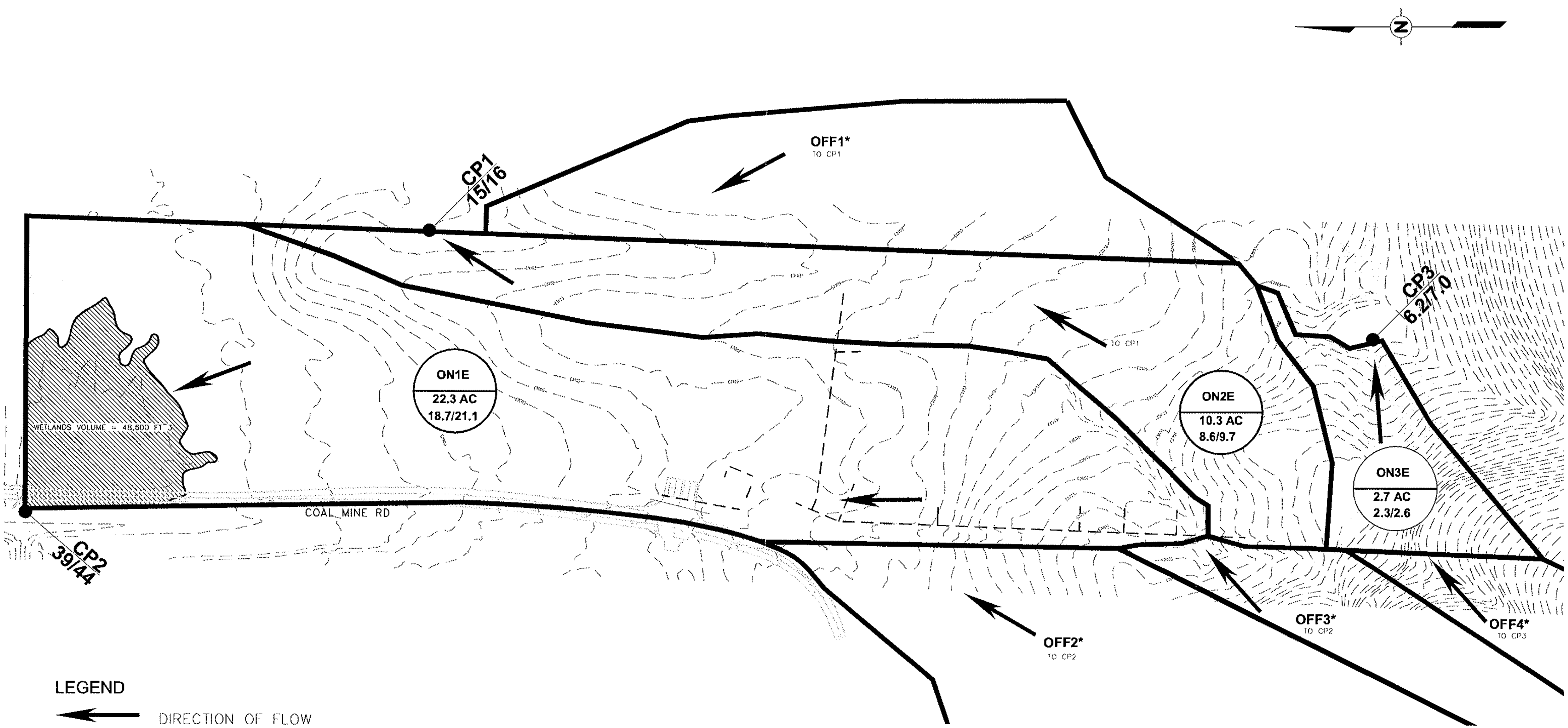
* REFERENCE THE ONSITE DRAINAGE MAPS (EXISTING/ PROPOSED CONDITIONS)

NOTE:
ATTENTION IS DRAWN TO THE FACT THAT THE SCALE OF THESE DRAWINGS MAY HAVE BEEN DISTORTED DURING REPRODUCTION PROCESSES

240 120 0 300
300 180 60 150

SCALE: 1" = 300'

FIGURE 3. OFFSITE DRAINAGE MAP



LEGEND

←	DIRECTION OF FLOW
—	BASIN BOUNDARY
ON1E / 22.3 AC / 18.7/21.1	BASIN NAME AREA Q_{25}(CFS)/Q_{100}(CFS)
● CP1 15/16	COMBINATION POINT Q_{25}(CFS)/Q_{100}(CFS)

* REFERENCE THE OFFSITE DRAINAGE BASIN MAP

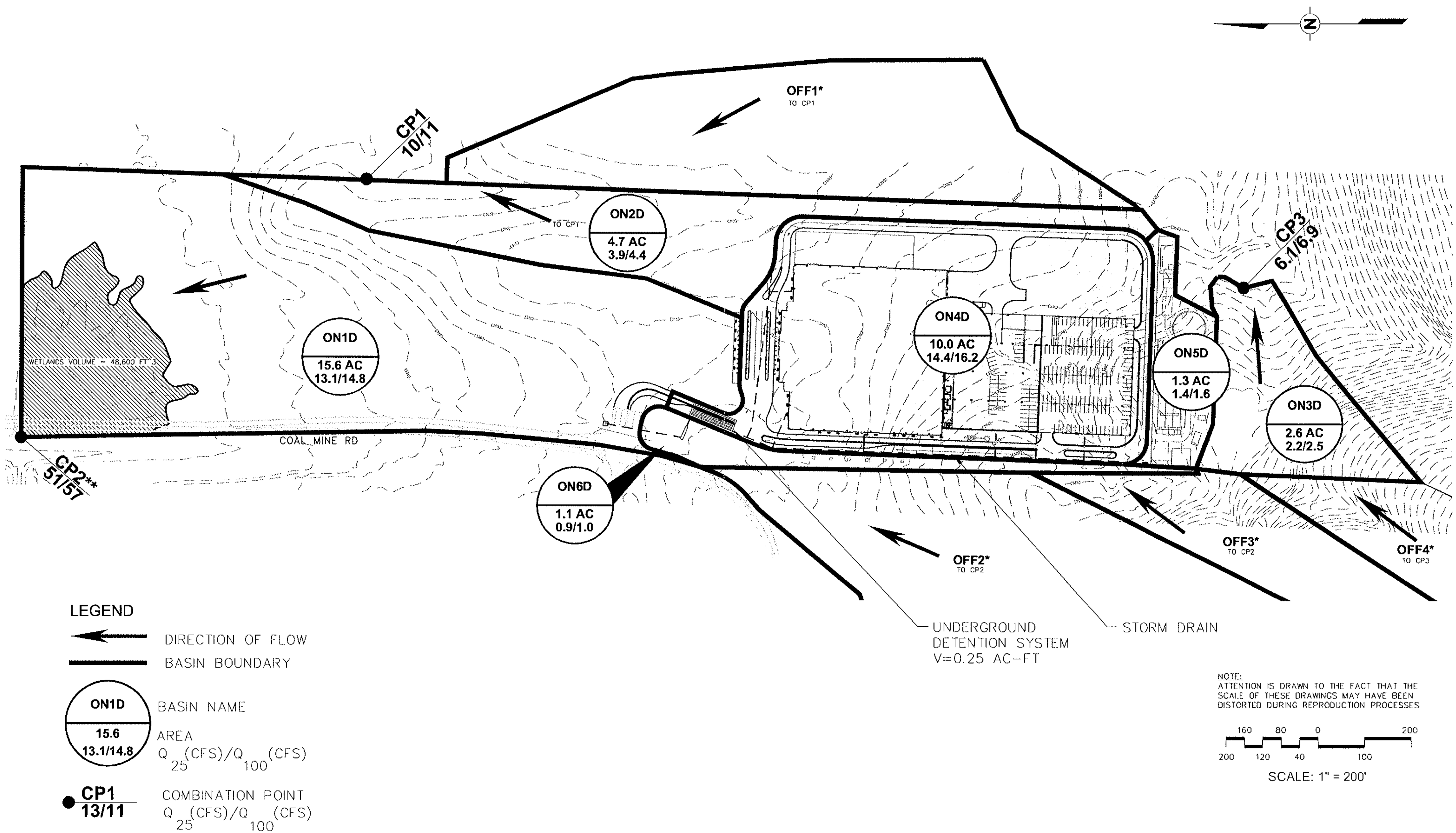
NOTE:
ATTENTION IS DRAWN TO THE FACT THAT THE SCALE OF THESE DRAWINGS MAY HAVE BEEN DISTORTED DURING REPRODUCTION PROCESSES

160 80 0 200
200 120 40 100

SCALE: 1" = 200'

FIGURE 4. EXISTING CONDITIONS DRAINAGE MAP

Kimley-Horn and Associates, Inc.



* REFERENCE THE OFFSITE DRAINAGE BASIN MAP

** INCLUDES 0.4 CFS TREATED EFFLUENT FROM CASINO SITE

FIGURE 5. PROPOSED CONDITIONS DRAINAGE MAP

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Path: K:\LAV_Civil\092467 Paul Steelman\011 Revised Buena Vista\Drainage\Reports\ADD2-update\Drawings\Basin exhibits.dwg / Xref: xGD-467011; xUTIL-467011; x-spots; x467004TP; xBM-467011; xVF-BVR-467011

Appendix B
Facility Design Calculations

- Hydrology - Rational Method
- Underground Detention
- HY-8 Culvert
- StormCAD Storm Drain

Hydrology - Rational Method

Kimley-Horn and Associates, Inc.

Project Name: Buena Vista
Project No: 092467004

Calculated By: TLK
Date: 6/22/06

Coefficient of Runoff

Existing Condition

DESIG:	SLOPE		SURFACE PERMEABILITY		VEGETATION		SURFACE		TOTAL C
OFF1	High	0.24	Moderate	0.07	Moderate	0.07	Low	0.05	0.43
OFF2	High	0.24	Moderate	0.07	Moderate	0.07	Low	0.05	0.43
OFF3	High	0.24	Moderate	0.07	Moderate	0.07	Low	0.05	0.43
OFF4	High	0.24	Moderate	0.07	Moderate	0.07	Low	0.05	0.43
ON1E	High	0.24	Moderate	0.07	Moderate	0.07	Low	0.05	0.43
ON2E	High	0.24	Moderate	0.07	Moderate	0.07	Low	0.05	0.43
ON3E	High	0.24	Moderate	0.07	Moderate	0.07	Low	0.05	0.43

References: Table 1 in Appendix A:Erosion & Sediment Control Guidelines for Developing Areas of the Sierras

Kimley-Horn and Associates, Inc.

Project Name: Buena Vista
Project No: 092467004

Calculated By: TLK
Date: 6/22/06

Rational Method

Existing Condition

Mean Annual Precipitation: **20 inches**

SUB-BASIN DATA			TIME OF CONCENTRATION			INTENSITY		RUNOFF		PEAK RATE	TIME BASE	STORM VOLUME	To CP2		
DESIG:	C (Table 1)	AREA Acre	L Mile	H ft	Tc Hr	I_{25} Inch/Hr	I_{100} Inch/Hr	Q_{25} cfs	Q_{100} cfs	Tp	Tb	V_D ft^3	STORM VOLUME V_D ac-ft	Q_{25} cfs	Q_{100} cfs
OFF1	0.43	7.1	0.30	59	0.13	1.95	2.20	6.0	6.7	0.15	0.40	4,842			
OFF2	0.43	19.5	0.35	317	0.08	1.95	2.20	16.4	18.4	0.15	0.40	13,298	0.3	16.4	18.4
OFF3	0.43	4.7	0.30	462	0.06	1.95	2.20	3.9	4.4	0.15	0.40	3,205	0.1	3.9	4.4
OFF4	0.43	4.7	0.30	460	0.06	1.95	2.20	3.9	4.4	0.15	0.40	3,205			
ON1E	0.43	22.3	0.40	113	0.15	1.95	2.20	18.7	21.1	0.15	0.40	15,208	0.3	18.7	21.1
ON2E	0.43	10.3	0.35	255	0.09	1.95	2.20	8.6	9.7	0.2	0.40	7,024			
ON3E	0.43	2.7	0.14	167	0.04	1.95	2.20	2.3	2.6	0.2	0.40	1,841			
Total		71.3						59.8	67.4			48,625	**0.7**	**39.0**	**44.0**

Tc = (11.9L^3/H)^0.385 Q = CIA Tp = 0.6 Tc Tb = 2.67 Tp V_D = 1800 (Q_{100} X Tb)

Notes: * If Tc is less than 15 minutes, use 15 minutes to estimate the intensities.

References: Erosion & Sediment Control Guidelines for Developing Areas of the Sierras

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Kimley-Horn and Associates, Inc.

Project Name: Buena Vista
Project No: 092467004

Calculated By: TDD
Date: 2/4/09

Coefficient of Runoff

Proposed Conditions

		UNIMPROVED										IMPROVED										TOTAL C
	AREA	% AREA	SLOPE		SURFACE		VEGETATION		SURFACE		TOTAL	ROOF		ASPHALT/CONCRETE		LANDSCAPED AREA		GRAVEL/ROADWAY		TOTAL		
BASIN	AC										C	% AREA	AREA	% AREA	AREA	% AREA	AREA	% AREA	AREA	AREA	C	
ON1D	15.60	100	High	0.24	Moderate	0.07	Moderate	0.07	Low	0.05	0.43									0.00	0.00	0.43
ON2D	4.70	100	High	0.24	Moderate	0.07	Moderate	0.07	Low	0.05	0.43									0.00	0.00	0.43
ON3D	2.60	100	High	0.24	Moderate	0.07	Moderate	0.07	Low	0.05	0.43									0.00	0.00	0.43
ON4D	10.00											51	5	26	3	23	2	0	0	10.00	0.74	0.74
ON5D	1.30											0	0	50	1	50	1	0	0	1.30	0.55	0.55
ON6D	1.10	100	High	0.24	Moderate	0.07	Moderate	0.07	Low	0.05	0.43									0.00	0.00	0.43
OFF1	7.10	100	High	0.24	Moderate	0.07	Moderate	0.07	Low	0.05	0.43									0.00	0.00	0.43
OFF2	19.50	100	High	0.24	Moderate	0.07	Moderate	0.07	Low	0.05	0.43									0.00	0.00	0.43
OFF3	4.70	100	High	0.24	Moderate	0.07	Moderate	0.07	Low	0.05	0.43									0.00	0.00	0.43
OFF4	4.70	100	High	0.24	Moderate	0.07	Moderate	0.07	Low	0.05	0.43									0.00	0.00	0.43

Improved "C"	
Roof	0.90
Asphalt/Concrete	0.85
Landscaped Area	0.25
Gravel Walks, Roadways	0.30

References: :Erosion & Sediment Control Guidelines for Developing Areas of the Sierras

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Kimley-Horn and Associates, Inc.

Project Name: Buena Vista
Project No: 092467004

Calculated By: TDD
Date: 2/4/09

Rational Method

Proposed Condition

SUB-BASIN DATA			TIME OF CONCENTRATION			INTENSITY		RUNOFF		PEAK RATE	TIME BASE	STORM VOLUME	To CP2**		
DESIG:	C (Table 1)	AREA Acre	L Mile	H ft	Tc* Hr	I_{25} Inch/Hr	I_{100} Inch/Hr	Q_{25} cfs	Q_{100} cfs	Tp	Tb	V_D ft^3	STORM VOLUME V_D ac-ft	Q_{25} cfs	Q_{100} cfs
ON1D	0.43	15.6	0.30	79.0	0.25	1.95	2.20	13.1	14.8	0.15	0.40	10,639	0.24	13.1	14.8
ON2D	0.43	4.7	0.17	53.0	0.25	1.95	2.20	3.9	4.4	0.15	0.40	3,205			
ON3D	0.43	2.6	0.11	171.0	0.25	1.95	2.20	2.2	2.5	0.15	0.40	1,773			
ON4D	0.74	10.0	0.21	54.0	0.25	1.95	2.20	14.4	16.2	0.15	0.40	11,697	0.27	14.4	16.2
ON5D	0.55	1.3	0.06	12.0	0.25	1.95	2.20	1.4	1.6	0.15	0.40	1,134	0.03	1.4	1.6
ON6D	0.43	1.1	0.23	92.0	0.25	1.95	2.20	0.9	1.0	0.15	0.40	750	0.02	0.9	1.0
OFF1	0.43	7.1	0.30	59	0.13	1.95	2.20	6.0	6.7	0.15	0.40	4,842			
OFF2	0.43	19.5	0.35	317	0.08	1.95	2.20	16.4	18.4	0.15	0.40	13,298	0.31	16	18.4
OFF3	0.43	4.7	0.30	462	0.06	1.95	2.20	3.9	4.4	0.15	0.40	3,205	0.07	3.9	4.4
OFF4	0.43	4.7	0.30	460	0.06	1.95	2.20	3.9	4.4	0.15	0.40	3,205			
Treated Effluent								0.4	0.4	0.15	0.40	288	0.01	0.4	0.4
Total		48.4						47.3	53.3			38,420	**0.70**	**37.4**	**42.1**

Tc = (11.9L^3/H)^0.385 Q = CIA Tp = 0.6 Tc Tb = 2.67 Tp V_D = 1800 (Q_{100} X Tb)

Notes:
* If Tc is less than 15 minutes, use 15 minutes to estimate the intensities.
** Areas ON4D, and ON5D drain to the proposed underground detention system prior to discharging to CP2

References: Erosion & Sediment Control Guidelines for Developing Areas of the Sierras

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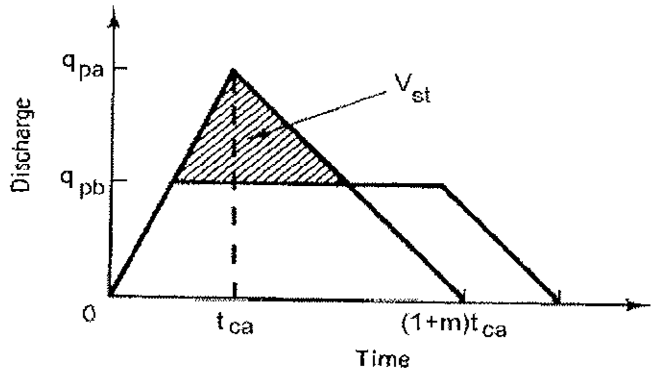
Underground Detention

Detention / Retention Pond Sizing
Abt & Grigg Method



$$V_{st} = 60\left(\frac{1+m}{2}\right)q_{pa}t_{ca}(1-\alpha)^2 \quad (5)$$

where V_{st} = storage volume required (ft^3)
m = ratio of hydrograph recession to time of peak (usually 1)
t_{ca} = after-development time of concentration (min)
q_{pa} = after-development peak discharge (ft^3/s)
$\alpha = q_{pb}/q_{pa}$
q_{pb} = outflow peak discharge (ft^3/s)

m =	1		
t_{ca} =	6	min	(Input)
q_{pa} =	18.2	cfs	(Input)
q_{pb} =	5.3	cfs	(Input)
α =	0.291		(Input)
V_{st} =	**3292**	**cf**	**(Storage Volume Required)**

Stormwater Detention System Worksheet

Project Buena Vista
Location
Engineer TLK
Date 6/22/2006

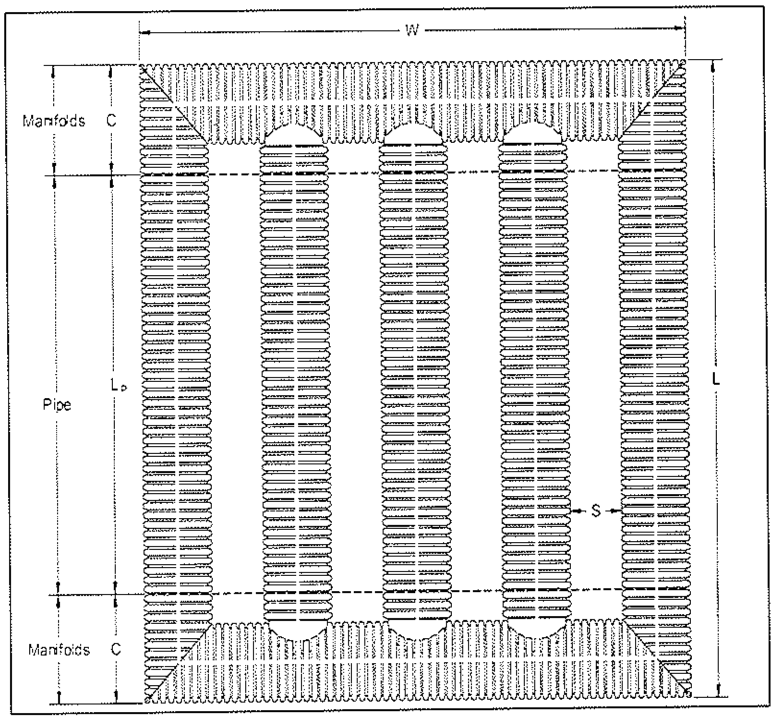
Pipe Dia. D (in)	Outside Dia. OD (ft)	C (ft)	Clr. Span S (ft)	Det. Area Factor (ft2/ft3)
12	1.20	1.75	1.10	2.86
15	1.46	2.00	1.07	2.07
18	1.77	2.36	1.19	1.66
24	2.32	2.97	1.57	1.23
30	2.93	4.04	2.23	1.05
36	3.48	4.52	2.09	0.79
42	3.98	5.44	2.92	0.65
42HC	3.90	4.95	2.10	0.64
48HC	4.39	5.45	2.11	0.53
60HC	5.46	5.91	2.87	0.43

1.) Design Storage Volume **Vst=** 4400 **ft3**

2.) Minimum Pipe Diameter to Satisfy Design **D=** 30 **in**

3.) Actual RAF for Selected Pipe Size **RAFact=** 0.64 **ft2/ft3**

Pipe OD= 2.93 **Clear span (S)=** 2.23 **C=** 4.04



A. If Width (W) Controls **Wmax=** 30 **ft**

Number of Pipe Runs Required (Npr): **Npr=** 6 **pipe runs**

Actual Width (Wact): **Wact=** 28.73 **ft**

System Length (L): **L=** 99 **ft**

Pipe Length Between Manifolds (Lp): **Lp=** 90 **ft**

Estimated Storage Provided **Vp=** 4833 **ft3**

Detention Surface Area Required (Ad): **Ad=** 2844 **ft2**

Vp must be greater than Vst OK? ___yes ___no

B. If Length (L) Controls **Lmax=** 100 **ft**

Number of Pipe Runs Required (Npr): **Npr=** 6 **pipe runs**

Actual Width (Wact): **Wact=** 28.73 **ft**

System Length (L): **L=** 98 **ft**

Pipe Length Between Manifolds (Lp): **Lp=** 89 **ft**

Estimated Storage Provided **Vp=** 4784 **ft3**

Detention Surface Area Required (Ad): **Ad=** 2815 **ft2**

Vp must be greater than Vst OK? ___yes ___no

1.) This worksheet is for estimations purposes only and should not take the place of a comprehensive engineering design.
2.) Estimated volumes are based on a flat detention system.

Hydrograph units

Tc [min]	15	Hydrograph formation from Erosion & Sediment Control Guidelines
Tp [min]	9	
Tb [min]	24.03	

	Existing Conditions		Proposed to Underground		Proposed to CP2	
	25-Year	100-Year	25-Year	100-Year	25-Year	100-Year
Qp [cfs]	39	44	15.8	17.8	34	38.7
Area [mi^2]	0.111	0.111	0.018	0.018	0.064	0.064
Time [min]	Q [cfs]	Q [cfs]	Q [cfs]	Q [cfs]	Q [cfs]	Q [cfs]
0	0.0	0.0	0.0	0.0	0.0	0.0
1	4.3	4.9	1.8	2.0	3.8	4.3
2	8.7	9.8	3.5	4.0	7.6	8.6
3	13.0	14.7	5.3	5.9	11.3	12.9
4	17.3	19.6	7.0	7.9	15.1	17.2
5	21.7	24.4	8.8	9.9	18.9	21.5
6	26.0	29.3	10.5	11.9	22.7	25.8
7	30.3	34.2	12.3	13.8	26.4	30.1
8	34.7	39.1	14.0	15.8	30.2	34.4
9	39.0	44.0	15.8	17.8	34.0	38.7
10	36.4	41.1	14.7	16.6	31.7	36.1
11	33.8	38.1	13.7	15.4	29.5	33.6
12	31.2	35.2	12.6	14.2	27.2	31.0
13	28.6	32.3	11.6	13.1	25.0	28.4
14	26.0	29.4	10.5	11.9	22.7	25.8
15	23.4	26.4	9.5	10.7	20.4	23.3
16	20.8	23.5	8.4	9.5	18.2	20.7
17	18.2	20.6	7.4	8.3	15.9	18.1
18	15.6	17.7	6.3	7.1	13.6	15.5
19	13.1	14.7	5.3	6.0	11.4	13.0
20	10.5	11.8	4.2	4.8	9.1	10.4
21	7.9	8.9	3.2	3.6	6.9	7.8
22	5.3	5.9	2.1	2.4	4.6	5.2
23	2.7	3.0	1.1	1.2	2.3	2.7
24	0.1	0.1	0.0	0.0	0.1	0.1

Stage-Storage-Discharge for Underground Storage

Orifice Coeff	0.63
Outlet Pipe Diameter [ft]	0.17
Weir Elevation [ft]	2.5
Weir Length [ft]	12.6
Weir Coeff	2.8

Elevation [SE]	Total Storage Volume	Σ Vol [SV]	Qpipe	Qweir	Outflow Q [SQ]
[ft]	[ft^3]	[ac-ft]	[cfs]	[cfs]	[cfs]
0.0	-	0	-	-	0.0
0.5	700	0.016	0.07	-	0.07
1.0	1,499	0.034	0.11	-	0.11
1.3	1,625	0.037	0.12	-	0.12
1.5	1,757	0.040	0.13	-	0.13
2.0	2,580	0.059	0.15	-	0.15
2.5	3,250	0.075	0.17	-	0.17
3.0	3,250	0.075	0.19	12.2	12.4
3.5	3,250	0.075	0.20	34.6	34.8
4.0	3,250	0.075	0.22	63.5	63.7
4.5	3,250	0.075	0.23	97.7	98.0
5.0	3,250	0.075	0.24	136.6	136.8
5.5	3,250	0.075	0.26	179.6	179.8
6.0	3,250	0.075	0.27	226.3	226.5
6.5	3,250	0.075	0.28	276.5	276.7
7.0	3,250	0.075	0.29	329.9	330.2
7.5	3,250	0.075	0.30	386.4	386.7
8.0	3,250	0.075	0.31	445.7	446.1
8.5	3,250	0.075	0.32	507.9	508.2
9.0	3,250	0.075	0.33	572.7	573.0

Detention Volume of Wetlands

Elevation [SE]	Total Storage Area	Total Storage Area	Average Area	Δ Elev	Vol	Σ Vol [SV]	Outflow Q [SQ]
[ft]	[ft^2]	[acre]	[acre]	[ft]	[ac-ft]	[ac-ft]	[cfs]
269	-	-				0	-
			0.75	1.0	0.75		
270	65,441	1.502				0.751	3
			1.93	0.5	0.97		
270.5	103,101	2.37				1.718	7

```
1***************************************                       ***************************************
 *                                     *                       *                                     *
 *   FLOOD HYDROGRAPH PACKAGE  (HEC-1)  *                      *   U.S. ARMY CORPS OF ENGINEERS      *
 *              JUN   1998              *                      *   HYDROLOGIC ENGINEERING CENTER     *
 *            VERSION 4.1               *                      *         609 SECOND STREET           *
 *                                      *                      *      DAVIS, CALIFORNIA 95616        *
 *  RUN DATE   06FEB09  TIME  14:31:13  *                      *          (916) 756-1104             *
 *                                      *                      *                                     *
 ****************************************                      ***************************************


                        X     X  XXXXXXX  XXXXX           X
                        X     X  X       X     X         XX
                        X     X  X       X                X
                        XXXXXXX  XXXX    X        XXXXX   X
                        X     X  X       X                X
                        X     X  X       X     X          X
                        X     X  XXXXXXX  XXXXX          XXX


          THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HEC1GS, HEC1DB, AND HEC1KW.

          THE DEFINITIONS OF VARIABLES -RTIMP- AND -RTIOR- HAVE CHANGED FROM THOSE USED WITH THE 1973-STYLE INPUT STRUCTURE.
          THE DEFINITION OF -AMSKK- ON RM-CARD WAS CHANGED WITH REVISIONS DATED 28 SEP 81. THIS IS THE FORTRAN77 VERSION
          NEW OPTIONS: DAMBREAK OUTFLOW SUBMERGENCE , SINGLE EVENT DAMAGE CALCULATION, DSS:WRITE STAGE FREQUENCY,
          DSS:READ TIME SERIES AT DESIRED CALCULATION INTERVAL   LOSS RATE:GREEN AND AMPT INFILTRATION
          KINEMATIC WAVE: NEW FINITE DIFFERENCE ALGORITHM

I                                         HEC-1 INPUT                                                  PAGE  1

          LINE        ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

            1         ID    Flying Cloud Casino at Buena Vista Rancheria
            2         ID    Hydrology for detention modeling
            3         ID    Existing Conditions, 25-year
            4         ID
                      *DIAGRAM
            5         IT       1              25
            6         IO       5

            7         KK   Exist
            8         KM   Subbasins draining to CP2, OFF2, OFF3, ON1E
            9         BA   0.111
           10         QI       0     4.3     8.7    13.0    17.3    21.7    26.0    30.3    34.7    39.0
           11         QI    36.4    33.8    31.2    28.6    26.0    23.4    20.8    18.2    15.6    13.1
           12         QI    10.5     7.9     5.3     2.7     0.1

           13         KK  WETLND
           14         KM   STORAGE ROUTING THROUGH WETLAND - DISCHARGE THROUGH EXISTING 18-INCH CMP
           15         RS       0    STOR       0
           16         SV       0    0.75    1.72
           17         SE     269     270   270.5
           18         SQ       0     3.4     6.5
           19         ZZ
1
             SCHEMATIC DIAGRAM OF STREAM NETWORK
 INPUT
  LINE      (V) ROUTING          (--->) DIVERSION OR PUMP FLOW

   NO.      (.) CONNECTOR        (<---) RETURN OF DIVERTED OR PUMPED FLOW

    7        Exist
                 V
                 V
   13       WETLND

 (***) RUNOFF ALSO COMPUTED AT THIS LOCATION
1***************************************                       ***************************************
 *                                     *                       *                                     *
 *   FLOOD HYDROGRAPH PACKAGE  (HEC-1)  *                      *   U.S. ARMY CORPS OF ENGINEERS      *
 *              JUN   1998              *                      *   HYDROLOGIC ENGINEERING CENTER     *
 *            VERSION 4.1               *                      *         609 SECOND STREET           *
 *                                      *                      *      DAVIS, CALIFORNIA 95616        *
 *  RUN DATE   06FEB09  TIME  14:31:13  *                      *          (916) 756-1104             *
 *                                      *                      *                                     *
 ****************************************                      ***************************************


                              Flying Cloud Casino at Buena Vista Rancheria
                              Hydrology for detention modeling
                              Existing Conditions, 25-year


   6 IO          OUTPUT CONTROL VARIABLES
                        IPRNT           5  PRINT CONTROL
                        IPLOT           0  PLOT CONTROL
                        QSCAL
```

```
     IT          HYDROGRAPH TIME DATA
                        NMIN           1  MINUTES IN COMPUTATION INTERVAL
                       IDATE      1    0  STARTING DATE
                       ITIME        0025  STARTING TIME
                          NQ         101  NUMBER OF HYDROGRAPH ORDINATES
                      NDDATE      1    0  ENDING DATE
                      NDTIME        0205  ENDING TIME
                       ICENT          19  CENTURY MARK

                COMPUTATION INTERVAL     .02 HOURS
                     TOTAL TIME BASE    1.67 HOURS

          ENGLISH UNITS
               DRAINAGE AREA          SQUARE MILES
               PRECIPITATION DEPTH    INCHES
               LENGTH, ELEVATION      FEET
               FLOW                   CUBIC FEET PER SECOND
               STORAGE VOLUME         ACRE-FEET
               SURFACE AREA           ACRES
               TEMPERATURE            DEGREES FAHRENHEIT
1
                                                                 RUNOFF SUMMARY
                                                          FLOW IN CUBIC FEET PER SECOND
                                                       TIME IN HOURS,  AREA IN SQUARE MILES

                                         PEAK    TIME OF      AVERAGE FLOW FOR MAXIMUM PERIOD       BASIN     MAXIMUM     TIME OF
             OPERATION      STATION      FLOW     PEAK                                              AREA       STAGE     MAX STAGE
+                                                               6-HOUR       24-HOUR      72-HOUR

             HYDROGRAPH AT
+                             Exist        39.      .15            5.            5.           5.      .11

             ROUTED TO
+                            WETLND         3.      .38            2.            2.           2.      .11
+                                                                                                              269.80         .38


 *** NORMAL END OF HEC-1 ***
```

```
1*****************************************                                          ***************************************
 *                                       *                                          *                                     *
 *   FLOOD HYDROGRAPH PACKAGE   (HEC-1)  *                                          *   U.S. ARMY CORPS OF ENGINEERS      *
 *              JUN   1998               *                                          *   HYDROLOGIC ENGINEERING CENTER     *
 *           VERSION 4.1                 *                                          *         609 SECOND STREET           *
 *                                       *                                          *      DAVIS, CALIFORNIA 95616        *
 * RUN DATE   06FEB09  TIME  14:31:45    *                                          *         (916) 756-1104              *
 *                                       *                                          *                                     *
 *****************************************                                          ***************************************


                    X     X  XXXXXXX   XXXXX          X
                    X     X  X        X     X        XX
                    X     X  X        X               X
                    XXXXXXX  XXXX     X        XXXXX  X
                    X     X  X        X               X
                    X     X  X        X     X         X
                    X     X  XXXXXXX   XXXXX         XXX


          THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HEC1GS, HEC1DB, AND HEC1KW.

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          NEW OPTIONS: DAMBREAK OUTFLOW SUBMERGENCE , SINGLE EVENT DAMAGE CALCULATION, DSS:WRITE STAGE FREQUENCY,
          DSS:READ TIME SERIES AT DESIRED CALCULATION INTERVAL   LOSS RATE:GREEN AND AMPT INFILTRATION
          KINEMATIC WAVE: NEW FINITE DIFFERENCE ALGORITHM
```

```
1                                                   HEC-1 INPUT                                                    PAGE  1

          LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

            1           ID    Flying Cloud Casino at Buena Vista Rancheria
            2           ID    Hydrology for detention modeling
            3           ID    Existing Conditions, 100-year
            4           ID
                        *DIAGRAM
            5           IT       1              25
            6           IO       5

            7           KK   Exist
            8           KM   Subbasins draining to CP2, OFF2, OFF3, ON1E
            9           BA   0.111
           10           QI       0     4.9     9.8    14.7    19.6    24.4    29.3    34.2    39.1    44.0
           11           QI    41.1    38.1    35.2    32.3    29.4    26.4    23.5    20.6    17.7    14.7
           12           QI    11.8     8.9     5.9     3.0     0.1

           13           KK  WETLND
           14           KM   STORAGE ROUTING THROUGH WETLAND - DISCHARGE THROUGH EXISTING 18-INCH CMP
           15           RS       0    STOR       0
           16           SV       0    0.75    1.72
           17           SE     269     270   270.5
           18           SQ       0     3.4     6.5
           19           ZZ
1
               SCHEMATIC DIAGRAM OF STREAM NETWORK
 INPUT
  LINE     (V) ROUTING         (--->) DIVERSION OR PUMP FLOW

   NO.     (.) CONNECTOR       (<---) RETURN OF DIVERTED OR PUMPED FLOW

    7       Exist
               V
               V
   13      WETLND

 (***) RUNOFF ALSO COMPUTED AT THIS LOCATION
```



```
1*****************************************                                          ***************************************
 *                                       *                                          *                                     *
 *   FLOOD HYDROGRAPH PACKAGE   (HEC-1)  *                                          *   U.S. ARMY CORPS OF ENGINEERS      *
 *              JUN   1998               *                                          *   HYDROLOGIC ENGINEERING CENTER     *
 *           VERSION 4.1                 *                                          *         609 SECOND STREET           *
 *                                       *                                          *      DAVIS, CALIFORNIA 95616        *
 * RUN DATE   06FEB09  TIME  14:31:45    *                                          *         (916) 756-1104              *
 *                                       *                                          *                                     *
 *****************************************                                          ***************************************
```



```
                              Flying Cloud Casino at Buena Vista Rancheria
                              Hydrology for detention modeling
                              Existing Conditions, 100-year


    6 IO          OUTPUT CONTROL VARIABLES
                         IPRNT          5  PRINT CONTROL
                         IPLOT          0  PLOT CONTROL
                         QSCAL         0.  HYDROGRAPH PLOT SCALE
```

```
 IT         HYDROGRAPH TIME DATA
                  NMIN          1  MINUTES IN COMPUTATION INTERVAL
                 IDATE     1    0  STARTING DATE
                 ITIME       0025  STARTING TIME
                    NQ        101  NUMBER OF HYDROGRAPH ORDINATES
                NDDATE     1    0  ENDING DATE
                NDTIME       0205  ENDING TIME
                 ICENT         19  CENTURY MARK

            COMPUTATION INTERVAL     .02 HOURS
                 TOTAL TIME BASE    1.67 HOURS

      ENGLISH UNITS
           DRAINAGE AREA          SQUARE MILES
           PRECIPITATION DEPTH    INCHES
           LENGTH, ELEVATION      FEET
           FLOW                   CUBIC FEET PER SECOND
           STORAGE VOLUME         ACRE-FEET
           SURFACE AREA           ACRES
           TEMPERATURE            DEGREES FAHRENHEIT
1
                                                  RUNOFF SUMMARY
                                           FLOW IN CUBIC FEET PER SECOND
                                        TIME IN HOURS,  AREA IN SQUARE MILES

                                      PEAK    TIME OF      AVERAGE FLOW FOR MAXIMUM PERIOD        BASIN     MAXIMUM     TIME OF
          OPERATION       STATION     FLOW     PEAK                                                AREA      STAGE     MAX STAGE
+                                                           6-HOUR       24-HOUR      72-HOUR

          HYDROGRAPH AT
+                           Exist      44.      .15            5.           5.           5.          .11

          ROUTED TO
+                          WETLND       3.      .38            2.           2.           2.          .11
+                                                                                                           269.90         .38


 *** NORMAL END OF HEC-1 ***
```

```
1****************************************                       **************************************
 *                                      *                       *                                    *
 *   FLOOD HYDROGRAPH PACKAGE  (HEC-1)  *                       *   U.S. ARMY CORPS OF ENGINEERS     *
 *             JUN   1998               *                       *   HYDROLOGIC ENGINEERING CENTER    *
 *             VERSION 4.1              *                       *        609 SECOND STREET           *
 *                                      *                       *     DAVIS, CALIFORNIA 95616        *
 *  RUN DATE   06FEB09  TIME  15:07:45  *                       *         (916) 756-1104             *
 *                                      *                       *                                    *
 ****************************************                       **************************************


                    X     X  XXXXXXX   XXXXX           X
                    X     X  X        X     X         XX
                    X     X  X        X                X
                    XXXXXXX  XXXX     X         XXXXX  X
                    X     X  X        X                X
                    X     X  X        X     X          X
                    X     X  XXXXXXX   XXXXX          XXX


     THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HEC1GS, HEC1DB, AND HEC1KW.

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     NEW OPTIONS: DAMBREAK OUTFLOW SUBMERGENCE , SINGLE EVENT DAMAGE CALCULATION, DSS:WRITE STAGE FREQUENCY,
     DSS:READ TIME SERIES AT DESIRED CALCULATION INTERVAL   LOSS RATE:GREEN AND AMPT INFILTRATION
     KINEMATIC WAVE: NEW FINITE DIFFERENCE ALGORITHM

1                                            HEC-1 INPUT                                            PAGE  1

         LINE        ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

            1        ID    Flying Cloud Casino at Buena Vista Rancheria
            2        ID    Hydrology for detention modeling
            3        ID    Proposed Conditions, 25-year
            4        ID
                     *DIAGRAM
            5        IT       1              25
            6        IO       5

            7        KK   Under
            8        KM   Subbasins draining to underground detention: ON4D and ON5D
            9        BA   0.018
           10        QI       0     1.8     3.6     5.4     7.2     9.0    10.8    12.6    14.4    16.2
           11        QI    15.1    14.0    13.0    11.9    10.8     9.7     8.7     7.6     6.5     5.4
           12        QI     4.3     3.3     2.2     1.1       0

           13        KK     DET
           14        KM   Underground detention routing
           15        RS       0    STOR       0
           16        SV       0   0.016   0.034   0.037   0.040   0.059   0.075   0.075   0.075
           17        SE       0     0.5     1.0    1.25     1.5     2.0     2.5     3.0     3.5
           18        SQ       0    0.07    0.11    0.12    0.13    0.15    0.17    12.4    34.8

           19        KK     SITE
           20        KM   Remainder of the site that drains to CP2 but doesn't go through the undergrou
           21        KM   detention system (Subbasins OFF3, OFF2, ON6D, and ON1D
           22        BA   0.064
           23        QI       0     3.8     7.6    11.3    15.1    18.9    22.7    26.4    30.2    34.0
           24        QI    31.7    29.5    27.2    25.0    22.7    20.4    18.2    15.9    13.6    11.4
           25        QI     9.1     6.9     4.6     2.3     0.1

           26        KK     CP2
           27        KM   Combine outflow from underground detention system with runoff from remainder
           28        KM   the site
           29        HC       2

           30        KK  WETLND
           31        KM   STORAGE ROUTING THROUGH WETLAND - DISCHARGE THROUGH EXISTING 18-INCH CMP
           32        RS       0    STOR       0
           33        SV       0    0.75    1.72
           34        SE     269     270   270.5
           35        SQ       0     3.2     6.0
           36        ZZ
1
              SCHEMATIC DIAGRAM OF STREAM NETWORK
 INPUT
  LINE      (V) ROUTING          (--->) DIVERSION OR PUMP FLOW

   NO.      (.) CONNECTOR        (<---) RETURN OF DIVERTED OR PUMPED FLOW

    7        Under
               V
               V
   13         DET
               .
               .
   19          .        SITE
               .           .
               .           .
```

```
   26         CP2............
                V
                V
   30      WETLND

 (***) RUNOFF ALSO COMPUTED AT THIS LOCATION
1****************************************
*                                       *
*   FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *
*              JUN   1998               *
*           VERSION 4.1                 *
*                                       *
*  RUN DATE   06FEB09  TIME  15:07:45   *
*                                       *
*****************************************

**************************************
*                                    *
*   U.S. ARMY CORPS OF ENGINEERS     *
*   HYDROLOGIC ENGINEERING CENTER    *
*       609 SECOND STREET            *
*     DAVIS, CALIFORNIA 95616        *
*         (916) 756-1104             *
*                                    *
**************************************


                     Flying Cloud Casino at Buena Vista Rancheria
                     Hydrology for detention modeling
                     Proposed Conditions, 25-year


   6 IO         OUTPUT CONTROL VARIABLES
                      IPRNT          5  PRINT CONTROL
                      IPLOT          0  PLOT CONTROL
                      QSCAL         0.  HYDROGRAPH PLOT SCALE

     IT         HYDROGRAPH TIME DATA
                       NMIN          1  MINUTES IN COMPUTATION INTERVAL
                      IDATE     1    0  STARTING DATE
                      ITIME       0025  STARTING TIME
                         NQ        101  NUMBER OF HYDROGRAPH ORDINATES
                     NDDATE     1    0  ENDING DATE
                     NDTIME       0205  ENDING TIME
                      ICENT         19  CENTURY MARK

                COMPUTATION INTERVAL     .02 HOURS
                     TOTAL TIME BASE    1.67 HOURS

        ENGLISH UNITS
             DRAINAGE AREA          SQUARE MILES
             PRECIPITATION DEPTH    INCHES
             LENGTH, ELEVATION      FEET
             FLOW                   CUBIC FEET PER SECOND
             STORAGE VOLUME         ACRE-FEET
             SURFACE AREA           ACRES
             TEMPERATURE            DEGREES FAHRENHEIT
1
                                        RUNOFF SUMMARY
                                  FLOW IN CUBIC FEET PER SECOND
                               TIME IN HOURS,  AREA IN SQUARE MILES
```

	OPERATION	STATION	PEAK FLOW	TIME OF PEAK	AVERAGE FLOW FOR MAXIMUM PERIOD 6-HOUR	24-HOUR	72-HOUR	BASIN AREA	MAXIMUM STAGE	TIME OF MAX STAGE
+										
	HYDROGRAPH AT									
+		Under	16.	.15	3.	3.	3.	.02		
	ROUTED TO									
+		DET	16.	.15	2.	2.	2.	.02		
+									3.07	.28
	HYDROGRAPH AT									
+		SITE	34.	.15	4.	4.	4.	.06		
	2 COMBINED AT									
+		CP2	50.	.15	6.	6.	6.	.08		
	ROUTED TO									
+		WETLND	3.	.38	2.	2.	2.	.08		
+									269.93	.38

```
 *** NORMAL END OF HEC-1 ***
```

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1***************************************                                                   ***************************************
 *                                     *                                                   *                                     *
 *   FLOOD HYDROGRAPH PACKAGE  (HEC-1)  *                                                  *   U.S. ARMY CORPS OF ENGINEERS      *
 *             JUN   1998               *                                                  *   HYDROLOGIC ENGINEERING CENTER     *
 *           VERSION 4.1                *                                                  *         609 SECOND STREET           *
 *                                      *                                                  *       DAVIS, CALIFORNIA 95616       *
 *  RUN DATE   06FEB09  TIME  15:09:52  *                                                  *         (916) 756-1104              *
 *                                      *                                                  *                                     *
 ***************************************                                                   ***************************************



                                                      X     X  XXXXXXX   XXXXX        X
                                                      X     X  X        X     X      XX
                                                      X     X  X        X             X
                                                      XXXXXXX  XXXX     X      XXXXX  X
                                                      X     X  X        X             X
                                                      X     X  X        X     X       X
                                                      X     X  XXXXXXX   XXXXX       XXX



          THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HEC1GS, HEC1DB, AND HEC1KW.

          THE DEFINITIONS OF VARIABLES -RTIMP- AND -RTIOR- HAVE CHANGED FROM THOSE USED WITH THE 1973-STYLE INPUT STRUCTURE.
          THE DEFINITION OF -AMSKK- ON RM-CARD WAS CHANGED WITH REVISIONS DATED 28 SEP 81. THIS IS THE FORTRAN77 VERSION
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          DSS:READ TIME SERIES AT DESIRED CALCULATION INTERVAL   LOSS RATE:GREEN AND AMPT INFILTRATION
          KINEMATIC WAVE: NEW FINITE DIFFERENCE ALGORITHM


1                                                          HEC-1 INPUT                                              PAGE  1

         LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

           1           ID     Flying Cloud Casino at Buena Vista Rancheria
           2           ID     Hydrology for detention modeling
           3           ID     Proposed Conditions, 100-year
           4           ID
                       *DIAGRAM
           5           IT       1              25
           6           IO       5

           7           KK    Under
           8           KM    Subbasins draining to underground detention: ON4D and ON5D
           9           BA    0.018
          10           QI       0      2.0     4.0     6.1     8.1    10.1    12.1    14.2    16.2    18.2
          11           QI     17.0    15.8    14.6    13.4    12.1    10.9     9.7     8.5     7.3     6.1
          12           QI      4.9     3.7     2.5     1.2     0.0

          13           KK      DET
          14           KM    Underground detention routing
          15           RS       0     STOR       0
          16           SV       0    0.016   0.034   0.037   0.040   0.059   0.075   0.075   0.075
          17           SE       0      0.5     1.0    1.25     1.5     2.0     2.5     3.0     3.5
          18           SQ       0     0.07    0.11    0.12    0.13    0.15    0.17    12.4    34.8

          19           KK      SITE
          20           KM    Remainder of the site that drains to CP2 but doesn't go through the undergrou
          21           KM    detention system (Subbasins OFF3, OFF2, ON6D, and ON1D
          22           BA    0.064
          23           QI       0      4.3     8.6    12.9    17.2    21.5    25.8    30.1    34.4    38.7
          24           QI     36.1    33.6    31.0    28.4    25.8    23.3    20.7    18.1    15.5    13.0
          25           QI     10.4     7.8     5.2     2.7     0.1

          26           KK      CP2
          27           KM    Combine outflow from underground detention system with runoff from remainder
          28           KM    the site
          29           HC       2

          30           KK   WETLND
          31           KM    STORAGE ROUTING THROUGH WETLAND - DISCHARGE THROUGH EXISTING 18-INCH CMP
          32           RS       0     STOR       0
          33           SV       0     0.75    1.72
          34           SE     269      270   270.5
          35           SQ       0      3.2     6.0
          36           ZZ
1
              SCHEMATIC DIAGRAM OF STREAM NETWORK
 INPUT
  LINE      (V) ROUTING          (--->) DIVERSION OR PUMP FLOW

   NO.      (.) CONNECTOR        (<---) RETURN OF DIVERTED OR PUMPED FLOW

    7        Under
               V
               V
   13         DET
               .
               .
   19          .           SITE
               .              .
               .              .
```

```
   26         CP2............
                V
                V
   30       WETLND

 (***) RUNOFF ALSO COMPUTED AT THIS LOCATION
1****************************************                              *************************************
*                                       *                              *                                   *
*   FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *                              *   U.S. ARMY CORPS OF ENGINEERS    *
*             JUN   1998                *                              *   HYDROLOGIC ENGINEERING CENTER   *
*           VERSION 4.1                 *                              *        609 SECOND STREET          *
*                                       *                              *      DAVIS, CALIFORNIA 95616      *
* RUN DATE   06FEB09  TIME  15:09:52    *                              *          (916) 756-1104           *
*                                       *                              *                                   *
****************************************                               *************************************


                    Flying Cloud Casino at Buena Vista Rancheria
                    Hydrology for detention modeling
                    Proposed Conditions, 100-year

  6 IO          OUTPUT CONTROL VARIABLES
                      IPRNT           5  PRINT CONTROL
                      IPLOT           0  PLOT CONTROL
                      QSCAL          0.  HYDROGRAPH PLOT SCALE

   IT           HYDROGRAPH TIME DATA
                       NMIN           1  MINUTES IN COMPUTATION INTERVAL
                      IDATE      1    0  STARTING DATE
                      ITIME        0025  STARTING TIME
                         NQ         101  NUMBER OF HYDROGRAPH ORDINATES
                     NDDATE      1    0  ENDING DATE
                     NDTIME        0205  ENDING TIME
                      ICENT          19  CENTURY MARK

                  COMPUTATION INTERVAL     .02 HOURS
                       TOTAL TIME BASE    1.67 HOURS

      ENGLISH UNITS
           DRAINAGE AREA           SQUARE MILES
           PRECIPITATION DEPTH     INCHES
           LENGTH, ELEVATION       FEET
           FLOW                    CUBIC FEET PER SECOND
           STORAGE VOLUME          ACRE-FEET
           SURFACE AREA            ACRES
           TEMPERATURE             DEGREES FAHRENHEIT
1
```

RUNOFF SUMMARY
FLOW IN CUBIC FEET PER SECOND
TIME IN HOURS, AREA IN SQUARE MILES

	OPERATION	STATION	PEAK FLOW	TIME OF PEAK	AVERAGE FLOW FOR MAXIMUM PERIOD 6-HOUR	24-HOUR	72-HOUR	BASIN AREA	MAXIMUM STAGE	TIME OF MAX STAGE
+	HYDROGRAPH AT	Under	18.	.15	3.	3.	3.	.02		
+	ROUTED TO	DET	18.	.15	3.	3.	3.	.02		
+									3.20	.15
+	HYDROGRAPH AT	SITE	39.	.15	5.	5.	5.	.06		
+	2 COMBINED AT	CP2	57.	.15	7.	7.	7.	.08		
+	ROUTED TO	WETLND	3.	.38	3.	3.	3.	.08		
+									270.03	.38

*** NORMAL END OF HEC-1 ***

HY-8 Culvert

Table 1 - Summary of Culvert Flows at Crossing: Driveway Crossing

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert 1 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
310.43	1.00	1.00	0.00	1
310.84	3.90	3.90	0.00	1
311.12	6.80	6.80	0.00	1
311.35	9.70	9.70	0.00	1
311.57	12.60	12.60	0.00	1
311.79	15.50	15.50	0.00	1
311.99	18.40	18.40	0.00	1
312.16	21.00	21.00	0.00	1
312.35	24.20	24.20	0.00	1
312.53	27.10	27.10	0.00	1
312.69	30.00	30.00	0.00	1
314.00	50.08	50.08	0.00	Overtopping

Table 2 - Culvert Summary Table: Culvert 1

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
1.00	1.00	310.43	0.425	0.000	1-S2n	0.288	0.306	0.288	0.208	2.723	3.841
3.90	3.90	310.84	0.842	0.000	1-S2n	0.557	0.614	0.563	0.347	4.208	5.398
6.80	6.80	311.12	1.119	0.000	1-S2n	0.734	0.809	0.739	0.427	4.977	6.203
9.70	9.70	311.35	1.354	0.000	1-S2n	0.895	0.977	0.896	0.488	5.472	6.779
12.60	12.60	311.57	1.570	0.000	1-S2n	1.020	1.121	1.021	0.539	5.922	7.237
15.50	15.50	311.79	1.790	0.000	1-S2n	1.143	1.252	1.151	0.582	6.202	7.622
18.40	18.40	311.99	1.991	0.000	1-S2n	1.258	1.366	1.265	0.621	6.489	7.956
21.00	21.00	312.16	2.159	0.000	1-S2n	1.353	1.470	1.360	0.652	6.740	8.223
24.20	24.20	312.35	2.355	0.000	1-S2n	1.471	1.580	1.473	0.688	7.004	8.520
27.10	27.10	312.53	2.526	0.000	1-S2n	1.574	1.676	1.575	0.718	7.210	8.765
30.00	30.00	312.69	2.694	0.000	1-S2n	1.675	1.772	1.681	0.746	7.364	8.990

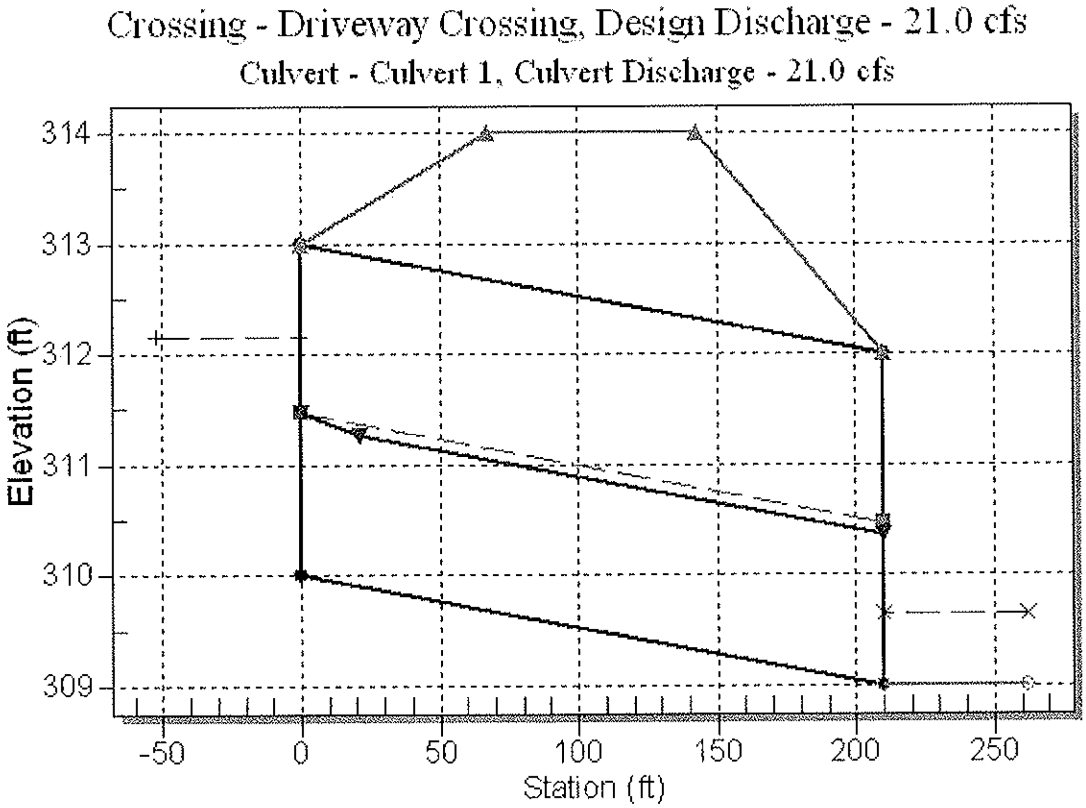
****

Inlet Elevation (invert): 310.00 ft, Outlet Elevation (invert): 309.00 ft

Culvert Length: 210.00 ft, Culvert Slope: 0.0048

****

Water Surface Profile Plot for Culvert: Culvert 1



Site Data - Culvert 1

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 310.00 ft

Outlet Station: 210.00 ft

Outlet Elevation: 309.00 ft

Number of Barrels: 1

Culvert Data Summary - Culvert 1

Barrel Shape: Circular

Barrel Diameter: 3.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Inlet Type: Conventional

Inlet Edge Condition: Square Edge with Headwall

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: Driveway Crossing)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
1.00	309.21	0.21	3.84	1.62	2.10
3.90	309.35	0.35	5.40	2.71	2.28
6.80	309.43	0.43	6.20	3.33	2.36
9.70	309.49	0.49	6.78	3.81	2.42
12.60	309.54	0.54	7.24	4.20	2.46
15.50	309.58	0.58	7.62	4.54	2.49
18.40	309.62	0.62	7.96	4.84	2.52
21.00	309.65	0.65	8.22	5.09	2.54
24.20	309.69	0.69	8.52	5.37	2.56
27.10	309.72	0.72	8.76	5.60	2.58
30.00	309.75	0.75	8.99	5.82	2.59

Tailwater Channel Data - Driveway Crossing

Tailwater Channel Option: Triangular Channel

Side Slope (H:V): 6.00 (_:1)

Channel Slope: 0.1250

Channel Manning's n: 0.0300

Channel Invert Elevation: 309.00 ft

Roadway Data for Crossing: Driveway Crossing

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 100.00 ft

Crest Elevation: 314.00 ft

Roadway Surface: Paved

Roadway Top Width: 75.00 ft

Kimley-Horn
and Associates, Inc.

Project	***BUENA VISTA CASINO***				
Subject	***RIP-RAP CALCULATION***				
Designed by	***TDD***	*Date*	***February 04, 2009***	*Job No.*	***92467004***
Checked by		*Date*		*Sheet No.*	1 of 2

CIRCULAR CULVERT:

$$\frac{\left(\frac{d_{50}}{D}\right)\left(\frac{y_t}{D}\right)^{1.2}}{\left(\frac{Q}{D^{2.5}}\right)} = 0.023$$

REF: Eq. 760 CCRFCD MANUAL

UNDERGROUND DETENTION OUTLET:

X =	d_{50}	=	rip rap size
3 =	D	=	diameter of pipe (ft)
0.50 =	$\frac{Y_t}{D}$	=	tailwater/diameter
21 =	Q	=	flow rate (cfs)

d_{50} = 0.21 ft = 2.56 inch rock **USE: 6-INCH ROCK**

Kimley-Horn
and Associates, Inc.

Project	***BUENA VISTA***				
Subject	***RIP_RAP CALCULATION***				
Designed by	***TDD***	*Date*	***February 04, 2009***	*Job No.*	***92467004***
Checked by		*Date*		*Sheet No.*	2 *of* 2

RIP-RAP PAD SIZE: UNDERGROUND DETENTION OUTLET

$$L = \left(\frac{1}{2\tan\alpha}\right)\left(\frac{A_t}{Y_t - W}\right)$$

REF: Eq. 764 CCRFCD MANUAL

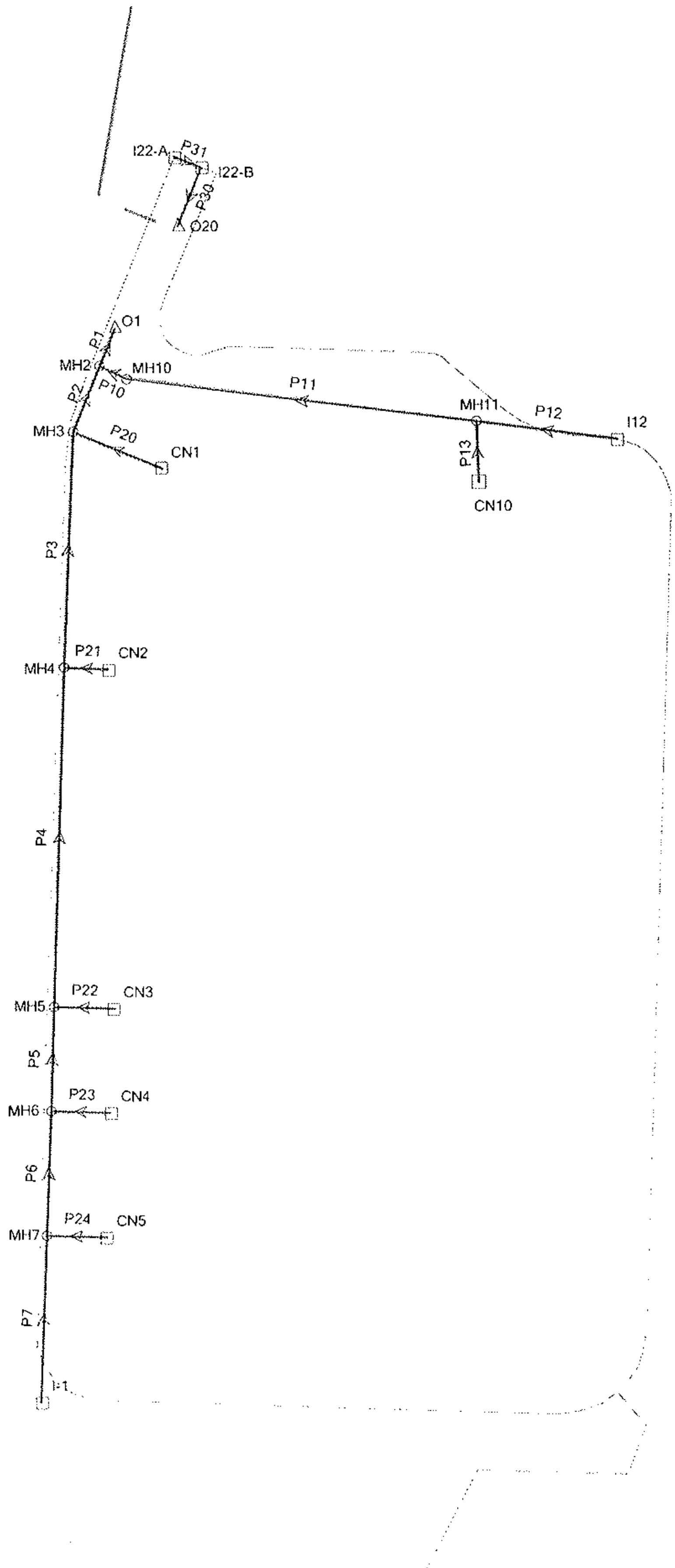
	L	=	length of protection (ft)
1.00 =	W	=	width/diameter outlet (ft)
0.50 =	Y_t	=	tailwater (ft)
1.20 =	1/(2tanX)	=	expansion angle of the culvert flow (see figure 714 or 715 in the CCRFCD)
2.63 =	A_t	=	Q/V
21.00 =	Q	=	design discharge (cfs)
8.00 =	V	=	allowable non-eroding velocity in the downstream channel (fps)

L= 5.10 ft

WILL USE 6 ft x 6 ft PAD

StormCAD Storm Drain

Scenario: Base



Title: Flying Cloud Casino at Buena Vista Rancheria
k:\...\calculations\stormcad\flyingcloud_sd.stm
02/06/09 01:10:32 PM© Bentley Systems, Inc. Haestad Methods Solution Center Watertown, CT 06795 USA +1-203-755-1666

Project Engineer: Laurie Marin
StormCAD v5.6 [05.06.012.00]

Scenario: Base

Pipe Summary Table

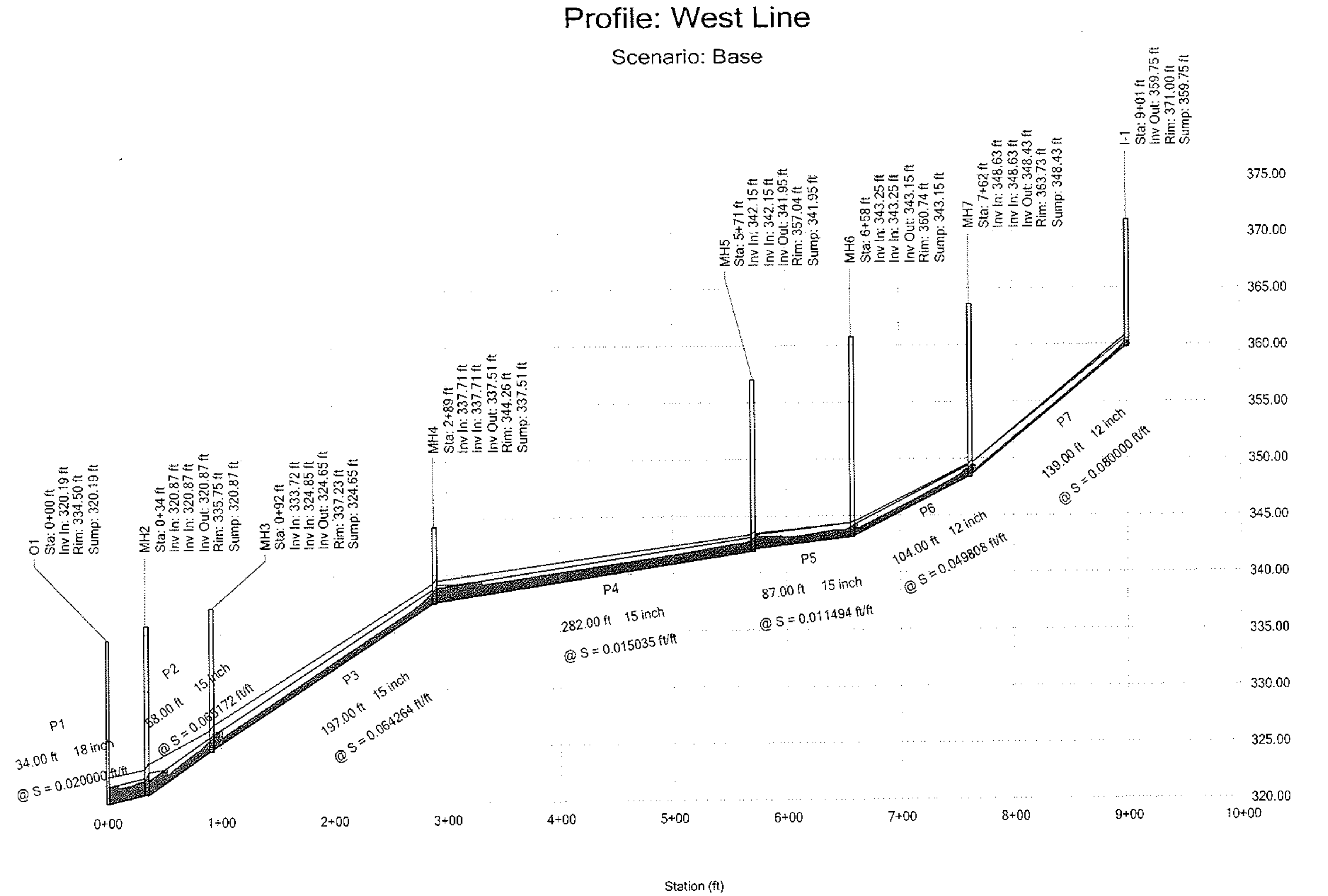
Label	Total System Flow (cfs)	Full Capacity (cfs)	Upstream Node	Downstream Node	Length (ft)	Constructed Slope (ft/ft)	Section Size	Upstream Invert Elevation (ft)	Downstream Invert Elevation (ft)	Upstream Ground Elevation (ft)	Downstream Ground Elevation (ft)	Upstream Cover (ft)	Downstream Cover (ft)	Hydraulic Grade Line In (ft)	Hydraulic Grade Line Out (ft)
P1	12.60	14.85	MH2	O1	34.00	0.020000	18 inch	320.87	320.19	335.75	334.50	13.38	12.81	322.21	321.69
P2	8.30	16.49	MH3	MH2	58.00	0.065172	15 inch	324.65	320.87	337.23	335.75	11.33	13.63	325.78	322.92
P3	7.40	16.37	MH4	MH3	197.00	0.064264	15 inch	337.51	324.85	344.26	337.23	5.50	11.13	338.59	326.41
P4	5.90	7.92	MH5	MH4	282.00	0.015035	15 inch	341.95	337.71	357.04	344.26	13.84	5.30	342.93	339.13
P5	4.30	6.93	MH6	MH5	87.00	0.011494	15 inch	343.15	342.15	360.74	357.04	16.34	13.64	343.99	343.34
P6	3.30	7.95	MH7	MH6	104.00	0.049808	12 inch	348.43	343.25	363.73	360.74	14.30	16.49	349.21	344.29
P7	1.80	10.08	I-1	MH7	139.00	0.080000	12 inch	359.75	348.63	371.00	363.73	10.25	14.10	360.32	349.52
P10	4.30	4.39	MH10	MH2	25.00	0.015200	12 inch	321.25	320.87	337.86	335.75	15.61	13.88	323.28	322.92
P11	4.30	5.03	MH11	MH10	292.00	0.019932	12 inch	327.27	321.45	340.65	337.86	12.38	15.41	328.14	323.28
P12	1.90	5.05	I12	MH11	117.00	0.020085	12 inch	329.62	327.27	334.20	340.65	3.58	12.38	330.21	328.58
P13	2.40	40.71	CN10	MH11	50.00	0.150200	18 inch	334.78	327.27	344.50	340.65	8.22	11.88	335.37	328.58
P20	0.90	7.97	CN1	MH3	80.00	0.050000	12 inch	337.72	333.72	342.00	337.23	3.28	2.51	338.12	333.95
P21	1.50	13.80	CN2	MH4	36.00	0.150000	12 inch	343.11	337.71	345.00	344.26	0.89	5.55	343.63	339.13
P22	1.60	13.80	CN3	MH5	50.00	0.150000	12 inch	349.65	342.15	358.50	357.04	7.85	13.89	350.19	343.34
P23	1.00	13.80	CN4	MH6	50.00	0.150000	12 inch	350.75	343.25	362.00	360.74	10.25	16.49	351.17	344.29
P24	1.50	13.80	CN5	MH7	50.00	0.150000	12 inch	356.13	348.63	365.00	363.73	7.87	14.10	356.65	349.52
P30	2.80	4.79	I22-B	O20	52.00	0.018077	12 inch	321.13	320.19	325.51	332.00	3.38	10.81	321.85	321.19
P31	1.40	5.15	I22-A	I22-B	23.00	0.020870	12 inch	321.61	321.13	324.61	325.51	2.00	3.38	322.11	322.12

Scenario: Base

Node Summary Table

Label	Additional Flow (cfs)	Known Flow (cfs)	Total System Flow (cfs)	Ground Elevation (ft)	Sump Elevation (ft)	Rim Elevation (ft)	Hydraulic Grade Line In (ft)	Hydraulic Grade Line Out (ft)
CN1	0.00	0.90	0.90	342.00	337.72	342.00	338.12	338.12
CN2	0.00	1.50	1.50	345.00	343.11	345.00	343.63	343.63
CN3	0.00	1.60	1.60	358.50	349.65	358.50	350.19	350.19
CN4	0.00	1.00	1.00	362.00	350.75	362.00	351.17	351.17
CN5	0.00	1.50	1.50	365.00	356.13	365.00	356.65	356.65
CN10	0.00	2.40	2.40	344.50	334.78	344.50	335.37	335.37
I-1	0.00	1.80	1.80	371.00	359.75	371.00	360.32	360.32
I12	0.00	1.90	1.90	334.20	329.62	334.20	330.21	330.21
I22-A	0.00	1.40	1.40	324.61	321.61	324.61	322.11	322.11
I22-B	1.40	0.00	2.80	325.51	321.13	325.51	322.12	321.85
MH2			12.60	335.75	320.87	335.75	322.92	322.21
MH3			8.30	337.23	324.65	337.23	326.41	325.78
MH4			7.40	344.26	337.51	344.26	339.13	338.59
MH5			5.90	357.04	341.95	357.04	343.34	342.93
MH6			4.30	360.74	343.15	360.74	344.29	343.99
MH7			3.30	363.73	348.43	363.73	349.52	349.21
MH10			4.30	337.86	321.25	337.86	323.28	323.28
MH11			4.30	340.65	327.27	340.65	328.58	328.14
O1			12.60	334.50	320.19	334.50	320.19	320.19
O20			2.80	332.00	320.19	332.00	320.19	320.19

Profile
Scenario: Base



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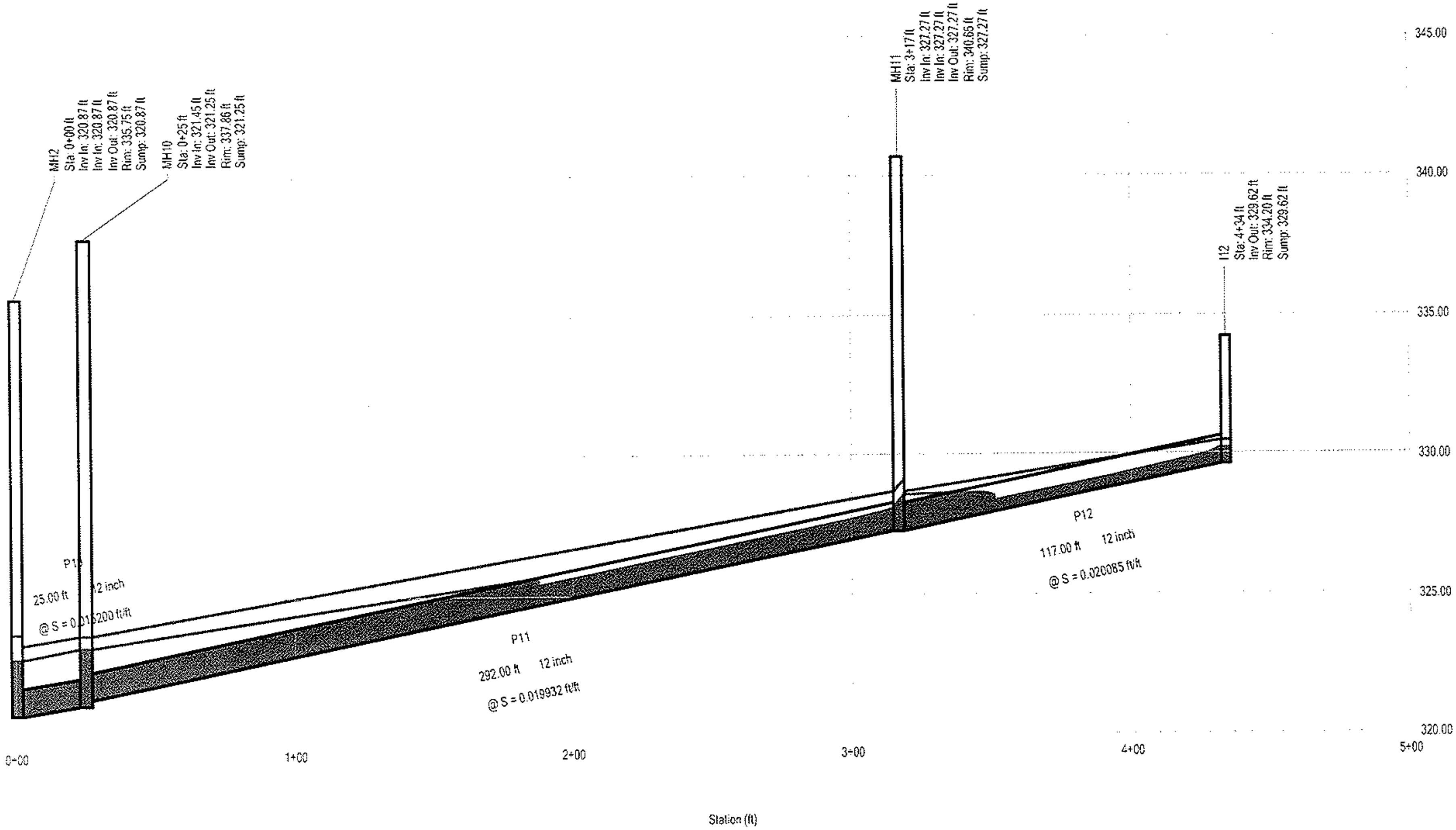
02/06/09 09:55:35 AM

Project Engineer: Laurie Marin
StormCAD v5.6 [05.06.012.00]

Profile
Scenario: Base

Profile: North Line
Scenario: Base

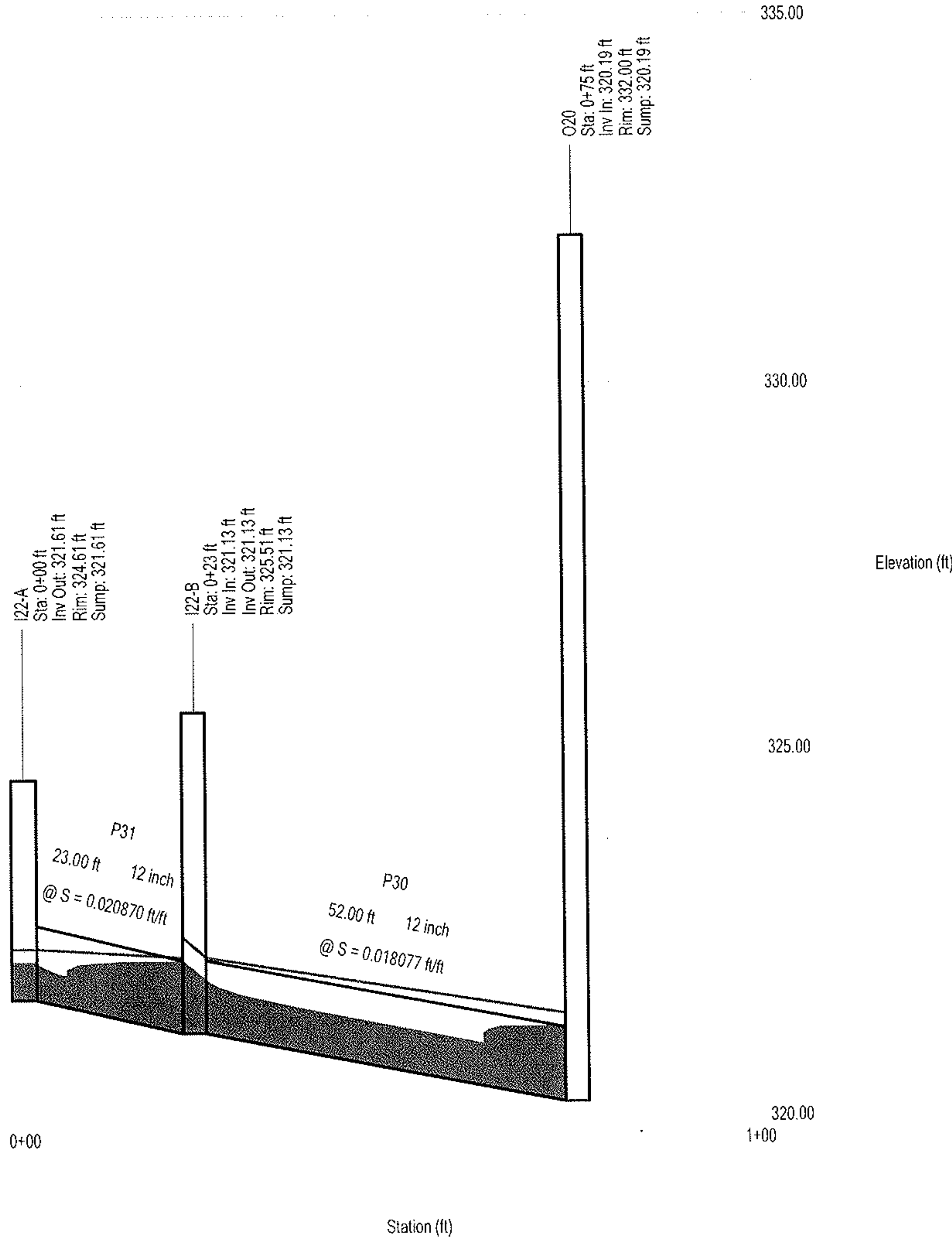


Title: Flying Cloud Casino at Buena Vista Rancheria
k:\...\calculations\stormcad\flyingcloud_sd.stm
02/06/09 09:57:41 AM

Project Engineer: Laurie Marin
StormCAD v5.6 [05.06.012.00]

Profile: Driveway Line

Scenario: Base



Appendix C
Reference Materials

- Erosion & Sediment Control Guidelines for the Developing Areas of the Sierras
- Technical Note 2.120, ADS Corporation

Erosion & Sediment Control Guidelines for the Developing Areas of the Sierras

COUNTY

Erosion & Sediment Control Guidelines for Developing Areas of the Sierras

Local offices: Jackson (209) 223-1846
Auburn (530) 823-5687

Prepared by the High Sierra RC&D Council

November 1981

A. Calculations for Peak Storm Runoff and Storm Runoff Volume

For sizing the components of various erosion control practices it is necessary to determine the peak runoff flow and the storm runoff volume. The Rational Method is used for calculating the peak storm runoff rate. An estimate of the runoff volume from the peak storm is made using the Triangular Hydrograph Method.

The rational method and the triangular hydrograph method are widely used and provide acceptable design flows for a large variety of applications.

The use of these methods should be limited to small watershed areas. It is anticipated that these methods will be used for watersheds less than one square mile in area. For areas greater than one square mile use SCS methods given in Appendix B.

Storm Runoff Rate by Rational Method

The basic equation in the rational formula is:

$$Q = C\ I\ A$$

Where
- Q = Peak Discharge, cubic feet per second
- C = Coefficient of runoff
- I = Average rainfall intensity, inches per hour for a given frequency and for a duration equal to the time of concentration (T_C)
- A = Drainage Area, acres

Peak Storm Runoff-The following procedure is used to calculate the peak storm runoff rate.

1. Using Figure 1 locate the project site with a section township and range description. Find the mean annual precipitation from the closest isohyetal contour.

2. Calculate the time of concentration (T_C)

   Using the following equation:[1]

   $$Tc = \cancel{\left(\frac{11.9\ L}{H}\right)^{0.385}} \qquad \left(\frac{11.9\ L^3}{H}\right)^{0.385}$$

   Where
   - Tc = time of concentration in hours
   - L = length of longest watercourse through watershed, in miles
   - H = elevation difference along longest watercourse, in feet

3. Enter Figure 2[2] at T_C calculated above, go vertically to desired storm frequency curve (10 yr., 25 yr., 100 yr.), then go horizontally to the mean annual precipitation determined in 1 above, read the intensity (I).

(1) "California Culvert Practice," California Highways and Public Works.
(2) "Loomis Basin Hydraulic Investigation Study."

4. Determine the area (A) of the watershed.

5. From Table 1, estimate the value of the coefficient of runoff (C). An example for determining "C" for improved and unimproved areas is given.

6. With "C", "I" and "A" calculate the peak storm runoff rate, (Q_p) in cubic feet per second (cfs).

$$Q = C\ I\ A$$

<u>Design Storm Volume</u> - The following procedure is used to calculate the design storm volume.

1. Determine mean annual precipitation, see step 1 for peak storm runoff.

2. Using design storm duration (D), enter Figure 2, go vertically to desired storm frequency curve (10-yr, 25-yr, 100-yr), then go horizontally to the mean annual precipitation determined in above 1, read the intensity (I).

3. Determine the area (A) of the watershed.

4. From Table 1 estimate the value of the coefficient of runoff (C).

5. With "C", "I", and "A" claculate the design storm peak flow rate (Q_D) in cubic feet per second.

$$Q = C\ I\ A$$

6. Calculate the time in hours from start of hydrograph rise to peak rate (T_p).

$$T_p = 0.5\ D = 0.6\ T_c \quad (3)$$

"D" and "T_c" have been determined above.

7. Calculate time base of hydrograph (T_b).

$$T_b = 2.67\ T_p \qquad (3)$$

8. Determine design storm volume (V_D) in cubic feet

$$V_D = 1800\ (Q_D \times T_b)$$

Figure 3 gives a graphical representation of the relationship between T_p, T_b, Q_D and V_D. The area enclosed by the triangle represents the design storm volume.

(3) "Design of Small Dams", US. Bureau of Reclamation.

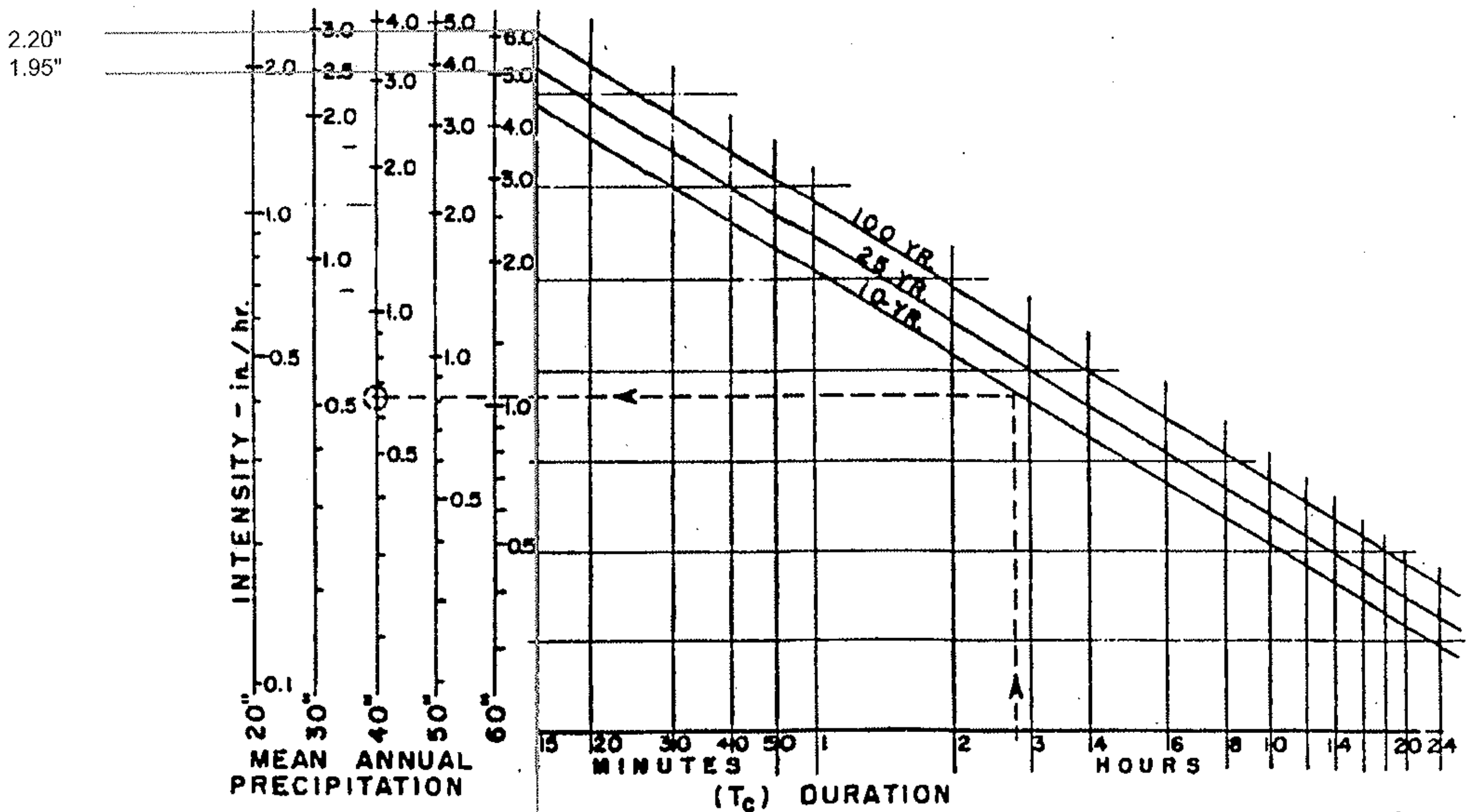


FIGURE 2 - TIME OF CONCENTRATION (Tc) VS. RAINFALL INTENSITY (I)

TABLE 1

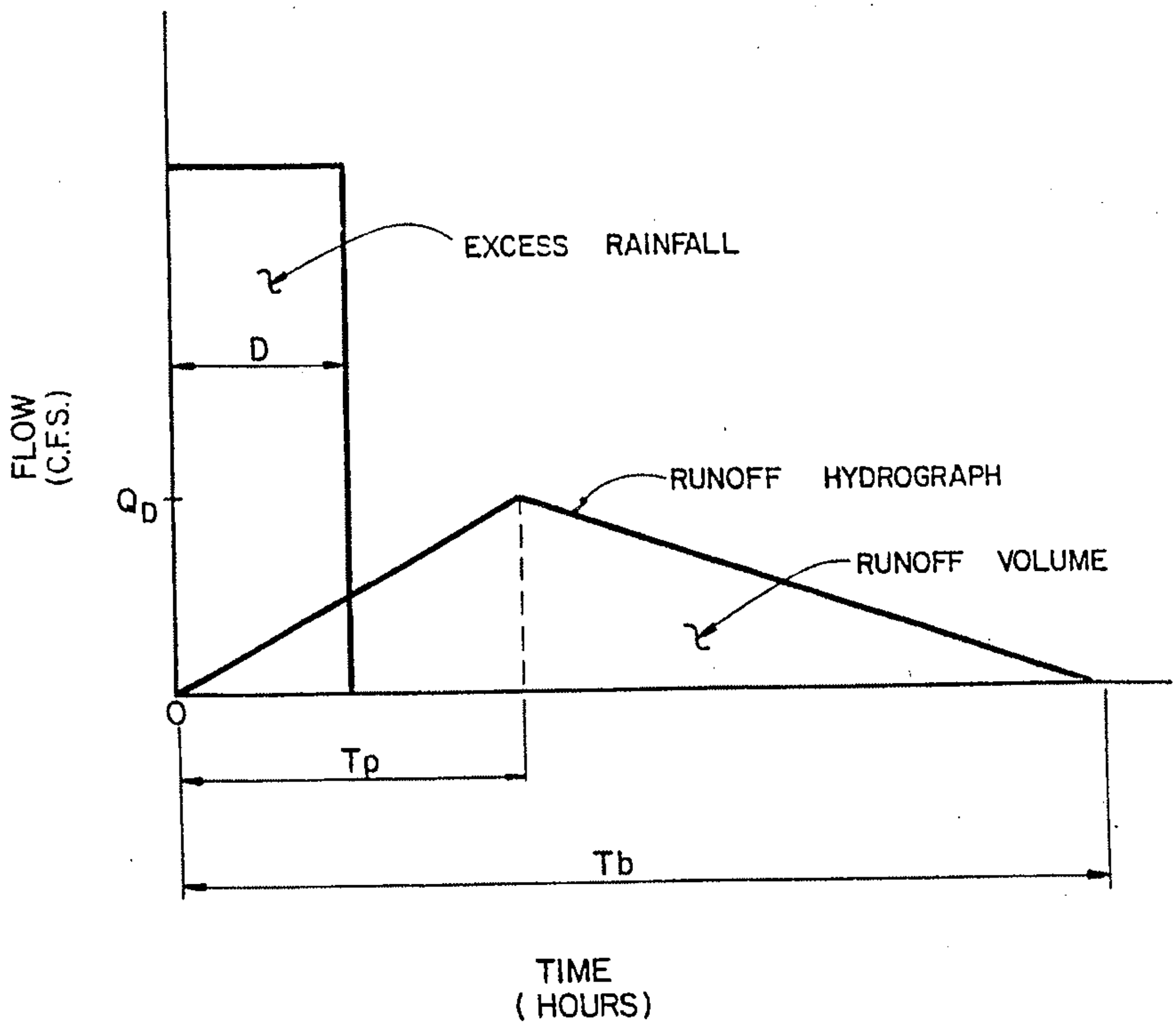
ESTIMATING "C" IN RATIONAL FORMULA

UNIMPROVED AREAS

CONDITION	EXTREME	HIGH	MODERATE	LOW
Slope	.32 Above 30%	.24 10% = 30%	.17 5 - 10%	.11 0 - 5%
Surface permeability.	.14 Bare rock or very thin soil.	.10 Impervious clays, shallow soils.	.07 Well drained soils.	.05 Deep sand, volcanic ash.
Vegetation	.14 None or very sparse.	.10 Less than 20% covered with substantial growth.	.07 About 50% covered with heavy growth.	.05 90% covered with heavy growth, deep humus layer.
Surface	.11 Smooth soil, slick rock, drainage flow continuous.	.09 Roughened soil or rocks.	.07 Drainage flow interrupted, many ponds, lakes, marshes.	.05 Drainage flow arrested, large lakes, ponds, marshes

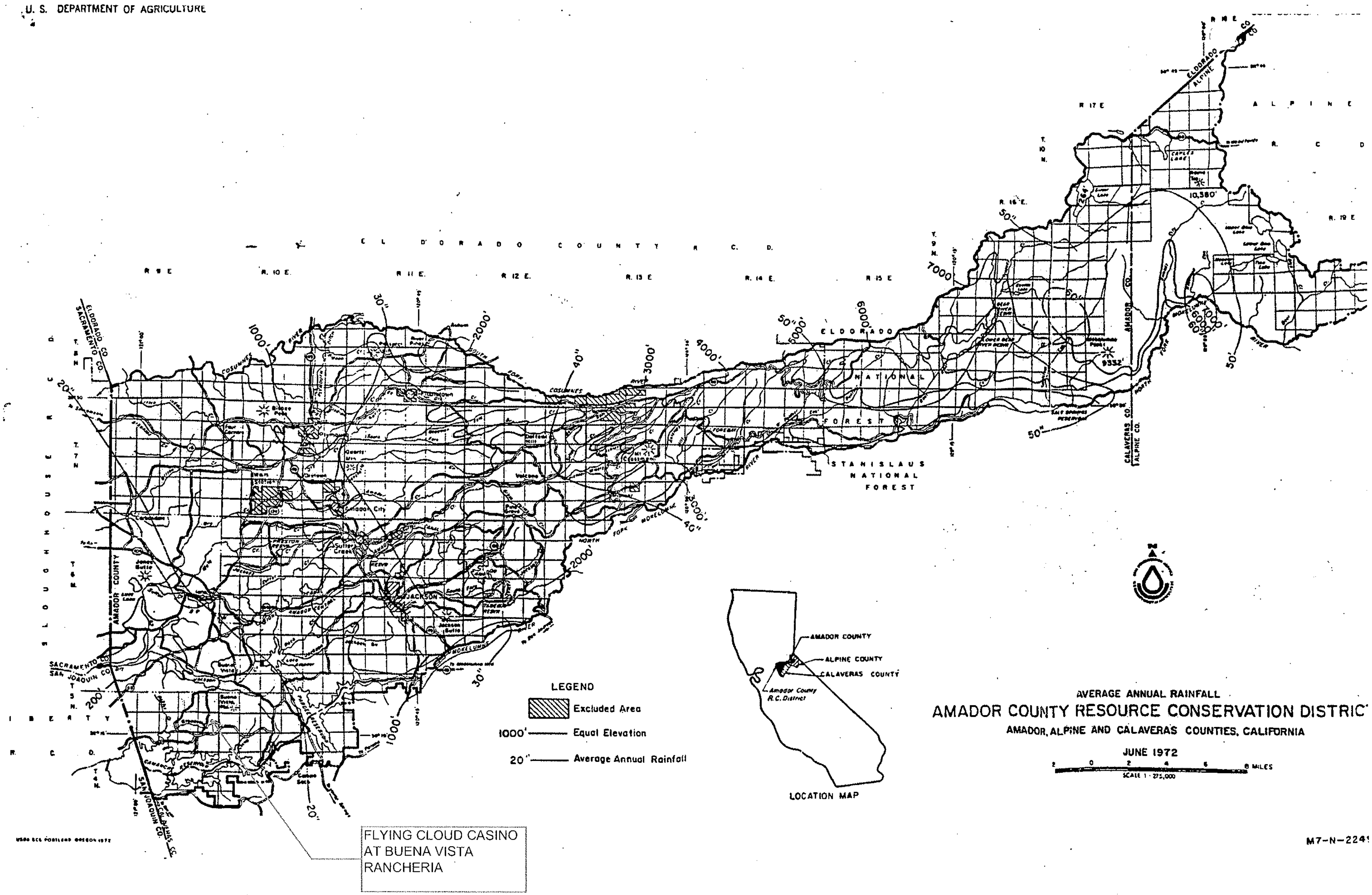
IMPROVED AREAS

Surface	C
Roof Surfaces	.90
Asphalt or Concrete Pavement, patios, driveways, streets, sidewalks	.85
Landscaped areas	.25
Gravel walks, roadways	.30



EXAMPLE OF THE TRIANGULAR HYDROGRAPH

mbc


U. S. DEPARTMENT OF AGRICULTURE
EL DORADO COUNTY R. C. D.
ELDORADO NATIONAL FOREST
STANISLAUS NATIONAL FOREST
ALPINE R. C. D.
LEGEND
Excluded Area
1000' Equal Elevation
20" Average Annual Rainfall
AMADOR COUNTY
ALPINE COUNTY
CALAVERAS COUNTY
Amador County R.C. District
LOCATION MAP
AVERAGE ANNUAL RAINFALL
AMADOR COUNTY RESOURCE CONSERVATION DISTRIC
AMADOR, ALPINE AND CALAVERAS COUNTIES, CALIFORNIA
JUNE 1972
8 MILES
M7-N-224
FLYING CLOUD CASINO
AT BUENA VISTA
RANCHERIA

Technical Note 2.120, ADS Corporation

Technical Notes

Technical Note 2.120
Re: Storm Water Detention/Retention System Design
Date: April 24, 1997 revised January 2000

I.) INTRODUCTION

In today's engineering community, storm water management is a design issue which never goes away. First, environmental regulations allow only a certain level of pollutants to be present in discharged storm water. Second, continued urbanization of land dramatically increases storm water runoff. This increase in runoff can cause problems in areas where recharge of aquifers is necessary in order to maintain a steady groundwater supply. This is especially a problem in coastal regions where seasonally low water table levels may cause lateral intrusion of salt water into the adjacent aquifers. In this case, *storm water retention systems*, which hold runoff in a defined area until the surrounding soil can accept it, are a necessity.

Another design constraint of storm water collection systems is the allowable rate of discharge. Most undeveloped land drains via overland flow into local tributaries or collection ponds and can naturally hold or convey only a certain rate of discharge from upstream systems. Runoff rates during a rainfall event which exceed that of the maximum allowed at the outfall must be detained and released through an outlet pipe at a controlled rate until the storm subsides. These *storm water detention systems* are common to storm water management practice.

Storm water retention and detention systems are present in the industry as either above-ground ponds or as subsurface piping. The former is the least expensive method, though it is the most inefficient use of developable land, is prone to early siltation and clogging, and poses long-term aesthetic problems such as insect breeding, weed growth and odor and refuse control issues. By comparison, subsurface retention/detention systems use available land efficiently while introducing low maintenance costs and posing little or no aesthetic problems.

This report covers the design of subsurface retention/detention systems utilizing ADS corrugated HDPE pipe and manifolds. This paper will provide the designer with a simplistic step-by-step approach to designing and sizing an efficient subsurface system. Additionally, a design aid, which computes the required system size based on the required storage volume and user defined constraints, has been added to assist in sizing underground pipe systems.

II.) DESIGN METHODOLOGY

A) **Overview:** Most design engineers use the rational method to determine design flow rates, although many feel that the TR-55 (SCS) methodology becomes more realistic for watershed larger than 40 acres. Since our experience has generally been with smaller watersheds, we will concentrate our efforts here exclusively on the rational method.

B) **Design Steps Using the Rational Method:**

1) **Determine Watershed Area:** A watershed is defined as the surface area that contributes runoff to a common point. This is usually determined from local surveys, although it is common practice to utilize locally available United States Geographical Survey (USGS) quadrangle sheets as a reliable source of topographic information.

3300 RIVERSIDE DRIVE COLUMBUS, OH 43221 (614) 457-3051 http://www.ADS-pipe.com

8.) **Construct Storm Water Hydrographs:** This is a plot of flow rate (Q) versus time during a rainfall event. Although there are a variety of methods used to estimate retention or detention volume, we will focus our efforts on the Abt and Grigg Method (Figure 4).

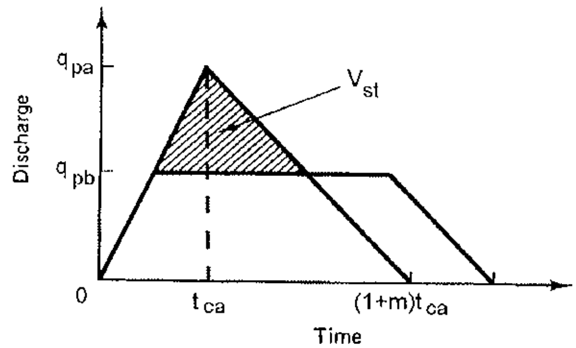


Figure 4: The Abt and Grigg Method

The Abt and Grigg method gives an estimation of retention or detention volumes required because it measures the difference between the runoff volume resulting from the rainfall occurrence and the outflow capacity of the storm sewer. As evidenced in Figure 4, it is assumed that the inflow hydrograph follows the outflow hydrograph until the capacity of the outlet is reached. The difference in area shown by the shaded portion equals the storage volume required; this can be calculated using Equation 5.

$$V_{st} = 60\left(\frac{1+m}{2}\right)q_{pa}\,t_{ca}\,(1-\alpha)^2 \qquad (5)$$

where V_{st} = storage volume required (ft^3)
m = ratio of hydrograph recession to time of peak (usually 1)
t_{ca} = after-development time of concentration (min)
q_{pa} = after-development peak discharge (ft^3/s)
$\alpha = q_{pb}/q_{pa}$
q_{pb} = outflow peak discharge (ft^3/s)

9.) **Size Yonr System:** A design aid to assist in sizing underground piping systems is included on this CD using the following methods for detention and retention systems.

a.) **Detention Systems:** Once you have calculated the storage volume required, subsurface detention systems can be sized to use standard ADS manifold components and pipe. The most efficiently sized systems can be obtained from Equation 6 when A_d is equal to DAF times V_{st}.

$$\text{Design is adequate when} \qquad A_d \geq DAF \cdot V_{st} \qquad (6)$$

where A_d = detention surface area (ft^2)
DAF = detention area factor (ft^2/ft^3) from Table 3

The amount of pipe is calculated as follows:

$$\text{Detention pipe required (ft):} \qquad L_d = \frac{V_{st}}{SC} \qquad (7)$$

where L_d = length of detention pipe required (ft)
SC = pipe's storage capacity (ft^3/ft) from Table 3

Appendix D

- Grading Plans

Flow Calculations for Jackson Creek and the Proposed Project.
December 10, 2008, Prepared by John Tinger, US EPA

EPA compared existing flows in the Jackson Creek to the increase in flows that may result from the project.

Existing Flows

The existing drainage from the project site flows generally north to a constructed channel that runs along Coal Mine Road, tributary to Jackson Creek near the town of Buena Vista. Jackson Creek is tributary to Dry Creek approximately 5 miles from the project site, and Dry Creek is tributary to the Mokelumne River. The Jackson Creek watershed encompasses approximately 60 square miles. The point at which the proposed discharge would reach Jackson Creek is approximately 1.8 miles from (west of) Lake Amador. Lake Amador is the source of water supplied by the Jackson Valley Irrigation District (JVID) to irrigation customers in the surrounding area. The flows in Jackson Creek at the project's tributary point are determined by JVID release from Lake Amador.[1]

Based on data provided by the Jackson Valley Irrigation District [2], typical overflows from the Amador dam reached 2900 acre-ft/day (1460 cfs) in 2007, with typical peak overflows ranging from 500-1,000 acre-ft/day. (250-500 cfs). During dam overflows, actual flows in Jackson Creek will be higher than the dam overflows due to rainfall flowing to Jackson Creek from the watershed downstream of the dam. However, EPA has conservatively assumed a typical peak dam overflow of **1500 cfs.**

During summer months, flows average around 10 to 20 acre-ft/day. (**5-10 cfs**). During the dry season, the flows in Jackson Creek are largely dependent on the dam overflows.

Flow Increase

Flow increase during storm events that will contribute to downstream erosion related to the project will occur from the wastewater treatment plant discharge and the increased stormwater runoff due to construction of impervious areas.

First, the average wastewater treatment plant discharge flow is projected to be 170,000 gallons per day with a weekend peak flow of approximately 250,000 gallons per day. EPA has conservatively selected the highest projected volume of 250,000 gallons per day, or 0.39 cfs.

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[1] Buena Vista NPDES Engineering Report from NPDES permit application, May 2005, Hydroscience Engineers, Inc, page 11.

[2] phone conversation 12/10/08

Second, the volume of runoff during a rain event will increase due to the increase in impervious surface areas (roads, parking lots, and roof surfaces) that have replaced vegetated areas and prevent rainwater from infiltration and evapotranspiring. The project has proposed a stormwater control structure to mitigate the affects of flow, however EPA has not included stormwater retention in its analysis as a conservative assumption.

Peak storm runoff was estimated using the rational method described in Appendix A of the *Erosion & Sediment Control Guidelines for the Developing Areas of the Sierra 1981* (referred to hereafter as the Guidelines) acquired from Amador County Public Works. Peak storm runoff was estimated for the project site in the existing and proposed conditions for the 25 year, 24 hour event and the 100 year, 24 hour peak runoff event, obtained from the *Technical Drainage Study, addendum No. 1 for Flying Cloud Casino at Buena Vista Rancheria*,(Kimley-Horn and Associates, Inc. September, 2005).

Existing Runoff Volumes:
Runoff: 59.8 cfs in the 25-year storm event.
Runoff: 67.4 cfs in the 100-year storm event.

Proposed:
Project Runoff: 71.6 cfs in the 25-year storm event.
Runoff: 80.8 cfs in the 100-year storm event.

Increase:
Runoff: 11.8 cfs in the 25-year storm event.
Runoff: 13.4 cfs in the 100-year storm event.

Therefore, a conservative projection of the combination peak wastewater treatment flow and the peak 100 year, 24 hour event would increase flow by **14 cfs.**

During summer months, flows from the proposed project will be less than **0.39 cfs** due to irrigation use of the discharge water.

Conclusions

During storm events, the proposed project may increase flows in Jackson Creek by up to 1% (14 cfs of 1500 cfs).

During the summer, the proposed project may increase flows in Jackson Creek by less than 8% (0.39 cfs of 5 cfs). During low flows, there is virtually no potential for increased erosion of the stream banks.