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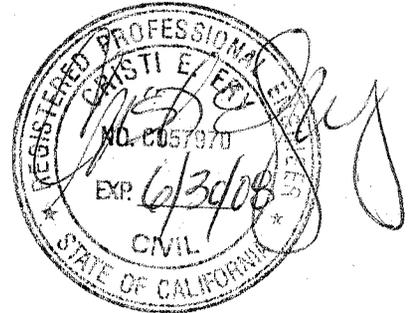mammoth lakes • bishop • redwood city • napa
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PRELIMINARY STORMWATER STUDY

FOR

Multi-House Residential Project
226, 228, 232 & 234 Eucalyptus Hill Drive
Santa Barbara, California
July, 2006

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EXHIBIT H

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Proposed Building and Hardscape Area Calcs (provided by Architect)
SLO County Standard D-2

Multi-House Residential Project
226 & 232 Eucalyptus Hill Drive
Santa Barbara, California

Introduction

This study was done to show how existing and proposed stormwater runoff transmits through the property to the public right of way. Hydraulic calculations for 25-year and 100-year storm events were done following the County of Santa Barbara Engineering Design Standards, 1987. Exhibits were prepared to show both the existing and proposed conditions and conveyance systems, and the 100-year storm event overland escape route and inundation areas.
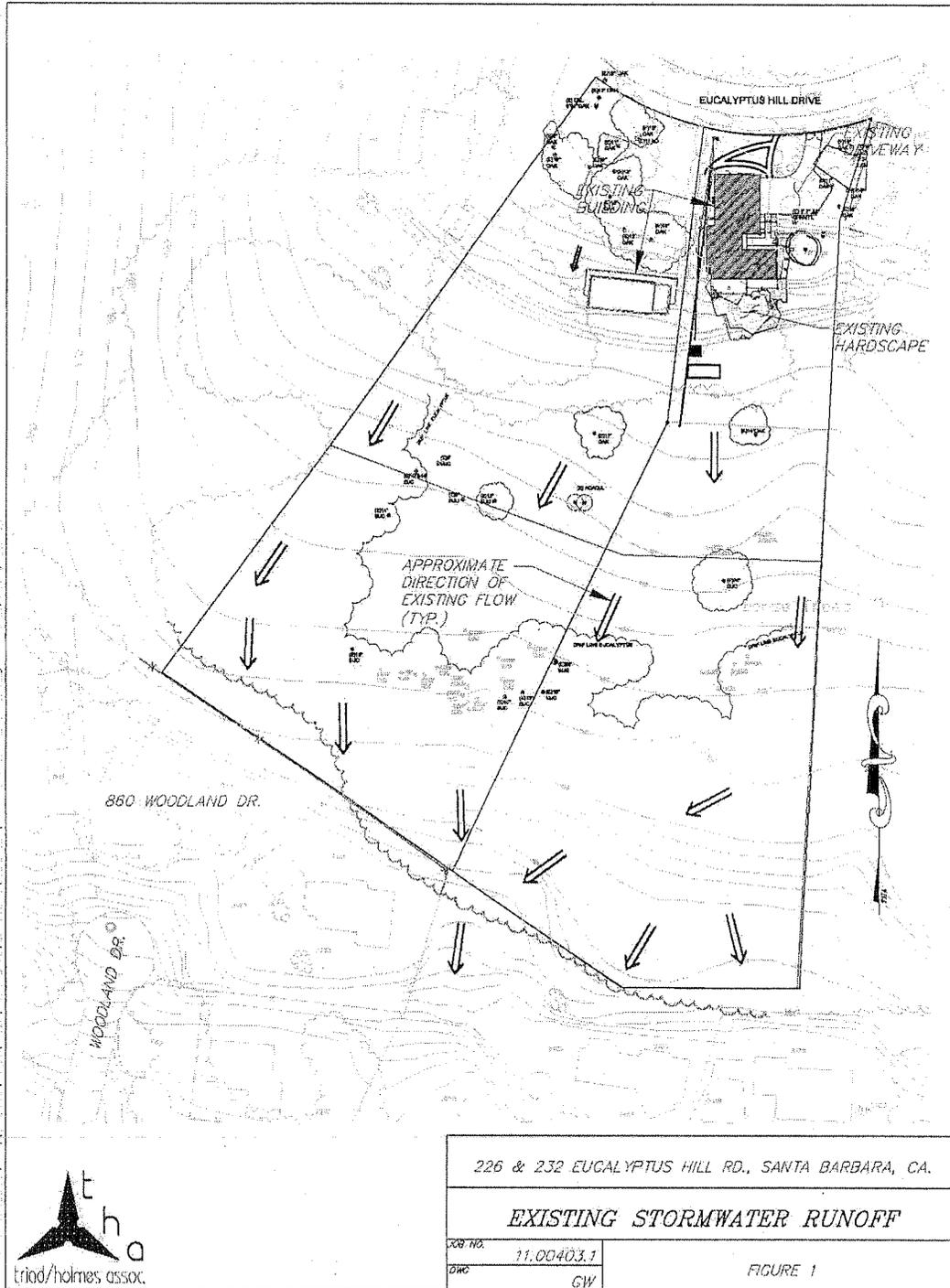
Project Description

The two existing lots, totaling 234,392 sq. ft., presently have a single family residence and out buildings with approximately 11,500 sq. ft. of impervious area (including buildings, hardscape, and driveway) with the remaining area landscaped, wooded or open ground. The topography slopes approximately 25% from north to south. Stormwater presently sheet flows off the southern boundary of the property into neighboring properties, and eventually into the public right-of-way (see Figure 1).

The project proposes to demolish the existing buildings and hardscape, and construct two new residences with two guesthouses and new driveways. Per quantities provided by the architect, the project proposes approximately 26,000 sq. ft. under roof and hardscape, approximately 23,000 sq. ft. of paved driveway, with the remaining area to be landscaped or left wooded (see appendix). This is an increase of approximately 37,500 sq. ft. of impervious surface from the existing stormwater runoff conditions.

The proposed upper lot of 107,510 sq. ft. (226&228 Eucalyptus Hill Drive) contains all of the existing impervious area (11,500 sq. ft.) and proposes a new total impervious area of approximately 32,500 sq. ft. The difference between existing and proposed impervious area is approximately 21,000 sq. ft.

The proposed lower lot of 134,882 sq. ft. (232&234 Eucalyptus Hill Drive) has no impervious area and proposes a new total impervious area of approximately 15,200 sq. ft.

It is our understanding stormwater from the impervious areas of the proposed project is proposed to be collected in a detention pond and in landscaped bioswales (designed by others). At the lower portion of the property it is proposed that stormwater runoff from within the boundary of channelized flow (the area influenced by the proposed impervious areas) be directed to the public right-of-way on Woodland Dr. through the private property at 860 Woodland Drive. Runoff from areas outside of the influence of the

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226 & 232 EUCALYPTUS HILL RD., SANTA BARBARA, CA.

EXISTING STORMWATER RUNOFF

JOB NO. 11.00403.1		
DWG GW		FIGURE 1

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proposed impervious areas and where the existing runoff patterns are not modified are proposed to remain flowing in the historical direction (see Figure 2).

Runoff Calculations

The Rational Method was used to estimate the runoff rate for a 25-year storm for retention volume calculations and for a 100-year storm for overland flow calculations.

Q=CIA   Rational Method   I = intensity   A = area

C = Runoff Coefficient   Ref. Santa Barbara County Engineering Design Standard
                              Appendix 12, Figure 2 Curve 1 and 2 (see note below).

Intensity, I   Calculated Tc < 12 minutes , therefore use 12 min.

I = 2.9 in/hr   Ref. Santa Barbara County Engineering Design Standard Appendix 12, Figure 1.
                Storm event = 25-year @ 12 minutes.

I = 3.7 in/hr   Ref. Santa Barbara County Engineering Design Standard Appendix 12, Figure 1.
                Storm event = 100-year @ 12 minutes.

Note: The Santa Barbara County Engineering Design Standard does not contain estimated C values for individual components of a watershed which is needed to compare the small difference between existing and proposed runoff quantities. A more detailed analysis using San Luis Obispo County Standard C values was done to more accurately show the impact of the increased impermeable area.

C Values from SLO County Standard D-2, see appendix:

Roof and Hardscape Runoff: C=0.90 – Impervious 2% to 10% slope

Driveway Runoff: C=0.95 – Impervious >10% slope

Landscape Runoff: C=0.35 – >10% slope, dense vegetation

Runoff for the Existing Condition (based on the proposed lot configuration)

The existing condition for 232 Eucalyptus Hill Drive (based on proposed 226 & 228 Eucalyptus Hill Dr) is:

Roof and Hardscape:	9,500 sq. ft
Driveway:	2,000 sq. ft
Landscape:	96,010 sq. ft.

$Q_{existing, 25 \, yr.} = 2.9[0.9(9,500)+0.95(2,000)+0.35(96,010)] / [(12)(3600)] = \mathbf{3.0 \ CFS}$

EUCALYPTUS HILL DRIVE

MAIN HOUSE
226 EUCALYPTUS
HILL DRIVE

STORMWATER
OUTSIDE THIS
BOUNDARY TO
FOLLOW HISTORICAL
FLOW PATH

MAIN HOUSE
DETACHED
GARAGE

MAIN GUEST HOUSE
228 EUCALYPTUS
HILL DRIVE

GALLERY HOUSE
234 EUCALYPTUS
HILL DRIVE

GALLERY
GUEST HOUSE
232 EUCALYPTUS
HILL DRIVE

DETENTION POND
BY OTHERS

860 WOODLAND DR.

GRADE TO DIRECT
100 YEAR STORM
RUNOFF AS SHOWN

CHECK STRUCTURE (DESIGNED
BY OTHERS) TO CREATE
DOWNSTREAM SHEET FLOW
FOR STORMWATER ENTERING
FROM UPSTREAM

PROPOSED
OVERLAND FLOW
ROUTE

DRAWING LEGEND
PROPOSED BUILDING AND HARDSCAPE
PROPOSED DRIVEWAY
BOUNDARY OF CHANNELIZED FLOW AREA
PROPOSED DRAINAGE DIRECTION
EXISTING DRAINAGE DIRECTION (APPROXIMATE)

226,228,232&234 EUCALYPTUS HILL RD., SANTA BARBARA, CA

PROPOSED STORMWATER RUNOFF

JOB NO. 11.00403.1		
DWG GW		FIGURE 2

triad/holmes assoc.

$$Q_{existing, 100 \, yr.} = 3.7[0.9(9,500)+0.95(2,000)+0.35(96,010)] / [(12)(3600)] = \textbf{3.8 CFS}$$

The existing condition for 226 Eucalyptus Hill Drive (based on the proposed 232 & 234 Eucalyptus Hill Dr.) is:

Roof and Hardscape: 0   sq. ft
Driveway: 0   sq. ft
Landscape: 134,882 sq. ft.

$$Q_{existing, 25 \, yr.} = 2.9[0.35(134,882)] / [(12)(3600)] = \textbf{3.2 CFS}$$

$$Q_{existing, 100 \, yr.} = 3.7[0.35(134,882)] / [(12)(3600)] = \textbf{4.0 CFS}$$

Runoff for the Proposed Condition (based on the proposed lot configuration)

The proposed condition for 226&228 Eucalyptus Hill Drive is:

Roof and Hardscape: 13,952 sq. ft
Driveway: 18,580 sq. ft
Landscape: 74,978 sq. ft.

$$Q_{proposed, 25 \, yr.} = 2.9[0.9(13,952)+0.95(18,580)+0.35(74,978)] / [(12)(3600)] = \textbf{3.8 CFS}$$

$$Q_{proposed, 100 \, yr.} = 3.7[0.9(13,952)+0.95(18,580)+0.35(74,978)] / [(12)(3600)] = \textbf{4.8 CFS}$$

The proposed condition for 232&234 Eucalyptus Hill Drive is:

Roof and Hardscape: 11,701 sq. ft
Driveway: 4,350 sq. ft
Landscape: 119,647 sq. ft.

$$Q_{proposed, 25 \, yr.} = 2.9[0.9(11,701)+0.95(4,350)+0.35(118,831)] / [(12)(3600)] = \textbf{3.8 CFS}$$

$$Q_{proposed, 100 \, yr.} = 3.7[0.9(11,701)+0.95(4,350)+0.35(118,831)] / [(12)(3600)] = \textbf{4.8 CFS}$$

Retention Volume Calculation

226&228 Eucalyptus Hill Drive

The difference between $Q_{existing, 25\ yr.}$ of 3.0 CFS and $Q_{proposed, 25\ yr.}$ of 3.8 CFS is **0.8 CFS** using the San Luis Obispo County C values. The equivalent rainfall intensity for the proposed project to match the existing conditions would be approximately 80% of the peak intensity of 2.9 in/hr, or 2.3 in/hr ((2.8/3.6)x100). Based on curve 6 on the Santa Barbara County Engineering Design Standard Appendix 12, Figure 1, it would take 19 minutes for a 25 year storm to decrease in intensity to 2.3 in/hr. It would take 900 Cu. ft. of storage to store the excess runoff until the rainfall intensity decreased to 2.3in/hr:

Retention Volume = 0.8 CFS * 19 Minutes * 60 Seconds per minute ≈ **900 Cu. ft.**

232&234 Eucalyptus Hill Drive

The difference between $Q_{existing, 25\ yr.}$ of 3.2 CFS and $Q_{proposed, 25\ yr.}$ of 3.8 CFS is **0.6 CFS** using the San Luis Obispo County C values with $Q_{existing, 25\ yr.}$ approximately 85% of $Q_{proposed, 25\ yr.}$ The equivalent rainfall intensity for the proposed project to match the existing conditions would be approximately 85% of the peak intensity of 2.9in/hr, or 2.45in/hr. Based on curve 6 on the Santa Barbara County Engineering Design Standard Appendix 12, Figure 1, it would take 17 minutes for a 25 year storm to decrease in intensity to 2.45in/hr. It would take approximately 600 Cu. ft. of storage to store the excess runoff until the rainfall intensity decreased to 2.3in/hr:

Retention Volume = 0.6 CFS * 17 Minutes * 60 Seconds per minute ≈ **600 cu. ft.**

100 Year Storm Overland Flow Calculation

The potential total overland flow for a 100-year storm from the proposed project is estimated as a total of 9.4 CFS as compared to the existing conditions estimate of 7.8 CFS. Of the estimated 9.4 CFS from the proposed project, approximately 1.8 CFS from approximately 65,000 sq. ft. of existing vegetated areas along the eastern and western boundaries sheet flows to the south and is not planned to be redirected as part of the proposed project. The remaining 7.6 CFS from the proposed projects will be directed to an existing drainage course through the property located at 860 Woodland Drive and then to Woodland Drive. A swale should be sized through 860 Woodland Drive to safely convey 7.6 CFS to Woodland Drive.

Conclusions

The Santa Barbara County method for determining the C value for the rational equation would be too general for such a large parcel. A more detailed analysis using the San Luis Obispo County C values incorporates the difference in impervious area when determining the design runoff for the existing and proposed conditions. It was determined that the proposed project would increase peak

runoff for a 25 year storm event by 1.3 CFS, resulting in a total retention volume of 1,400 cu. ft. required for both parcels. Potential peak overland flow from a 100 year storm event is estimated at 9.5 CFS for both parcels. The retention volume for each parcel (shown above) was determined.

The following recommendations should be incorporated into the final grading and drainage design:

1. Based on an analysis of pre-development and proposed post-development conditions, a combined total of 1,500 cu. ft. of stormwater retention would required to maintain the peak runoff flow rate at present conditions. The project proposes to incorporate a detention pond. The use of multiple bioswales may also be part of the stormwater retention design by incorporating check structures in the bioswales. To eliminate standing water, the pond and bioswales should be free-draining by having a small orifice (such as with a short 1 inch pipe section) at the low point of the detention pond or at the check structure in the bioswale. The drains will need to be maintained on a regular basis to ensure they are not clogged.

2. Stormwater runoff should be directed to sheet flow over vegetated ground as much as possible. The proposed detention pond at the lower end of the property should be constructed with a non-eroding level top that would allow runoff from uphill areas to sheet flow over as wide an area as possible prior to being redirected to concentrated flow and leaving the property.

3. The stormwater runoff from the area influenced by the proposed project (not following the historical flow path) should be directed away from the proposed structures and to a drainage easement (to be obtained as part of this project) on 860 Woodland Drive. Overland flow for a 100-year storm event of 7.6 CFS should also be provided by constructing a swale across 860 Woodland Drive onto Woodland Drive. The swale will need to be designed based on the slope and material of construction.

Appendix

EUCALYPTUS HILL DRIVE
SITE DATA

232&234 EUCALYPTUS HILL DRIVE (SOUTH LOT)

LOT AREA: 134,882 3.10 acres
Impervious Driveway 3,260
Pervious Driveway (crushed stone or perm. Paver) 1,090
total driveway 4,350 s.f.

	Bulding Area	Hardscape Area
GALLERY HOUSE:		
Gallery HouseTotal Building coverage:	4,905 s.f.	
Gallery House Hardscape		
courtyard 2217 s.f.		
south patio & reflecting pool 1255 s.f.		
m. bedroom s. patio 176 s.f.		
total hardscape		3,648 s.f.
GALLERY GUEST HOUSE:		
Gallerly Guest House Total Building coverage:	1,805	
Gallery Guest House Patio		
entry patio 75 s.f.		
south patio 1147 s.f.		
west bedroom patio 121 s.f.		1,343 s.f.
TOTAL	6,710 s.f.	4,991 s.f.

TOTAL BUILDING AND HARDSCAPE 11,701 s.f.

Total Building, Hardscape, and Driveway 16,051

EUCALYPTUS HILL DRIVE
SITE DATA

226&228 EUCALYPTUS HILL DRIVE (NORTH LOT)

LOT AREA:

Impervious Driveway@Euc. Hill Drive (easement)	107,510 2.47 acres
Impervious Driveway	2,752
Pervious Driveway (crushed stone or perm. Paver	8,843
total driveway	6,985
	18,580 s.f.

	Bulding area	Hardscape Area
MAIN HOUSE:		
Main HouseTotal Building coverage:	6,395 s.f.	
Main House Hardscape		
main level south patio	2722 s.f.	
lower level south patio	178 s.f.	
West patio (off M. Bed)	447 s.f.	
Kitchen ramp & studio west	231 s.f.	
Entry courtyard (open above)	450 s.f.	
total hardscape		4,028 s.f.
DETACHED GARAGE:		
Total Building coverage:	814	
MAIN GUEST HOUSE:		
Total Building coverage:	1,675	
Main Guest House Patio		1040 s.f.
TOTAL	8,884 s.f.	5,068 s.f.

TOTAL BUILDING AND HARDSCAPE   13,952 s.f.

Total Building, Hardscape, and Driveway   32,532

TABLE OF COEFFICIENT RUNOFF CHART

TYPE OF DEVELOPMENT		TYPE OF SOIL**	COEFFICIENT OF RUNOFF FOR* SLOPE <2%; 2% to 10%; >10%		
URBAN	20,000 sq. ft.	C	.35 ;	.40 ;	.45
	"	S	.25 ;	.35 ;	.40
	10,000 sq. ft.	C	.40 ;	.45 ;	.55
	"	S	.30 ;	.40 ;	.45
	6,000 sq. ft.	C	.45 ;	.55 ;	.65
	"	S	.35 ;	.40 ;	.50
	APARTMENTS	C	.50 ;	.60 ;	.70
	"	S	.40 ;	.50 ;	.60
	INDUSTRIAL	C	.55 ;	.65 ;	.75
	"	S	.45 ;	.55 ;	.65
	COMMERCIAL	C	.75 ;	.80 ;	.85
	"	S	.70 ;	.75 ;	.80
RURAL	DENSE VEGETATION	C	.15 ;	.25 ;	.35
	"	S	.10 ;	.15 ;	.20
	MODERATE VEGETATION	C	.20 ;	.30 ;	.40
	"	S	.15 ;	.20 ;	.25
	SPARSE VEGETATION	C	.25 ;	.35 ;	.45
	"	S	.20 ;	.25 ;	.30
	IMPERVIOUS; PAVED, ETC.		.85 ;	.90 ;	.95

* Note: These values are intended to be a minimum; higher values may be required by the County Engineer.

** Note: Soil Type

C = Clay, Adobe, Rock or Impervious Material

S = Sand, Gravel, Loam or Pervious Material