TPM 21080
ER 07-14-008

CEQA PRELIMINARY DRAINAGE STUDY

For

MONTANA SERENA ROAD

COUNTY OF SAN DIEGO - CALIFORNIA

Prepared By

TAIT
CONSULTING, INC.
702 Civic Center Drive
Oceanside, CA 92054
Phone 760 433-1166
Fax 760 433-1017

Prepared For

FRANK & KATHLEEN BONGIOVANNI

Revised December 2009
Revised August 2011

SDC DPLU RCVD 09-13-11
TPM21080RPL2

TABLE OF CONTENTS

EXHIBITS

1.0 Location

Montana Serena is located East of the City of El Cajon along Freeway 8 within San Diego County and southeast of the West La Cresta Road off-ramp. Refer to Thomas Guide Map page 1233 or (See Exhibit 1 – Vicinity Map).

2.0 Introduction

This report was prepared to analyze the storm water discharge generated by the development of four single-family residential lots including building pads, private driveways, and finished grading around the site. The new lots are located within the County of San Diego.

We will determine the volume of storm water discharged from the drainage basins for the pre-developed and post-developed situations. We will indicate how the flow will be intercepted and conveyed into the existing storm drain system.

3.0 Pre-Developed Hydrology Conditions and Calculations

The following analysis was preformed in conjunction with the San Diego County Hydrology manual (SDCHM). Unless otherwise indicated all calculation worksheets are from the appendices of the SDCHM and included in this report.

Using the Soil Hydrological Groups Map found in the SDCHM, we determined the soil type belonging to Group D, and identified as LpE2 (Las Posas fine sandy loam, 15 to 30 percent slopes, eroded). From Table 3-1 of the SDCHM, run-off coefficients have been determined to be 0.35 for the Pre-Developed situation.

To determine the Initial Time of Concentration for each drainage basin we used Table 3-2 from the SDCHM.

Table 3-1 of the SDCHM was used to determine the runoff coefficient for the Pre-Developed calculations. (See Exhibit 5). Weighted C values have been used, ranging from 0.36 for natural areas, to 0.41 for Low Density Residential (1 DU/Ac.), depending on the approximate portion of development in each drainage basin.

Figure 3-4 of the SDCHM was used to determine the travel time for each basin after the initial time of concentration, since the basins will remain predominantly natural.

Using the determined Initial Time of Concentration + the calculated Time of Travel, the rainfall intensity was arrived at by using Figure 3-1 from the SDCHM, (See Exhibit 8). The intensity for each of the drainage basins is shown in Table 1.

4.0 Pre-Developed Drainage Basins

In the pre-developed situation, the site was divided into 7 existing drainage basins and are identified as Basins A, B, C, D, E, F, and G, all having individual outlets. Each drainage basin is further discussed below. (See Exhibit 3 – Pre-Development Drainage Basins). The existing drainage basins consist primarily of undisturbed natural terrain – open space and natural drainage swales. The existing culvert pipe capacities were calculated using the Orifice formula $Q = C \times A \times \sqrt{(2gh)}$.

Basin A

This basin slopes southerly toward Montana Serena Road, a private driveway. A natural drainage swale sloping southwesterly along the northerly side of Montana Serena Road collects the storm water runoff from the basin hillside. The storm water collected in the swale is directed toward an existing 18" cmp culvert and passes the flow onto Basin G across the private road. The culvert pipe is limited to conveying 17.6 cfs with 5' of head.

Basin B

This drainage basin's hillside also slopes southerly toward Montana Serena Road and is collected by the same existing natural swale as in the case of Basin A. The swale continues to slope southwesterly conveying the storm water flows to a second 18" cmp culvert. The second culvert also passes the flow onto Drainage Basin G and is limited to conveying 17.6 cfs with 5' of head.

Basin C

This drainage basin's hillside slopes westerly to southwesterly toward Montana Serena Road. Storm water is again, collected from the same natural swale along the northerly side of the private roadway and continues to flow westerly to a third 18" cmp culvert. The culvert passes the storm water flow onto Drainage Basin D and is limited to conveying 24.4 cfs with 9' of head.

Basin D

This basin is located on the southerly side of Montana Serena Road where it begins its highest elevation. Storm water crossing this basin flows into a sedimentation pond located at the base on the northerly side of an existing unnamed dirt roadway that will be paved as part of this proposed project development. A weighted C value has been calculated for this proposed impervious surface in the post-developed situation. The sedimentation pond releases the settled storm water through an existing 24" cmp culvert crossing under the dirt roadway onto Basin D. A two-minuet detention time has been added to the time of concentration for releasing the storm water from the sedimentation pond. The existing 24" cmp culvert is limited to conveying storm water flows onto Drainage Basin E of 21.4 cfs with 3' of head.

Basin E

This basin is located east of Montana Serena Road and slopes south to southwesterly conveying storm water from the existing culvert pipe underneath the unnamed roadway into an existing natural swale that flows into an existing detention pond located at the southwest corner of the basin. A two-minuet detention time has been added to the time of concentration for releasing storm water from the detention pond. Storm water is released from the natural swale offsite through an existing 24" cmp culvert and outlets onto the west side of Montana Serena Road.

Basin F

This basin is centrally located within the site and slopes southerly where storm water is released offsite through an existing 12" cmp and into an existing sedimentation pond. The existing 12" cmp is limited to conveying 7.5 cfs with 4' of head.

Basin G

This basin is located to the north and predominately to the east of the project site. The basin slopes southwesterly where storm water is conveyed by an existing natural swale that divides the basin. The concentrated storm water is conveyed via the existing natural swale eventually winding its way southerly and continuing its flow offsite away from the project site to the southeast.

5.0 Pre-Developed Calculations

In the pre-developed situation, drainage areas have been divided into sub basins resulting in 7 drainage basins, (A thru G). (See Exhibit 3 – Pre-Developed Drainage Basins).

The following table was calculated as discussed in the Pre-Developed Hydrology Conditions and Calculations section above.

TABLE 1

See following page. Revised to address comments.

Total Combined Flows to Node Outlets (See Exhibit 3 – Pre-Developed Drainage Basins)

TABLE 2

Node	Q_{100}	Velocity
	cfs	fps
302	50.3	~~7.6~~8.1
102	26.2	~~5.6~~8.3
200	10.6	5.5

Table 1: Pre- Development

		P6	P24	P6 / P24	Adj. P	Initial Area			Remaining Flowline		T from Fig. 3-4	D	I	Land Use	Soil Type	C	A	CA	Q	Distance to Junction	Node at Junction	Tt	Total D			Adjusted Intensity			Q_{T1}	Q_{T2}	Q_{T3}	Adjusted Cumulative Q	Vel.		Comments
		in.	in.	%	in.	L_M	Slope	Ti	L	△ E		min.	in/hr				Ac.		cfs			Travel Time to Junction	Cumulative T1	Cumulative T2	Cumulative T3	I1	I2	I3					fps		
Basin A	Node	from Isopluvials		From Hydro Manual Fig 3-2		ft.	%	Min.	Miles	ft.	Min.	Tc + T	Fig 3-2		Exh. 2	Manual Table 3-1			CIA	ft															
2 Year Storm Event	301	1.4	2.3	60%	1.4	100	>10	6.4	0.492	185	9.2	15.6	1.8	Natural	D	0.35	5.10	1.79	3.2	1330		3.1										3.2	1.8		
10 Year Storm	301	1.98	3.8	52%	2.0	100	>10	6.4	0.333	185	5.9	12.3	3.0	Natural	D	0.35	5.10	1.79	5.3	1330		3.1										5.3	3.0	18	" culvert
100 Year Storm	301	2.9	6.4	45%	2.9	100	>10	6.4	0.333	185	5.9	12.3	4.3	Natural	D	0.35	5.10	1.79	**7.6**	1330		3.1										7.6	4.3		
	300			2 Year	1.4	100	>10	6.4	0.098	246	1.3	7.7	2.8	Natural	D	0.35	1.80	0.63	1.8	1000		2.4										1.8	1.0		
Basin B	300			10 Year	2	100	>10	6.4	0.098	246	1.3	7.7	4.0	Natural	D	0.35	1.80	0.63	2.5	1000		2.4										2.5	1.4	18	" culvert
	300			100 Year	2.9	100	>10	6.4	0.098	246	1.3	7.7	5.8	Natural	D	0.35	1.80	0.63	**3.6**	1000		2.4										3.6	2.1		
	302			2 Year	1.4	100	>10	6.4	0.417	493	5.2	11.6	2.1	Natural	D	0.35	26.50	9.28	19.9	0	302	0.0	10.1	11.6	18.8	2.4	2.1	1.6	20.7	**23.4**	18.9	23.4			
Basin G	302			10 Year	2	100	>10	6.4	0.417	493	5.2	11.6	3.1	Natural	D	0.35	26.50	9.28	28.4	0	302	0.0	10.1	11.6	15.4	3.4	3.1	2.5	30.5	**34.7**	30.8	34.7			Natural triangular channel w/ 2.5:1 side slopes, no significant impact.
	302			100 Year	2.9	100	>10	6.4	0.417	493	5.2	11.6	4.4	Natural	D	0.35	26.50	9.28	**41.2**	0	302	0.0	10.1	11.6	15.4	4.9	4.4	3.7	44.3	**50.3**	44.7	50.3	8.1		
	100			2 Year	1.4	100	>10	6.4	0.284	419	3.6	10.0	2.4	Natural	D	0.35	12.20	4.27	10.1	360	100	2.0										10.1	5.7		
Basin C	100			10 Year	2	100	>10	6.4	0.284	419	3.6	10.0	3.4	Natural	D	0.35	12.20	4.27	14.4	360	100	2.0										14.4	8.2	18	" culvert
	100			100 Year	2.9	100	>10	6.4	0.284	419	3.6	10.0	4.9	Natural	D	0.35	12.20	4.27	**20.9**	360	100	2.0										20.9	11.8		
	101			2 Year	1.4	100	>10	6.4	0.067	100	1.2	7.6	2.8	Natural	D	0.35	2.30	0.81	2.3	1150	101	6.4	7.6	12.0		2.8	2.1		**11.5**	9.8		11.5	6.5		
Basin D	101			10 Year	2	100	>10	6.4	0.067	100	1.2	7.6	4.0	Natural	D	0.35	2.30	0.81	3.2	1150	101	6.4	7.6	12.0		4.0	3.0		**16.5**	14.0		16.5	9.3	18	" culvert
	101			100 Year	2.9	100	>10	6.4	0.067	100	1.2	7.6	5.8	Natural	D	0.35	2.30	0.81	**4.7**	1150	101	6.4	7.6	12.0		5.8	4.4		**23.9**	20.3		23.9	13.5		
	102			2 Year	1.4	100	>10	6.4	0.237	97	5.1	11.5	2.2	Natural	D	0.36	14.30	5.15	11.1	0	102	0.00	7.6	14.0		2.8	1.9		8.3	**12.7**		12.7	4.0		
Basin E	102			10 Year	2	100	>10	6.4	0.237	97	5.1	11.5	3.1	Natural	D	0.36	14.30	5.15	15.9	0	102	0.00	7.6	14.0		4.0	2.7		11.9	**18.1**		18.1	5.8	24	" culvert, adequate
	102			100 Year	2.9	100	>10	6.4	0.237	97	5.1	11.5	4.5	Natural	D	0.36	14.30	5.15	**23.0**	**0**	102	**0.00**	7.6	14.0		5.8	3.9		17.2	**26.2**		26.2	8.3		
	200			2 Year	1.4	100	>10	6.4	0.104	99	1.9	8.3	2.7	Natural	D	0.35	5.50	1.93	5.1		200											5.1			
Basin F	200			10 Year	2	100	>10	6.4	0.104	99	1.9	8.3	3.8	Natural	D	0.35	5.50	1.93	7.3		200											7.3			Natural triangular channel with 2.5:1 side slopes, no significant impact.
	200			100 Year	2.9	100	>10	6.4	0.104	99	1.9	8.3	5.5	Natural	D	0.35	5.50	1.93	**10.6**		200											10.6	5.5		

		P6	P24	P6 / P24	Adj. P	Initial Area			Remaining Flowline			D	I			C	A	Q		Tt	Total D			Adjusted Intensity							Vel.		Comments	Vel.		Comments
		in.	in.	%	in.	L_M	Slope	Ti	L	Δ E	T from Fig. 3-4 *	min.	in/ hr	Land Use	Soil Type		Ac.	cfs	Node at Junction	Travel Time to Junction	Cumulative T1	Cumulative T2	Cumulative T3	I1	I2	I3	Q_{T1}	Q_{T2}	Q_{T3}	Adjusted Cumulative Q	fps			fps		
Basin A	Node	from Isopluvials		From Hydro Manual Fig 3-2		ft.	%	Min	Miles	ft.	Min.	Tc + T	Fig 3-2		Exh. 2	Manual Tbl 3-1		CIA																		
2 Year Storm Event	301	1.4	2.3	60%	1.4	100	>10	6.4	0.49	185	9.2	15.6	1.8	Nat-ural	D	0.35	5.10	3.2		3.1										3.2	1.8					
10 Year Storm	301	1.98	3.8	52%	2.0	100	>10	6.4	0.33	185	5.9	12.3	3.0	Nat-ural	D	0.35	5.10	5.3		3.1										5.3	3.0	18	" culvert			
100 Year Storm	301	2.9	6.4	45%	2.9	100	>10	6.4	0.33	185	5.9	12.3	4.3	Nat-ural	D	0.35	5.10	**7.6**		3.1										7.6	4.3					
	300			2 Year	1.4	100	>10	6.4	0.1	246	1.3	7.7	2.8	Nat-ural	D	0.35	1.80	1.8		2.4										1.8	1.0					
Basin B	300			10 Year	2	100	>10	6.4	0.1	246	1.3	7.7	4.0	Nat-ural	D	0.35	1.80	2.5		2.4										2.5	1.4	18	" culvert			
	300			100 Year	2.9	100	>10	6.4	0.1	246	1.3	7.7	5.8	Nat-ural	D	0.35	1.80	**3.6**		2.4										3.6	2.1					
	302			2 Year	1.4	100	>10	6.4	0.42	493	5.2	11.6	2.1	Nat. / LDR -1.0	D	0.36	26.50	20.4	302	0.0	10.1	11.6	18.8	2.4	2.1	1.6	21.2	**24.0**	19.3	24.0						
Basin G	302			10 Year	2	100	>10	6.4	0.42	493	5.2	11.6	3.1	Nat. / LDR -1.0	D	0.36	26.50	29.2	302	0.0	10.1	11.6	15.4	3.4	3.1	2.5	31.3	**35.5**	31.5	35.5			Natural triangular channel with 2.5:1 side slopes, no signify-cant impact.			
	302			100 Year	2.9	100	>10	6.4	0.42	493	5.2	11.6	4.4	Nat. / LDR -1.0	D	0.36	26.50	**42.3**	302	0.0	10.1	11.6	15.4	4.9	4.4	3.7	45.3	**51.4**	45.7	51.4	7.7					
	100			2 Year	1.4	100	>10	6.4	0.28	419	3.6	10.0	2.4	Nat-ural	D	0.35	12.20	10.1	100	2.0										10.1	5.7					
Basin C	100			10 Year	2	100	>10	6.4	0.28	419	3.6	10.0	3.4	Nat-ural	D	0.35	12.20	14.4	100	2.0										14.4	8.2	18	" culvert			
	100			100 Year	2.9	100	>10	6.4	0.28	419	3.6	10.0	4.9	Nat-ural	D	0.35	12.20	**20.9**	100	2.0										20.9	11.8					
	101			2 Year	1.4	100	>10	6.4	0.07	100	1.2	7.6	2.8	Nat-ural	D	0.35	2.3	2.3	101	6.4	7.6	12.0		2.8	2.1		**11.5**	9.8		11.5	6.5					
Basin D	101			10 Year	2	100	>10	6.4	0.07	100	1.2	7.6	4.0	Nat-ural	D	0.35	2.3	3.2	101	6.4	7.6	12.0		4.0	3.0		**16.5**	14.0		16.5	9.3	18	" culvert			
	101			100 Year	2.9	100	>10	6.4	0.07	100	1.2	7.6	5.8	Nat-ural	D	0.35	2.3	**4.7**	101	6.4	7.6	12.0		5.8	4.4		**23.9**	20.3		23.9	13.5					

6.0 Post-Development Drainage Basins

In the post-developed situation, the drainage areas will remain similar to the existing drainage basin sizes, with minor modifications due to the proposed grading. (See Exhibit 4 – Post-Developed Drainage Basins).

The storm water discharged from these areas will be filtered through grass-lined swales (bio-filters).

Table 3-1 of the SDCHM was used to determine the runoff coefficient for the Post-Developed calculations. (See Exhibit 5). Runoff coefficients fall between "Natural" and "Low Density Residential – 1.0). The coefficient is based upon the approximate percentage of development within the basin.

The following table was calculated as discussed in the Pre-Developed Hydrology Conditions and Calculations section above.

7.0 Post-Developed Calculations

TABLE 3

See following page. Revised to address comments.

Total combined Flows to Node Outlets (See Exhibit 4 – Post Development Drainage Basins)

TABLE 4

Node	Q_{100}	Velocity
	cfs	fps
302	51.4	7.7
102	~~25.3~~27.1	~~5.5~~8.6
200	9.3	5.3

		P6 in.	P24 in.	P6 / P24 %	Adj. P in.	Initial Area L_M	Slope	Ti	Remaining Flowline L	$\triangle$ E	T from Fig. 3-4 *	D min.	I in/hr	Land Use	Soil Type	C	A Ac.	Q cfs	Node at Junction	Tt Travel Time to Junction	Total D Cumulative T1	Cumulative T2	Cumulative T3	Adjusted Intensity I1	I2	I3	Q_{T1}	Q_{T2}	Q_{T3}	Adjusted Cumulative Q	Vel. fps		Comments	Vel. fps		Comments
Basin E	102a			2 Year	1.4	100	>10	6.4	0.24	97	5.1	11.5	2.2	Nat. / LDR -1.0	D	0.38	13.00	10.7	102	0.00	7.6	14.0		2.8	1.9		8.1	**12.2**		12.2						
	102a			10 Year	2	100	>10	6.4	0.24	97	5.1	11.5	3.1	Nat. / LDR -1.0	D	0.38	13.00	15.2	102	0.00	7.6	14.0		4.0	2.7		11.5	**17.4**		17.4						
	102a			100 Year	2.9	100	>10	6.4	0.24	97	5.1	11.5	4.5	Nat. / LDR -1.0	D	0.38	13.00	**22.1**	102	**0.00**	7.6	14.0		5.8	3.9		16.7	**25.3**		25.3						
Basin E2	102			2 Year	1.4	100	>10	6.4	0.11	100	2.1	8.5	2.6	Nat-ural	D	0.35	1.3	1.2	102	0.00	8.5	14.0		2.6	1.9		7.7	**13.1**		13.1	0.7	18	" culvert under Pcl 2 Driveway, adequate	4.2	24	" culvert under Montana Serena (cummula-tive flow), adequate
	102			10 Year	2	100	>10	6.4	0.11	100	2.1	8.5	3.7	Nat-ural	D	0.35	1.3	1.7	102	0.00	8.5	14.0		3.7	2.7		11.0	**18.7**		18.7	1.0			5.9		
	102			100 Year	2.9	100	>10	6.4	0.11	100	2.1	8.5	5.4	Nat-ural	D	0.35	1.3	**2.5**	102	**0.00**	8.5	14.0		5.4	3.9		16.0	**27.1**		27.1	1.4			8.6		
Basin F	200			2 Year	1.4	85	2	9.2	0.1	99	1.9	11.1	2.2	Nat. / LDR -1.0	D	0.37	5.5	4.5	200											4.5			Natural triangular channel with 2.5:1 side slopes, no signify-cant impact.			
	200			10 Year	2	85	2	9.2	0.1	99	1.9	11.1	3.1	Nat. / LDR -1.0	D	0.37	5.5	6.4	200											6.4						
	200			100 Year	2.9	85	2	9.2	0.1	99	1.9	11.1	4.6	Nat. / LDR -1.0	D	0.37	5.5	**9.3**	200											9.3	5.3					

8.0 Existing Culvert Pipe Capacities

The existing outlet at Node 102, a 24" diameter CMP pipe is at a gradient of 6.2%. Using the Orifice formula we determined that the pipe capacity = 26.2 cfs. Therefore, the existing 24" outlet pipe will accommodate the 23.9 cfs from the developed site.

Just downstream of the existing outlet at Node 200, an 18" diameter CMP pipe is at a gradient of 15.4%. Using Orifice formula we calculated the pipe capacity = 21.4 cfs. Therefore, the existing 18" outlet pipe will accommodate the 9.3 cfs from the developed site.

The existing outlet at Node 302 is an existing natural swale having a depth of 6.0' at its most constricted point at the outlet. Using Manning's formula we calculated the depth of flow to be 1.64' deep. Therefore, the natural swale will accommodate the combined 51.4 cfs from the developed site and the off-site areas.

~~9.0 Proposed Inlet and Culvert Capacity~~

At Node 101, there is an existing 24" culvert. Currently there is a large amount of debris in the culvert and the upstream end of the culvert is outside of the road easement. As part of the construction of this subdivision, the culvert will need to be cleaned out. In order to maintain the upstream end of the culvert free of debris, the project owner shall:

1. Obtain a notarized irrevocable letter of permission to grade and improve the existing structure, or
2. Shorten the culvert and construct a debris rack at the upstream end of the culvert, within the existing easement/property. The road grading must be adjusted to maintain the required graded width.

9.0 Drainage From Basin E2

Sub Basin E2 has been analyzed separately to ~~install an inlet and culvert under~~determine the capacity of the existing 3 trench drains in the existing driveway on Parcel 2. It has been calculated that Sub-Basin ~~E4~~E2 has an approach flow of 2.5 cfs~~.~~ (or about 0.83 cfs per drain). We will use the ~~orifice formula,~~Manning equation to calculate the ~~inlet capability of a 24" x 24" area drain in a ponded situation, 0.3 ft. deep~~capacity of the trench drains.

Where:

Q = ~~C~~(1.49/n) x A x ~~(2gh)~~R $^{2/3}$ x S $^{1/2}$

N = 0.~~50~~015

~~C = 0.6~~ A = ~~2~~1.0 ft x 1.0 ft = 1.0 sf

R = A/P = 1.0 sf / 3 ft = 0.33 ft

S = 0.005

Q cap. = 3.4 ~~(allowing~~cfs for ~~40% blockage of the area~~each trench drain~~) h =~~ ≥ 0.3~~0~~

~~Q = 36.3 cfs > 2.5~~83 cfs, therefore, maximum approach flow can be intercepted.

~~Using Manning's formula for pipe capacity, we have calculated that an 18" diameter cmp culvert pipe, flowing 2/3 full, at a gradient of 1% has the capacity of 7.2 cfs. Therefore, the 24" inlet and 18" cmp culvert pipe will carry the flow underneath the existing driveway.~~

Velocity for each trench drain = Q/A = 0.83/1.0 = 0.8 fps

Therefore, no energy dissipation is needed.

10.0 Limit of Hydraulic Influence

The maximum width of inundation for the natural swales in Basins E & G have been calculated for the pre and post developed situations using Manning's Equation for depth of flow with an "n" value of 0.06. Assuming each swale having a side slope of 2.5:1 and based on the longitudinal slope of each swale and the Q_{100} flowing in each we determined the following:

Drainage Basin E	Q	n	ss	s	d	A	V	Minimum Width of Swale Required
								(feet)
Pre-Development	26.2	0.06	0.4	0.083	1.37	4.7	5.6	6.9
Post Development	25.3	0.06	0.4	0.083	1.36	4.6	5.5	6.8

Drainage Basin F	Q	n	ss	s	d	A	V	Minimum Width of Swale Required
								(feet)
Pre-Development	10.6	0.06	0.4	0.15	0.88	1.9	5.5	4.4
Post Development	9.3	0.06	0.4	0.15	0.83	1.7	5.3	4.2

Drainage Basin G	Q	n	ss	s	d	A	V	Minimum Width of Swale Required
								(feet)
Pre-Development	50.3	0.06	0.4	0.13	1.63	6.6	7.6	8.1
Post Development	51.4	0.06	0.4	0.13	1.64	6.7	7.7	8.2

11.0 Comparison of Pre and Post Development Flows

Basin	Pre-Development		Post Development		Increase				
	Q_{100}	Velocity	Q_{100}	Vel.	Q_{100}	%	Vel.	%	Comments
	cfs	fps	cfs	fps	cfs		fps		
A	7.6	4.3	7.6	4.3	0.0	0%	0.0	0%	No change in runoff coefficient or time of concentration.
B	3.6	2.1	3.6	2.1	0.0	0%	0.0	0%	No change in runoff coefficient or time of concentration.
G	50.3	7.6	51.4	7.7	1.2	2%	0.0	1%	Slight increase in runoff coefficient.
C	20.9	11.8	20.9	11.8	0.0	0%	0.0	0%	No change in runoff coefficient or time of concentration.
D	23.9	13.5	23.9	13.5	0.0	0%	0.0	0%	No change in runoff coefficient or time of concentration.
E	26.2	5.6	25.3	5.5	-0.9	-4%	0.0	-1%	Slight increase in runoff coefficient, smaller drainage area (see E2).
E2			25.3	14.3	N.A.		N.A.		Separated drainage area to calculate flow under driveway.
F	10.6	5.5	9.3	5.3	-1.3	-12%	-0.2	-3%	Slight increase in runoff coefficient, but a decrease in intensity, due to a longer Ti.

12.0 Conclusion

We have determined that the approach flow from each basin will sheet flow from building lots, along the private driveways or in grass-lined bio-filtration swales.

The entire approach flow will be intercepted, filtered, detained & discharged into the existing storm drain systems along Montana Serena Drive or into natural drainage swales and off the project site. Rock energy dissipaters will be used to prevent adverse downstream impacts in natural drainage courses that might otherwise occur with the slight increases in flows.

We have shown that the increase in flows at the existing culvert under Montana Serena and the culvert under the existing ~~driveway~~driveways will not be adversely impacted.

In fact, due to the low density of the proposed project and the proposed pervious pavements and bio-swales, the hydrologic and hydraulic impact of this project upon the existing drainage system in the area is so small it will be negligible. We have also shown that the existing drainage system is capable of conveying the post development flows.