

APPENDIX B



TECHNICAL MEMORANDUM Preservation Ranch – Evans 1.0 Hydrology Study of Existing and Future Conditions

PREPARED FOR: John Riley, Winzler & Kelly

PREPARED BY: Parastou Hooshialsadat, Winzler & Kelly

REVIEWED BY: Rick Jorgensen, Winzler & Kelly

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1. INTRODUCTION

Winzler & Kelly (W&K) has performed a hydrology study for storm drainage systems within Preservation Ranch, Evans 1.0 Vineyard with a total area of 156.44 acres. This hydrologic study determines the peak 10-year, 25-year and 100-year discharge corresponding to existing and fully developed conditions of the improvement plan. The proposed storm drain system consists of five different pipelines that convey the overland flows into two designated reservoirs.

Input parameters were developed from surface topography, land use projections, soil types, and rainfall patterns of the project area. The purpose of the hydrologic analysis was to establish flow rates of watersheds resulting from design storm events for the existing and proposed conditions as well as a preliminary estimate of pipeline sizing and the capacity of the reservoirs at developed conditions.

2. HYDROLOGY ANALYSIS

The Sonoma County Water Agency (SCWA) developed design criteria and methodology to estimate peak flows for drainage systems in the *Flood Control Design Criteria Manual*. In accordance with SCWA criteria, the 10-year, 25-year, and 100-year design storms were simulated for this study.

The Rational Method as outlined in the standard manual was used to establish peak flows for the 10-year, 25-year, and 100-year flows. The Rational Method relates design discharge (Q) to tributary watershed area (A), intensity of rainfall (I), runoff coefficient (C) and factor (K) with the following equation:

$$Q = k * C * I * A$$

Haestad's Quick TR-55 was used – utilizing the modified Rational Method- to estimate hydrograph volume for watersheds routed to proposed detention basin locations under developed conditions.

2.1 Pre-development Conditions

In accordance with the standards for steep vegetated areas, the runoff coefficient C of 0.30 and initial time of concentration of 15 minutes has been used. Project location indicates a mean seasonal precipitation of 75 inches which gives a value of 2.5 for the K factor. The project area has been divided into several small watersheds as shown in Figures 1 and 2. The calculations and results of 10-year, 25-year and 100-year storm events for each individual tributary area are presented in Table 1. The largest tributary area is 4.42 acre which produces a 100 year peak overland flow of 12.05 cfs.

2.1 Post-development Conditions

The proposed storm drain system consists of five pipelines which collect the overland flows from watersheds 1A, 2A, 2B, 2C and 2D through several drop inlets and carry it into reservoir B and reservoir C as shown in Figures 3 and 4. See Table 2, 5 pages, for sub areas included in each watershed and for recommended pipe sizing. The hydrologic parameters assumed for post-development conditions are the same as pre-development conditions except that the time of concentration for the first overland flow in watershed 2D is 10 minutes since the tributary area is reduced. The pipe velocities were calculated using Manning's equation ($n=0.012$) and assuming full pipe flow. The calculations and results of 10-year, 25-year and 100-year storm events for each individual watershed are presented in Table 2.

The proposed reservoirs are mainly to be utilized for irrigation but are also available for stormwater detention. The design concept is to have two-feet of operational storage, above the irrigation storage pool, for stormwater detention. Outflow from the reservoir above the maximum irrigation pool storage elevation will be controlled by a restricting weir.

Storm runoff generated from watershed 1A will be stored in reservoir B. Preliminary sizing of the reservoir indicates that approximately 3.5 acre-feet of storage will be available in the upper two feet. The 100-year hydrograph developed utilizing Haestad's QUICK TR-55 indicates an approximate volume of 9 acre-feet requiring that approximately 5.5 acre feet will need to be discharged. The peak outflow from Reservoir B is estimated to be just over 6 cfs requiring a 0.5 foot wide weir.

Storm runoff generated from watersheds 2B and 2C combine with the storm runoff from watershed 2A. This, combined with runoff generated from watershed 2D, will be stored in reservoir C. Preliminary sizing of the reservoir indicates that approximately 7 acre-feet will be available in the upper two feet. The 100-year hydrograph developed utilizing Haestad's QUICK TR-55 indicates an approximate volume of 17.5 acre-feet requiring that approximately 10.6 acre feet will need to be discharged. The peak outflow from Reservoir C is estimated to be 12 cfs requiring a 1.2 foot wide weir. Refer to Table 3.

SUMMARY

This hydrologic analysis for Evans 1.0 Vineyard, located on the Preservation Ranch, was conducted to compare runoff rates for existing and fully developed conditions. Using the design criteria established by the SCWA, W&K simulated design storms with recurrence intervals of 10, 25, and 100-years. Hydrology calculations were developed using the Rational Method and land use, rainfall intensity information, and sub-watershed drainage boundaries. Runoff rates were generated at node locations for each of the tributary areas. The ultimate use of these results will be to design the storm drain system and storage reservoir for the proposed vineyard development.

REFERENCES

Sonoma County Water Agency, *Flood Control Design Criteria Manual, 3rd Edition*, August 1983.

**Preservation Ranch - Evans 1.0
Storm Drain Model Study**

Table 1 - Pre-development Conditions

Area	Time of Conc. Tc (min)	K	C	Δ Area (acres)	KΔAC	10-YEAR		25-YEAR		100-YEAR	
						I (in/hr)	Q (ft/sec)	I (in/hr)	Q (ft/sec)	I (in/hr)	Q (ft/sec)
1	15.0	2.50	0.30	1.23	0.92	1.70	1.57	1.95	1.80	2.42	2.24
2	15.0	2.50	0.30	2.31	1.73	1.70	2.95	1.95	3.38	2.42	4.20
3	15.0	2.50	0.30	1.44	1.08	1.70	1.84	1.95	2.11	2.42	2.62
4	15.0	2.50	0.30	3.86	2.90	1.70	4.93	1.95	5.65	2.42	7.01
5	15.0	2.50	0.30	2.04	1.53	1.70	2.61	1.95	2.99	2.42	3.71
6	15.0	2.50	0.30	2.15	1.61	1.70	2.75	1.95	3.15	2.42	3.91
7	15.0	2.50	0.30	2.72	2.04	1.70	3.48	1.95	3.98	2.42	4.94
8	15.0	2.50	0.30	3.05	2.29	1.70	3.90	1.95	4.47	2.42	5.54
9	15.0	2.50	0.30	2.51	1.88	1.70	3.21	1.95	3.68	2.42	4.56
10	15.0	2.50	0.30	1.19	0.89	1.70	1.52	1.95	1.74	2.42	2.16
11	15.0	2.50	0.30	1.53	1.15	1.70	1.96	1.95	2.24	2.42	2.78
12	15.0	2.50	0.30	2.26	1.70	1.70	2.89	1.95	3.31	2.42	4.11
13	15.0	2.50	0.30	2.46	1.85	1.70	3.14	1.95	3.60	2.42	4.47
14	15.0	2.50	0.30	2.22	1.67	1.70	2.84	1.95	3.25	2.42	4.03
15	15.0	2.50	0.30	2.54	1.91	1.70	3.25	1.95	3.72	2.42	4.62
16	15.0	2.50	0.30	3.81	2.86	1.70	4.87	1.95	5.58	2.42	6.92
17	15.0	2.50	0.30	2.61	1.96	1.70	3.34	1.95	3.82	2.42	4.74
18	15.0	2.50	0.30	2.59	1.94	1.70	3.31	1.95	3.79	2.42	4.71
19	15.0	2.50	0.30	3.15	2.36	1.70	4.03	1.95	4.61	2.42	5.72
20	15.0	2.50	0.30	0.73	0.55	1.70	0.93	1.95	1.07	2.42	1.33
21	15.0	2.50	0.30	1.59	1.19	1.70	2.03	1.95	2.33	2.42	2.89
22	15.0	2.50	0.30	1.33	1.00	1.70	1.70	1.95	1.95	2.42	2.42
23	15.0	2.50	0.30	1.24	0.93	1.70	1.58	1.95	1.82	2.42	2.25
24	15.0	2.50	0.30	2.83	2.12	1.70	3.62	1.95	4.15	2.42	5.14
25	15.0	2.50	0.30	1.65	1.24	1.70	2.11	1.95	2.42	2.42	3.00
26	15.0	2.50	0.30	1.33	1.00	1.70	1.70	1.95	1.95	2.42	2.42
27	15.0	2.50	0.30	2.47	1.85	1.70	3.16	1.95	3.62	2.42	4.49
28	15.0	2.50	0.30	2.46	1.85	1.70	3.14	1.95	3.60	2.42	4.47
29	15.0	2.50	0.30	1.68	1.26	1.70	2.15	1.95	2.46	2.42	3.05
30	15.0	2.50	0.30	3.11	2.33	1.70	3.97	1.95	4.56	2.42	5.65
31	15.0	2.50	0.30	2.95	2.21	1.70	3.77	1.95	4.32	2.42	5.36
32	15.0	2.50	0.30	2.85	2.14	1.70	3.64	1.95	4.18	2.42	5.18
33	15.0	2.50	0.30	2.33	1.75	1.70	2.98	1.95	3.41	2.42	4.23
34	15.0	2.50	0.30	4.42	3.32	1.70	5.65	1.95	6.48	2.42	8.03
35	15.0	2.50	0.30	1.26	0.95	1.70	1.61	1.95	1.85	2.42	2.29
36	15.0	2.50	0.30	2.76	2.07	1.70	3.53	1.95	4.04	2.42	5.02
37	15.0	2.50	0.30	3.18	2.39	1.70	4.06	1.95	4.66	2.42	5.78
38	15.0	2.50	0.30	2.60	1.95	1.70	3.32	1.95	3.81	2.42	4.72
39	15.0	2.50	0.30	1.23	0.92	1.70	1.57	1.95	1.80	2.42	2.24
40	15.0	2.50	0.30	1.36	1.02	1.70	1.74	1.95	1.99	2.42	2.47
41	15.0	2.50	0.30	1.00	0.75	1.70	1.28	1.95	1.46	2.42	1.82
42	15.0	2.50	0.30	2.01	1.51	1.70	2.57	1.95	2.94	2.42	3.65

Note : Overland flow for all tributary areas.

Calculated By: PH

Checked By: RJ

**Preservation Ranch - Evans 1.0
Storm Drain Model Study**

Table 2 - Post-development Conditions; Watershed 1A

Node	Area	Elevation (ft)	Distance (ft)	Slope (ft/ft)	Velocity (ft/sec)	(minutes)		K	C	Δ Area (acres)	Total Area (acres)	KΔAC	Σ(KΔAC)	10-YEAR		25-YEAR		100-YEAR		Comments
						Travel Time	Total Time							I (in/hr)	Q (ft/sec)	I (in/hr)	Q (ft/sec)	I (in/hr)	Q (ft/sec)	
						Initial														
1	13	1130				15.0	Initial	2.50	0.45	1.65		1.86		1.70	3.16	1.95	3.63	2.42	4.5	Overland Flow
2	36	1122	300	0.027	9.3	0.5	15.5	2.50	0.45	2.61	4.26	2.94	4.79	1.67	8.02	1.92	9.19	2.38	11.4	15" HDPE
3	35	1107	150	0.100	15.6	0.2	15.7	2.50	0.45	0.26	4.52	0.29	5.09	1.66	8.46	1.91	9.70	2.37	12.0	15" HDPE
4	34	1096	300	0.037	12.4	0.4	16.1	2.50	0.45	4.12	8.64	4.64	9.72	1.64	15.96	1.88	18.30	2.33	22.7	18" HDPE
5	9	1095	250	0.004	5.7	0.7	16.8	2.50	0.45	1.62	10.26	1.82	11.54	1.60	18.51	1.84	21.25	2.28	26.3	18" HDPE
6	32 + 10	1082	220	0.059	15.7	0.2	17.1	2.50	0.45	1.57	11.83	1.77	13.31	1.59	21.19	1.83	24.33	2.26	30.1	18" HDPE
7	5	1075	300	0.023	11.9	0.4	17.5	2.50	0.45	1.83	13.66	2.06	15.37	1.57	24.16	1.81	27.74	2.23	34.3	24" HDPE
8	4	1010	700	0.093	21.8	0.5	18.0	2.50	0.45	3.32	16.98	3.74	19.10	1.55	29.56	1.78	33.95	2.20	42.0	24" HDPE
9	-	965	350	0.129	25.7	0.2	18.2	2.50	0.45	0.00	16.98	0.00	19.10	1.54	29.51	1.77	33.89	2.18	41.9	24" HDPE

Calculated By: PH

Checked By: RJ

**Preservation Ranch - Evans 1.0
Storm Drain Model Study**

Table 2 - Post-development Conditions; Watershed 2A

Node	Area	Elevation (ft)	Distance (ft)	Slope (ft/ft)	Velocity (ft/sec)	Time of Conc.		K	C	Δ Area (acres)	Total Area (acres)	KΔAC	Σ(KΔAC)	10-YEAR		25-YEAR		100-YEAR		Comments
						Travel Time	Total Time							I (in/hr)	Q (ft/sec)	I (in/hr)	Q (ft/sec)	I (in/hr)	Q (ft/sec)	
1	31	1170				15.0	Initial	2.50	0.45	0.73		0.82		1.70	1.40	1.95	1.60	2.42	2.0	Overland Flow
2	30+AA	1162	1050	0.008	5.6	3.1	18.1	2.50	0.45	3.71	4.44	4.18	5.00	1.54	7.71	1.77	8.86	2.19	11.0	18" HDPE
3	15	1160	170	0.012	7.0	0.4	18.5	2.50	0.45	1.31	5.75	1.47	6.47	1.53	9.87	1.75	11.34	2.17	14.0	18" HDPE
4	37	1157	300	0.010	6.5	0.8	19.3	2.50	0.45	1.85	7.60	2.08	8.55	1.49	12.77	1.72	14.68	2.12	18.1	18" HDPE
5	F	1155	600	0.003	3.7	2.7	21.2	2.50	0.45	2.64	10.24	2.97	11.52	1.42	16.37	1.63	18.83	2.02	23.3	27" HDPE

Calculated By: PH

Checked By: RJ

**Preservation Ranch - Evans 1.0
Storm Drain Model Study**

Table 2 - Post-development Conditions; Watershed 2B

Node	Area	Elevation (ft)	Distance (ft)	Slope (ft/ft)	Velocity (ft/sec)	(minutes)		K	C	Δ Area (acres)	Total Area (acres)	KΔAC	Σ(KΔAC)	10-YEAR		25-YEAR		100-YEAR		Comments
						Travel Time	Total Time							I (in/hr)	Q (ft/sec)	I (in/hr)	Q (ft/sec)	I (in/hr)	Q (ft/sec)	
1	A	1172				15.0	Initial	2.50	0.45	0.49		0.55		1.70	0.94	1.95	1.08	2.42	1.3	Overland Flow
2	B+C+D	1171	340	0.003	3.9	1.5	16.5	2.50	0.45	2.15	2.64	2.42	2.97	1.62	4.82	1.86	5.53	2.31	6.9	21" HDPE
3	E	1167	1050	0.004	5.2	3.4	19.8	2.50	0.45	4.88	7.52	5.49	8.46	1.47	12.45	1.69	14.31	2.09	17.7	27" HDPE
4	16+38	1166	400	0.003	4.5	1.5	21.3	2.50	0.45	1.55	9.07	1.74	10.20	1.42	14.46	1.63	16.64	2.01	20.5	30" HDPE
5	17	1165	250	0.004	5.7	0.7	22.0	2.50	0.45	1.28	10.35	1.44	11.64	1.39	16.22	1.60	18.66	1.98	23.0	30" HDPE
7*	-	1155	260	0.038	15.3	0.3	22.3	2.50	0.45	0.00	20.51	0.00	20.51	1.38	28.37	1.59	32.66	1.96	40.3	30" HDPE
8**	-	1150	100	0.050	18.9	0.1	22.4	2.50	0.45	0.00	30.75	0.00	30.75	1.38	42.45	1.59	48.87	1.96	60.3	30" HDPE

* Confluence of WS 2B and WS 2C

** Confluence of WS 2B, WS 2C and WS 2A

Calculated By: PH

Checked By: RJ

**Preservation Ranch - Evans 1.0
Storm Drain Model Study**

Table 2 - Post-development Conditions; Watershed 2C

Node	Area	Elevation (ft)	Distance (ft)	Slope (ft/ft)	Velocity (ft/sec)	(minutes)		K	C	Δ Area (acres)	Total Area (acres)	KΔAC	Σ(KΔAC)	10-YEAR		25-YEAR		100-YEAR		Comments
						Travel Time	Total Time							I (in/hr)	Q (ft/sec)	I (in/hr)	Q (ft/sec)	I (in/hr)	Q (ft/sec)	
1	J	1178				15.0	Initial	2.50	0.45	1.21		1.36		1.70	2.32	1.95	2.66	2.42	3.3	Overland Flow
2	K	1175	800	0.004	4.4	3.0	18.0	2.50	0.45	3.04	4.25	3.42	4.78	1.55	7.39	1.78	8.49	2.20	10.5	21" HDPE
3	L	1172	400	0.008	6.8	1.0	19.0	2.50	0.45	2.56	6.81	2.88	7.66	1.50	11.52	1.73	13.24	2.14	16.4	24" HDPE
4	19	1170	400	0.005	6.0	1.1	20.1	2.50	0.45	0.89	7.70	1.00	8.66	1.46	12.64	1.68	14.53	2.07	18.0	27" HDPE
5	18	1168	370	0.005	6.2	1.0	21.1	2.50	0.45	1.13	8.83	1.27	9.93	1.42	14.13	1.64	16.26	2.02	20.1	27" HDPE
6	17	1165	250	0.012	8.6	0.5	21.6	2.50	0.45	1.33	10.16	1.50	11.43	1.41	16.07	1.62	18.49	2.00	22.8	27" HDPE

Calculated By: PH

Checked By: RJ

**Preservation Ranch - Evans 1.0
Storm Drain Model Study**

Table 2 - Post-development Conditions; Watershed 2D

Node	Area	Elevation (ft)	Distance (ft)	Slope (ft/ft)	Velocity (ft/sec)	Time of Conc.		K	C	Δ Area (acres)	Total Area (acres)	KΔAC	Σ(KΔAC)	10-YEAR		25-YEAR		100-YEAR		Comments	
						Travel Time	Total Time							I (in/hr)	Q (ft/sec)	I (in/hr)	Q (ft/sec)	I (in/hr)	Q (ft/sec)		
1	39	1180				10.0	Initial	2.50	0.45	0.08		0.09			2.11	0.19	2.41	0.22	3.00	0.3	Overland Flow
2	22+I	1160	600	0.033	9.0	1.1	11.1	2.50	0.45	1.64	1.72	1.85	1.94	2.00	3.86	2.28	4.41	2.84	5.5	12" HDPE	
3	23	1158	170	0.012	7.0	0.4	11.5	2.50	0.45	1.10	2.82	1.24	3.17	1.96	6.21	2.24	7.10	2.79	8.8	18" HDPE	
4	H	1156	300	0.007	5.3	0.9	12.5	2.50	0.45	0.77	3.59	0.87	4.04	1.88	7.58	2.15	8.68	2.67	10.8	18" HDPE	
5	24	1155	130	0.008	6.9	0.3	12.8	2.50	0.45	1.95	5.54	2.19	6.23	1.85	11.55	2.12	13.22	2.64	16.4	24" HDPE	
6	25+G	1154	300	0.003	4.9	1.0	13.8	2.50	0.45	1.42	6.96	1.60	7.83	1.78	13.94	2.04	15.96	2.53	19.8	24" HDPE	
7	26	1152	230	0.009	7.3	0.5	14.3	2.50	0.45	0.53	7.49	0.60	8.43	1.75	14.71	2.00	16.85	2.48	20.9	24" HDPE	
8	-	1150	100	0.020	10.1	0.2	14.5	2.50	0.45	0.00	7.49	0.00	8.43	1.73	14.71	1.99	16.85	2.47	20.9	24" HDPE	

Calculated By: PH

Checked By: RJ

**Preservation Ranch - Evans 1.0
Storm Drain Model Study**

Table 3 -Estimated Storage Capacity of Detention Basins

Detention Basin	Storage - upper 2-feet (Ac-Ft)	Contributing Watersheds	Estimated 100-year Hydrograph (Ac-Ft)	Estimated Outflow (cfs)	Peak Storm Duration
B	3.5	1A	9.1	6.2	24-Hour Storm
C	6.9	2A, 2B, 2C	14.0		24-Hour Storm
		2D	3.5		24-Hour Storm
		2A, 2B, 2C, 2D	17.5	12.0	24-Hour Storm

Calculated By: RJ