Appendix G:

Napa Oaks Hydrology and Hydraulics Calculations

Napa Oaks

Hydrology & Hydraulic Calculations

Prepared for:
City of Napa

Developer:
Davidon Homes

Job# 10-1021-10
April 2015

CONSULTING
PLANNING · ENGINEERING · CONSTRUCTION

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NAPA OAKS
HYDROLOGY & HYDRAULIC ANALYSIS

This report has been prepared to show the proposed runoff flows that can be anticipated upon completion of this development. The hydrology and hydraulic calculations and the methods used to size the basins have been prepared using the standard methods approved by the City of Napa.

For ease of reference, a location map (Appendix H), as well as hydrology maps for existing conditions and proposed improvements (Appendix I), have been included in this report.

Introduction

Napa Oaks is an 80.6 acre project site. This planned development is for 53 single-family residential homes. The main access point for the project will be on Old Sonoma Road near Casswall Street. The site is bordered by Old Sonoma Road to the north, residential development to the east and vineyards to the south and west. The development is set on a hillside site, with three existing peaks, with some relatively steep slopes. The site is currently pasture land.

Four primary storm drain systems will be constructed within the streets to convey the 10-year storm. Residential lots will drain into private yard drains. The yard drains will be directed to the streets via sheet flow and through curb drains. The runoff from the lots will ultimately drain to the primary storm drains within the streets via curb inlets and catch basins or will be collected in an area drain system and piped to the primary storm drain system. The storm water runoff from the developed area will drain to one of the two detention/water quality basins that will be incorporated into the site. Three main storm drain systems will collect and convey storm water to the two basins. The main basin will be located near Casswall Street in the vicinity of the intersection of Casswall and Idaho Street. This basin will collect runoff from Storm Drain Lines A and C. This basin collects water from approximately half of the site. The basin will drain to the existing storm drain system in Casswall via a new storm drain line. The secondary basin is located near the Southern boundary. This basin will collect runoff from Strom Drain Line D. This basin will collect runoff from approximately 11 acres of the site. The basin will drain to an existing drainage swale (Raynes Creek) that leaves the site to the south.

The storm water runoff from the open space hillside behind the development will be diverted to field inlets and into the primary storm drain system.

Hydrology

The hydrology calculations herein have been prepared based on the City of Napa's criteria for storm drain systems. The subdivision portion was based on the rational method to calculate the 10-year storm runoff quantities. The rational method uses the formula Q=CiA where Q is the flow in cubic

feet per second, C is the runoff coefficient, i is the rainfall intensity in inches per hour, A is the area of drainage in acres. The runoff coefficients for this project were developed using the City's standard runoff coefficients (see Appendix F). The rainfall intensity numbers for the 10-year storm were interpolated from the City's Rainfall Intensity – Duration tables (see Appendix E).

For the open space areas/overland flow, the time of concentration for the existing conditions, was calculated by using the Kirpich equation (see Appendix C). The length was accomplished by measuring the distance between the most distant points, down to the field inlet within the watershed area. A minimum time of concentration of 5 minute was held for all ditches, if the calculation resulted in a time of concentration of less than 5 minutes.

For non-open space areas, a minimum of 5 minutes from roof to gutter was utilized as the initial time of concentration.

With the initial time of concentration having been calculated, the intensity factors were determined using the City's Rainfall Intensity- Duration tables. The flows to the upstream structures were then determined and calculated using the rational method. The flows into the remaining structures on that same line were then calculated using a time of concentration developed from travel time of the flows in the pipe added to the initial time of concentration. This method was repeated yielding a total flow at the downstream end of the system.

For the calculations of velocity in the pipe, the velocity is calculated as being the product of the average velocity in the pipe times the velocity factor, described below. The average velocity is simply the design Q (flow rate) divided by the area of the pipe. The velocity factor is derived from any standard chart of hydraulic element for circular pipe. The velocity factor calculations are based on several basic factors all derived from a standard chart based on the percent of full flow in the pipe.

<u>Hydraulics</u>

The hydraulic analysis of the storm drain system utilizes generally accepted backwater methodology – where:

HGL (upstream) = Hf + He + Tw

HGL = Hydraulic Grade Line

Hf = Head Loss Due to Friction

He = Head Loss Due to Entrance and Exit Configuration

Tw = Tailwater Elevation

All of the starting HGLs were established using the soffit of the headwalls.

For conservatism, the calculated HGL has been compared to the elevation of the upstream pipe

soffit. The greater value of these two elevations is used as the tailwater elevation for analysis of the next upstream segment. Critical depth has been assumed as the starting tailwater elevation at the point of discharge. The entrance loss coefficients in Appendix F have been used in calculating head loss. Throughout the system, minimum City standards for hydraulic freeboard have been observed.

Basin Sizing – Water Quality

Both basins were sized based on the City of Napa Post Construction Stormwater Pollution Prevention Design Standards. The basins were sized using the Caltrans Basin Sizer Program using a volume based analysis. The program required two variables, the location of the site based on latitude and longitude and the design runoff coefficient. A weighted average of all coefficients for the watersheds within the Napa Oaks project was used. The program uses these variables to calculate the unit basin storage volume (in inches). The report from the Basin Sizer program is included in Appendix D. To determine the minimum basin size for water quality, the unit basin storage volume was multiplied by the tributary drainage area for each basin.

Currently, the designed sizes for the basins are larger than the minimum basin size needed for volume based water quality. The final design of the site will incorporate the basins not just for water quality, but also for detention of storm water.

The discharge pipes from the basin are designed to meter the flow out to accommodate the maximum flow allowed in the downstream system. The riser height (H_o) to limit the flow into the proposed 18" storm drain pipe that will drain both basins will be set using the following equation:

$$Q=CA(2gH-H_o)^{0.5}$$

Where: Q = discharge (maximum flow for outlet pipe in cfs)
C = orifice coefficient (typically 0.66)
A = area of orifice (ft)
G = gravitational constant (32.2 ft/s)
H = water surface elevation (ft)
H_o = orifice elevation (ft)

Basin Sizing - Detention

The detention analysis was completed in conformance with guidelines contained in the City of Napa Public Works Standard Specifications, Section 2- Drainage Design Standards. Per these guidelines the detention basins are sized to provide peak flow attenuation for the 10-, 25-, and 100-year storm events. PondPack software program was used to model the post-development conditions and provide computations for the analysis. Within the model the SCS (Soil Conservation Service) unit hydrograph, SCS Type 1a storm, and SCS Curve Number loss method per the TR-20 method were used to identify pre- and post-project runoff rates from the site.

A number of assumptions were made to approximate the actual physical conditions that would prevail at the site. These include the following:

Watershed delineations: Contributing drainage areas were delineated at points of concentration downstream from the two stormwater basins at the site for both the pre-and post-project site conditions. These delineations are displayed on the attached Figures 1 and 2 with their areas and other modeling parameters tabulated in Appendix D.

Curve Numbers: A uniform Curve Number (CN) of 79 was assigned to the pre- condition watersheds based on standard tables assuming grasslands in fair condition on hydrologic group C soils. A uniform Curve Number (CN) of 83 was assigned to the post- condition watersheds based on standard tables assuming residential districts of approximately ¼ acre lots in fair condition on hydrologic group C soils.

Time lag: Time of concentrations for all undeveloped areas were determined using the SCS Upland Method, where the time of concentration n equals the flow path length divided by a velocity taken from Figure 15.2 in the SCS National Engineering Handbook, Section 4, 1972. Time of concentration through the storm drain was taken to be the piped distance divided by an average velocity of 10 feet/second plus a 10 minute initial roof-to-gutter time on the lots. Time lag was calculated by multiplying the time of concentration by 0.6.

SCS design storms: Rainfall depth-duration tables provided in the City of Napa Public Works Standard Specifications indicate that the total anticipated 10-year, 24-hour rainfall event is on the order of 4.12 inches with a 25-year rainfall of 4.95 inches and a 100-year rainfall of 6.14 inches. This rainfall was distributed in the model using the SCS Type 1a storm distribution.

Basin volumes: Stage-storage relations for the stormwater basins were derived from grading information provided on the tentative map. A summary of the modeled basin parameters are included in Appendix D.

Basin outflow controls: At lower water surface elevations in the basins, flow is assumed to be released through an underdrained sandy soil layer along the basin floor with an infiltration rate of 5 inches per hour. Outflow orifices and riser weirs at higher elevations in the basins provide a controlled release for higher flow rates from the basin. The outlet configurations for each basin are described in greater detailed in Appendix D.

Modeled peak outflows from the pre- and post project watersheds for the 10-, 25-, and 100-year rainfall events are summarized in Appendix D. Results of routing the modeled hydrographs through the proposed basins are included in Appendix D. These results indicate that the basins provide the necessary volume to satisfy the City's peak flow attenuation criteria for the 10-, 25, and 100- year rainfall events.

APPENDIX A

10-1021-10	**10 YEAR HYDROLOGY CALCULATIONS**
DATE: 4/13/15	NAPA OAKS
REV:	POST-DEVELOPED CONDITIONS
BY: SDG	DAVIDON HOMES

DK CONSULTING

n=	0.015	
i=	28	
DESIGN STORM	10	YR

POINT	AREA DSG	AREA (acres)	DESIGN COEFF.	A x C	SUM A x C	TIME C. (min)	I (in/hr)	PEAK FLOW (cfs)	PIPE DIA	VEL. (f/s)	PIPE SLOPE	LENGTH	D TIME (min)	MAX CAPACITY FLOW (cfs)	PIPE (q/Q)	VEL FCTR (v/V)
LINE A																
FI #9	DA FI9	0.79	0.55	0.43	0.43	5.00	3.00	1.30	18	8.30	0.1038	12.04	0.02	29.32	4%	0.50
CB #22	DA CB22	0.97	0.65	0.63	1.07	5.02	2.99	3.18	18	3.09	0.0100	119.09	0.64	9.10	35%	0.60
CB #20	DA CB20, LINE A-12	0.16	0.95	0.15	2.07	5.67	2.92	6.03	18	4.64	0.0100	153.61	0.55	9.11	66%	0.90
CB#19	DA CB19, LINE A-13	0.95	0.11	0.10	2.22	6.22	2.86	6.33	18	4.62	0.0099	98.72	0.36	9.07	70%	0.90
SDMH#3	LINE A-9, LINE A-10	0.00	0.00	0.00	6.07	6.57	2.80	17.00	24	7.17	0.0163	149.79	0.35	25.01	68%	0.90
CB #14	DA CB14, LINE A-8	0.11	0.96	0.11	6.28	6.92	2.78	17.45	24	8.64	0.0533	149.31	0.29	45.25	39%	0.60
SDMH #2	LINE A-6, LINE A-7	0.00	0.00	0.00	7.26	7.21	2.75	19.97	24	11.64	0.0967	418.30	0.60	60.95	33%	0.60
CB #10	DA CB10, LINE A-5	1.80	0.65	1.17	10.42	7.81	2.68	27.92	24	11.49	0.0943	184.24	0.27	60.18	46%	0.60
CB #9	DA CB9, LINE C	0.09	0.95	0.09	16.85	8.08	2.64	44.47	24	16.62	0.0710	133.26	0.13	52.22	85%	1.00
CB #7	DA CB7, LINE A-4, LINE A-3	0.07	0.95	0.07	19.14	8.21	2.62	50.15	24	19.52	0.1209	289.43	0.25	68.15	74%	0.90
CB #5	DA CB5, LINE A2	1.28	0.55	0.70	20.85	8.46	2.60	54.22	24	21.75	0.1500	289.37	0.22	75.91	71%	0.90
CB #3	DA CB3, LINE A-1	0.77	0.55	0.42	21.41	8.68	2.57	55.02	24	18.79	0.1120	288.00	0.26	65.60	84%	0.90
CB #2	DA CB2	0.15	0.95	0.14	21.55	8.93	2.53	55.02	24	17.65	0.0800	22.00	0.02	55.43	99%	1.00
CB #1	DA CB1	0.14	0.95	0.13	21.69	8.96	2.53	55.02	24	25.76	0.2105	65.88	0.04	89.93	61%	0.90
SDMH #1	-	0.00	0.00	0.00	21.69	9.00	2.51	55.02	24	23.23	0.1712	64.53	0.05	81.10	68%	0.90
HW #1						9.04										

POINT	AREA DSG	AREA (acres)	DESIGN COEFF.	A x C	SUM A x C	TIME C. (min)	I (in/hr)	PEAK FLOW (cfs)	PIPE DIA	VEL. (f/s)	PIPE SLOPE	LENGTH	D TIME (min)	MAX CAPACITY FLOW (cfs)	PIPE (q/Q)	VEL FCTR (v/V)
LINE A-1																
CB #4	DA CB4	0.14	0.95	0.13	0.13	5.00	3.00	0.40	18	2.57	0.0100	22.00	0.14	9.10	4%	0.50
CB #3						5.14										
LINE A-2																
CB #6	DA CB6	1.55	0.65	1.01	1.01	5.00	3.00	3.02	18	3.09	0.0100	22.00	0.12	9.10	33%	0.60
CB #5						5.12										
LINE A-3																
CB #8	DA CB8	1.40	0.65	0.91	0.91	5.00	3.00	2.73	18	3.09	0.0100	57.86	0.31	9.11	30%	0.60
CB #7						5.31										
LINE A-4																
FI #1	DA FI1	2.03	0.65	1.32	1.32	5.57	2.90	3.83	18	15.66	0.3700	18.00	0.02	55.36	7%	0.50
CB #7						5.59										
LINE A-5																
FI #2	DA FI2	3.30	0.55	1.82	1.82	5.00	3.00	5.45	18	4.60	0.0110	12.67	0.05	9.57	57%	0.85
CB #11	DA CB11	0.18	0.95	0.17	1.99	5.05	2.97	5.90	18	14.07	0.2985	22.01	0.03	49.72	12%	0.50
CB #10						5.07										
LINE A-6																
CB #12	DA CB12	0.15	0.95	0.14	0.14	5.00	3.00	0.43	18	5.76	0.0501	21.97	0.06	20.36	2%	0.50
SDMH #2						5.06										
LINE A-7																
FI #3	DA FI3	0.83	0.65	0.54	0.54	5.00	3.00	1.62	18	5.69	0.0488	11.48	0.03	20.10	8%	0.50
CB #13	DA CB13	0.47	0.65	0.31	0.85	5.03	2.98	2.52	18	8.19	0.1012	51.36	0.10	28.96	9%	0.50
SDMH #2						5.14										
LINE A-8																
FI #4	DA FI4	0.18	0.55	0.10	0.10	5.00	3.00	0.30	18	1.79	0.0048	20.75	0.19	6.32	5%	0.50
CB #14						5.19										
LINE A-9																
CB #15	DA CB15	2.60	0.65	1.69	1.69	5.00	3.00	5.07	18	12.14	0.2222	32.50	0.04	42.89	12%	0.50
SDMH #3						5.04										

POINT	AREA DSG	AREA (acres)	DESIGN COEFF.	A x C	SUM A x C	TIME C. (min)	I (in/hr)	PEAK FLOW (cfs)	PIPE DIA	VEL. (f/s)	PIPE SLOPE	LENGTH	D TIME (min)	MAX CAPACITY FLOW (cfs)	PIPE (q/Q)	VEL FCTR (v/V)
LINE A-10																
FI #5	DA FI5	1.22	0.55	0.67	0.67	5.00	3.00	2.01	18	7.82	0.0922	11.50	0.02	27.63	7%	0.50
CB #17	DA CB17	0.35	0.65	0.23	0.90	5.02	2.98	2.68	18	6.19	0.0577	128.16	0.35	21.87	12%	0.50
CB #16	DA CB16, LINE A-11	0.67	0.65	0.44	2.17	5.37	2.96	6.41	18	9.17	0.1269	52.00	0.09	32.42	20%	0.50
SDMH #3						5.02										
LINE A-11																
CB #18	DA CB18	1.28	0.65	0.83	0.83	5.00	3.00	2.50	18	3.78	0.0150	22.00	0.10	11.15	22%	0.60
CB #16						5.10										
LINE A-12																
FI #8	DA FI7	0.15	0.55	0.08	0.08	5.00	3.00	0.25	18	11.85	0.2117	74.62	0.10	41.88	1%	0.50
FI #9	DA FI6	0.22	0.55	0.12	0.20	5.10	2.98	0.61	18	3.19	0.0154	11.05	0.06	11.29	5%	0.50
CB #21	DA CB21	0.68	0.95	0.65	0.85	5.16	2.97	2.52	18	14.59	0.3209	21.41	0.02	51.55	5%	0.50
CB #20						5.19										
LINE A-13																
FI #6	DA FI6	0.08	0.55	0.04	0.04	5.00	3.00	0.13	18	13.40	0.2707	34.65	0.04	47.35	0%	0.50
CB #19						5.04										
LINE B																
FI #10	DA FI10	6.49	0.55	3.57	3.57	6.43	2.83	10.10	18	13.82	0.2000	12.00	0.01	40.70	25%	0.60
CB #24	DA CB24	0.15	0.95	0.14	3.71	6.44	2.82	10.47	18	5.14	0.0100	69.20	0.22	9.09	115%	1.00
CB #23	DA CB23	0.22	0.95	0.21	3.92	6.67	2.81	11.02	18	5.15	0.0100	45.05	0.15	9.10	121%	1.00
SDMH #4						6.81										
LINE C																
CB #32	DA CB32	2.86	0.65	1.86	1.86	5.00	3.00	5.58	18	4.63	0.0100	38.00	0.14	9.10	61%	0.90
CB #31	DA CB31	1.49	0.65	0.97	2.83	5.14	2.98	8.43	18	5.15	0.0100	65.00	0.21	9.10	93%	1.00
SDMH #5	-	0.00	0.00	0.00	2.83	5.35	2.96	8.43	18	7.02	0.0516	31.00	0.07	20.68	41%	0.60
CB #30	DA CB30	1.52	0.65	0.99	3.82	5.42	2.95	11.26	18	12.15	0.1545	172.34	0.24	35.77	31%	0.60
CB #28	DA CB28, LINE C-4	0.25	0.65	0.16	4.19	5.66	2.93	12.27	18	11.91	0.1486	139.00	0.19	35.08	35%	0.60
CB #27	DA CB27, LINE C-3	0.37	0.60	0.22	4.69	5.85	2.92	13.70	18	11.51	0.1388	130.94	0.19	33.90	40%	0.60
CB #26	DA CB26	0.07	0.95	0.07	4.76	6.04	2.88	13.70	18	16.50	0.2850	27.16	0.03	48.58	28%	0.60

POINT	AREA DSG	AREA (acres)	DESIGN COEFF.	A x C	SUM A x C	TIME C. (min)	I (in/hr)	PEAK FLOW (cfs)	PIPE DIA	VEL. (f/s)	PIPE SLOPE	LENGTH	D TIME (min)	MAX CAPACITY FLOW (cfs)	PIPE (q/Q)	VEL FCTR (v/V)
SDMH #4	LINE C-1, LINE C-2	0.00	0.00	0.00	6.34	6.07	2.86	18.14	24	6.23	0.0100	22.05	0.06	19.58	93%	1.00
CB #9						6.13										
LINE C-1																
FI #11	DA FI11	2.10	0.55	1.16	1.16	5.00	3.00	3.47	18	5.30	0.0424	71.88	0.23	18.75	18%	0.50
SDMH #4						5.23										
LINE C-2																
CB #22	DA CB22	0.66	0.65	0.43	0.43	5.00	3.00	1.29	18	10.62	0.1699	48.25	0.08	37.52	3%	0.50
SDMH #4						5.08										
LINE C-3																
FI #12	DA FI12	0.51	0.55	0.28	0.28	5.00	3.00	0.84	18	5.50	0.0457	34.39	0.10	19.44	4%	0.50
CB #27						5.10										
LINE C-4																
CB #29	DA CB29	0.30	0.70	0.21	0.21	5.00	3.00	0.63	18	1.82	0.0050	22.00	0.20	6.44	10%	0.50
CB #28						5.20										
LINE D																
FI #13	DA FI13	2.94	0.55	1.62	1.62	5.00	3.00	4.85	18	8.10	0.0687	11.50	0.02	23.85	20%	0.60
CB #33	DA CB33, LINE D-1	0.21	0.95	0.20	1.82	5.02	2.99	5.43	18	4.81	0.0242	374.85	1.30	14.16	38%	0.60
CB #35	DA CB35	2.27	0.65	1.48	3.29	6.32	2.85	9.38	18	8.10	0.0342	61.65	0.13	16.84	56%	0.85
CB #36	DA CB26	0.20	0.95	0.19	3.48	6.45	2.83	9.85	18	7.96	0.0330	235.22	0.49	16.54	60%	0.85
CB #37	DA CB37	4.03	0.65	2.62	6.10	6.94	2.78	16.96	18	16.03	0.1341	19.09	0.02	33.33	51%	0.85
HW #2						6.96										
LINE D-1																
CB #34	DA CB34	0.90	0.65	0.59	0.59	5.00	3.00	1.76	18	2.18	0.0050	30.00	0.23	6.44	27%	0.60
CB #33						5.23										
LINE E																
RISER #2	BASIN #2	-	-	-	-	-	-	16.96	18	14.01	0.2056	72.94	0.09	41.27	41%	0.60
OUTFALL #1																

POINT	AREA DSG	AREA (acres)	DESIGN COEFF.	A x C	SUM A x C	TIME C. (min)	I (in/hr)	PEAK FLOW (cfs)	PIPE DIA	VEL. (f/s)	PIPE SLOPE	LENGTH	D TIME (min)	MAX CAPACITY FLOW (cfs)	PIPE (q/Q)	VEL FCTR (v/V)
LINE F																
RISER #1 EX CB	BASIN #1	-	-	-	-	-	-	55.02	18	5.15	0.0100	99.98	0.32	9.10	605%	1.00

10-1021-10	**100 YEAR HYDROLOGY CALCULATIONS**
DATE: 4/13/15	NAPA OAKS
REV:	POST-DEVELOPED CONDITIONS
BY: SDG	DAVIDON HOMES

DK CONSULTING

n=	0.015	
i=	28	
DESIGN STORM	100	YR

POINT	AREA DSG	AREA (acres)	DESIGN COEFF.	A x C	SUM A x C	TIME C. (min)	I (in/hr)	PEAK FLOW (cfs)	PIPE DIA	VEL. (f/s)	PIPE SLOPE	LENGTH	D TIME (min)	MAX CAPACITY FLOW (cfs)	PIPE (q/Q)	VEL FCTR (v/V)
LINE A																
FI #9	DA FI9	0.79	0.55	0.43	0.43	5.00	4.32	1.88	18	8.30	0.1038	12.04	0.02	29.32	6%	0.50
CB #22	DA CB22	0.97	0.65	0.63	1.07	5.02	4.31	4.59	18	4.38	0.0100	119.09	0.45	9.10	50%	0.85
CB #20	DA CB20, LINE A-12	0.16	0.95	0.15	2.07	5.48	4.25	8.78	18	5.16	0.0100	153.61	0.50	9.11	96%	1.00
CB#19	DA CB19, LINE A-13	0.95	0.11	0.10	2.22	5.97	4.17	9.24	18	5.13	0.0099	98.72	0.32	9.07	102%	1.00
SDMH#3	LINE A-9, LINE A-10	0.00	0.00	0.00	6.07	6.29	4.12	25.01	24	7.96	0.0163	149.79	0.31	25.01	100%	1.00
CB #14	DA CB14, LINE A-8	0.11	0.96	0.11	6.28	6.61	4.07	25.54	24	12.24	0.0533	149.31	0.20	45.25	56%	0.85
SDMH #2	LINE A-6, LINE A-7	0.00	0.00	0.00	7.26	6.81	4.05	29.42	24	11.64	0.0967	418.30	0.60	60.95	48%	0.60
CB #10	DA CB10, LINE A-5	1.80	0.65	1.17	10.42	7.41	3.95	41.16	24	17.24	0.0943	184.24	0.18	60.18	68%	0.90
CB #9	DA CB9, LINE C	0.09	0.95	0.09	16.85	7.59	3.92	66.03	24	16.62	0.0710	133.26	0.13	52.22	126%	1.00
CB #7	DA CB7, LINE A-4, LINE A-3	0.07	0.95	0.07	19.14	7.72	3.91	74.84	24	21.69	0.1209	289.43	0.22	68.15	110%	1.00
CB #5	DA CB5, LINE A2	1.28	0.55	0.70	20.85	7.94	3.88	80.91	24	24.16	0.1500	289.37	0.20	75.91	107%	1.00
CB #3	DA CB3, LINE A-1	0.77	0.55	0.42	21.41	8.14	3.85	82.43	24	20.88	0.1120	288.00	0.23	65.60	126%	1.00
CB #2	DA CB2	0.15	0.95	0.14	21.55	8.37	3.78	82.43	24	17.65	0.0800	22.00	0.02	55.43	149%	1.00
CB #1	DA CB1	0.14	0.95	0.13	21.69	8.39	3.71	82.43	24	28.63	0.2105	65.88	0.04	89.93	92%	1.00
SDMH #1	-	0.00	0.00	0.00	21.69	8.43	3.70	82.43	24	25.82	0.1712	64.53	0.04	81.10	102%	1.00
HW #1						8.47										

POINT	AREA DSG	AREA (acres)	DESIGN COEFF.	A x C	SUM A x C	TIME C. (min)	I (in/hr)	FLOW (cfs)	PIPE DIA	VEL. (f/s)	PIPE SLOPE	LENGTH	D TIME (min)	FLOW (cfs)	PIPE (q/Q)	VEL FCTR (v/V)
LINE A-1																
CB #4	DA CB4	0.14	0.95	0.13	0.13	5.00	4.32	0.57	18	2.57	0.0100	22.00	0.14	9.10	6%	0.50
CB #3						5.14										
LINE A-2																
CB #6	DA CB6	1.55	0.65	1.01	1.01	5.00	4.32	4.35	18	3.09	0.0100	22.00	0.12	9.10	48%	0.60
CB #5						5.12										
LINE A-3																
CB #8	DA CB8	1.4	0.65	0.91	0.91	5.00	4.32	3.93	18	3.09	0.0100	57.86	0.31	9.11	43%	0.60
CB #7						5.31										
LINE A-4																
FI #1	DA FI1	2.03	0.65	1.32	1.32	5.00	4.32	5.70	18	15.66	0.3700	18.00	0.02	55.36	10%	0.50
CB #7						5.02										
LINE A-5																
FI #2	DA FI2	3.3	0.55	1.82	1.82	5.00	4.32	7.84	18	4.87	0.0110	12.67	0.04	9.57	82%	0.90
CB #11	DA CB11	0.18	0.95	0.17	1.99	5.04	4.31	8.56	18	14.07	0.2985	22.01	0.03	49.72	17%	0.50
CB #10						5.07										
LINE A-6																
CB #12	DA CB12	0.15	0.95	0.14	0.14	5.00	4.32	0.62	18	5.76	0.0501	21.97	0.06	20.36	3%	0.50
SDMH #2						5.06										
LINE A-7																
FI #3	DA FI3	0.83	0.65	0.54	0.54	5.00	4.32	2.33	18	5.69	0.0488	11.48	0.03	20.10	12%	0.50
CB #13	DA CB13	0.47	0.65	0.31	0.85	5.03	4.31	3.64	18	8.19	0.1012	51.36	0.10	28.96	13%	0.50
SDMH #2						5.14										
LINE A-8																
FI #4	DA FI4	0.18	0.55	0.10	0.10	5.00	4.32	0.43	18	1.79	0.0048	20.75	0.19	6.32	7%	0.50
CB #14						5.19										

POINT	AREA DSG	AREA (acres)	DESIGN COEFF.	A x C	SUM A x C	TIME C. (min)	I (in/hr)	FLOW (cfs)	PIPE DIA	VEL. (f/s)	PIPE SLOPE	LENGTH	D TIME (min)	FLOW (cfs)	PIPE (q/Q)	VEL FCTR (v/V)
LINE A-9																
CB #15	DA CB15	2.6	0.65	1.69	1.69	5.00	4.32	7.30	18	12.14	0.2222	32.50	0.04	42.89	17%	0.50
SDMH #3						5.04										
LINE A-10																
FI #5	DA FI5	1.22	0.55	0.67	0.67	5.00	4.32	2.90	18	7.82	0.0922	11.50	0.02	27.63	10%	0.50
CB #17	DA CB17	0.35	0.65	0.23	0.90	5.02	4.31	3.87	18	6.19	0.0577	128.16	0.35	21.87	18%	0.50
CB #16	DA CB16, LINE A-11	0.67	0.65	0.44	2.17	5.37	4.26	9.23	18	11.01	0.1269	52.00	0.08	32.42	28%	0.60
SDMH #3											0.0000					
LINE A-11																
CB #18	DA CB18	1.28	0.65	0.83	0.83	5.00	4.32	3.59	18	3.78	0.0150	22.00	0.10	11.15	32%	0.60
CB #16						5.10										
LINE A-12																
FI #8	DA FI7	0.15	0.55	0.08	0.08	5.00	4.32	0.36	18	11.85	0.2117	74.62	0.10	41.88	1%	0.50
FI #9	DA FI6	0.22	0.55	0.12	0.20	5.10	4.31	0.88	18	3.19	0.0154	11.05	0.06	11.29	8%	0.50
CB #21	DA CB21	0.68	0.95	0.65	0.85	5.16	4.30	3.65	18	14.59	0.3209	21.41	0.02	51.55	7%	0.50
CB #20																
LINE A-13																
FI #6	DA FI6	0.08	0.55	0.04	0.04	5.00	4.32	0.19	18	13.40	0.2707	34.65	0.04	47.35	0%	0.50
CB #19						5.04										
LINE B																
FI #10	DA FI10	6.49	0.55	3.57	3.57	5.00	4.32	15.42	18	13.82	0.2000	12.00	0.01	40.70	38%	0.60
CB #24	DA CB24	0.15	0.95	0.14	3.71	5.01	4.32	16.04	18	5.14	0.0100	69.20	0.22	9.09	176%	1.00
CB #23	DA CB23	0.22	0.95	0.21	3.92	5.24	4.30	16.86	18	5.15	0.0100	45.05	0.15	9.10	185%	1.00
SDMH #4						5.38										
LINE C																
CB #32	DA CB32	2.86	0.65	1.86	1.86	5.00	4.32	8.03	18	5.15	0.0100	38.00	0.12	9.10	88%	1.00
CB #31	DA CB31	1.49	0.65	0.97	2.83	5.12	4.30	12.16	18	5.15	0.0100	65.00	0.21	9.10	134%	1.00
SDMH #5	-	0.00	0.00	0.00	2.83	5.33	4.27	12.16	18	9.95	0.0516	31.00	0.05	20.68	59%	0.85

POINT	AREA DSG	AREA (acres)	DESIGN COEFF.	A x C	SUM A x C	TIME C. (min)	I (in/hr)	FLOW (cfs)	PIPE DIA	VEL. (f/s)	PIPE SLOPE	LENGTH	D TIME (min)	FLOW (cfs)	PIPE (q/Q)	VEL FCTR (v/V)
CB #30	DA CB30	1.52	0.65	0.99	3.82	5.39	4.26	16.25	18	12.15	0.1545	172.34	0.24	35.77	45%	0.60
CB #28	DA CB28, LINE C-4	0.25	0.65	0.16	4.19	5.62	4.23	17.72	18	16.87	0.1486	139.00	0.14	35.08	51%	0.85
CB #27	DA CB27, LINE C-3	0.37	0.60	0.22	4.69	5.76	4.20	19.70	18	16.31	0.1388	130.94	0.13	33.90	58%	0.85
CB #26	DA CB26	0.07	0.95	0.07	4.76	5.89	4.18	19.88	18	16.50	0.2850	27.16	0.03	48.58	41%	0.60
SDMH #4	LINE C-1, LINE C-2	0.00	0.00	0.00	6.34	5.92	4.15	26.32	24	6.23	0.0100	22.05	0.06	19.58	134%	1.00
CB #9						5.98										
LINE C-1																
FI #11	DA FI11	2.1	0.55	1.16	1.16	5.00	4.32	4.99	18	6.37	0.0424	71.88	0.19	18.75	27%	0.60
SDMH #4						5.19										
LINE C-2																
CB #22	DA CB22	0.66	0.65	0.43	0.43	5.00	4.32	1.85	18	10.62	0.1699	48.25	0.08	37.52	5%	0.50
SDMH #4						5.08										
LINE C-3																
FI #12	DA FI12	0.51	0.55	0.28	0.28	5.00	4.32	1.21	18	5.50	0.0457	34.39	0.10	19.44	6%	0.50
CB #27						5.10										
LINE C-4																
CB #29	DA CB29	0.3	0.7	0.21	0.21	5.00	4.32	0.91	18	1.82	0.0050	22.00	0.20	6.44	14%	0.50
CB #28						5.20										
LINE D																
FI #13	DA FI13	2.94	0.55	1.62	1.62	5.00	4.32	6.99	18	8.10	0.0687	11.50	0.02	23.85	29%	0.60
CB #33	DA CB33, LINE D-1	0.21	0.95	0.20	1.82	5.02	4.32	7.85	18	6.81	0.0242	374.85	0.92	14.16	55%	0.85
CB #35	DA CB35	2.27	0.65	1.48	3.29	5.94	4.17	13.73	18	8.57	0.0342	61.65	0.12	16.84	82%	0.90
CB #36	DA CB26	0.20	0.95	0.19	3.48	6.06	4.15	14.45	18	9.36	0.0330	235.22	0.42	16.54	87%	1.00
CB #37	DA CB37	4.03	0.65	2.62	6.10	6.48	4.10	25.02	18	16.97	0.1341	19.09	0.02	33.33	75%	0.90
HW #2						6.50										

APPENDIX B

10-1021-10
DATE: 4/13/15
REV:
BY: SDG

HYDRAULIC CALCULATIONS
NAPA OAKS
POST-DEVELOPED CONDITIONS
DAVIDON HOMES

DK CONSULTING

n=	0.015	
i=	28	
DESIGN STORM	10	YR

LOW POINT	HIGH POINT	DESIGN FLOW Q	PIPE DIA D	VELOCITY V	LENGTH L	FRICTION SLOPE Sf	JUNCT FACTOR K	JUNCT LOSS Hj	FRICTION LOSS Hl	TOTAL LOSS Ht	PIPE INV	PIPE SLOPE	WATER SURFACE HGL	HEAD WTR D+INV SOF	RIM ELEV	FREE-BOARD	COVER
LINE A																	
	HW #1										66.00		68.00		68.00		
HW #1	SDMH #1	55.02	24	17.51	64.53	0.0788	0.42	2.00	5.08	7.08	77.05	0.1712	79.05	79.05	91.30	12.25	12.25
SDMH #1	CB #1	55.02	24	17.51	65.88	0.0788	0.42	2.00	5.19	7.19	90.92	0.2105	92.92	92.92	101.94	9.02	9.02
CB #1	CB #2	55.02	24	17.51	22.00	0.0788	1.25	5.95	1.73	7.69	92.68	0.0800	100.61	94.68	101.94	1.33	7.26
CB #2	CB #3	55.02	24	17.51	288.00	0.0788	0.17	0.81	22.68	23.49	124.94	0.1120	126.94	126.94	134.14	7.20	7.20
CB #3	CB #5	54.22	24	17.26	289.37	0.0765	0.17	0.79	22.13	22.92	168.35	0.1500	170.35	170.35	176.80	6.45	6.45
CB #5	CB #7	50.15	24	15.96	289.43	0.0654	0.17	0.67	18.94	19.61	203.34	0.1209	205.34	205.34	212.72	7.38	7.38
CB #7	CB #9	44.47	24	14.16	133.26	0.0515	0.17	0.53	6.86	7.39	212.80	0.0710	214.80	214.80	222.91	8.11	8.11
CB #9	CB #10	27.92	24	8.89	184.24	0.0203	0.17	0.21	3.74	3.95	229.89	0.0943	231.89	231.89	239.34	7.45	7.45
CB #10	SDMH #2	19.97	24	6.36	418.30	0.0104	1.25	0.78	4.34	5.13	270.34	0.0967	272.34	272.34	275.90	3.56	3.56
SDMH #2	CB #14	17.45	24	5.55	149.31	0.0079	0.17	0.08	1.18	1.26	276.70	0.0533	278.70	278.70	283.32	4.62	4.62
CB #14	SDMH#3	17.00	24	5.41	149.79	0.0075	0.25	0.11	1.13	1.24	279.14	0.0163	281.14	281.14	290.20	9.06	9.06
SDMH#3	CB#19	6.33	18	3.58	98.72	0.0048	0.17	0.03	0.48	0.51	280.12	0.0099	281.65	281.62	292.81	11.16	11.19
CB#19	CB #20	6.03	18	3.41	153.61	0.0044	0.17	0.03	0.67	0.71	281.66	0.0100	283.16	283.16	292.69	9.53	9.53
CB #20	CB #22	3.18	18	1.80	119.09	0.0012	1.25	0.06	0.15	0.21	282.85	0.0100	284.35	284.35	286.85	2.50	2.50
CB #22	FI #9	1.30	18	0.74	12.04	0.0002	0.17	0.00	0.00	0.00	284.10	0.1038	285.60	285.60	287.60	2.00	2.00
FI #9																	
LINE A-1																	
	CB #3										125.44		126.94		134.14		
CB #3	CB #4	0.40	18	0.23	22.00	0.0000	1.25	0.00	0.00	0.00	125.66	0.0100	127.16	127.16	134.14	6.98	6.98
CB #4																	

LOW POINT	HIGH POINT	DESIGN FLOW Q	PIPE DIA D	VELOCITY V	LENGTH L	FRICTION SLOPE Sf	JUNCT FACTOR K	JUNCT LOSS Hj	FRICTION LOSS Hl	TOTAL LOSS Ht	PIPE INV	PIPE SLOPE	WATER SURFACE HGL	HEAD WTR D+INV SOF	RIM ELEV	FREE-BOARD	COVER
LINE A-2																	
	CB #5										168.85		170.35		176.80		
CB #5	CB #6	3.02	18	1.71	22.00	0.0011	1.25	0.06	0.02	0.08	169.07	0.0100	170.57	170.57	176.80	6.23	6.23
CB #6																	
LINE A-3																	
	CB #7										203.84		205.34		212.72		
CB #7	CB #8	2.73	18	1.54	57.86	0.0009	1.25	0.05	0.05	0.10	204.42	0.3700	205.92	205.92	212.33	6.41	6.41
CB #8																	
LINE A-4																	
	CB #7										203.84		205.34		212.72		
CB #7	FI #1	3.83	18	2.17	18.00	0.0018	1.25	0.09	0.03	0.12	204.42	0.3700	205.92	205.92	214.00	8.08	8.08
FI #1																	
LINE A-5																	
	CB #10										230.39		231.89		239.34		
CB #10	CB #11	5.90	18	3.34	22.01	0.0042	0.17	0.03	0.09	0.12	236.96	0.2985	238.46	238.46	239.80	1.34	1.34
CB #11	FI #2	5.45	18	3.08	12.67	0.0036	1.25	0.18	0.05	0.23	237.10	0.0110	238.69	238.60	240.60	1.91	2.00
FI #2																	
LINE A-6																	
	SDMH #2										269.24		272.34		275.90		
SDMH #2	CB #12	0.43	18	0.24	21.97	0.0000	1.25	0.00	0.00	0.00	270.34	0.0501	272.34	271.84	275.97	3.63	4.13
CB #12																	
LINE A-7																	
	SDMH #2										269.24		272.34		275.90		
SDMH #2	CB #13	2.52	18	1.42	51.36	0.0008	0.17	0.01	0.04	0.04	274.44	0.1012	275.94	275.94	278.06	2.12	2.12
CB #13	FI #3	1.62	18	0.92	11.48	0.0003	1.25	0.02	0.00	0.02	275.00	0.0488	276.50	276.50	278.50	2.00	2.00
FI #3																	
LINE A-8																	
	CB #14										278.70		278.70		283.32		
CB #14	FI #4	0.30	18	0.17	20.75	0.0000	1.25	0.00	0.00	0.00	276.80	0.0048	278.70	278.30	280.30	1.60	2.00
FI #4																	

LOW POINT	HIGH POINT	DESIGN FLOW Q	PIPE DIA D	VELOCITY V	LENGTH L	FRICTION SLOPE Sf	JUNCT FACTOR K	JUNCT LOSS Hj	FRICTION LOSS Hl	TOTAL LOSS Ht	PIPE INV	PIPE SLOPE	WATER SURFACE HGL	HEAD WTR D+INV SOF	RIM ELEV	FREE-BOARD	COVER
LINE A-9																	
	SDMH #3										279.14		281.14		290.20		
SDMH #3	CB #15	5.07	18	2.87	32.50	0.0031	1.25	0.16	0.10	0.26	286.36	0.2222	287.86	287.86	290.36	2.50	2.50
CB #15																	
LINE A-10																	
	SDMH #3										279.14		281.14		290.20		
SDMH #3	CB #16	6.41	18	3.63	52.00	0.0050	1.25	0.26	0.26	0.51	285.74	0.1269	287.24	287.24	290.07	2.83	2.83
CB #16	CB #17	2.68	18	1.52	128.16	0.0009	1.25	0.04	0.11	0.16	293.14	0.0577	294.64	294.64	297.14	2.50	2.50
CB #17	FI #5	2.01	18	1.14	11.50	0.0005	0.17	0.00	0.01	0.01	294.20	0.0922	295.70	295.70	297.70	2.00	2.00
FI #5																	
LINE A-11																	
	CB #16										285.74		287.24		290.07		
CB #16	CB #18	2.50	18	1.41	22.00	0.0008	1.25	0.04	0.02	0.06	286.07	0.0150	287.57	287.57	290.07	2.50	2.50
CB #18																	
LINE A-12																	
	CB #20										281.66		283.16		292.69		
CB #20	CB #21	2.52	18	1.43	21.41	0.0008	0.75	0.02	0.02	0.04	288.53	0.3209	290.03	290.03	292.19	2.16	2.16
CB #21	FI #9	0.61	18	0.34	11.05	0.0000	1.25	0.00	0.00	0.00	288.70	0.0154	290.20	290.20	292.20	2.00	2.00
FI #9	FI #8	0.25	18	0.14	74.62	0.0000	1.25	0.00	0.00	0.00	304.50	0.2117	306.00	306.00	308.00	2.00	2.00
FI #8																	
LINE A-13																	
	CB #19										280.12		281.65		292.81		
CB #19	FI #6	0.13	18	0.07	34.65	0.0000	1.25	0.00	0.00	0.00	289.50	0.2707	291.00	291.00	293.50	2.50	2.50
FI #6																	
LINE B																	
	SDMH #4										80.50		79.05		91.30		
SDMH #4	CB #23	11.02	18	6.24	45.05	0.0146	1.25	0.75	0.66	1.41	80.95	0.0100	82.45	82.45	89.10	6.65	6.65
CB #23	CB #24	10.47	18	5.92	69.20	0.0132	0.50	0.27	0.92	1.19	81.64	0.0100	83.64	83.14	89.40	5.76	6.26
CB #24	FI #10	10.10	18	5.72	12.00	0.0123	1.25	0.63	0.15	0.78	84.04	0.2000	85.54	85.54	90.65	5.11	5.11
FI #10																	
LINE C																	
	CB #9										212.30		214.80		222.91		
CB #9	SDMH #4	18.14	24	5.77	22.05	0.0086	0.25	0.13	0.19	0.32	212.52	0.0100	215.12	214.52	223.00	7.88	8.48
SDMH #4	CB #26	13.70	18	7.75	27.16	0.0226	0.17	0.16	0.62	0.77	220.76	0.2850	222.26	222.26	225.76	3.50	3.50
CB #26	CB #27	13.70	18	7.75	130.94	0.0226	0.17	0.16	2.96	3.12	238.93	0.1388	240.43	240.43	243.43	3.00	3.00

LOW POINT	HIGH POINT	DESIGN FLOW Q	PIPE DIA D	VELOCITY V	LENGTH L	FRICTION SLOPE Sf	JUNCT FACTOR K	JUNCT LOSS Hj	FRICTION LOSS Hl	TOTAL LOSS Ht	PIPE INV	PIPE SLOPE	WATER SURFACE HGL	HEAD WTR D+INV SOF	RIM ELEV	FREE-BOARD	COVER
CB #27	CB #28	12.27	18	6.94	139.00	0.0182	0.17	0.13	2.53	2.65	259.58	0.1486	261.08	261.08	264.50	3.42	3.42
CB #28	CB #30	11.26	18	6.37	172.34	0.0153	0.17	0.11	2.63	2.74	286.21	0.1545	287.71	287.71	290.33	2.62	2.62
CB #30	SDMH #5	8.43	18	4.77	31.00	0.0086	1.25	0.44	0.27	0.71	287.81	0.0516	289.31	289.31	292.90	3.59	3.59
SDMH #5	CB #31	8.43	18	4.77	65.00	0.0086	1.25	0.44	0.56	1.00	288.46	0.0100	290.31	289.96	293.63	3.32	3.67
CB #31	CB #32	5.58	18	3.16	38.00	0.0038	1.25	0.19	0.14	0.34	288.84	0.0100	290.64	290.34	293.63	2.99	3.29
CB #32																	
LINE C-1																	
	SDMH #4										213.02		215.12		223.00		
SDMH #4	Fl #11	3.47	18	1.96	71.88	0.0014	1.25	0.07	0.10	0.18	216.07	0.0424	217.57	217.57	219.60	2.03	2.03
Fl #11																	
LINE C-2																	
	SDMH #4										213.02		215.12		223.00		
SDMH #4	CB #22	1.29	18	0.73	48.25	0.0002	1.25	0.01	0.01	0.02	221.22	0.1699	222.72	222.72	226.64	3.92	3.92
CB #22																	
LINE C-3																	
	CB #27										238.93		240.43		243.43		
CB #27	Fl #12	0.84	18	0.48	34.39	0.0001	1.25	0.00	0.00	0.01	240.50	0.0457	242.00	242.00	244.00	2.00	2.00
Fl #12																	
LINE C-4																	
	CB #28										259.58		261.08		264.50		
CB #28	CB #29	0.63	18	0.36	22.00	0.0000	1.25	0.00	0.00	0.00	259.69	0.0050	261.19	261.19	264.08	2.89	2.89
CB #29																	
LINE D																	
	HW #2										232.00		236.00		236.00		
HW #2	CB #37	16.96	18	9.60	19.09	0.0347	0.17	0.24	0.66	0.91	234.56	0.1341	236.91	236.06	238.56	1.65	2.50
CB #37	CB #36	9.85	18	5.58	235.22	0.0117	0.17	0.08	2.76	2.84	242.33	0.0330	243.83	243.83	246.53	2.70	2.70
CB #36	CB #35	9.38	18	5.31	61.65	0.0106	1.25	0.55	0.65	1.20	244.44	0.0342	245.94	245.94	248.44	2.50	2.50
CB #35	CB #33	5.43	18	3.07	374.85	0.0036	0.17	0.02	1.33	1.36	253.51	0.0242	255.01	255.01	258.32	3.31	3.31
CB #33	Fl #13	4.85	18	2.75	11.50	0.0028	1.25	0.15	0.03	0.18	254.30	0.0687	255.80	255.80	257.80	2.00	2.00
Fl #13																	
LINE D-1																	
	CB #33										253.51		255.01		258.32		
CB #33	CB #34	1.76	18	0.99	30.00	0.0004	1.25	0.02	0.01	0.03	253.66	0.0050	255.16	255.16	258.16	3.00	3.00
CB #34																	

10-1021-10
DATE: 4/13/15
REV:
BY: SDG

100 YEAR- HYDRAULIC CALCULATIONS
NAPA OAKS
POST-DEVELOPED CONDITIONS
DAVIDON HOMES

DK CONSULTING

n=	0.015
i=	28
DESIGN STORM	100

LOW POINT	HIGH POINT	DESIGN FLOW Q	PIPE DIA D	VELOCITY V	LENGTH L	FRICTION SLOPE Sf	JUNCT FACTOR K	JUNCT LOSS Hj	FRICTION LOSS Hl	TOTAL LOSS Ht	PIPE INV	PIPE SLOPE	WATER SURFACE HGL	HEAD WTR D+INV SOF	RIM ELEV	FREE-BOARD	COVER
LINE A																	
	HW #1										66.00		68.00		68.00		
HW #1	SDMH #1	82.43	24	26.24	64.53	0.1768	0.42	4.49	11.41	15.90	77.05	0.1712	83.90	79.05	91.30	7.40	12.25
SDMH #1	CB #1	82.43	24	26.24	65.88	0.1768	0.42	4.49	11.65	16.14	90.92	0.2105	100.03	92.92	101.94	1.91	9.02
CB #1	CB #2	82.43	24	26.24	22.00	0.1768	1.25	13.36	3.89	17.25	92.68	0.0800	117.28	94.68	101.94	(15.34)	7.26
CB #2	CB #3	82.43	24	26.24	288.00	0.1768	0.17	1.82	50.91	52.73	124.94	0.1120	170.01	126.94	134.14	(35.87)	7.20
CB #3	CB #5	80.91	24	25.76	289.37	0.1703	0.17	1.75	49.29	51.04	168.35	0.1500	221.05	170.35	176.80	(44.25)	6.45
CB #5	CB #7	74.84	24	23.82	289.43	0.1457	0.17	1.50	42.18	43.68	203.34	0.1209	264.73	205.34	212.72	(52.01)	7.38
CB #7	CB #9	66.03	24	21.02	133.26	0.1135	0.17	1.17	15.12	16.28	212.80	0.0710	281.01	214.80	222.91	(58.10)	8.11
CB #9	CB #10	41.16	24	13.10	184.24	0.0441	0.17	0.45	8.12	8.57	229.89	0.0943	289.58	231.89	239.34	(50.24)	7.45
CB #10	SDMH #2	29.42	24	9.36	418.30	0.0225	1.25	1.70	9.42	11.12	270.34	0.0967	300.70	272.34	275.90	(24.80)	3.56
SDMH #2	CB #14	25.54	24	8.13	149.31	0.0170	0.17	0.17	2.53	2.71	276.70	0.0533	303.41	278.70	283.32	(20.09)	4.62
CB #14	SDMH#3	25.01	24	7.96	149.79	0.0163	0.25	0.25	2.44	2.68	279.14	0.0163	306.09	281.14	290.20	(15.89)	9.06
SDMH#3	CB#19	9.24	18	5.23	98.72	0.0103	0.17	0.07	1.02	1.09	280.12	0.0099	307.18	281.62	292.81	(14.37)	11.19
CB#19	CB #20	8.78	18	4.97	153.61	0.0093	0.17	0.07	1.43	1.50	281.66	0.0100	308.68	283.16	292.69	(15.99)	9.53
CB #20	CB #22	4.59	18	2.60	119.09	0.0025	1.25	0.13	0.30	0.43	282.85	0.0100	309.11	284.35	286.85	(22.26)	2.50
CB #22	FI #9	1.88	18	1.06	12.04	0.0004	0.17	0.00	0.01	0.01	284.10	0.1038	309.12	285.60	287.60	(21.52)	2.00
FI #9																	
LINE A-1																	
	CB #3										125.44		170.01		134.14		
CB #3	CB #4	0.57	18	0.33	22.00	0.0000	1.25	0.00	0.00	0.00	125.66	0.0100	170.01	127.16	134.14	(35.87)	6.98
CB #4																	
LINE A-2																	
	CB #5										168.85		221.05		176.80		
CB #5	CB #6	4.35	18	2.46	22.00	0.0023	1.25	0.12	0.05	0.17	169.07	0.0100	221.21	170.57	176.80	(44.41)	6.23
CB #6																	

LOW POINT	HIGH POINT	DESIGN FLOW Q	PIPE DIA D	VELOCITY V	LENGTH L	FRICTION SLOPE Sf	JUNCT FACTOR K	JUNCT LOSS Hj	FRICTION LOSS Hl	TOTAL LOSS Ht	PIPE INV	PIPE SLOPE	WATER SURFACE HGL	HEAD WTR D+INV SOF	RIM ELEV	FREE-BOARD	COVER
LINE A-3																	
	CB #7										203.84		264.73		212.72		
CB #7	CB #8	2.73	18	1.54	57.86	0.0009	1.25	0.05	0.05	0.10	204.42	0.3700	264.82	205.92	212.33	(52.49)	6.41
CB #8																	
LINE A-4																	
	CB #7										203.84		264.73		212.72		
CB #7	FI #1	5.70	18	3.23	18.00	0.0039	1.25	0.20	0.07	0.27	204.42	0.3700	265.00	205.92	214.00	(51.00)	8.08
FI #1																	
LINE A-5																	
	CB #10										230.39		289.58		239.34		
CB #10	CB #11	8.56	18	4.84	22.01	0.0088	0.17	0.06	0.19	0.26	236.96	0.2985	289.84	238.46	239.80	(50.04)	1.34
CB #11	FI #2	7.84	18	4.44	12.67	0.0074	1.25	0.38	0.09	0.48	237.10	0.0110	290.32	238.60	240.60	(49.72)	2.00
FI #2																	
LINE A-6																	
	SDMH #2										269.24		300.70		275.90		
SDMH #2	CB #12	0.62	18	0.35	21.97	0.0000	1.25	0.00	0.00	0.00	270.34	0.0501	300.70	271.84	275.97	(24.73)	4.13
CB #12																	
LINE A-7																	
	SDMH #2										269.24		300.70		275.90		
SDMH #2	CB #13	3.64	18	2.06	51.36	0.0016	0.17	0.01	0.08	0.09	274.44	0.1012	300.79	275.94	278.06	(22.73)	2.12
CB #13	FI #3	2.33	18	1.32	11.48	0.0007	1.25	0.03	0.01	0.04	275.00	0.0488	300.84	276.50	278.50	(22.34)	2.00
FI #3																	
LINE A-8																	
	CB #14										278.70		303.41		283.32		
CB #14	FI #4	0.30	18	0.17	20.75	0.0000	1.25	0.00	0.00	0.00	276.80	0.0048	303.41	278.30	280.30	(23.11)	2.00
FI #4																	
LINE A-9																	
	SDMH #3										279.14		309.12		290.20		
SDMH #3	CB #15	5.07	18	2.87	32.50	0.0031	1.25	0.16	0.10	0.26	286.36	0.2222	309.38	287.86	290.36	(19.02)	2.50
CB #15																	

LOW POINT	HIGH POINT	DESIGN FLOW Q	PIPE DIA D	VELOCITY V	LENGTH L	FRICTION SLOPE Sf	JUNCT FACTOR K	JUNCT LOSS Hj	FRICTION LOSS Hl	TOTAL LOSS Ht	PIPE INV	PIPE SLOPE	WATER SURFACE HGL	HEAD WTR D+INV SOF	RIM ELEV	FREE-BOARD	COVER
LINE A-10																	
	SDMH #3										279.14		309.12		290.20		
SDMH #3	CB #16	9.23	18	5.22	52.00	0.0103	1.25	0.53	0.53	1.06	285.74	0.1269	310.18	287.24	290.07	(20.11)	2.83
CB #16	CB #17	3.87	18	2.19	128.16	0.0018	1.25	0.09	0.23	0.33	293.14	0.0577	310.51	294.64	297.14	(13.37)	2.50
CB #17	Fl #5	2.90	18	1.64	11.50	0.0010	0.17	0.01	0.01	0.02	294.20	0.0922	310.53	295.70	297.70	(12.83)	2.00
Fl #5																	
LINE A-11																	
	CB #16										285.74		310.18		290.07		
CB #16	CB #18	3.59	18	2.03	22.00	0.0016	1.25	0.08	0.03	0.11	286.07	0.0150	310.30	287.57	290.07	(20.23)	2.50
CB #18																	
LINE A-12																	
	CB #20										281.66		308.68		292.69		
CB #20	CB #21	3.65	18	2.07	21.41	0.0016	0.75	0.05	0.03	0.08	288.53	0.3209	308.76	290.03	292.19	(16.57)	2.16
CB #21	Fl #9	0.88	18	0.50	11.05	0.0001	1.25	0.00	0.00	0.01	288.70	0.0154	308.77	290.20	292.20	(16.57)	2.00
Fl #9	Fl #8	0.36	18	0.20	74.62	0.0000	1.25	0.00	0.00	0.00	304.50	0.2117	308.77	306.00	308.00	(0.77)	2.00
Fl #8																	
LINE A-13																	
	CB #19										280.12		307.18		292.81		
CB #19	Fl #6	0.19	18	0.11	34.65	0.0000	1.25	0.00	0.00	0.00	289.50	0.2707	307.18	291.00	293.50	(13.68)	2.50
Fl #6																	
LINE B																	
	SDMH #4										80.50		86.94		91.30		
SDMH #4	CB #23	16.86	18	9.54	45.05	0.0343	1.25	1.77	1.55	3.31	80.95	0.0100	90.25	82.45	89.10	(1.15)	6.65
CB #23	CB #24	16.04	18	9.07	69.20	0.0310	0.50	0.64	2.15	2.79	81.64	0.0100	93.04	83.14	89.40	(3.64)	6.26
CB #24	Fl #10	15.42	18	8.73	12.00	0.0287	1.25	1.48	0.34	1.82	84.04	0.2000	94.86	85.54	90.65	(4.21)	5.11
Fl #10																	

LOW POINT	HIGH POINT	DESIGN FLOW Q	PIPE DIA D	VELOCITY V	LENGTH L	FRICTION SLOPE Sf	JUNCT FACTOR K	JUNCT LOSS Hj	FRICTION LOSS Hl	TOTAL LOSS Ht	PIPE INV	PIPE SLOPE	WATER SURFACE HGL	HEAD WTR D+INV SOF	RIM ELEV	FREE-BOARD	COVER
LINE C																	
	CB #9										212.30		281.01		222.91		
CB #9	SDMH #4	26.32	24	8.38	22.05	0.0180	0.25	0.27	0.40	0.67	212.52	0.0100	281.68	214.52	223.00	(58.68)	8.48
SDMH #4	CB #26	19.88	18	11.25	27.16	0.0477	0.17	0.33	1.30	1.63	220.76	0.0100	283.31	222.26	225.76	(57.55)	3.50
CB #26	CB #27	19.70	18	11.15	130.94	0.0468	0.17	0.33	6.13	6.46	238.93	0.0516	289.77	240.43	243.43	(46.34)	3.00
CB #27	CB #28	17.72	18	10.03	139.00	0.0379	0.17	0.27	5.26	5.53	259.58	0.1545	295.30	261.08	264.50	(30.80)	3.42
CB #28	CB #30	16.25	18	9.20	172.34	0.0319	0.17	0.22	5.49	5.72	286.21	0.1486	301.02	287.71	290.33	(10.69)	2.62
CB #30	SDMH #5	12.16	18	6.88	31.00	0.0178	1.25	0.92	0.55	1.47	287.81	0.1388	302.49	289.31	292.90	(9.59)	3.59
SDMH #5	CB #31	12.16	18	6.88	65.00	0.0178	1.25	0.92	1.16	2.08	288.46	0.2850	304.57	289.96	293.63	(10.94)	3.67
CB #31	CB #32	8.03	18	4.54	38.00	0.0078	1.25	0.40	0.30	0.70	288.84	0.0100	305.26	290.34	293.63	(11.63)	3.29
CB #32																	
LINE C-1																	
	SDMH #4										213.02		281.68		223.00		
SDMH #4	FI #11	4.99	18	2.82	71.88	0.0030	1.25	0.15	0.22	0.37	216.07	0.0424	282.05	217.57	219.60	(62.45)	2.03
FI #11																	
LINE C-2																	
	SDMH #4										213.02		281.68		223.00		
SDMH #4	CB #22	1.85	18	1.05	48.25	0.0004	1.25	0.02	0.02	0.04	221.22	0.1699	281.72	222.72	226.64	(55.08)	3.92
CB #22																	
LINE C-3																	
	CB #27										238.93		289.77		243.43		
CB #27	FI #12	1.21	18	0.69	34.39	0.0002	1.25	0.01	0.01	0.02	240.50	0.0457	289.79	242.00	244.00	(45.79)	2.00
FI #12																	
LINE C-4																	
	CB #28										259.58		295.30		264.50		
CB #28	CB #29	0.91	18	0.51	22.00	0.0001	1.25	0.01	0.00	0.01	259.69	0.0050	295.31	261.19	264.08	(31.23)	2.89
CB #29																	
LINE D																	
	HW #2										232.00		236.00		236.00		
HW #2	CB #37	25.02	18	14.16	19.09	0.0755	0.17	0.53	1.44	1.97	234.56	0.1341	237.97	236.06	238.56	0.59	2.50
CB #37	CB #36	14.45	18	8.18	235.22	0.0252	0.17	0.18	5.93	6.10	242.33	0.0330	244.07	243.83	246.53	2.46	2.70
CB #36	CB #35	13.73	18	7.77	61.65	0.0227	1.25	1.17	1.40	2.57	244.44	0.0342	246.65	245.94	248.44	1.79	2.50
CB #35	CB #33	7.85	18	4.44	374.85	0.0074	0.17	0.05	2.79	2.84	253.51	0.0242	255.01	255.01	258.32	3.31	3.31
CB #33	FI #13	6.99	18	3.95	11.50	0.0059	1.25	0.30	0.07	0.37	254.30	0.0687	255.80	255.80	257.80	2.00	2.00
FI #13																	

LOW POINT	HIGH POINT	DESIGN FLOW Q	PIPE DIA D	VELOCITY V	LENGTH L	FRICTION SLOPE Sf	JUNCT FACTOR K	JUNCT LOSS Hj	FRICTION LOSS Hl	TOTAL LOSS Ht	PIPE INV	PIPE SLOPE	WATER SURFACE HGL	HEAD WTR D+INV SOF	RIM ELEV	FREE-BOARD	COVER
LINE D-1																	
	CB #33										253.51		255.01		258.32		
CB #33	CB #34	2.53	18	1.43	30.00	0.0008	1.25	0.04	0.02	0.06	253.66	0.0050	255.16	255.16	258.16	3.00	3.00
CB #34																	

APPENDIX C

NAPA OAKS HYDROLOGY
Tc CALCULATIONS

Kirpich Tc Equation: $0.0078 * \left(\frac{L}{\sqrt{S}}\right)^{0.77}$

where:
T_c = Time of Concentration (min.)
L = Distance measured along the watercourse to the furthest point in the watershed (ft)
S = Average slope along L

Kirpich Multipliers

Channel	*Multiplier*
General overland flow, natural grassed channels	2.0
Natural basins with well defined channels, bare earth overland flow, mowed channels	1.0
Asphalt surfaces	0.4
Concrete	0.2

DRAINAGE AREA	LENGTH (FT)	HIGH POINT (FT)	LOW POINT (FT)	AVERAGE SLOPE (FT/FT)	T_c (MIN)	MULTIPLIER	Tc (MIN)
Ditch #1/FI #9							
Overland	130.00	332	288	0.3385	0.50	2.0	1.00
Ditch	285.00	288	284.6	0.0119	3.33	0.2	0.67
Ditch #2/FI #7						Total	1.67
Overland	50.00	332	305	0.5400	0.20	2.0	0.40
Ditch	192.00	305	292.2	0.0667	1.27	0.2	0.25
Ditch #3/FI #8						Total	0.66
Overland	45.00	310	309.5	0.0111	0.83	2.0	1.65
Ditch	57.00	309.5	308	0.0263	0.71	0.2	0.14
Ditch #4/FI #8						Total	1.80
Overland	90.00	310	309.5	0.0056	1.84	2.0	3.68
Ditch	150.00	309.5	308	0.0100	2.18	0.2	0.44
Ditch #5/FI #6						Total	4.12
Overland	33.00	310	298	0.3636	0.17	2.0	0.34
Ditch	95.00	309.5	308	0.0158	1.28	0.2	0.26
Ditch #6/FI #5						Total	0.60
Overland	70.00	328	302	0.3714	0.30	2.0	0.60
Ditch	125.00	309.5	308	0.0120	1.76	0.2	0.35
Ditch #7/FI #5						Total	0.95

NAPA OAKS HYDROLOGY
Tc CALCULATIONS

Kirpich Tc Equation: $0.0078 * \left(\frac{L}{\sqrt{S}}\right)^{0.77}$

where:
T_c = Time of Concentration (min.)
L = Distance measured along the watercourse to the furthest point in the watershed (ft)
S = Average slope along L

Kirpich Multipliers

Channel	*Multiplier*
General overland flow, natural grassed channels	2.0
Natural basins with well defined channels, bare earth overland flow, mowed channels	1.0
Asphalt surfaces	0.4
Concrete	0.2

DRAINAGE AREA	LENGTH (FT)	HIGH POINT (FT)	LOW POINT (FT)	AVERAGE SLOPE (FT/FT)	T_c (MIN)	MULTIPLIER	Tc (MIN)
Overland	130.00	344	320	0.1846	0.63	2.0	1.27
Ditch	430.00	320	297.7	0.0519	2.60	0.2	0.52
Ditch #8/FI #13						Total	1.79
Overland	340.00	357.2	268	0.2624	1.16	2.0	2.32
Ditch	226.00	268	257.8	0.0451	1.67	0.2	0.33
Ditch #9/FI #13						Total	2.66
Overland	36.00	313	303	0.2778	0.20	2.0	0.40
Overland	63.00	303	302	0.0159	0.93	2.0	1.87
Overland	40.00	302	280	0.5500	0.17	2.0	0.34
Ditch	455.00	280	257.8	0.0488	2.78	0.2	0.56
Ditch #10/FI #3						Total	3.16
Overland	10.00	310	304	0.6000	0.06	2.0	0.11
Overland	82.00	304	302	0.0244	0.97	2.0	1.94

NAPA OAKS HYDROLOGY
Tc CALCULATIONS

Kirpich Tc Equation: $0.0078 * \left(\frac{L}{\sqrt{S}}\right)^{0.77}$

where:
T_c = Time of Concentration (min.)
L = Distance measured along the watercourse to the furthest point in the watershed (ft)
S = Average slope along L

Kirpich Multipliers

Channel	*Multiplier*
General overland flow, natural grassed channels	2.0
Natural basins with well defined channels, bare earth overland flow, mowed channels	1.0
Asphalt surfaces	0.4
Concrete	0.2

DRAINAGE AREA	LENGTH (FT)	HIGH POINT (FT)	LOW POINT (FT)	AVERAGE SLOPE (FT/FT)	T_c (MIN)	MULTIPLIER	Tc (MIN)
Overland	36.00	302	282	0.5556	0.15	2.0	0.31
Ditch	97.00	282	278.5	0.0361	0.95	0.2	0.19
Ditch #11/FI #2						Total	2.55
Overland	227.00	341	244	0.4273	0.71	2.0	1.41
Ditch	185.00	244	240.6	0.0184	2.02	0.2	0.40
Ditch #12/FI #12						Total	1.82
Overland	228.00	341	245	0.4211	0.71	2.0	1.42
Ditch	110.00	245	242	0.0273	1.16	0.2	0.23
Ditch #13/FI#11						Total	1.66
Overland	350.00	314	225	0.2543	1.20	2.0	2.40
Ditch	430.00	225	219.5	0.0128	4.45	0.2	0.89
Ditch #14/FI#1						Total	3.30
Overland	70.00	296.6	280.5	0.2300	0.36	2.0	0.72
Ditch	528.00	280.5	234	0.0881	2.48	0.2	0.50
Overland	306.00	234	214	0.0654	1.83	2.0	3.66
Ditch #15/FI#4						Total	4.88
Overland	100.00	295	281	0.1400	0.58	2.0	1.15
Ditch	50.00	281	280.3	0.0140	0.82	0.2	0.16
FI #10						Total	1.32
Overland	1142.00	332	90.65	0.2113	3.21	2.0	6.42
FI #2						Total	6.42
Overland	182.00	310	268	0.2308	0.75	2.0	1.51
Overland	230.00	268	260	0.0348	1.87	2.0	3.74
Overland	415.00	268	240.6	0.0660	2.30	2.0	4.61
						Total	9.86

10-1021-10	**V-Ditch Calculations**
DATE 4/27/2015	NAPA OAKS
	POST-DEVELOPED CONDITIONS
BY: DIS	DAVIDON HOMES
	10-year Design Storm

K'= Computed Value from attached Table 7-10
T= Width (2' for J-ditches, 2.5' for v-ditches)
Concrete n= 0.015 Mannings coefficient
Open Space n= 0.200 Contra Costa County Runoff Coefficient
k= 7.00 Coefficient of velocity versus slope relationship for short pasture grass
V= velocity in channel
s= slope of channel
D= depth of water

Rational Method:

Qp = CiA

Parabolic Channel 'K' Value

Q_p = (K'/n) * T^8/3 *s^0.5
K' = (Qp*n) / (T^8/3 *s^0.5)

Ditch ID	**Qp** cfs. proposed	**=**	**C** Design coeff.	**i** Intensity Inch/Hour	**Tc** Time of Concentration	**A** AREA (Acres)	**K'** calculated	**=**	**Qp** cfs. proposed	**n** Mannings coeff.	**T^8/3** Feet	**s**	**s^0.5**	Water depth D as found in Table 7-10 **K'=D/T from table**	**D=K'*T**
Ditch #1	1.30	=	0.55	3.00	5.00	0.79	0.0282		1.30	0.015	6.35	0.0119	0.109	0.11	0.70
Ditch #2	0.36	=	0.55	3.00	5.00	0.22	0.0033		0.36	0.015	6.35	0.0667	0.258	0.04	0.25
Ditch #3	0.07	=	0.55	3.00	5.00	0.04	0.0010		0.07	0.015	6.35	0.0263	0.162	0.02	0.13
Ditch #4	0.18	=	0.55	3.00	5.00	0.11	0.0043		0.18	0.015	6.35	0.0100	0.100	0.01	0.06
Ditch #5	0.13	=	0.55	3.00	5.00	0.08	0.0025		0.13	0.015	6.35	0.0158	0.126	0.03	0.19
Ditch #6	0.40	=	0.55	3.00	5.00	0.24	0.0085		0.40	0.015	6.35	0.0120	0.110	0.06	0.38
Ditch #7	1.62	=	0.55	3.00	5.00	0.98	0.0093		1.62	0.015	11.51	0.0519	0.228	0.06	0.69
Ditch #8	2.77	=	0.55	3.00	5.00	1.68	0.0170		2.77	0.015	11.51	0.0451	0.212	0.09	0.98
Ditch #9	2.11	=	0.55	3.00	5.00	1.28	0.0125		2.11	0.015	11.51	0.0488	0.221	0.07	0.81
Ditch #10	1.62	=	0.65	3.00	5.00	0.83	0.0111		1.62	0.015	11.51	0.0361	0.190	0.07	0.81
Ditch #11	1.29	=	0.55	3.00	5.00	0.78	0.0224		1.29	0.015	6.35	0.0184	0.136	0.10	0.63
Ditch #12	0.84	=	0.55	3.00	5.00	0.51	0.0120		0.84	0.015	6.35	0.0273	0.165	0.07	0.44
Ditch #13	3.47	=	0.55	3.00	5.00	2.10	0.0724		3.47	0.015	6.35	0.0128	0.113	0.19	1.21
Ditch #14	3.96	=	0.65	3.00	5.00	2.03	0.0366		3.96	0.015	6.35	0.0654	0.256	0.13	0.83
Ditch #15	0.30	=	0.55	3.00	5.00	0.18	0.0059		0.30	0.015	6.35	0.0140	0.118	0.05	0.32

NOTE: Parabolic Channel 'K" Value equation reference Kings Handbook of Hydraulics, Seventh Edition.
See attached Table 7-10

TABLE 7.10 Values of K' in Formula $Q = (K'/n)b^{8/3}s^{1/2}$ for Trapezoidal Channels (*Continued*)

$\frac{D^*}{b}$	Side slopes of channel, ratio of horizontal to vertical									
	Vertical	¼:1	½:1	¾:1	1:1	1½:1	2:1	2½:1	3:1	4:1
0.26	0.0801	0.0884	0.0957	0.1021	0.1078	0.1180	0.1273	0.1361	0.1448	0.1619
0.27	0.0846	0.0936	0.1017	0.1087	0.1151	0.1264	0.1366	0.1465	0.1561	0.1751
0.28	0.0891	0.0990	0.1078	0.1156	0.1226	0.1350	0.1464	0.1572	0.1678	0.1888
0.29	0.0937	0.1045	0.1141	0.1226	0.1303	0.1439	0.1564	0.1684	0.1801	0.2032
0.30	0.0983	0.1100	0.1205	0.1298	0.1382	0.1532	0.1669	0.1800	0.1928	0.2181
0.31	0.103	0.116	0.127	0.137	0.146	0.163	0.178	0.192	0.206	0.234
0.32	0.108	0.121	0.134	0.145	0.155	0.173	0.189	0.204	0.220	0.250
0.33	0.112	0.127	0.141	0.153	0.163	0.183	0.200	0.217	0.234	0.267
0.34	0.117	0.133	0.148	0.160	0.172	0.193	0.212	0.231	0.249	0.284
0.35	0.122	0.139	0.155	0.169	0.181	0.204	0.225	0.245	0.264	0.303
0.36	0.127	0.145	0.162	0.177	0.190	0.215	0.237	0.259	0.280	0.321
0.37	0.132	0.151	0.169	0.185	0.200	0.226	0.250	0.274	0.296	0.341
0.38	0.137	0.158	0.177	0.194	0.210	0.238	0.264	0.289	0.313	0.361
0.39	0.142	0.164	0.184	0.203	0.220	0.250	0.278	0.304	0.331	0.382
0.40	0.147	0.170	0.192	0.212	0.230	0.262	0.292	0.321	0.349	0.404
0.41	0.152	0.177	0.200	0.221	0.240	0.275	0.307	0.337	0.367	0.426
0.42	0.157	0.184	0.208	0.230	0.251	0.288	0.322	0.354	0.386	0.449
0.43	0.162	0.190	0.216	0.240	0.262	0.301	0.337	0.372	0.406	0.473
0.44	0.167	0.197	0.225	0.250	0.273	0.314	0.353	0.390	0.426	0.498
0.45	0.172	0.204	0.233	0.260	0.284	0.328	0.369	0.409	0.447	0.523

TABLE 7.10 Values of K' in Formula $Q = (K'/n)b^{8/3}s^{1/2}$ for Trapezoidal Channels

$\frac{D^*}{b}$	Side slopes of channel, ratio of horizontal to vertical									
	Vertical	¾:1	½:1	¾:1	1:1	1½:1	2:1	2½:1	3:1	4:1
0.01	0.00046	0.00046	0.00046	0.00046	0.00046	0.00046	0.00047	0.00047	0.00047	0.00047
0.02	0.00144	0.00145	0.00146	0.00146	0.00147	0.00148	0.00149	0.00149	0.00150	0.00151
0.03	0.00279	0.00282	0.00284	0.00286	0.00288	0.00291	0.00293	0.00296	0.00298	0.00302
0.04	0.00444	0.00451	0.00457	0.00461	0.00465	0.00471	0.00477	0.00482	0.00486	0.00495
0.05	0.00637	0.00649	0.00659	0.00667	0.00674	0.00685	0.00695	0.00704	0.00713	0.00731
0.06	0.00853	0.00872	0.00888	0.00902	0.00913	0.00932	0.00948	0.00963	0.00978	0.01007
0.07	0.01089	0.01119	0.01143	0.01163	0.01180	0.01209	0.01234	0.01257	0.01279	0.01324
0.08	0.01345	0.01387	0.01421	0.01449	0.01474	0.01515	0.01551	0.01585	0.01618	0.01683
0.09	0.01619	0.01675	0.01721	0.01760	0.01794	0.01851	0.01901	0.01948	0.01994	0.02084
0.10	0.01908	0.01981	0.02043	0.02094	0.02139	0.02215	0.02282	0.02345	0.02406	0.02528
0.11	0.0221	0.0231	0.0238	0.0245	0.0251	0.0261	0.0269	0.0278	0.0286	0.0302
0.12	0.0253	0.0265	0.0275	0.0283	0.0290	0.0303	0.0314	0.0324	0.0334	0.0355
0.13	0.0286	0.0300	0.0313	0.0322	0.0332	0.0347	0.0361	0.0374	0.0387	0.0412
0.14	0.0320	0.0338	0.0352	0.0365	0.0376	0.0395	0.0412	0.0428	0.0444	0.0475
0.15	0.0356	0.0376	0.0394	0.0409	0.0422	0.0445	0.0466	0.0485	0.0504	0.0542
0.16	0.0392	0.0416	0.0437	0.0455	0.0471	0.0498	0.0523	0.0546	0.0569	0.0614
0.17	0.0429	0.0458	0.0482	0.0503	0.0522	0.0554	0.0583	0.0610	0.0637	0.0691
0.18	0.0467	0.0500	0.0529	0.0553	0.0575	0.0612	0.0646	0.0678	0.0710	0.0772
0.19	0.0507	0.0544	0.0577	0.0605	0.0630	0.0674	0.0713	0.0750	0.0787	0.0859
0.20	0.0547	0.0589	0.0627	0.0659	0.0687	0.0737	0.0783	0.0826	0.0868	0.0952
0.21	0.0587	0.0636	0.0678	0.0715	0.0747	0.0804	0.0856	0.0905	0.0954	0.1049
0.22	0.0629	0.0683	0.0731	0.0772	0.0809	0.0874	0.0932	0.0989	0.1043	0.1152
0.23	0.0671	0.0732	0.0785	0.0832	0.0873	0.0946	0.1012	0.1076	0.1138	0.1260
0.24	0.0714	0.0781	0.0841	0.0893	0.0939	0.1021	0.1096	0.1167	0.1237	0.1374
0.25	0.0757	0.0832	0.0898	0.0956	0.1007	0.1099	0.1182	0.1262	0.1340	0.1494

APPENDIX D

10-1021-10	**BASIN AND OUTFALL SIZING**
DATE: 4/13/15	NAPA OAKS
REV:	POST-DEVELOPED CONDITIONS
BY: SDG	DAVIDON HOMES

CONSULTING

Minimum basin size= unit basin storage volume*drainage area

BASIN	UNIT BASIN STORAGE VOLUME (IN)	DRAINAGE AREA (ACRES)	MINIMUM BASIN SIZE (CF)	DESIGNED BASIN SIZE (CF)
#1	0.74	34.89	74,977	155,840
#2	0.74	10.55	22,672	38,364

* NOTE: UNIT BASIN STORAGE VOLUME WAS DETERMINED FROM THE CALTRANS BASIN SIZER PROGRAM. PLEASE SEE THE PRINTOUT FROM THE PROGRAM ON THE FOLLOWING PAGE.

Project: Napa Oaks

Latitude: 38.3094
Longitude: -122.2961

Caltrans Stations
Name: NAPA
Distance: 1.54
Elevation: 6
Years of data: 18

Water Quality Volumes

85th Percentile 24-hr Storm (in) 0.8

Maximized Volume Method (in)
Drawdown Time (Hours) 48
Runoff Coefficient 0.80
Unit Basin Storage Volume (in) 0.74

Water Quality Flows

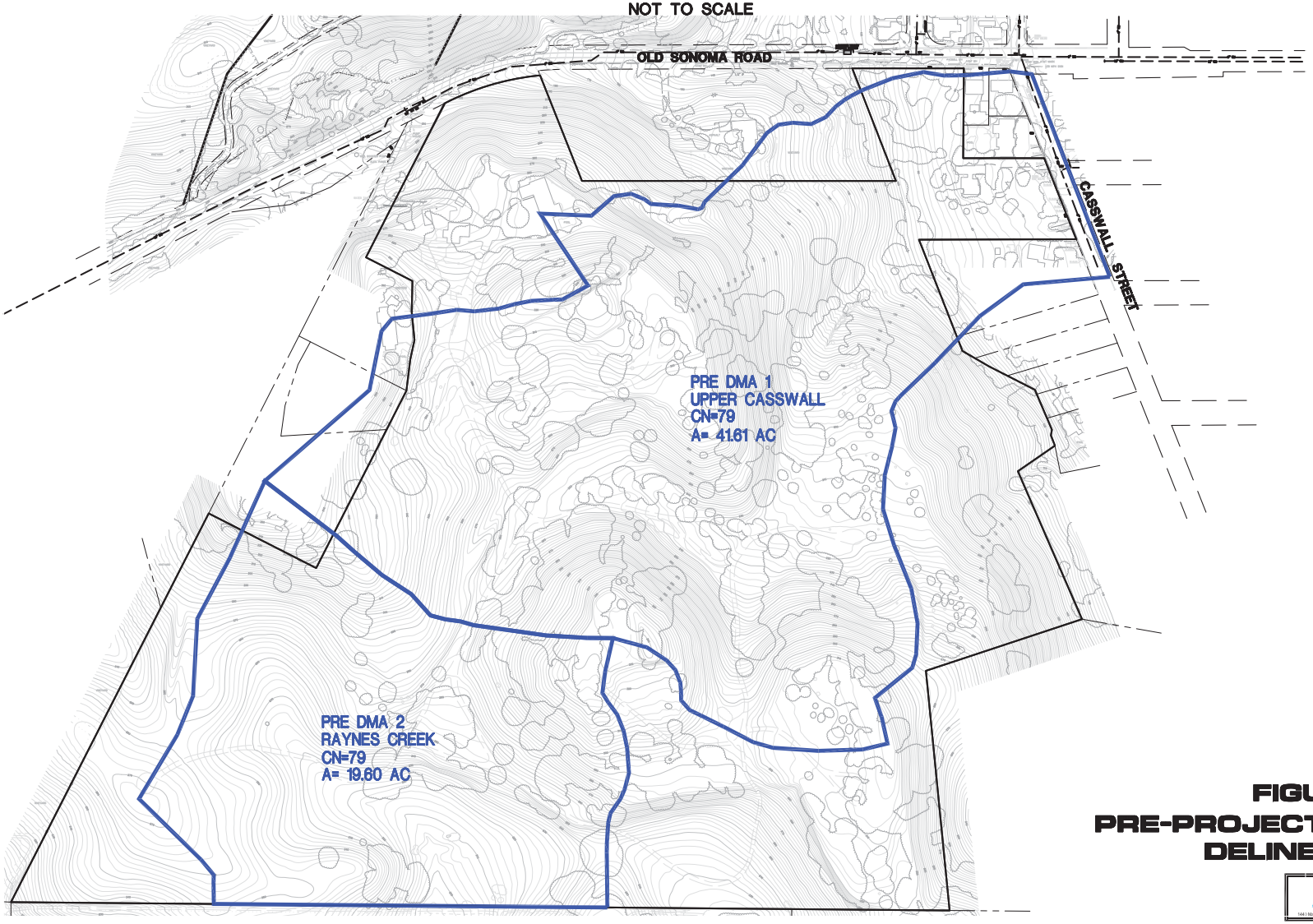
Caltrans Water Quality Flows
Region 2, all counties: 0.2 in/hour.

Basin Sizer Version 1.47

NAPA OAKS WATERSHED MAP

NAPA, CALIFORNIA

DAVIDON HOMES
APRIL 2015
NOT TO SCALE



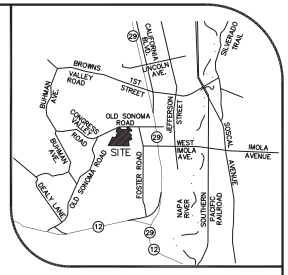


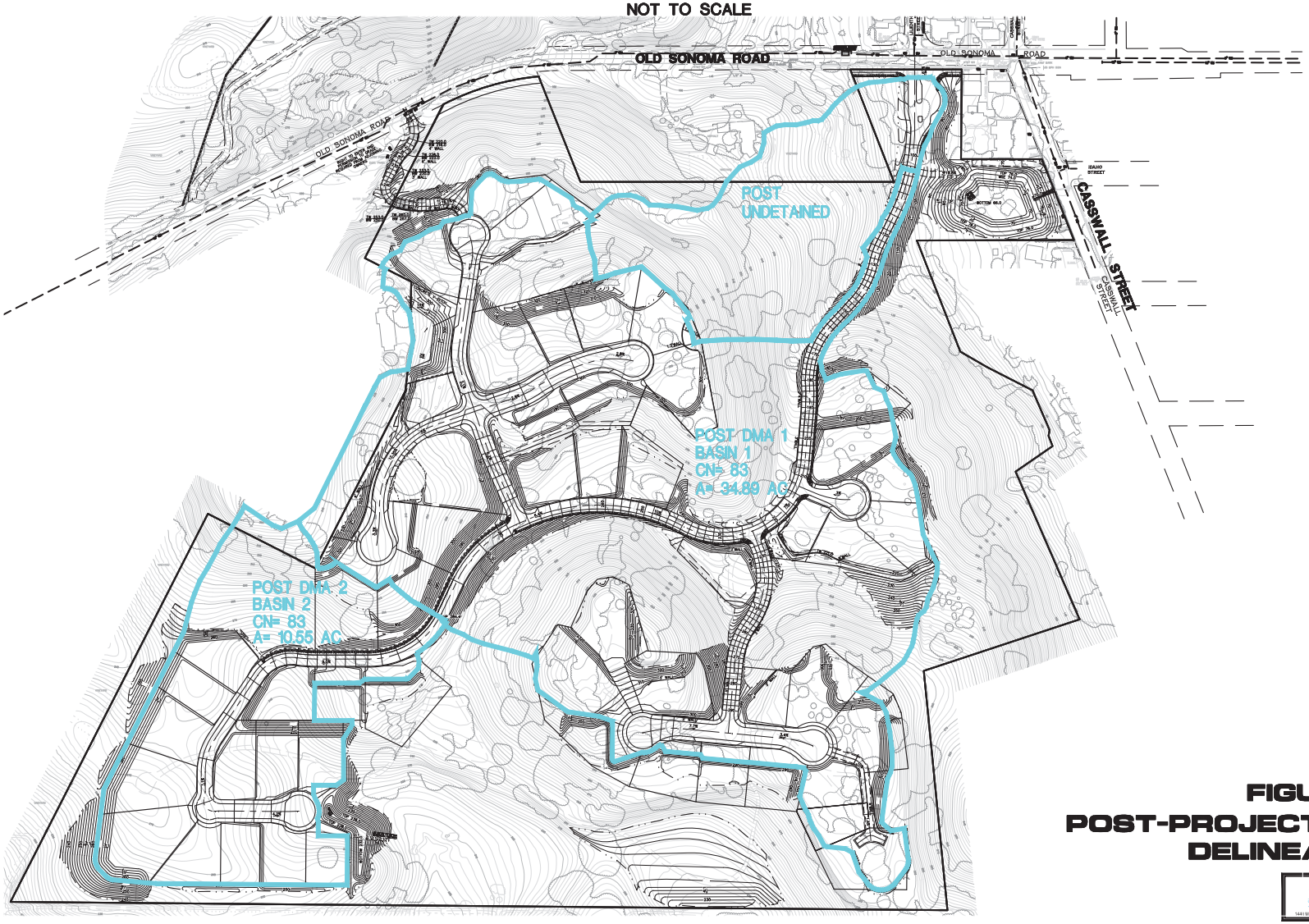
FIGURE 1
PRE-PROJECT WATERSHED DELINEATIONS

CONSULTING
PLANNING • ENGINEERING • CONSTRUCTION
1443 Merle Lane, Suite 202, Walnut Creek, California 94595 (925) 935-0555 Tel. (925) 935-0910 Fax

NAPA OAKS WATERSHED MAP

NAPA, CALIFORNIA

DAVIDON HOMES
APRIL 2015
NOT TO SCALE



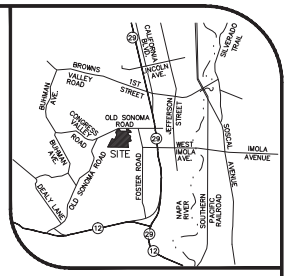
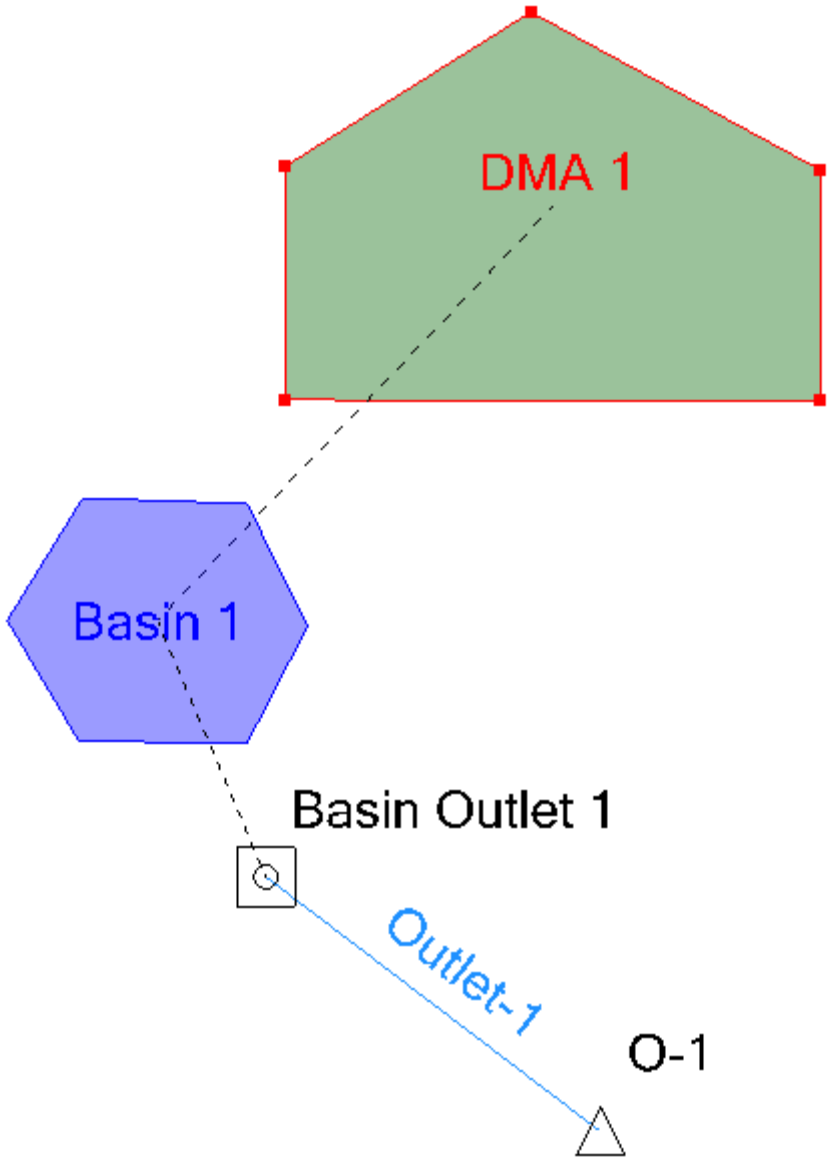


FIGURE 2
POST-PROJECT WATERSHED DELINEATIONS

CONSULTING
PLANNING · ENGINEERING · SURVEYING
1441 Maria Lane, Suite 200, Walnut Creek, California 94596 (925) 932-6866 Tel. (925) 930-8910 Fax

\\1FSVOK_Shared\Projects\2015\15028-Napa Oaks\dwg\Drainage\1028_WS_Jun04.dwg 4/27/15


DMA 1
Basin 1
Basin Outlet 1
Outlet-1
O-1

PondMaker Worksheet Detailed Report: Worksheet (Basin 1)

Element Details

ID	58
Label	Worksheet (Basin 1)
Select Pond to Design	Basin 1
Flow Allowed Below Target	90.0
Flow Allowed Above Target	0.0
Flow Allowed Below Target	90.0
Flow Allowed Above Target	0.0
Volume Allowed Below Target	80.0
Volume Allowed Above Target	25.0
Tolerance Display	Display numerical values for tolerance fields

Notes

Volume

Pond Type	Elevation-Area	Use Void Space?	False

Elevation-Area

Pond Elevation (ft)	Pond Area (acres)
66.00	0.221
66.50	0.236
68.00	0.279
70.00	0.342
72.00	0.410
74.00	0.483
76.00	0.564

Infiltration

Infiltration Method	Average Infiltration Rate	Infiltration Rate (Average)	5.0000 in/h

Output

Detention Time	Compute All Methods

Initial Conditions

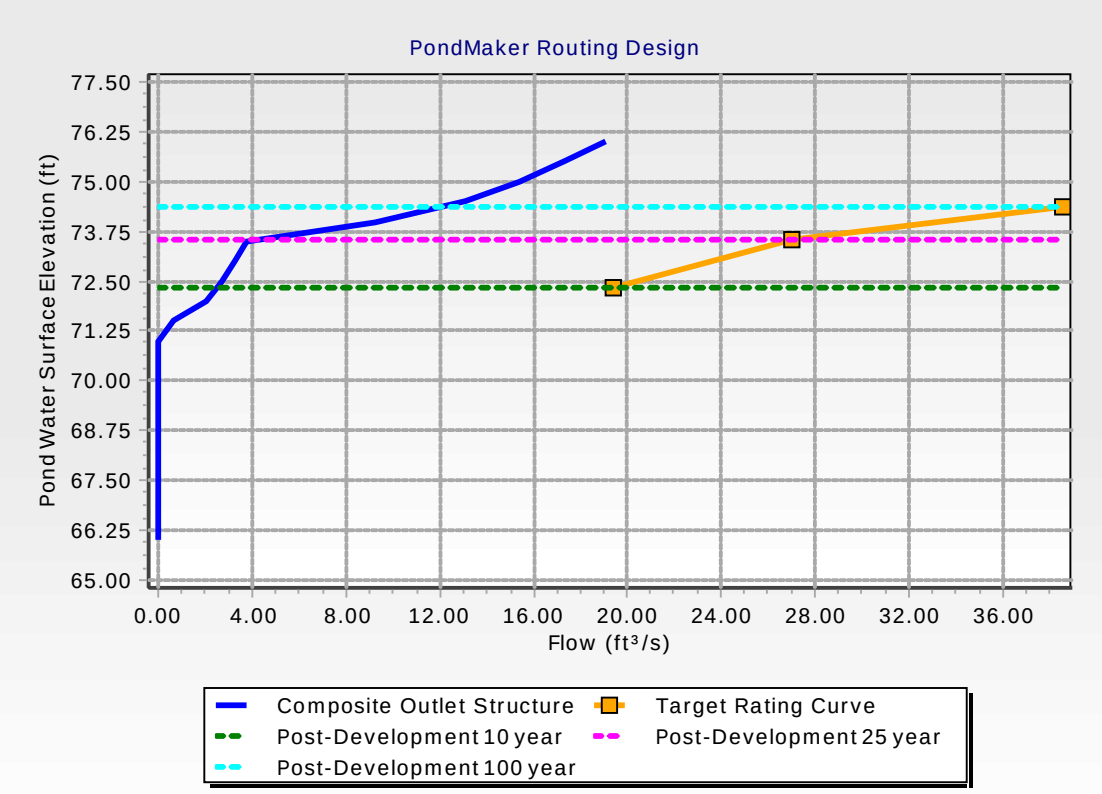
Is Outflow Averaging On?	True	Define Starting Water Surface Elevation	Pond Invert

PondMaker Worksheet Detailed Report: Worksheet (Basin 1)

PondMaker Worksheet (Routing Design)

Design Scenario	Design Return Event	Target Peak Outflow (ft³/s)	Computed Peak Outflow (ft³/s)	Computed Peak Outflow vs. Target (ft³/s)	Target Outflow Volume (ac-ft)
Post-Development 10 year	10	19.39	2.47	-16.92	7.148
Post-Development 25 year	25	26.99	4.20	-22.79	9.566
Post-Development 100 year	100	38.54	11.89	-26.65	13.194

Computed Volume Outflow (ac-ft)	Computed Outflow Volume vs. Target (ac-ft)	Routing Outlet Structure	Computed Max Water Elevation (ft)	Freeboard Depth (ft)	Maximum Storage (ac-ft)
2.274	-4.874	Composite Outlet Structure	72.32	3.68	2.004
4.050	-5.516	Composite Outlet Structure	73.54	2.46	2.544
6.816	-6.378	Composite Outlet Structure	74.34	1.66	2.931



Requested Pond Water Surface Elevations	
Minimum (Headwater)	66.00 ft
Increment (Headwater)	0.50 ft
Maximum (Headwater)	76.00 ft

Outlet Connectivity

Structure Type	Outlet ID	Direction	Outfall	E1 (ft)	E2 (ft)
Stand Pipe	Riser - 1	Forward	Culvert - 1	73.50	76.00
Orifice-Circular	Orifice - 1	Forward	Culvert - 1	71.00	76.00
Culvert-Circular	Culvert - 1	Forward	TW	59.40	76.00
Tailwater Settings	Tailwater			(N/A)	(N/A)

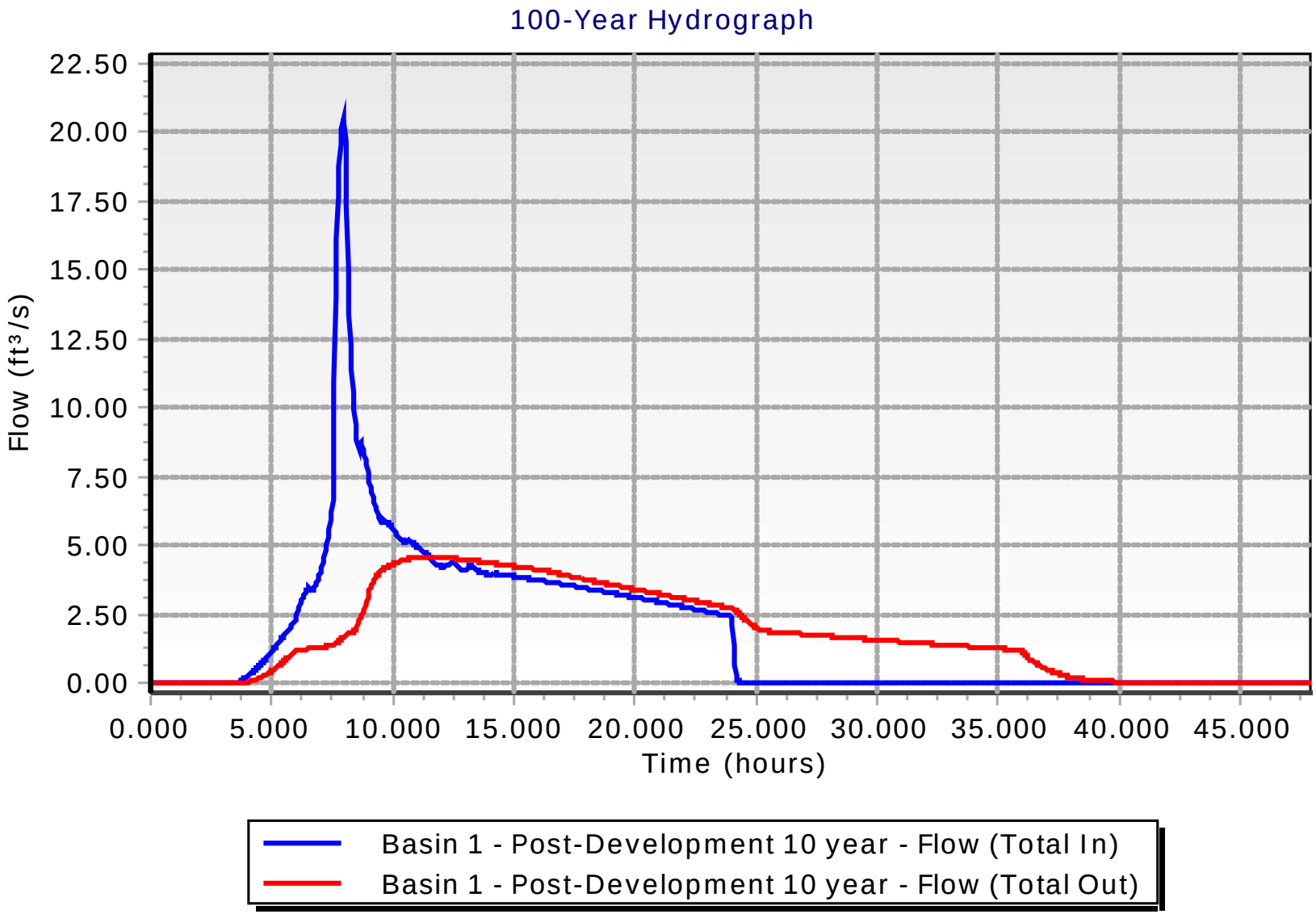
Structure ID: Orifice - 1 Structure Type: Orifice-Circular	
Number of Openings	1
Elevation	71.00 ft
Orifice Diameter	10.0 in
Orifice Coefficient	0.600

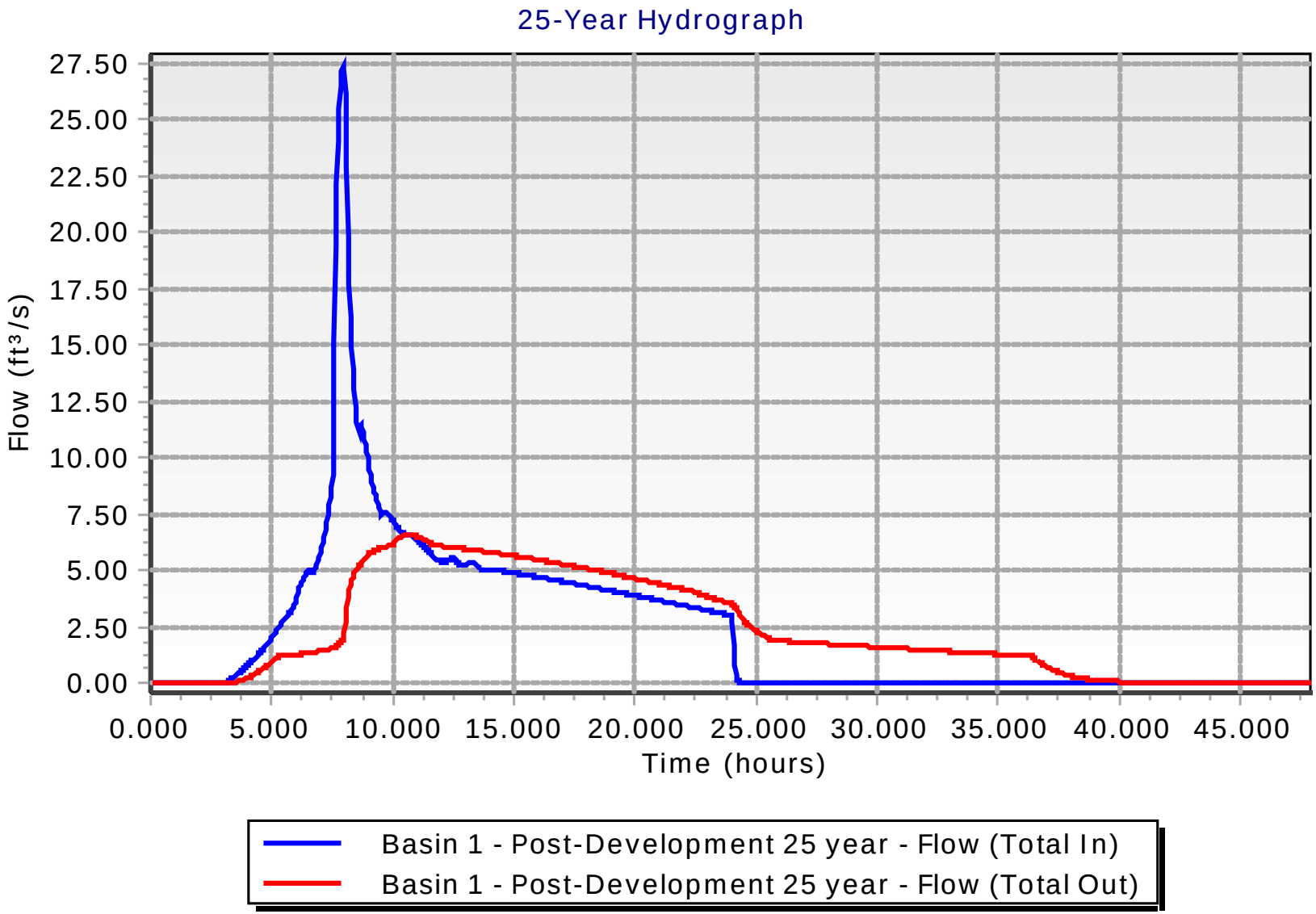
Structure ID: Riser - 1 Structure Type: Stand Pipe	
Number of Openings	1
Elevation	73.50 ft
Diameter	18.0 in
Orifice Area	1.8 ft²
Orifice Coefficient	0.600
Weir Length	4.71 ft
Weir Coefficient	3.00 (ft^0.5)/s
K Reverse	1.000
Manning's n	0.000
Kev, Charged Riser	0.000
Weir Submergence	False
Orifice H to crest	False

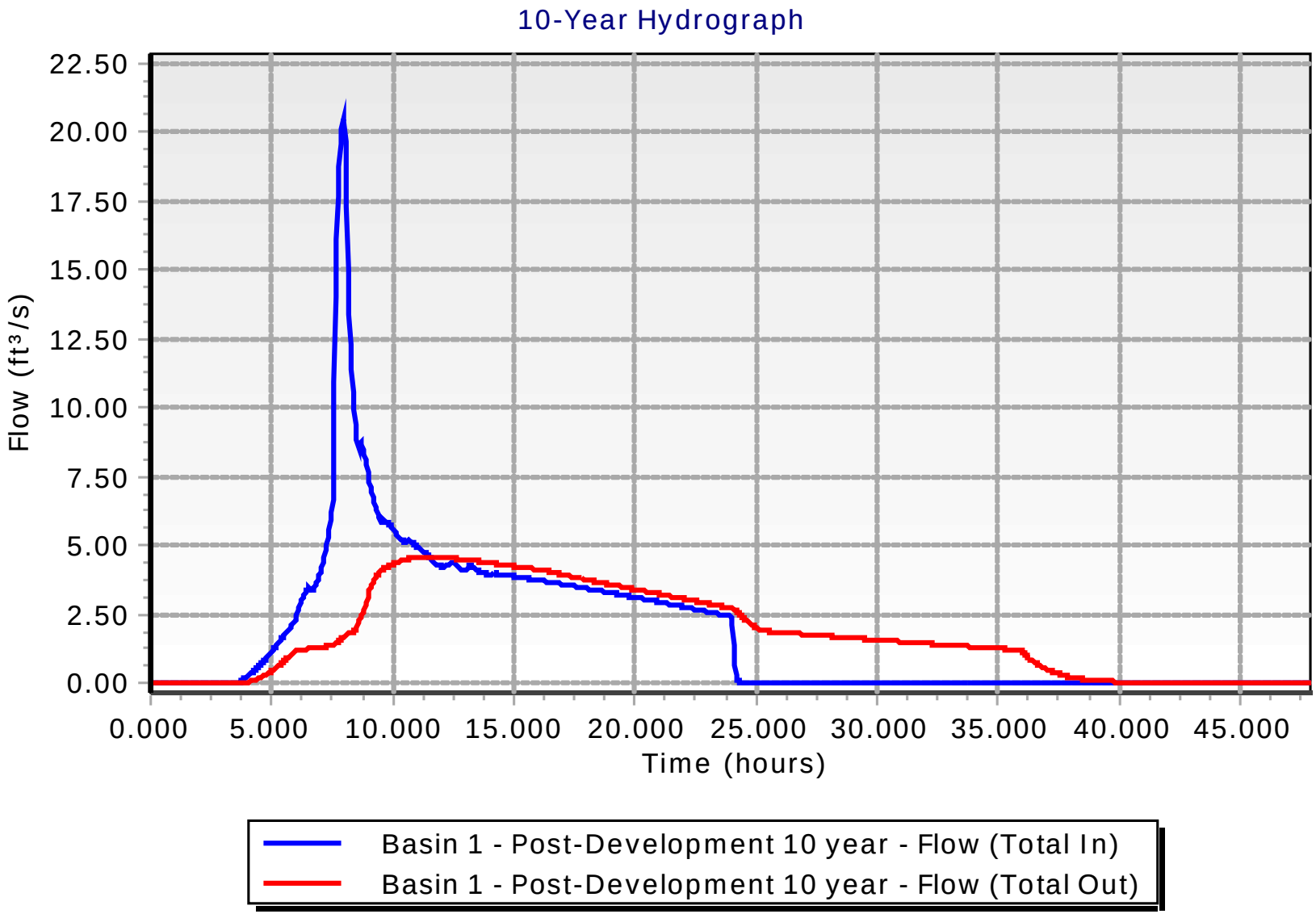
Structure ID: Culvert - 1 Structure Type: Culvert-Circular	
Number of Barrels	1
Diameter	18.0 in
Length	100.00 ft
Length (Computed Barrel)	100.00 ft
Slope (Computed)	0.010 ft/ft

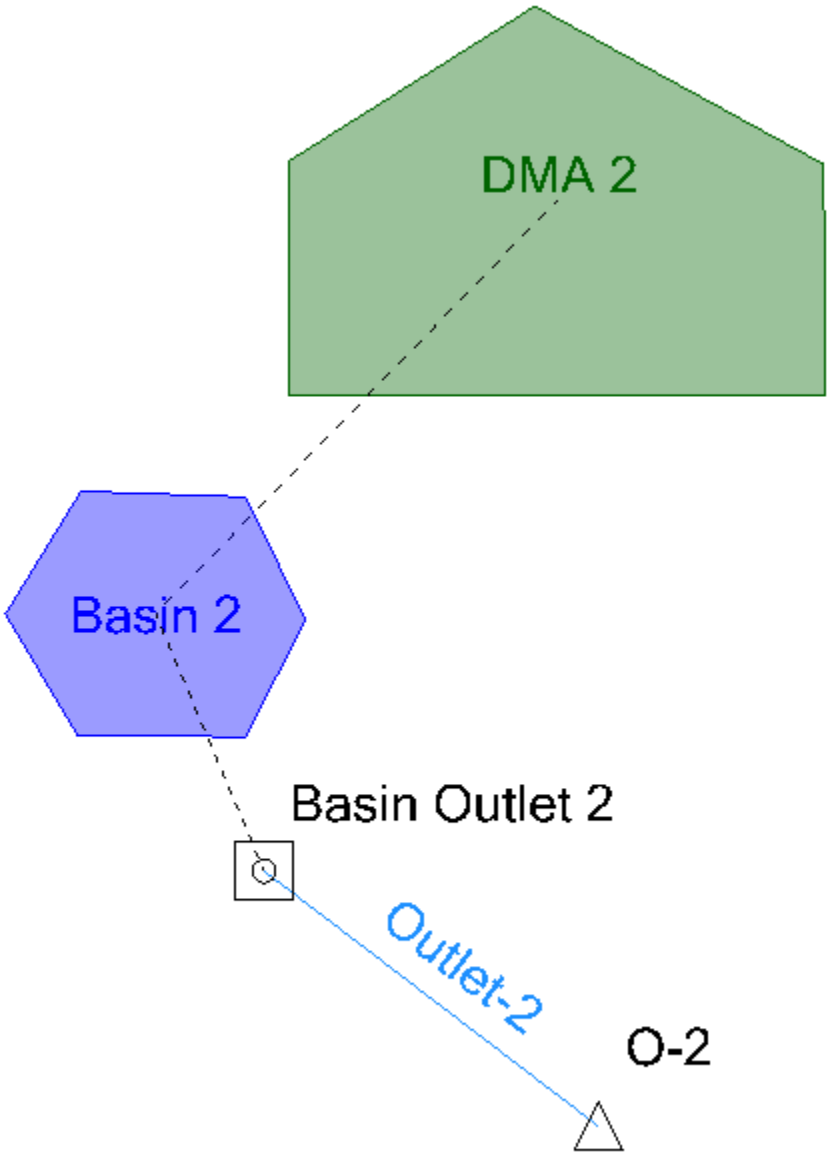
Outlet Control Data	
Manning's n	0.013
Ke	0.200
Kb	0.018
Kr	0.000
Convergence Tolerance	0.00 ft

Inlet Control Data	
Equation Form	Form 1
K	0.0045
M	2.0000
C	0.0317
Y	0.6900


100-Year Hydrograph
Flow (ft³/s)
22.50
20.00
17.50
15.00
12.50
10.00
7.50
5.00
2.50
0.00
0.000
5.000
10.000
15.000
20.000
25.000
30.000
35.000
40.000
45.000
Time (hours)
Basin 1 - Post-Development 10 year - Flow (Total In)
Basin 1 - Post-Development 10 year - Flow (Total Out)


25-Year Hydrograph
Flow (ft³/s)
27.50
25.00
22.50
20.00
17.50
15.00
12.50
10.00
7.50
5.00
2.50
0.00
0.000
5.000
10.000
15.000
20.000
25.000
30.000
35.000
40.000
45.000
Time (hours)
Basin 1 - Post-Development 25 year - Flow (Total In)
Basin 1 - Post-Development 25 year - Flow (Total Out)


10-Year Hydrograph
Flow (ft³/s)
22.50
20.00
17.50
15.00
12.50
10.00
7.50
5.00
2.50
0.00
0.000
5.000
10.000
15.000
20.000
25.000
30.000
35.000
40.000
45.000
Time (hours)
Basin 1 - Post-Development 10 year - Flow (Total In)
Basin 1 - Post-Development 10 year - Flow (Total Out)


DMA 2
Basin 2
Basin Outlet 2
Outlet-2
O-2

PondMaker Worksheet Detailed Report: Worksheet (Basin 2)

Element Details

ID	58
Label	Worksheet (Basin 2)
Select Pond to Design	Basin 2
Flow Allowed Below Target	90.0
Flow Allowed Above Target	50.0
Flow Allowed Below Target	90.0
Flow Allowed Above Target	50.0
Volume Allowed Below Target	80.0
Volume Allowed Above Target	50.0
Tolerance Display	Display numerical values for tolerance fields

Notes

Volume

Pond Type	Elevation-Area	Use Void Space?	False

Elevation-Area

Pond Elevation (ft)	Pond Area (acres)
232.00	0.0535
234.00	0.0960
236.00	0.1407
238.00	0.1944

Infiltration

Infiltration Method	Average Infiltration Rate	Infiltration Rate (Average)	5.0000 in/h

Output

Detention Time	Compute All Methods

Initial Conditions

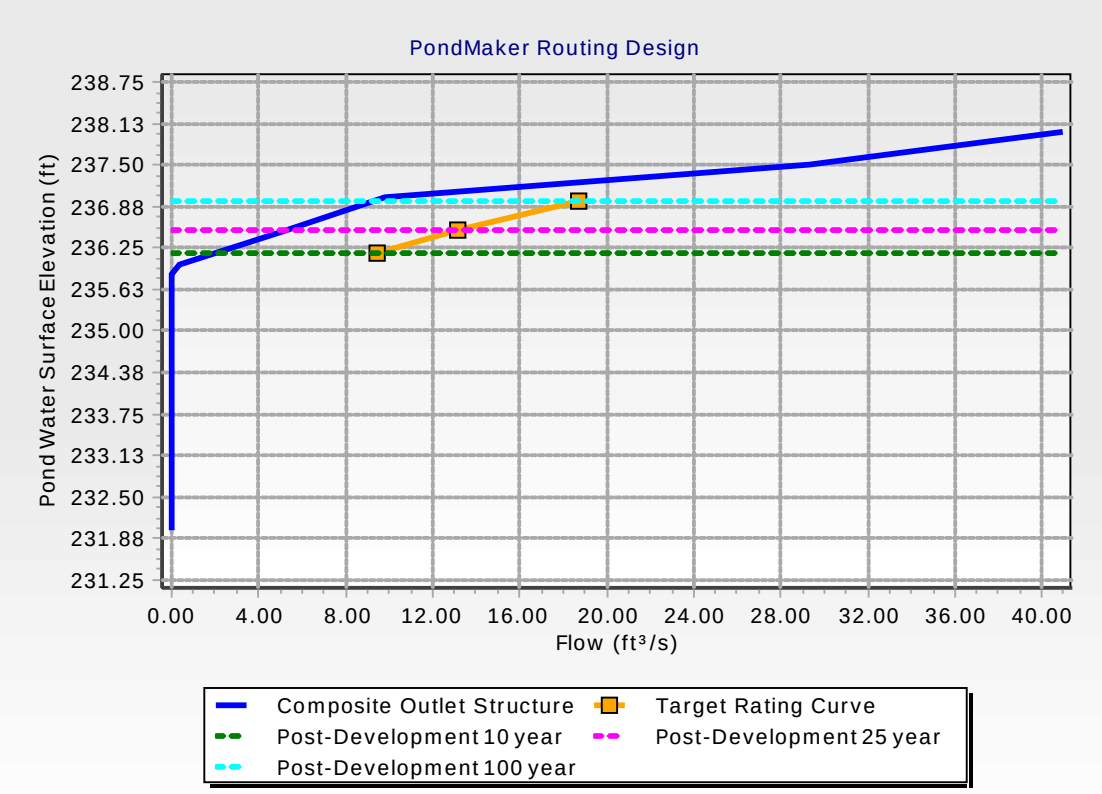
Is Outflow Averaging On?	True	Define Starting Water Surface Elevation	Pond Invert

PondMaker Worksheet Detailed Report: Worksheet (Basin 2)

PondMaker Worksheet (Routing Design)

Design Scenario	Design Return Event	Target Peak Outflow (ft³/s)	Computed Peak Outflow (ft³/s)	Computed Peak Outflow vs. Target (ft³/s)	Target Outflow Volume (ac-ft)
Post-Development 10 year	10	9.46	1.95	-7.51	3.367
Post-Development 25 year	25	13.13	5.32	-7.81	4.506
Post-Development 100 year	100	18.70	9.29	-9.40	6.215

Computed Volume Outflow (ac-ft)	Computed Outflow Volume vs. Target (ac-ft)	Routing Outlet Structure	Computed Max Water Elevation (ft)	Freeboard Depth (ft)	Maximum Storage (ac-ft)
0.695	-2.672	Composite Outlet Structure	236.17	1.83	0.407
1.292	-3.214	Composite Outlet Structure	236.53	1.47	0.461
2.193	-4.022	Composite Outlet Structure	236.95	1.05	0.528



Requested Pond Water Surface Elevations	
Minimum (Headwater)	232.00 ft
Increment (Headwater)	0.50 ft
Maximum (Headwater)	238.00 ft

Outlet Connectivity

Structure Type	Outlet ID	Direction	Outfall	E1 (ft)	E2 (ft)
Orifice-Circular	Orifice - 4	Forward	Culvert - 1	235.85	238.00
Orifice-Circular	Orifice - 3	Forward	Culvert - 1	235.85	238.00
Orifice-Circular	Orifice - 2	Forward	Culvert - 1	235.85	238.00
Orifice-Circular	Orifice - 1	Forward	Culvert - 1	235.85	238.00
Stand Pipe	Riser - 1	Forward	Culvert - 1	237.00	238.00
Orifice-Circular	Orifice - 5	Forward	Culvert - 1	235.85	238.00
Culvert-Circular	Culvert - 1	Forward	TW	220.00	238.00
Tailwater Settings	Tailwater			(N/A)	(N/A)

Structure ID: Orifice - 1 Structure Type: Orifice-Circular	
Number of Openings	1
Elevation	235.85 ft
Orifice Diameter	10.0 in
Orifice Coefficient	0.600

Structure ID: Riser - 1 Structure Type: Stand Pipe	
Number of Openings	1
Elevation	237.00 ft
Diameter	60.0 in
Orifice Area	19.6 ft²
Orifice Coefficient	0.600
Weir Length	15.71 ft
Weir Coefficient	3.00 (ft^0.5)/s
K Reverse	1.000
Manning's n	0.000
Kev, Charged Riser	0.000
Weir Submergence	False
Orifice H to crest	False

Structure ID: Culvert - 1
Structure Type: Culvert-Circular

Number of Barrels	1
Diameter	18.0 in
Length	75.00 ft
Length (Computed Barrel)	75.17 ft
Slope (Computed)	0.067 ft/ft

Outlet Control Data	
Manning's n	0.013
Ke	0.200
Kb	0.018
Kr	0.000
Convergence Tolerance	0.00 ft

Inlet Control Data	
Equation Form	Form 1
K	0.0045
M	2.0000
C	0.0317
Y	0.6900
T1 ratio (HW/D)	1.062
T2 ratio (HW/D)	1.164
Slope Correction Factor	-0.500

Use unsubmerged inlet control 0 equation below T1 elevation.
Use submerged inlet control 0 equation above T2 elevation

In transition zone between unsubmerged and submerged inlet control,
interpolate between flows at T1 & T2...

T1 Elevation	221.59 ft	T1 Flow	7.58 ft^3/s
T2 Elevation	221.75 ft	T2 Flow	8.66 ft^3/s

Structure ID: Orifice - 2
Structure Type: Orifice-Circular

Number of Openings	1
Elevation	235.85 ft
Orifice Diameter	10.0 in
Orifice Coefficient	0.600

Structure ID: Orifice - 3
Structure Type: Orifice-Circular

Number of Openings	1
Elevation	235.85 ft
Orifice Diameter	10.0 in
Orifice Coefficient	0.600

Structure ID: Orifice - 4
Structure Type: Orifice-Circular

Number of Openings	1
Elevation	235.85 ft
Orifice Diameter	8.0 in
Orifice Coefficient	0.600

Structure ID: Orifice - 5
Structure Type: Orifice-Circular

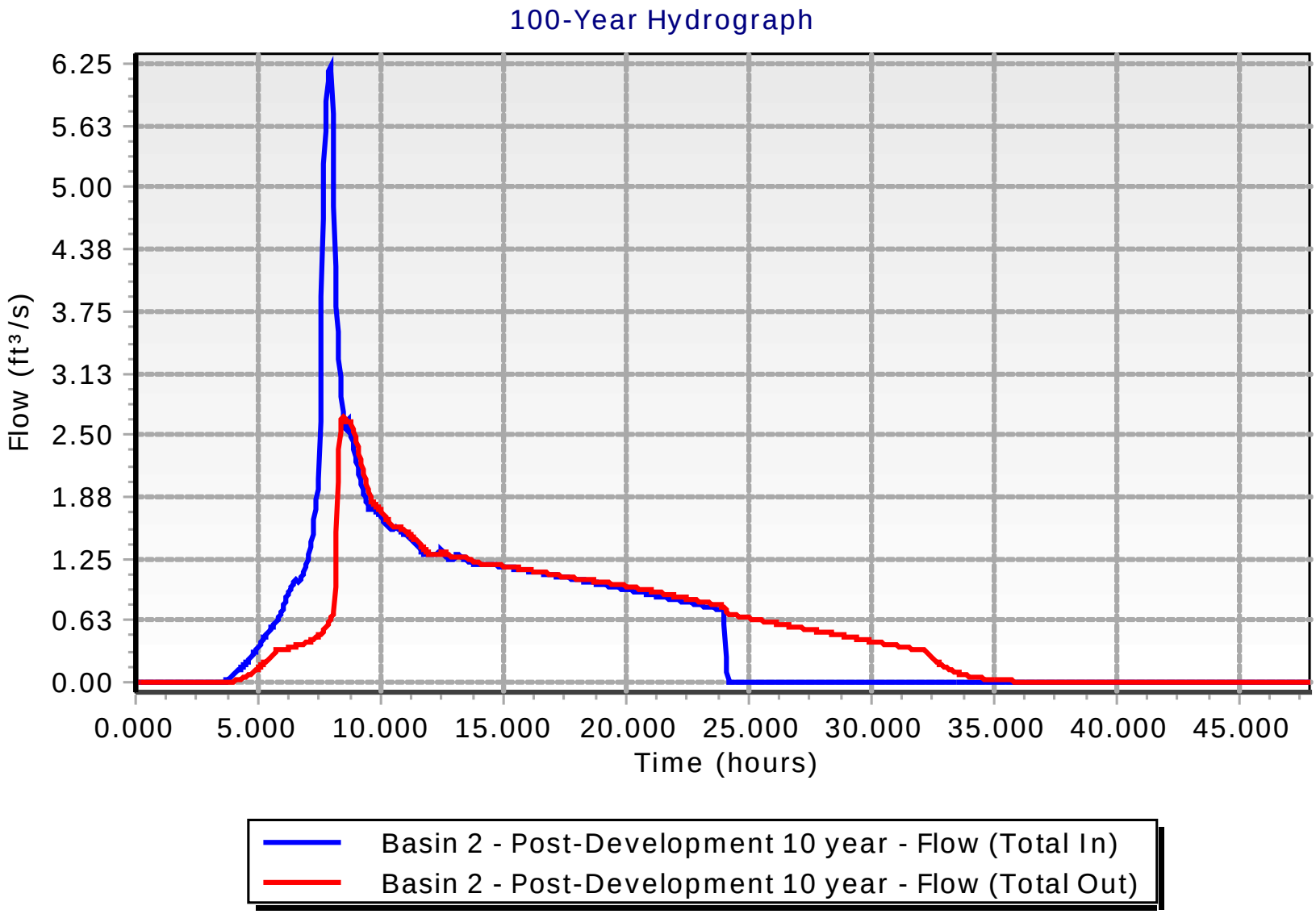
Number of Openings	1
Elevation	235.85 ft
Orifice Diameter	8.0 in
Orifice Coefficient	0.600

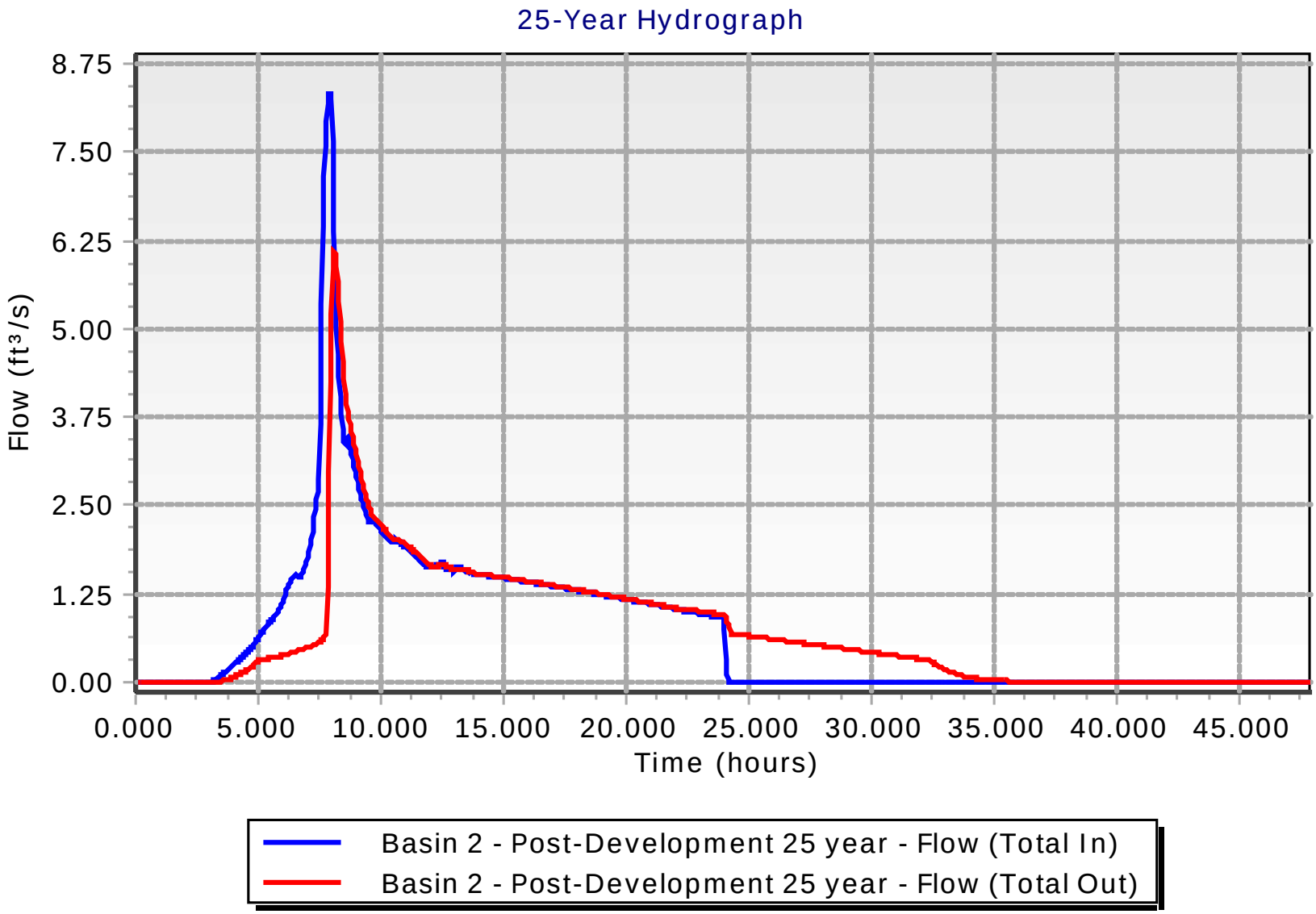
Structure ID: TW
Structure Type: TW Setup, DS Channel

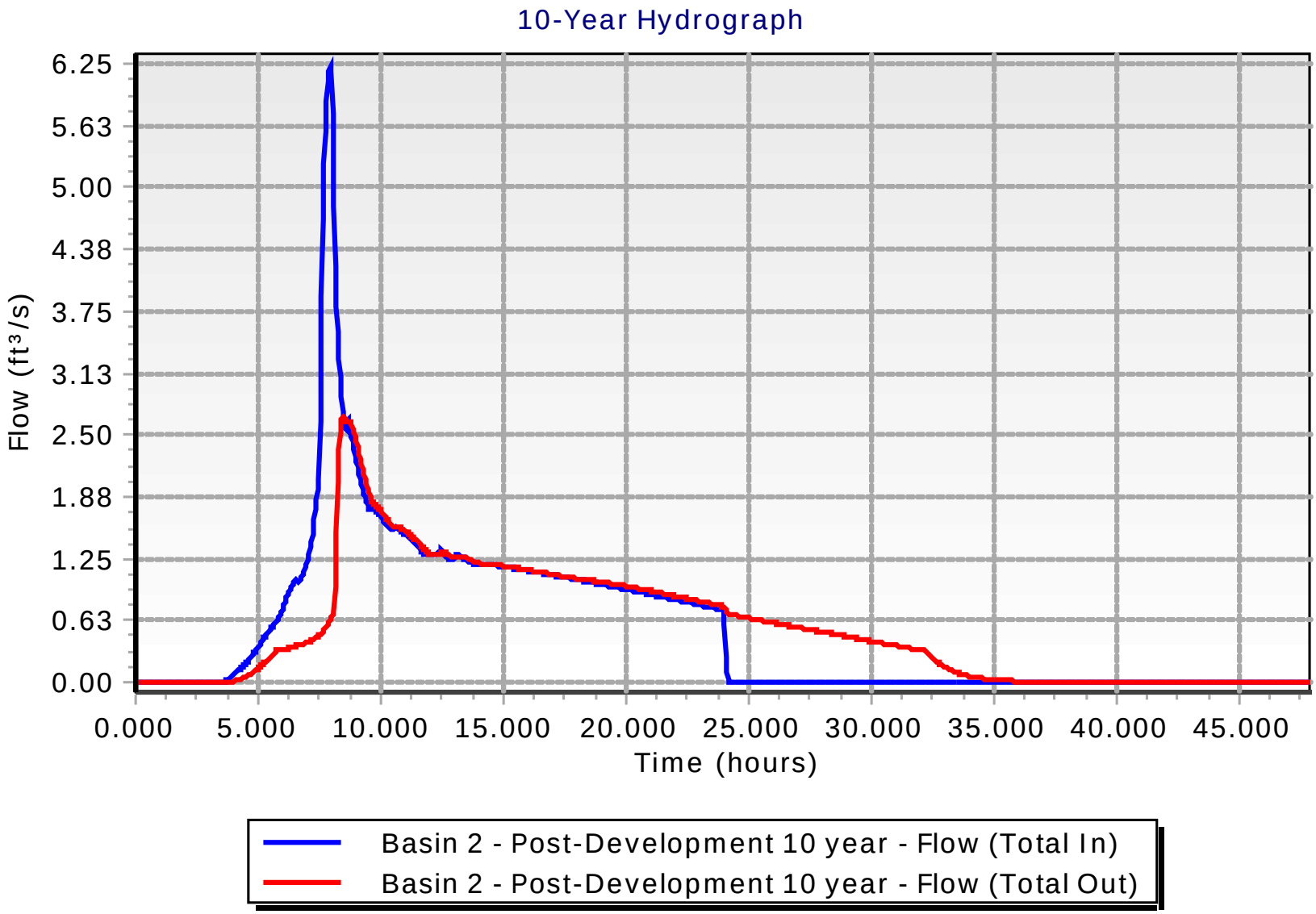
Tailwater Type	Free Outfall

Convergence Tolerances

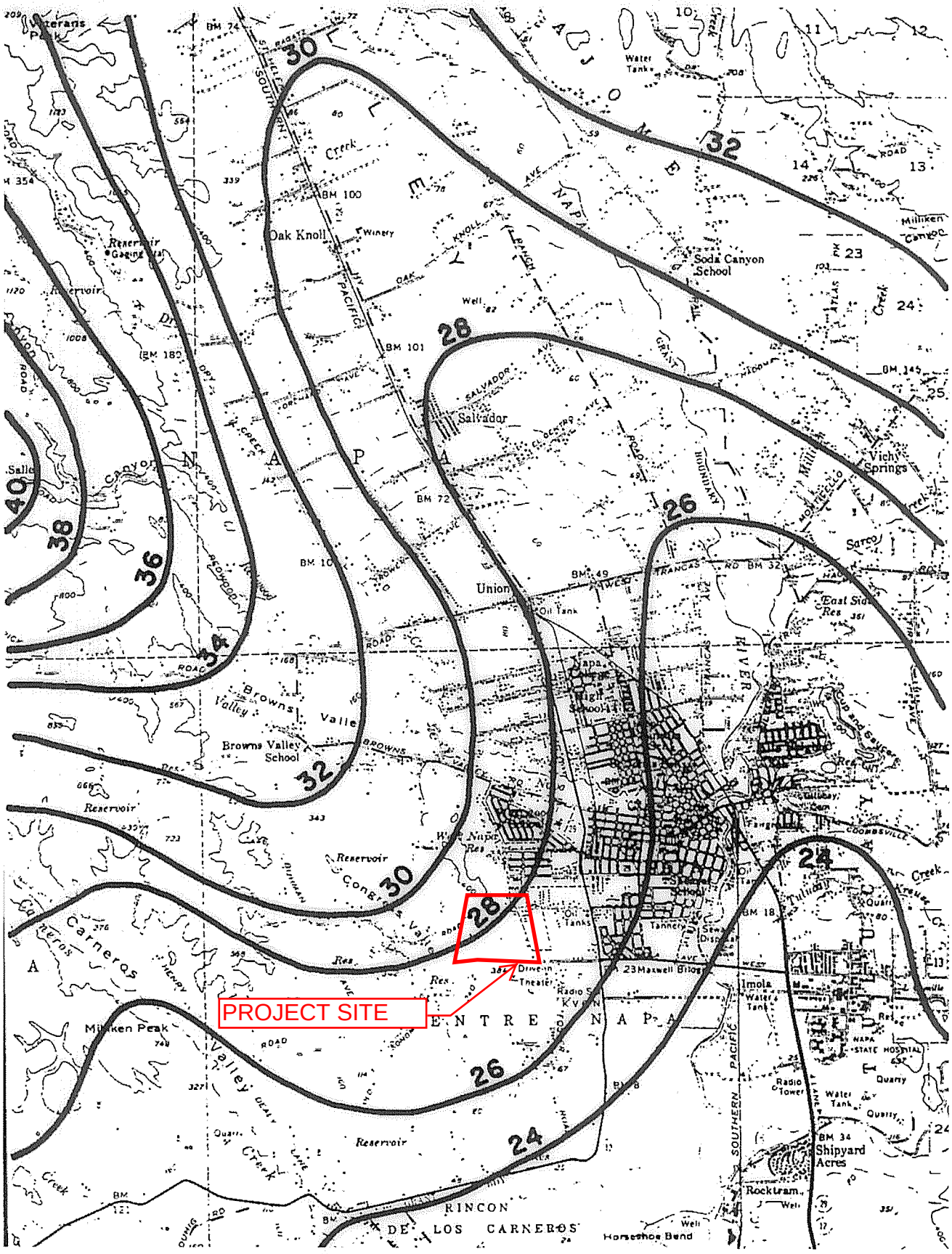
Maximum Iterations	30
Tailwater Tolerance (Minimum)	0.01 ft
Tailwater Tolerance (Maximum)	0.50 ft
Headwater Tolerance (Minimum)	0.01 ft
Headwater Tolerance (Maximum)	0.50 ft
Flow Tolerance (Minimum)	0.001 ft^3/s
Flow Tolerance (Maximum)	10.000 ft^3/s


100-Year Hydrograph
Flow (ft³/s)
6.25
5.63
5.00
4.38
3.75
3.13
2.50
1.88
1.25
0.63
0.00
0.000
5.000
10.000
15.000
20.000
25.000
30.000
35.000
40.000
45.000
Time (hours)
Basin 2 - Post-Development 10 year - Flow (Total In)
Basin 2 - Post-Development 10 year - Flow (Total Out)


25-Year Hydrograph
8.75
7.50
6.25
5.00
3.75
2.50
1.25
0.00
Flow (ft³/s)
0.000
5.000
10.000
15.000
20.000
25.000
30.000
35.000
40.000
45.000
Time (hours)
Basin 2 - Post-Development 25 year - Flow (Total In)
Basin 2 - Post-Development 25 year - Flow (Total Out)


10-Year Hydrograph
Flow (ft³/s)
6.25
5.63
5.00
4.38
3.75
3.13
2.50
1.88
1.25
0.63
0.00
0.000
5.000
10.000
15.000
20.000
25.000
30.000
35.000
40.000
45.000
Time (hours)
Basin 2 - Post-Development 10 year - Flow (Total In)
Basin 2 - Post-Development 10 year - Flow (Total Out)

APPENDIX E



CITY OF NAPA

DEPARTMENT OF PUBLIC WORKS

TITLE

ISOHYETAL MAP OF NAPA CITY BY S.C.S. - NAPA STUDY 1965

DRAWN BY: F.E.T.	CHECKED:
DATE: 3-19-87	APPROVED:
SCALE: NONE	DWG. NO. CHART 2.2
FIELD NOTES: D-65-32	

Frequency	Rainfall Intensity/Storm Duration, inches per hour									
	5 M	15 M	1 hr	2 hr	3 hr	6 hr	12 hr	24 hr	2 D	4 D
2-yr	1.8	1.08	0.57	0.41	0.34	0.25	0.16	0.1	0.06	0.04
5-yr	2.4	1.52	0.8	0.58	0.47	0.35	0.23	0.14	0.09	0.06
10-yr	3	1.84	0.97	0.7	0.57	0.42	0.28	0.17	0.11	0.07
25-yr	3.6	2.24	1.16	0.83	0.68	0.5	0.33	0.2	0.14	0.08
50-yr	3.84	2.48	1.3	0.94	0.76	0.57	0.37	0.23	0.16	0.1
100-yr	4.32	2.76	1.44	1.04	0.84	0.63	0.41	0.26	0.17	0.11
500-yr	5.4	3.4	1.78	1.28	1.04	0.78	0.51	0.32	0.22	0.14

Chart is from City of Napa 2006 Storm Drainage Master Plan Table 3-2

CITY OF NAPA

DEPARTMENT OF PUBLIC WORKS

TITLE

RAINFALL INTENSITY - DURATION
CITY OF NAPA

DRAWN BY: K.D.M

DATE: JULY 2008

SCALE: NONE

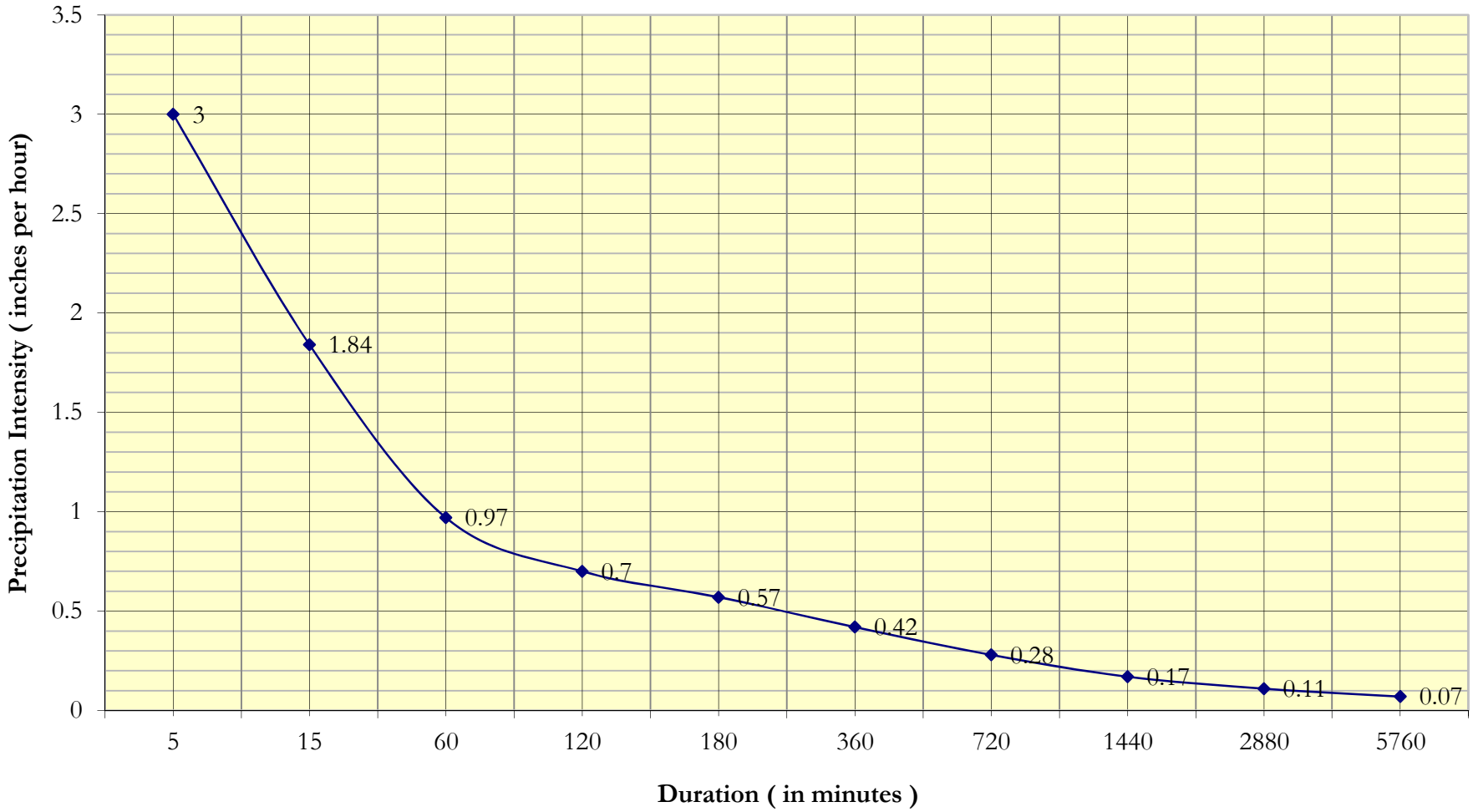
FIELD NOTES:

CHECKED:

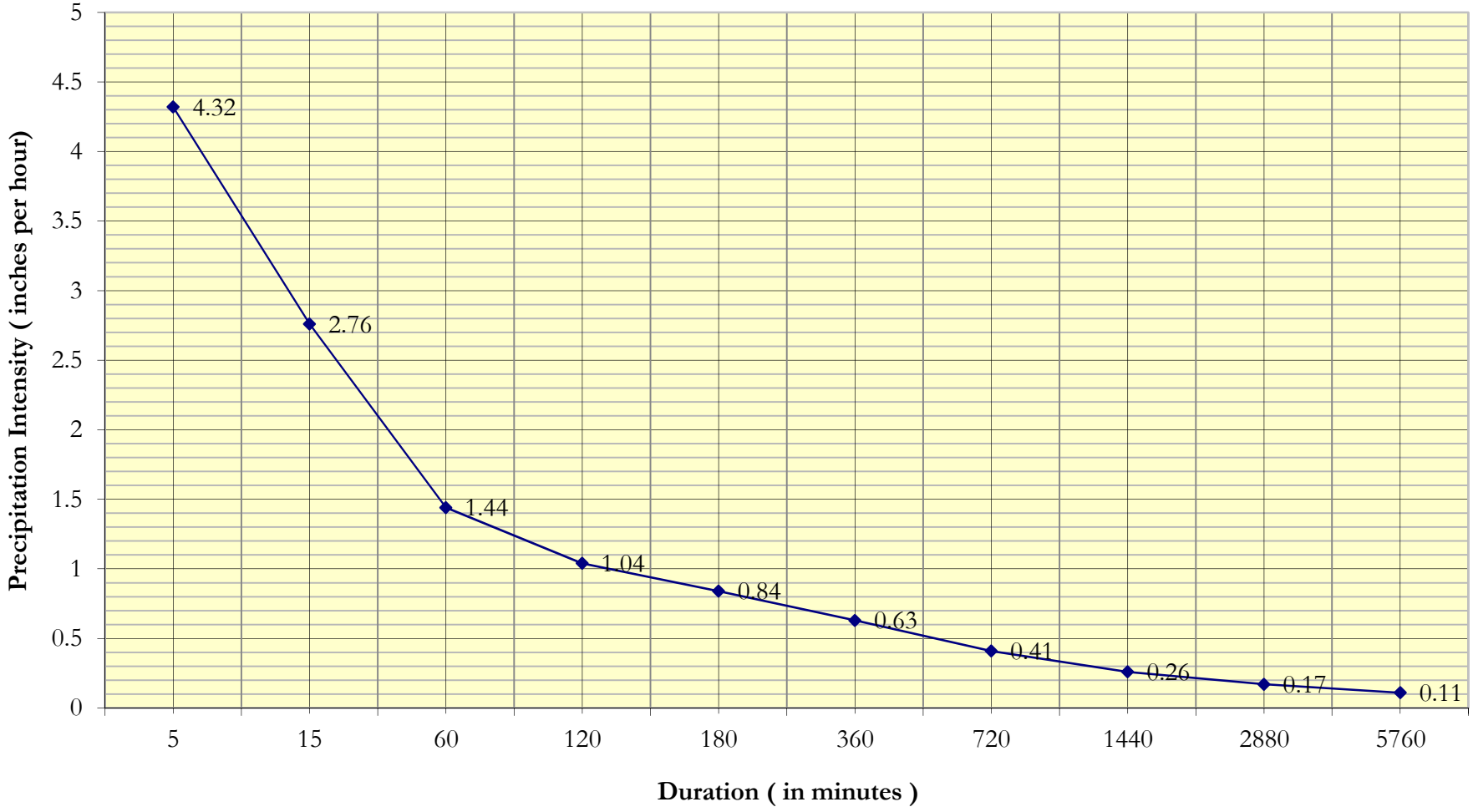
APPROVED:

DWG. NO. TABLE 2.3

Rainfall Intensity / Storm Duration
10 Year



Rainfall Intensity / Storm Duration
100 Year



APPENDIX F

Zoning or Surface Type	Runoff Coefficient, C
Paved areas (asphalt or concrete)	0.95
Industrial Areas	0.85
Commercial areas	0.85
Residential areas	
Single family, ave. slope less than 2%	0.5
Single family, ave. slope between 2% & 7%	0.55
Single family, ave. slope greater than 7%	0.65
Multi-family, detached	0.65
Multi-family, attached	0.7
Schools	0.45
Agricultural land	0.45
Undeveloped open spaces, including pasture	
Average slope less than 2%	0.4
Average slope between 2% & 7%	0.47
Average slope greater than 7%	0.55
Oak timber and heavy brush	
Average slope less than 2%	0.35
Average slope between 2% & 7%	0.42
Average slope greater than 7%	0.5

These coefficients are to be used for a return period of 10-years. For return periods of 25 and 100 years, modify the table values as follows:

25 year return: C = Table Value x 1.07

100 year return: C = Table Value x 1.25

Note: No value of "C" shall be modified beyond 1.0.

CITY OF NAPA

DEPARTMENT OF PUBLIC WORKS

TITLE

RUNOFF COEFFICIENT FOR RATIONAL METHOD

DRAWN BY: K.D.M

DATE: JULY 2008

SCALE: NONE

FIELD NOTES:

CHECKED:

APPROVED:

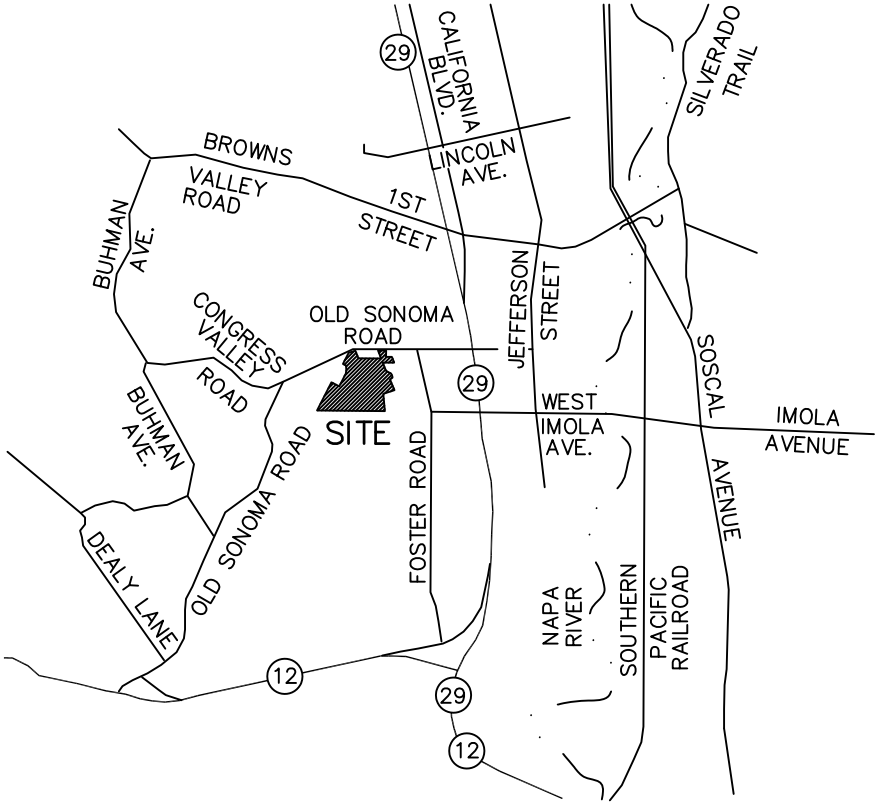
DWG. NO. TABLE 2.4

APPENDIX G

dk Consulting Entrance Loss Coefficients

TABLE OF HEAD LOSS FACTORS THROUGH STRUCTURES	K
1. Straight Run with change in pipe size	0.25
2. Straight Run with same size pipe	0.17
3. 0° to 45° Deflection w/ change in pipe size	0.50
4. 0° to 45° Deflection w/ same in pipe size	0.42
5. 45° to 90° Deflection w/ same in pipe size	0.75
6. 45° to 90° w/ change in pipe size	1.00
7. 90° Deflection	1.25
8. Drop Manhole	1.25
9. Short Radius Curves from 50′ and down	0.35

APPENDIX H



VICINITY MAP

APPENDIX I

NAPA OAKS HYDROLOGY MAP

NAPA, CALIFORNIA

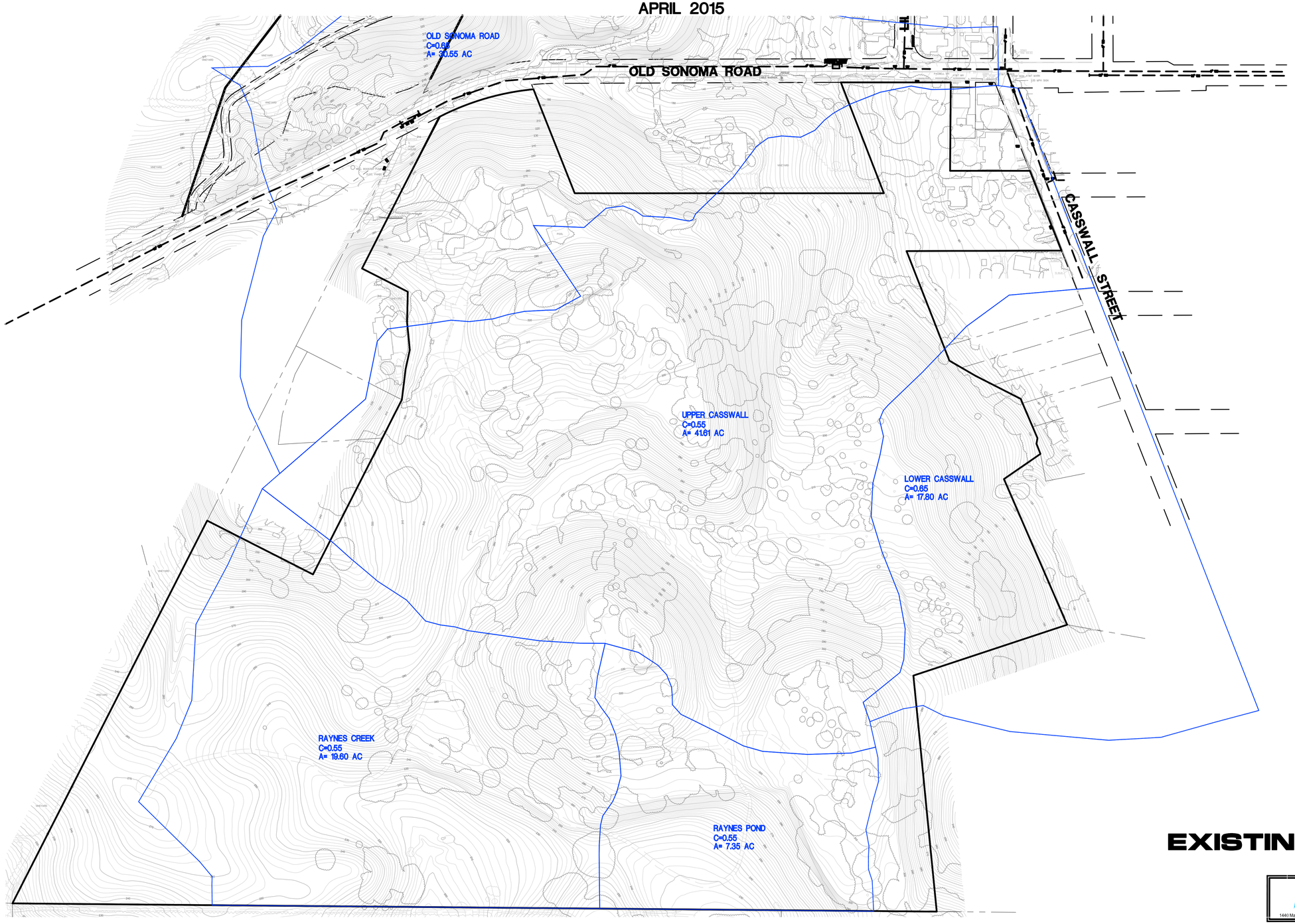
DAVIDON HOMES

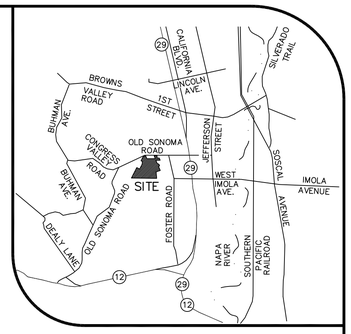
APRIL 2015

GRAPHIC SCALE

120 0 60 120 240 480

(IN FEET)
1 inch = 120 ft.





EXISTING CONDITIONS

CONSULTING
PLANNING · ENGINEERING · CONSTRUCTION
1440 Maria Lane, Suite 200, Walnut Creek, California 94596 (925) 932-6868 Tel. (925) 932-0910 Fax