NAPA OAKS HYDROLOGY MAP

NAPA, CALIFORNIA

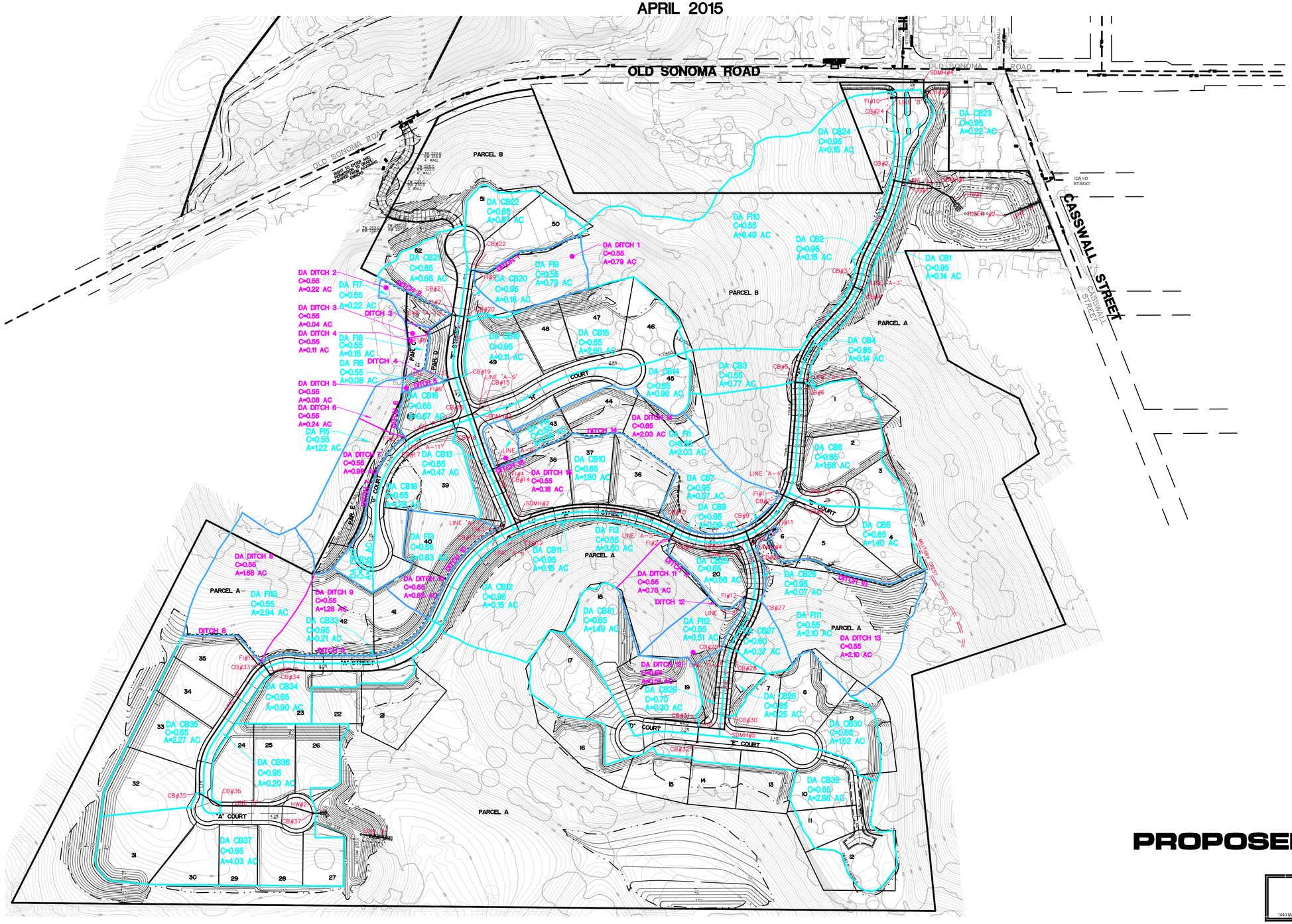
DAVIDON HOMES

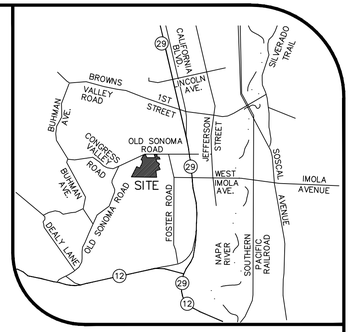
APRIL 2015

GRAPHIC SCALE

120 0 60 120 240 480

(IN FEET)
1 inch = 120 ft.





PROPOSED CONDITIONS

CONSULTING
PLANNING · ENGINEERING · CONSTRUCTION
1440 Maria Lane, Suite 200, Walnut Creek, California 94596 (925) 932-4868 Tel. (925) 932-0910 Fax

Napa Oaks

RECEIVED
NOV - 1 2011
COMMUNITY DEVELOPMENT
DEPARTMENT

Hydrology & Hydraulic Calculations

Prepared for:
City of Napa

Developer:
Davidon Homes

Job# 10-1021-10
March 2011

CONSULTING
PLANNING · ENGINEERING · CONSTRUCTION

1440 Maria Lane. Suite 200. Walnut Creek. CA 94596 / Tel: (925) 932-6868 / Fax: (925) 932-0910

TABLE OF CONTENTS

		Page
1.	Introduction	1
2.	Hydrology Calculations Outline	1
3.	Hydraulic Calculations Outline	2
4.	Basin Sizing	3

5. Appendices

A.) 10-year and 100-year Hydrology Calculations

B.) 10-year and 100-year Hydraulic Calculations

C.) V-Ditch Calculations
   a. Including Time of Concentration Calculations

D.) Basin Sizing Calculations
   a. Water Quality
   b. Detention

E.) Isohyetal Map of Napa City
   a. City of Napa – Rainfall Intensity-Duration Tables
   b. Graph of Intensity versus Duration for 10-year and 100-year storms

F.) City of Napa – Runoff Coefficient for Rational Method

G.) Entrance Loss Coefficients

H.) Location Map

I.) Hydrology Map

   a. Existing Conditions
   b. Proposed Improvements

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 54 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 Lines D and E. This basin will collect runoff from approximately 17 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.

Hydraulics

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. The Army Corps of Engineer's HEC-HMS software platform was used to 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 Table 1 of Appendix D.

Curve Numbers: A uniform Curve Number (CN) of 79 was assigned to the pre- and post-project condition watersheds based on standard tables assuming grasslands in fair condition on hydrologic group C soils.

Impervious area: Impervious percentages were not included in the composite CN. Instead the HEC-HMS model was run with a percent impervious area as a separate parameter. The percent impervious areas for the pre-project condition were taken from aerial photographs while the percent impervious areas for the post-project condition were delineated from the tentative map.

Time lag: Time of concentrations for all undeveloped areas were determined using the SCS Upland Method, where the time of concentration 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 on Table 2 of 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 on the Table 2 in Appendix D.

Modeled peak outflows from the pre- and post project watersheds for the 10-, 25-, and 100-year rainfall events are summarized on Table 3 in Appendix D. Results of routing the modeled hydrographs through the proposed basins are included in Figures 3 and 4 of 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
DATE: 3/31/2011
REV:
BY: CSG

10 YEAR HYDROLOGY CALCULATIONS
NAPA OAKS
POST-DEVELOPED CONDITIONS
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 #8	DA FI8	0.54	0.55	0.30	0.30	5.00	3.00	0.89	18	13.89	0.2910	19.45	0.02	49.09	2%	0.50
CB #19	DA CB19	2.26	0.65	1.47	1.77	5.02	2.99	5.28	18	3.06	0.0035	189.41	1.03	5.41	98%	1.00
CB #18	DA CB18, LINE A-10	0.10	0.95	0.10	2.07	6.05	2.87	5.94	18	4.27	0.0085	254.50	0.99	8.38	71%	0.90
SDMH #4	LINE A-8, LINE A-9	0.00	0.00	0.00	5.67	7.05	2.75	15.58	24	5.59	0.0099	61.50	0.18	19.52	80%	0.90
CB #15	DA CB15	0.94	0.55	0.52	6.18	7.23	2.73	16.88	24	6.24	0.0100	225.23	0.60	19.59	86%	1.00
CB #14	DA CB14	0.11	0.95	0.10	6.29	7.83	2.58	16.22	24	5.65	0.0101	29.63	0.09	19.72	82%	0.90
SDMH #3	LINE A-7	0.00	0.00	0.00	6.88	7.92	2.57	17.68	24	8.97	0.0574	77.20	0.14	46.95	38%	0.60
SDMH #7	LINE A-12	0.00	0.00	0.00	6.97	8.06	2.61	18.19	24	8.97	0.0574	79.25	0.15	46.96	39%	0.60
SDMH #2	LINE A-6	0.00	0.00	0.00	8.04	8.21	2.63	21.14	24	11.60	0.0960	329.01	0.47	60.72	35%	0.60
CB #10	DA CB10, LINE A-5	2.03	0.65	1.32	10.36	8.68	2.56	26.51	24	11.57	0.0955	184.24	0.27	60.56	44%	0.60
CB #9	DA CB9, LINE C	0.09	0.95	0.09	16.49	8.95	2.53	41.71	24	14.56	0.0672	133.26	0.15	50.82	82%	0.90
CB #7	DA CB7, LINE A-4, LINE A-3	0.07	0.95	0.07	18.78	9.10	2.52	47.31	24	19.45	0.1200	291.59	0.25	67.89	70%	0.90
CB #5	DA CB5, LINE A-2	1.28	0.55	0.70	20.49	9.35	2.51	51.42	24	21.75	0.1500	289.37	0.22	75.91	68%	0.90
CB #3	DA CB3, LINE A-1	0.76	0.55	0.42	21.04	9.57	2.50	52.60	24	18.79	0.1120	288.00	0.26	65.60	80%	0.90
CB #2	DA CB2	0.15	0.95	0.14	21.18	9.83	2.49	52.74	24	17.65	0.0800	22.00	0.02	55.43	95%	1.00
CB #1	DA CB1	0.14	0.95	0.13	21.31	9.85	2.49	53.07	24	24.33	0.2105	65.88	0.05	89.93	59%	0.85
SDMH #1	-	0.00	0.00	0.00	21.31	9.89	2.48	52.86	24	23.23	0.1712	64.53	0.05	81.10	65%	0.90
HW #1						9.94										

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	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	1.39	0.65	0.90	0.90	5.00	3.00	2.71	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	1.59	0.55	0.87	0.87	5.00	3.00	2.62	18	3.21	0.0108	13.00	0.07	9.44	28%	0.60
CB #11	DA CB11	0.13	0.95	0.12	1.00	5.07	2.98	2.97	18	14.07	0.2986	22.00	0.03	49.73	6%	0.50
CB #10						5.09										
LINE A-6																
FI #3	DA FI3	0.76	0.60	0.46	0.46	5.00	3.00	1.37	18	2.57	0.0100	10.00	0.06	9.10	15%	0.50
CB #12	DA CB12	0.94	0.65	0.61	1.07	5.06	2.98	3.18	18	3.49	0.0127	22.00	0.11	10.27	31%	0.60
SDMH #2						5.17										
LINE A-7																
FI #4	DA FI4	0.53	0.55	0.29	0.29	6.33	2.87	0.84	18	11.44	0.1974	11.50	0.02	40.43	2%	0.50
CB #13	DA CB13	0.46	0.65	0.30	0.59	6.35	2.87	1.69	18	7.19	0.0780	49.72	0.12	25.42	7%	0.50
SDMH #3						6.46										
LINE A-8																
FI #5	DA FI5	1.42	0.55	0.78	0.78	5.00	3.00	2.34	18	3.48	0.0127	35.39	0.17	10.26	23%	0.60
CB #16	DA CB16, LINE A-11	0.51	0.65	0.33	1.85	5.17	2.96	5.49	18	10.51	0.1665	53.50	0.08	37.14	15%	0.50
SDMH #4						5.25										

DK CONSULTING HYDROLOGY CALCULATIONS

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 #17	DA CB17	2.68	0.65	1.74	1.74	5.00	3.00	5.23	18	14.10	0.3000	32.50	0.04	49.85	10%	0.50
SDMH #4						5.04										
LINE A-10																
FI #7	DA FI7	0.15	0.55	0.08	0.08	5.00	3.00	0.25	18	13.87	0.2901	56.19	0.07	49.02	1%	0.50
FI #6	DA FI6	0.23	0.55	0.13	0.21	5.07	2.98	0.62	18	4.68	0.0330	43.08	0.15	16.52	4%	0.50
CB #18						5.22										
LINE A-11																
CB #38	DA CB38	1.14	0.65	0.74	0.74	5.00	3.00	2.22	18	3.47	0.0182	22.00	0.11	12.27	18%	0.50
CB #16						5.11										
LINE A-12																
FI #17	DA FI17	0.17	0.55	0.09	0.09	5.00	3.00	0.28	18	5.35	0.0432	150.00	0.47	18.92	1%	0.50
SDMH #7						5.47										
LINE B																
FI #9	DA FI9	6.47	0.55	3.56	3.56	6.43	2.85	10.14	18	10.78	0.1217	8.96	0.01	31.74	32%	0.60
CB #21	DA CB21	0.15	0.95	0.14	3.70	6.44	2.84	10.51	18	6.31	0.0150	69.20	0.18	11.16	94%	1.00
CB #20	DA CB20	0.22	0.95	0.21	3.91	6.63	2.83	11.07	18	6.37	0.0153	45.05	0.12	11.26	98%	1.00
SDMH #8						6.74										
LINE C																
CB #29	DA CB29	2.53	0.65	1.64	1.64	5.00	3.00	4.93	18	4.38	0.0100	38.00	0.14	9.10	54%	0.85
CB #28	DA CB28	1.44	0.65	0.94	2.58	5.14	2.97	7.66	18	5.10	0.0098	53.00	0.17	9.01	85%	1.00
SDMH #6	-	0.00	0.00	0.00	2.58	5.32	2.93	7.56	18	8.67	0.0787	31.00	0.06	25.53	30%	0.60
CB #27	DA CB27	1.33	0.65	0.86	3.45	5.38	2.92	10.06	18	12.40	0.1611	172.34	0.23	36.52	28%	0.60
CB #25	DA CB25, LINE C-4	0.25	0.65	0.16	3.81	5.61	2.90	11.05	18	12.10	0.1533	170.42	0.23	35.63	31%	0.60
CB #24	DA CB24, LINE C-3	0.45	0.60	0.27	4.37	5.84	2.89	12.62	18	11.77	0.1450	99.52	0.14	34.65	36%	0.60
CB #23	DA CB23	0.06	0.95	0.06	4.42	5.98	2.86	12.65	18	11.77	0.1451	27.16	0.04	34.66	36%	0.60
SDMH #5	LINE C-1, LINE C-2	0.00	0.00	0.00	6.05	6.02	2.86	17.29	24	6.23	0.0100	22.05	0.06	19.58	88%	1.00
CB #9						6.08										

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 C-1																
FI #10	DA FI10	2.18	0.55	1.20	1.20	5.00	3.00	3.60	18	5.30	0.0424	71.88	0.23	18.75	19%	0.50
SDMH #5						5.23										
LINE C-2																
CB #22	DA CB22	0.65	0.65	0.42	0.42	5.00	3.00	1.27	18	10.62	0.1699	48.25	0.08	37.52	3%	0.50
SDMH #5						5.08										
LINE C-3																
FI #11	DA FI11	0.52	0.55	0.29	0.29	5.00	3.00	0.86	18	2.57	0.0099	34.18	0.22	9.08	9%	0.50
CB #24						5.22										
LINE C-4																
CB #26	DA CB26	0.29	0.70	0.20	0.20	5.00	3.00	0.61	18	2.57	0.0100	22.00	0.14	9.10	7%	0.50
CB #25						5.14										
LINE D																
FI #13	DA FI13	3.25	0.55	1.79	1.79	5.00	3.00	5.36	18	10.30	0.1600	11.50	0.02	36.40	15%	0.50
CB #32	DA CB32	0.24	0.95	0.23	2.02	5.02	2.99	6.03	18	7.66	0.0615	66.37	0.14	22.56	27%	0.60
CB #31	DA CB31	1.73	0.65	1.12	3.14	5.16	2.97	9.33	18	7.83	0.0285	152.25	0.32	15.37	61%	0.90
CB #39	DA CB29	0.15	0.95	0.14	3.28	5.49	2.91	9.55	18	6.55	0.0200	254.63	0.65	12.87	74%	0.90
CB #30	DA CB30	3.28	0.65	2.13	5.41	6.13	2.85	15.43	18	10.79	0.1220	128.00	0.20	31.79	49%	0.60
FI #12	DA FI12	0.50	0.55	0.28	5.69	6.33	2.83	16.10	18	12.40	0.0715	178.00	0.24	24.34	66%	0.90
FI #11	DA FI11	0.04	0.55	0.02	5.71	6.57	2.80	15.99	18	9.16	0.0317	221.05	0.40	16.19	99%	1.00
HW #2						6.97										
LINE E																
FI #16	DA FI16	0.42	0.60	0.25	0.25	5.00	3.00	0.76	18	19.95	0.6000	4.00	0.00	70.49	1%	0.50
CB #36	DA CB36	0.14	0.95	0.13	0.39	5.00	3.00	1.16	18	9.28	0.1300	225.54	0.40	32.81	4%	0.50
CB #35	DA CB35	0.24	0.90	0.22	0.60	5.41	2.91	1.75	18	4.82	0.0350	193.61	0.67	17.03	10%	0.50
CB #34	DA CB34, LINE E-2	0.10	0.95	0.10	1.13	6.08	2.86	3.24	18	9.05	0.1235	149.07	0.27	31.98	10%	0.50
CB #33	DA CB33, LINE E-1	0.58	0.65	0.38	1.79	6.35	2.83	5.07	18	8.35	0.0731	34.75	0.07	24.60	21%	0.60
HW #3						6.42										

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 E-1																
FI #14	DA FI14	0.51	0.55	0.28	0.28	5.00	3.00	0.84	18	4.07	0.0250	4.00	0.02	14.39	6%	0.50
CB #33						5.02										
LINE E-2																
FI #15	DA FI15	1.19	0.55	0.65	0.65	5.56	2.90	1.90	18	4.07	0.0250	4.00	0.02	14.39	13%	0.50
CB #34						5.58										
LINE F																
RISER #1	BASIN	-	-	-	-	-	-	52.74	18	5.15	0.0100	99.98	0.32	9.10	579%	1.00
EX CB																
LINE G																
RISER #2	BASIN	-	-	-	-	-	-	21.06	18	6.65	0.0167	60.00	0.15	11.75	179%	1.00
OUTFALL #1																

10-1021-10	**100 YEAR HYDROLOGY CALCULATIONS**
DATE: 3/31/2011	NAPA OAKS
REV:	POST-DEVELOPED CONDITIONS
BY: CSG	DAVIDON HOMES

DK CONSULTING

n=	0.015	
i=	12.5	
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 #8	DA FI8	0.54	0.55	0.30	0.30	5.00	4.32	1.28	18	13.89	0.2910	19.45	0.02	49.09	3%	0.50
CB #19	DA CB19	2.26	0.65	1.47	1.77	5.02	4.31	7.61	18	3.06	0.0035	189.41	1.03	5.41	141%	1.00
CB #18	DA CB18, LINE A-10	0.10	0.95	0.10	2.07	6.05	4.18	8.65	18	4.74	0.0085	254.50	0.89	8.38	103%	1.00
SDMH #4	LINE A-8, LINE A-9	0.00	0.00	0.00	5.67	6.95	4.00	22.66	24	6.21	0.0099	61.50	0.16	19.52	116%	1.00
CB #15	DA CB15	0.94	0.55	0.52	6.18	7.11	3.97	24.54	24	6.24	0.0100	225.23	0.60	19.59	125%	1.00
CB #14	DA CB14	0.11	0.95	0.10	6.29	7.71	3.87	24.33	24	6.28	0.0101	29.63	0.08	19.72	123%	1.00
SDMH #3	LINE A-7	0.00	0.00	0.00	6.88	7.79	3.86	26.55	24	12.70	0.0574	77.20	0.10	46.95	57%	0.85
SDMH #7	LINE A-12	0.00	0.00	0.00	6.88	7.89	4.86	33.42	24	13.45	0.0574	79.25	0.10	46.96	71%	0.90
SDMH #2	LINE A-6	0.00	0.00	0.00	7.94	7.89	3.85	30.59	24	16.43	0.0960	329.01	0.33	60.72	50%	0.85
CB #10	DA CB10, LINE A-5	2.03	0.65	1.32	10.26	8.23	3.76	38.59	24	17.35	0.0955	184.24	0.18	60.56	64%	0.90
CB #9	DA CB9, LINE C	0.09	0.95	0.09	16.39	8.41	3.72	60.98	24	16.18	0.0672	133.26	0.14	50.82	120%	1.00
CB #7	DA CB7, LINE A-4, LINE A-3	0.07	0.95	0.07	18.68	8.54	3.71	69.31	24	21.61	0.1200	291.59	0.22	67.89	102%	1.00
CB #5	DA CB5, LINE A-2	1.28	0.55	0.70	20.39	8.77	3.69	75.25	24	24.16	0.1500	289.37	0.20	75.91	99%	1.00
CB #3	DA CB3, LINE A-1	0.76	0.55	0.42	20.94	8.97	3.65	76.45	24	20.88	0.1120	288.00	0.23	65.60	117%	1.00
CB #2	DA CB2	0.15	0.95	0.14	21.09	9.20	3.60	75.91	24	17.65	0.0800	22.00	0.02	55.43	137%	1.00
CB #1	DA CB1	0.14	0.95	0.13	21.22	9.22	3.59	76.18	24	25.76	0.2105	65.88	0.04	89.93	85%	0.90
SDMH #1	-	0.00	0.00	0.00	25.13	9.26	3.58	89.97	24	25.82	0.1712	64.53	0.04	81.10	111%	1.00
HW #1																

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	1.39	0.65	0.90	0.90	5.00	4.32	3.90	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	1.59	0.55	0.87	0.87	5.00	4.32	3.78	18	3.21	0.0108	13.00	0.07	9.44	40%	0.60
CB #11	DA CB11	0.13	0.95	0.12	1.00	5.07	4.31	4.30	18	14.07	0.2986	22.00	0.03	49.73	9%	0.50
CB #10						5.09										
LINE A-6																
FI #3	DA FI3	0.76	0.6	0.46	0.46	5.00	4.32	1.97	18	3.09	0.0100	10.00	0.05	9.10	22%	0.60
CB #12	DA CB12	0.94	0.65	0.61	1.07	5.05	4.32	4.61	18	3.49	0.0127	22.00	0.11	10.27	45%	0.60
SDMH #2						5.16										
LINE A-7																
FI #4	DA FI4	0.53	0.55	0.29	0.29	5.00	4.32	1.26	18	11.44	0.1974	11.50	0.02	40.43	3%	0.50
CB #13	DA CB13	0.46	0.65	0.30	0.59	5.02	4.31	2.55	18	7.19	0.0780	49.72	0.12	25.42	10%	0.50
SDMH #3						5.13										
LINE A-8																
FI #5	DA FI5	1.42	0.55	0.78	0.78	5.00	4.32	3.37	18	3.48	0.0127	35.39	0.17	10.26	33%	0.60
CB #16	DA CB16, LINE A-11	0.51	0.65	0.33	1.85	5.17	4.30	7.97	18	12.61	0.1665	53.50	0.07	37.14	21%	0.60
SDMH #4						5.24										

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 #17	DA CB17	2.68	0.65	1.74	1.74	5.00	4.32	7.53	18	14.10	0.3000	32.50	0.04	49.85	15%	0.50
SDMH #4						5.04										
LINE A-10																
FI #7	DA FI7	0.15	0.55	0.08	0.08	5.00	4.32	0.36	18	13.87	0.2901	56.19	0.07	49.02	1%	0.50
FI #6	DA FI6	0.23	0.55	0.13	0.21	5.07	4.31	0.90	18	4.68	0.0330	43.08	0.15	16.52	5%	0.50
CB #18						5.22										
LINE A-11																
CB #38	DA CB38	1.14	0.65	0.74	0.74	5.00	4.32	3.20	18	4.17	0.0182	22.00	0.09	12.27	26%	0.60
CB #16						5.09										
LINE A-12																
FI #17	DA FI17	0.17	0.55	0.09	0.09	5.00	4.32	0.40	18	5.35	0.0432	150.00	0.47	18.92	2%	0.50
SDMH #7						5.47										
LINE B																
FI #9	DA FI9	6.47	0.55	3.56	3.56	5.00	4.32	15.37	18	10.78	0.1217	8.96	0.01	31.74	48%	0.60
CB #21	DA CB21	0.15	0.95	0.14	3.70	5.01	4.32	15.99	18	6.31	0.0150	69.20	0.18	11.16	143%	1.00
CB #20	DA CB20	0.22	0.95	0.21	3.91	5.20	4.29	16.77	18	6.37	0.0153	45.05	0.12	11.26	149%	1.00
SDMH #8						5.31										
LINE C																
CB #29	DA CB29	2.53	0.65	1.64	1.64	5.00	4.32	7.10	18	4.63	0.0100	38.00	0.14	9.10	78%	0.90
CB #28	DA CB28	1.44	0.65	0.94	2.58	5.14	4.30	11.10	18	5.10	0.0098	53.00	0.17	9.01	123%	1.00
SDMH #6	-	0.00	0.00	0.00	2.58	5.31	4.26	10.99	18	8.67	0.0787	31.00	0.06	25.53	43%	0.60
CB #27	DA CB27	1.33	0.65	0.86	3.45	5.37	4.25	14.64	18	12.40	0.1611	172.34	0.23	36.52	40%	0.60
CB #25	DA CB25, LINE C-4	0.25	0.65	0.16	3.81	5.60	4.24	16.16	18	12.10	0.1533	170.42	0.23	35.63	45%	0.60
CB #24	DA CB24, LINE C-3	0.45	0.60	0.27	4.37	5.84	4.22	18.43	18	16.67	0.1450	99.52	0.10	34.65	53%	0.85
CB #23	DA CB23	0.06	0.95	0.06	4.42	5.94	4.21	18.62	18	16.67	0.1451	27.16	0.03	34.66	54%	0.85
SDMH #5	LINE C-1, LINE C-2	0.00	0.00	0.00	6.05	5.96	4.20	25.39	24	6.23	0.0100	22.05	0.06	19.58	130%	1.00
CB #9						6.02										

DK CONSULTING HYDROLOGY CALCULATIONS

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 C-1																
FI #10	DA FI10	2.18	0.55	1.20	1.20	5.00	4.32	5.18	18	6.37	0.0424	71.88	0.19	18.75	28%	0.60
SDMH #5						5.19										
LINE C-2																
CB #22	DA CB22	0.65	0.65	0.42	0.42	5.00	4.32	1.83	18	10.62	0.1699	48.25	0.08	37.52	5%	0.50
SDMH #5						5.08										
LINE C-3																
FI #11	DA FI11	0.52	0.55	0.29	0.29	5.00	4.32	1.24	18	2.57	0.0099	34.18	0.22	9.08	14%	0.50
CB #24						5.22										
LINE C-4																
CB #26	DA CB26	0.29	0.7	0.20	0.20	5.00	4.32	0.88	18	2.57	0.0100	22.00	0.14	9.10	10%	0.50
CB #25						5.14										
LINE D																
FI #13	DA FI13	3.25	0.55	1.79	1.79	5.00	4.32	7.72	18	12.36	0.1600	11.50	0.02	36.40	21%	0.60
CB #32	DA CB32	0.24	0.95	0.23	2.02	5.02	4.32	8.71	18	7.66	0.0615	66.37	0.14	22.56	39%	0.60
CB #31	DA CB31	1.73	0.65	1.12	3.14	5.16	4.30	13.50	18	8.70	0.0285	152.25	0.29	15.37	88%	1.00
CB #39	DA CB29	0.15	0.95	0.14	3.28	5.45	4.25	13.95	18	7.28	0.0200	254.63	0.58	12.87	108%	1.00
CB #30	DA CB30	3.28	0.65	2.13	5.41	6.03	4.16	22.52	18	16.19	0.1220	128.00	0.13	31.79	71%	0.90
FI #12	DA FI12	0.50	0.55	0.28	5.69	6.17	4.14	23.55	18	13.77	0.0715	178.00	0.22	24.34	97%	1.00
FI #11	DA FI11	0.04	0.55	0.02	5.71	6.38	4.12	23.53	18	9.16	0.0317	221.05	0.40	16.19	145%	1.00
HW #2						6.78										
LINE E																
FI #16	DA FI16	0.42	0.60	0.25	0.25	5.00	4.32	1.09	18	19.95	0.6000	4.00	0.00	70.49	2%	0.50
CB #36	DA CB36	0.14	0.95	0.13	0.39	5.00	4.32	1.66	18	9.28	0.1300	225.54	0.40	32.81	5%	0.50
CB #35	DA CB35	0.24	0.9	0.22	0.60	5.41	4.25	2.55	18	4.82	0.0350	193.61	0.67	17.03	15%	0.50
CB #34	DA CB34, LINE E-2	0.10	0.95	0.10	1.35	6.08	4.16	5.62	18	9.05	0.1235	149.07	0.27	31.98	18%	0.50
CB #33	DA CB33, LINE E-1	0.58	0.65	0.38	2.01	6.35	4.12	8.27	18	8.35	0.0731	34.75	0.07	24.60	34%	0.60
HW #3																

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 E-1																
FI #14	DA FI14	0.51	0.55	0.28	0.28	5.00	4.32	1.21	18	4.07	0.0250	4.00	0.02	14.39	8%	0.50
CB #33						5.02										
LINE E-2																
FI #15	DA FI15	1.19	0.55	0.65	0.65	5.00	4.32	2.83	18	4.07	0.0250	4.00	0.02	14.39	20%	0.50
CB #34						5.02										

APPENDIX B

10-1021-10
DATE: 3/31/2011
REV:
BY: CSG

HYDRAULIC CALCULATIONS
NAPA OAKS
POST-DEVELOPED CONDITIONS
DAVIDON HOMES

DK CONSULTING

n=	0.015	
i=	12.5	
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	52.86	24	16.83	64.53	0.0727	0.42	1.85	4.69	6.54	77.05	0.1712	79.05	79.05	91.30	12.25	12.25
SDMH #1	CB #1	53.07	24	16.89	65.88	0.0733	0.17	0.75	4.83	5.58	90.92	0.2105	92.92	92.92	102.44	9.52	9.52
CB #1	CB #2	52.74	24	16.79	22.00	0.0724	1.25	5.47	1.59	7.06	92.68	0.0800	99.98	94.68	102.44	2.46	7.76
CB #2	CB #3	52.60	24	16.74	288.00	0.0720	0.17	0.74	20.73	21.47	124.94	0.1120	126.94	126.94	134.64	7.70	7.70
CB #3	CB #5	51.42	24	16.37	289.37	0.0688	0.17	0.71	19.91	20.62	168.35	0.1500	170.35	170.35	177.30	6.95	6.95
CB #5	CB #7	47.31	24	15.06	291.59	0.0582	0.17	0.60	16.98	17.58	203.34	0.1200	205.34	205.34	213.14	7.80	7.80
CB #7	CB #9	41.71	24	13.28	133.26	0.0453	0.17	0.47	6.03	6.50	212.30	0.0672	214.30	214.30	223.33	9.03	9.03
CB #9	CB #10	26.51	24	8.44	184.24	0.0183	0.17	0.19	3.37	3.56	229.89	0.0955	231.89	231.89	239.80	7.91	7.91
CB #10	SDMH #2	21.14	24	6.73	329.01	0.0116	0.17	0.12	3.83	3.94	261.47	0.0960	263.47	263.47	268.80	5.33	5.33
SDMH #2	SDMH #7	18.19	24	5.79	79.25	0.0086	0.17	0.09	0.68	0.77	266.02	0.0574	268.02	268.02	273.90	5.88	5.88
SDMH #7	SDMH #3	17.68	24	5.63	77.20	0.0081	1.25	0.61	0.63	1.24	270.45	0.0574	272.45	272.45	277.60	5.15	5.15
SDMH #3	CB #14	16.22	24	5.16	29.63	0.0068	0.17	0.07	0.20	0.27	270.75	0.0101	272.75	272.75	279.51	6.76	6.76
CB #14	CB #15	16.88	24	5.37	225.23	0.0074	0.17	0.08	1.67	1.75	273.00	0.0100	275.00	275.00	288.66	13.66	13.66
CB #15	SDMH #4	15.58	24	4.96	61.50	0.0063	0.25	0.10	0.39	0.48	273.61	0.0099	275.61	275.61	289.60	13.99	13.99
SDMH #4	CB #18	5.94	18	3.36	254.50	0.0043	0.17	0.03	1.08	1.11	276.27	0.0085	277.77	277.77	292.69	14.92	14.92
CB #18	CB #19	5.28	18	2.99	189.41	0.0034	1.25	0.17	0.64	0.81	276.94	0.0035	278.58	278.44	281.94	3.36	3.50
CB #19	FI #8	0.89	18	0.50	19.45	0.0001	1.25	0.00	0.00	0.01	282.60	0.2910	284.10	284.10	286.10	2.00	2.00
FI #8																	
LINE A-1																	
	CB #3										125.44		126.94		134.64		
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	134.64	7.48	7.48
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		177.30		
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	177.30	6.73	6.73
CB #6																	
LINE A-3																	
	CB #7										203.84		205.34		213.14		
CB #7	CB #8	2.71	18	1.53	57.86	0.0009	1.25	0.05	0.05	0.10	204.42	0.0100	205.92	205.92	212.83	6.91	6.91
CB #8																	
LINE A-4																	
	CB #7										203.84		205.34		213.14		
CB #7	FI #1	3.83	18	2.17	18.00	0.0018	1.25	0.09	0.03	0.12	210.50	0.3700	212.00	212.00	214.00	2.00	2.00
FI #1																	
LINE A-5																	
	CB #10										230.39		231.89		239.80		
CB #10	CB #11	2.97	18	1.68	22.00	0.0011	0.17	0.01	0.02	0.03	236.96	0.2986	238.46	238.46	239.80	1.34	1.34
CB #11	FI #2	2.62	18	1.48	13.00	0.0008	1.25	0.04	0.01	0.05	237.10	0.0108	238.60	238.60	240.60	2.00	2.00
FI #2																	
LINE A-6																	
	SDMH #2										261.91		263.47		268.80		
SDMH #2	CB #12	3.18	18	1.80	22.00	0.0012	0.17	0.01	0.03	0.04	262.19	0.0127	263.69	263.69	269.28	5.59	5.59
CB #12	FI #3	1.37	18	0.77	10.00	0.0002	1.25	0.01	0.00	0.01	262.29	0.0100	263.79	263.79	270.00	6.21	6.21
FI #3																	
LINE A-7																	
	SDMH #3										270.95		272.45		277.60		
SDMH #3	CB #13	1.69	18	0.96	49.72	0.0003	1.25	0.02	0.02	0.04	274.83	0.0780	276.33	276.33	279.87	3.54	3.54
CB #13	FI #4	0.84	18	0.47	11.50	0.0001	1.25	0.00	0.00	0.01	277.10	0.1974	278.60	278.60	280.60	2.00	2.00
FI #4																	
LINE A-8																	
	SDMH #4										274.11		275.61		289.60		
SDMH #4	CB #16	5.49	18	3.10	53.50	0.0036	0.75	0.11	0.19	0.31	283.02	0.1665	284.52	284.52	291.89	7.37	7.37
CB #16	FI #5	2.34	18	1.33	35.39	0.0007	1.25	0.03	0.02	0.06	283.47	0.0127	284.97	284.97	287.00	2.03	2.03
FI #5																	

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 #4										274.11		275.61		289.60		
SDMH #4	CB #17	5.23	18	2.96	32.50	0.0033	1.25	0.17	0.11	0.28	283.86	0.3000	285.36	285.36	290.86	5.50	5.50
CB #17																	
LINE A-10																	
	CB #18										287.78		277.77		292.69		
CB #18	FI #6	0.62	18	0.35	43.08	0.0000	0.75	0.00	0.00	0.00	289.20	0.0330	290.70	290.70	292.90	2.20	2.20
FI #6	FI #7	0.25	18	0.14	56.19	0.0000	1.25	0.00	0.00	0.00	305.50	0.2901	307.00	307.00	309.00	2.00	2.00
FI #7																	
LINE A-11																	
	CB #16										283.02		284.52		291.89		
CB #16	CB #38	2.22	18	1.26	22.00	0.0006	1.25	0.03	0.01	0.04	283.42	0.0182	284.92	284.92	291.89	6.97	6.97
CB #38																	
LINE A-12																	
	SDMH #7										266.02		268.02		273.90		
SDMH #7	FI #17	0.28	18	0.16	150.00	0.0000	1.25	0.00	0.00	0.00	272.50	0.0432	274.00	274.00	277.50	3.50	3.50
FI #17																	
LINE B																	
	SDMH #8										80.50		79.05		91.30		
SDMH #8	CB #20	11.07	18	6.26	45.05	0.0148	1.25	0.76	0.67	1.43	81.19	0.0153	82.69	82.69	89.60	6.91	6.91
CB #20	CB #21	10.51	18	5.95	69.20	0.0133	0.50	0.27	0.92	1.20	82.95	0.0150	84.45	84.45	89.90	5.45	5.45
CB #21	FI #9	10.14	18	5.74	8.96	0.0124	1.25	0.64	0.11	0.75	84.04	0.1217	85.54	85.54	90.65	5.11	5.11
FI #9																	
LINE C																	
	CB #9										212.30		214.30		223.33		
CB #9	SDMH #5	17.29	24	5.50	22.05	0.0078	0.25	0.12	0.17	0.29	212.52	0.0100	214.59	214.52	223.00	8.41	8.48
SDMH #5	CB #23	12.65	18	7.16	27.16	0.0193	0.17	0.14	0.52	0.66	216.96	0.1451	218.46	218.46	225.76	7.30	7.30
CB #23	CB #24	12.62	18	7.14	99.52	0.0192	0.17	0.13	1.91	2.05	231.39	0.1450	232.89	232.89	239.38	6.49	6.49
CB #24	CB #25	11.05	18	6.25	170.42	0.0147	0.17	0.10	2.51	2.61	257.52	0.1533	259.02	259.02	264.50	5.48	5.48
CB #25	CB #27	10.06	18	5.69	172.34	0.0122	0.17	0.09	2.10	2.19	285.28	0.1611	286.78	286.78	290.33	3.55	3.55
CB #27	SDMH #6	7.56	18	4.28	31.00	0.0069	1.25	0.36	0.21	0.57	287.72	0.0787	289.22	289.22	292.90	3.68	3.68
SDMH #6	CB #28	7.66	18	4.34	53.00	0.0071	1.25	0.37	0.38	0.74	288.24	0.0098	289.96	289.74	293.63	3.67	3.89
CB #28	CB #29	4.93	18	2.79	38.00	0.0029	1.25	0.15	0.11	0.26	288.62	0.0100	290.22	290.12	293.63	3.41	3.51
CB #29																	

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-1																	
	SDMH #5										213.02		214.59		223.00		
SDMH #5	FI #10	3.60	18	2.04	71.88	0.0016	1.25	0.08	0.11	0.19	216.07	0.0424	217.57	217.57	219.60	2.03	2.03
FI #10																	
LINE C-2																	
	SDMH #5										213.02		214.59		223.00		
SDMH #5	CB #22	1.27	18	0.72	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 #24										231.39		232.89		239.38		
CB #24	FI #11	0.86	18	0.49	34.18	0.0001	1.25	0.00	0.00	0.01	231.73	0.0099	233.23	233.23	239.60	6.37	6.37
FI #11																	
LINE C-4																	
	CB #25										257.52		259.02		264.50		
CB #25	CB #26	0.61	18	0.34	22.00	0.0000	1.25	0.00	0.00	0.00	257.74	0.0100	259.24	259.24	264.50	5.26	5.26
CB #26																	
LINE D																	
	HW #2										204.00		206.00		206.00		
HW #2	FI #11	15.99	18	9.05	221.05	0.0309	0.17	0.22	6.82	7.04	211.00	0.0317	213.04	212.50	216.50	3.46	4.00
FI #11	FI #12	16.10	18	9.11	178.00	0.0313	0.17	0.22	5.57	5.79	223.73	0.0715	225.23	225.23	229.20	3.97	3.97
FI #12	CB #30	15.43	18	8.73	128.00	0.0287	1.25	1.48	3.68	5.16	239.35	0.1220	240.85	240.85	246.94	6.09	6.09
CB #30	CB #39	9.55	18	5.41	254.63	0.0110	0.17	0.08	2.80	2.88	244.44	0.0200	245.94	245.94	250.40	4.46	4.46
CB #39	CB #31	9.33	18	5.28	152.25	0.0105	1.25	0.54	1.60	2.14	248.78	0.0285	250.28	250.28	253.81	3.53	3.53
CB #31	CB #32	6.03	18	3.41	66.37	0.0044	1.25	0.23	0.29	0.52	252.86	0.0615	254.36	254.36	257.96	3.60	3.60
CB #32	FI #13	5.36	18	3.03	11.50	0.0035	1.25	0.18	0.04	0.22	254.70	0.1600	256.20	256.20	258.20	2.00	2.00
FI #13																	
LINE E																	
	HW #3										204.00		206.00		206.00		
HW #3	CB #33	5.07	18	2.87	34.75	0.0031	1.25	0.16	0.11	0.27	206.54	0.0731	208.04	208.04	212.55	4.51	4.51
CB #33	CB #34	3.24	18	1.84	149.07	0.0013	0.17	0.01	0.19	0.20	224.95	0.1235	226.45	226.45	230.62	4.17	4.17
CB #34	CB #35	1.75	18	0.99	193.61	0.0004	1.17	0.02	0.07	0.09	231.73	0.0350	233.23	233.23	238.43	5.20	5.20
CB #34	CB #36	1.16	18	0.65	225.54	0.0002	1.25	0.01	0.04	0.04	261.05	0.1300	262.55	262.55	265.11	2.56	2.56
CB #36	FI #16	0.76	18	0.43	4.00	0.0001	1.25	0.00	0.00	0.00	263.45	0.6000	264.95	264.95	266.95	2.00	2.00
FI #16																	

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 E-1																	
	CB #33										204.00		208.04		212.55		
CB #33	FI #14	0.84	18	0.48	4.00	0.0001	1.25	0.00	0.00	0.00	204.10	0.0250	208.04	205.60	213.05	5.01	7.45
FI #14																	
LINE E-2																	
	CB #34										206.54		226.45		230.62		
CB #34	FI #15	1.90	18	1.07	4.00	0.0004	1.25	0.02	0.00	0.02	206.64	0.0250	226.47	208.14	230.72	4.25	22.58
FI #15																	

10-1021-10
DATE: 3/31/2011
REV:
BY: CSG

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

DK CONSULTING

n=	0.015
i=	12.5
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	89.97	24	28.64	64.53	0.2106	0.42	5.35	13.59	18.94	77.05	0.1712	86.94	79.05	91.30	4.36	12.25
SDMH #1	CB #1	76.18	24	24.25	65.88	0.1510	0.17	1.55	9.95	11.50	90.92	0.2105	98.44	92.92	102.44	4.00	9.52
CB #1	CB #2	75.91	24	24.16	22.00	0.1499	1.25	11.33	3.30	14.63	92.68	0.0800	113.07	94.68	102.44	(10.63)	7.76
CB #2	CB #3	76.45	24	24.33	288.00	0.1521	0.17	1.56	43.79	45.35	124.94	0.1120	158.42	126.94	134.64	(23.78)	7.70
CB #3	CB #5	75.25	24	23.95	289.37	0.1473	0.17	1.51	42.63	44.15	168.35	0.1500	202.57	170.35	177.30	(25.27)	6.95
CB #5	CB #7	69.31	24	22.06	291.59	0.1250	0.17	1.28	36.44	37.73	203.34	0.1200	240.30	205.34	213.14	(27.16)	7.80
CB #7	CB #9	60.98	24	19.41	133.26	0.0967	0.17	0.99	12.89	13.89	212.30	0.0672	254.19	214.30	223.33	(30.86)	9.03
CB #9	CB #10	38.59	24	12.28	184.24	0.0387	0.17	0.40	7.14	7.53	229.89	0.0955	261.72	231.89	239.80	(21.92)	7.91
CB #10	SDMH #2	30.59	24	9.74	329.01	0.0243	0.17	0.25	8.01	8.26	261.47	0.0960	269.98	263.47	268.80	(1.18)	5.33
SDMH #2	SDMH #7	33.42	24	10.64	79.25	0.0291	0.17	0.30	2.30	2.60	266.02	0.0574	272.58	268.02	273.90	1.32	5.88
SDMH #7	SDMH #3	26.55	24	8.45	77.20	0.0183	1.25	1.39	1.42	2.80	270.45	0.0574	272.78	272.45	277.60	4.82	5.15
SDMH #3	CB #14	24.33	24	7.74	29.63	0.0154	0.17	0.16	0.46	0.61	270.75	0.0101	273.40	272.75	279.51	6.11	6.76
CB #14	CB #15	24.54	24	7.81	225.23	0.0157	0.17	0.16	3.53	3.69	273.00	0.0100	277.09	275.00	288.66	11.57	13.66
CB #15	SDMH #4	22.66	24	7.21	61.50	0.0134	0.25	0.20	0.82	1.02	273.61	0.0099	278.11	275.61	289.60	11.49	13.99
SDMH #4	CB #18	8.65	18	4.90	254.50	0.0090	0.17	0.06	2.30	2.36	276.27	0.0085	280.48	277.77	292.69	12.21	14.92
CB #18	CB #19	7.61	18	4.31	189.41	0.0070	1.25	0.36	1.32	1.68	276.94	0.0035	282.16	278.44	281.94	(0.22)	3.50
CB #19	FI #8	1.28	18	0.73	19.45	0.0002	1.25	0.01	0.00	0.01	282.60	0.2910	284.10	284.10	286.10	2.00	2.00
FI #8																	
LINE A-1																	
	CB #3										125.44		158.42		134.64		
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	158.43	127.16	134.64	(23.79)	7.48
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		202.57		177.30		
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	202.74	170.57	177.30	(25.44)	6.73
CB #6																	
LINE A-3																	
	CB #7										203.84		240.30		213.14		
CB #7	CB #8	3.90	18	2.21	57.86	0.0018	1.25	0.09	0.11	0.20	204.42	0.0100	240.50	205.92	212.83	(27.67)	6.91
CB #8																	
LINE A-4																	
	CB #7										203.84		240.30		213.14		
CB #7	FI #1	5.70	18	3.23	18.00	0.0039	1.25	0.20	0.07	0.27	210.50	0.3700	240.57	212.00	214.00	(26.57)	2.00
FI #1																	
LINE A-5																	
	CB #10										230.39		261.72		239.80		
CB #10	CB #11	4.30	18	2.43	22.00	0.0022	0.17	0.02	0.05	0.06	236.96	0.2986	261.79	238.46	239.80	(21.99)	1.34
CB #11	FI #2	3.78	18	2.14	13.00	0.0017	1.25	0.09	0.02	0.11	237.10	0.0108	261.90	238.60	240.60	(21.30)	2.00
FI #2																	
LINE A-6																	
	SDMH #2										261.91		269.98		268.80		
SDMH #2	CB #12	4.61	18	2.61	22.00	0.0026	0.17	0.02	0.06	0.07	262.19	0.0127	270.06	263.69	269.28	(0.78)	5.59
CB #12	FI #3	1.97	18	1.11	10.00	0.0005	1.25	0.02	0.00	0.03	262.29	0.0100	270.08	263.79	270.00	(0.08)	6.21
FI #3																	
LINE A-7																	
	SDMH #3										270.95		272.78		277.60		
SDMH #3	CB #13	2.55	18	1.44	49.72	0.0008	1.25	0.04	0.04	0.08	274.83	0.0780	276.33	276.33	279.87	3.54	3.54
CB #13	FI #4	1.26	18	0.71	11.50	0.0002	1.25	0.01	0.00	0.01	277.10	0.1974	278.60	278.60	280.60	2.00	2.00
FI #4																	
LINE A-8																	
	SDMH #4										274.11		278.11		289.60		
SDMH #4	CB #16	7.97	18	4.51	53.50	0.0077	0.75	0.24	0.41	0.65	283.02	0.1665	284.52	284.52	291.89	7.37	7.37
CB #16	FI #5	3.37	18	1.91	35.39	0.0014	1.25	0.07	0.05	0.12	283.47	0.0127	284.97	284.97	287.00	2.03	2.03
FI #5																	

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 #4										283.86		278.11		289.60		
SDMH #4	CB #17	7.53	18	4.26	32.50	0.0068	1.25	0.35	0.22	0.57	283.86	0.3000	285.36	285.36	290.86	5.50	5.50
CB #17																	
LINE A-10																	
	CB #18										287.78		280.48		292.69		
CB #18	FI #6	0.90	18	0.51	43.08	0.0001	0.75	0.00	0.00	0.01	289.20	0.0330	290.70	290.70	292.90	2.20	2.20
FI #6	FI #7	0.36	18	0.20	56.19	0.0000	1.25	0.00	0.00	0.00	305.50	0.2901	307.00	307.00	309.00	2.00	2.00
FI #7																	
LINE A-11																	
	CB #16										283.42		284.52		291.89		
CB #16	CB #38	3.20	18	1.81	22.00	0.0012	1.25	0.06	0.03	0.09	283.02	0.0182	284.61	284.52	291.89	7.28	7.37
CB #38																	
LINE B																	
	SDMH #8										80.50		86.94		91.30		
SDMH #8	CB #20	16.77	18	9.49	45.05	0.0340	1.25	1.75	1.53	3.28	81.19	0.0153	90.22	82.69	89.60	(0.62)	6.91
CB #20	CB #21	15.99	18	9.05	69.20	0.0308	0.50	0.64	2.13	2.77	82.95	0.0150	92.99	84.45	89.90	(3.09)	5.45
CB #21	FI #9	15.37	18	8.70	8.96	0.0285	1.25	1.47	0.26	1.72	84.04	0.1217	94.71	85.54	90.65	(4.06)	5.11
FI #9																	
LINE C																	
	CB #9										212.30		254.19		223.33		
CB #9	SDMH #5	25.39	24	8.08	22.05	0.0168	0.25	0.25	0.37	0.62	212.52	0.0100	254.81	214.52	223.00	(31.81)	8.48
SDMH #5	CB #23	18.62	18	10.54	27.16	0.0419	0.17	0.29	1.14	1.43	216.96	0.1451	256.24	218.46	225.76	(30.48)	7.30
CB #23	CB #24	18.43	18	10.43	99.52	0.0410	0.17	0.29	4.08	4.36	231.39	0.1450	260.61	232.89	239.38	(21.23)	6.49
CB #24	CB #25	16.16	18	9.14	170.42	0.0315	0.17	0.22	5.37	5.59	257.52	0.1533	266.20	259.02	264.50	(1.70)	5.48
CB #25	CB #27	14.64	18	8.29	172.34	0.0259	0.17	0.18	4.46	4.64	285.28	0.1611	286.78	286.78	290.33	3.55	3.55
CB #27	SDMH #6	10.99	18	6.22	31.00	0.0146	1.25	0.75	0.45	1.20	287.72	0.0787	289.22	289.22	292.90	3.68	3.68
SDMH #6	CB #28	11.10	18	6.28	53.00	0.0149	1.25	0.77	0.79	1.55	288.24	0.0098	290.77	289.74	293.63	2.86	3.89
CB #28	CB #29	7.10	18	4.02	38.00	0.0061	1.25	0.31	0.23	0.55	288.62	0.0100	291.32	290.12	293.63	2.31	3.51
CB #29																	

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-1																	
	SDMH #5										213.02		254.81		223.00		
SDMH #5	FI #10	5.18	18	2.93	71.88	0.0032	1.25	0.17	0.23	0.40	216.07	0.0424	255.21	217.57	219.60	(35.61)	2.03
FI #10																	
LINE C-2																	
	SDMH #5										213.02		254.81		223.00		
SDMH #5	CB #22	1.83	18	1.03	48.25	0.0004	1.25	0.02	0.02	0.04	221.22	0.1699	254.85	222.72	226.64	(28.21)	3.92
CB #22																	
LINE C-3																	
	CB #24										231.39		260.61		239.38		
CB #24	FI #11	1.24	18	0.70	34.18	0.0002	1.25	0.01	0.01	0.02	231.73	0.0099	260.62	233.23	239.60	(21.02)	6.37
FI #11																	
LINE C-4																	
	CB #25										257.52		266.20		264.50		
CB #25	CB #26	0.88	18	0.50	22.00	0.0001	1.25	0.00	0.00	0.01	257.74	0.0100	266.20	259.24	264.50	(1.70)	5.26
CB #26																	
LINE D																	
	HW #2										204.00		206.00		206.00		
HW #2	FI #11	23.53	18	13.32	221.05	0.0668	0.17	0.47	14.77	15.24	211.00	0.0317	221.24	212.50	216.50	(4.74)	4.00
FI #11	FI #12	23.55	18	13.33	178.00	0.0670	0.17	0.47	11.92	12.39	223.73	0.0715	233.63	225.23	229.20	(4.43)	3.97
FI #12	CB #30	22.52	18	12.75	128.00	0.0612	1.25	3.15	7.84	10.99	239.35	0.1220	244.62	240.85	246.94	2.32	6.09
CB #30	CB #39	13.95	18	7.89	254.63	0.0235	0.17	0.16	5.98	6.14	244.44	0.0200	250.76	245.94	250.40	(0.36)	4.46
CB #39	CB #31	13.50	18	7.64	152.25	0.0220	1.25	1.13	3.35	4.48	248.78	0.0285	255.24	250.28	253.81	(1.43)	3.53
CB #31	CB #32	8.71	18	4.93	66.37	0.0091	1.25	0.47	0.61	1.08	252.86	0.0615	256.32	254.36	257.96	1.64	3.60
CB #32	FI #13	7.72	18	4.37	11.50	0.0072	1.25	0.37	0.08	0.45	254.70	0.1600	256.77	256.20	258.20	1.43	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 E																	
	HW #3										204.00		206.00		206.00		
HW #3	CB #33	8.27	18	4.68	34.75	0.0083	1.25	0.43	0.29	0.71	206.54	0.0731	208.04	208.04	212.55	4.51	4.51
CB #33	CB #34	5.62	18	3.18	149.07	0.0038	0.17	0.03	0.57	0.59	224.95	0.1235	226.45	226.45	230.62	4.17	4.17
CB #34	CB #35	2.55	18	1.45	34.75	0.0008	1.17	0.04	0.03	0.07	231.73	0.1951	233.23	233.23	238.43	5.20	5.20
CB #35	CB #36	1.66	18	0.94	225.54	0.0003	1.25	0.02	0.08	0.09	261.05	0.1300	262.55	262.55	265.11	2.56	2.56
CB #36	FI #16	1.09	18	0.62	4.00	0.0001	1.25	0.01	0.00	0.01	263.45	0.6000	264.95	264.95	266.95	2.00	2.00
FI #16																	
LINE E-1																	
	CB #33										204.00		208.04		212.55		
CB #33	FI #14	1.21	18	0.69	4.00	0.0002	1.25	0.01	0.00	0.01	204.10	0.0250	208.05	205.60	213.05	5.00	7.45
FI #14																	
LINE E-2																	
	CB #34										206.54		226.45		230.62		
CB #34	FI #15	2.83	18	1.60	4.00	0.0010	1.25	0.05	0.00	0.05	206.64	0.0250	226.50	208.14	230.72	4.22	22.58
FI #15																	

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#10							
Overland	350.00	314	225	0.2543	1.20	2.0	2.40
Ditch	429.00	225	219.6	0.0126	4.47	0.2	0.89
						Total	3.30
Ditch #2/FI#1							
Overland	70.00	296.6	280.5	0.2300	0.36	2.0	0.72
Ditch	538.00	280.5	234	0.0864	2.54	0.2	0.51
Overland	306.00	234	214	0.0654	1.83	2.0	3.66
						Total	4.89
Ditch #3/FI #2							
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
Overland	467.00	321	240.6	0.1722	1.74	2.0	3.49
						Total	3.49
Ditch #4/FI #11							
Overland	229.00	341	244	0.4236	0.71	2.0	1.43
Ditch	130.00	244	239.6	0.0338	1.22	0.2	0.24
						Total	1.67
Ditch #5/FI #5							
Overland	18.00	321.7	311.7	0.5556	0.09	2.0	0.18
Overland	70.00	311.7	311	0.0100	1.21	2.0	2.42
Overland	53.00	311	299.5	0.2170	0.30	2.0	0.60
Ditch	369.00	299.5	270	0.0799	1.95	0.2	0.39
						Total	3.59
Ditch #6/FI #16							
Overland	16.00	321.7	311.7	0.6250	0.08	2.0	0.16
Overland	73.00	311.7	311	0.0096	1.27	2.0	2.54
Overland	51.00	311	299.5	0.2255	0.29	2.0	0.57
Ditch	184.00	299.5	266.95	0.1769	0.84	0.2	0.17
						Total	3.44

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 #7A/FI #7							
Overland	49.00	310	309.5	0.0102	0.91	2.0	1.82
Ditch	89.00	309.5	309	0.0056	1.82	0.2	0.36
						Total	2.19
Ditch #7B/FI #7							
Overland	16.00	310	309.5	0.0313	0.25	2.0	0.50
Ditch	50.00	309.5	309	0.0100	0.93	0.2	0.19
						Total	0.69
Ditch #8/FI #6							
Overland	62.00	312	305	0.1129	0.43	2.0	0.87
Ditch	212.00	305	292.9	0.0571	1.45	0.2	0.29
						Total	1.16
Ditch #9/FI #8							
Overland	132.00	332	288	0.3333	0.51	2.0	1.02
Ditch	198.00	288	281.6	0.0323	1.72	0.2	0.34
						Total	1.37
Ditch #10/FI #16							
Overland	17.00	283.4	280	0.2000	0.13	2.0	0.26
Ditch	213.00	280	266.95	0.0613	1.42	0.2	0.28
						Total	0.54
Ditch #11/FI #15							
Overland	15.00	319.8	309.8	0.6667	0.07	2.0	0.15
Overland	27.00	309.8	298.2	0.4296	0.14	2.0	0.27
Overland	59.00	298.2	298	0.0034	1.61	2.0	3.22
Overland	226.00	298	236	0.2743	0.83	2.0	1.67
Ditch	146.00	236	230.62	0.0368	1.29	0.2	0.26
						Total	5.56
Ditch #12/FI #14							
Overland	219.00	264	229	0.1598	1.00	2.0	2.00
Ditch	152.00	229	212.55	0.1082	0.88	2.0	1.76
						Total	3.76

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 #13/FI #5							
Overland	120.00	342	320	0.1833	0.60	2.0	1.20
Ditch	537.00	320	287	0.0615	2.89	0.2	0.58
						Total	1.77
Ditch #14/FI #4							
Overland	20.00	319	308	0.5500	0.10	2.0	0.20
Overland	92.00	308	307.8	0.0022	2.69	2.0	5.38
Overland	58.00	307.9	282	0.4466	0.24	2.0	0.49
Ditch	97.00	282	280.6	0.0144	1.35	0.2	0.27
						Total	6.33
Ditch #15/FI #13							
Overland	17.00	319	309	0.5882	0.08	2.0	0.17
Overland	34.00	309	308.8	0.0059	0.85	2.0	1.70
Overland	56.00	308.8	282.7	0.4661	0.23	2.0	0.46
Ditch	490.00	282.7	258.2	0.0500	2.91	0.2	0.58
						Total	2.92
Ditch #16/FI #13							
Overland	360.00	357.2	270	0.2422	1.25	2.0	2.50
Ditch	221.00	270	258.2	0.0534	1.54	0.2	0.31
						Total	2.81
FI #9							
Overland	1142.00	332	90.65	0.2113	3.21	2.0	6.42
						Total	6.42
FI #12							
Overland	255.00	258	229.2	0.1129	1.29	2.0	2.58
						Total	2.58
FI #11							
Overland	191.00	248.7	216.5	0.1686	0.88	2.0	1.77
						Total	1.77

10-1021-10	**V-Ditch Calculations**
DATE 3/15/2011	NAPA OAKS
	POST-DEVELOPED CONDITIONS
BY: CSG	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	3.60	=	0.55	3.00	5.00	2.18	0.0757		3.60	0.015	6.35	0.0126	0.112	0.18	1.14
Ditch #2	2.24	=	0.65	3.00	5.00	1.15	0.0180		2.24	0.015	6.35	0.0864	0.294	0.13	0.83
Ditch #3	1.32	=	0.55	3.00	5.00	0.80	0.0230		1.32	0.015	6.35	0.0184	0.136	0.15	0.97
Ditch #4	0.86	=	0.55	3.00	5.00	0.52	0.0110		0.86	0.015	6.35	0.0338	0.184	0.07	0.44
Ditch #5	1.37	=	0.60	3.00	5.00	0.76	0.0114		1.37	0.015	6.35	0.0799	0.283	0.06	0.38
Ditch #6	0.56	=	0.60	3.00	5.00	0.31	0.0031		0.56	0.015	6.35	0.1769	0.421	0.03	0.18
Ditch #7A	0.25	=	0.55	3.00	5.00	0.15	0.0078		0.25	0.015	6.35	0.0056	0.075	0.04	0.25
Ditch #7B	0.25	=	0.55	3.00	5.00	0.15	0.0058		0.25	0.015	6.35	0.0100	0.100	0.06	0.37
Ditch #8	0.38	=	0.55	3.00	5.00	0.23	0.0038		0.38	0.015	6.35	0.0571	0.239	0.04	0.22
Ditch #9	0.89	=	0.55	3.00	5.00	0.54	0.0117		0.89	0.015	6.35	0.0323	0.180	0.09	0.57
Ditch #10	0.18	=	0.55	3.00	5.00	0.11	0.0010		0.18	0.015	11.51	0.0613	0.248	0.02	0.20
Ditch #11	3.30	=	0.55	2.90	5.56	2.07	0.0224		3.30	0.015	11.51	0.0368	0.192	0.05	0.55
Ditch #12	0.84	=	0.55	3.00	5.00	0.51	0.0033		0.84	0.015	11.51	0.1082	0.329	0.08	0.94
Ditch #13	1.58	=	0.55	3.00	5.00	0.96	0.0083		1.58	0.015	11.51	0.0615	0.248	0.05	0.58
Ditch #14	0.84	=	0.55	2.87	6.33	0.53	0.0091		0.84	0.015	11.51	0.0144	0.120	0.05	0.58
Ditch #15	3.10	=	0.55	3.00	5.00	1.88	0.0181		3.10	0.015	11.51	0.0500	0.224	0.05	0.58
Ditch #16	2.26	=	0.55	3.00	5.00	1.37	0.0127		2.26	0.015	11.51	0.0534	0.231	0.05	0.58

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

$\frac{D^*}{b}$	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
0.01	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	0.0323	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

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

0.46	0.177	0.211	0.242	0.270	0.296	0.342	0.386	0.428	0.469	0.549
0.47	0.183	0.218	0.250	0.280	0.307	0.357	0.403	0.447	0.491	0.576
0.48	0.188	0.225	0.259	0.290	0.319	0.372	0.421	0.468	0.513	0.604
0.49	0.193	0.232	0.268	0.301	0.332	0.387	0.439	0.488	0.537	0.632
0.50	0.198	0.239	0.277	0.312	0.344	0.403	0.457	0.509	0.561	0.661
0.51	0.204	0.246	0.286	0.323	0.357	0.419	0.476	0.531	0.585	0.691
0.52	0.209	0.254	0.296	0.334	0.370	0.435	0.495	0.553	0.610	0.722
0.53	0.214	0.261	0.305	0.345	0.383	0.451	0.515	0.576	0.636	0.754
0.54	0.220	0.269	0.315	0.357	0.396	0.468	0.535	0.600	0.663	0.787
0.55	0.225	0.276	0.324	0.369	0.410	0.486	0.556	0.623	0.690	0.820
0.56	0.231	0.284	0.334	0.381	0.424	0.503	0.577	0.648	0.717	0.854
0.57	0.236	0.291	0.344	0.393	0.438	0.521	0.599	0.673	0.746	0.889
0.58	0.241	0.299	0.354	0.405	0.453	0.540	0.621	0.698	0.775	0.925
0.59	0.247	0.307	0.364	0.418	0.467	0.558	0.643	0.725	0.805	0.962
0.60	0.252	0.315	0.375	0.430	0.482	0.577	0.666	0.751	0.835	1.000
0.61	0.258	0.323	0.385	0.443	0.497	0.597	0.689	0.779	0.866	1.04
0.62	0.263	0.331	0.396	0.456	0.513	0.617	0.713	0.807	0.898	1.08
0.63	0.269	0.339	0.407	0.470	0.528	0.637	0.738	0.835	0.930	1.12
0.64	0.274	0.347	0.418	0.483	0.544	0.657	0.763	0.864	0.964	1.16
0.65	0.280	0.356	0.429	0.497	0.561	0.678	0.788	0.894	0.997	1.20
0.66	0.285	0.364	0.440	0.511	0.577	0.699	0.814	0.924	1.03	1.29
0.67	0.291	0.372	0.451	0.525	0.594	0.721	0.840	0.955	1.07	1.29
0.68	0.297	0.381	0.462	0.539	0.611	0.743	0.867	0.986	1.10	1.33
0.69	0.302	0.389	0.474	0.553	0.628	0.766	0.894	1.019	1.14	1.38
0.70	0.308	0.398	0.486	0.568	0.645	0.788	0.922	1.051	1.18	1.43
0.71	0.313	0.407	0.497	0.583	0.663	0.812	0.951	1.08	1.22	1.47
0.72	0.319	0.415	0.509	0.598	0.681	0.835	0.979	1.12	1.26	1.52
0.73	0.325	0.424	0.521	0.613	0.699	0.859	1.009	1.15	1.29	1.57
0.74	0.330	0.433	0.534	0.629	0.718	0.884	1.039	1.19	1.34	1.62
0.75	0.336	0.442	0.546	0.644	0.737	0.908	1.069	1.22	1.38	1.68

APPENDIX D

10-1021-10	BASIN ANF OUTFALL SIZING
DATE: 3/31/2011	NAPA OAKS
REV:	POST-DEVELOPED CONDITIONS
BY: CSG	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	0.58	33.99	71,563	155,840
#2	0.58	12.37	26,044	37,878

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

BASIN	DISCHARGE Q (CFS)	ORIFACE COEFFICIENT C (ACRES)	AREA OF ORIFACE A (FT^2)	GRAVITIATION CONSTANT G (CF)	WATER SURFACE ELEVATION H (FT)	ORIFACE ELEVATION H_O (FT)
1	9.10	0.66	1.77	32.2	5.5	4.6
2	11.75	0.66	1.77	32.2	4.5	2.9

Napa Oaks

Output from Caltrans Basin Sizer Program

Project: napa oaks

Latitude: 38.2666
Longitude: -122.3098

Caltrans Stations
Name: NAPA
Distance: 4.38
Elevation: 6
Years of data: 18

Water Quality Volumes

Maximized Volume Method (in)
Drawdown Time (Hours) 48
Runoff Coefficient 0.62
Unit Basin Storage Volume (in) 0.58

Water Quality Flows

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

Table 1. Summary of hydrologic modeling parameters for HEC-HMS runoff modeling, Napa Oaks

Parameter	Pre-Project Conditions		Post-Project Conditions				*Units*
	North	South	North Detained	North Undetained	South Detained	South Undetained	
Drainage area	37.6 0.059	18.7 0.029	35.3 0.055	1.5 0.002	13.7 0.022	5.6 0.009	*acres* *square miles*
SCS Curve Number	79	79	79	79	79	79	*n.a.*
Impervious cover	1	0	25	26	20	4	*%*
Time lag	6	3	9	6	7	7	*minutes*

Table 2. Summary of stormwater basin modeling parameters, Napa Oaks

North Basin

Elevation *(feet)*	Storage *(acre-feet)*	Outflow *(cfs)*
66.0	0.00	0.0
66.5	0.11	1.1
67.0	0.24	1.1
67.5	0.36	1.1
68.0	0.50	1.1
68.5	0.64	1.1
69.0	0.80	1.1
69.5	0.95	1.1
70.0	1.12	1.1
70.5	1.30	1.1
71.0	1.48	1.1
71.5	1.67	1.1
72.0	1.87	3.1
72.5	2.08	6.8
73.0	2.30	11.5
73.5	2.53	16.0
74.0	2.77	19.0
74.5	3.01	21.5
75.0	3.27	23.8

Notes:
- 5 in/hr outflow through highly pervious underdrained basin floor over an area of 9,700 square results in 1.1 cfs outflow from the basin
- high flow controlled release from basin through a 1.7 by 1.7-foot square orifice with an invert elevation of 71.5 feet

South Basin

Elevation *(feet)*	Storage *(acre-feet)*	Outflow *(cfs)*
204.0	0.00	0.0
204.5	0.05	0.5
205.0	0.10	0.5
205.5	0.16	0.5
206.0	0.22	0.5
206.5	0.28	0.5
207.0	0.35	0.5
207.5	0.43	0.5
208.0	0.51	0.5
208.5	0.59	0.5
209.0	0.68	6.1
209.5	0.78	12.7
210.0	0.88	15.4

Notes:
- 5 in/hr outflow through highly pervious underdrained basin floor over an area of 4,000 square results in 0.5 cfs outflow from the basin
- high flow controlled release from basin through a 2-foot diameter riser pipe with a spill elevation of 208.6 feet

Table 3. Summary of modeled peak runoff rates and basin routing outflows, Napa Oaks

	North Basin				
R.I. Storm *(years)*	pre-project *(cfs)*	post-project undetained *(cfs)*	post-project detained *(cfs)*	north basin outflow *(cfs)*	post-project total *(cfs)*
100	**36.5**	1.7	37.8	19.8	**20.6**
25	**25.8**	1.2	27.9	11.4	**11.9**
10	**18.6**	0.9	21.2	6.1	**6.4**

	South Basin				
R.I. Storm *(years)*	pre-project *(cfs)*	post-project undetained *(cfs)*	post-project detained *(cfs)*	south basin outflow *(cfs)*	post-project total *(cfs)*
100	**18.4**	5.5	14.5	12.7	**17.8**
25	**13.0**	3.9	10.6	7.0	**9.6**
10	**9.4**	2.8	8.0	3.2	**4.3**

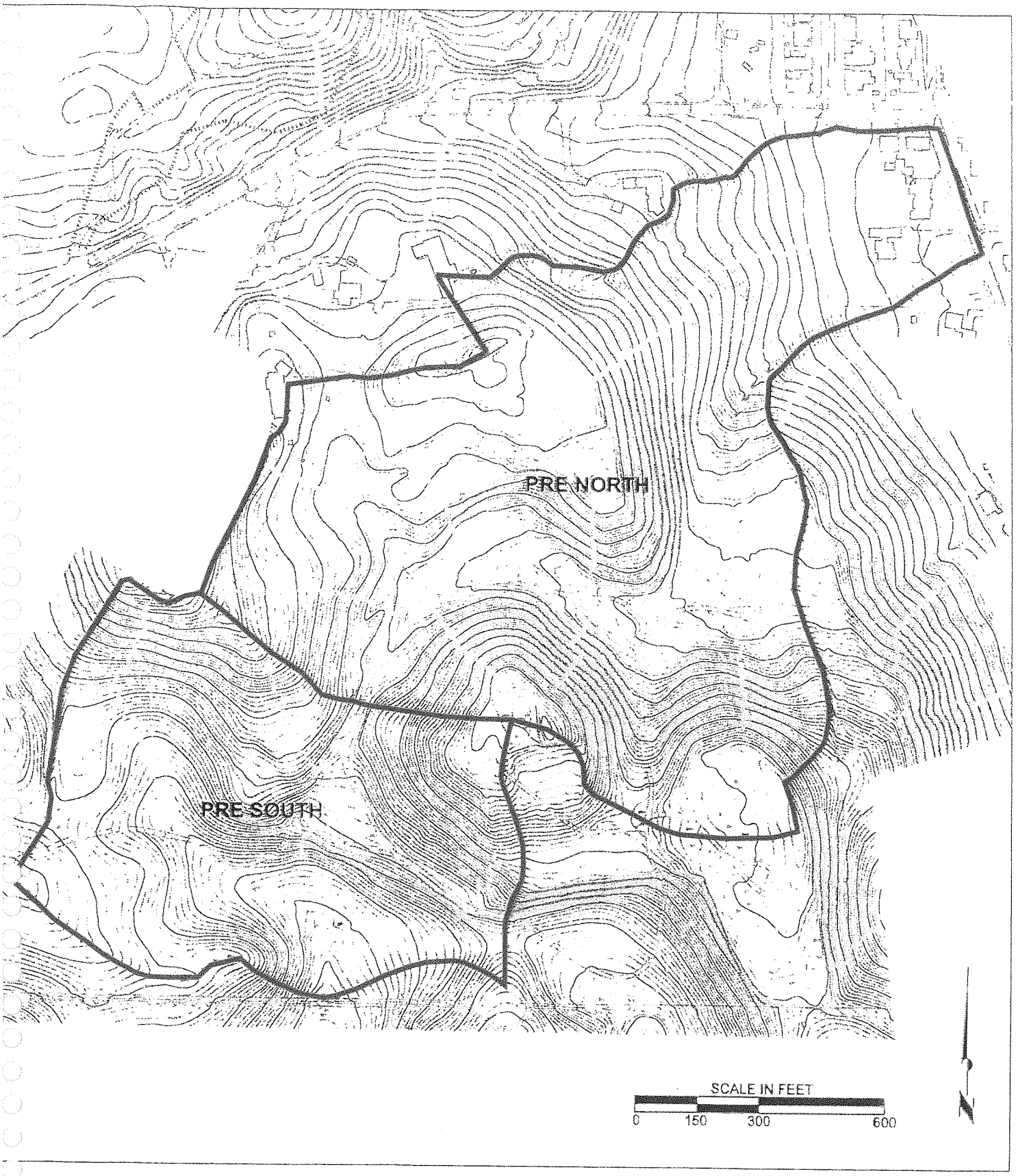


Figure 1. Pre-project watershed delineations, Napa Oaks

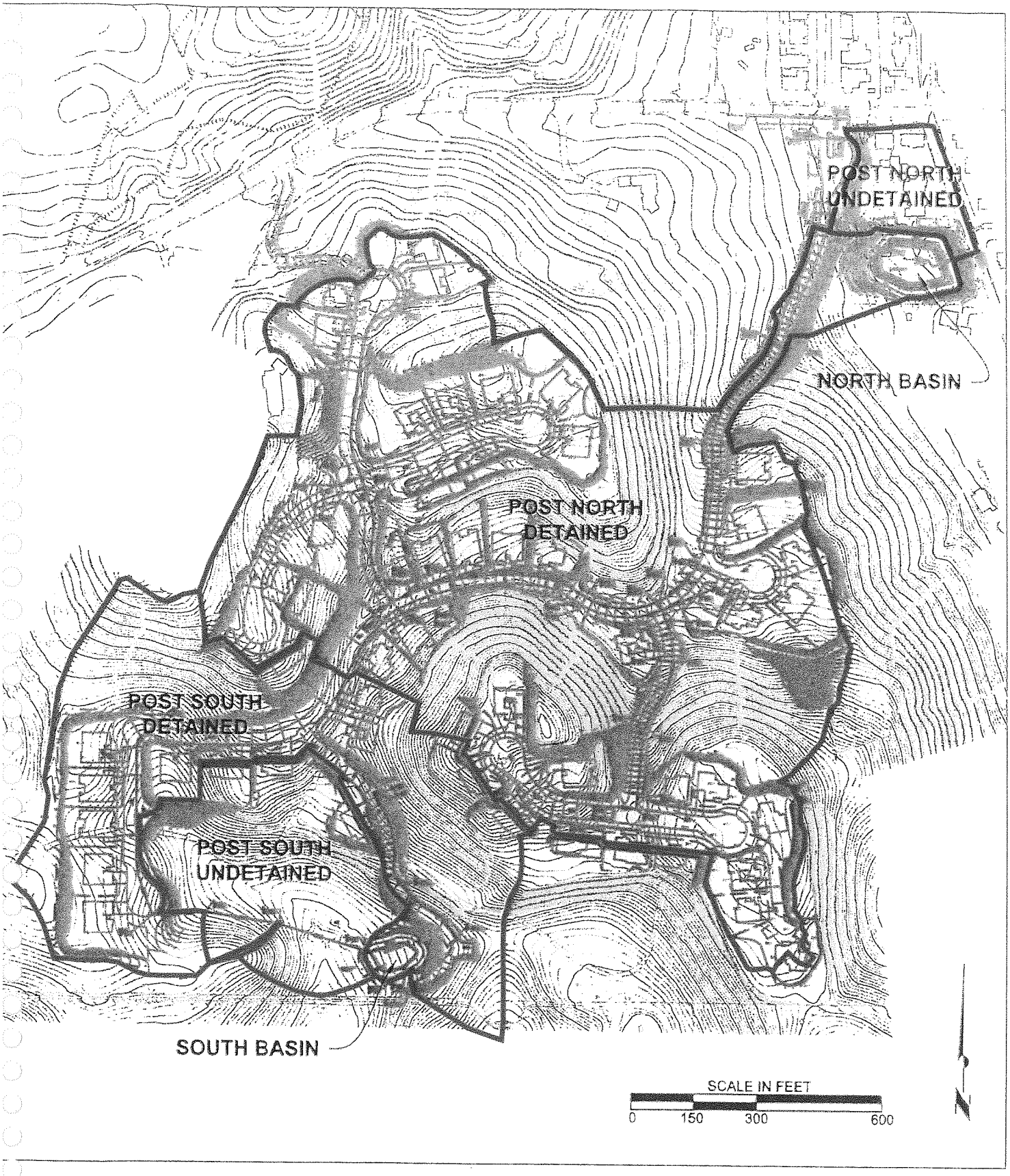


Figure 2. Post-project watershed delineations, Napa Oaks

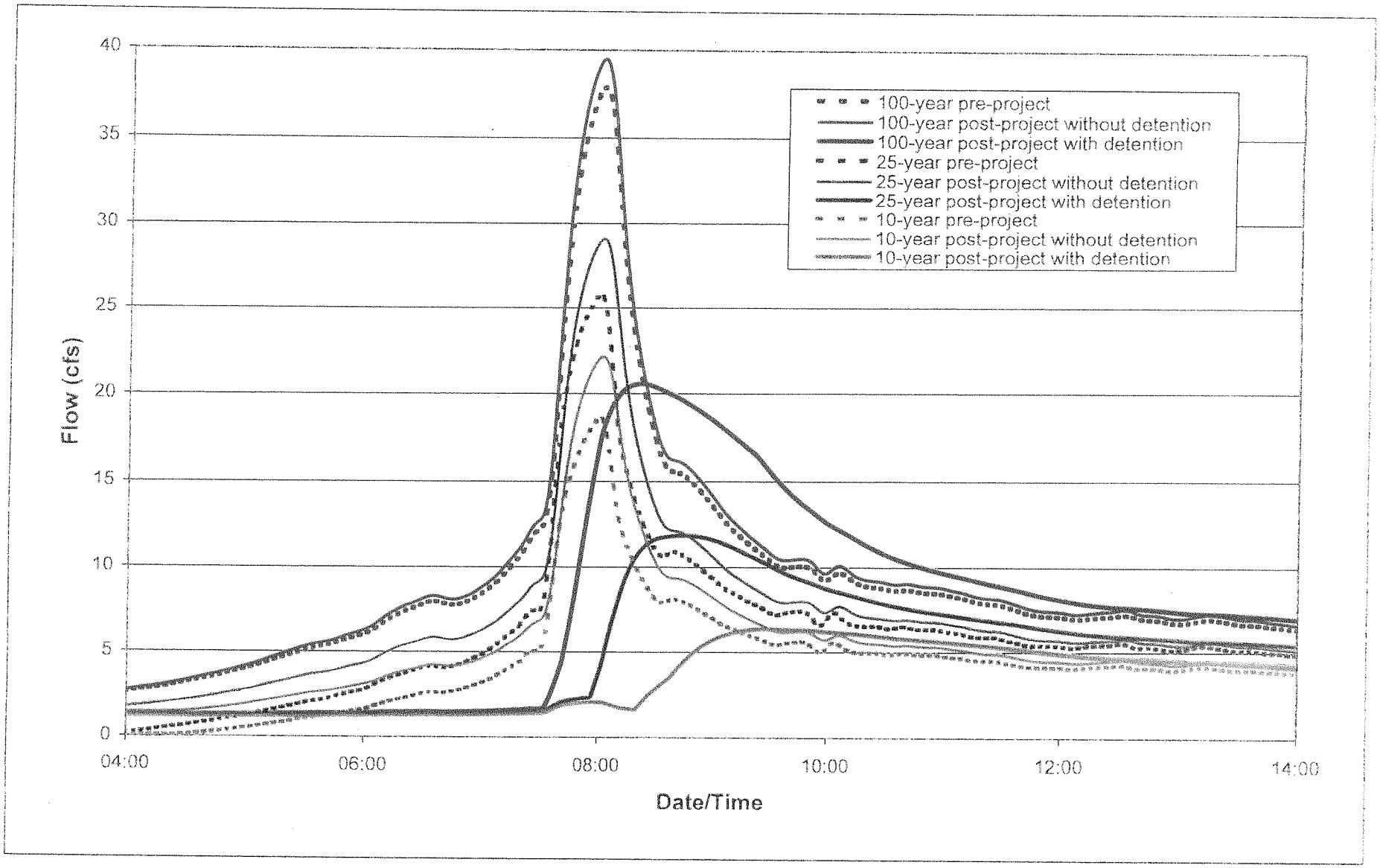


Figure 3. North Basin modeled hydrographs and routing, Napa Oaks

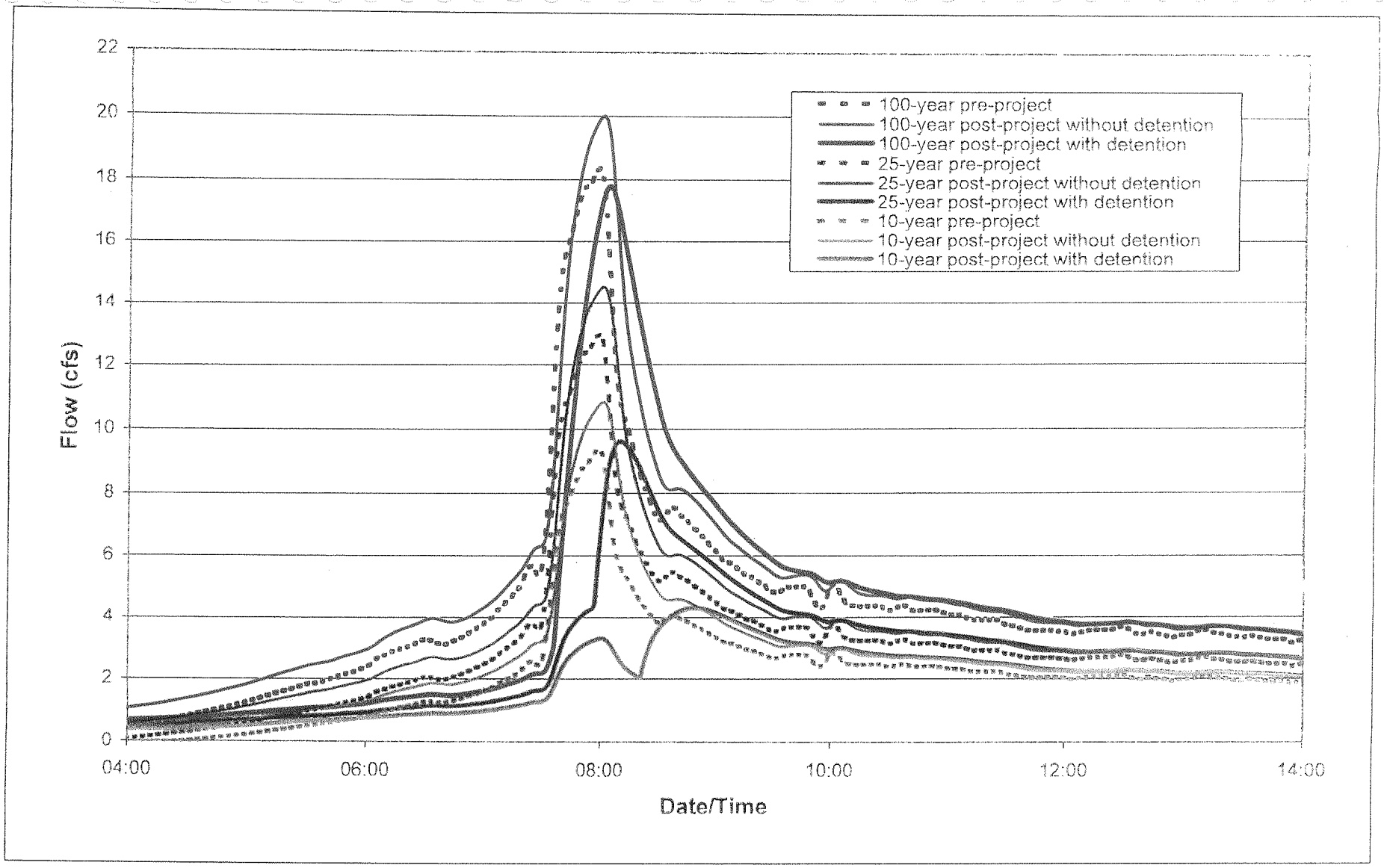
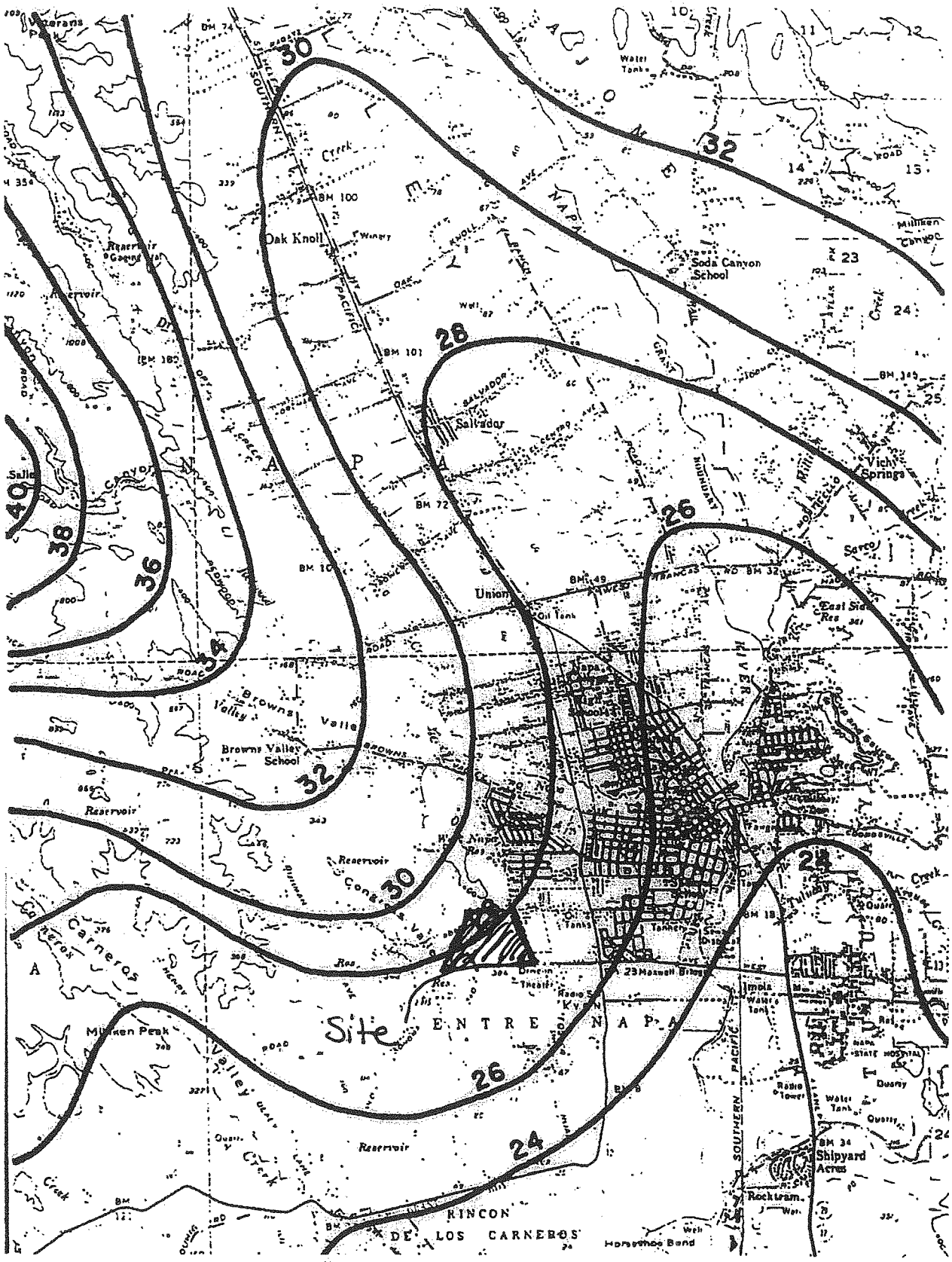


Figure 4. South Basin modeled hydrographs and routing, Napa Oaks

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

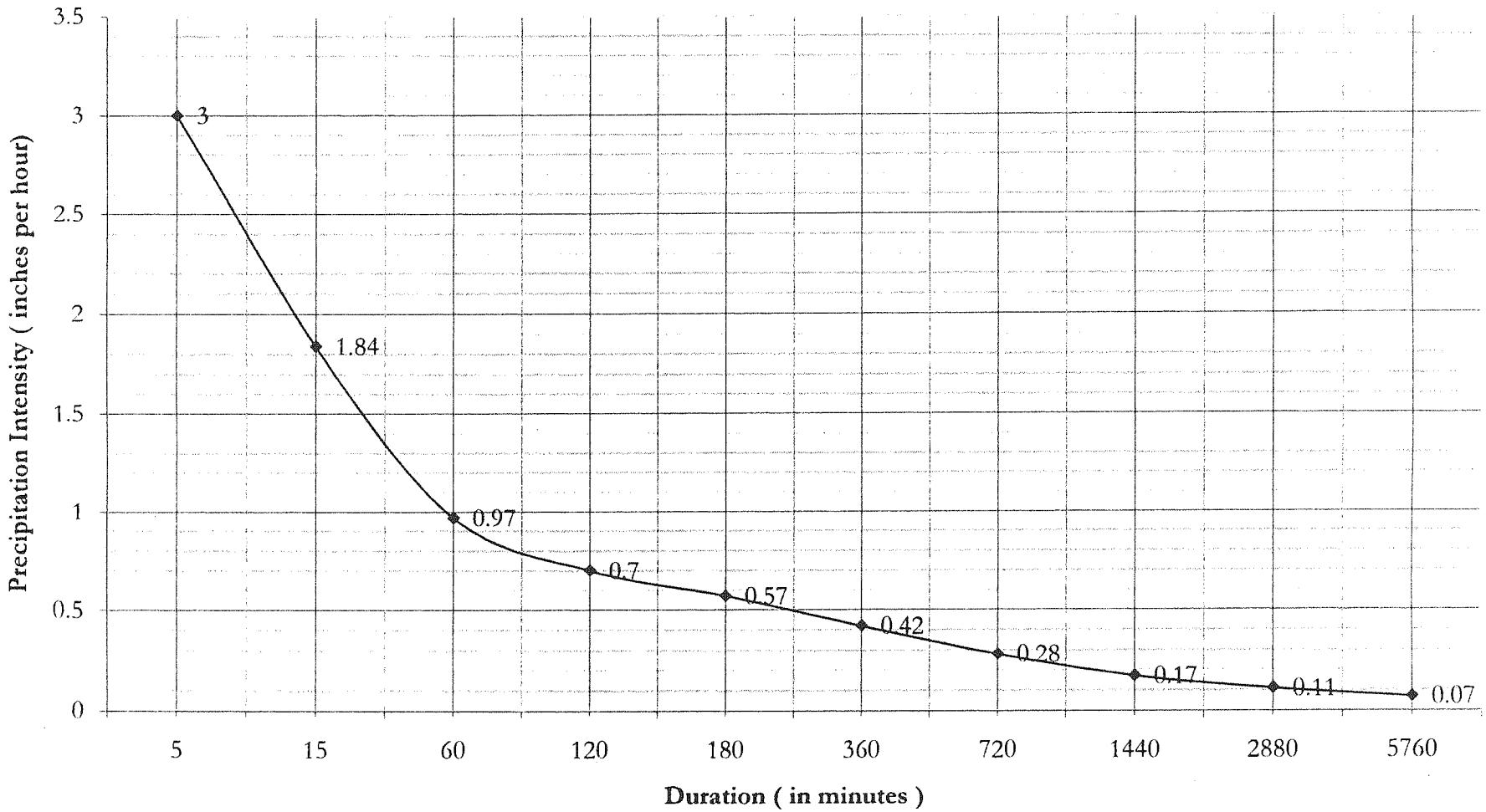
FIELD NOTES:

CHECKED:

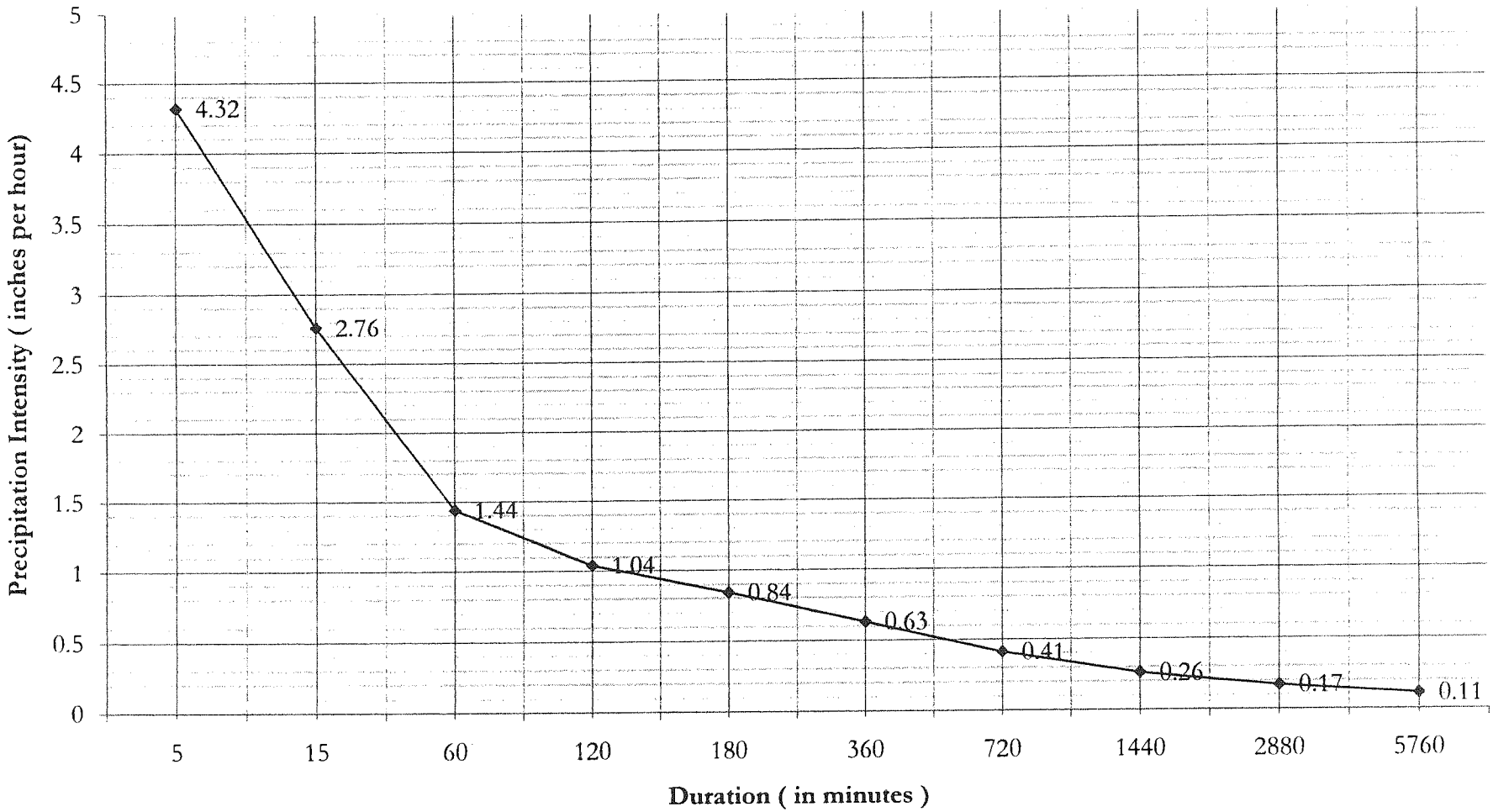
APPROVED:

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

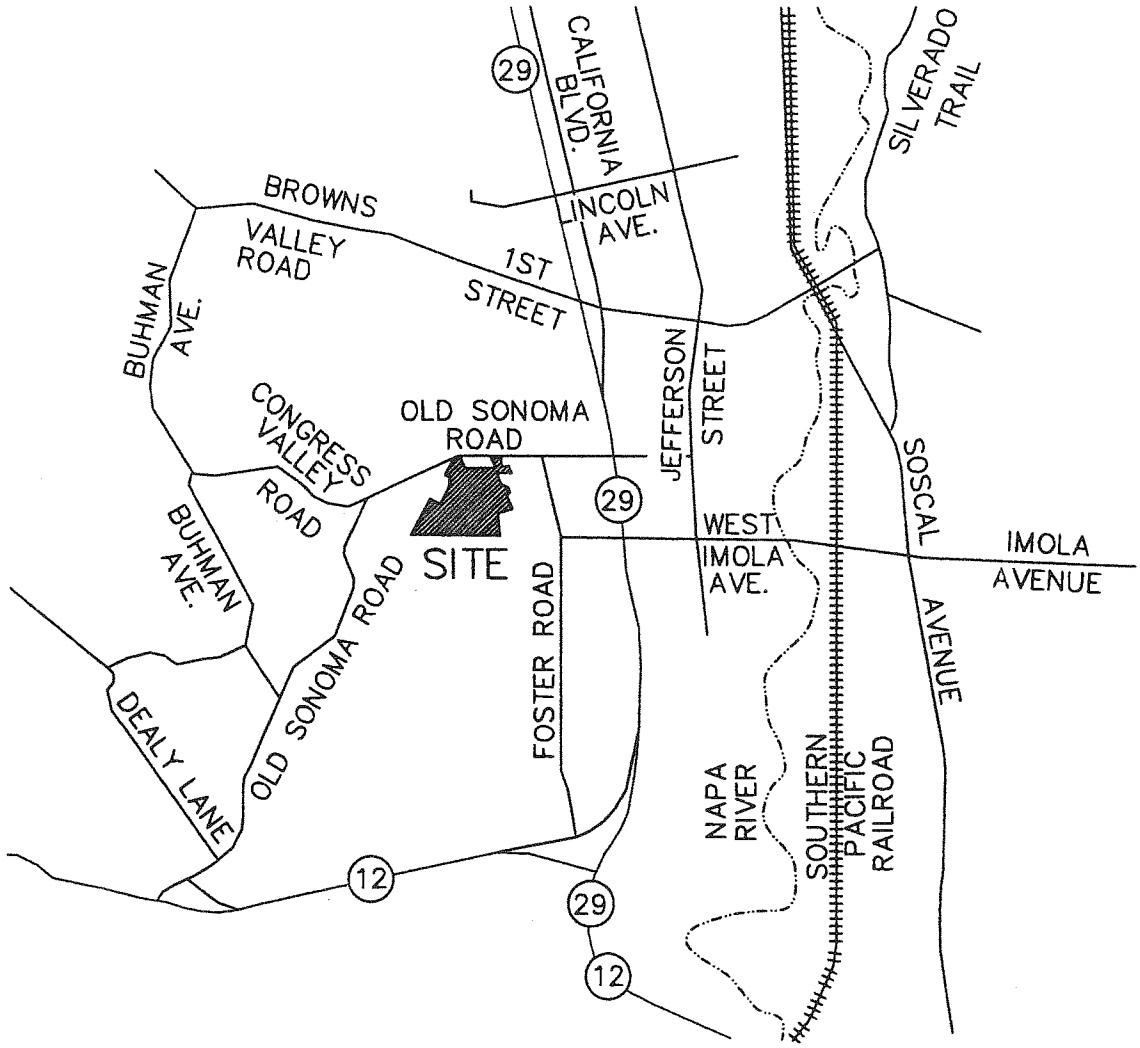
DRAWN BY: K.D.M	CHECKED:
DATE: JULY 2008	APPROVED:
SCALE: NONE	DWG. NO. TABLE 2.4
FIELD NOTES:	

APPENDIX G

dk Consulting Entrance Loss Coefficients

TABLE OF HEAD LOSS FACTORS THROUGH STRUCTURES	K
1. Straight Run with change in pipe size	.25
2. Straight Run with same size pipe	.17
3. 0° to 45° Deflection w/ change in pipe size	.50
4. 0° to 45° Deflection w/ same in pipe size	.42
5. 45° to 90° Deflection w/ same in pipe size	.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	.35

APPENDIX H



VICINITY MAP

APPENDIX I