Kiowa
Engineering Corporation

July 26, 2019

Ms. Anna Bergmark
City of Colorado Springs Water Resources Engineering
30 South Nevada Suite 401
Colorado Springs, Colorado 80903

RE: Wolf Ranch Master Development Drainage Plan Amendment, Drainage Evaluation, Colorado Springs, Colorado (Kiowa Project No. 17049)

Dear Anna:

On behalf of the Wolf Ranch Development, Kiowa is providing the City with a drainage evaluation for the above referenced project. The overall Wolf Ranch master plan is being proposed for revision. Revision to the master plan will that require an update to the approved Master Development Drainage Plan (MDDP). The MDDP for Wolf Ranch was last updated and approved by the City in June 2018. The location of Wolf Ranch is shown on Figure 1.

The updated master plan shows changes to the proposed land uses for those portions of Wolf Ranch that remain to be developed. The revisions to the land use densities could have an impact upon the sizing of the major drainageway, storm sewer outfall and stormwater detention primarily within "east" Wolf Ranch. At this time all the stormwater detention basins identified in the approved MDDP have been built or are currently under construction. Attached to this evaluation is the current and proposed land use plans for Wolf Ranch.

Kiowa has reviewed the proposed land use plan and has found that overall, the land use densities are decreasing from what was assumed in the updated MDDP. In the design of the full spectrum detention basins (FSD's), the key parameter that determines the detention storage volume is the imperviousness of the watershed tributary to the FSD. The proposed land uses within each watershed tributary to detention basins A4, F18/19, F 28, H and G were reviewed. Changes in imperviousness are as follows:

Detention basin #	% Imperviousness per design	% Imperviousness per rev ODP
A4	NC	NC
F18	9.9	12.3
F19	17.9	20.0
F28	35.5	35.0
G	28.7	41.3
H	60	60

The land uses as proposed in the revised master plan have been checked against the land uses assumed when each of the above facilities was designed. Changes in basin area and/or

1604 South 21st Street, Colorado Springs, Colorado 80904
Ph: (719) 630-7342 Fax: (719) 630-0406 www.kiowaengineering.com

imperviousness were input to UD-Detention and the performance of the outlet structure(s) with respect the release times for the water quality capture volume (WQCV), and excess urban runoff volume (EURV), verified. Calculations that support the findings have been included within Appendix A. A discussion of the results for each of the FSD's follows.

Detention Basin A4: This FSD was designed and constructed in 2008 following the approved Wolf Ranch master plan. The land use assumptions made at the time of the design were recalculated using the land uses proposed in the updated Wolf Ranch master plan. It was found that the imperviousness of the watershed tributary to A4 would be unchanged by the land uses as proposed in the revised Wolf Ranch master plan. Therefore, no modifications to the outlet works or storage pool will be required.

Detention Basin F18: This FSD was designed and constructed in 2017-2018 following the approved Wolf Ranch master plan. The land use assumptions made at the time of the design is lower than what was found when the revised master plan is assumed. It was found that the increase in imperviousness effected the release times of the WQCV and EURV. The perforated plate as built will need to be modified or replaced to achieve the desired release rates. A revised perforated plate layout has been presented in Appendix A. An amendment to the design report and construction drawings for Detention Basin F18/F19 will need to be submitted to the City for review and approval prior to commencing with the replacement of the plate.

Detention Basin F19: This FSD was designed and constructed in 2017-2018 following the approved Wolf Ranch master plan. The land use assumptions made at the time of the design is lower than what is found when the revised master plan is assumed. It was found that the increase in imperviousness affected the release times of the WQCV and EURV however none of the release rates exceeded the minimums for all frequencies, included the 5-year and 100-year recurrence intervals. No modifications will be required for the plate at detention basin F19.

Detention Basin F28: This FSD was designed and constructed in 2015-2016 following the approved Wolf Ranch master plan. The land use assumptions made at the time of the design match the land uses proposed in the revised master plan. It was found that the imperviousness of the watershed using the land uses shown in the revised master plan is slightly reduced for the F28 watershed. However, the reduction does not change the function of the facility and therefore no modifications to the outlet works or storage pool will be required

Detention Basin G: This FSD was designed and constructed in 2017-2018 following the approved Wolf Ranch master plan. The land use assumptions made at the time of the design is lower than what was found when the revised master plan is assumed. It was also found that the watershed area had been reduced from what was assumed in the design (160 acres versus 185 acres). The reduction in area was accounted for in the watershed area used in the design of Detention Basin H. It was found that the increase in imperviousness combined with the decrease in the watershed area affected the release times of the WQCV and EURV however none of the release rates exceeded the minimums for all frequencies, included the 5-year and 100-year recurrence intervals. No modifications will be required for the plate at detention basin G.

Detention Basin H: This FSD was designed in 2018 and is presently under construction following the revised Wolf Ranch master plan. The land use assumptions made at the time of the design matches the land uses as obtained using the revised master plan. No modification of the outlet works or storage pool will be required.

Based upon the review of the revised Wolf Ranch master plan and the calculations enclosed, modification of the perforated plates for detention basins F18, F19 and G is warranted. However, the

hydrologic evaluation and associated findings summarized in the current approved MDDP (June 2018), would not be altered or changed in any measurable way regarding the design of the major drainageways and outfall storm sewers. The flood detention capabilities of each of the detention basins will not be affected by the changes in the land uses as proposed in the revised Wolf Ranch master plan. Accordingly, it would be Kiowa's opinion that there is no need to update the Wolf Ranch MDDP at this time.

If you have any questions, please do not hesitate to contact me.

Sincerely,
KIOWA ENGINEERING CORPORATION

Richard N. Wray, P.E.
Principal

17049mddp update

Signature Page

Wolf Ranch

Engineer's Statement

This report and plan for the drainage design of the Wolf Ranch was prepared by me (or under my direct supervision) and is correct to the best of my knowledge and belief. Said report and plan has been prepared in accordance with the City of Colorado Springs Drainage Criteria Manual and is in conformity with the master plan of the drainage basin. I understand that the City of Colorado Springs does not and will not assume liability for drainage facilities designed by others. I accept responsibility for any liability caused by any negligent acts, errors or omissions on my part in preparing this report.

SIGNATURE (Affix Seal): _____ 7/26/19

Colorado P.E. No 19310 Date

COLORADO REGISTERED RICHARD NORMAN WEAVER 19310 PROFESSIONAL ENGINEER

Developer's Statement

Nor'Wood Development hereby certifies that the drainage facilities for Wolf Ranch shall constructed according to the design presented in this report. I understand that the City of Colorado Springs does not and will not assume liability for the drainage facilities designed and/or certified by my engineer and that are submitted to the City of Colorado Springs pursuant to section 7.7.906 of the City Code; and cannot, on behalf of Nor'Wood Development guarantee that final design review will absolve Nor'Wood Development and/or their successors and/or assigns of future liability for improper design. I further understand that approval of the final plat does not imply approval of my engineer's drainage design.

Nor'Wood Development

_____ 7/25/19

Authorized Signature Date

Bobby L. Ingels

Printed Name

VICE-PRESIDENT

Title

111 SOUTH TEJON ST., STE. 222 80903

Address:

City of Colorado Springs Statement:

Filed in accordance with Section 7.7.906 of the Code of the City of Colorado Springs, 2001, as amended.

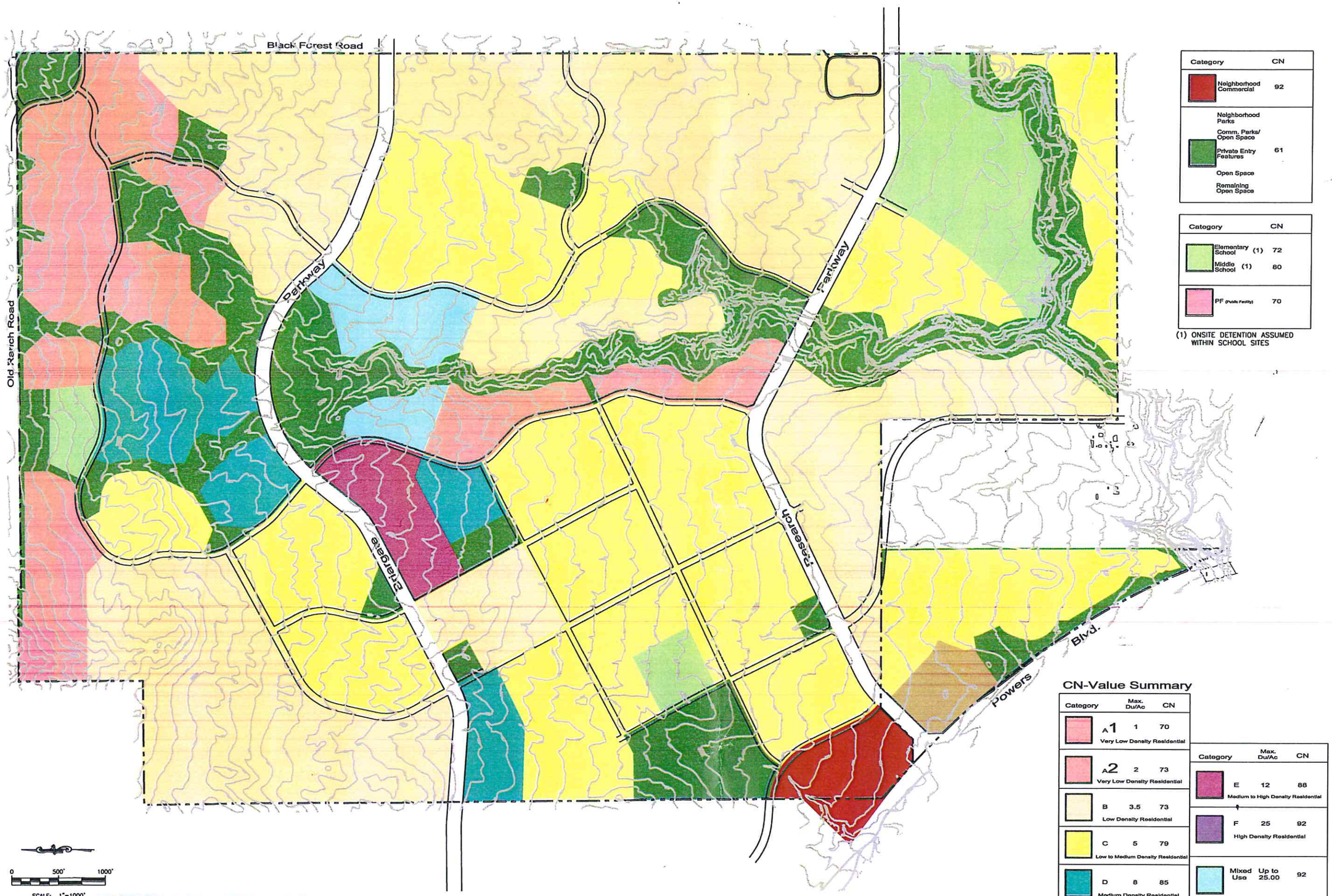
Anna Bergmark 08/29/2019

For City Engineer Date

Conditions:

Appendix A

Design Calculations



APPROVED WB MASTER PLAN : 5-18-16

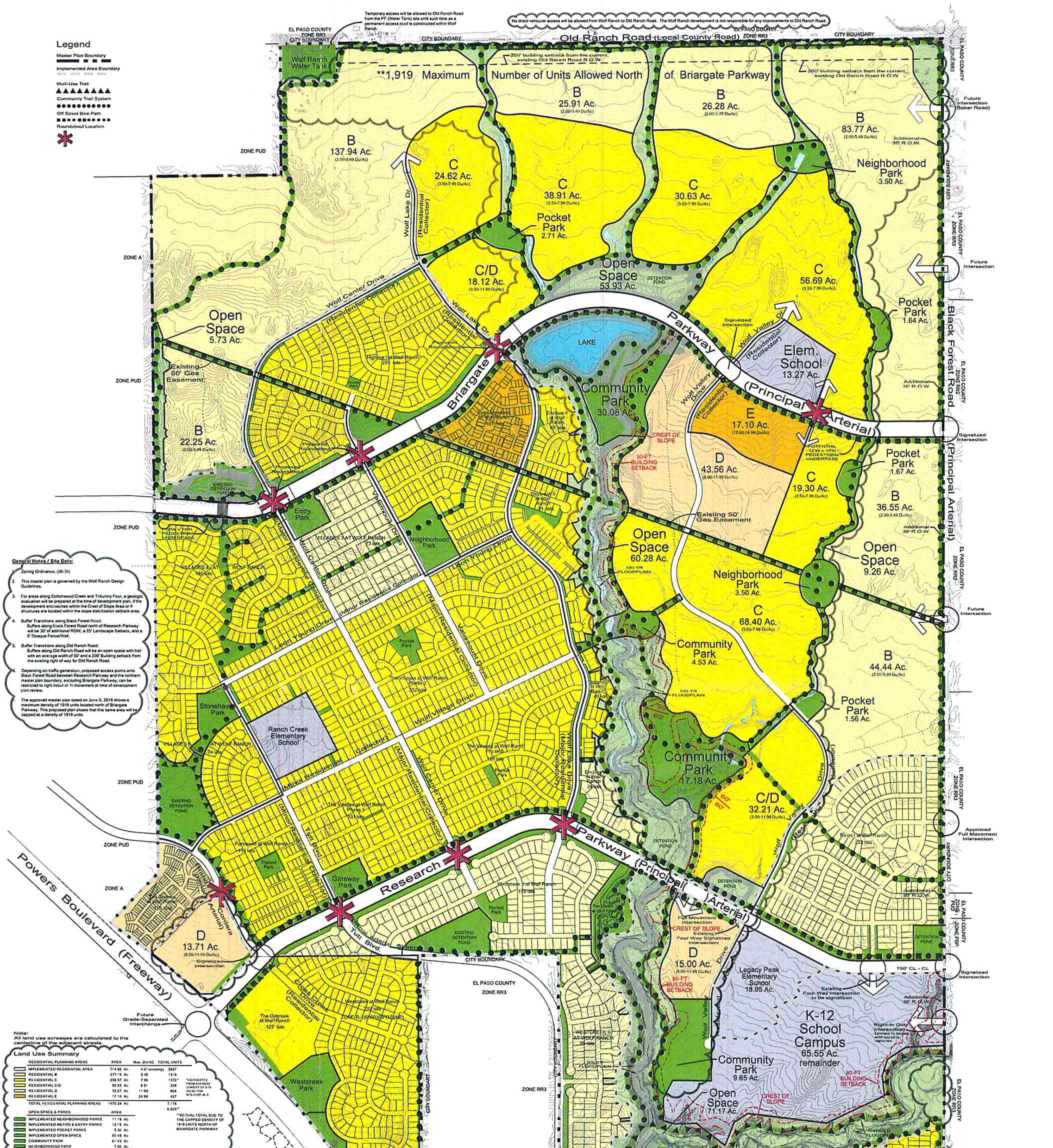
Kiowa Engineering Corporation
1604 South 21st Street
Colorado Springs, Colorado
80904
(719) 630-7342

WOLF RANCH
MASTER DEVELOPMENT DRAINAGE PLAN UPDATE
HYDROLOGIC LANDUSE MAP
COLORADO SPRINGS, COLORADO

Project No.:	18003
Date:	5/8/2018
Design:	RNW
Drawn:	EAK
Check:	RNW
Revisions:	

SHEET
Fig. 3

18003 Fig3.dwg/May 03, 2018



Legend

- Master Plan Boundary
- Implemented Area Boundary
- Multi-Use Trail
- Community Trail System
- Off Street Bike Path
- Roundabout Location

General Notes / Site Data:

1. Zoning Ordinance: (05-39)
2. This master plan is governed by the Wolf Ranch Design Guidelines.
3. For areas along Cottonwood Creek and Tributary Four, a geologic evaluation will be prepared at the time of development plan, if the development encroaches within the Crest of Slope Area or if structures are located within the slope stabilization setback area.
4. Buffer Transitions along Black Forest Road: Buffers along Black Forest Road north of Research Parkway will be 30' of additional ROW, a 25' Landscape Setback, and a 6' Opaque Fence/Wall.
5. Buffer Transitions along Old Ranch Road: Buffers along Old Ranch Road will be an open space with trail with an average width of 50' and a 200' Building setback from the existing right of way for Old Ranch Road.
6. Depending on traffic generation, proposed access points onto Black Forest Road between Research Parkway and the northern master plan boundary, excluding Briargate Parkway, can be restricted to right in/out or ¾ movement at time of development plan review.
7. The approved master plan dated on June 9, 2016 shows a maximum density of 1919 units located north of Briargate Parkway. This proposed plan shows that this same area will be capped at a density of 1919 units.

Note:
All land use acreages are calculated to the centerline of the adjacent streets.

Land Use Summary

RESIDENTIAL PLANNING AREAS	AREA	Max. DU/AC	TOTAL UNITS
IMPLEMENTED RESIDENTIAL AREA	714.92 Ac.	4.01 (existing)	2867
RESIDENTIAL B	377.15 Ac.	3.49	1316
RESIDENTIAL C	238.57 Ac.	7.99	1372*
RESIDENTIAL C/D	50.33 Ac.	6.51	328
RESIDENTIAL D	72.27 Ac.	11.99	866
RESIDENTIAL E	17.10 Ac.	24.99	427
TOTAL RESIDENTIAL PLANNING AREAS	1470.34 Ac.		7,176 6,825**

*CALCULATED FROM AVERAGE DENSITY OF 5.75 DU/AC FOR RESIDENTIAL C

**ACTUAL TOTAL DUE TO THE CAPPED DENSITY OF 1919 UNITS NORTH OF BRIARGATE PARKWAY

OPEN SPACE & PARKS	AREA
IMPLEMENTED NEIGHBORHOOD PARKS	11.19 Ac.
IMPLEMENTED METRO & ENTRY PARKS	12.15 Ac.
IMPLEMENTED POCKET PARKS	5.30 Ac.
IMPLEMENTED OPEN SPACE	93.48 Ac.
COMMUNITY PARK	61.43 Ac.
NEIGHBORHOOD PARK	7.00 Ac.
POCKET PARK	7.57 Ac.
OPEN SPACE	200.37 Ac.
TOTAL OPEN SPACE & PARKS	398.49 Ac.

SCHOOLS & PUBLIC FACILITIES	AREA
IMPLEMENTED ELEMENTARY SCHOOL	10.44 Ac.
IMPLEMENTED K-12 SCHOOL CAMPUS	18.95 Ac.
IMPLEMENTED PUBLIC FACILITY	4.95 Ac.
ELEMENTARY SCHOOL	13.27 Ac.
K-12 SCHOOL CAMPUS	65.55 Ac.
TOTAL SCHOOLS & PUBLIC FACILITIES	113.16 Ac.

Master Plan / PUD Plan Approval and Amendment History

File Number	Approval Date	Revision Description
CPC MP 01-83	November 8, 2001	Original Wolf Ranch MP Approval - previously a portion of the Briargate Master Plan
CPC PUP 04-00048	February 22, 2005	Original Wolf Ranch PUD Plan Approval
CPC MP 04-000343	January 8, 2006	Amendment to add additions to master plan. Addition of 200 ac to plan. Combined previous C(3.5-4.99 du/ac) and C(3.5-7.99 du/ac) planning area with average density capped at 5.75 du/ac for the new C category. Minor adjustments [illegible] master plans. Revision to show detention ponds as a result of Master Drainage Master Plan Study.
CPC MP 05-80	April 4, 2008	[illegible]
CPC MP 05-80-A1MJ08	January 15, 2009	[illegible]
CPC MP 05-00080-A2MN11	July 15, 2011	[illegible]
CPC MP 05-00080-A3MN13	August 13, 2013	[illegible]
CPC MP 05-00080-A4MJ14	August 28, 2014	[illegible]
CPC MP 05-00080-A5MN15	August 13, 2015	[illegible]
CPC MP 05-00080-A6MN16	June 09, 2016	[illegible]
CPC MP 05-00080-A7MJ19	Pending	[illegible]

Master Plan
WOLF RANCH
Colorado Springs, CO

A Master Planned Community by
Nor'wood Development Group
111 South Tejon Suite 222 Colorado Springs, CO 80903

DATE: 09/12/2001
Revised: 01/24/02,12/01/04, 11/09/05, 1-23-06, 8-12-08, 2-10-09, 07-14-11, 08-09-13, 04-29-14, 06-01-15, 05-18-16, 05-23-19

City File No.: CPC MP 05-00080-A7MJ19

PROPOSED UPDATE

Table 6-10. (continued)

Other Agricultural Lands[1]	Treatment	Hydrologic Condition	% I	HSG A	HSG B	HSG C	HSG D
Pasture, grassland, or range—continuous forage for grazing[4]	-----	Poor	---	68	79	86	89
	-----	Fair	---	49	69	79	84
	-----	Good	---	39	61	74	80
Meadow—continuous grass, protected from grazing and generally mowed for hay	-----	-----	---	30	58	71	78
Brush—brush-weed-grass mixture with brush the major element[5]	-----	Poor	---	48	67	77	83
	-----	Fair	---	35	56	70	77
	-----	Good	---	30	48	65	73
Woods—grass combination (orchard or tree farm)[6]	-----	Poor	---	57	73	82	86
	-----	Fair	---	43	65	76	82
	-----	Good	---	32	58	72	79
Woods[7]	-----	Poor	---	45	66	77	83
	-----	Fair	---	36	60	73	79
	-----	Good	---	30	55	70	77
Farmsteads—buildings, lanes, driveways, and surrounding lots	-----	-----	---	59	74	82	86
Arid and Semi-arid Rangelands[1]	**Treatment**	**Hydrologic Condition[8]**	**% I**	**HSG A**	**HSG B**	**HSG C**	**HSG D**
Herbaceous—mixture of grass, weeds, and low-growing brush, with brush the minor element	-----	Poor	---	-----	80	87	93
	-----	Fair	---	-----	71	81	89
	-----	Good	---	-----	62	74	85
Oak-aspen—mountain brush mixture of oak brush, aspen, mountain mahogany, bitter brush, maple, and other brush	-----	Poor	---	-----	66	74	79
	-----	Fair	---	-----	48	57	63
	-----	Good	---	-----	30	41	48
Pinyon-juniper—pinyon, juniper, or both; grass understory	-----	Poor	---	-----	75	85	89
	-----	Fair	---	-----	58	73	80
	-----	Good	---	-----	41	61	71
Sagebrush with grass understory	-----	Poor	---	-----	67	80	85
	-----	Fair	---	-----	51	63	70
	-----	Good	---	-----	35	47	55
Desert shrub—major plants include saltbush, greasewood, creosotebush, blackbrush, bursage, palo verde, mesquite, and cactus	-----	Poor	---	63	77	85	88
	-----	Fair	---	55	72	81	86
	-----	Good	---	49	68	79	84

: $I_a = 0.1\ S$

[2] Crop residue cover applies only if residue is on at least 5% of the surface throughout the year.

[3] Hydraulic condition is based on combination factors that affect infiltration and runoff, including (a) density and canopy of vegetative areas, (b) amount of year-round cover, (c) amount of grass or close-seeded legumes, (d) percent of residue cover on the land surface (good ≥ 20%), and (e) degree of surface roughness. Poor: Factors impair infiltration and tend to increase runoff. Good: Factors encourage average and better than average infiltration and tend to decrease runoff.

[4] Poor: <50%) ground cover or heavily grazed with no mulch. Fair: 50 to 75% ground cover and not heavily grazed. Good: > 75% ground cover and lightly or only occasional

[5] Poor: <50% ground cover. Fair: 50 to 75% ground cover. Good: >75% ground cover.

[6] CN's shown were computed for areas with 50% woods and 50% grass (pasture) cover. Other combinations of conditions may be computed from the CN's for woods

[7] Poor: Forest litter, small trees, and brush are destroyed by heavy grazing or regular burning. Fair: Woods are grazed but not burned, and some forest litter covers the soil. Good: Woods are protected from grazing, and litter and brush adequately cover the soil.

[8] Poor: <30% ground cover (litter, grass, and brush overstory). Fair: 30 to 70% ground cover. Good: > 70% ground cover.

4.6 Lag Time

While the NRCS curve numbers are used to calculate the volume of runoff and magnitude of losses, to transform the volume of runoff into a hydrograph using the NRCS dimensionless unit hydrograph, the lag time must be specified. The lag time is defined as the time from the centroid of the rainfall distribution of a storm to the peak discharge produced by the watershed. For this Manual, the lag time is defined as a fraction of the time of concentration (t_c) as shown in Equation 6-13.

$$t_{lag} = 0.6 \cdot t_c \qquad \text{(Eq. 6-13)}$$

Table 6-10. NRCS Curve Numbers for Frontal Storms & Thunderstorms for Developed Conditions (ARCII)

Fully Developed Urban Areas (vegetation established)[1]	Treatment	Hydrologic Condition	%I	Pre-Development CN			
				HSG A	HSG B	HSG C	HSG D
Open space (lawns, parks, golf courses, cemeteries, etc.):							
Poor condition (grass cover < 50%)	-----	-----	---	68	79	86	89
Fair condition (grass cover 50% to 75%)	-----	-----	---	49	69	79	84
Good condition (grass cover > 75%)	-----	-----	---	39	61	74	80
Impervious areas:							
Paved parking lots, roofs, driveways, etc. (excluding right-of-way	-----	-----	---	98	98	98	98
Streets and roads:							
Paved; curbs and storm sewers (excluding right-of-way)	-----	-----	---	98	98	98	98
Paved; open ditches (including right-of-way)	-----	-----	---	83	89	92	93
Gravel (including right-of-way)	-----	-----	---	76	85	89	91
Dirt (including right-of-way)	-----	-----	---	72	82	87	89
Western desert urban areas:							
Natural desert landscaping (pervious areas only)	-----	-----	---	63	77	85	88
Artificial desert landscaping (impervious weed barrier, desert shrub with 1- to 2-inch sand or gravel mulch and basin borders)	-----	-----	---	96	96	96	96
Urban districts:							
Commercial and business	-----	-----	85	89	92	94	95
Industrial	-----	-----	72	81	88	91	93
Residential districts by average lot size:							
1/8 acre or less (town houses)	-----	-----	65	77	85	90	92
1/4 acre	-----	-----	38	61	75	83	87
1/3 acre	-----	-----	30	57	72	81	86
1/2 acre	-----	-----	25	54	70	80	85
1 acre	-----	-----	20	51	68	79	84
2 acres	-----	-----	12	46	65	77	82
Developing Urban Areas[1]	**Treatment[2]**	**Hydrologic Condition[3]**	**%I**	**HSG A**	**HSG B**	**HSG C**	**HSG D**
Newly graded areas (pervious areas only, no vegetation)	-----	-----	---	77	86	91	94
Cultivated Agricultural Lands[1]	**Treatment**	**Hydrologic Condition**	**%I**	**HSG A**	**HSG B**	**HSG C**	**HSG D**
Fallow	Bare soil	-----	---	77	86	91	94
	Crop residue cover (CR)	Poor	---	76	85	90	93
		Good	---	74	83	88	90
Row crops	Straight row (SR)	Poor	---	72	81	88	91
		Good	---	67	78	85	89
	SR + CR	Poor	---	71	80	87	90
		Good	---	64	75	82	85
	Contoured (C)	Poor	---	70	79	84	88
		Good	---	65	75	82	86
	C + CR	Poor	---	69	78	83	87
		Good	---	64	74	81	85
	Contoured & terraced (C&T)	Poor	---	66	74	80	82
		Good	---	62	71	78	81
	C&T+ CR	Poor	---	65	73	79	81
		Good	---	61	70	77	80
Small grain	SR	Poor	---	65	76	84	88
		Good	---	63	75	83	87
	SR + CR	Poor	---	64	75	83	86
		Good	---	60	72	80	84
	C	Poor	---	63	74	82	85
		Good	---	61	73	81	84
	C + CR Poor	Poor	---	62	73	81	84
		Good	---	60	72	80	83
	C&T	Poor	---	61	72	79	82
		Good	---	59	70	78	81
	C&T+ CR	Poor	---	60	71	78	81
		Good	---	58	69	77	80

Kiowa Engineering Corporation

Project Name: WR WODP Project No: 17049

Description: Hydrology FSP

By: RWW Date: 6/11/19

% Imp Check Det. Basin F18

Per ODP as revised; 3.58 DU/ac = .28 ac
39% Imp

Area to F18

F2-F5	327.6 ac	5 ac-10 ac lots	
F10	11.5 ac	1.1 ac OS	10.4 ac .28 lots
F11	29.4 ac	5.1 ac OS	24.3 ac .28 ac lots
F12	37.7 ac	4.2 ac OS	33.5 ac .28 ac lots
F16	17.3 ac	17.3 ac .28 ac lots	
F17	24.3 ac	16.1 ac OS	8.2 ac .28 ac lots
F18	62.7 ac	13.5 ac OS	49.2 ac .28 ac lots

Total 510.72 ac

% Imp.

	2%
F2-F5	
F10	(1.1(.02) + 10.4(.39))/11.5 = .35
F11	(5.1(.02) + 24.3(.39))/29.4 = .33
F12	(4.2(.02) + 33.5(.39))/37.7 = .35
F16	.39
F17	(16.1(.02) + 8.2(.39))/24.3 = .14
F18	(13.5(.02) + 49.2(.39))/62.7 = .31

Weighted % Imp

$$\frac{.31(62.7) + 327.6(.02) + .35(11.5) + .33(29.4) + .35(37.7) + .39(17.3) + .14(24.3)}{510.72} = 12.3\%$$

Kiowa Engineering Corporation

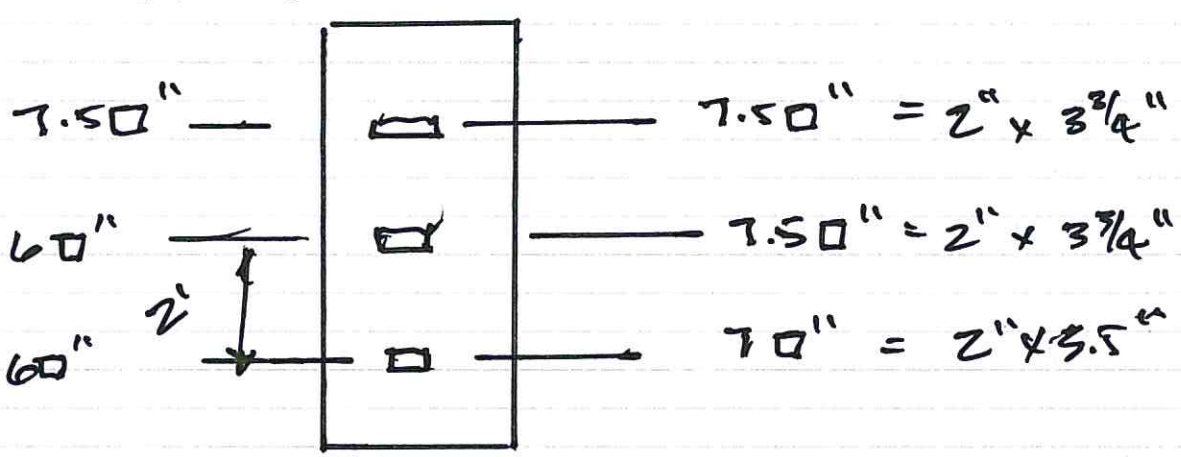
Project Name: WR - NDOT Project No: 17049

Description: Hydrology FSD

By: RSW Date: 6/11/19

Per Design: I_a = 9.86

Due to increase in I_a, perf. plate needs to be resized due to increased in WQCV + EURV



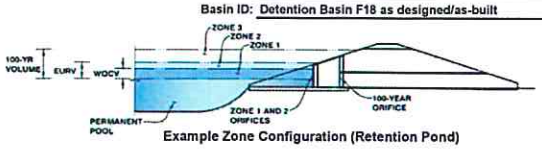
F18 AS-BUILT

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

UD-Detention, Version 3.07 (February 2017)

Project: Wolf Ranch Development

Basin ID: Detention Basin F18 as designed/as-built



Example Zone Configuration (Retention Pond)

Required Volume Calculation

Selected BMP Type =	EDB	
Watershed Area =	510.72	acres
Watershed Length =	6,150	ft
Watershed Slope =	0.029	ft/ft
Watershed Imperviousness =	9.86%	percent
Percentage Hydrologic Soil Group A =	0.0%	percent
Percentage Hydrologic Soil Group B =	100.0%	percent
Percentage Hydrologic Soil Groups C/D =	0.0%	percent
Desired WQCV Drain Time =	40.0	hours
Location for 1-hr Rainfall Depths =	Denver - Capitol Building	
Water Quality Capture Volume (WQCV) =	2.818	acre-feet
Excess Urban Runoff Volume (EURV) =	4.728	acre-feet
2-yr Runoff Volume (P1 = 1.19 in.) =	3.246	acre-feet
5-yr Runoff Volume (P1 = 1.5 in.) =	5.056	acre-feet
10-yr Runoff Volume (P1 = 1.75 in.) =	11.607	acre-feet
25-yr Runoff Volume (P1 = 2 in.) =	30.860	acre-feet
50-yr Runoff Volume (P1 = 2.25 in.) =	42.890	acre-feet
100-yr Runoff Volume (P1 = 2.52 in.) =	58.605	acre-feet
500-yr Runoff Volume (P1 = 3.2 in.) =	90.785	acre-feet
Approximate 2-yr Detention Volume =	3.013	acre-feet
Approximate 5-yr Detention Volume =	4.733	acre-feet
Approximate 10-yr Detention Volume =	9.885	acre-feet
Approximate 25-yr Detention Volume =	13.837	acre-feet
Approximate 50-yr Detention Volume =	14.469	acre-feet
Approximate 100-yr Detention Volume =	18.718	acre-feet

Optional User Override 1-hr Precipitation	
1.19	inches
1.50	inches
1.75	inches
2.00	inches
2.25	inches
2.52	inches
3.20	inches

Depth Increment = ft

Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Top of Micropool	--	0.00	--	--	--	250	0.006		
	--	1.30	--	--	--	766	0.018	653	0.015
	--	2.30	--	--	--	6,208	0.143	4,147	0.095
	--	3.30	--	--	--	30,385	0.698	22,444	0.515
	--	4.30	--	--	--	75,257	1.728	75,265	1.728
	--	5.30	--	--	--	140,214	3.219	183,000	4.201
	--	6.30	--	--	--	172,835	3.968	339,524	7.794
	--	7.30	--	--	--	182,661	4.193	517,272	11.875
	--	8.30	--	--	--	191,876	4.405	704,541	16.174
	--	9.30	--	--	--	309,808	7.112	955,383	21.933
	--	10.30	--	--	--	327,554	7.520	1,274,064	29.248
	--	11.30	--	--	--	341,309	7.835	1,608,495	36.926
	--	12.30	--	--	--	352,435	8.091	1,955,367	44.889
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FIB As-built

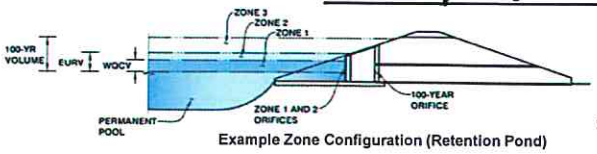
FIB

Detention Basin Outlet Structure Design

UD-Detention, Version 3.07 (February 2017)

Project: Wolf Ranch Development

Basin ID: Detention Basin FIB As designed-as-built



Example Zone Configuration (Retention Pond)

	Stage (ft)	Zone Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	4.82	2.818	Orifice Plate
Zone 2 (EURV)	5.47	1.910	Orifice Plate
Zone 3 (100-year)	8.81	13.991	Weir&Pipe (Restrict)
		18.718	Total

User Input: Orifice at Underdrain Outlet (typically used to drain WQCV in a Filtration BMP)

Underdrain Orifice Invert Depth =	N/A	ft (distance below the filtration media surface)
Underdrain Orifice Diameter =	N/A	inches

Calculated Parameters for Underdrain

Underdrain Orifice Area =	N/A	ft^2
Underdrain Orifice Centroid =	N/A	feet

User Input: Orifice Plate with one or more orifices or Elliptical Slot Weir (typically used to drain WQCV and/or EURV in a sedimentation BMP)

Invert of Lowest Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Orifice Plate =	6.00	ft (relative to basin bottom at Stage = 0 ft)
Orifice Plate: Orifice Vertical Spacing =	N/A	inches
Orifice Plate: Orifice Area per Row =	N/A	inches

Calculated Parameters for Plate

WQ Orifice Area per Row =	N/A	ft^2
Elliptical Half-Width =	N/A	feet
Elliptical Slot Centroid =	N/A	feet
Elliptical Slot Area =	N/A	ft^2

User Input: Stage and Total Area of Each Orifice Row (numbered from lowest to highest)

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.00	2.00	4.00					
Orifice Area (sq. inches)	6.00	6.00	7.50					

	Row 9 (optional)	Row 10 (optional)	Row 11 (optional)	Row 12 (optional)	Row 13 (optional)	Row 14 (optional)	Row 15 (optional)	Row 16 (optional)
Stage of Orifice Centroid (ft)								
Orifice Area (sq. inches)								

User Input: Vertical Orifice (Circular or Rectangular)

	Not Selected	Not Selected	
Invert of Vertical Orifice =	N/A	N/A	ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Vertical Orifice =	N/A	N/A	ft (relative to basin bottom at Stage = 0 ft)
Vertical Orifice Diameter =	N/A	N/A	inches

Calculated Parameters for Vertical Orifice

	Not Selected	Not Selected	
Vertical Orifice Area =	N/A	N/A	ft^2
Vertical Orifice Centroid =	N/A	N/A	feet

User Input: Overflow Weir (Dropbox) and Grate (Flat or Sloped)

	Zone 3 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	6.30	N/A	ft (relative to basin bottom at Stage = 0 ft)
Overflow Weir Front Edge Length =	15.00	N/A	feet
Overflow Weir Slope =	0.00	N/A	H:V (enter zero for flat grate)
Horiz. Length of Weir Sides =	8.00	N/A	feet
Overflow Grate Open Area % =	70%	N/A	%, grate open area/total area
Debris Clogging % =	50%	N/A	%

Calculated Parameters for Overflow Weir

	Zone 3 Weir	Not Selected	
Height of Grate Upper Edge, H_t =	6.30	N/A	feet
Over Flow Weir Slope Length =	8.00	N/A	feet
Grate Open Area / 100-yr Orifice Area =	5.28	N/A	should be ≥ 4
Overflow Grate Open Area w/o Debris =	84.00	N/A	ft^2
Overflow Grate Open Area w/ Debris =	42.00	N/A	ft^2

User Input: Outlet Pipe w/ Flow Restriction Plate (Circular Orifice, Restrictor Plate, or Rectangular Orifice)

	Zone 3 Restrictor	Not Selected	
Depth to Invert of Outlet Pipe =	0.50	N/A	ft (distance below basin bottom at Stage = 0 ft)
Outlet Pipe Diameter =	54.00	N/A	inches
Restrictor Plate Height Above Pipe Invert =	54.00		inches

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

	Zone 3 Restrictor	Not Selected	
Outlet Orifice Area =	15.90	N/A	ft^2
Outlet Orifice Centroid =	2.25	N/A	feet
Half-Central Angle of Restrictor Plate on Pipe =	3.14	N/A	radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=	10.80	ft (relative to basin bottom at Stage = 0 ft)
Spillway Crest Length =	15.00	feet
Spillway End Slopes =	0.00	H:V
Freeboard above Max Water Surface =	0.50	feet

Calculated Parameters for Spillway

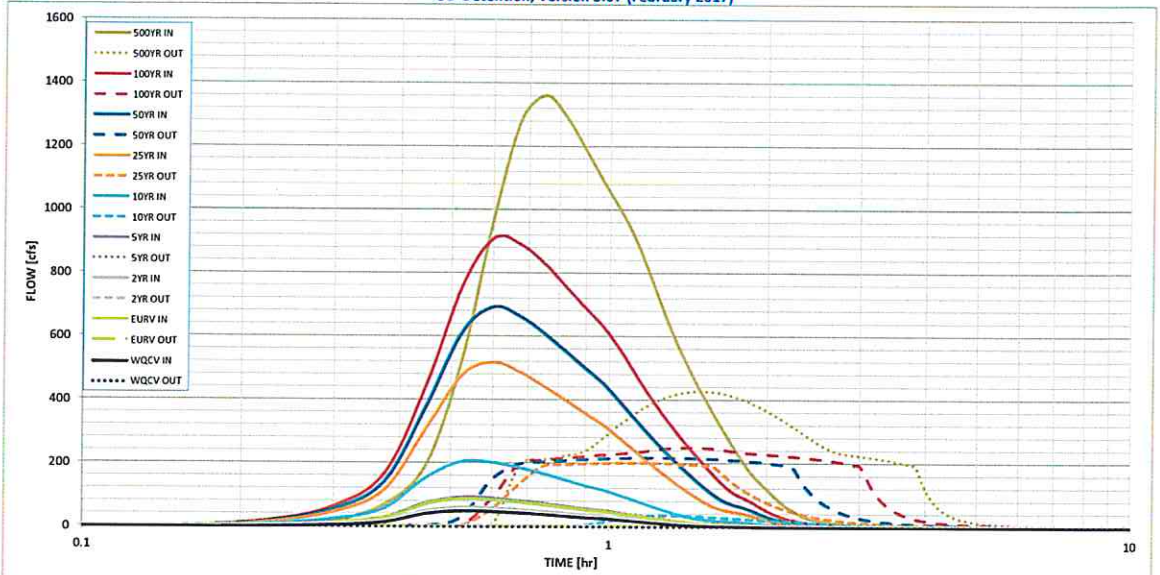
Spillway Design Flow Depth=	0.00	feet
Stage at Top of Freeboard =	11.30	feet
Basin Area at Top of Freeboard =	7.84	acres

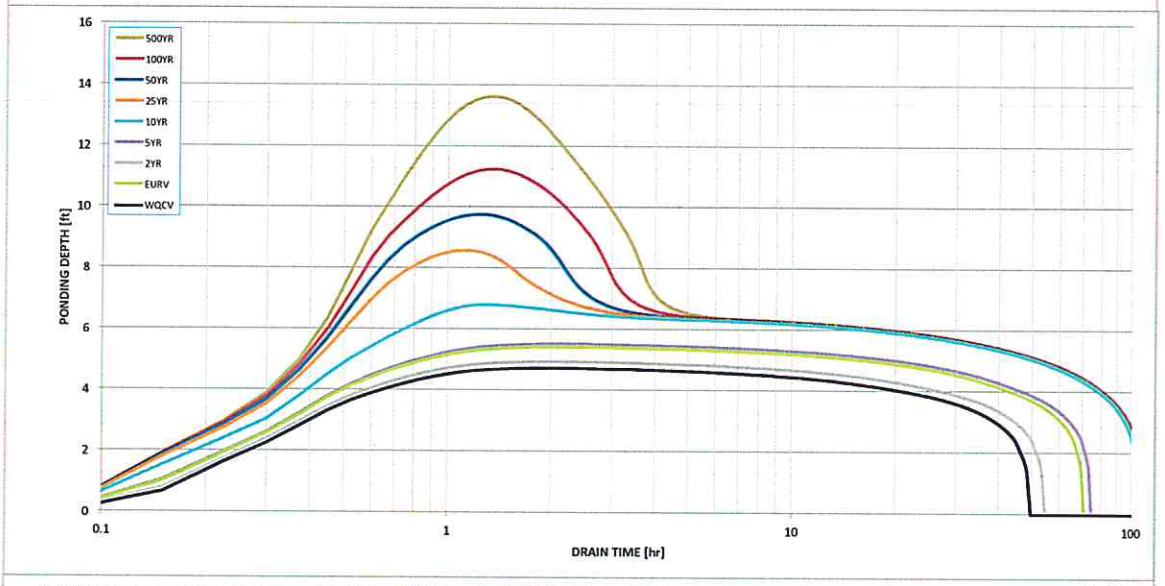
Routed Hydrograph Results

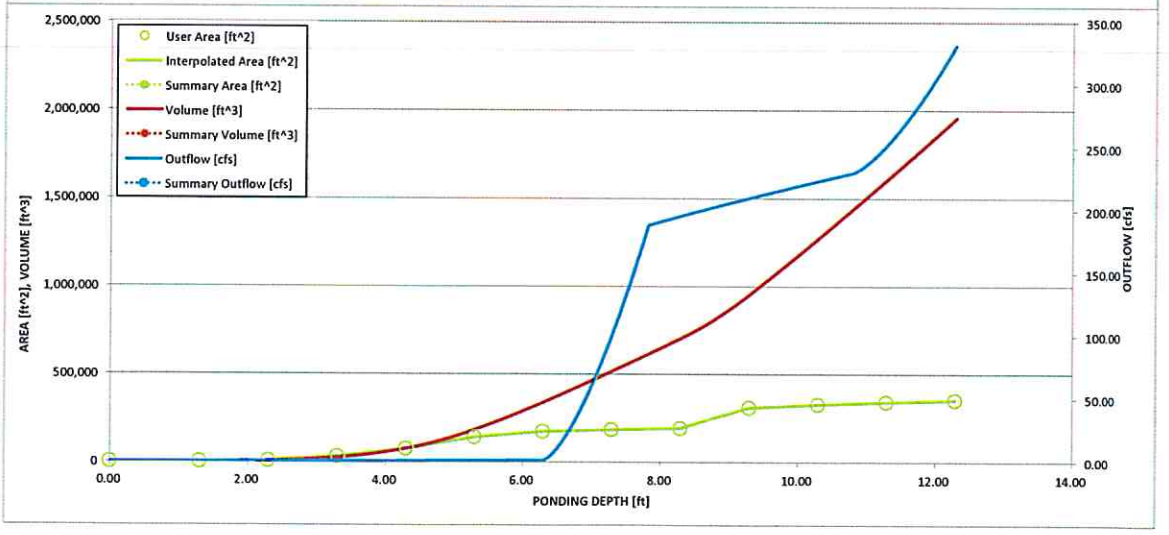
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	0.53	1.07	1.19	1.50	1.75	2.00	2.25	2.52	3.20
Calculated Runoff Volume (acre-ft) =	2.818	4.728	3.246	5.056	11.607	30.860	42.890	58.605	90.785
OPTIONAL Override Runoff Volume (acre-ft) =									
Inflow Hydrograph Volume (acre-ft) =	2.818	4.728	3.246	5.051	11.599	30.860	42.892	58.602	90.765
Predevelopment Unit Peak Flow, q (cfs/acre) =	0.00	0.00	0.01	0.02	0.23	0.75	1.04	1.39	2.09
Predevelopment Peak Q (cfs) =	0.0	0.0	7.1	12.1	119.1	384.8	531.8	711.9	1069.6
Peak Inflow Q (cfs) =	51.0	84.9	58.7	90.6	203.2	516.0	690.9	908.7	1360.5
Peak Outflow Q (cfs) =	1.0	1.1	1.0	1.2	34.9	199.9	216.5	248.3	426.1
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	0.1	0.3	0.5	0.4	0.3	0.4
Structure Controlling Flow =	Plate	Plate	Plate	Plate	Overflow Grate 1	Outlet Plate 1	Outlet Plate 1	Spillway	N/A
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	N/A	0.4	2.4	2.6	2.8	2.9
Max Velocity through Grate 2 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours) =	46	66	50	69	96	85	79	73	61
Time to Drain 99% of Inflow Volume (hours) =	48	68	53	72	101	97	95	93	87
Maximum Ponding Depth (ft) =	4.76	5.41	4.92	5.50	6.79	8.56	9.74	11.23	13.61
Area at Maximum Ponding Depth (acres) =	2.40	3.29	2.65	3.37	4.08	5.11	7.29	7.81	8.09
Maximum Volume Stored (acre-ft) =	2.656	4.527	3.086	4.860	9.725	17.411	25.101	36.300	44.889

Detention Basin Outlet Structure Design

UD-Detention, Version 3.07 (February 2017)







S-A-V-D Chart Axis Override	X-axis	Left Y-Axis	Right Y-Axis
minimum bound			
maximum bound			

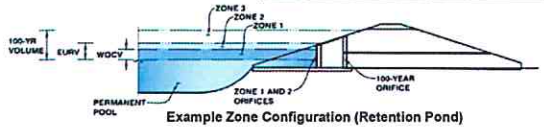
F18

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

UD-Detention, Version 3.07 (February 2017)

Project: Wolf Ranch Development

Basin ID: Detention Basin F18 as designed/as-built with updated % imp from ODP



Example Zone Configuration (Retention Pond)

Required Volume Calculation

Selected BMP Type =	EDB			
Watershed Area =	510.72	acres		
Watershed Length =	6,150	ft		
Watershed Slope =	0.029	ft/ft		
Watershed Imperviousness =	12.30%	percent		
Percentage Hydrologic Soil Group A =	0.0%	percent		
Percentage Hydrologic Soil Group B =	100.0%	percent		
Percentage Hydrologic Soil Groups C/D =	0.0%	percent		
Desired WQCV Drain Time =	40.0	hours		
Location for 1-hr Rainfall Depths =	Denver - Capitol Building			
Water Quality Capture Volume (WQCV) =	3.389	acre-feet	Optional User Override 1-hr Precipitation	
Excess Urban Runoff Volume (EURV) =	6.003	acre-feet		
2-yr Runoff Volume (P1 = 1.19 in.) =	4.213	acre-feet	1.19	inches
5-yr Runoff Volume (P1 = 1.5 in.) =	6.446	acre-feet	1.50	inches
10-yr Runoff Volume (P1 = 1.75 in.) =	13.373	acre-feet	1.75	inches
25-yr Runoff Volume (P1 = 2 in.) =	32.430	acre-feet	2.00	inches
50-yr Runoff Volume (P1 = 2.25 in.) =	44.404	acre-feet	2.25	inches
100-yr Runoff Volume (P1 = 2.52 in.) =	60.050	acre-feet	2.52	inches
500-yr Runoff Volume (P1 = 3.2 in.) =	92.221	acre-feet	3.20	inches
Approximate 2-yr Detention Volume =	3.914	acre-feet		
Approximate 5-yr Detention Volume =	6.037	acre-feet		
Approximate 10-yr Detention Volume =	11.501	acre-feet		
Approximate 25-yr Detention Volume =	15.513	acre-feet		
Approximate 50-yr Detention Volume =	16.308	acre-feet		
Approximate 100-yr Detention Volume =	20.809	acre-feet		

Depth Increment = ft

Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Top of Micropool	--	0.00	--	--	--	250	0.006		
	--	1.30	--	--	--	766	0.018	653	0.015
	--	2.30	--	--	--	6,208	0.143	4,147	0.095
	--	3.30	--	--	--	30,385	0.698	22,444	0.515
	--	4.30	--	--	--	75,257	1.728	75,265	1.728
	--	5.30	--	--	--	140,214	3.219	183,000	4.201
	--	6.30	--	--	--	172,835	3.968	339,524	7.794
	--	7.30	--	--	--	182,661	4.193	517,272	11.875
	--	8.30	--	--	--	191,876	4.405	704,541	16.174
	--	9.30	--	--	--	309,808	7.112	955,383	21.933
	--	10.30	--	--	--	327,554	7.520	1,274,064	29.248
	--	11.30	--	--	--	341,309	7.835	1,608,495	36.926
	--	12.30	--	--	--	352,435	8.091	1,955,367	44.889
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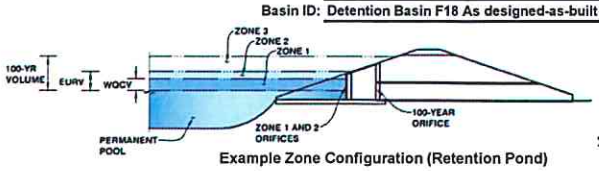
Detention Basin Outlet Structure Design

UD-Detention, Version 3.07 (February 2017)

Project: Wolf Ranch Development Research Parkway Filing No. 5

Basin ID: Detention Basin F18 As designed-as-built with updated % imp per ODP



Example Zone Configuration (Retention Pond)

	Stage (ft)	Zone Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	5.04	3.389	Orifice Plate
Zone 2 (EURV)	5.83	2.614	Orifice Plate
Zone 3 (100-year)	9.14	14.806	Weir&Pipe (Restrict)
		20.809	Total

User Input: Orifice at Underdrain Outlet (typically used to drain WQCV in a Filtration BMP)

Underdrain Orifice Invert Depth =	N/A	ft (distance below the filtration media surface)
Underdrain Orifice Diameter =	N/A	inches

Calculated Parameters for Underdrain

Underdrain Orifice Area =	N/A	ft^2
Underdrain Orifice Centroid =	N/A	feet

User Input: Orifice Plate with one or more orifices or Elliptical Slot Weir (typically used to drain WQCV and/or EURV in a sedimentation BMP)

Invert of Lowest Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Orifice Plate =	6.00	ft (relative to basin bottom at Stage = 0 ft)
Orifice Plate: Orifice Vertical Spacing =	N/A	inches
Orifice Plate: Orifice Area per Row =	N/A	inches

Calculated Parameters for Plate

WQ Orifice Area per Row =	N/A	ft^2
Elliptical Half-Width =	N/A	feet
Elliptical Slot Centroid =	N/A	feet
Elliptical Slot Area =	N/A	ft^2

User Input: Stage and Total Area of Each Orifice Row (numbered from lowest to highest)

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.00	2.00	4.00					
Orifice Area (sq. inches)	6.00	6.00	7.50					

	Row 9 (optional)	Row 10 (optional)	Row 11 (optional)	Row 12 (optional)	Row 13 (optional)	Row 14 (optional)	Row 15 (optional)	Row 16 (optional)
Stage of Orifice Centroid (ft)								
Orifice Area (sq. inches)								

User Input: Vertical Orifice (Circular or Rectangular)

	Not Selected	Not Selected	
Invert of Vertical Orifice =	N/A	N/A	ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Vertical Orifice =	N/A	N/A	ft (relative to basin bottom at Stage = 0 ft)
Vertical Orifice Diameter =	N/A	N/A	inches

Calculated Parameters for Vertical Orifice

	Not Selected	Not Selected	
Vertical Orifice Area =	N/A	N/A	ft^2
Vertical Orifice Centroid =	N/A	N/A	feet

User Input: Overflow Weir (Dropbox) and Grate (Flat or Sloped)

	Zone 3 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	6.30	N/A	ft (relative to basin bottom at Stage = 0 ft)
Overflow Weir Front Edge Length =	15.00	N/A	feet
Overflow Weir Slope =	0.00	N/A	H:V (enter zero for flat grate)
Horiz. Length of Weir Sides =	8.00	N/A	feet
Overflow Grate Open Area % =	70%	N/A	%, grate open area/total area
Debris Clogging % =	50%	N/A	%

Calculated Parameters for Overflow Weir

	Zone 3 Weir	Not Selected	
Height of Grate Upper Edge, H_t =	6.30	N/A	feet
Over Flow Weir Slope Length =	8.00	N/A	feet
Grate Open Area / 100-yr Orifice Area =	5.28	N/A	should be ≥ 4
Overflow Grate Open Area w/o Debris =	84.00	N/A	ft^2
Overflow Grate Open Area w/ Debris =	42.00	N/A	ft^2

User Input: Outlet Pipe w/ Flow Restriction Plate (Circular Orifice, Restrictor Plate, or Rectangular Orifice)

	Zone 3 Restrictor	Not Selected	
Depth to Invert of Outlet Pipe =	0.50	N/A	ft (distance below basin bottom at Stage = 0 ft)
Outlet Pipe Diameter =	54.00	N/A	inches
Restrictor Plate Height Above Pipe Invert =	54.00		inches

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

	Zone 3 Restrictor	Not Selected	
Outlet Orifice Area =	15.90	N/A	ft^2
Outlet Orifice Centroid =	2.25	N/A	feet
Half-Central Angle of Restrictor Plate on Pipe =	3.14	N/A	radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=	10.80	ft (relative to basin bottom at Stage = 0 ft)
Spillway Crest Length =	15.00	feet
Spillway End Slopes =	0.00	H:V
Freeboard above Max Water Surface =	0.50	feet

Calculated Parameters for Spillway

Spillway Design Flow Depth=	0.00	feet
Stage at Top of Freeboard =	11.30	feet
Basin Area at Top of Freeboard =	7.84	acres

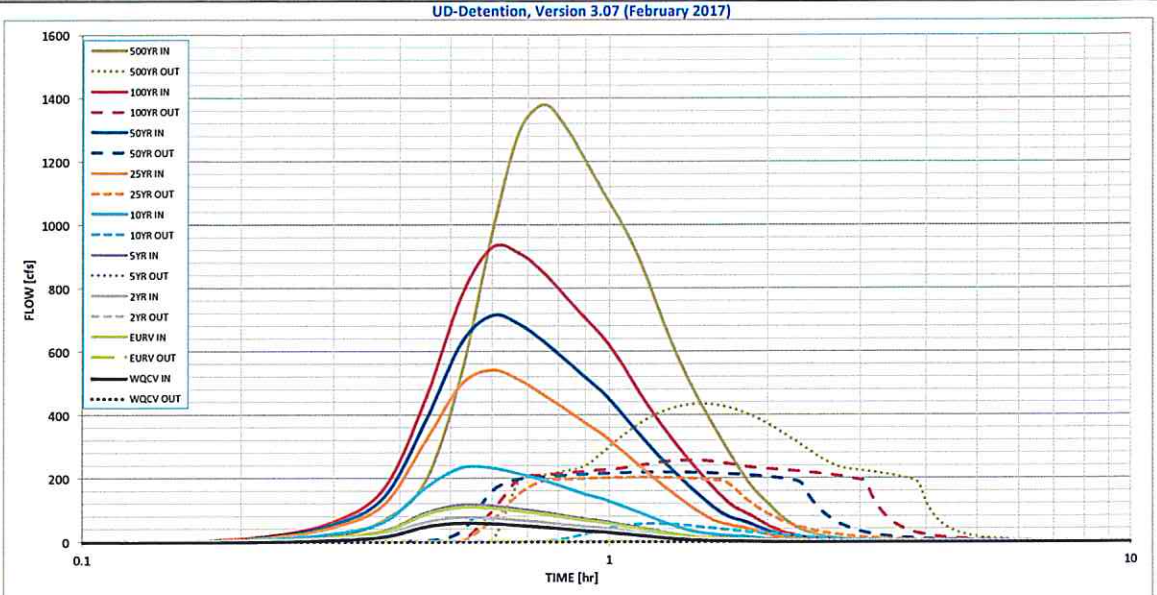
Routed Hydrograph Results

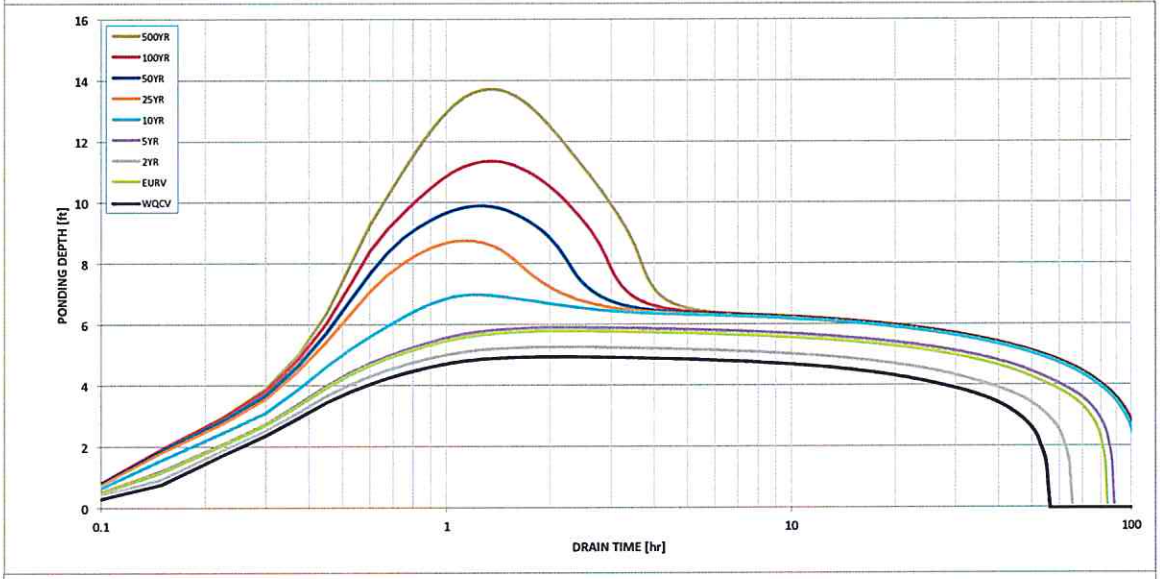
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	0.53	1.07	1.19	1.50	1.75	2.00	2.25	2.52	3.20
Calculated Runoff Volume (acre-ft) =	3.389	6.003	4.213	6.446	13.373	32.430	44.404	60.050	92.221
OPTIONAL Override Runoff Volume (acre-ft) =									
Inflow Hydrograph Volume (acre-ft) =	3.389	6.003	4.213	6.443	13.367	32.432	44.403	60.053	92.160
Predevelopment Unit Peak Flow, q (cfs/acre) =	0.00	0.00	0.01	0.02	0.23	0.75	1.04	1.39	2.09
Predevelopment Peak Q (cfs) =	0.0	0.0	7.1	12.1	119.1	384.8	531.8	711.9	1069.6
Peak Inflow Q (cfs) =	61.2	107.2	75.8	114.8	232.9	540.3	712.7	927.9	1379.6
Peak Outflow Q (cfs) =	1.0	1.2	1.1	1.2	56.3	202.4	218.4	255.7	433.6
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	0.1	0.5	0.5	0.4	0.4	0.4
Structure Controlling Flow =	Plate	Plate	Plate	Plate	Overflow Grate 1	Outlet Plate 1	Outlet Plate 1	Spillway	N/A
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	N/A	0.6	2.4	2.6	2.8	2.9
Max Velocity through Grate 2 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours) =	52	78	60	82	95	84	78	72	60
Time to Drain 99% of Inflow Volume (hours) =	54	81	63	85	101	97	95	92	87
Maximum Ponding Depth (ft) =	4.98	5.77	5.25	5.89	6.97	8.74	9.89	11.35	13.71
Area at Maximum Ponding Depth (acres) =	2.73	3.57	3.14	3.66	4.12	5.57	7.35	7.85	8.09
Maximum Volume Stored (acre-ft) =	3.220	5.797	4.042	6.231	10.503	18.318	26.126	37.318	44.889

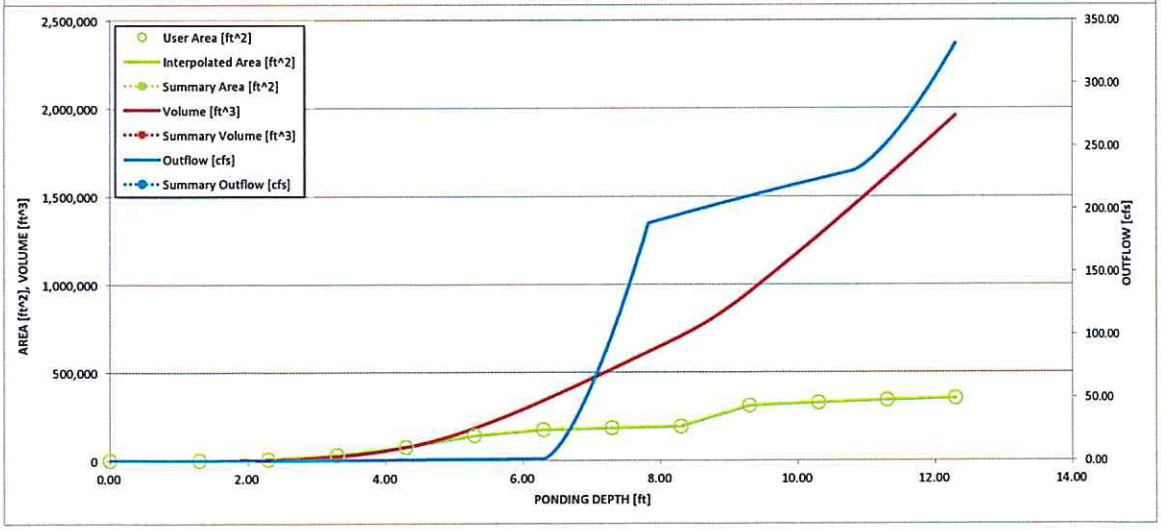
EXCEEDS ALLOWABLE RELEASE TIME.
NEED TO ALTER PLATE

Detention Basin Outlet Structure Design

UD-Detention, Version 3.07 (February 2017)







S-A-V-D Chart Axis Override	X-axis	Left Y-Axis	Right Y-Axis
minimum bound			
maximum bound			

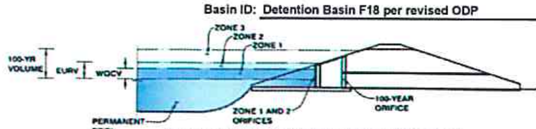
DETENTION BASIN STAGE-STORAGE TABLE BUILDER

F18 Per ODP AND DEV. PERF. PLATE

UD-Detention, Version 3.07 (February 2017)

Project: Wolf Ranch Development

Basin ID: Detention Basin F18 per revised ODP



Example Zone Configuration (Retention Pond)

Required Volume Calculation

Selected BMP Type =	EDB			
Watershed Area =	510.72	acres		
Watershed Length =	6,150	ft		
Watershed Slope =	0.029	ft/ft		
Watershed Imperviousness =	12.30%	percent		
Percentage Hydrologic Soil Group A =	0.0%	percent		
Percentage Hydrologic Soil Group B =	100.0%	percent		
Percentage Hydrologic Soil Groups C/D =	0.0%	percent		
Desired WQCV Drain Time =	40.0	hours		
Location for 1-hr Rainfall Depths =	Denver - Capitol Building			
Water Quality Capture Volume (WQCV) =	3.389	acre-feet	Optional User Override 1-hr Precipitation	
Excess Urban Runoff Volume (EURV) =	6.003	acre-feet		
2-yr Runoff Volume (P1 = 1.19 in.) =	4.213	acre-feet	1.19	inches
5-yr Runoff Volume (P1 = 1.5 in.) =	6.446	acre-feet	1.50	inches
10-yr Runoff Volume (P1 = 1.75 in.) =	13.373	acre-feet	1.75	inches
25-yr Runoff Volume (P1 = 2 in.) =	32.430	acre-feet	2.00	inches
50-yr Runoff Volume (P1 = 2.25 in.) =	44.404	acre-feet	2.25	inches
100-yr Runoff Volume (P1 = 2.52 in.) =	60.050	acre-feet	2.52	inches
500-yr Runoff Volume (P1 = 3.2 in.) =	92.221	acre-feet	3.20	inches
Approximate 2-yr Detention Volume =	3.914	acre-feet		
Approximate 5-yr Detention Volume =	6.037	acre-feet		
Approximate 10-yr Detention Volume =	11.501	acre-feet		
Approximate 25-yr Detention Volume =	15.513	acre-feet		
Approximate 50-yr Detention Volume =	16.308	acre-feet		
Approximate 100-yr Detention Volume =	20.809	acre-feet		

Depth Increment = ft

Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Top of Micropool	--	0.00	--	--	--	250	0.006		
	--	1.30	--	--	--	766	0.018	653	0.015
	--	2.30	--	--	--	6,208	0.143	4,147	0.095
	--	3.30	--	--	--	30,385	0.698	22,444	0.515
	--	4.30	--	--	--	75,257	1.728	75,265	1.728
	--	5.30	--	--	--	140,214	3.219	183,000	4.201
	--	6.30	--	--	--	172,835	3.968	339,524	7.794
	--	7.30	--	--	--	182,661	4.193	517,272	11.875
	--	8.30	--	--	--	191,876	4.405	704,541	16.174
	--	9.30	--	--	--	309,808	7.112	955,383	21.933
	--	10.30	--	--	--	327,554	7.520	1,274,064	29.248
	--	11.30	--	--	--	341,309	7.835	1,608,495	36.926
	--	12.30	--	--	--	352,435	8.091	1,955,367	44.889
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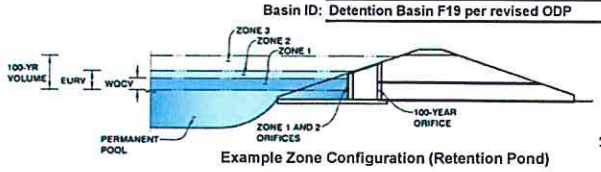
F19 Revised per ODP

Detention Basin Outlet Structure Design

UD-Detention, Version 3.07 (February 2017)

Project: Wolf Ranch Development

Basin ID: Detention Basin F19 per revised ODP



Example Zone Configuration (Retention Pond)

	Stage (ft)	Zone Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	5.04	3.389	Orifice Plate
Zone 2 (EURV)	5.83	2.614	Orifice Plate
Zone 3 (100-year)	9.14	14.806	Weir&Pipe (Restrict)
		20.809	Total

User Input: Orifice at Underdrain Outlet (typically used to drain WQCV in a Filtration BMP)

Underdrain Orifice Invert Depth =	N/A	ft (distance below the filtration media surface)
Underdrain Orifice Diameter =	N/A	inches

Calculated Parameters for Underdrain

Underdrain Orifice Area =	N/A	ft^2
Underdrain Orifice Centroid =	N/A	feet

User Input: Orifice Plate with one or more orifices or Elliptical Slot Weir (typically used to drain WQCV and/or EURV in a sedimentation BMP)

Invert of Lowest Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Orifice Plate =	6.00	ft (relative to basin bottom at Stage = 0 ft)
Orifice Plate: Orifice Vertical Spacing =	N/A	inches
Orifice Plate: Orifice Area per Row =	N/A	inches

Calculated Parameters for Plate

WQ Orifice Area per Row =	N/A	ft^2
Elliptical Half-Width =	N/A	feet
Elliptical Slot Centroid =	N/A	feet
Elliptical Slot Area =	N/A	ft^2

User Input: Stage and Total Area of Each Orifice Row (numbered from lowest to highest)

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.00	2.00	4.00					
Orifice Area (sq. inches)	7.00	7.50	7.50					

	Row 9 (optional)	Row 10 (optional)	Row 11 (optional)	Row 12 (optional)	Row 13 (optional)	Row 14 (optional)	Row 15 (optional)	Row 16 (optional)
Stage of Orifice Centroid (ft)								
Orifice Area (sq. inches)								

User Input: Vertical Orifice (Circular or Rectangular)

	Not Selected	Not Selected	
Invert of Vertical Orifice =	N/A	N/A	ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Vertical Orifice =	N/A	N/A	ft (relative to basin bottom at Stage = 0 ft)
Vertical Orifice Diameter =	N/A	N/A	inches

Calculated Parameters for Vertical Orifice

	Not Selected	Not Selected	
Vertical Orifice Area =	N/A	N/A	ft^2
Vertical Orifice Centroid =	N/A	N/A	feet

User Input: Overflow Weir (Dropbox) and Grate (Flat or Sloped)

	Zone 3 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	6.30	N/A	ft (relative to basin bottom at Stage = 0 ft)
Overflow Weir Front Edge Length =	15.00	N/A	feet
Overflow Weir Slope =	0.00	N/A	H:V (enter zero for flat grate)
Horiz. Length of Weir Sides =	8.00	N/A	feet
Overflow Grate Open Area % =	70%	N/A	%, grate open area/total area
Debris Clogging % =	50%	N/A	%

Calculated Parameters for Overflow Weir

	Zone 3 Weir	Not Selected	
Height of Grate Upper Edge, H_t =	6.30	N/A	feet
Over Flow Weir Slope Length =	8.00	N/A	feet
Grate Open Area / 100-yr Orifice Area =	5.28	N/A	should be ≥ 4
Overflow Grate Open Area w/o Debris =	84.00	N/A	ft^2
Overflow Grate Open Area w/ Debris =	42.00	N/A	ft^2

User Input: Outlet Pipe w/ Flow Restriction Plate (Circular Orifice, Restrictor Plate, or Rectangular Orifice)

	Zone 3 Restrictor	Not Selected	
Depth to Invert of Outlet Pipe =	0.50	N/A	ft (distance below basin bottom at Stage = 0 ft)
Outlet Pipe Diameter =	54.00	N/A	inches
Restrictor Plate Height Above Pipe Invert =	54.00		inches

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

	Zone 3 Restrictor	Not Selected	
Outlet Orifice Area =	15.90	N/A	ft^2
Outlet Orifice Centroid =	2.25	N/A	feet
Half-Central Angle of Restrictor Plate on Pipe =	3.14	N/A	radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=	10.80	ft (relative to basin bottom at Stage = 0 ft)
Spillway Crest Length =	15.00	feet
Spillway End Slopes =	0.00	H:V
Freeboard above Max Water Surface =	0.50	feet

Calculated Parameters for Spillway

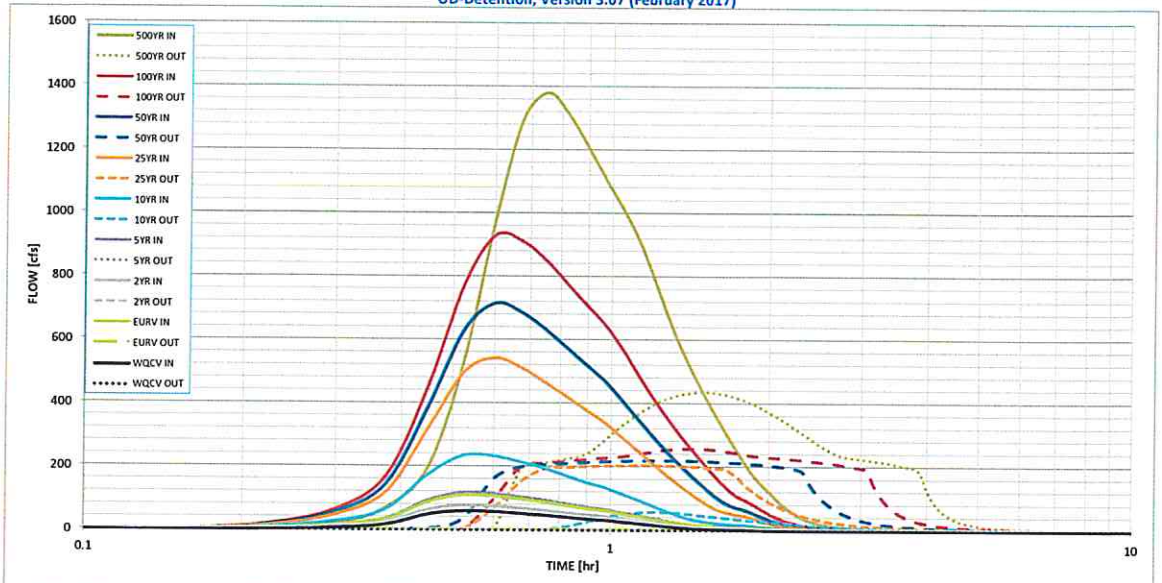
Spillway Design Flow Depth=	0.00	feet
Stage at Top of Freeboard =	11.30	feet
Basin Area at Top of Freeboard =	7.84	acres

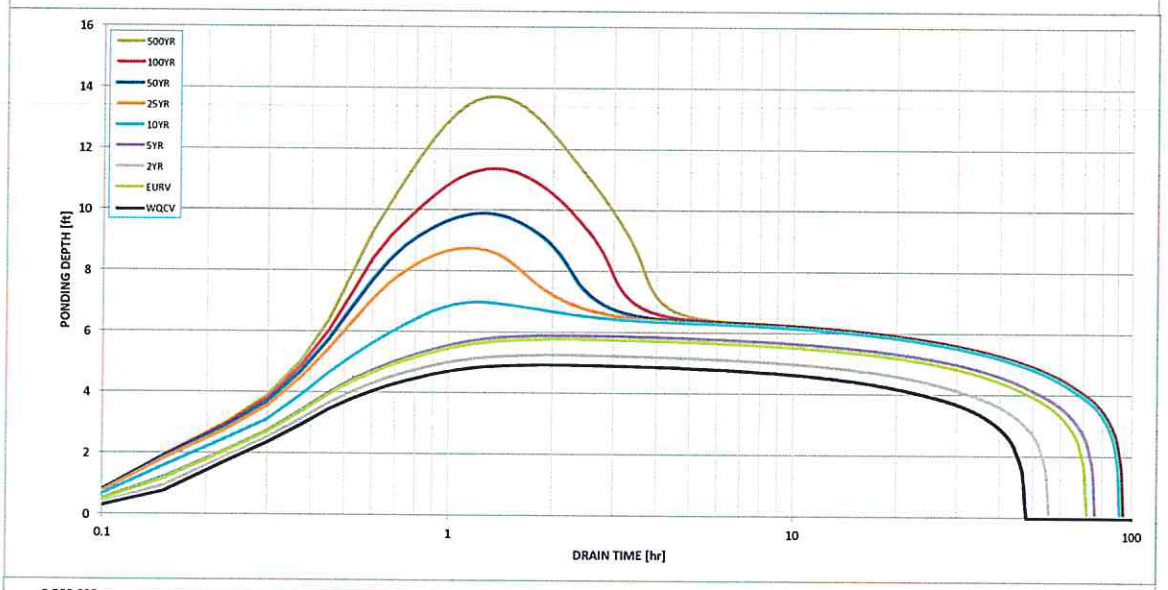
Routed Hydrograph Results

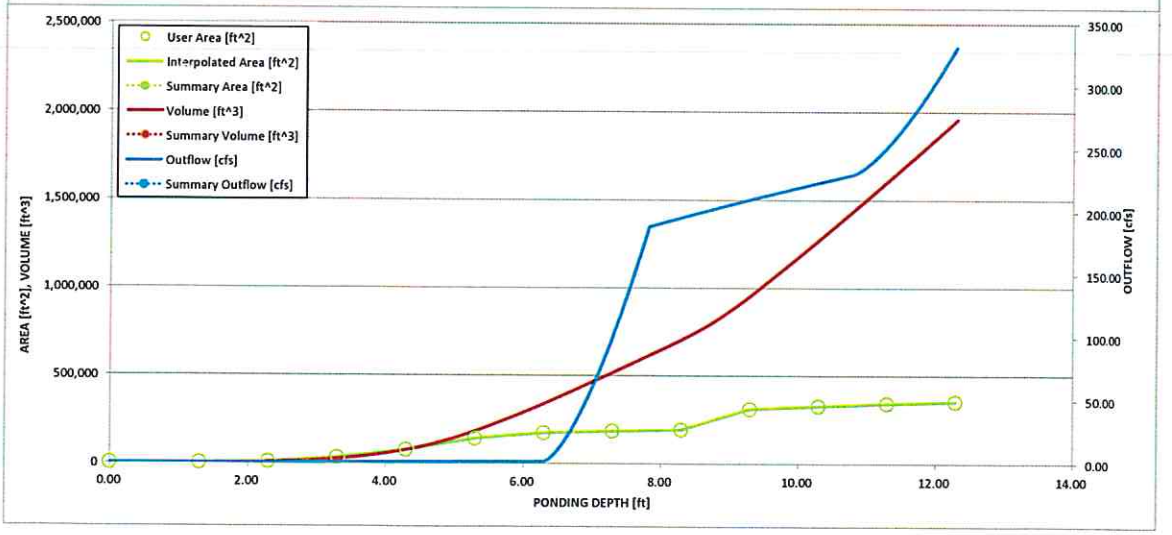
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	0.53	1.07	1.19	1.50	1.75	2.00	2.25	2.52	3.20
Calculated Runoff Volume (acre-ft) =	3.389	6.003	4.213	6.446	13.373	32.430	44.404	60.050	92.221
OPTIONAL Override Runoff Volume (acre-ft) =									
Inflow Hydrograph Volume (acre-ft) =	3.389	6.003	4.213	6.443	13.367	32.432	44.403	60.053	92.160
Predevelopment Unit Peak Flow, q (cfs/acre) =	0.00	0.00	0.01	0.02	0.23	0.75	1.04	1.39	2.09
Predevelopment Peak Q (cfs) =	0.0	0.0	7.1	12.1	119.1	384.8	531.8	711.9	1069.6
Peak Inflow Q (cfs) =	61.2	107.2	75.8	114.8	232.9	540.3	712.7	927.9	1379.6
Peak Outflow Q (cfs) =	1.2	1.4	1.3	1.4	56.3	202.4	218.4	255.6	433.5
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	0.1	0.5	0.5	0.4	0.4	0.4
Structure Controlling Flow =	Plate	Plate	Plate	Plate	Overflow Grate 1	Outlet Plate 1	Outlet Plate 1	Spillway	N/A
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	N/A	0.6	2.4	2.6	2.8	2.9
Max Velocity through Grate 2 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours) =	44	66	51	70	82	73	69	63	53
Time to Drain 99% of Inflow Volume (hours) =	46	69	54	73	87	84	82	80	76
Maximum Ponding Depth (ft) =	4.97	5.77	5.24	5.89	6.97	8.74	9.89	11.35	13.71
Area at Maximum Ponding Depth (acres) =	2.71	3.56	3.13	3.65	4.12	5.57	7.35	7.85	8.09
Maximum Volume Stored (acre-ft) =	3.193	5.761	4.011	6.194	10.503	18.318	26.126	37.318	44.889

Detention Basin Outlet Structure Design

UD-Detention, Version 3.07 (February 2017)







S-A-V-D Chart Axis Override	X-axis	Left Y-Axis	Right Y-Axis
minimum bound			
maximum bound			

Kiowa Engineering Corporation

Project Name: WR MODP Project No: 17049

Description: Hydrology - FSD

By: RCW Date: 6/11/19

% Imp Check Det. Basin F19

Per ODP as revised total of 1819 lots allowed north of Briargate

Current platted lots north of Briargate: Highline: 251

Net lots 1819 - 251 = 1568 lots remain

Density = 1668/465 Ac = 3.58 DU/ac

Area to F19 .28 Per 6-10 I = 5

F1	106.2 ac	5 Ac lots
FB	40.3 ac	7ac OS; 33.3 Ac .28 ac/lots
F9	27.5 ac	1.7ac OS ; 25.8 ac .28 ac/lots
F19	65.3 ac	7.7 ac OS : 57.6 ac .28 ac lots
	239.3	

% Imp To F19 per Revised ODP

F1 = 2%

FB (7(.02) + 33.3(.39))/40.3 = 32.5%

F9 (1.7(.02) + 25.8(.39))/27.5 = 36.7%

F19 (7.7(.02) + 57.6(.39))/65.3 = 34.6%

Wtd % I

$$\frac{(106.2(.02) + 40.3(32.5) + 27.5(.367) + 65.3(.346)}{239.3} = 20.0$$

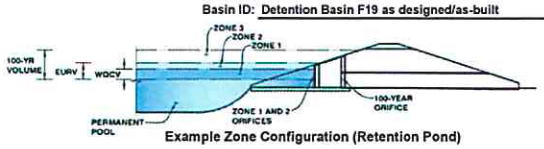
F19 As-Built

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

UD-Detention, Version 3.07 (February 2017)

Project: Wolf Ranch Development Research Parkway Filing No. 5

Basin ID: Detention Basin F19 as designed/as-built



Example Zone Configuration (Retention Pond)

Required Volume Calculation

Selected BMP Type =	EDB	
Watershed Area =	239.30	acres
Watershed Length =	6,150	ft
Watershed Slope =	0.029	ft/ft
Watershed Imperviousness =	17.86%	percent
Percentage Hydrologic Soil Group A =	0.0%	percent
Percentage Hydrologic Soil Group B =	100.0%	percent
Percentage Hydrologic Soil Groups C/D =	0.0%	percent
Desired WQCV Drain Time =	40.0	hours
Location for 1-hr Rainfall Depths =	User Input	
Water Quality Capture Volume (WQCV) =	2.124	acre-feet
Excess Urban Runoff Volume (EURV) =	4.208	acre-feet
2-yr Runoff Volume (P1 = 1.19 in.) =	3.064	acre-feet
5-yr Runoff Volume (P1 = 1.5 in.) =	4.549	acre-feet
10-yr Runoff Volume (P1 = 1.75 in.) =	8.152	acre-feet
25-yr Runoff Volume (P1 = 2 in.) =	16.872	acre-feet
50-yr Runoff Volume (P1 = 2.25 in.) =	22.422	acre-feet
100-yr Runoff Volume (P1 = 2.52 in.) =	29.679	acre-feet
500-yr Runoff Volume (P1 = 3.2 in.) =	44.743	acre-feet
Approximate 2-yr Detention Volume =	2.852	acre-feet
Approximate 5-yr Detention Volume =	4.263	acre-feet
Approximate 10-yr Detention Volume =	7.131	acre-feet
Approximate 25-yr Detention Volume =	9.003	acre-feet
Approximate 50-yr Detention Volume =	9.507	acre-feet
Approximate 100-yr Detention Volume =	11.799	acre-feet

Optional User Override 1-hr Precipitation	
1.19	inches
1.50	inches
1.75	inches
2.00	inches
2.25	inches
2.52	inches
3.20	inches

Depth Increment = ft

Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Top of Micropool	--	0.00	--	--	--	20	0.000		
	--	0.80	--	--	--	20	0.000	16	0.000
	--	1.80	--	--	--	2,716	0.062	1,357	0.031
	--	2.80	--	--	--	14,822	0.340	10,153	0.233
	--	3.80	--	--	--	45,231	1.038	40,179	0.922
	--	4.80	--	--	--	85,506	1.963	105,548	2.423
	--	5.80	--	--	--	100,764	2.313	198,683	4.561
	--	6.80	--	--	--	107,573	2.470	302,851	6.953
	--	7.30	--	--	--	111,162	2.552	357,535	8.208
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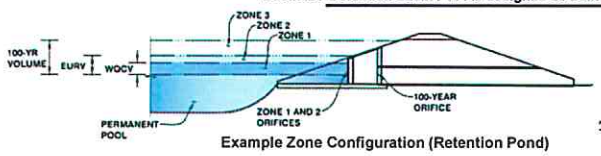
Detention Basin Outlet Structure Design

UD-Detention, Version 3.07 (February 2017)

Project: Wolf Ranch Development Research Parkway Filing No. 5

Basin ID: Detention Basin F19 As designed-as-built



Example Zone Configuration (Retention Pond)

	Stage (ft)	Zone Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	4.65	2.124	Orifice Plate
Zone 2 (EURV)	5.65	2.083	Orifice Plate
Zone 3 (100-year)		7.591	Weir&Pipe (Restrict)
		11.799	Total

User Input: Orifice at Underdrain Outlet (typically used to drain WQCV in a Filtration BMP)

Underdrain Orifice Invert Depth =	N/A	ft (distance below the filtration media surface)
Underdrain Orifice Diameter =	N/A	inches

Calculated Parameters for Underdrain

Underdrain Orifice Area =	N/A	ft^2
Underdrain Orifice Centroid =	N/A	feet

User Input: Orifice Plate with one or more orifices or Elliptical Slot Weir (typically used to drain WQCV and/or EURV in a sedimentation BMP)

Invert of Lowest Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Orifice Plate =	5.65	ft (relative to basin bottom at Stage = 0 ft)
Orifice Plate: Orifice Vertical Spacing =	N/A	inches
Orifice Plate: Orifice Area per Row =	N/A	inches

Calculated Parameters for Plate

WQ Orifice Area per Row =	N/A	ft^2
Elliptical Half-Width =	N/A	feet
Elliptical Slot Centroid =	N/A	feet
Elliptical Slot Area =	N/A	ft^2

User Input: Stage and Total Area of Each Orifice Row (numbered from lowest to highest)

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.00	1.92	3.84					
Orifice Area (sq. inches)	5.70	5.70	3.50					

	Row 9 (optional)	Row 10 (optional)	Row 11 (optional)	Row 12 (optional)	Row 13 (optional)	Row 14 (optional)	Row 15 (optional)	Row 16 (optional)
Stage of Orifice Centroid (ft)								
Orifice Area (sq. inches)								

User Input: Vertical Orifice (Circular or Rectangular)

	Not Selected	Not Selected	
Invert of Vertical Orifice =	N/A	N/A	ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Vertical Orifice =	N/A	N/A	ft (relative to basin bottom at Stage = 0 ft)
Vertical Orifice Diameter =	N/A	N/A	inches

Calculated Parameters for Vertical Orifice

	Not Selected	Not Selected	
Vertical Orifice Area =	N/A	N/A	ft^2
Vertical Orifice Centroid =	N/A	N/A	feet

User Input: Overflow Weir (Dropbox) and Grate (Flat or Sloped)

	Zone 3 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	5.77	N/A	ft (relative to basin bottom at Stage = 0 ft)
Overflow Weir Front Edge Length =	7.00	N/A	feet
Overflow Weir Slope =	0.00	N/A	H:V (enter zero for flat grate)
Horiz. Length of Weir Sides =	4.00	N/A	feet
Overflow Grate Open Area % =	70%	N/A	%, grate open area/total area
Debris Clogging % =	50%	N/A	%

Calculated Parameters for Overflow Weir

	Zone 3 Weir	Not Selected	
Height of Grate Upper Edge, H_t =	5.77	N/A	feet
Over Flow Weir Slope Length =	4.00	N/A	feet
Grate Open Area / 100-yr Orifice Area =	11.09	N/A	should be ≥ 4
Overflow Grate Open Area w/o Debris =	19.60	N/A	ft^2
Overflow Grate Open Area w/ Debris =	9.80	N/A	ft^2

User Input: Outlet Pipe w/ Flow Restriction Plate (Circular Orifice, Restrictor Plate, or Rectangular Orifice)

	Zone 3 Restrictor	Not Selected	
Depth to Invert of Outlet Pipe =	0.33	N/A	ft (distance below basin bottom at Stage = 0 ft)
Outlet Pipe Diameter =	18.00	N/A	inches
Restrictor Plate Height Above Pipe Invert =	18.00		inches

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

	Zone 3 Restrictor	Not Selected	
Outlet Orifice Area =	1.77	N/A	ft^2
Outlet Orifice Centroid =	0.75	N/A	feet
Half-Central Angle of Restrictor Plate on Pipe =	3.14	N/A	radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=	5.77	ft (relative to basin bottom at Stage = 0 ft)
Spillway Crest Length =	60.00	feet
Spillway End Slopes =	4.00	H:V
Freeboard above Max Water Surface =	0.50	feet

Calculated Parameters for Spillway

Spillway Design Flow Depth=	0.69	feet
Stage at Top of Freeboard =	6.96	feet
Basin Area at Top of Freeboard =	2.50	acres

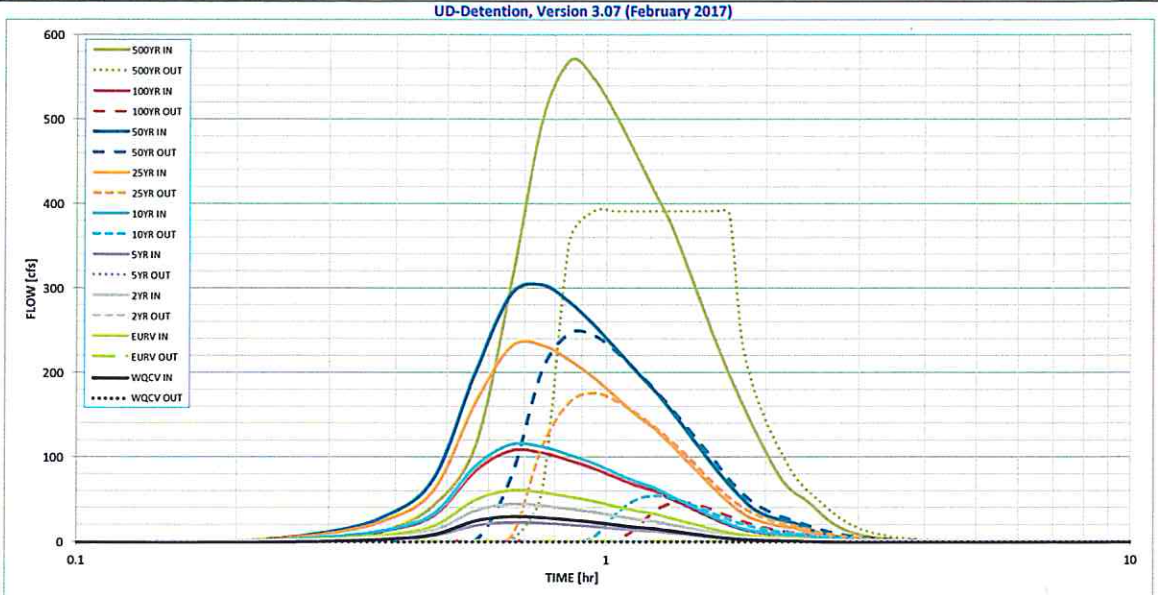
Routed Hydrograph Results

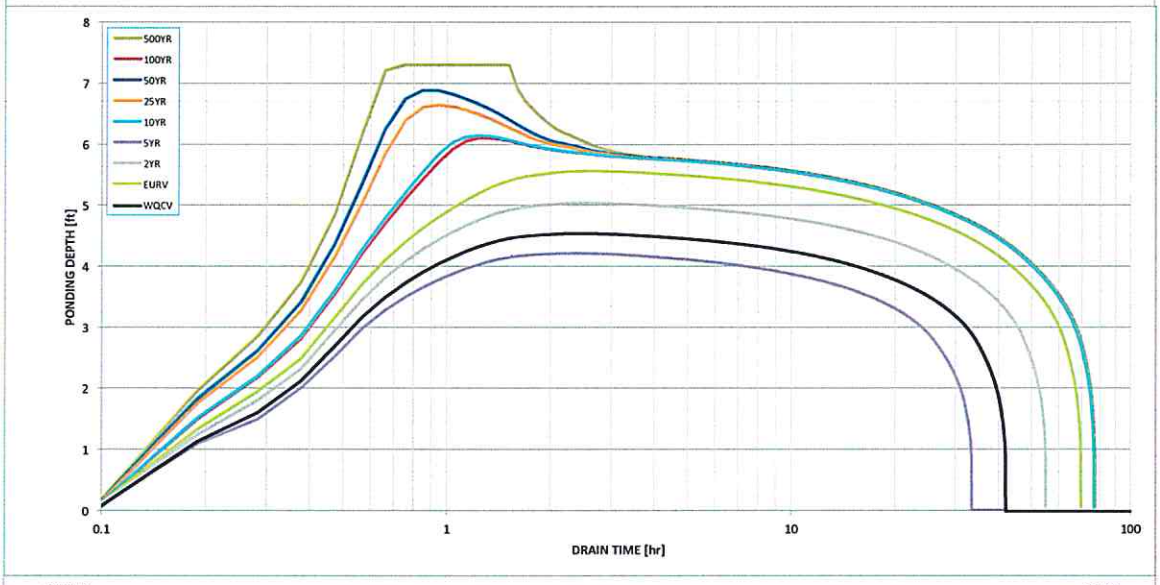
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	0.53	1.07	1.19	1.50	1.75	2.00	2.25	2.52	3.20
Calculated Runoff Volume (acre-ft) =	2.124	4.208	3.064	4.549	8.152	16.872	22.422	29.679	44.743
OPTIONAL Override Runoff Volume (acre-ft) =				1.560				7.640	
Inflow Hydrograph Volume (acre-ft) =	2.124	4.207	3.064	1.559	8.149	16.868	22.417	7.630	44.737
Predevelopment Unit Peak Flow, q (cfs/acre) =	0.00	0.00	0.01	0.02	0.17	0.57	0.79	1.07	1.61
Predevelopment Peak Q (cfs) =	0.0	0.0	2.4	4.2	39.8	135.9	188.3	255.0	385.2
Peak Inflow Q (cfs) =	30.7	60.1	44.0	22.6	114.5	232.1	303.4	107.5	569.5
Peak Outflow Q (cfs) =	0.8	1.0	0.9	0.8	53.9	175.4	245.8	45.6	390.8
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	0.2	1.4	1.3	1.3	0.2	1.0
Structure Controlling Flow =	Plate	Plate	Plate	Plate	Spillway	Spillway	Spillway	Spillway	N/A
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	N/A	0.5	1.0	1.0	0.5	1.1
Max Velocity through Grate 2 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours) =	39	65	51	31	69	63	60	69	48
Time to Drain 99% of Inflow Volume (hours) =	41	68	54	33	73	71	69	73	65
Maximum Ponding Depth (ft) =	4.56	5.56	5.04	4.21	6.14	6.65	6.88	6.10	7.30
Area at Maximum Ponding Depth (acres) =	1.73	2.23	2.04	1.42	2.37	2.44	2.48	2.36	2.55
Maximum Volume Stored (acre-ft) =	1.961	4.016	2.884	1.426	5.357	6.559	7.151	5.262	8.208

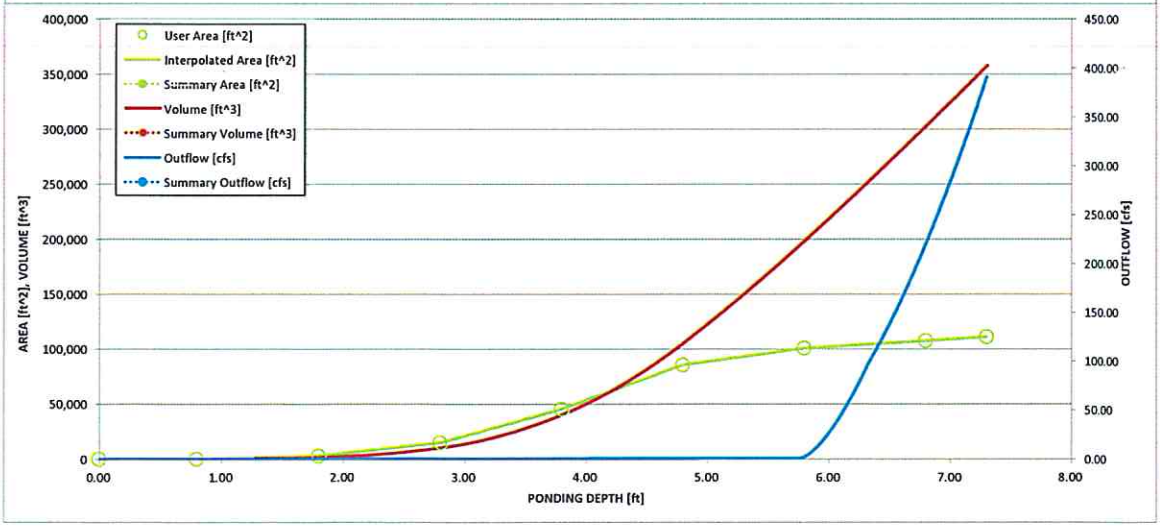
100-year determined using HEC-1 routing model

Detention Basin Outlet Structure Design

UD-Detention, Version 3.07 (February 2017)







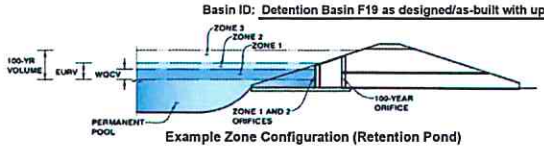
S-A-V-D Chart Axis Override	X-axis	Left Y-Axis	Right Y-Axis
minimum bound			
maximum bound			

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

UD-Detention, Version 3.07 (February 2017)

Project: Wolf Ranch Development Research Parkway Filing No. 5

Basin ID: Detention Basin F19 as designed/as-built with updated % imp from ODP



Example Zone Configuration (Retention Pond)

Required Volume Calculation

Selected BMP Type =	EDB	
Watershed Area =	239.30	acres
Watershed Length =	6,150	ft
Watershed Slope =	0.029	ft/ft
Watershed Imperviousness =	20.00%	percent
Percentage Hydrologic Soil Group A =	0.0%	percent
Percentage Hydrologic Soil Group B =	100.0%	percent
Percentage Hydrologic Soil Groups C/D =	0.0%	percent
Desired WQCV Drain Time =	40.0	hours
Location for 1-hr Rainfall Depths =	User Input	
Water Quality Capture Volume (WQCV) =	2.307	acre-feet
Excess Urban Runoff Volume (EURV) =	4.755	acre-feet
2-yr Runoff Volume (P1 = 1.19 in.) =	3.501	acre-feet
5-yr Runoff Volume (P1 = 1.5 in.) =	5.150	acre-feet
10-yr Runoff Volume (P1 = 1.75 in.) =	8.878	acre-feet
25-yr Runoff Volume (P1 = 2 in.) =	17.517	acre-feet
50-yr Runoff Volume (P1 = 2.25 in.) =	23.045	acre-feet
100-yr Runoff Volume (P1 = 2.52 in.) =	30.272	acre-feet
500-yr Runoff Volume (P1 = 3.2 in.) =	45.333	acre-feet
Approximate 2-yr Detention Volume =	3.261	acre-feet
Approximate 5-yr Detention Volume =	4.828	acre-feet
Approximate 10-yr Detention Volume =	7.807	acre-feet
Approximate 25-yr Detention Volume =	9.663	acre-feet
Approximate 50-yr Detention Volume =	10.207	acre-feet
Approximate 100-yr Detention Volume =	12.546	acre-feet

Optional User Override 1-hr Precipitation	
1.19	inches
1.50	inches
1.75	inches
2.00	inches
2.25	inches
2.52	inches
3.20	inches

Depth Increment = ft

Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Top of Micropool	--	0.00	--	--	--	20	0.000		
	--	0.80	--	--	--	20	0.000	16	0.000
	--	1.80	--	--	--	2,716	0.062	1,357	0.031
	--	2.80	--	--	--	14,822	0.340	10,153	0.233
	--	3.80	--	--	--	45,231	1.038	40,179	0.922
	--	4.80	--	--	--	85,506	1.963	105,548	2.423
	--	5.80	--	--	--	100,764	2.313	198,683	4.561
	--	6.80	--	--	--	107,573	2.470	302,851	6.953
	--	7.30	--	--	--	111,162	2.552	357,535	8.208
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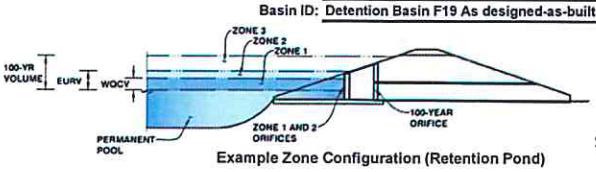
Detention Basin Outlet Structure Design

UD-Detention, Version 3.07 (February 2017)

Project: Wolf Ranch Development Research Parkway Filing No. 5

Basin ID: Detention Basin F19 As designed-as-built with updated imperviousness



Example Zone Configuration (Retention Pond)

	Stage (ft)	Zone Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	4.74	2.307	Orifice Plate
Zone 2 (EURV)	5.89	2.448	Orifice Plate
Zone 3 (100-year)		7.792	Weir&Pipe (Restrict)
		12.546	Total

User Input: Orifice at Underdrain Outlet (typically used to drain WQCV in a Filtration BMP)

Underdrain Orifice Invert Depth =	N/A	ft (distance below the filtration media surface)
Underdrain Orifice Diameter =	N/A	inches

Calculated Parameters for Underdrain

Underdrain Orifice Area =	N/A	ft^2
Underdrain Orifice Centroid =	N/A	feet

User Input: Orifice Plate with one or more orifices or Elliptical Slot Weir (typically used to drain WQCV and/or EURV in a sedimentation BMP)

Invert of Lowest Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Orifice Plate =	5.65	ft (relative to basin bottom at Stage = 0 ft)
Orifice Plate: Orifice Vertical Spacing =	N/A	inches
Orifice Plate: Orifice Area per Row =	N/A	inches

Calculated Parameters for Plate

WQ Orifice Area per Row =	N/A	ft^2
Elliptical Half-Width =	N/A	feet
Elliptical Slot Centroid =	N/A	feet
Elliptical Slot Area =	N/A	ft^2

User Input: Stage and Total Area of Each Orifice Row (numbered from lowest to highest)

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.00	1.92	3.84					
Orifice Area (sq. inches)	5.70	5.70	3.50					

	Row 9 (optional)	Row 10 (optional)	Row 11 (optional)	Row 12 (optional)	Row 13 (optional)	Row 14 (optional)	Row 15 (optional)	Row 16 (optional)
Stage of Orifice Centroid (ft)								
Orifice Area (sq. inches)								

User Input: Vertical Orifice (Circular or Rectangular)

	Not Selected	Not Selected	
Invert of Vertical Orifice =	N/A	N/A	ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Vertical Orifice =	N/A	N/A	ft (relative to basin bottom at Stage = 0 ft)
Vertical Orifice Diameter =	N/A	N/A	inches

Calculated Parameters for Vertical Orifice

	Not Selected	Not Selected	
Vertical Orifice Area =	N/A	N/A	ft^2
Vertical Orifice Centroid =	N/A	N/A	feet

User Input: Overflow Weir (Dropbox) and Grate (Flat or Sloped)

	Zone 3 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	5.77	N/A	ft (relative to basin bottom at Stage = 0 ft)
Overflow Weir Front Edge Length =	7.00	N/A	feet
Overflow Weir Slope =	0.00	N/A	H:V (enter zero for flat grate)
Horiz. Length of Weir Sides =	4.00	N/A	feet
Overflow Grate Open Area % =	70%	N/A	%, grate open area/total area
Debris Clogging % =	50%	N/A	%

Calculated Parameters for Overflow Weir

	Zone 3 Weir	Not Selected	
Height of Grate Upper Edge, H_t =	5.77	N/A	feet
Over Flow Weir Slope Length =	4.00	N/A	feet
Grate Open Area / 100-yr Orifice Area =	11.09	N/A	should be ≥ 4
Overflow Grate Open Area w/o Debris =	19.60	N/A	ft^2
Overflow Grate Open Area w/ Debris =	9.80	N/A	ft^2

User Input: Outlet Pipe w/ Flow Restriction Plate (Circular Orifice, Restrictor Plate, or Rectangular Orifice)

	Zone 3 Restrictor	Not Selected	
Depth to Invert of Outlet Pipe =	0.33	N/A	ft (distance below basin bottom at Stage = 0 ft)
Outlet Pipe Diameter =	18.00	N/A	inches
Restrictor Plate Height Above Pipe Invert =	18.00		inches

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

	Zone 3 Restrictor	Not Selected	
Outlet Orifice Area =	1.77	N/A	ft^2
Outlet Orifice Centroid =	0.75	N/A	feet
Half-Central Angle of Restrictor Plate on Pipe =	3.14	N/A	radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=	5.77	ft (relative to basin bottom at Stage = 0 ft)
Spillway Crest Length =	60.00	feet
Spillway End Slopes =	4.00	H:V
Freeboard above Max Water Surface =	0.50	feet

Calculated Parameters for Spillway

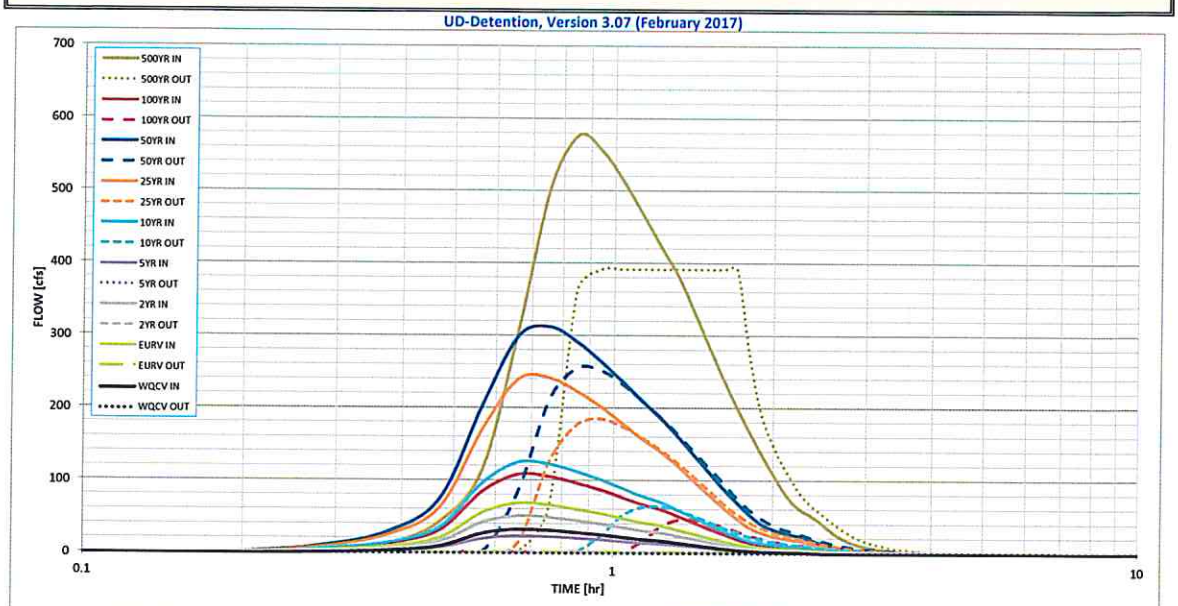
Spillway Design Flow Depth=	0.69	feet
Stage at Top of Freeboard =	6.96	feet
Basin Area at Top of Freeboard =	2.50	acres

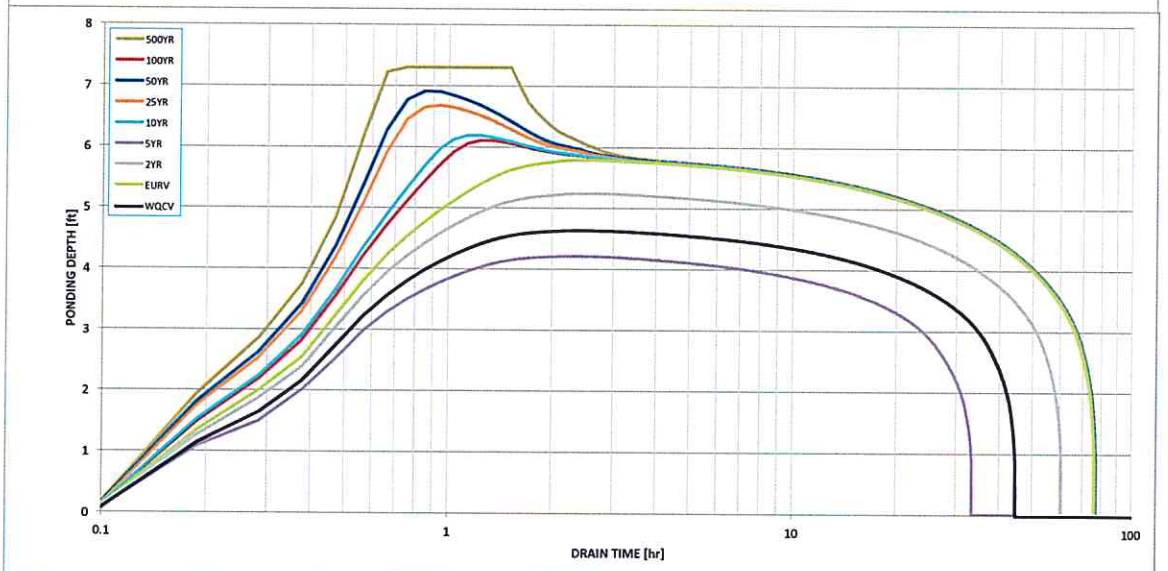
Routed Hydrograph Results

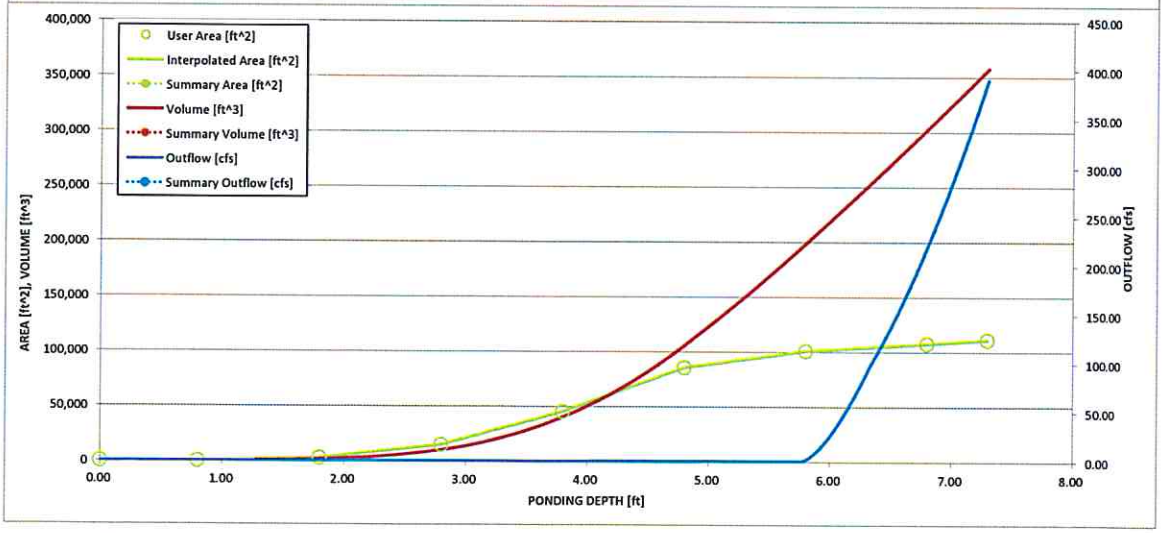
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	0.53	1.07	1.19	1.50	1.75	2.00	2.25	2.52	3.20
Calculated Runoff Volume (acre-ft) =	2.307	4.755	3.501	5.150	8.878	17.517	23.045	30.272	45.333
OPTIONAL Override Runoff Volume (acre-ft) =				1.560				7.640	
Inflow Hydrograph Volume (acre-ft) =	2.306	4.755	3.500	1.559	8.876	17.511	23.038	7.630	45.325
Predevelopment Unit Peak Flow, q (cfs/acre) =	0.00	0.00	0.01	0.02	0.17	0.57	0.79	1.07	1.61
Predevelopment Peak Q (cfs) =	0.0	0.0	2.4	4.2	39.8	135.9	188.3	255.0	385.2
Peak Inflow Q (cfs) =	33.2	67.7	50.2	22.6	124.5	240.9	311.4	107.5	576.2
Peak Outflow Q (cfs) =	0.8	1.7	0.9	0.8	63.7	184.3	254.2	45.6	390.8
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	0.2	1.6	1.4	1.4	0.2	1.0
Structure Controlling Flow =	Plate	Spillway	Plate	Plate	Spillway	Spillway	Spillway	Spillway	N/A
Max Velocity through Grate 1 (fps) =	N/A	0.01	N/A	N/A	0.7	1.0	1.0	0.5	1.1
Max Velocity through Grate 2 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours) =	42	71	57	31	68	63	59	69	47
Time to Drain 99% of Inflow Volume (hours) =	43	74	59	33	73	71	69	73	64
Maximum Ponding Depth (ft) =	4.66	5.79	5.24	4.21	6.19	6.68	6.91	6.10	7.30
Area at Maximum Ponding Depth (acres) =	1.82	2.31	2.12	1.42	2.37	2.45	2.49	2.36	2.55
Maximum Volume Stored (acre-ft) =	2.139	4.538	3.321	1.426	5.451	6.633	7.225	5.262	8.208

Detention Basin Outlet Structure Design

UD-Detention, Version 3.07 (February 2017)







S-A-V-D Chart Axis Override	X-axis	Left Y-Axis	Right Y-Axis
minimum bound			
maximum bound			

% Imp Check: Det. F28

Proposed land Uses.

Comm. Park 17.2 + 30.08 + 4.53 + 3.2 + 1.67 + 1.64 + .45 = 60.6 Ac

Open Space: 60.3 + 9.3 = 69.6

B 2.0 - 3.5 DU/Ac: 26.2 + 6 + 66.7 = 98.9

C 3.5 to 8.0 DU/Ac: 68.4 + 19.3 + 56.7 = 144.4

D 8 - 12 DU/Ac 43.6 Ac

E 12 - 24 17.1 Ac

Elem School 13.3 Ac

Summary

	Area	% Imp
Park	60.6	10 %
OS	69.6	2%
B *	98.9	25
C	144.4	55
D	43.6	65
E	17.1	TD
Elem School	13.3	35
	447.5	(490 used in design)

* use 2 DU/Ac

Weighted % Imp=

$$\frac{60.6(.1)+69.2(.02)+98.9(.25)+144.4(.55)+43.6(.65)+17.1(.70)+13.3(.35)}{441.5} = .35$$

per drainage; 35.5 % used. Therefore no adjustment to outlet work required.

SOURCE: F28 Final Drg Report

EXCESS URBAN RUNOFF CONTROL (FULL-SPECTRUM) DETENTION SIZING

Project: WOLF RANCH DETENTION BASIN AT DB F28

Basin ID: Full Spectrum Basin Calcs

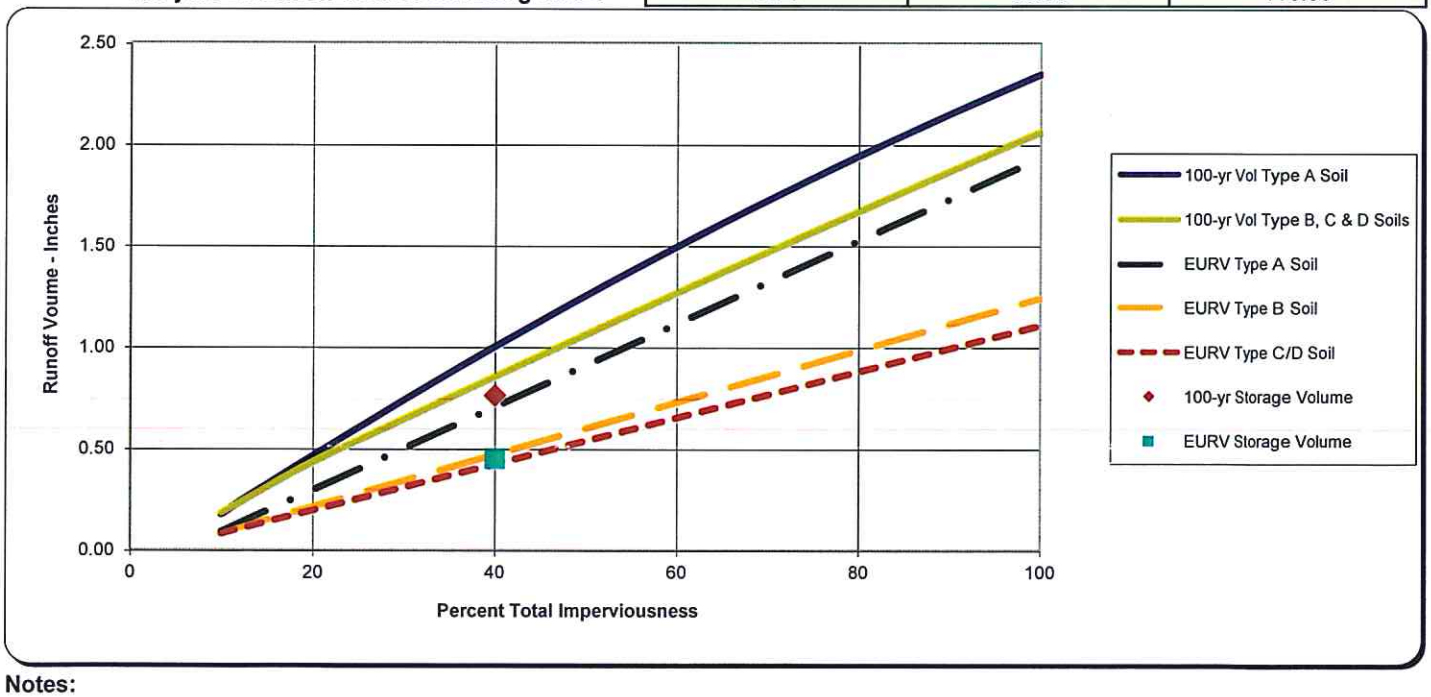
* User input data shown in blue.

Area of Watershed (acres)	490.00	
Subwatershed Imperviousness	40.0%	
Level of Minimizing Directly Connected Impervious Area (MDCIA)	1	1
Effective Imperviousness[1]	35.5%	

Hydrologic Soil Type	Percentage of Area	Area (acres)
Type A	0.0%	0.0
Type B	100.0%	490.0
Type C or D	0.0%	0.0

Recommended Horton's Equation Parameters for CUHP		
Infiltration (inches per hour)		Decay Coefficient--α
Initial--f_i	Final--fo	
4.5	0.6	0.0018

	Detention Volumes [2,5]		Maximum Allowable Release Rate, cfs[3]
	(watershed inches)	(acre-feet)	
Excess Urban Runoff Volume[4]	0.45	18.41	Design Oulet to Empty EURV in 72 Hours
100-year Detention Volume Including WQCV [5]	0.76	30.99	416.50



Notes:

1) Effective imperviousness is based on Figure ND-1 of the Urban Storm Drainage Criteria Manual (USDCM).

2) Results shown reflect runoff reduction from Level 1 or 2 MDCIA and are plotted at the watershed's total imperviousness value; the impact of MDCIA is reflected by the results being below the curves.

3) Maximum allowable release rates for 100-year event are based on Table SO-1. Outlet for the Excess Urban Runoff Volume (EURV) to be designed to empty out the EURV in 72 hours. Outlet design is similar to one for the WQCV outlet of an extended detention basin (i.e., perforated plate with a micro-pool) and extends to top of EURV water surface elevation.

4) EURV approximates the difference between developed and pre-developed runoff volume.

5) 100-yr detention volume includes EURV. No need to add more volume for WQCV or EURV

% Imp Check: Detention Basin G

Area check:

Per Det. G Design Report:

- Onsite 137 Acres
- Offsite 51.8 Acres

187 Ac.

w/ Det. H; some area was taken out of the area to Sb. to G.

Area Det. H per June 2018 MDDP: .0375 SM
= 23.7 Ac

Per Final Design: Area = 49.8 Ac
Net decrease to G = 26.1 Ac

∴ Total area draining to Det G = 187 - 26.1 = 160.9

Land uses per Revised ODP

B (2-3.5 DU/Ac) 54.8 CN = 75
1/4 Ac Ia = 38%

C 3.5-8 54.3 Ac CN = 85
1/8 Ac Ia = 65

Offsite 51.8 Ac CN = 61
(per June 2018 MDDP) Ia 20%

Def. Basin 6 Cont'd.

$$\text{Wtd \% Imp} = \frac{54.8(.38) + 54.3(.65) + 51.8(.20)}{160.9}$$

$$= 41.3\%$$

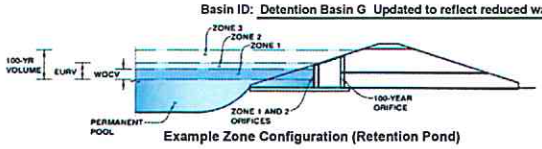
DET G AS-BUILT w/ REV AREA & VOL

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

UD-Detention, Version 3.07 (February 2017)

Project: Wolf Ranch Development Research Parkway Filing No. 5

Basin ID: Detention Basin G Updated to reflect reduced watershed area and revised ODP



Example Zone Configuration (Retention Pond)

Required Volume Calculation

Selected BMP Type =	EDB	
Watershed Area =	160.90	acres
Watershed Length =	5,150	ft
Watershed Slope =	0.027	ft/ft
Watershed Imperviousness =	41.30%	percent
Percentage Hydrologic Soil Group A =	0.0%	percent
Percentage Hydrologic Soil Group B =	100.0%	percent
Percentage Hydrologic Soil Groups C/D =	0.0%	percent
Desired WQCV Drain Time =	40.0	hours
Location for 1-hr Rainfall Depths =	User Input	
Water Quality Capture Volume (WQCV) =	2.457	acre-feet
Excess Urban Runoff Volume (EURV) =	6.996	acre-feet
2-yr Runoff Volume (P1 = 1.19 in.) =	5.535	acre-feet
5-yr Runoff Volume (P1 = 1.5 in.) =	7.678	acre-feet
10-yr Runoff Volume (P1 = 1.75 in.) =	10.827	acre-feet
25-yr Runoff Volume (P1 = 2 in.) =	16.096	acre-feet
50-yr Runoff Volume (P1 = 2.25 in.) =	19.659	acre-feet
100-yr Runoff Volume (P1 = 2.52 in.) =	24.327	acre-feet
500-yr Runoff Volume (P1 = 3.2 in.) =	34.429	acre-feet
Approximate 2-yr Detention Volume =	5.175	acre-feet
Approximate 5-yr Detention Volume =	7.208	acre-feet
Approximate 10-yr Detention Volume =	9.862	acre-feet
Approximate 25-yr Detention Volume =	10.988	acre-feet
Approximate 50-yr Detention Volume =	11.524	acre-feet
Approximate 100-yr Detention Volume =	13.155	acre-feet

Optional User Override 1-hr Precipitation	
1.19	inches
1.50	inches
1.75	inches
2.00	inches
2.25	inches
2.52	inches
3.20	inches

Stage-Storage Calculation

Depth Increment = ft

Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Top of Micropool	--	0.00	--	--	--	15	0.000		
	--	1.00	--	--	--	9,920	0.228	4,869	0.112
	--	2.00	--	--	--	33,140	0.761	26,167	0.601
	--	3.00	--	--	--	54,124	1.243	70,129	1.610
	--	4.00	--	--	--	58,500	1.343	126,441	2.903
	--	5.00	--	--	--	62,810	1.442	187,096	4.295
	--	6.00	--	--	--	67,218	1.543	252,110	5.788
	--	7.00	--	--	--	71,728	1.647	321,583	7.383
	--	8.00	--	--	--	76,338	1.752	395,616	9.082
	--	9.00	--	--	--	81,048	1.861	474,309	10.889
	--	10.00	--	--	--	85,859	1.971	557,763	12.804
	--	11.00	--	--	--	90,770	2.084	646,077	14.832
	--	12.00	--	--	--	95,782	2.199	739,353	16.973
	--	13.00	--	--	--	100,895	2.316	837,692	19.231
	--	14.00	--	--	--	106,108	2.436	941,193	21.607
	--	15.00	--	--	--	111,421	2.558	1,049,958	24.104
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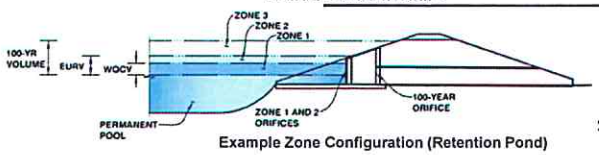
Detention Basin Outlet Structure Design

UD-Detention, Version 3.07 (February 2017)

Project: Wolf Ranch Development Research Parkway Filing No. 5

Basin ID: Detention Basin G



Example Zone Configuration (Retention Pond)

	Stage (ft)	Zone Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	3.67	2.457	Orifice Plate
Zone 2 (EURV)	6.77	4.539	Orifice Plate
Zone 3 (100-year)	10.18	6.159	Weir&Pipe (Restrict)
		13.155	Total

User Input: Orifice at Underdrain Outlet (typically used to drain WQCV in a Filtration BMP)

Underdrain Orifice Invert Depth =	N/A	ft (distance below the filtration media surface)
Underdrain Orifice Diameter =	N/A	inches

Calculated Parameters for Underdrain

Underdrain Orifice Area =	N/A	ft^2
Underdrain Orifice Centroid =	N/A	feet

User Input: Orifice Plate with one or more orifices or Elliptical Slot Weir (typically used to drain WQCV and/or EURV in a sedimentation BMP)

Invert of Lowest Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Orifice Plate =	5.68	ft (relative to basin bottom at Stage = 0 ft)
Orifice Plate: Orifice Vertical Spacing =	22.70	inches
Orifice Plate: Orifice Area per Row =	N/A	inches

Calculated Parameters for Plate

WQ Orifice Area per Row =	N/A	ft^2
Elliptical Half-Width =	N/A	feet
Elliptical Slot Centroid =	N/A	feet
Elliptical Slot Area =	N/A	ft^2

User Input: Stage and Total Area of Each Orifice Row (numbered from lowest to highest)

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.00	1.89	3.79					
Orifice Area (sq. inches)	9.61	9.61	9.62					

	Row 9 (optional)	Row 10 (optional)	Row 11 (optional)	Row 12 (optional)	Row 13 (optional)	Row 14 (optional)	Row 15 (optional)	Row 16 (optional)
Stage of Orifice Centroid (ft)								
Orifice Area (sq. inches)								

User Input: Vertical Orifice (Circular or Rectangular)

	Not Selected	Not Selected	
Invert of Vertical Orifice =	N/A	N/A	ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Vertical Orifice =	N/A	N/A	ft (relative to basin bottom at Stage = 0 ft)
Vertical Orifice Diameter =	N/A	N/A	inches

Calculated Parameters for Vertical Orifice

	Not Selected	Not Selected	
Vertical Orifice Area =	N/A	N/A	ft^2
Vertical Orifice Centroid =	N/A	N/A	feet

User Input: Overflow Weir (Dropbox) and Grate (Flat or Sloped)

	Zone 3 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	6.00	N/A	ft (relative to basin bottom at Stage = 0 ft)
Overflow Weir Front Edge Length =	6.50	N/A	feet
Overflow Weir Slope =	3.60	N/A	H:V (enter zero for flat grate)
Horiz. Length of Weir Sides =	5.00	N/A	feet
Overflow Grate Open Area % =	70%	N/A	%, grate open area/total area
Debris Clogging % =	50%	N/A	%

Calculated Parameters for Overflow Weir

	Zone 3 Weir	Not Selected	
Height of Grate Upper Edge, H_t =	7.39	N/A	feet
Over Flow Weir Slope Length =	5.19	N/A	feet
Grate Open Area / 100-yr Orifice Area =	7.52	N/A	should be ≥ 4
Overflow Grate Open Area w/o Debris =	23.61	N/A	ft^2
Overflow Grate Open Area w/ Debris =	11.81	N/A	ft^2

User Input: Outlet Pipe w/ Flow Restriction Plate (Circular Orifice, Restrictor Plate, or Rectangular Orifice)

	Zone 3 Restrictor	Not Selected	
Depth to Invert of Outlet Pipe =	4.08	N/A	ft (distance below basin bottom at Stage = 0 ft)
Outlet Pipe Diameter =	24.00	N/A	inches
Restrictor Plate Height Above Pipe Invert =	24.00		inches

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

	Zone 3 Restrictor	Not Selected	
Outlet Orifice Area =	3.14	N/A	ft^2
Outlet Orifice Centroid =	1.00	N/A	feet
Half-Central Angle of Restrictor Plate on Pipe =	3.14	N/A	radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=	15.00	ft (relative to basin bottom at Stage = 0 ft)
Spillway Crest Length =	40.00	feet
Spillway End Slopes =	10.00	H:V
Freeboard above Max Water Surface =	1.00	feet

Calculated Parameters for Spillway

Spillway Design Flow Depth=	0.84	feet
Stage at Top of Freeboard =	16.84	feet
Basin Area at Top of Freeboard =	2.56	acres

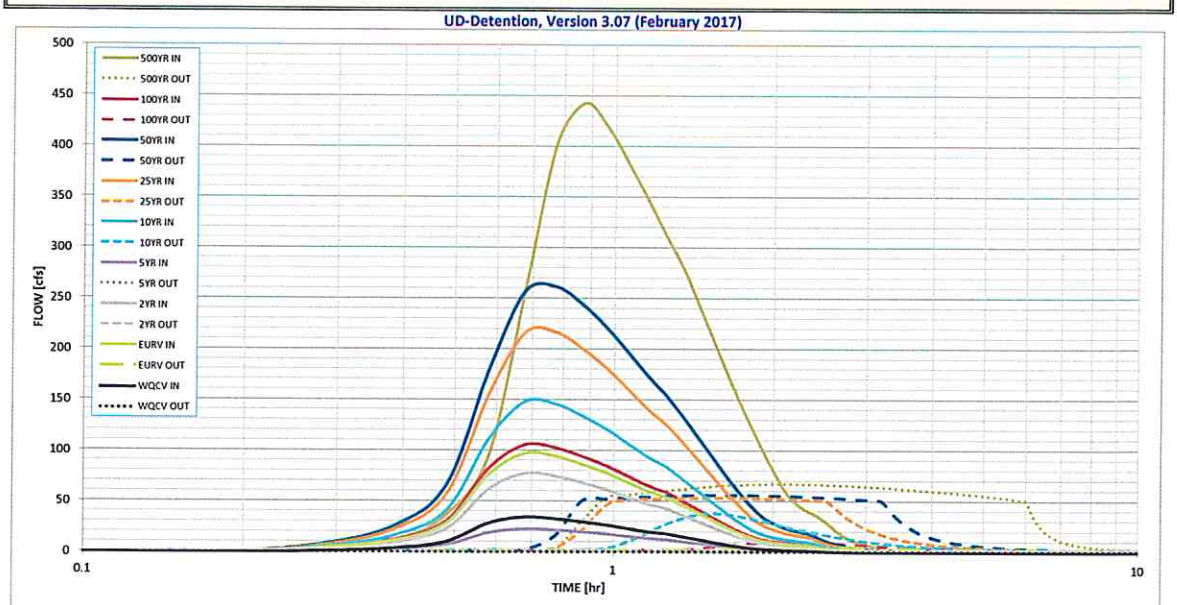
Routed Hydrograph Results

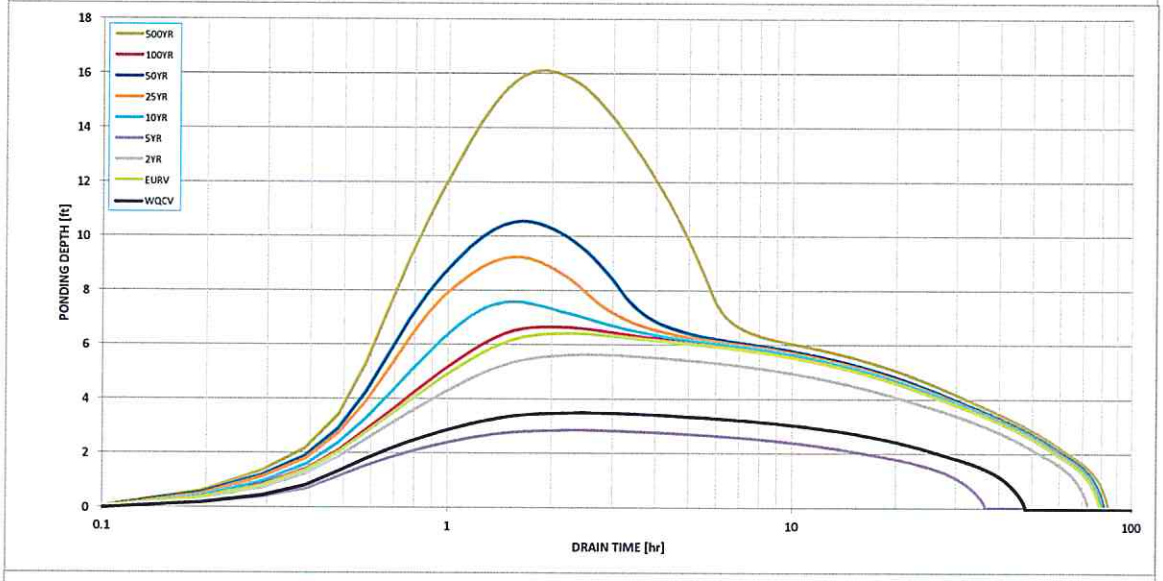
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	0.53	1.07	1.19	1.50	1.75	2.00	2.25	2.52	3.20
Calculated Runoff Volume (acre-ft) =	2.457	6.996	5.535	7.678	10.827	16.096	19.659	24.327	34.429
OPTIONAL Override Runoff Volume (acre-ft) =				1.560				7.640	
Inflow Hydrograph Volume (acre-ft) =	2.459	6.997	5.536	1.560	10.833	16.108	19.669	7.637	34.457
Predevelopment Unit Peak Flow, q (cfs/acre) =	0.00	0.00	0.01	0.02	0.16	0.55	0.77	1.04	1.57
Predevelopment Peak Q (cfs) =	0.0	0.0	1.6	2.8	25.9	88.8	123.1	166.9	252.3
Peak Inflow Q (cfs) =	34.6	96.4	76.7	22.1	147.3	216.2	261.0	105.0	442.5
Peak Outflow Q (cfs) =	1.0	5.4	1.8	0.9	37.6	53.1	55.8	9.2	66.8
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	0.3	1.5	0.6	0.5	0.1	0.3
Structure Controlling Flow =	Plate	Overflow Grate 1	Plate	Plate	Overflow Grate 1	Outlet Plate 1	Outlet Plate 1	Overflow Grate 1	#REF!
Max Velocity through Grate 1 (fps) =	N/A	0.14	N/A	N/A	1.5	2.1	2.2	0.3	2.6
Max Velocity through Grate 2 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours) =	44	70	65	34	67	63	61	70	56
* Time to Drain 99% of Inflow Volume (hours) =	46	75	69	35	75	73	73	75	71
Maximum Ponding Depth (ft) =	3.53	6.41	5.63	2.84	7.57	9.22	10.55	6.64	16.11
Area at Maximum Ponding Depth (acres) =	1.29	1.59	1.51	1.17	1.71	1.88	2.03	1.61	2.56
Maximum Volume Stored (acre-ft) =	2.270	6.429	5.224	1.417	8.338	11.301	13.885	6.796	24.104

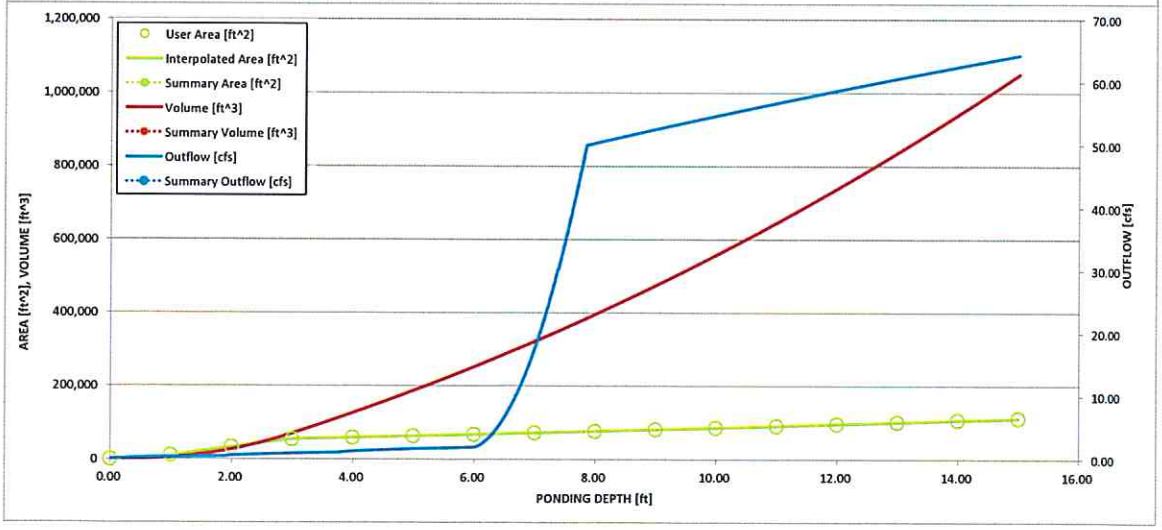
* Do revision to ex. perf. plate orifice.

Detention Basin Outlet Structure Design

UD-Detention, Version 3.07 (February 2017)







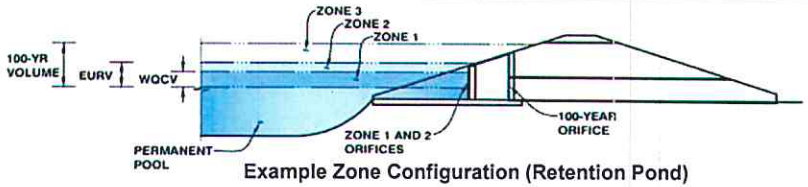
S-A-V-D Chart Axis Override	X-axis	Left Y-Axis	Right Y-Axis
minimum bound			
maximum bound			

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

UD-Detention, Version 3.07 (February 2017)

Project: Wolf Ranch Development Research Parkway Filing No. 5

Basin ID: Detention Basin H



Example Zone Configuration (Retention Pond)

Required Volume Calculation

Selected BMP Type =	EDB	
Watershed Area =	49.67	acres
Watershed Length =	1,500	ft
Watershed Slope =	0.030	ft/ft
Watershed Imperviousness =	62.00%	percent
Percentage Hydrologic Soil Group A =	0.0%	percent
Percentage Hydrologic Soil Group B =	100.0%	percent
Percentage Hydrologic Soil Groups C/D =	0.0%	percent
Desired WQCV Drain Time =	40.0	hours
Location for 1-hr Rainfall Depths =	User Input	
Water Quality Capture Volume (WQCV) =	1.006	acre-feet
Excess Urban Runoff Volume (EURV) =	3.349	acre-feet
2-yr Runoff Volume (P1 = 1.19 in.) =	2.759	acre-feet
5-yr Runoff Volume (P1 = 1.5 in.) =	3.703	acre-feet
10-yr Runoff Volume (P1 = 1.75 in.) =	4.800	acre-feet
25-yr Runoff Volume (P1 = 2 in.) =	6.264	acre-feet
50-yr Runoff Volume (P1 = 2.25 in.) =	7.318	acre-feet
100-yr Runoff Volume (P1 = 2.52 in.) =	8.702	acre-feet
500-yr Runoff Volume (P1 = 3.2 in.) =	11.813	acre-feet
Approximate 2-yr Detention Volume =	2.584	acre-feet
Approximate 5-yr Detention Volume =	3.479	acre-feet
Approximate 10-yr Detention Volume =	4.463	acre-feet
Approximate 25-yr Detention Volume =	4.819	acre-feet
Approximate 50-yr Detention Volume =	5.021	acre-feet
Approximate 100-yr Detention Volume =	5.459	acre-feet

Optional User Override 1-hr Precipitation	
1.19	inches
1.50	inches
1.75	inches
2.00	inches
2.25	inches
2.52	inches
3.20	inches

Depth Increment = ft

Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Top of Micropool	--	0.00	--	--	--	64	0.001		
	--	2.00				270	0.006	331	0.008
	--	4.00				17,038	0.391	17,642	0.405
	--	6.00				21,809	0.501	56,489	1.297
	--	8.00				26,697	0.613	104,995	2.410
	--	10.00				32,498	0.746	164,190	3.769
	--	12.00				38,582	0.886	235,270	5.401
	--	14.00	--	--	--	47,275	1.085	321,127	7.372
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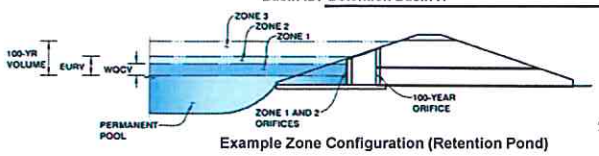
Detention Basin Outlet Structure Design

UD-Detention, Version 3.07 (February 2017)

Project: Wolf Ranch Development Research Parkway Filing No. 5

Basin ID: Detention Basin H



Example Zone Configuration (Retention Pond)

	Stage (ft)	Zone Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	5.40	1.006	Orifice Plate
Zone 2 (EURV)	9.43	2.343	Orifice Plate
Zone 3 (100-year)	12.07	2.110	Weir&Pipe (Restrict)
		5.459	Total

User Input: Orifice at Underdrain Outlet (typically used to drain WQCV in a Filtration BMP)

Underdrain Orifice Invert Depth =	N/A	ft (distance below the filtration media surface)
Underdrain Orifice Diameter =	N/A	inches

Calculated Parameters for Underdrain

Underdrain Orifice Area =	N/A	ft^2
Underdrain Orifice Centroid =	N/A	feet

User Input: Orifice Plate with one or more orifices or Elliptical Slot Weir (typically used to drain WQCV and/or EURV in a sedimentation BMP)

Invert of Lowest Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Orifice Plate =	8.27	ft (relative to basin bottom at Stage = 0 ft)
Orifice Plate: Orifice Vertical Spacing =	33.10	inches
Orifice Plate: Orifice Area per Row =	N/A	inches

Calculated Parameters for Plate

WQ Orifice Area per Row =	N/A	ft^2
Elliptical Half-Width =	N/A	feet
Elliptical Slot Centroid =	N/A	feet
Elliptical Slot Area =	N/A	ft^2

User Input: Stage and Total Area of Each Orifice Row (numbered from lowest to highest)

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.00	2.76	5.51					
Orifice Area (sq. inches)	3.00	3.25	9.62					

	Row 9 (optional)	Row 10 (optional)	Row 11 (optional)	Row 12 (optional)	Row 13 (optional)	Row 14 (optional)	Row 15 (optional)	Row 16 (optional)
Stage of Orifice Centroid (ft)								
Orifice Area (sq. inches)								

User Input: Vertical Orifice (Circular or Rectangular)

	Not Selected	Not Selected	
Invert of Vertical Orifice =	N/A	N/A	ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Vertical Orifice =	N/A	N/A	ft (relative to basin bottom at Stage = 0 ft)
Vertical Orifice Diameter =	N/A	N/A	inches

Calculated Parameters for Vertical Orifice

	Not Selected	Not Selected	
Vertical Orifice Area =	N/A	N/A	ft^2
Vertical Orifice Centroid =	N/A	N/A	feet

User Input: Overflow Weir (Dropbox) and Grate (Flat or Sloped)

	Zone 3 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	9.26	N/A	ft (relative to basin bottom at Stage = 0 ft)
Overflow Weir Front Edge Length =	8.00	N/A	feet
Overflow Weir Slope =	4.00	N/A	H:V (enter zero for flat grate)
Horiz. Length of Weir Sides =	4.50	N/A	feet
Overflow Grate Open Area % =	70%	N/A	%, grate open area/total area
Debris Clogging % =	50%	N/A	%

Calculated Parameters for Overflow Weir

	Zone 3 Weir	Not Selected	
Height of Grate Upper Edge, H_t =	10.39	N/A	feet
Over Flow Weir Slope Length =	4.64	N/A	feet
Grate Open Area / 100-yr Orifice Area =	5.44	N/A	should be ≥ 4
Overflow Grate Open Area w/o Debris =	25.98	N/A	ft^2
Overflow Grate Open Area w/ Debris =	12.99	N/A	ft^2

User Input: Outlet Pipe w/ Flow Restriction Plate (Circular Orifice, Restrictor Plate, or Rectangular Orifice)

	Zone 3 Restrictor	Not Selected	
Depth to Invert of Outlet Pipe =	0.50	N/A	ft (distance below basin bottom at Stage = 0 ft)
Outlet Pipe Diameter =	30.00	N/A	inches
Restrictor Plate Height Above Pipe Invert =	28.10		inches

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

	Zone 3 Restrictor	Not Selected	
Outlet Orifice Area =	4.78	N/A	ft^2
Outlet Orifice Centroid =	1.22	N/A	feet
Half-Central Angle of Restrictor Plate on Pipe =	2.63	N/A	radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=	12.03	ft (relative to basin bottom at Stage = 0 ft)
Spillway Crest Length =	59.00	feet
Spillway End Slopes =	4.00	H:V
Freeboard above Max Water Surface =	1.00	feet

Calculated Parameters for Spillway

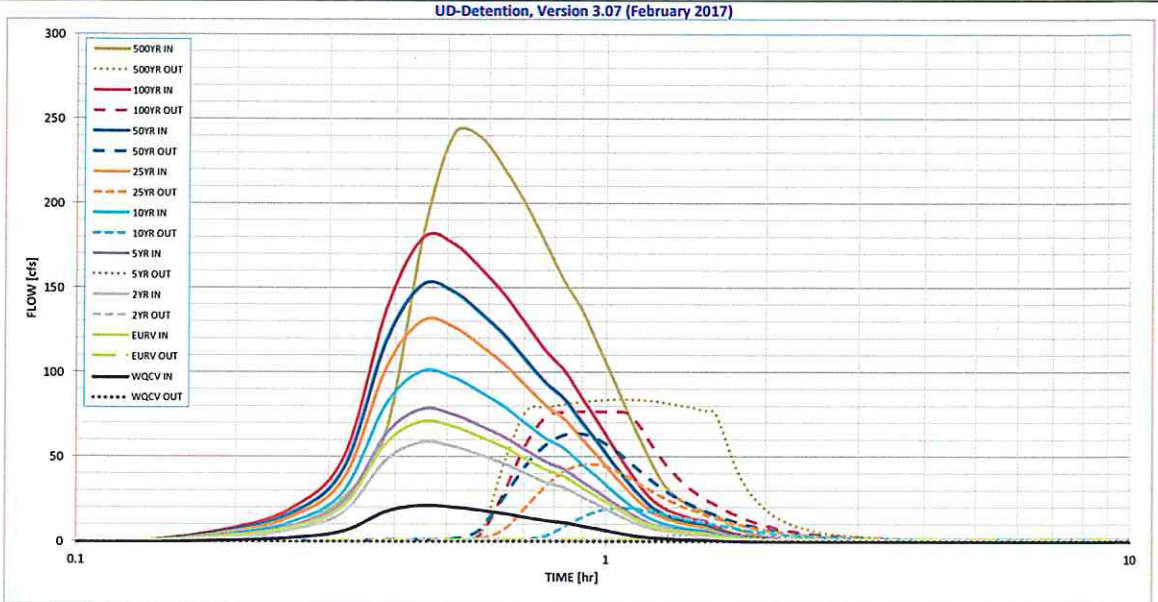
Spillway Design Flow Depth=	0.96	feet
Stage at Top of Freeboard =	13.99	feet
Basin Area at Top of Freeboard =	1.08	acres

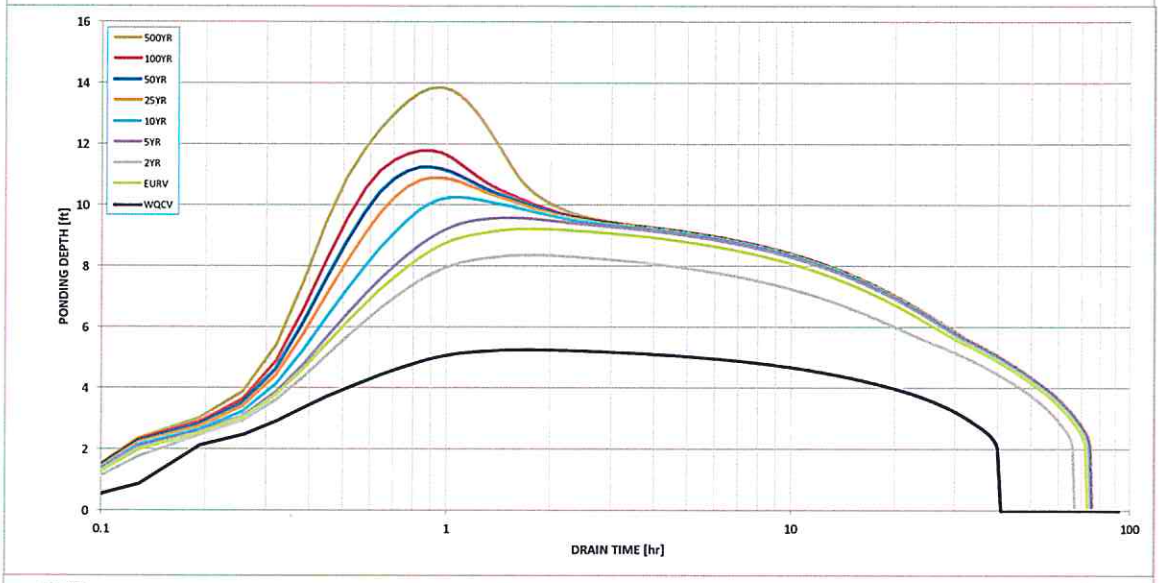
Routed Hydrograph Results

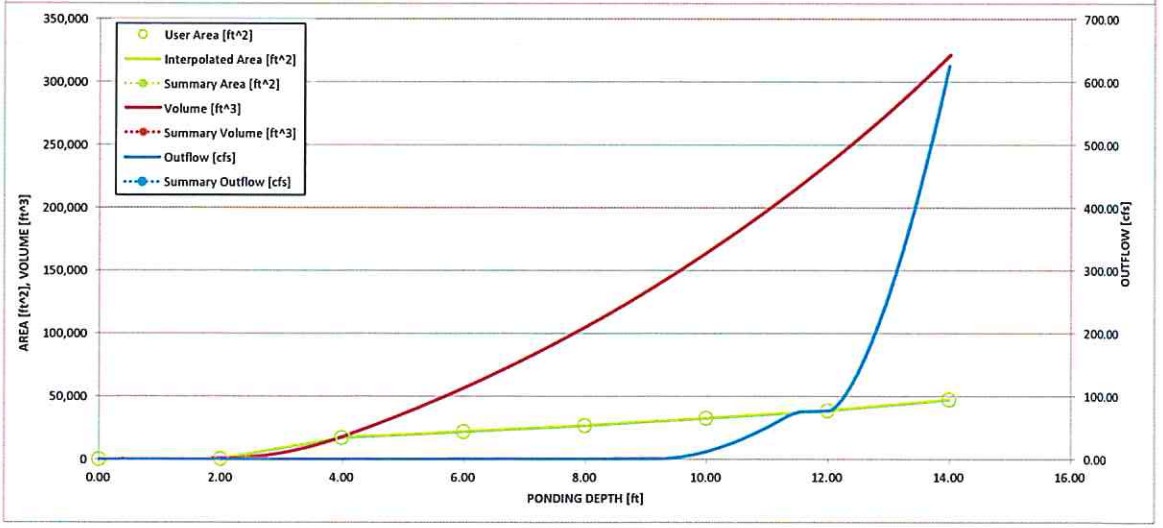
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	0.53	1.07	1.19	1.50	1.75	2.00	2.25	2.52	3.20
Calculated Runoff Volume (acre-ft) =	1.006	3.349	2.759	3.703	4.800	6.264	7.318	8.702	11.813
OPTIONAL Override Runoff Volume (acre-ft) =									
Inflow Hydrograph Volume (acre-ft) =	1.005	3.345	2.755	3.698	4.795	6.256	7.303	8.687	11.794
Predevelopment Unit Peak Flow, q (cfs/acre) =	0.00	0.00	0.02	0.03	0.29	0.91	1.26	1.67	2.50
Predevelopment Peak Q (cfs) =	0.0	0.0	0.8	1.4	14.5	45.2	62.4	82.9	124.1
Peak Inflow Q (cfs) =	21.6	70.7	58.4	78.0	100.6	130.4	151.7	179.5	241.3
Peak Outflow Q (cfs) =	0.4	1.2	1.1	3.9	19.7	45.0	63.4	76.5	83.7
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	2.7	1.4	1.0	1.0	0.9	0.7
Structure Controlling Flow =	Plate	Plate	Plate	Overflow Grate 1	Overflow Grate 1	Overflow Grate 1	Overflow Grate 1	Outlet Plate 1	Spillway
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	0.1	0.7	1.7	2.4	2.9	3.1
Max Velocity through Grate 2 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours) =	38	66	61	67	65	63	62	60	57
Time to Drain 99% of Inflow Volume (hours) =	40	70	65	71	71	70	69	69	67
Maximum Ponding Depth (ft) =	5.29	9.22	8.35	9.57	10.25	10.88	11.24	11.77	13.84
Area at Maximum Ponding Depth (acres) =	0.46	0.69	0.64	0.72	0.76	0.81	0.83	0.87	1.07
Maximum Volume Stored (acre-ft) =	0.951	3.201	2.629	3.455	3.958	4.445	4.748	5.199	7.200

Detention Basin Outlet Structure Design

UD-Detention, Version 3.07 (February 2017)







S-A-V-D Chart Axis Override	X-axis	Left Y-Axis	Right Y-Axis
minimum bound			
maximum bound			