REVISED Hydrology Report – SHL Cathiard LLC

Includes: WinTR55 Modeling
March 1, 2021

BACKGROUND
The project site is located at 1889 West Zinfandel Lane, CA (APN 027-100-037), in the foothills on the west side of Napa Valley. Watersheds for the project area are defined as follows:

- Watershed 1: 60.6 acres comprised of Woods, Woods-Grass Combo, Rangeland, existing vineyard, and a pond (TABLE 3). This watershed contains new development Blocks M and O. There is a cut-of swale on the west side of the access road that diverts the majority of run-on water to the northern watershed boundary. A flow-line was defined that analyzed an existing swale and existing culvert and discharges to the east and flows north. The existing culvert is a 10" smooth walled pipe, non-metallic, and assumed to be asbestos. Both boundaries of the watershed converge at the outlet, which is an unnamed tributary to the Napa River.
    - SubWatershed 1 was included to analyze anticipated maximum inlet flows to the existing culvert and to size new and replacement culvert (TABLE 4).

Soil types encountered in the watersheds include the following:

- (166) Montara clay loam, 5-30% slopes, HSG=D
- (110) Boomer-Forward-Felta complex, 30-50% slopes, HSG=D
- (161) Maxwell clay, 2-9% slopes, HSG=D
- (171) Pleasanton loam, 2-5% slopes, HSG=C
- (139) Forward silt loam, 12-57% slopes, HSG=C
- (140) Forward silt loam, 30-75% slopes, HSG=C
- (183) Water

Soil types that are rated C Hydrologic Soil Group (HSG) are fringe areas that will not be altered during development. For simplicity in modeling (and a conservative measure), all areas of the watersheds were assumed to be rated D HSG.

METHODOLOGY

This approach of this hydrology analysis is summarized below; it was designed to address a few different objectives and areas of interest. Please refer to Pre- and Post-Development TR55 maps for watershed definitions and flowline locations.

1. The pre- and post-development cover types were mapped and analyzed as a Cn comparison to evaluate the overall change in cover within Watershed #1 (TABLE 3). This Cn analysis is sufficient to show no change in peak discharge in areas where no drainage changes are proposed, such as the northern portion of the watershed and Block M.
2. Two different flow lines were defined within Watershed #1 where drainage changes are proposed
   a. The first was defined to analyze impact of culvert installations across Block O. In this case, segment lengths and slopes remain constant and properties for Segments 3a and 3b were changed to reflect culvert upgrades (see TABLE 5 and TABLE 6). Segments were defined as follows:

TABLE 1 *(Pre and Post) Culvert Analysis Flowlines*

	PRE				POST		
#	Segment	Length	Slope	#	Segment	Length	Slope
1	Sheet Flow	100	21	1	Sheet Flow	100	21
2	Shallow Concentrated	393	19	2	Shallow Concentrated	393	19
3a	Concentrated (swale)	248	18	3a	Concentrated (12" pipe)	248	18
3b	Concentrated (10" pipe)	264	9	3b	Concentrated (18" pipe)	264	9
4	Concentrated (channel)	2136	6	4	Concentrated (channel)	2136	6
	Total Length	**3141**			**Total Length**	**3141**	

   b. The second flowline was defined across the landslide repair area to assess the impact of a proposed diversion ditch at the top of Block O. In this case, the post-development flowlines are longer to divert flow away from the landslide repair area, but water ultimately ends up in the same reach. Segments were defined as follows and a new ID# was assigned to each new segment geometry:

TABLE 2 *(Pre and Post) Ditch Analysis Flowlines*

	PRE		
#	Segment	Length	Slope
5	Sheet Flow	100	22
6	Shallow Concentrated	759	15
7	Concentrated (channel)	2025	7
	Total Length	**2884**	

	POST		
#	Segment	Length	Slope
5	Sheet Flow	100	22
8	Shallow Concentrated	41	25
9	Concentrated (ditch + woods)	483	19
10	Concentrated (channel)	2481	7
	Total Length	**3105**	

3. Finally, Subwatershed #1 was defined to analyze the run-off volumes that may be entering the new proposed culverts described in Bullet 2.a, above. The area of post-construction Subwatershed #1 is reduced due to the installation of the diversion ditch described in Bullet 2.b, above. In this case, the total area of the subwatershed is reduced by 0.27 acres, but there is no change in weighted Cn (TABLE 4).

WinTR55 Land Use designations for each watershed were defined as follows.

TABLE 3 *(PRE + POST) Cover Type for Watershed #1*

Watershed #1			
Landuse	PRE (acres)	POST (acres)	Cn
Impervious (Pond)	2.13	2.13	98
Existing Vineyard (fair)	16.03	16.03	84
New Vineyard (good)	-	13.1	80
Rangeland (fair)	7.19	-	84
Wood/Grass Combo (fair)	4.23	0.8	82
Woods (good)	26.98	22.57	77
Farmstead	4.03	5.96	86
Total acres	**60.59**	**60.59**	
Weighted Cn	**81**	**81**	

TABLE 4 *(PRE + POST) Cover Type for SubWatershed #1*

SubWatershed #1			
Landuse	PRE (acres)	POST (acres)	Cn
Existing Vineyard (fair)	0.52	0.52	84
New Vineyard (good)	-	1.89	80
Rangeland (fair)	1.36	-	84
Woods-Grass Combo (fair)	0.02	-	82
Woods (good)	1.27	0.31	77
Farmstead	0.14	0.32	86
Total acres	**3.31**	**3.04**	
Weighted Cn	**81**	**81**	

Due to limitations in the number of concentrated flow segments that can be input to WinTR55, Segments 3.a and 3.b were consolidated for Pre-development (TABLE 5) and Post-Development (TABLE 6) conditions. Furthermore, it was discovered while revising this hydrology report that a 12" and 18" corrugated culvert is adequate to handle predicted storm flows while still reducing the post-development time of concentration (the original submission specified a 18" and 24" culvert, respectively).

TABLE 5 *PRE-Development assumptions for Segments 3a + 3b (Culvert Analysis)*

Watershed 1: Segments 3.a and 3.b Existing Conditions Flow Velocity							
Channel	d (in)	Length (ft)	slope	n	A (ft^2)	WP (ft)	Velocity (ft/s)
(3.a) Swale	-	248	18%	0.040	2.00	3.83	10
(3.b) Smooth Asbestos Pipe	10	264	9%	0.011	0.44	1.75	16.1
	Total Length	**512**				**weighted ave**	**13.1**

TABLE 6 *POST-Development assumptions for Segments 3a + 3b (Culvert Analysis)*

Watershed 1: Segments 3.a and 3.b Post-Development Flow Velocity							
Channel	d (in)	Length (ft)	slope	n	A (ft^2)	WP (ft)	Velocity (ft/s)
(3.a) Corrugated PE	12	248	18%	0.025	0.63	2.09	11.3
(3.b) Corrugated PE	18	264	9%	0.025	1.42	3.14	10.5
	Total Length	**512**				**weighted ave**	**10.9**

TABLE 7 *POST-Development assumptions for Segment 9 (Ditch Analysis)*

Watershed 1: Segment 9, Concentrated Flow Post-Development Flow Velocity						
Channel	Length (ft)	slope	n	A (ft^2)	WP (ft)	Velocity (ft/s)
Upper Section (Ditch)	83	5%	0.03	1.90	4.40	6.3
Lower Section (Woods)	400	22%	0.05	3.00	7.20	7.8
	483				**weighted ave**	**7.5**

"POST" conditions in the new vineyard areas will establish at least 80% cover crop in all vineyard blocks, which qualifies as "good" hydrologic condition per the NRCS Engineering Fieldbook. In addition, the 10" asbestos culvert will be upgraded to an 18" corrugated PE pipe and the inlet swale will be upgraded to a 12" corrugated PE pipe. The outlet of the lower culvert will be improved to a pipe level spreader. Although the level spreader will further reduce flow velocities and disperse concentrated flow, it was not included in the hydrology analysis.

RESULTS

Run-off potential in Watershed 1 from the Culvert Analysis flowline will decrease due to the drainage upgrades (TABLE 7):

TABLE 8 *(Pre + Post) Peak Flow for Culvert Analysis Flowline*

	Peak Flow (cfs)			
	2-yr	10-yr	50-yr	100-yr
Watershed - 1 (Existing)	21.25	36.95	53.48	60.50
Watershed - 1 (Future)	21.19	33.32	48.27	54.65

TABLE 9 *(Pre + Post) Peak Flow for Ditch Analysis Flowline*

	Peak Flow (cfs)			
	2-yr	10-yr	50-yr	100-yr
Watershed - 1 (Existing)	19.16	33.38	48.36	54.71
Watershed - 1 (Future)	19.13	33.32	48.27	54.65

Maximum peak flow to the culvert was calculated using SubWatershed 1 at the inlet to Segment 3.b (TABLE 8), which would be a conservatively high estimate for the inlet to culvert at Segment 3.a (see attached watershed map for segment locations). It is a small sub-watershed (3.3 acres) and there was no difference in existing versus post-development results, because the weighted Cn is the same and Tc was less than 0.1 and defaulted to their minimum value (0.1) for both cases.

TABLE 10

	Peak Flow (cfs)		
	10-yr	25-yr	100-yr
SubWatershed - 1 (culvert)	2.16	2.71	3.53

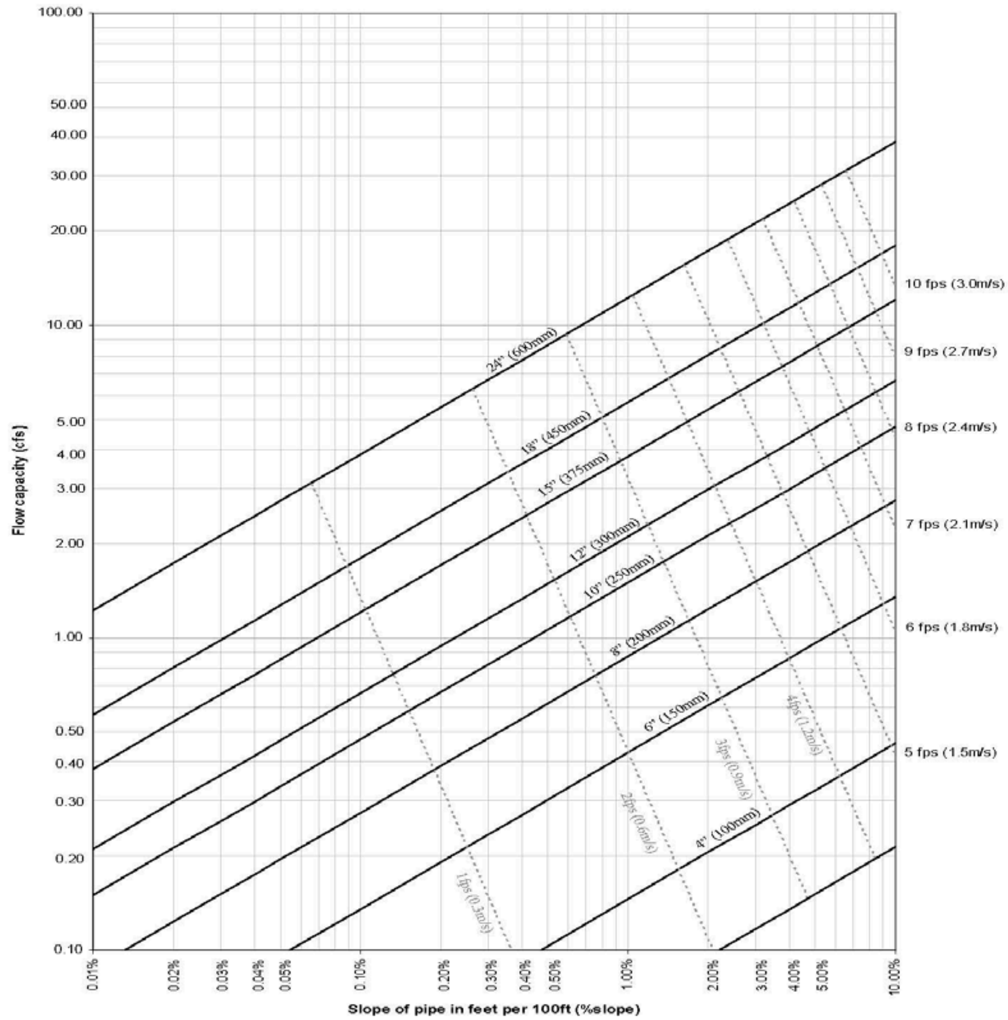
Figure 1 illustrates that the proposed culvert sizes (12 in and 18 in) are adequate to handle modeled peak flows.

ATTACHMENTS

Figure 1: Pipe Discharge Capacity
Land Cover Map – Existing
Land Cover Map – Future
WinTR55 Results – Watershed 1: Existing (Culvert Analysis Flowline)
WinTR55 Results – Watershed 1: Future (Culvert Analysis Flowline)
WinTR55 Results – Watershed 1: Existing (Ditch Analysis Flowline)
WinTR55 Results – Watershed 1: Future (Ditch Analysis Flowline)
WinTR55 Results – SubWatershed 1: Existing
WinTR55 Results – SubWatershed 1: Future

ADS, Inc. Drainage Handbook *Hydraulics ◆ 3-6*

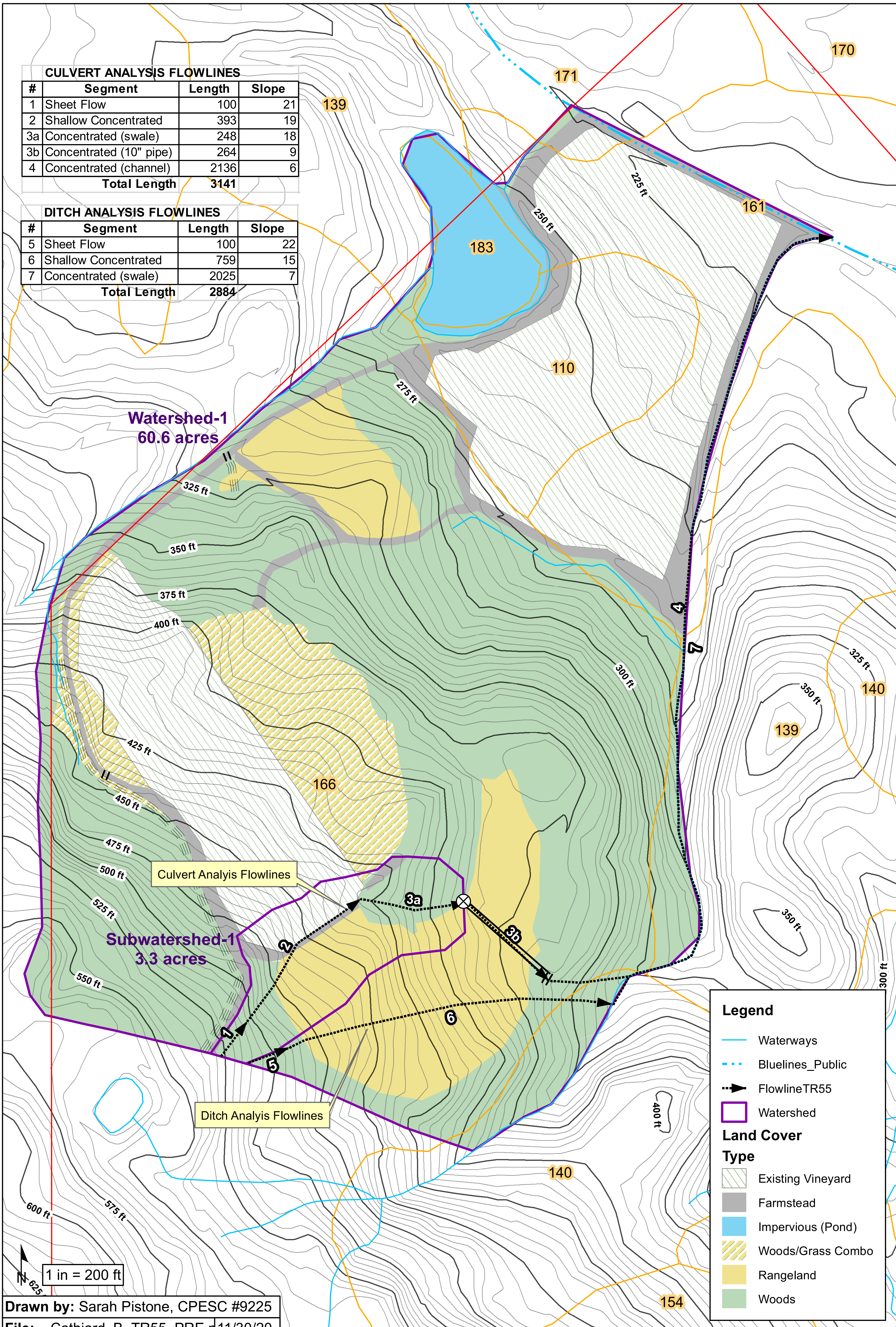
Figure 3-2
Discharge Rates for ADS Single Wall Heavy Duty and Highway Pipe



1cfs = 0.02832 m^3/s
1ft/s = 0.30480 m/s
1% = 0.01 ft/ft

Note: Based on a design Manning's "n" described in Table 3-1 for respective diameter.
Pipe may not be available in all diameters shown.
Solid lines indicate pipe diameters. Dashed lines indicate approximate average velocity.

Figure 1 From ADS. Inc. Drainage Handbook, July 2014



CULVERT ANALYSIS FLOWLINES

#	Segment	Length	Slope
1	Sheet Flow	100	21
2	Shallow Concentrated	393	19
3a	Concentrated (swale)	248	18
3b	Concentrated (10" pipe)	264	9
4	Concentrated (channel)	2136	6
	Total Length	**3141**	

DITCH ANALYSIS FLOWLINES

#	Segment	Length	Slope
5	Sheet Flow	100	22
6	Shallow Concentrated	759	15
7	Concentrated (swale)	2025	7
	Total Length	**2884**	

Drawn by: Sarah Pistone, CPESC #9225

File: ...Cathiard_B_TR55_PRE.r 11/30/20

LincolnAE LLC
Agricultural Engineering

If bar does not measure 1 in then map is not to scale.

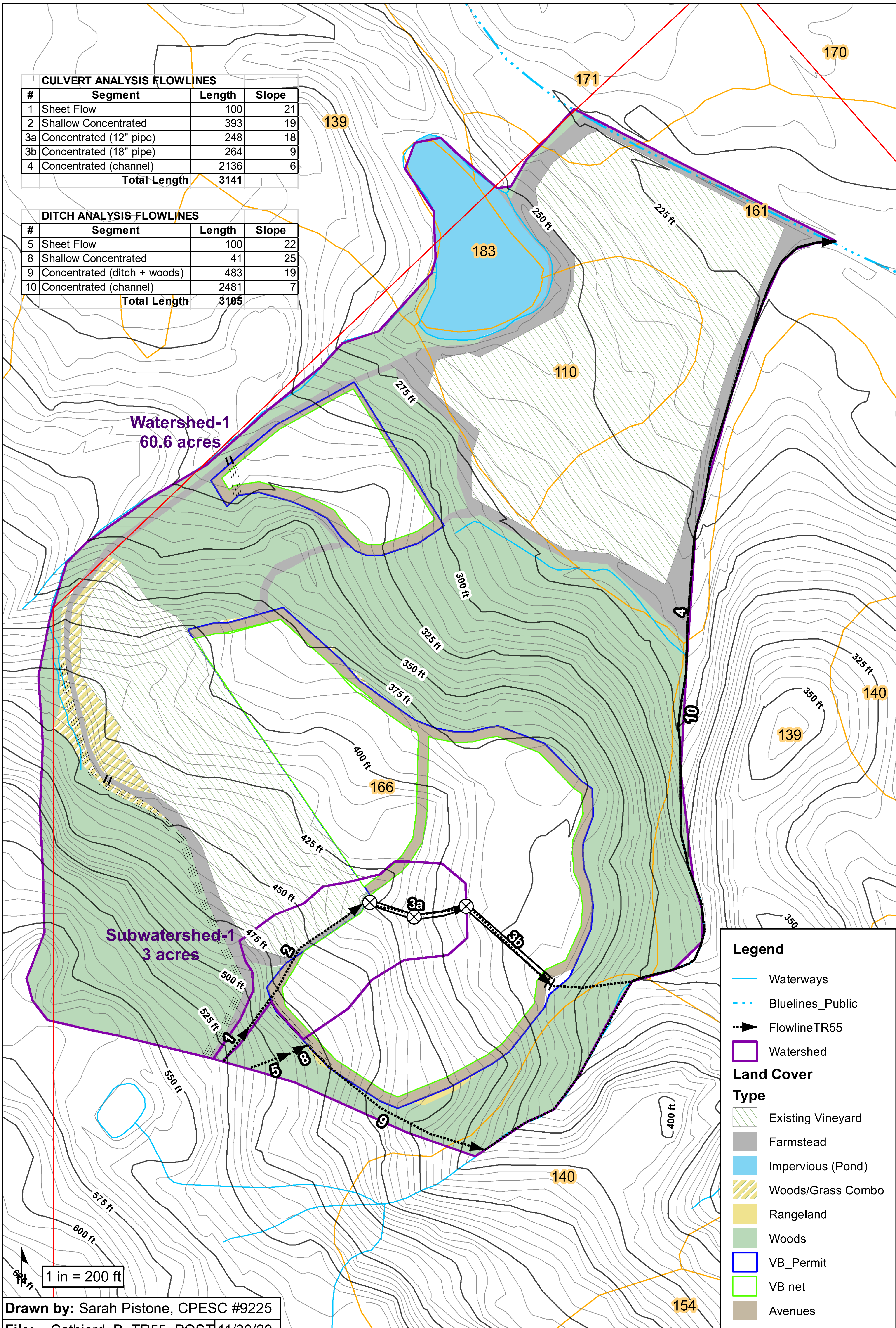
Cathiard: TR-55 Map
Existing Conditions
1889 W Zinfandel Lane, St Helena, CA

CULVERT ANALYSIS FLOWLINES

#	Segment	Length	Slope
1	Sheet Flow	100	21
2	Shallow Concentrated	393	19
3a	Concentrated (12" pipe)	248	18
3b	Concentrated (18" pipe)	264	9
4	Concentrated (channel)	2136	6
	Total Length	3141	

DITCH ANALYSIS FLOWLINES

#	Segment	Length	Slope
5	Sheet Flow	100	22
8	Shallow Concentrated	41	25
9	Concentrated (ditch + woods)	483	19
10	Concentrated (channel)	2481	7
	Total Length	3105	



Legend

- Waterways
- Bluelines_Public
- FlowlineTR55
- Watershed

Land Cover Type

- Existing Vineyard
- Farmstead
- Impervious (Pond)
- Woods/Grass Combo
- Rangeland
- Woods
- VB_Permit
- VB net
- Avenues

Drawn by: Sarah Pistone, CPESC #9225

File: ...Cathiard_B_TR55_POST 11/30/20

LincolnAE LLC
Agricultural Engineering

If bar does not measure 1 in then map is not to scale.

Cathiard: TR-55 Map
Future Conditions
1889 W Zinfandel Lane, St Helena, CA

WinTR-55 Current Data Description

--- Identification Data ---

User: SPistone CULVERT ANALYSIS Date: 11/30/20
Project: CATHIARD Units: English
SubTitle: Watershed 1 - PRE Areal Units: Acres
State: California
County: Napa
Filename: C:\Users\Sarah\OneDrive - LincolnAE\AE Clients\Chateau Smith-Haute-Lafitte\ECP_2019 (T1)\Watersh

--- Sub-Area Data ---

Name	Description	Reach	Area(ac)	RCN	Tc
Watershed1	Watershed	Outlet	60.59	81	.177

Total area: 60.59 (ac)

--- Storm Data --

Rainfall Depth by Rainfall Return Period

2-Yr (in)	5-Yr (in)	10-Yr (in)	25-Yr (in)	50-Yr (in)	100-Yr (in)	-Yr (in)
3.98	4.98	5.78	6.85	7.64	8.43	.0

Storm Data Source: User-provided custom storm data
Rainfall Distribution Type: Type CA-1
Dimensionless Unit Hydrograph: <standard>

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SPistone CATHIARD
Watershed 1 - PRE
Napa County, California

Watershed Peak Table

Sub-Area or Reach Identifier	Peak Flow by Rainfall Return Period 2-Yr (cfs)	10-Yr (cfs)	50-Yr (cfs)	100-Yr (cfs)
SUBAREAS				
Watershed1	21.25	36.95	53.48	60.50
REACHES				
OUTLET	21.25	36.95	53.48	60.50

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Napa County, California

Sub-Area Summary Table

Sub-Area Identifier	Drainage Area (ac)	Time of Concentration (hr)	Curve Number	Receiving Reach	Sub-Area Description
Watershed1	60.59	0.177	81	Outlet	Watershed

Total Area: 60.59 (ac)

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SPistone CATHIARD

Watershed 1 - PRE

Napa County, California

Sub-Area Time of Concentration Details

	Sub-Area Identifier/	Flow Length (ft)	Slope (ft/ft)	Mannings's n	End Area (sq ft)	Wetted Perimeter (ft)	Velocity (ft/sec)	Travel Time (hr)
	Watershed1							
	SHEET	100	0.2100	0.150				0.057
	SHALLOW	393	0.1900	0.050				0.016
Table 5 -->	CHANNEL	512					13.100	0.011
	CHANNEL	2136	0.0600	0.040	3.50	6.00	6.380	0.093
							Time of Concentration	.177

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SPistone CATHIARD

Watershed 1 - PRE

Napa County, California

Sub-Area Land Use and Curve Number Details

Sub-Area Identifier	Land Use		Hydrologic Soil Group	Sub-Area Area (ac)	Curve Number
Watershed1	Paved parking lots, roofs, driveways		D	2.13	98
	User defined urban (Click button or		D	16.03	84
	Pasture, grassland or range	(fair)	D	7.19	84
	Woods - grass combination	(fair)	D	4.23	82
	Woods	(good)	D	26.98	77
	Farmsteads		D	4.03	86
	Total Area / Weighted Curve Number			60.59	81

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WinTR-55 Current Data Description

--- Identification Data ---

User: SPistone CULVERT ANALYSIS Date: 3/1/21
Project: CATHIARD Units: English
SubTitle: Watershed 1 - POST Areal Units: Acres
State: California
County: Napa
Filename: C:\Users\Sarah\OneDrive - LincolnAE\AE Clients\Chateau Smith-Haute-Lafitte\ECP_2019 (T1)\Watersh

--- Sub-Area Data ---

Name	Description	Reach	Area(ac)	RCN	Tc
Watershed1	Watershed	Outlet	60.59	81	.179

Total area: 60.59 (ac)

--- Storm Data --

Rainfall Depth by Rainfall Return Period

2-Yr (in)	5-Yr (in)	10-Yr (in)	25-Yr (in)	50-Yr (in)	100-Yr (in)	-Yr (in)
3.98	4.98	5.78	6.85	7.64	8.43	.0

Storm Data Source: User-provided custom storm data
Rainfall Distribution Type: Type CA-1
Dimensionless Unit Hydrograph: <standard>

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SPistone CATHIARD
Watershed 1 - POST
Napa County, California

Watershed Peak Table

Sub-Area or Reach Identifier	Peak Flow by Rainfall Return Period 2-Yr (cfs)	10-Yr (cfs)	50-Yr (cfs)	100-Yr (cfs)
SUBAREAS				
Watershed1	21.19	36.89	53.39	60.43
REACHES				
OUTLET	21.19	36.89	53.39	60.43

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Napa County, California

Sub-Area Summary Table

Sub-Area Identifier	Drainage Area (ac)	Time of Concentration (hr)	Curve Number	Receiving Reach	Sub-Area Description
Watershed1	60.59	0.179	81	Outlet	Watershed

Total Area: 60.59 (ac)

SPistone

CATHIARD
Watershed 1 - POST
Napa County, California

Sub-Area Time of Concentration Details

Sub-Area Identifier/	Flow Length (ft)	Slope (ft/ft)	Mannings's n	End Area (sq ft)	Wetted Perimeter (ft)	Velocity (ft/sec)	Travel Time (hr)
Watershed1							
SHEET	100	0.2100	0.150				0.057
SHALLOW	393	0.1900	0.050				0.016
Table 6 --> CHANNEL	512					10.900	0.013
CHANNEL	2136	0.0600	0.040	3.50	6.00	6.380	0.093
						Time of Concentration	.179

SPistone

CATHIARD
Watershed 1 - POST
Napa County, California

Sub-Area Land Use and Curve Number Details

Sub-Area Identifier	Land Use		Hydrologic Soil Group	Sub-Area Area (ac)	Curve Number
Watershed1	Paved parking lots, roofs, driveways		D	2.13	98
	Pasture, grassland or range	(fair)	D	16.03	84
	Pasture, grassland or range	(good)	D	13.1	80
	Woods - grass combination	(fair)	D	.8	82
	Woods	(good)	D	22.57	77
	Farmsteads		D	5.96	86
	Total Area / Weighted Curve Number			60.59	81

WinTR-55 Current Data Description

--- Identification Data ---

User: SPistone DITCH ANALYSIS Date: 11/30/20
Project: CATHIARD Units: English
SubTitle: Watershed 1 - PRE Areal Units: Acres
State: California
County: Napa
Filename: C:\Users\Sarah\OneDrive - LincolnAE\AE Clients\Chateau Smith-Haute-Lafitte\ECP_2019 (T1)\Watersh

--- Sub-Area Data ---

Name	Description	Reach	Area(ac)	RCN	Tc
Watershed1	Watershed	Outlet	60.59	81	.33

Total area: 60.59 (ac)

--- Storm Data --

Rainfall Depth by Rainfall Return Period

2-Yr (in)	5-Yr (in)	10-Yr (in)	25-Yr (in)	50-Yr (in)	100-Yr (in)	-Yr (in)
3.98	4.98	5.78	6.85	7.64	8.43	.0

Storm Data Source: User-provided custom storm data
Rainfall Distribution Type: Type CA-1
Dimensionless Unit Hydrograph: <standard>

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SPistone CATHIARD
Watershed 1 - PRE
Napa County, California

Watershed Peak Table

Sub-Area or Reach Identifier	Peak Flow by Rainfall Return Period 2-Yr (cfs)	10-Yr (cfs)	50-Yr (cfs)	100-Yr (cfs)
SUBAREAS				
Watershed1	19.16	33.38	48.36	54.71
REACHES				
OUTLET	19.16	33.38	48.36	54.71

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Napa County, California

Sub-Area Summary Table

Sub-Area Identifier	Drainage Area (ac)	Time of Concentration (hr)	Curve Number	Receiving Reach	Sub-Area Description
Watershed1	60.59	0.330	81	Outlet	Watershed

Total Area: 60.59 (ac)

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SPistone CATHIARD

Watershed 1 - PRE

Napa County, California

Sub-Area Time of Concentration Details

Sub-Area Identifier/	Flow Length (ft)	Slope (ft/ft)	Mannings's n	End Area (sq ft)	Wetted Perimeter (ft)	Velocity (ft/sec)	Travel Time (hr)
Watershed1							
SHEET	100	0.2200	0.800				0.214
SHALLOW	759	0.1500	0.050				0.034
CHANNEL	2025	0.0700	0.040	3.50	6.00	6.860	0.082
					Time of Concentration		.33
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SPistone CATHIARD

Watershed 1 - PRE

Napa County, California

Sub-Area Land Use and Curve Number Details

Sub-Area Identifier	Land Use		Hydrologic Soil Group	Sub-Area Area (ac)	Curve Number
Watershed1	Paved parking lots, roofs, driveways		D	2.13	98
	User defined urban (Click button or		D	16.03	84
	Pasture, grassland or range	(fair)	D	7.19	84
	Woods - grass combination	(fair)	D	4.23	82
	Woods	(good)	D	26.98	77
	Farmsteads		D	4.03	86
	Total Area / Weighted Curve Number			60.59	81
				=====	==

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WinTR-55 Current Data Description

--- Identification Data ---

DITCH ANALYSIS

User: SPistone   Date: 3/1/21
Project: CATHIARD   Units: English
SubTitle: Watershed 1 - POST   Areal Units: Acres
State: California
County: Napa
Filename: C:\Users\Sarah\OneDrive - LincolnAE\AE Clients\Chateau Smith-Haute-Lafitte\ECP_2019 (T1)\Watersh

--- Sub-Area Data ---

Name	Description	Reach	Area(ac)	RCN	Tc
Watershed1	Watershed	Outlet	60.59	81	.333

Total area: 60.59 (ac)

--- Storm Data --

Rainfall Depth by Rainfall Return Period

2-Yr (in)	5-Yr (in)	10-Yr (in)	25-Yr (in)	50-Yr (in)	100-Yr (in)	-Yr (in)
3.98	4.98	5.78	6.85	7.64	8.43	.0

Storm Data Source: User-provided custom storm data
Rainfall Distribution Type: Type CA-1
Dimensionless Unit Hydrograph: <standard>

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SPistone CATHIARD
Watershed 1 - POST
Napa County, California

Watershed Peak Table

Sub-Area or Reach Identifier	Peak Flow by Rainfall Return Period 2-Yr (cfs)	10-Yr (cfs)	50-Yr (cfs)	100-Yr (cfs)
SUBAREAS				
Watershed1	19.13	33.32	48.27	54.65
REACHES				
OUTLET	19.13	33.32	48.27	54.65

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Napa County, California

Sub-Area Summary Table

Sub-Area Identifier	Drainage Area (ac)	Time of Concentration (hr)	Curve Number	Receiving Reach	Sub-Area Description
Watershed1	60.59	0.333	81	Outlet	Watershed

Total Area: 60.59 (ac)

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SPistone

CATHIARD
Watershed 1 - POST
Napa County, California

Sub-Area Time of Concentration Details

	Sub-Area Identifier/	Flow Length (ft)	Slope (ft/ft)	Mannings's n	End Area (sq ft)	Wetted Perimeter (ft)	Velocity (ft/sec)	Travel Time (hr)
	Watershed1							
	SHEET	100	0.2200	0.800				0.214
	SHALLOW	41	0.2500	0.050				0.001
Table 7 -->	CHANNEL	483					7.500	0.018
	CHANNEL	2481	0.0700	0.040	3.50	6.00	6.892	0.100
							Time of Concentration	.333
								========

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SPistone

CATHIARD
Watershed 1 - POST
Napa County, California

Sub-Area Land Use and Curve Number Details

Sub-Area Identifier	Land Use		Hydrologic Soil Group	Sub-Area Area (ac)	Curve Number
Watershed1	Paved parking lots, roofs, driveways		D	2.13	98
	User defined urban (Click button or		D	16.03	84
	Pasture, grassland or range	(fair)	D	7.19	84
	Woods - grass combination	(fair)	D	4.23	82
	Woods	(good)	D	26.98	77
	Farmsteads		D	4.03	86
	Total Area / Weighted Curve Number			60.59	81
				=====	==

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