PPI ENGINEERING

VINEYARD DESIGN
EROSION CONTROL
WATER DEVELOPMENT
DRAINAGE
PERMITTING
GPS/GIS

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Napa, California 94558
707-253-1806
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MEMORANDUM

Date: October 29, 2018

To: Patrick Ryan, Napa County Planning, Building and Environmental Services

From: James R. Bushey, P.E.
Cody J. Corsetti, P.E. Cody Corsetti

Cc: Brian Bordona, Napa County Planning, Building and Environmental Services

Re: Three Twins Vineyard ECP - APN 025-380-017
Hydrologic Analysis

This memo transmits the findings of a hydrologic analysis for the above-referenced Track I Erosion Control Plan (ECP). HydroCAD software was used to estimate pre- and post-project runoff from watersheds containing the proposed development areas. The software uses the Natural Resource Conservation Service (NRCS) TR-20 method to calculate runoff. The analysis uses the Type IA 24-hr storm distribution and includes site-specific National Oceanic and Atmospheric Administration (NOAA) point precipitation data for the ranch.

Two watersheds were delineated for the hydrologic modeling. Watershed 1 runoff flows to a swale located on the west side of Greenfield Road. Watershed 2 flows to a swale located on the east side of the property. Both swales drain to Lake Hennessey. Please see the attached figures for the location of each watershed.

Soils within the watersheds were obtained from the NRCS Web Soil Survey and are classified as the following:

Haire Loam, 2-9% Slopes (Map Unit Symbol 146)
Sobrante Loam, 5-30% Slopes (Map Unit Symbol 178)
Sobrante Loam, 30-50% Slopes (Map Unit Symbol 179)

The Sobrante Loams are classified as Hydrologic Soil Group (HSG) C. The Haire Loam is classified as HSG D. Please see the attached figures for soil type delineations within the vicinity of each watershed.

Land use areas were initially delineated based on Napa County Orthophotos and both Michael W. Brooks & Associates and Napa County Contours. A site visit was then conducted on August 2, 2018 by Cody Corsetti of PPI Engineering to ground truth the orthophotos and determine the existing land use conditions. The land use hydrologic conditions were classified based on the respective covers as poor (less than 50% cover), fair (50%-75% cover) or good (greater than or equal to 75% cover). The HydroCAD software analyzes the land use data along with the

corresponding soil HSGs to determine a weighted Curve Number (CN) for runoff calculations. Please see the attached figures for existing and proposed land use delineations.

The Time of Concentration (Tc) flow path within each watershed was determined using both Michael W. Brooks & Associates and Napa County Contours. The flow path in each watershed was drafted from the hydrologically most distant point (longest travel time) in the watershed to the watershed outlet per NRCS standards. For both watersheds the Tc did not change from pre- to post-project conditions. The proposed project will not change any of the existing drainage patterns and does not include any surface water conveyance infrastructure. Please see the attached figures for both the pre- and post-project Tc flow paths by watershed.

Pre- and post-project runoff calculations from the HydroCAD models for each individual watershed are summarized in Table 1 below. Runoff was calculated for the 2-, 10-, 50- and 100-year storms respectively for each watershed.

Table 1. Individual Watershed Summary

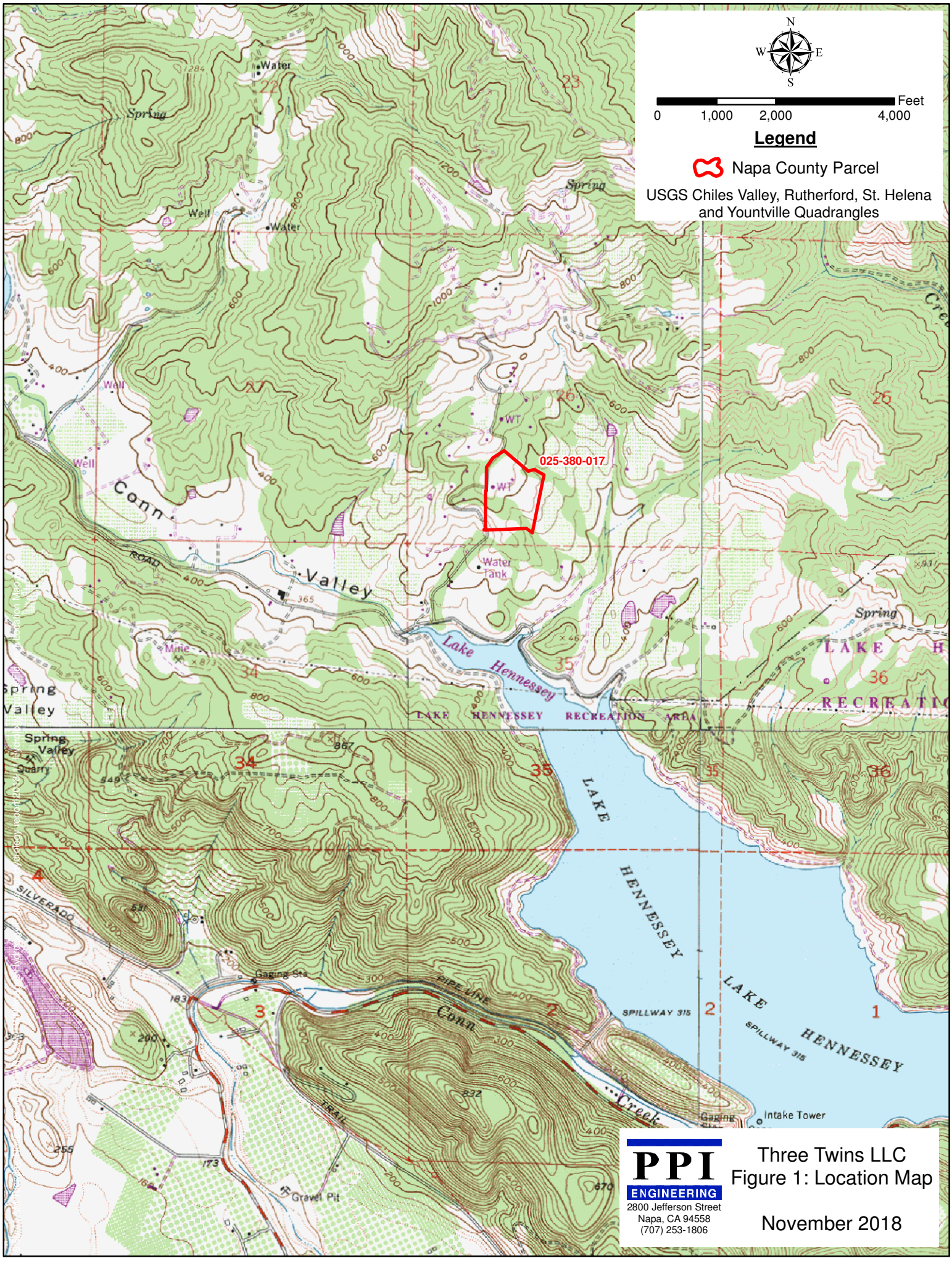
	Runoff (cfs)					
	Watershed 1			Watershed 2		
	Pre-Project	Post-Project	Increase / Decrease	Pre-Project	Post-Project	Increase / Decrease
2-Year Storm	4.35	4.35	0.00	4.75	4.75	0.00
10-Year Storm	9.41	9.41	0.00	9.81	9.81	0.00
50-Year Storm	15.14	15.14	0.00	15.46	15.46	0.00
100-Year Storm	17.68	17.68	0.00	17.94	17.94	0.00

Both watersheds show no net change in runoff from pre- to post-project conditions. This is due to the fact that neither the curve number (CN) nor the time of concentration (Tc) in these respective watersheds changed for post-project analysis. Please see the attached HydroCAD analyses for inputs, details and summaries of the hydrologic modeling. Based on our analysis, there are no predicted net runoff increases, and no negative hydrologic impacts are expected as a result of this project.



ATTACHMENT A

SUPPORTING FIGURES

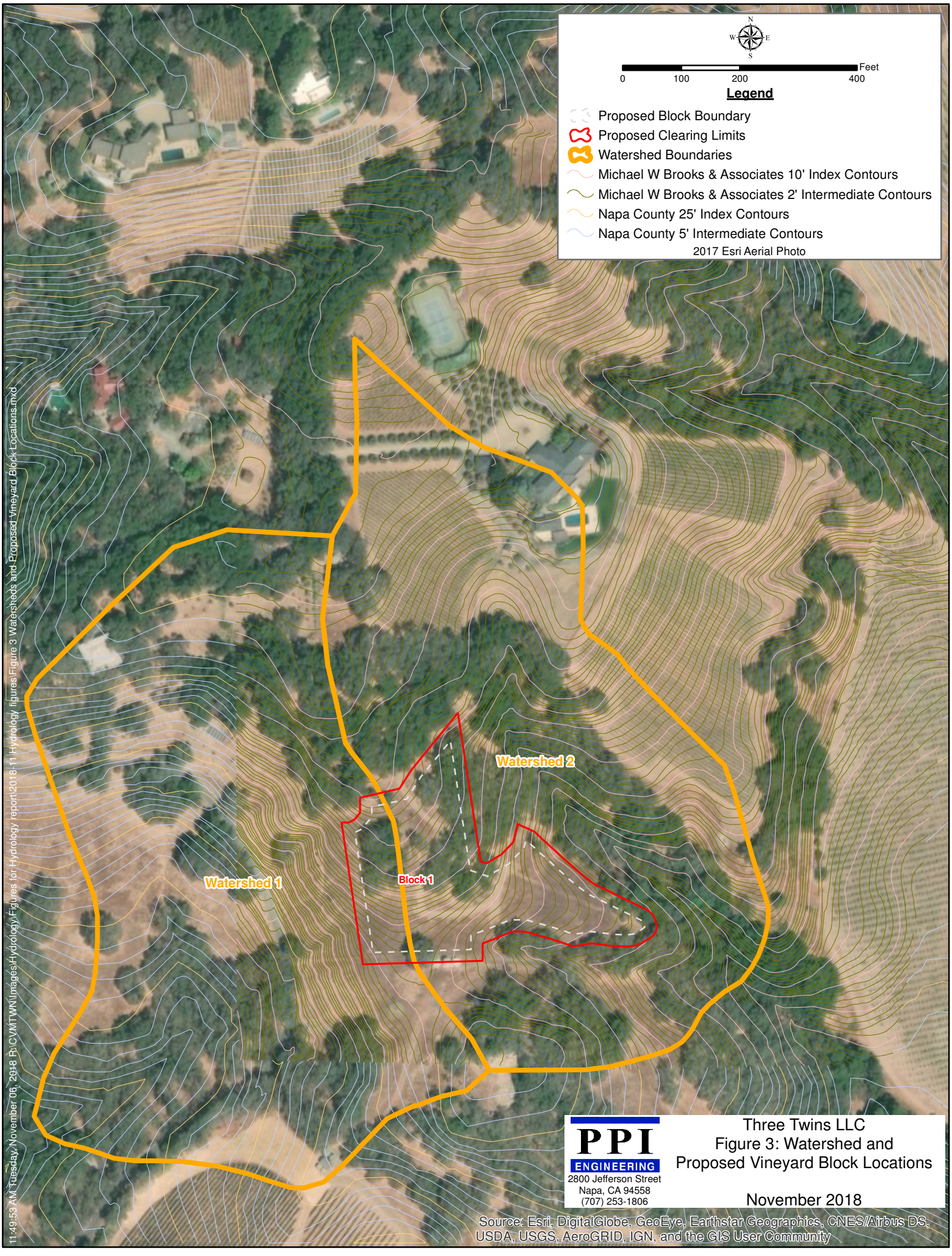


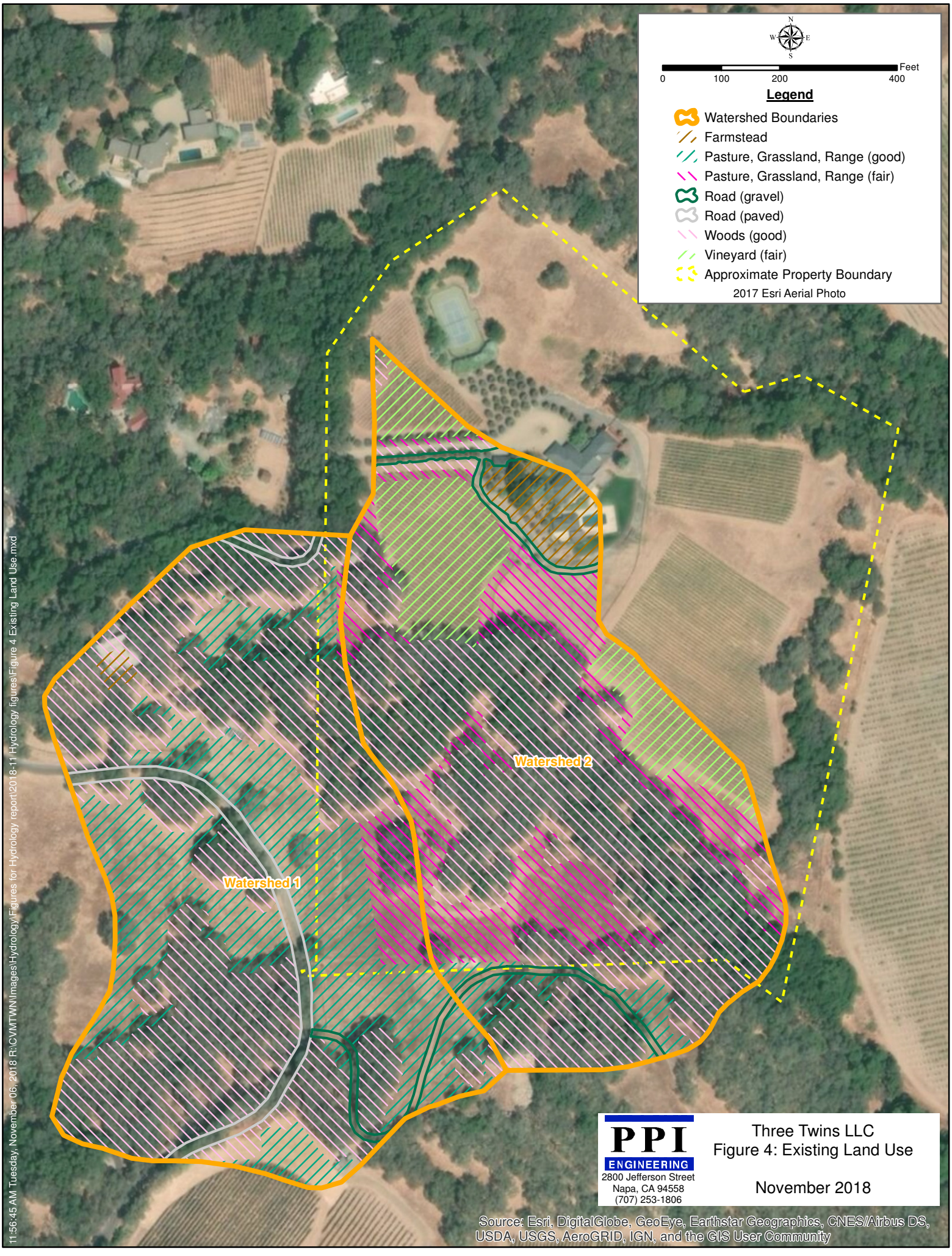
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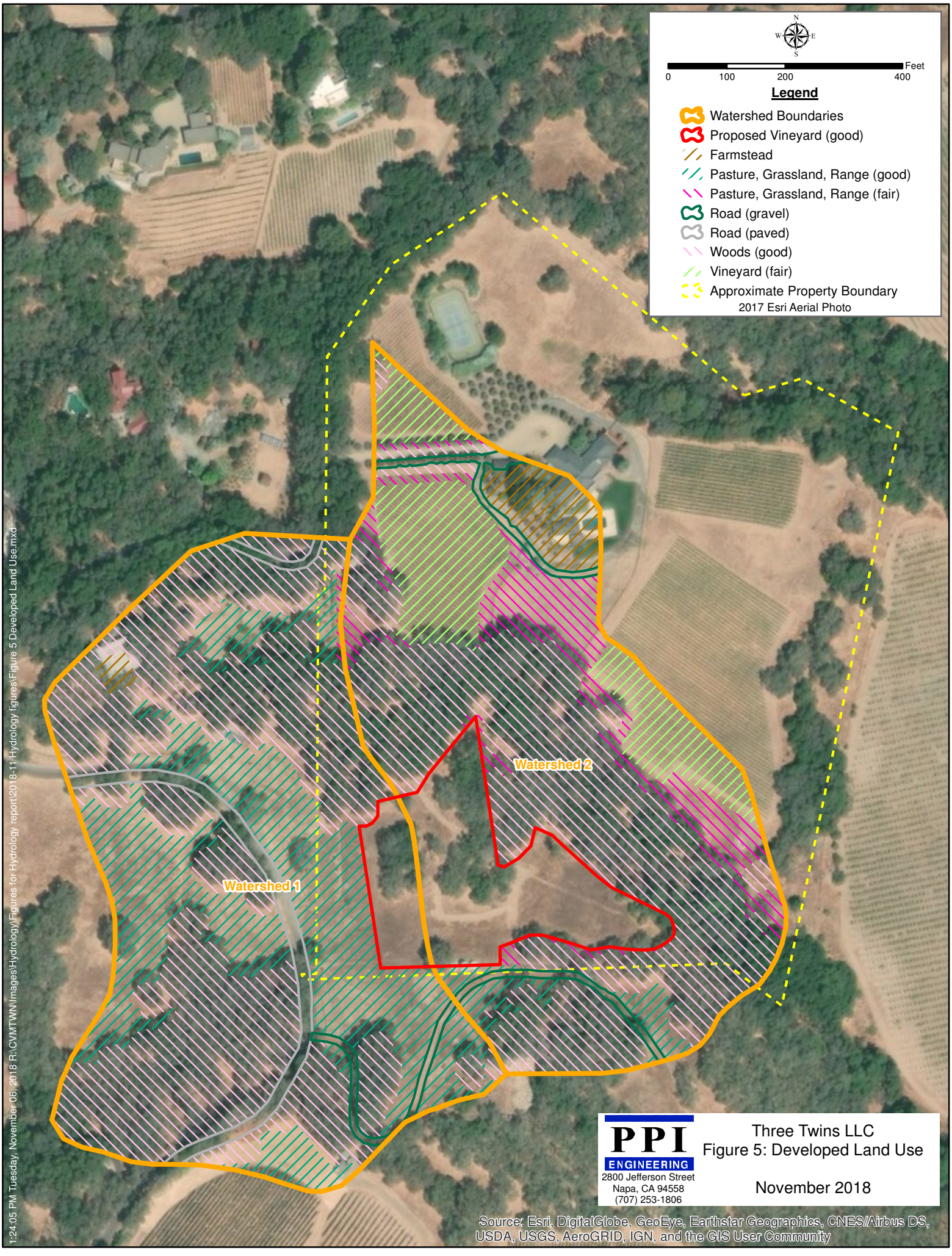
Three Twins LLC
Figure 1: Location Map

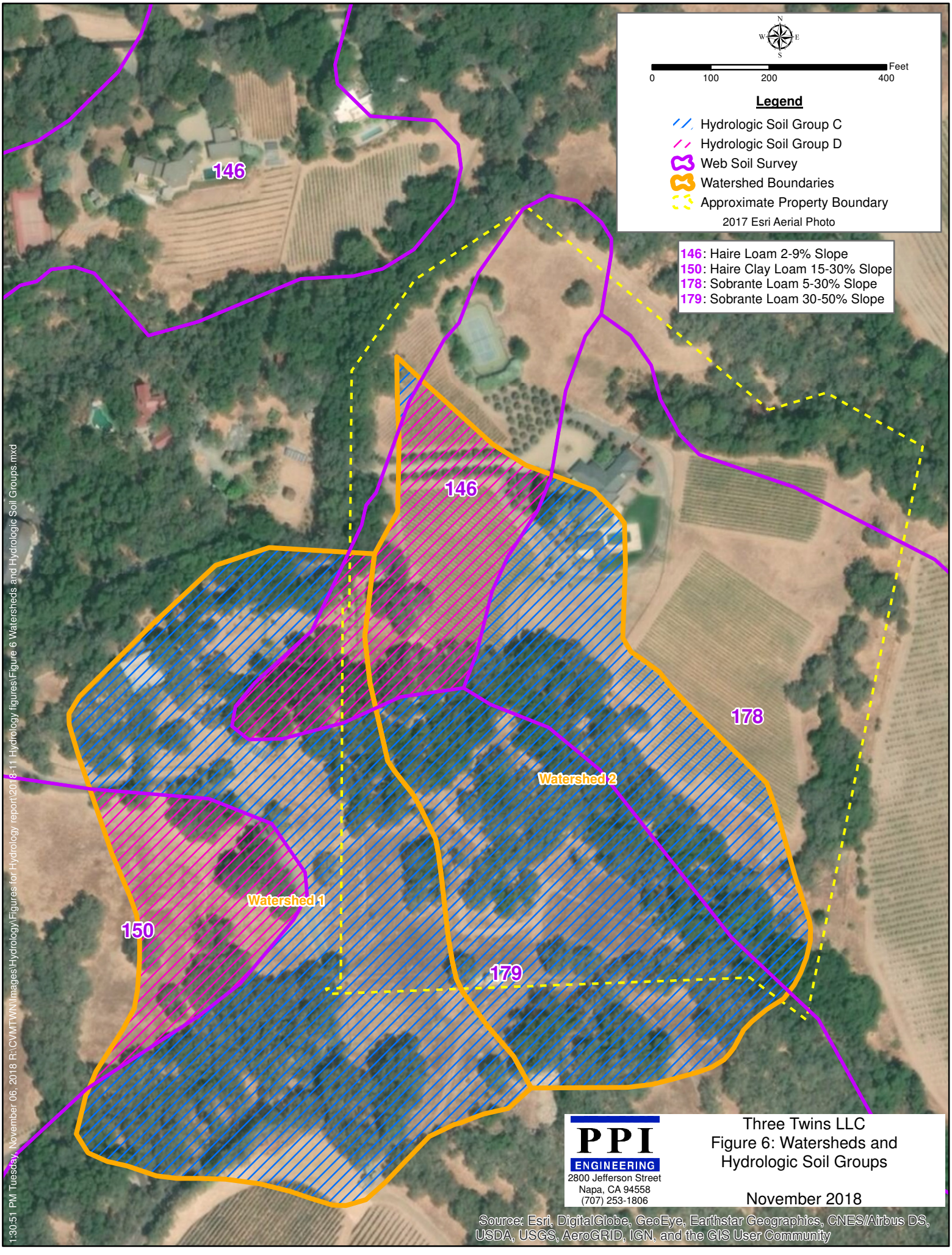
November 2018

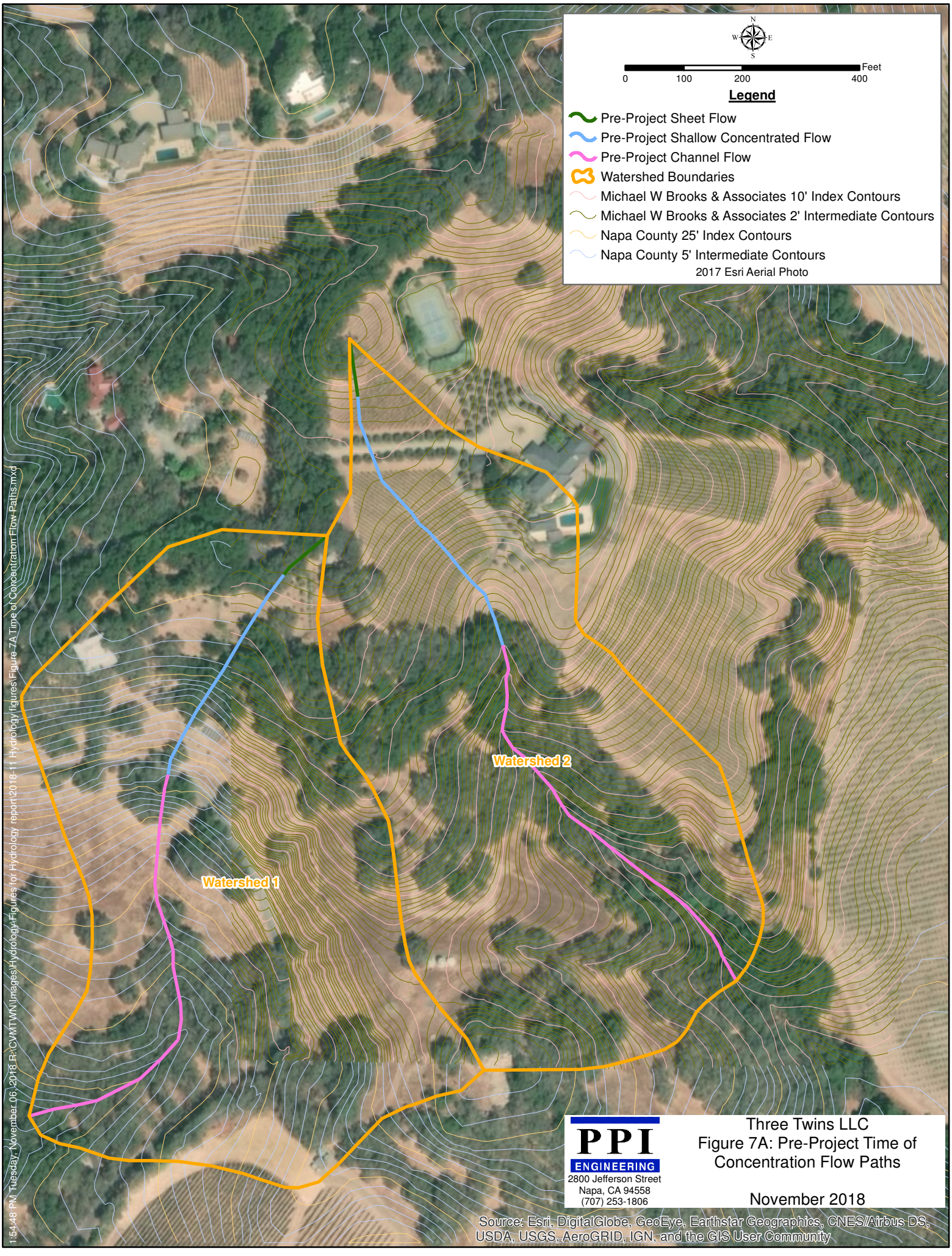

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Feet
Legend
Ephemeral Stream, Mapped by WRA
Ephemeral Stream, Assumed by PPI
Michael W Brooks & Associates 10' Index Contours
Michael W Brooks & Associates 2' Intermediate Contours
Napa County 25' Index Contours
Napa County 5' Intermediate Contours
2017 Esri Aerial Photo
9:54:08 AM, Tuesday, November 06, 2018, R:\CVM\TWN\Images\Hydrology\Figures for Hydrology report\2018-11 Hydrology figures\Figure 2 Property Boundary and Waters.mxd
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Napa, CA 94558
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Figure 2: Property Boundary & Waters
November 2018
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

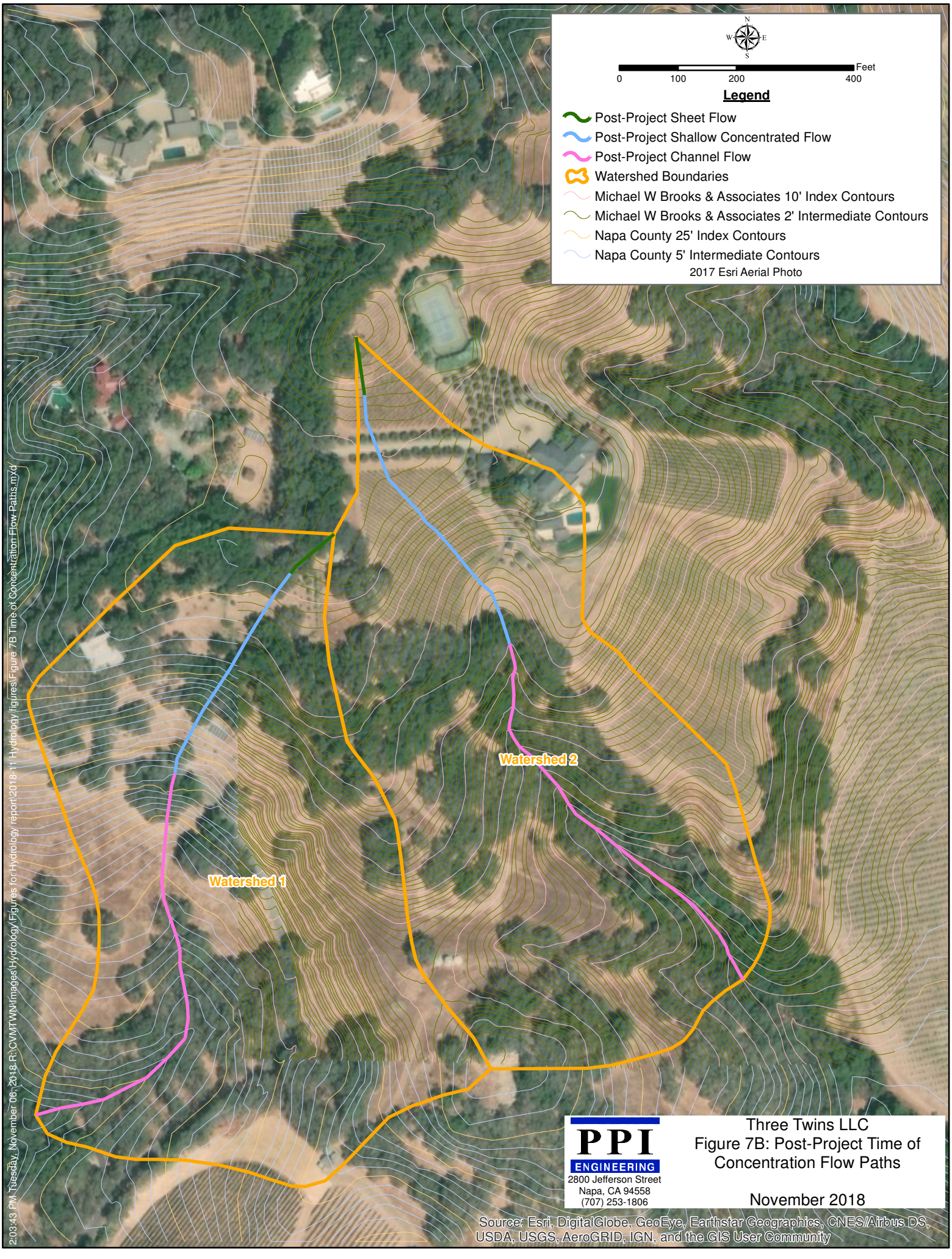

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Feet
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Proposed Block Boundary
Proposed Clearing Limits
Watershed Boundaries
Michael W Brooks & Associates 10' Index Contours
Michael W Brooks & Associates 2' Intermediate Contours
Napa County 25' Index Contours
Napa County 5' Intermediate Contours
2017 Esri Aerial Photo
Watershed 1
Watershed 2
Block 1
11:49:53 AM Tuesday, November 06, 2018 P:\CVMTWN\Images\Hydrology\Figures for Hydrology report\2018-11 Hydrology figures\Figure 3 Watersheds and Proposed Vineyard Block Locations.mxd
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Napa, CA 94558
(707) 253-1806
Three Twins LLC
Figure 3: Watershed and
Proposed Vineyard Block Locations
November 2018
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community


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Watershed Boundaries
Farmstead
Pasture, Grassland, Range (good)
Pasture, Grassland, Range (fair)
Road (gravel)
Road (paved)
Woods (good)
Vineyard (fair)
Approximate Property Boundary
2017 Esri Aerial Photo
Watershed 1
Watershed 2
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Figure 4: Existing Land Use
November 2018
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
11:56:45 AM Tuesday, November 06, 2018 R:\CVMTWN\Images\Hydrology\Figures for Hydrology report\2018-11 Hydrology figures\Figure 4 Existing Land Use.mxd


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Watershed Boundaries
Proposed Vineyard (good)
Farmstead
Pasture, Grassland, Range (good)
Pasture, Grassland, Range (fair)
Road (gravel)
Road (paved)
Woods (good)
Vineyard (fair)
Approximate Property Boundary
2017 Esri Aerial Photo
Watershed 1
Watershed 2
1:24:05 PM Tuesday, November 06, 2018 R:\CVMTWN\Images\Hydrology\Figures for Hydrology report\2018-11 Hydrology figures\Figure 5 Developed Land Use.mxd
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Figure 5: Developed Land Use
November 2018
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

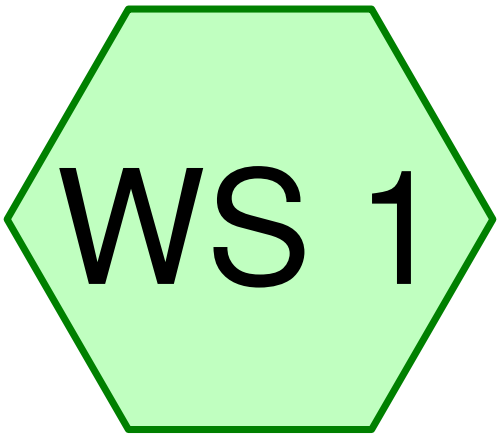

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Hydrologic Soil Group C
Hydrologic Soil Group D
Web Soil Survey
Watershed Boundaries
Approximate Property Boundary
2017 Esri Aerial Photo
146: Haire Loam 2-9% Slope
150: Haire Clay Loam 15-30% Slope
178: Sobrante Loam 5-30% Slope
179: Sobrante Loam 30-50% Slope
146
146
178
Watershed 2
Watershed 1
150
179
1:30:51 PM Tuesday, November 06, 2018 R:\CVM\TWN\Images\Hydrology\Figures for Hydrology report\2018-11 Hydrology figures\Figure 6 Watersheds and Hydrologic Soil Groups.mxd
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Napa, CA 94558
(707) 253-1806
Three Twins LLC
Figure 6: Watersheds and
Hydrologic Soil Groups
November 2018
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS,
USDA, USGS, AeroGRID, IGN, and the GIS User Community


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Pre-Project Sheet Flow
Pre-Project Shallow Concentrated Flow
Pre-Project Channel Flow
Watershed Boundaries
Michael W Brooks & Associates 10' Index Contours
Michael W Brooks & Associates 2' Intermediate Contours
Napa County 25' Index Contours
Napa County 5' Intermediate Contours
2017 Esri Aerial Photo
Watershed 1
Watershed 2
1:5448 PM Tuesday, November 06, 2018 P:\CWMTWN\Images\Hydrology\Figures for Hydrology report\2018-11 Hydrology figures\Figure 7A Time of Concentration Flow Paths.mxd
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Figure 7A: Pre-Project Time of Concentration Flow Paths
November 2018
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community


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Post-Project Sheet Flow
Post-Project Shallow Concentrated Flow
Post-Project Channel Flow
Watershed Boundaries
Michael W Brooks & Associates 10' Index Contours
Michael W Brooks & Associates 2' Intermediate Contours
Napa County 25' Index Contours
Napa County 5' Intermediate Contours
2017 Esri Aerial Photo
Watershed 1
Watershed 2
2:03:43 PM Tuesday, November 06, 2018 R:\CVM\TWW\Images\Hydrology\Figures for Hydrology report\2018-11 Hydrology figures\Figure 7B Time of Concentration Flow Paths.mxd
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Figure 7B: Post-Project Time of Concentration Flow Paths
November 2018
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

ATTACHMENT B

HYDROCAD ANALYSES



Subcat WS 1

Subcat Reach Pond Link

Routing Diagram for Three Twins Pre-Project Hydrology
Prepared by PPI Engineering., Printed 11/1/2018
HydroCAD® 10.00-17 s/n 09429 © 2016 HydroCAD Software Solutions LLC

Summary for Subcatchment WS 1: Subcat WS 1

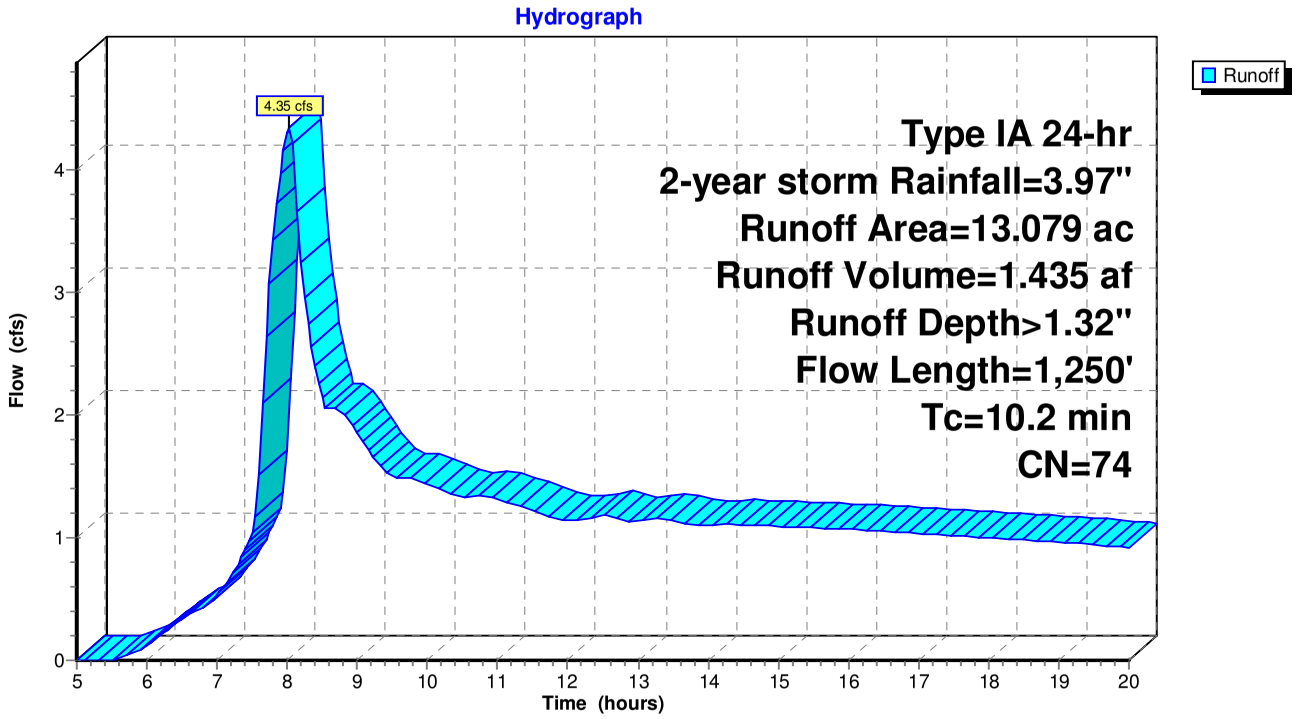
Runoff = 4.35 cfs @ 8.03 hrs, Volume= 1.435 af, Depth> 1.32"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr 2-year storm Rainfall=3.97"

Area (ac)	CN	Description
0.078	82	Farmsteads, HSG C
0.138	89	Gravel roads, HSG C
0.326	79	Pasture/grassland/range, Fair, HSG C
0.042	84	Pasture/grassland/range, Fair, HSG D
3.238	74	Pasture/grassland/range, Good, HSG C
1.481	80	Pasture/grassland/range, Good, HSG D
0.421	92	Paved roads w/open ditches, 50% imp, HSG C
0.144	93	Paved roads w/open ditches, 50% imp, HSG D
5.660	70	Woods, Good, HSG C
1.551	77	Woods, Good, HSG D
13.079	74	Weighted Average
12.796		97.84% Pervious Area
0.283		2.16% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.4	28	0.0500	0.06		**Sheet Flow, SHEET** Woods: Dense underbrush n= 0.800 P2= 3.97"
1.0	468	0.2500	8.05		**Shallow Concentrated Flow, SHALLOW** Unpaved Kv= 16.1 fps
0.0	20	0.1500	9.14	7.18	**Pipe Channel, 12" CMP CULVERT** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.025 Corrugated metal
0.4	439	0.2100	18.00	287.98	**Trap/Vee/Rect Channel Flow, CHANNEL 1** Bot.W=2.00' D=2.00' Z= 2.0 & 4.0 '/' Top.W=14.00' n= 0.040
0.4	295	0.0800	11.11	177.75	**Trap/Vee/Rect Channel Flow, CHANNEL 2** Bot.W=2.00' D=2.00' Z= 2.0 & 4.0 '/' Top.W=14.00' n= 0.040
10.2	1,250	Total			

Subcatchment WS 1: Subcat WS 1



Summary for Subcatchment WS 1: Subcat WS 1

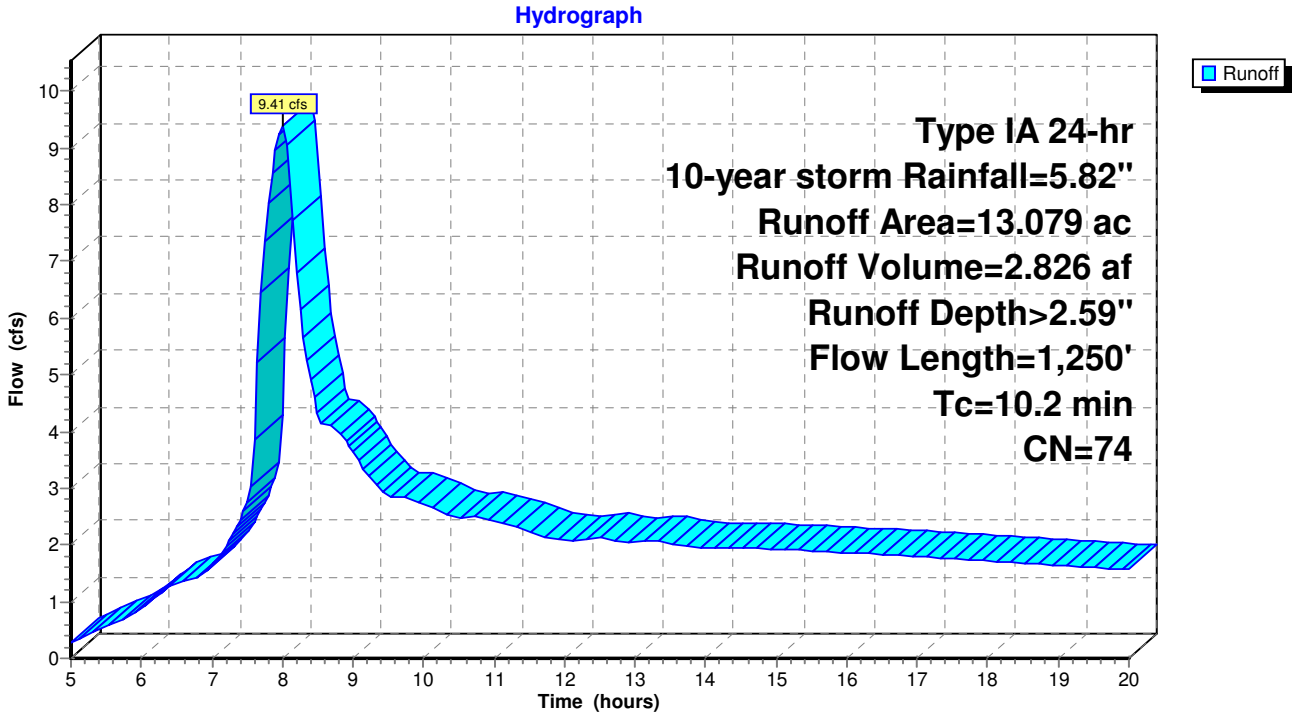
Runoff = 9.41 cfs @ 8.01 hrs, Volume= 2.826 af, Depth> 2.59"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr 10-year storm Rainfall=5.82"

Area (ac)	CN	Description
0.078	82	Farmsteads, HSG C
0.138	89	Gravel roads, HSG C
0.326	79	Pasture/grassland/range, Fair, HSG C
0.042	84	Pasture/grassland/range, Fair, HSG D
3.238	74	Pasture/grassland/range, Good, HSG C
1.481	80	Pasture/grassland/range, Good, HSG D
0.421	92	Paved roads w/open ditches, 50% imp, HSG C
0.144	93	Paved roads w/open ditches, 50% imp, HSG D
5.660	70	Woods, Good, HSG C
1.551	77	Woods, Good, HSG D
13.079	74	Weighted Average
12.796		97.84% Pervious Area
0.283		2.16% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.4	28	0.0500	0.06		**Sheet Flow, SHEET** Woods: Dense underbrush n= 0.800 P2= 3.97"
1.0	468	0.2500	8.05		**Shallow Concentrated Flow, SHALLOW** Unpaved Kv= 16.1 fps
0.0	20	0.1500	9.14	7.18	**Pipe Channel, 12" CMP CULVERT** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.025 Corrugated metal
0.4	439	0.2100	18.00	287.98	**Trap/Vee/Rect Channel Flow, CHANNEL 1** Bot.W=2.00' D=2.00' Z= 2.0 & 4.0 '/' Top.W=14.00' n= 0.040
0.4	295	0.0800	11.11	177.75	**Trap/Vee/Rect Channel Flow, CHANNEL 2** Bot.W=2.00' D=2.00' Z= 2.0 & 4.0 '/' Top.W=14.00' n= 0.040
10.2	1,250	Total			

Subcatchment WS 1: Subcat WS 1



Summary for Subcatchment WS 1: Subcat WS 1

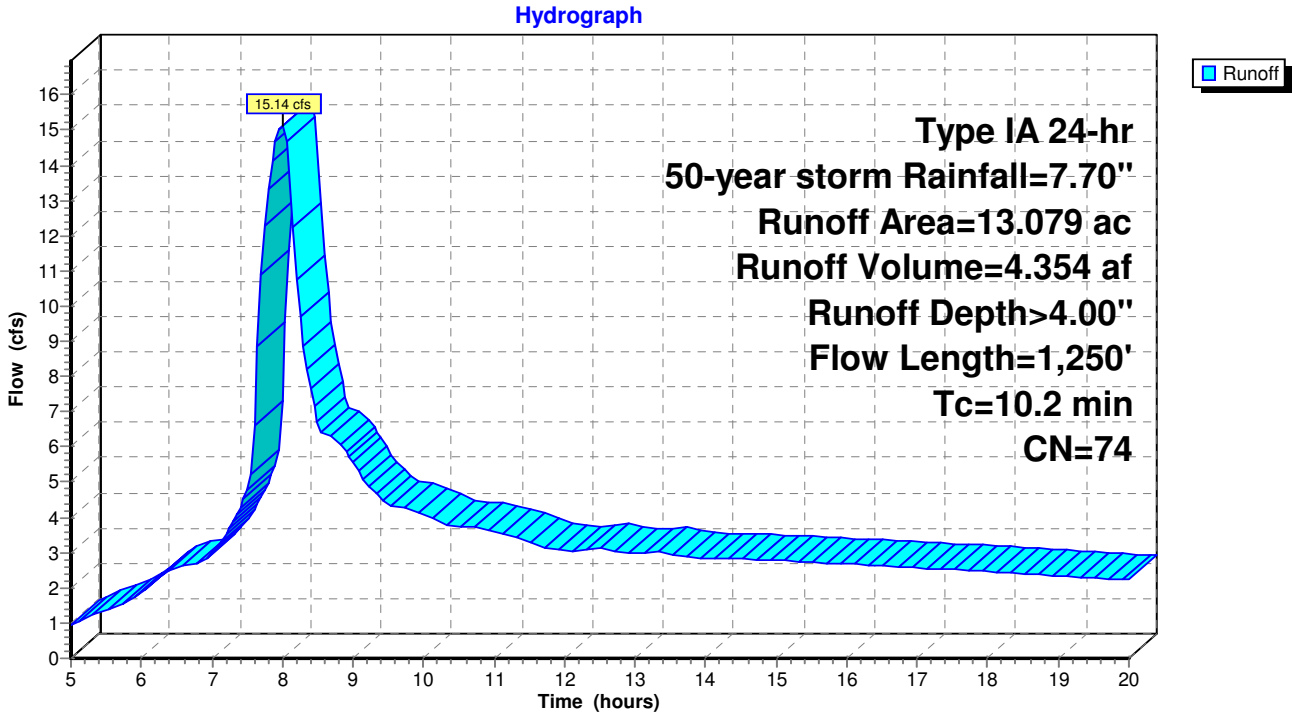
Runoff = 15.14 cfs @ 8.00 hrs, Volume= 4.354 af, Depth> 4.00"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr 50-year storm Rainfall=7.70"

Area (ac)	CN	Description
0.078	82	Farmsteads, HSG C
0.138	89	Gravel roads, HSG C
0.326	79	Pasture/grassland/range, Fair, HSG C
0.042	84	Pasture/grassland/range, Fair, HSG D
3.238	74	Pasture/grassland/range, Good, HSG C
1.481	80	Pasture/grassland/range, Good, HSG D
0.421	92	Paved roads w/open ditches, 50% imp, HSG C
0.144	93	Paved roads w/open ditches, 50% imp, HSG D
5.660	70	Woods, Good, HSG C
1.551	77	Woods, Good, HSG D
13.079	74	Weighted Average
12.796		97.84% Pervious Area
0.283		2.16% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.4	28	0.0500	0.06		**Sheet Flow, SHEET** Woods: Dense underbrush n= 0.800 P2= 3.97"
1.0	468	0.2500	8.05		**Shallow Concentrated Flow, SHALLOW** Unpaved Kv= 16.1 fps
0.0	20	0.1500	9.14	7.18	**Pipe Channel, 12" CMP CULVERT** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.025 Corrugated metal
0.4	439	0.2100	18.00	287.98	**Trap/Vee/Rect Channel Flow, CHANNEL 1** Bot.W=2.00' D=2.00' Z= 2.0 & 4.0 '/' Top.W=14.00' n= 0.040
0.4	295	0.0800	11.11	177.75	**Trap/Vee/Rect Channel Flow, CHANNEL 2** Bot.W=2.00' D=2.00' Z= 2.0 & 4.0 '/' Top.W=14.00' n= 0.040
10.2	1,250	Total			

Subcatchment WS 1: Subcat WS 1



Summary for Subcatchment WS 1: Subcat WS 1

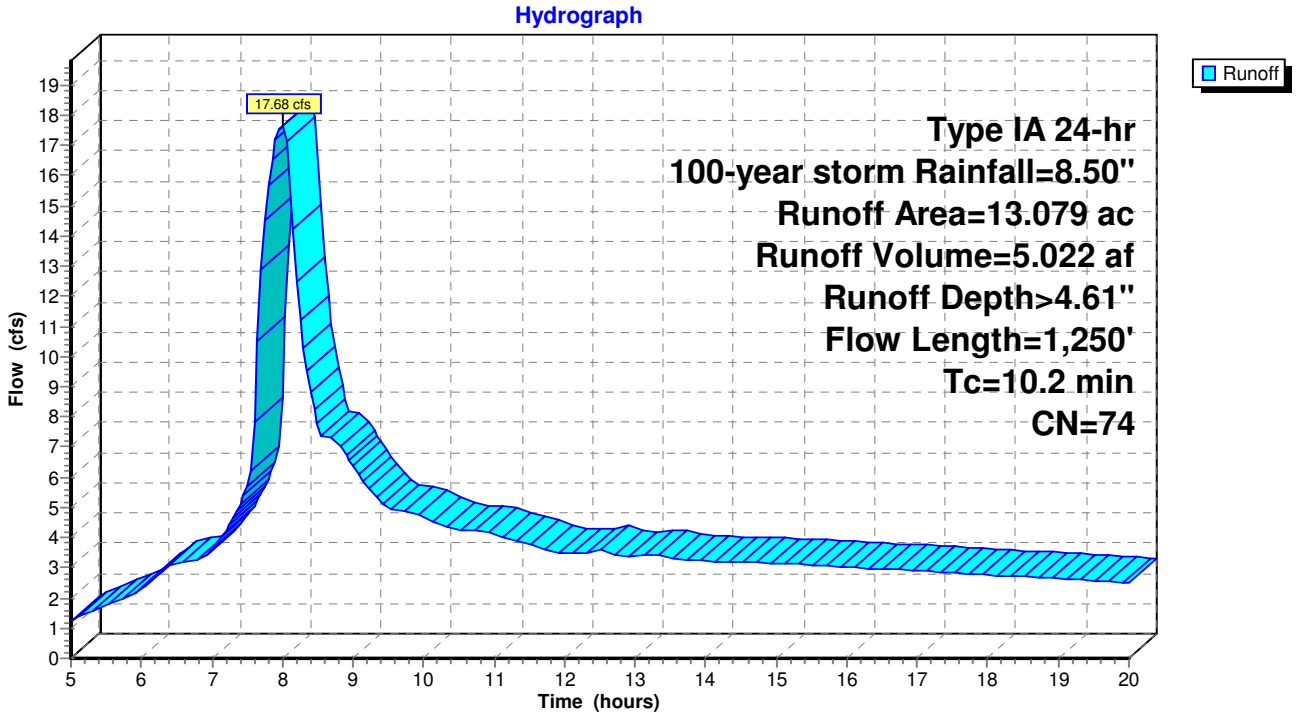
Runoff = 17.68 cfs @ 7.99 hrs, Volume= 5.022 af, Depth> 4.61"

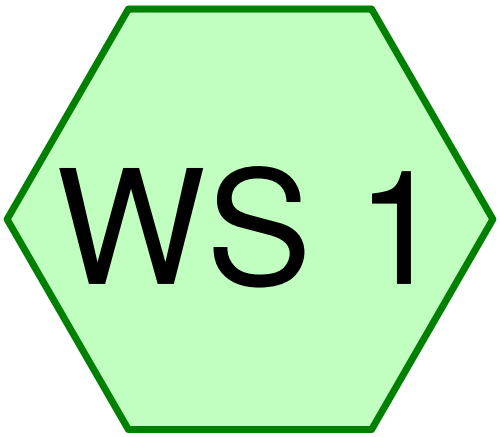
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr 100-year storm Rainfall=8.50"

Area (ac)	CN	Description
0.078	82	Farmsteads, HSG C
0.138	89	Gravel roads, HSG C
0.326	79	Pasture/grassland/range, Fair, HSG C
0.042	84	Pasture/grassland/range, Fair, HSG D
3.238	74	Pasture/grassland/range, Good, HSG C
1.481	80	Pasture/grassland/range, Good, HSG D
0.421	92	Paved roads w/open ditches, 50% imp, HSG C
0.144	93	Paved roads w/open ditches, 50% imp, HSG D
5.660	70	Woods, Good, HSG C
1.551	77	Woods, Good, HSG D
13.079	74	Weighted Average
12.796		97.84% Pervious Area
0.283		2.16% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.4	28	0.0500	0.06		**Sheet Flow, SHEET** Woods: Dense underbrush n= 0.800 P2= 3.97"
1.0	468	0.2500	8.05		**Shallow Concentrated Flow, SHALLOW** Unpaved Kv= 16.1 fps
0.0	20	0.1500	9.14	7.18	**Pipe Channel, 12" CMP CULVERT** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.025 Corrugated metal
0.4	439	0.2100	18.00	287.98	**Trap/Vee/Rect Channel Flow, CHANNEL 1** Bot.W=2.00' D=2.00' Z= 2.0 & 4.0 '/' Top.W=14.00' n= 0.040
0.4	295	0.0800	11.11	177.75	**Trap/Vee/Rect Channel Flow, CHANNEL 2** Bot.W=2.00' D=2.00' Z= 2.0 & 4.0 '/' Top.W=14.00' n= 0.040
10.2	1,250	Total			

Subcatchment WS 1: Subcat WS 1





Subcat WS 1

Subcat Reach Pond Link

Routing Diagram for Three Twins Post-Project Hydrology
Prepared by PPI Engineering., Printed 11/1/2018
HydroCAD® 10.00-17 s/n 09429 © 2016 HydroCAD Software Solutions LLC

Summary for Subcatchment WS 1: Subcat WS 1

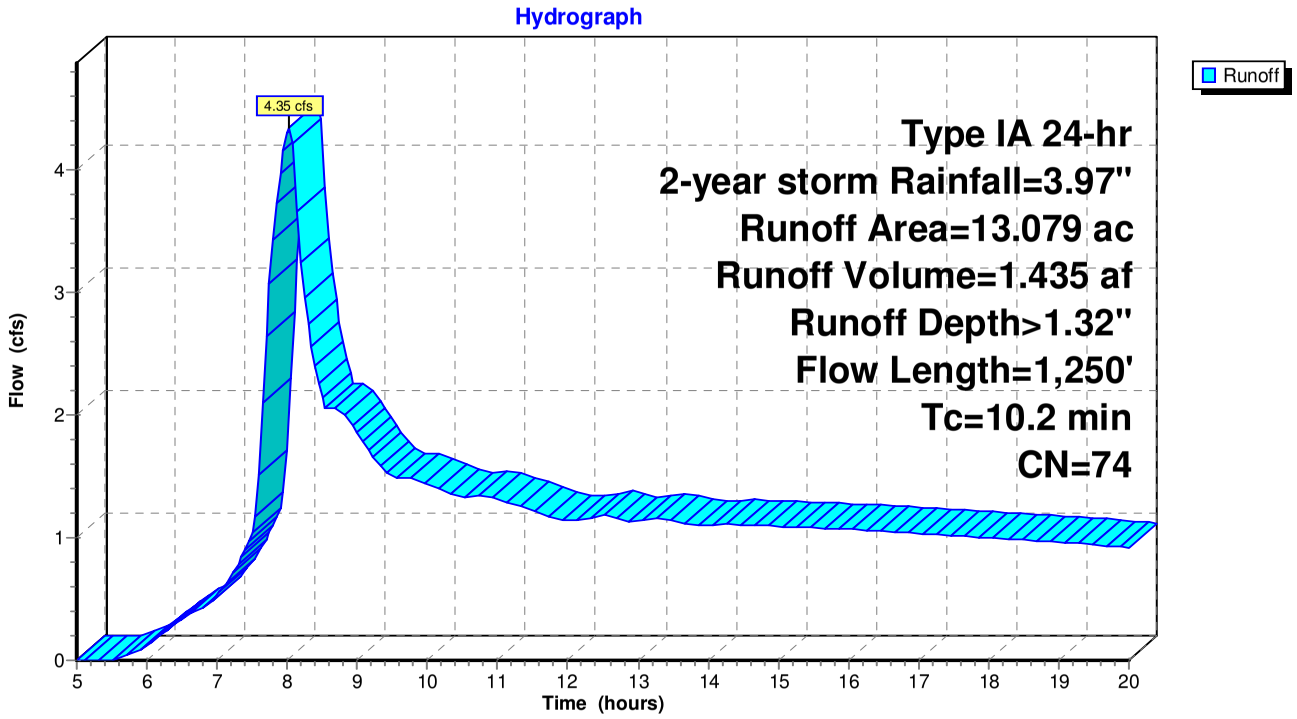
Runoff = 4.35 cfs @ 8.03 hrs, Volume= 1.435 af, Depth> 1.32"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr 2-year storm Rainfall=3.97"

	Area (ac)	CN	Description
*	0.001	0	, HSG C
	0.078	82	Farmsteads, HSG C
	0.138	89	Gravel roads, HSG C
	0.001	79	Pasture/grassland/range, Fair, HSG C
	0.043	84	Pasture/grassland/range, Fair, HSG D
	3.238	74	Pasture/grassland/range, Good, HSG C
	1.481	80	Pasture/grassland/range, Good, HSG D
	0.421	92	Paved roads w/open ditches, 50% imp, HSG C
	0.144	93	Paved roads w/open ditches, 50% imp, HSG D
	0.536	75	Vineyard, Good, HSG C
	5.447	70	Woods, Good, HSG C
	1.551	77	Woods, Good, HSG D
	13.079	74	Weighted Average
	12.796		97.84% Pervious Area
	0.283		2.16% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.4	28	0.0500	0.06		**Sheet Flow, SHEET** Woods: Dense underbrush n= 0.800 P2= 3.97"
1.0	468	0.2500	8.05		**Shallow Concentrated Flow, SHALLOW** Unpaved Kv= 16.1 fps
0.0	20	0.1500	9.14	7.18	**Pipe Channel, 12" CMP CULVERT** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.025 Corrugated metal
0.4	439	0.2100	18.00	287.98	**Trap/Vee/Rect Channel Flow, CHANNEL 1** Bot.W=2.00' D=2.00' Z= 2.0 & 4.0 '/' Top.W=14.00' n= 0.040
0.4	295	0.0800	11.11	177.75	**Trap/Vee/Rect Channel Flow, CHANNEL 2** Bot.W=2.00' D=2.00' Z= 2.0 & 4.0 '/' Top.W=14.00' n= 0.040
10.2	1,250	Total			

Subcatchment WS 1: Subcat WS 1



Summary for Subcatchment WS 1: Subcat WS 1

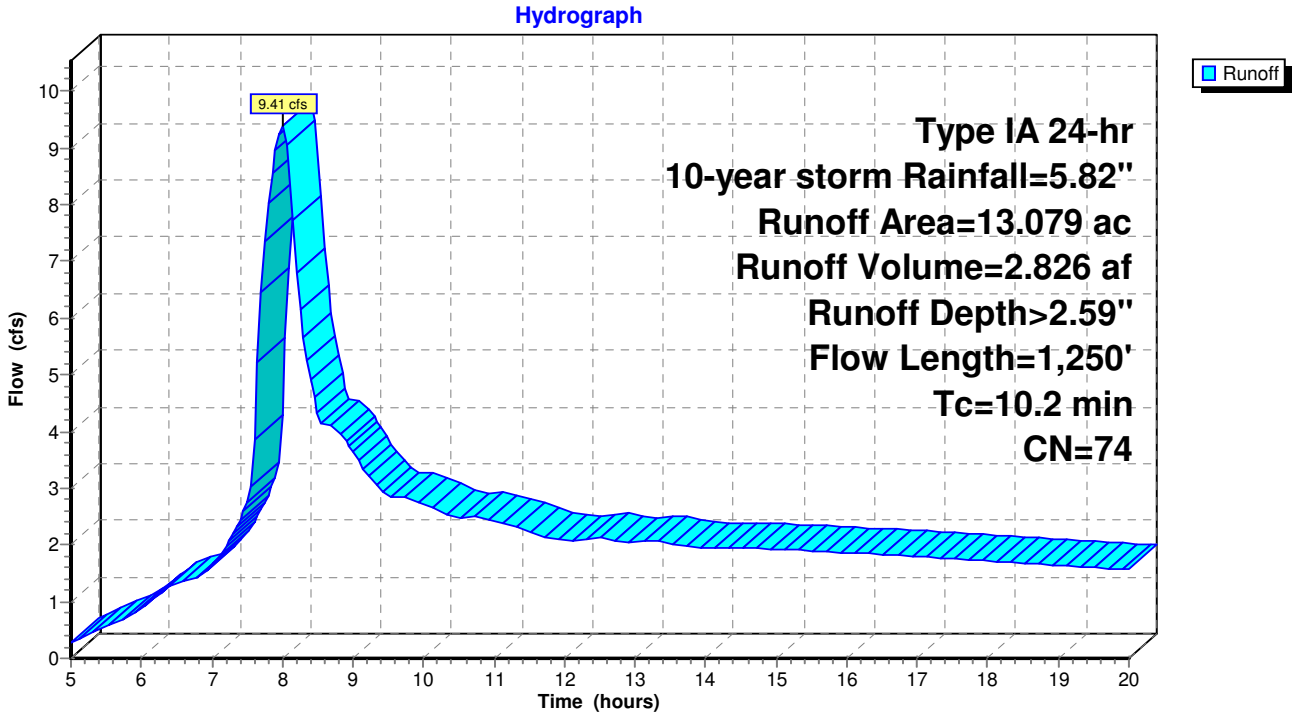
Runoff = 9.41 cfs @ 8.01 hrs, Volume= 2.826 af, Depth> 2.59"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr 10-year storm Rainfall=5.82"

	Area (ac)	CN	Description
*	0.001	0	, HSG C
	0.078	82	Farmsteads, HSG C
	0.138	89	Gravel roads, HSG C
	0.001	79	Pasture/grassland/range, Fair, HSG C
	0.043	84	Pasture/grassland/range, Fair, HSG D
	3.238	74	Pasture/grassland/range, Good, HSG C
	1.481	80	Pasture/grassland/range, Good, HSG D
	0.421	92	Paved roads w/open ditches, 50% imp, HSG C
	0.144	93	Paved roads w/open ditches, 50% imp, HSG D
	0.536	75	Vineyard, Good, HSG C
	5.447	70	Woods, Good, HSG C
	1.551	77	Woods, Good, HSG D
	13.079	74	Weighted Average
	12.796		97.84% Pervious Area
	0.283		2.16% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.4	28	0.0500	0.06		**Sheet Flow, SHEET** Woods: Dense underbrush n= 0.800 P2= 3.97"
1.0	468	0.2500	8.05		**Shallow Concentrated Flow, SHALLOW** Unpaved Kv= 16.1 fps
0.0	20	0.1500	9.14	7.18	**Pipe Channel, 12" CMP CULVERT** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.025 Corrugated metal
0.4	439	0.2100	18.00	287.98	**Trap/Vee/Rect Channel Flow, CHANNEL 1** Bot.W=2.00' D=2.00' Z= 2.0 & 4.0 '/' Top.W=14.00' n= 0.040
0.4	295	0.0800	11.11	177.75	**Trap/Vee/Rect Channel Flow, CHANNEL 2** Bot.W=2.00' D=2.00' Z= 2.0 & 4.0 '/' Top.W=14.00' n= 0.040
10.2	1,250	Total			

Subcatchment WS 1: Subcat WS 1



Summary for Subcatchment WS 1: Subcat WS 1

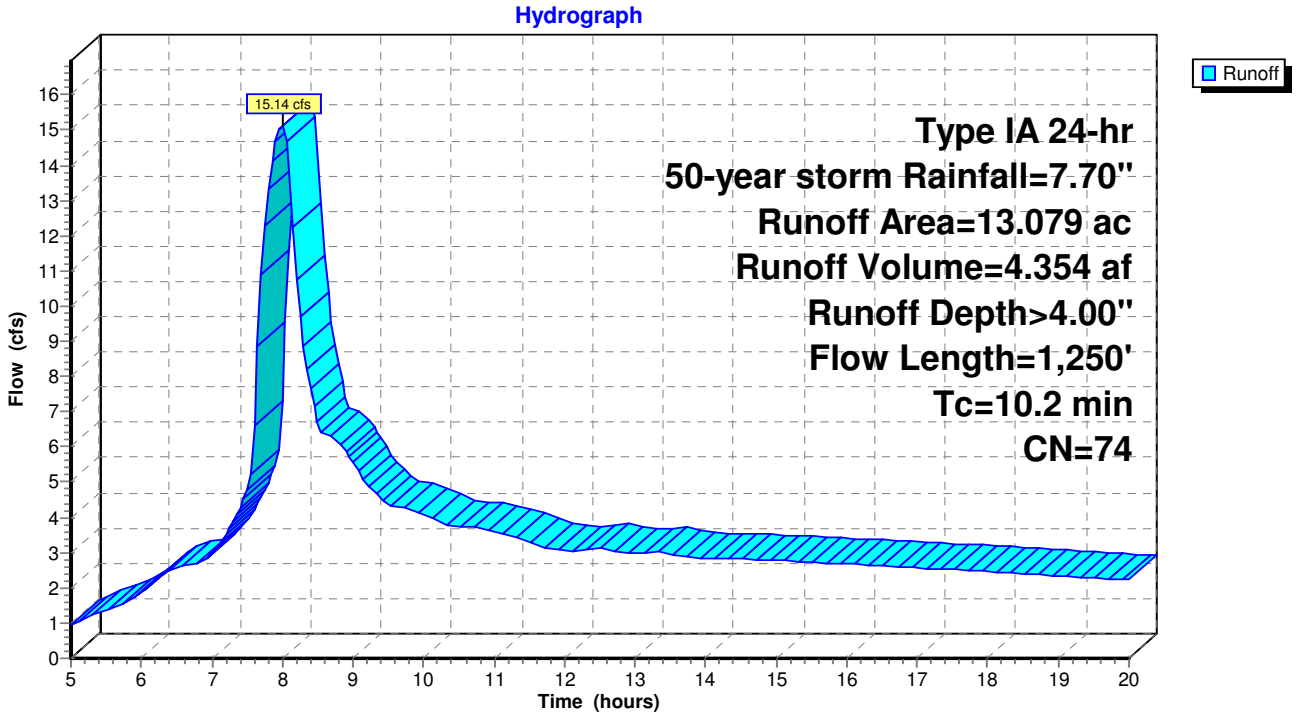
Runoff = 15.14 cfs @ 8.00 hrs, Volume= 4.354 af, Depth> 4.00"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr 50-year storm Rainfall=7.70"

	Area (ac)	CN	Description
*	0.001	0	, HSG C
	0.078	82	Farmsteads, HSG C
	0.138	89	Gravel roads, HSG C
	0.001	79	Pasture/grassland/range, Fair, HSG C
	0.043	84	Pasture/grassland/range, Fair, HSG D
	3.238	74	Pasture/grassland/range, Good, HSG C
	1.481	80	Pasture/grassland/range, Good, HSG D
	0.421	92	Paved roads w/open ditches, 50% imp, HSG C
	0.144	93	Paved roads w/open ditches, 50% imp, HSG D
	0.536	75	Vineyard, Good, HSG C
	5.447	70	Woods, Good, HSG C
	1.551	77	Woods, Good, HSG D
	13.079	74	Weighted Average
	12.796		97.84% Pervious Area
	0.283		2.16% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.4	28	0.0500	0.06		**Sheet Flow, SHEET** Woods: Dense underbrush n= 0.800 P2= 3.97"
1.0	468	0.2500	8.05		**Shallow Concentrated Flow, SHALLOW** Unpaved Kv= 16.1 fps
0.0	20	0.1500	9.14	7.18	**Pipe Channel, 12" CMP CULVERT** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.025 Corrugated metal
0.4	439	0.2100	18.00	287.98	**Trap/Vee/Rect Channel Flow, CHANNEL 1** Bot.W=2.00' D=2.00' Z= 2.0 & 4.0 '/' Top.W=14.00' n= 0.040
0.4	295	0.0800	11.11	177.75	**Trap/Vee/Rect Channel Flow, CHANNEL 2** Bot.W=2.00' D=2.00' Z= 2.0 & 4.0 '/' Top.W=14.00' n= 0.040
10.2	1,250	Total			

Subcatchment WS 1: Subcat WS 1



Summary for Subcatchment WS 1: Subcat WS 1

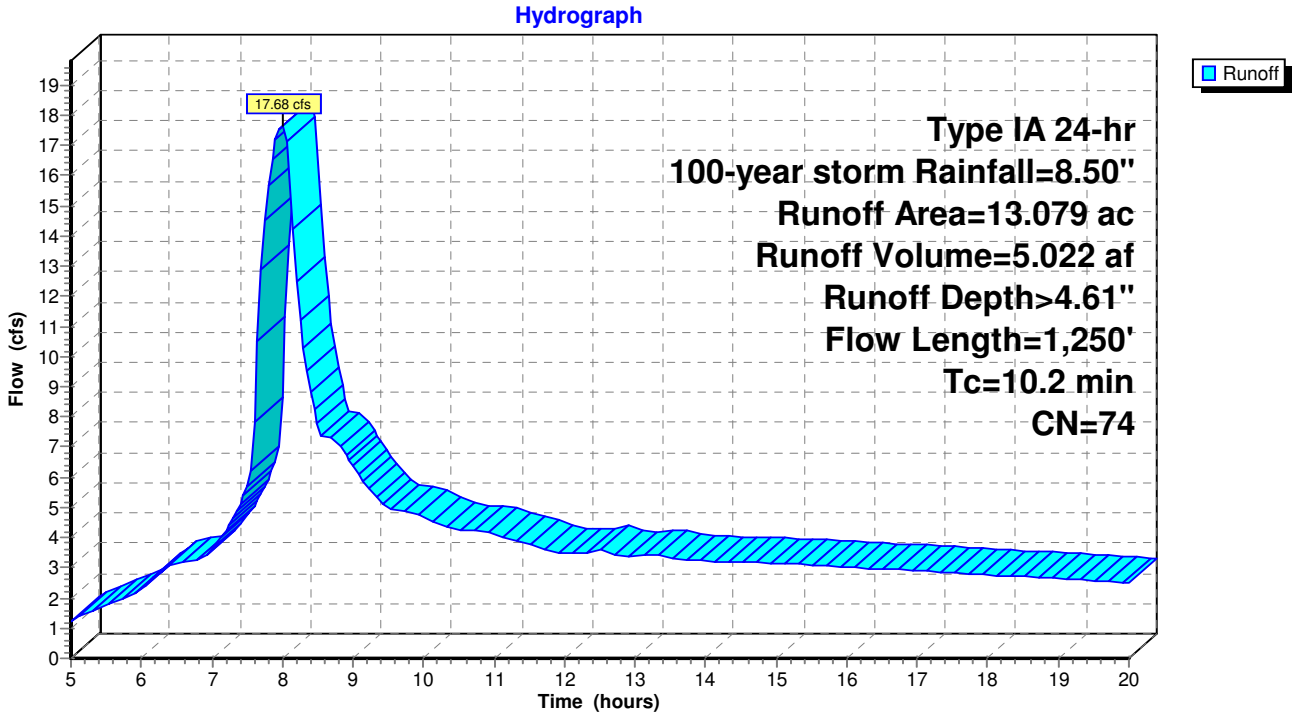
Runoff = 17.68 cfs @ 7.99 hrs, Volume= 5.022 af, Depth> 4.61"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr 100-year storm Rainfall=8.50"

Area (ac)	CN	Description
* 0.001	0	, HSG C
0.078	82	Farmsteads, HSG C
0.138	89	Gravel roads, HSG C
0.001	79	Pasture/grassland/range, Fair, HSG C
0.043	84	Pasture/grassland/range, Fair, HSG D
3.238	74	Pasture/grassland/range, Good, HSG C
1.481	80	Pasture/grassland/range, Good, HSG D
0.421	92	Paved roads w/open ditches, 50% imp, HSG C
0.144	93	Paved roads w/open ditches, 50% imp, HSG D
0.536	75	Vineyard, Good, HSG C
5.447	70	Woods, Good, HSG C
1.551	77	Woods, Good, HSG D
13.079	74	Weighted Average
12.796		97.84% Pervious Area
0.283		2.16% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.4	28	0.0500	0.06		**Sheet Flow, SHEET** Woods: Dense underbrush n= 0.800 P2= 3.97"
1.0	468	0.2500	8.05		**Shallow Concentrated Flow, SHALLOW** Unpaved Kv= 16.1 fps
0.0	20	0.1500	9.14	7.18	**Pipe Channel, 12" CMP CULVERT** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.025 Corrugated metal
0.4	439	0.2100	18.00	287.98	**Trap/Vee/Rect Channel Flow, CHANNEL 1** Bot.W=2.00' D=2.00' Z= 2.0 & 4.0 '/' Top.W=14.00' n= 0.040
0.4	295	0.0800	11.11	177.75	**Trap/Vee/Rect Channel Flow, CHANNEL 2** Bot.W=2.00' D=2.00' Z= 2.0 & 4.0 '/' Top.W=14.00' n= 0.040
10.2	1,250	Total			

Subcatchment WS 1: Subcat WS 1





Subcat WS 2

Subcat Reach Pond Link

Routing Diagram for Three Twins Pre-Project Hydrology
Prepared by PPI Engineering., Printed 11/1/2018
HydroCAD® 10.00-17 s/n 09429 © 2016 HydroCAD Software Solutions LLC

Summary for Subcatchment WS 2: Subcat WS 2

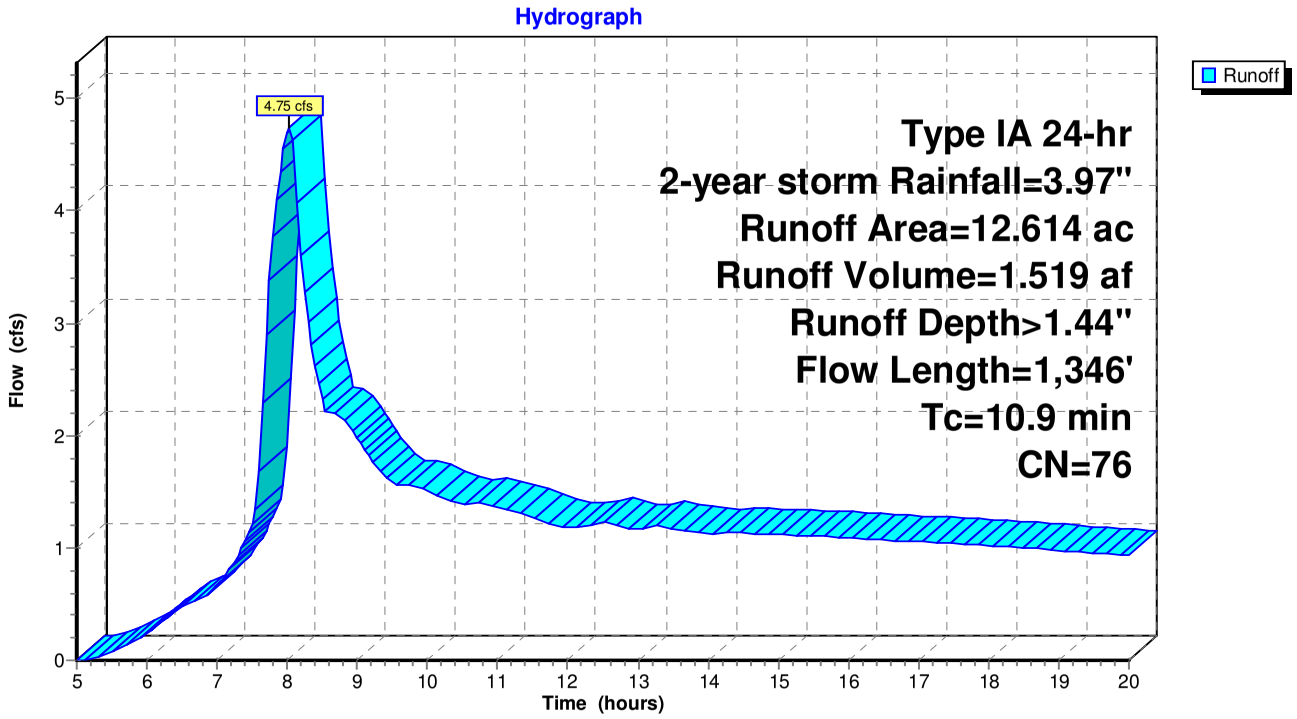
Runoff = 4.75 cfs @ 8.03 hrs, Volume= 1.519 af, Depth> 1.44"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr 2-year storm Rainfall=3.97"

	Area (ac)	CN	Description
*	0.000	0	, HSG C
	0.487	82	Farmsteads, HSG C
	0.096	86	Farmsteads, HSG D
	0.174	89	Gravel roads, HSG C
	0.110	91	Gravel roads, HSG D
	2.538	79	Pasture/grassland/range, Fair, HSG C
	0.281	84	Pasture/grassland/range, Fair, HSG D
	0.426	74	Pasture/grassland/range, Good, HSG C
	0.920	79	Vineyard, Fair, HSG C
	1.202	84	Vineyard, Fair, HSG D
	5.768	70	Woods, Good, HSG C
	0.612	77	Woods, Good, HSG D
	12.614	76	Weighted Average
	12.614		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.3	43	0.1200	0.09		**Sheet Flow, SHEET** Woods: Dense underbrush n= 0.800 P2= 3.97"
1.8	562	0.1100	5.34		**Shallow Concentrated Flow, SHALLOW** Unpaved Kv= 16.1 fps
0.8	741	0.1600	16.14	322.78	**Trap/Vee/Rect Channel Flow, CHANNEL** Bot.W=3.00' D=2.00' Z= 2.0 & 5.0 '/' Top.W=17.00' n= 0.040
10.9	1,346	Total			

Subcatchment WS 2: Subcat WS 2



Summary for Subcatchment WS 2: Subcat WS 2

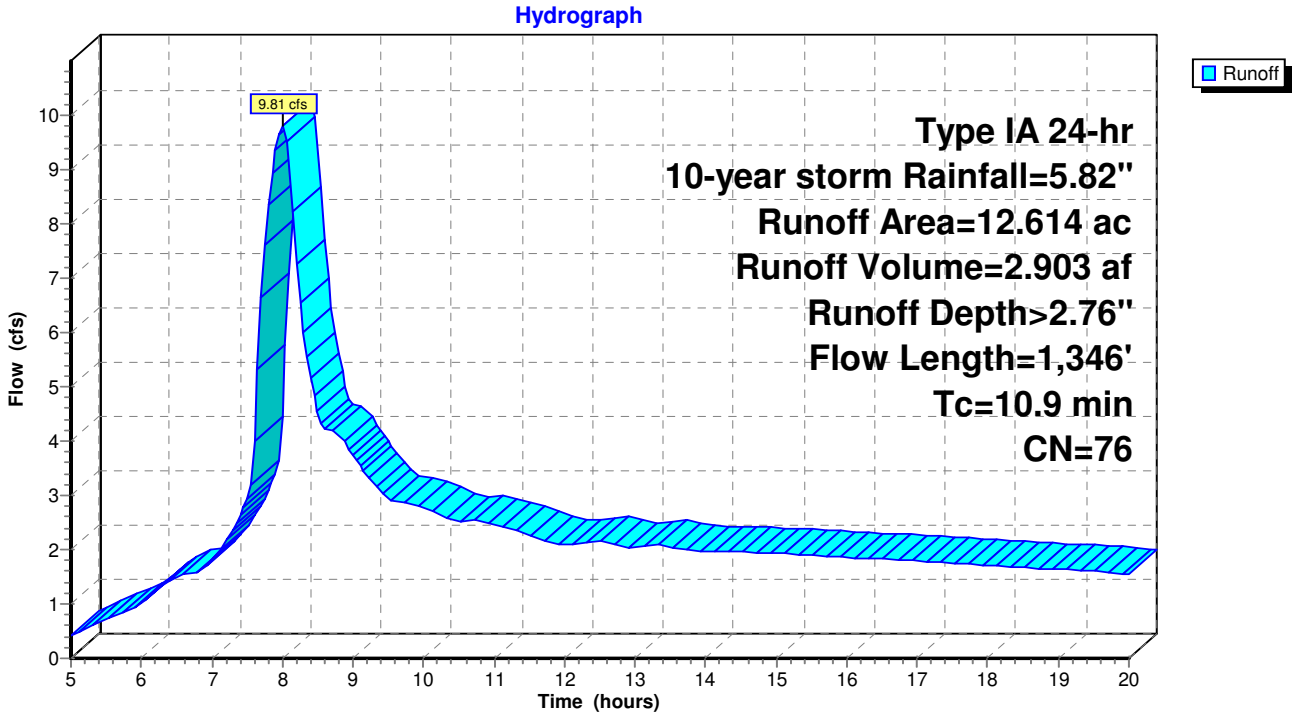
Runoff = 9.81 cfs @ 8.02 hrs, Volume= 2.903 af, Depth> 2.76"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr 10-year storm Rainfall=5.82"

	Area (ac)	CN	Description
*	0.000	0	, HSG C
	0.487	82	Farmsteads, HSG C
	0.096	86	Farmsteads, HSG D
	0.174	89	Gravel roads, HSG C
	0.110	91	Gravel roads, HSG D
	2.538	79	Pasture/grassland/range, Fair, HSG C
	0.281	84	Pasture/grassland/range, Fair, HSG D
	0.426	74	Pasture/grassland/range, Good, HSG C
	0.920	79	Vineyard, Fair, HSG C
	1.202	84	Vineyard, Fair, HSG D
	5.768	70	Woods, Good, HSG C
	0.612	77	Woods, Good, HSG D
	12.614	76	Weighted Average
	12.614		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.3	43	0.1200	0.09		**Sheet Flow, SHEET** Woods: Dense underbrush n= 0.800 P2= 3.97"
1.8	562	0.1100	5.34		**Shallow Concentrated Flow, SHALLOW** Unpaved Kv= 16.1 fps
0.8	741	0.1600	16.14	322.78	**Trap/Vee/Rect Channel Flow, CHANNEL** Bot.W=3.00' D=2.00' Z= 2.0 & 5.0 '/' Top.W=17.00' n= 0.040
10.9	1,346	Total			

Subcatchment WS 2: Subcat WS 2



Summary for Subcatchment WS 2: Subcat WS 2

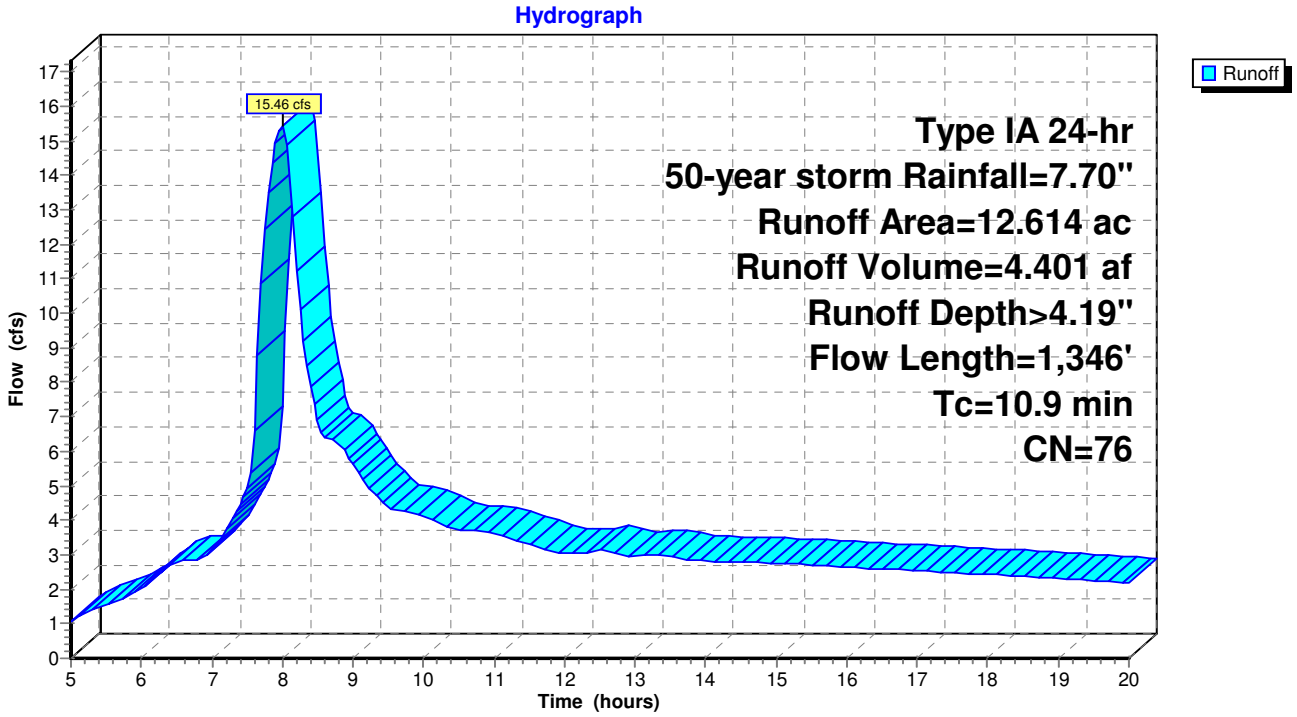
Runoff = 15.46 cfs @ 8.00 hrs, Volume= 4.401 af, Depth> 4.19"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr 50-year storm Rainfall=7.70"

	Area (ac)	CN	Description
*	0.000	0	, HSG C
	0.487	82	Farmsteads, HSG C
	0.096	86	Farmsteads, HSG D
	0.174	89	Gravel roads, HSG C
	0.110	91	Gravel roads, HSG D
	2.538	79	Pasture/grassland/range, Fair, HSG C
	0.281	84	Pasture/grassland/range, Fair, HSG D
	0.426	74	Pasture/grassland/range, Good, HSG C
	0.920	79	Vineyard, Fair, HSG C
	1.202	84	Vineyard, Fair, HSG D
	5.768	70	Woods, Good, HSG C
	0.612	77	Woods, Good, HSG D
	12.614	76	Weighted Average
	12.614		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.3	43	0.1200	0.09		**Sheet Flow, SHEET** Woods: Dense underbrush n= 0.800 P2= 3.97"
1.8	562	0.1100	5.34		**Shallow Concentrated Flow, SHALLOW** Unpaved Kv= 16.1 fps
0.8	741	0.1600	16.14	322.78	**Trap/Vee/Rect Channel Flow, CHANNEL** Bot.W=3.00' D=2.00' Z= 2.0 & 5.0 '/' Top.W=17.00' n= 0.040
10.9	1,346	Total			

Subcatchment WS 2: Subcat WS 2



Summary for Subcatchment WS 2: Subcat WS 2

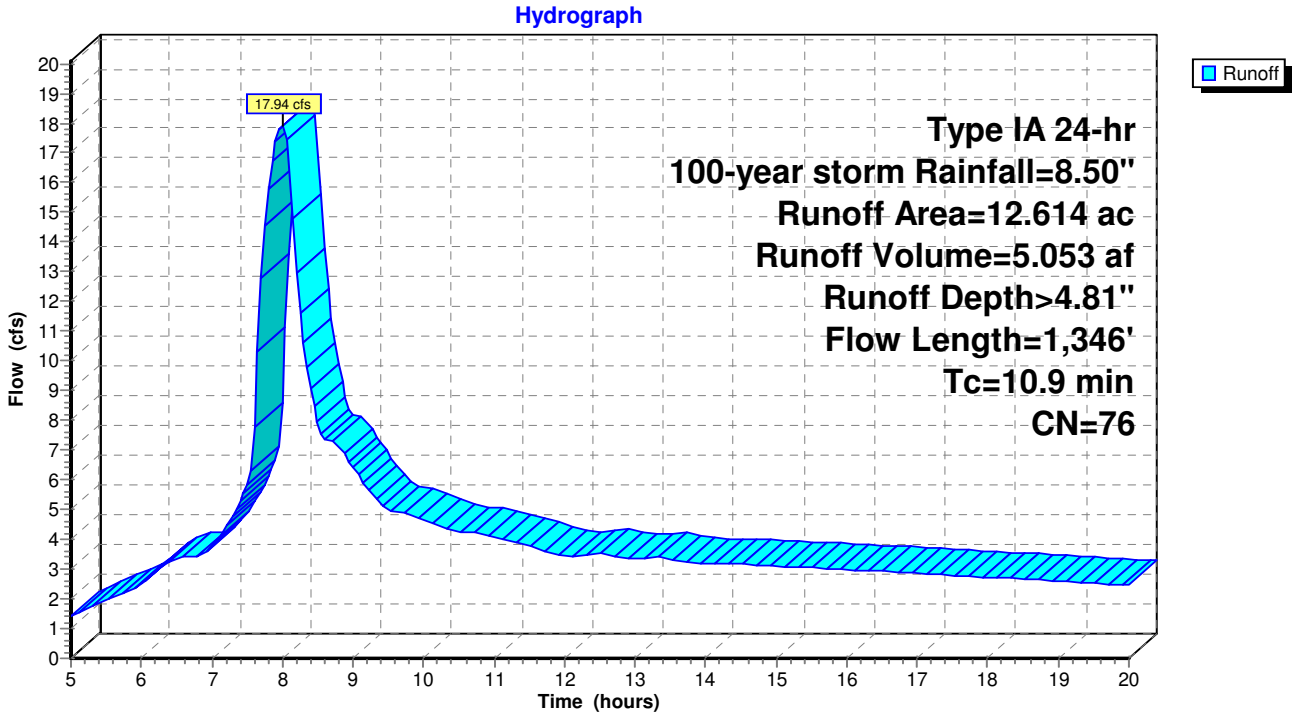
Runoff = 17.94 cfs @ 8.00 hrs, Volume= 5.053 af, Depth> 4.81"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr 100-year storm Rainfall=8.50"

	Area (ac)	CN	Description
*	0.000	0	, HSG C
	0.487	82	Farmsteads, HSG C
	0.096	86	Farmsteads, HSG D
	0.174	89	Gravel roads, HSG C
	0.110	91	Gravel roads, HSG D
	2.538	79	Pasture/grassland/range, Fair, HSG C
	0.281	84	Pasture/grassland/range, Fair, HSG D
	0.426	74	Pasture/grassland/range, Good, HSG C
	0.920	79	Vineyard, Fair, HSG C
	1.202	84	Vineyard, Fair, HSG D
	5.768	70	Woods, Good, HSG C
	0.612	77	Woods, Good, HSG D
	12.614	76	Weighted Average
	12.614		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.3	43	0.1200	0.09		**Sheet Flow, SHEET** Woods: Dense underbrush n= 0.800 P2= 3.97"
1.8	562	0.1100	5.34		**Shallow Concentrated Flow, SHALLOW** Unpaved Kv= 16.1 fps
0.8	741	0.1600	16.14	322.78	**Trap/Vee/Rect Channel Flow, CHANNEL** Bot.W=3.00' D=2.00' Z= 2.0 & 5.0 '/' Top.W=17.00' n= 0.040
10.9	1,346	Total			

Subcatchment WS 2: Subcat WS 2





Subcat WS 2

Subcat Reach Pond Link

Routing Diagram for Three Twins Post-Project Hydrology
Prepared by PPI Engineering., Printed 11/1/2018
HydroCAD® 10.00-17 s/n 09429 © 2016 HydroCAD Software Solutions LLC

Summary for Subcatchment WS 2: Subcat WS 2

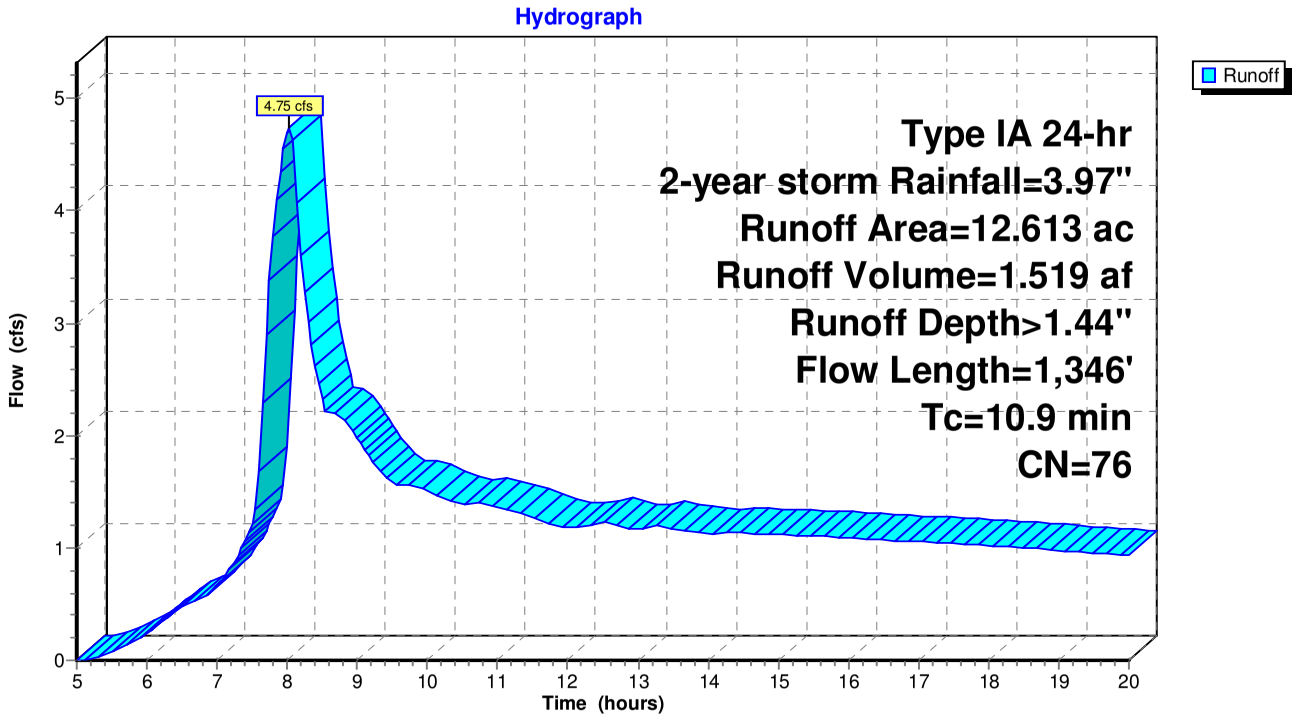
Runoff = 4.75 cfs @ 8.03 hrs, Volume= 1.519 af, Depth> 1.44"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr 2-year storm Rainfall=3.97"

	Area (ac)	CN	Description
*	0.000	0	, HSG C
	0.487	82	Farmsteads, HSG C
	0.096	86	Farmsteads, HSG D
	0.174	89	Gravel roads, HSG C
	0.110	91	Gravel roads, HSG D
	1.386	79	Pasture/grassland/range, Fair, HSG C
	0.281	84	Pasture/grassland/range, Fair, HSG D
	0.426	74	Pasture/grassland/range, Good, HSG C
	0.920	79	Vineyard, Fair, HSG C
	1.202	84	Vineyard, Fair, HSG D
	1.932	75	Vineyard, Good, HSG C
	4.988	70	Woods, Good, HSG C
	0.611	77	Woods, Good, HSG D
	12.613	76	Weighted Average
	12.613		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.3	43	0.1200	0.09		**Sheet Flow, SHEET** Woods: Dense underbrush n= 0.800 P2= 3.97"
1.8	562	0.1100	5.34		**Shallow Concentrated Flow, SHALLOW** Unpaved Kv= 16.1 fps
0.8	741	0.1600	16.14	322.78	**Trap/Vee/Rect Channel Flow, CHANNEL** Bot.W=3.00' D=2.00' Z= 2.0 & 5.0 '/' Top.W=17.00' n= 0.040
10.9	1,346	Total			

Subcatchment WS 2: Subcat WS 2



Summary for Subcatchment WS 2: Subcat WS 2

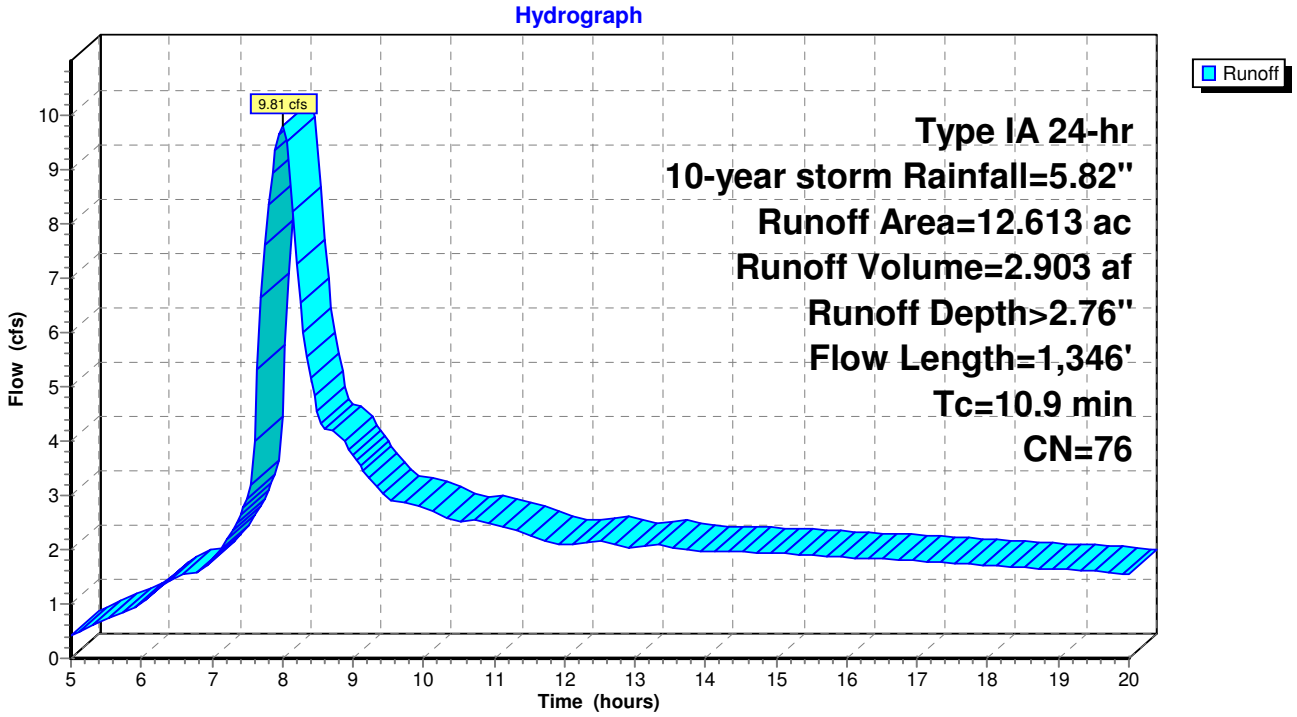
Runoff = 9.81 cfs @ 8.02 hrs, Volume= 2.903 af, Depth> 2.76"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr 10-year storm Rainfall=5.82"

	Area (ac)	CN	Description
*	0.000	0	, HSG C
	0.487	82	Farmsteads, HSG C
	0.096	86	Farmsteads, HSG D
	0.174	89	Gravel roads, HSG C
	0.110	91	Gravel roads, HSG D
	1.386	79	Pasture/grassland/range, Fair, HSG C
	0.281	84	Pasture/grassland/range, Fair, HSG D
	0.426	74	Pasture/grassland/range, Good, HSG C
	0.920	79	Vineyard, Fair, HSG C
	1.202	84	Vineyard, Fair, HSG D
	1.932	75	Vineyard, Good, HSG C
	4.988	70	Woods, Good, HSG C
	0.611	77	Woods, Good, HSG D
	12.613	76	Weighted Average
	12.613		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.3	43	0.1200	0.09		**Sheet Flow, SHEET** Woods: Dense underbrush n= 0.800 P2= 3.97"
1.8	562	0.1100	5.34		**Shallow Concentrated Flow, SHALLOW** Unpaved Kv= 16.1 fps
0.8	741	0.1600	16.14	322.78	**Trap/Vee/Rect Channel Flow, CHANNEL** Bot.W=3.00' D=2.00' Z= 2.0 & 5.0 '/' Top.W=17.00' n= 0.040
10.9	1,346	Total			

Subcatchment WS 2: Subcat WS 2



Summary for Subcatchment WS 2: Subcat WS 2

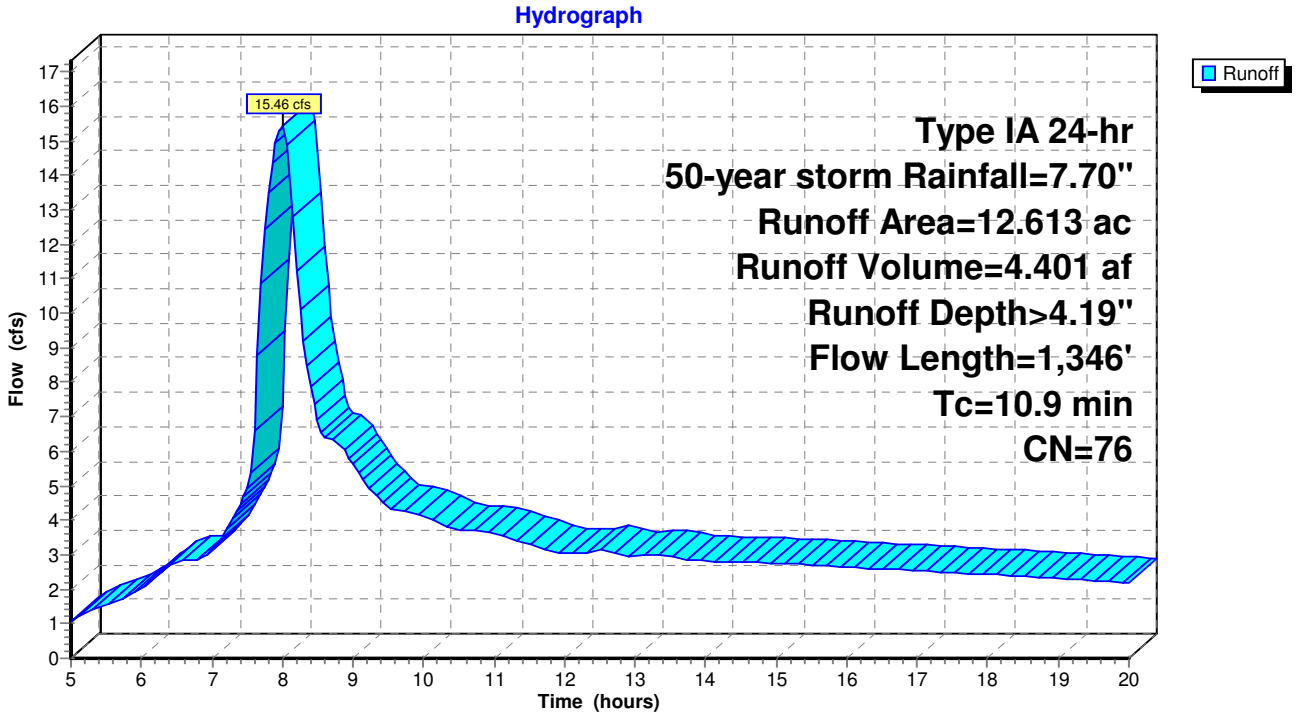
Runoff = 15.46 cfs @ 8.00 hrs, Volume= 4.401 af, Depth> 4.19"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr 50-year storm Rainfall=7.70"

	Area (ac)	CN	Description
*	0.000	0	, HSG C
	0.487	82	Farmsteads, HSG C
	0.096	86	Farmsteads, HSG D
	0.174	89	Gravel roads, HSG C
	0.110	91	Gravel roads, HSG D
	1.386	79	Pasture/grassland/range, Fair, HSG C
	0.281	84	Pasture/grassland/range, Fair, HSG D
	0.426	74	Pasture/grassland/range, Good, HSG C
	0.920	79	Vineyard, Fair, HSG C
	1.202	84	Vineyard, Fair, HSG D
	1.932	75	Vineyard, Good, HSG C
	4.988	70	Woods, Good, HSG C
	0.611	77	Woods, Good, HSG D
	12.613	76	Weighted Average
	12.613		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.3	43	0.1200	0.09		**Sheet Flow, SHEET** Woods: Dense underbrush n= 0.800 P2= 3.97"
1.8	562	0.1100	5.34		**Shallow Concentrated Flow, SHALLOW** Unpaved Kv= 16.1 fps
0.8	741	0.1600	16.14	322.78	**Trap/Vee/Rect Channel Flow, CHANNEL** Bot.W=3.00' D=2.00' Z= 2.0 & 5.0 '/' Top.W=17.00' n= 0.040
10.9	1,346	Total			

Subcatchment WS 2: Subcat WS 2



Summary for Subcatchment WS 2: Subcat WS 2

Runoff = 17.94 cfs @ 8.00 hrs, Volume= 5.053 af, Depth> 4.81"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type IA 24-hr 100-year storm Rainfall=8.50"

	Area (ac)	CN	Description
*	0.000	0	, HSG C
	0.487	82	Farmsteads, HSG C
	0.096	86	Farmsteads, HSG D
	0.174	89	Gravel roads, HSG C
	0.110	91	Gravel roads, HSG D
	1.386	79	Pasture/grassland/range, Fair, HSG C
	0.281	84	Pasture/grassland/range, Fair, HSG D
	0.426	74	Pasture/grassland/range, Good, HSG C
	0.920	79	Vineyard, Fair, HSG C
	1.202	84	Vineyard, Fair, HSG D
	1.932	75	Vineyard, Good, HSG C
	4.988	70	Woods, Good, HSG C
	0.611	77	Woods, Good, HSG D
	12.613	76	Weighted Average
	12.613		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.3	43	0.1200	0.09		**Sheet Flow, SHEET** Woods: Dense underbrush n= 0.800 P2= 3.97"
1.8	562	0.1100	5.34		**Shallow Concentrated Flow, SHALLOW** Unpaved Kv= 16.1 fps
0.8	741	0.1600	16.14	322.78	**Trap/Vee/Rect Channel Flow, CHANNEL** Bot.W=3.00' D=2.00' Z= 2.0 & 5.0 '/' Top.W=17.00' n= 0.040
10.9	1,346	Total			

Subcatchment WS 2: Subcat WS 2

