Appendix G-5: Camas Solar Project Drainage Report

Tuusso Energy
Camas Solar Project:
DRAINAGE REPORT

Date: July 2017

Prepared by:
Encompass Engineering & Surveying
407 Swiftwater Blvd
Cle Elum, WA 98922

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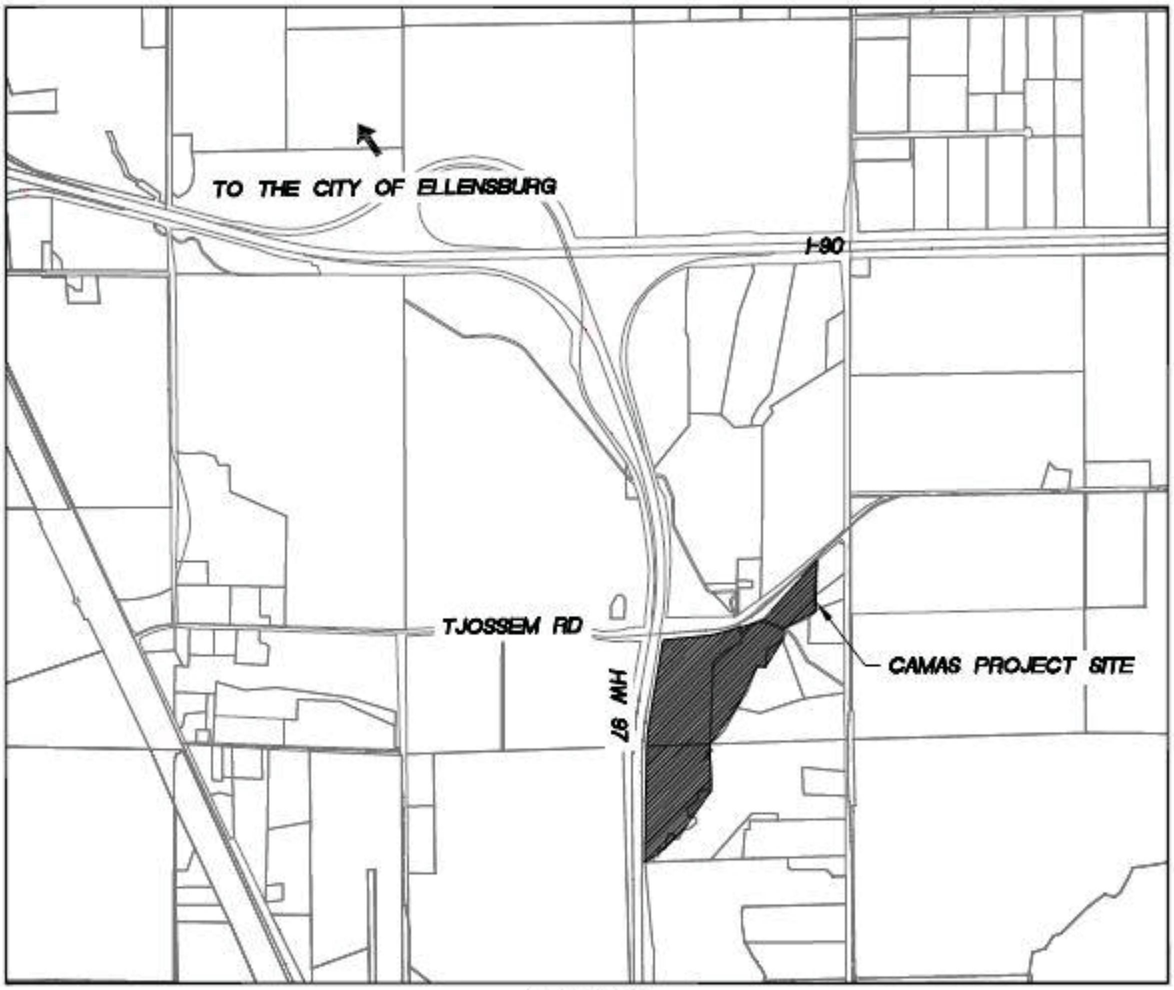
I. INTRODUCTION

Per Kittitas County assessor records the Tuusso Energy: Camas Solar Project site is comprised of Tax Parcel Nos. 50233, 10566, 20568, and 920233, at 2100 Tjossem Road in Ellensburg, WA, in the SE ¼ of Section 18 and the NE ¼ of Section 19, Township 17 North, Range 19 East W.M. The project site is 51.21 acres and currently used as agricultural land to produce hay. See Vicinity Map below.



VICINITY MAP

The purpose of this project is to convert the site to photovoltaic solar project with minimal change to the existing topography and site features. The proposed site will consist of rows of modular trackers with solar panels, all-weather access roads, and inverter stations to convert power from the solar panels. The solar panels are attached to horizontal supports that run north-south, and the panels themselves rotate east to west, in order to maximize sun exposure. Access to the site is from the north of the site, off of Tjossem Road.

II. EXISTING CONDITIONS

The site is currently an open field used to make hay using flood irrigation methods. The overall topography of the site gently slopes to the south. The surface water that does not infiltrate flows to the south. The western edge of the site is bordered by an irrigation ditch flowing to the south, while a second irrigation ditch flows southwest along the southeastern edge of the site. These irrigation ditches meet at the southwest corner of the site before crossing under HWY 82 in existing irrigation infrastructure. A third irrigation ditch runs southeast through the northern portion of the site. Existing conditions can be seen in Figure 1.

a. Drainage Basins

For the purpose of this report, the site is considered to be made up of two drainage basins, which can be seen in Figure 1. Drainage Basin 1 captures the majority of the site, and it includes everything that is south and west or the irrigation ditch that runs through the northern portion of the site. Drainage Basin 2 is the small, northeast portion of the site that is separated from the rest of the site by a prominent irrigation ditch, as previously mentioned. All of the runoff is either infiltrated on-site or flows to the south/southwest. The existing drainage currently has a barn on it which results in 0.06 acres of impervious area on the site, while the remaining 51.15 acres are pervious.

b. Downstream Analysis

As noted above, all runoff from the site flows into the existing irrigation ditch that leaves the site at the southwest corner of the site and flows under HWY 82. This ditch is currently maintained by the current landowner. The irrigation ditch is part of a larger irrigation network that serves the rural areas south of Ellensburg. As this ditch is an irrigation facility, the flow rates are currently controlled as needed. The ditch flows south from the site for approximately ½ mile before discharging into Naneum Creek and then Wilson Creek. No issues have been brought up in relation to the existing irrigation infrastructure downstream of the project site.

c. Soil Report

An NRCS Web Soil Survey was performed for the site in order to obtain onsite soil types. The results of the reports give descriptions of the soils found in the project area and the corresponding hydrologic soil groups. The results can be seen in APPENDIX A. The site is composed of Opnish ashy loam, Mitta ashy silt loam, and Nosal ashy silt loam, all with 0-2% slopes. Opnish ashy loam and Mitta ashy silt loam belong to Hydrologic Soil Group C. Nosal ashy silt loam is classified as Group C for drained areas and Group D for undrained areas. For this study, it is considered Group D, which is the more conservative classification.

III. PROPOSED CONDITIONS

The proposed development on this site consists of adding solar trackers, access roads, fencing, and associated electrical infrastructure. The new impervious surface will be a portion of the solar trackers (described below), the proposed all-weather access roads (which may be compacted soil or gravel) that will run northeast/southwest through the site, and the electrical infrastructure that is made up of five inverters and one utility disconnect with a project metering location. Each inverter and the utility disconnect, resides on its own concrete pad. The access roads were conservatively modeled as gravel roads.

a. <u>Solar Panel Array</u>

A series of modular trackers will be installed throughout the site. Each tracker is essentially a long horizontal support (of various lengths), held in place by evenly spaced driven H-beams. The trackers are oriented north-south, with solar panels attached to the entire length of the tracker. The solar panels rotate and tilt east to west to maximize sun exposure. The panels will generate runoff within the site, however, due to the way the panels tilt and that they are not continuous structures, they are not considered impervious in the proposed conditions calculations. The panels do not reduce available ground surface for infiltration. The ground below the solar panels will have native plantings, and therefore it will continue to intercept and infiltrate runoff water from the panels. The only impervious area due to the solar panels is from the posts in the ground upon which the solar panels are attached. For impervious calculations, the posts are conservatively estimated to make up 5% of the total area of the solar tracker configuration.

b. <u>Drainage Basin</u>

Minimal grading and ground disturbance will take place as part of this project. The access roads, concrete pads for the electrical infrastructure, and solar tracker posts are the only impervious surfaces proposed for the site. The portion of the solar panel array installation that actually disturbs the ground is very minimal as well. Because of this, existing topography and drainage patterns will remain relatively undisturbed, and the proposed drainage basins encompass the same area as the existing drainage basins. Proposed conditions can be seen in Figure 2.

IV. HYDROLOGIC MODELING- SANTA BARBARA URBAN HYDROGRAPH METHOD

Hydrologic analysis for the proposed project is consistent with Title 12 of the Kittitas County Code and the 2004 *SWMMEW*. In order to properly analyze the impacts of the proposed development on the watershed, runoff modeling was done using the Santa Barbara Urban Hydrograph method (SBUH), SCS Type 1A 24-hour storm event for Region 2 per the 2004 *SWMMEW*. This was done to determine peak runoff during the 2-year, 10-year, 25-year and 100-year storm events. Calculations were performed utilizing HydroCAD version 10.00-18, which is accepted by the Department of Ecology as a proper simulation modeling program.

a. <u>Precipitation</u>

The precipitation information used for the pre-development and post-development run-off calculations is based on the isopluvial maps provided in the 2004 *SWMMEW* and can be seen in APPENDIX B. The inputs for this project site south of Ellensburg are seen below:

P_{2yr} = 1.0”
P_{10yr} = 1.2”
P_{25yr} = 1.6”
P_{100yr} = 2.0”

b. <u>Curve Number</u>

The SCS Curve Number (CN) is a function of the soil type and ground cover. It is used to determine the portion of the precipitation depth that will be conveyed as runoff. The curve numbers are pulled from *Technical Release 55 Urban Hydrology for Small Watersheds*, and the curve numbers used can be seen in Table 1.

Table 1: Curve Numbers Used

DESCRIPTION	HYDROLOGIC SOIL GROUP			
	A	B	C	D
Meadow	30	58	71	78
Impervious areas	98	98	98	98
Gravel Roads	76	85	89	91

Using the soils report and the curve number table, a composite curve number was determined for the proposed and existing basins. A detailed curve number breakdown can be seen in APPENDIX C. Calculations can also be seen in APPENDIX D and E as part of the HydroCAD report.

c. Time of Concentration

Time of concentration is the time it takes for the runoff to get from the most hydrologically distant location to the point of collection for the basin. The flow path is broken up into three segments, with the hydrologic travel time calculated separate for each segment.

- Sheet flow- flow over plane surfaces which usually occurs at the headwaters of a catchment area. The maximum allowable length for sheet flow is 300-ft
- Shallow concentrated flow-flow in headwater areas where flow begins to concentrate in small rills or rough channels
- Channel flow- flow that is concentrated in defined channels

The time of concentration is the total of the travel times for each flow segment. Time of concentration calculations can be seen in APPENDIX D and E as part of the HydroCAD report.

d. Flow Calculations

HydroCAD uses all of the inputs described above in order to determine the peak flows for various storm events. All the inputs are combined to create an instantaneous hydrograph which is then routed through a modeled reservoir with a time delay equal to the time of concentration in order to generate the runoff hydrograph. The runoff hydrograph can be found in APPENDIX D and E as part of the HydroCAD report. The peak runoff values for the 2, 10, 25 and 100-year storms can be seen below in Table 2.

Table 2: Flow rates

Q (cfs)				
Time Span	**2-yr**	10-yr	**25-yr**	100-yr
Existing Basin 1	**0.07**	0.17	**0.50**	1.09
Existing Basin 2	**0.01**	0.02	**0.06**	0.13
Proposed Basin 1	**0.09**	0.20	**0.57**	1.20
Proposed Basin 2	**0.01**	0.02	**0.07**	0.15

V. HYDROLOGIC ANALYSIS

As seen in the calculated peak flow rates, the increased runoff due to proposed site development is minimal. The 2-yr peak flow is increased by 0.02 cfs for Basin 1, while it remains unchanged for Basin 2. The 25-yr peak flow is increased by 0.07 cfs and 0.01 cfs for Basins 1 and 2 respectively. Typically, *SWMMEW* requires developments to release runoff at or below one half of the existing 2-yr peak flow and at or below the existing 25-yr peak flow, as well as for that runoff to be treated.

Per Chapter 2.2.6 of the *SWMMEW* there are exemptions for new development when flow control is not required as long as certain conditions are met. Per chapter 2.6.6 exemption 1, states: "Any project able to disperse, without discharging to surface waters, the total 25-year runoff volume for the proposed development condition" is exempt from meeting the flow control requirements. The Camas project will use full dispersion as the main way to handle increased flows due to impervious areas. As outlined in *SWMMEW* Chapter 6.5, BMP F6.42, full dispersion allows up to 10% of the site that is impervious to be characterized as non-effective impervious area by dispersing runoff into the native vegetation area. On the Camas site, the impervious areas conservatively make up to 4.0% of the site while the rest of the site maintains plantings similar to existing vegetation. This is under the 10% threshold, making full dispersion a viable option.

Chapter 2.2.5 of the *SWMMEW* summarizes the requirements for treating storm water runoff to reduce pollutant loads and concentrations. Runoff treatment is required for all projects creating 5,000 square feet or more of pollutant-generating impervious surfaces (PGIS). The Camas site is not classified as a high use site and all of the proposed impervious surfaces are considered Non-Pollutant Generating Impervious Surfaces (NPGIS). Infrequently used maintenance access roads are classified as NPGIS, and thus are exempt from basic treatment requirements. The solar panels are detached impervious surfaces which the water flows off of and into natural vegetation below. The inverter pads are concrete pads, which the inverters and transformers sit on. The inverters contain no fluids. The transformers may be "dry", meaning they contain no fluids, or they may contain fluids, that has not been finalized yet. If they do contain fluid, it would be Envirotemp or a similar biodegradable vegetable based coolant. Therefore, the inverter pads will be considered NPGIS as well, however if that classification is challenged, they make up no more than 3,600 square feet, which is below the 5,000 square feet threshold. The Camas site meets the exemption requirement, and therefore no treatment measures will be necessary or put in place.

While analyzing the effects of increased storm water runoff, it is also important to note any other changes that will occur on the site due to the development. One thing of note on the Camas site is that it is currently cultivated using flood irrigation methods. In this method, an excess amount of water is applied to the site for irrigation, and the general assumption is that half of the applied water actually goes to the crop while the other half is lost to evaporation, runoff, infiltration or transpiration (*Alliance for Water Efficiency: Flood Irrigation Introduction*). With the construction of this project, the flood irrigation will be minimized, if not stopped completely. The net loss of surface water due to reducing flood irrigation will be greater than the minimal increases in stormwater runoff due to the construction associated with the solar panel farm. Therefore, the additional runoff of the peak 2-yr and 25-yr storms of 0.02 and 0.07 cfs respectively, is considered negligible when analyzing the site as a whole.

VI. COMPLIANCE WITH *SWMMEW* CORE ELEMENTS

All new development projects must comply with the 8 Core Elements outlined in Chapter 2 in the *SWMMEW* when applicable. Exemptions exist for each Core Element and vary depending on requirements that must be met. The Core Elements are listed below in relation to the proposed development of the Tuusso Energy: Camas Solar Project, and exemptions are noted when applicable

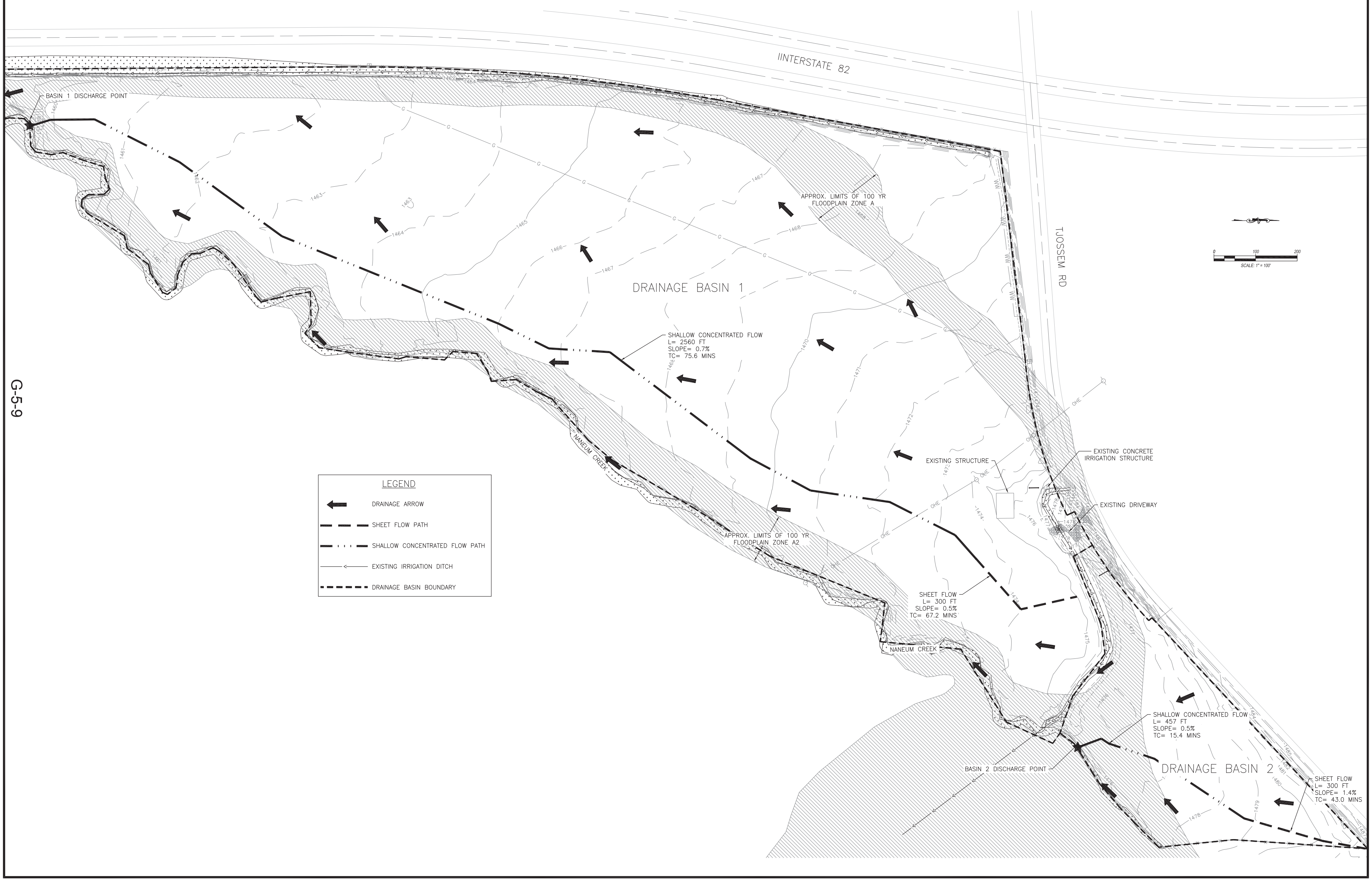
1. Preparation of a Stormwater Site Plan:
    - This can be seen in Figure 2- Proposed Drainage Basin Map, and will be included in the civil plans.
2. Construction Stormwater Pollution Prevention:
    - This will be included as part of the SWPPP submittal.
3. Source Control Pollution
    - The only potential fluid on the site is a biodegradable vegetable based coolant, which is not classified as a pollutant. Therefore, no point source pollutants are on the site.
4. Preservation of Natural Drainage Systems
    - Minimal grading will occur on site and natural drainage patterns will be maintained.
5. Runoff Treatment
    - The site satisfies the requirement for full dispersion and is not a high use site, making it exempt from runoff treatment.
6. Flow Control
    - Per Exemption 1 in chapter 2.6.6 of *SWMMEW*, the site will use full dispersion to control the 2 and 25-yr flows.
7. Operation and Maintenance
    - No on-site maintenance is required for full dispersion. Maintenance of existing off-site drainage ditches will be performed by the current landowner.
8. Local Requirements
    - There are no local ordinances above and beyond what is outlined in *SWMMEW*

VII. CONCLUSION

The Tuusso Energy: Camas Solar Project involves transforming 51.21 acres of an existing hay field, into a solar project. The project consists of adding an array of solar panels, access roads, and the associated electrical infrastructure. Existing topography will be preserved to the maximum extent possible and native plantings will be made throughout the site. From a stormwater and drainage standpoint, the biggest impacts of the project will be from converting 2.06 acres into impervious surfaces in the form of all-weather access roads, electrical infrastructure, and posts for the solar trackers. 2.06 acres is an overestimate of impervious area, as it maxes out the percentage of impervious to pervious surfaces based on the design of the solar panel trackers. All site and location factors were taken into account in order to perform the SBUH hydrologic modelling method. The calculations from the modelling showed that the runoff generated from the 2-yr storm increased from 0.07 cfs to 0.09 cfs for Basin 1 while it remained at 0.01 cfs for Basin 2. Runoff generated from the 25-yr storm increased from 0.50 cfs to 0.57 cfs for Basin 1 and from 0.06 cfs to 0.07 cfs for Basin 2. This increased runoff can be handled by full dispersion throughout the site, due to protecting a majority of the existing vegetation. The increased runoff is also considered negligible, due to the reduction of flood irrigation to the site which will accompany the project.

TUUSSO ENERGY - CAMAS SITE

A PORTION OF THE SE 1/4 OF SECTION 18 AND THE NE 1/4 OF SECTION 19, T. 17 N., R. 19 E., W.M.
KITTITAS COUNTY, STATE OF WASHINGTON



TUUSSO ENERGY, LLC

CAMAS SITE

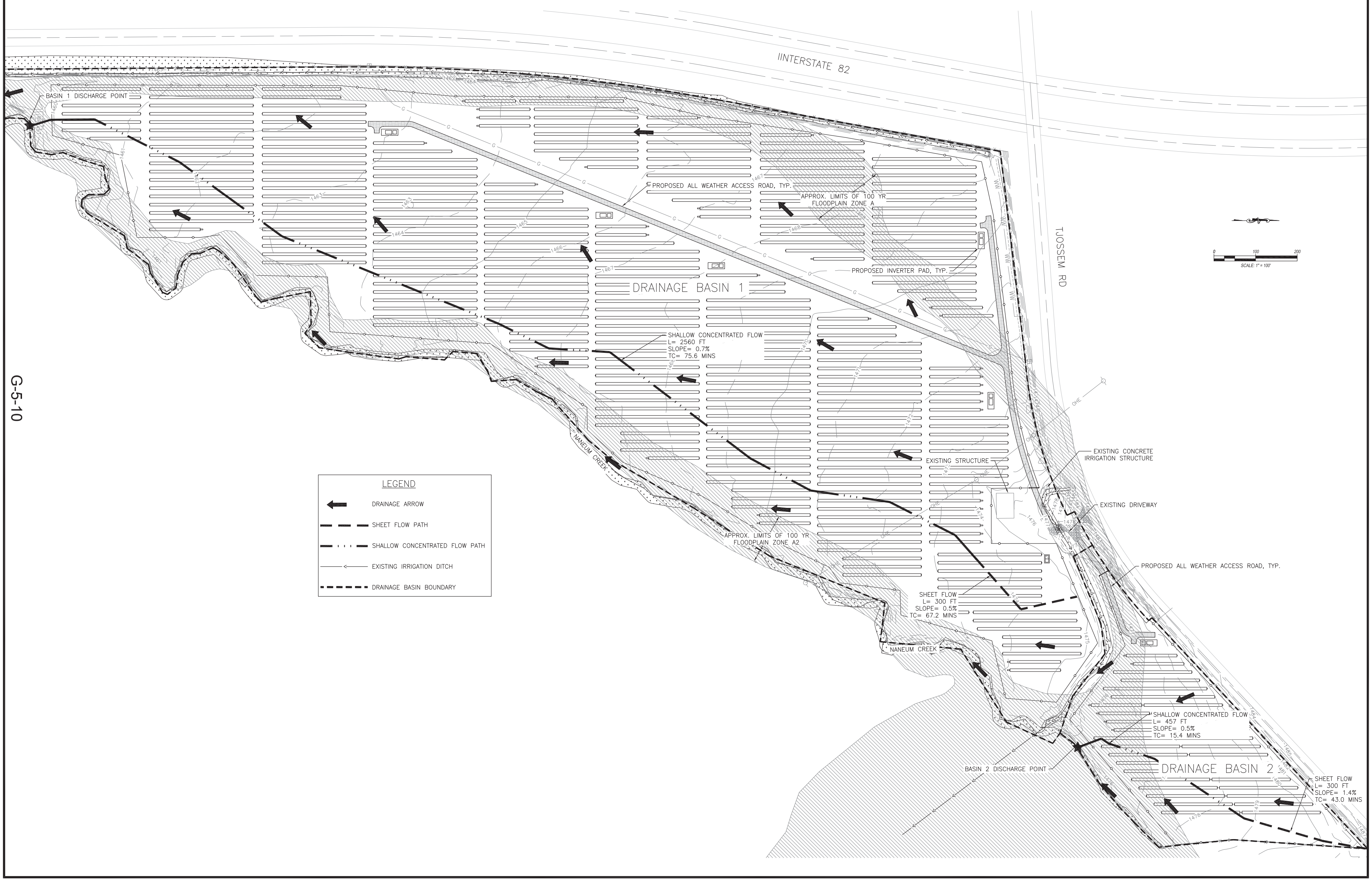
EXISTING DRAINAGE CONDITIONS

Encompass
ENGINEERING & SURVEYING
Western Washington Division
165 NE Juniper Street, Suite 201 ▪ Issaquah, WA 98027 ▪ Phone: (425) 392-0250 ▪ Fax: (425) 391-3055
Eastern Washington Division
407 Swiftwater Blvd. ▪ Cle Elum, WA 98922 ▪ Phone: (509) 674-7433 ▪ Fax: (509) 674-7419

JOB NO.	17017
DATE	July 2017
SCALE	AS SHOWN
DESIGNED	SF
DRAWN	SF
CHECKED	TML
APPROVED	TML
SHEET	FIG-1

TUUSSO ENERGY - CAMAS SITE

A PORTION OF THE SE 1/4 OF SECTION 18 AND THE NE 1/4 OF SECTION 19, T. 17 N., R. 19 E., W.M.
KITTITAS COUNTY, STATE OF WASHINGTON



TUUSSO ENERGY, LLC
CAMAS SITE

PROPOSED DRAINAGE CONDITIONS

Encompass
ENGINEERING & SURVEYING
Western Washington Division
165 NE Juniper Street, Suite 201 • Issaquah, WA 98027 • Phone: (425) 392-0250 • Fax: (425) 391-3055
Eastern Washington Division
407 Swiftwater Blvd. • Cle Elum, WA 98922 • Phone: (509) 674-7433 • Fax: (509) 674-7419

JOB NO.	17017
DATE	July 2017
SCALE	AS SHOWN
DESIGNED	SF
DRAWN	SF
CHECKED	TML
APPROVED	TML
SHEET	FIG-2

Appendix A:

NRCS WEB SOIL SURVEY


120° 30' 34" W
120° 29' 50" W
46° 57' 42" N
46° 57' 2" N
689500
689600
689700
689800
689900
690000
690100
690200
690300
690400
5203900
5203800
5203700
5203600
5203500
5203400
5203300
5203200
5203100
5203000
5202900
5202800
Tjossem Rd
635
838
791
82
Naneum Creek
Number 6 Rd
Soil Map may not be valid at this scale.
Map Scale: 1:5,970 if printed on A portrait (8.5" x 11") sheet.
N
Meters
0 50 100 200 300
Feet
0 250 500 1000 1500
Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 10N WGS84

MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Rating Polygons

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Lines

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Points

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Water Features

Streams and Canals

Transportation

- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background

Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Kittitas County Area, Washington
Survey Area Data: Version 9, Sep 9, 2016

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Jul 19, 2010—Aug 19, 2010

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Hydrologic Soil Group

Hydrologic Soil Group— Summary by Map Unit — Kittitas County Area, Washington (WA637)				
Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
635	Opnish ashy loam, 0 to 2 percent slopes	C	0.8	1.5%
791	Mitta ashy silt loam, drained, 0 to 2 percent slopes	C	41.1	80.3%
838	Nosal ashy silt loam, 0 to 2 percent slopes	C/D	9.3	18.3%
Totals for Area of Interest			**51.2**	**100.0%**

Description

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The soils in the United States are assigned to four groups (A, B, C, and D) and three dual classes (A/D, B/D, and C/D). The groups are defined as follows:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.

Rating Options

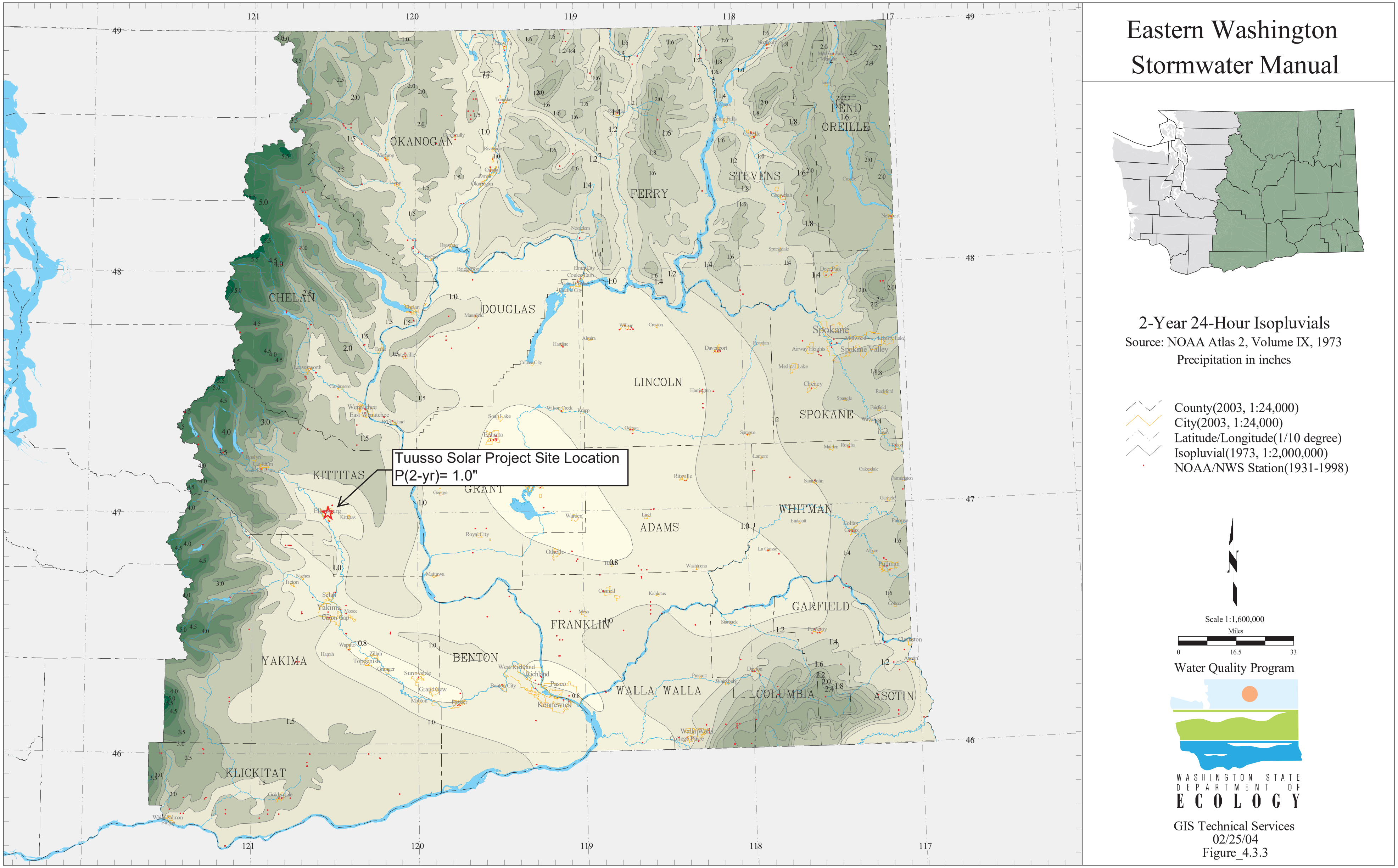
Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

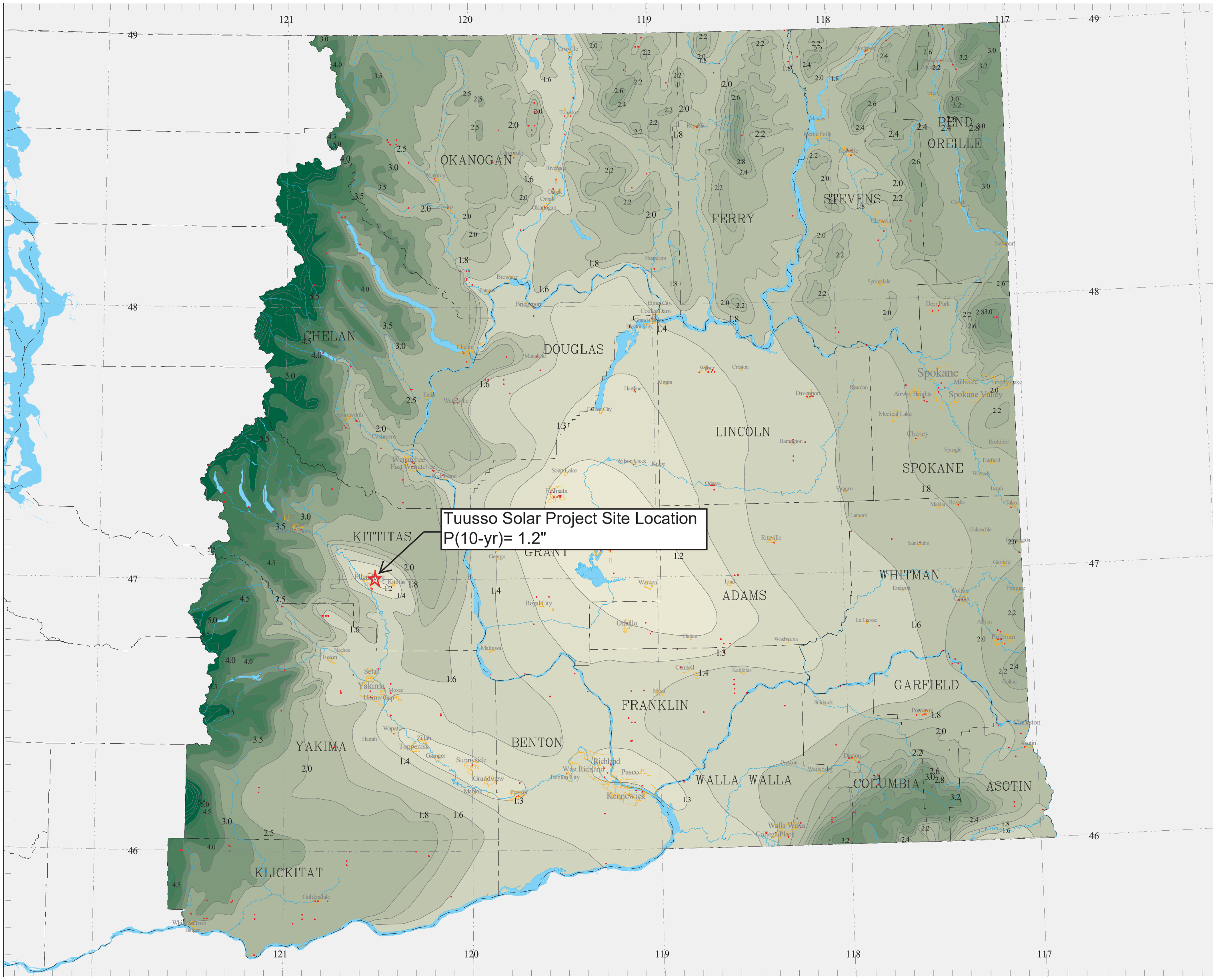
Tie-break Rule: Higher

Appendix B:

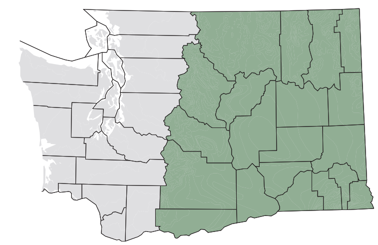
SWMMEW ISOPLUVIAL MAPS



Eastern Washington
Stormwater Manual
2-Year 24-Hour Isopluvials
Source: NOAA Atlas 2, Volume IX, 1973
Precipitation in inches
County(2003, 1:24,000)
City(2003, 1:24,000)
Latitude/Longitude(1/10 degree)
Isopluvial(1973, 1:2,000,000)
NOAA/NWS Station(1931-1998)
N
Scale 1:1,600,000
Miles
0
16.5
33
Water Quality Program
WASHINGTON STATE
DEPARTMENT OF
ECOLOGY
GIS Technical Services
02/25/04
Figure_4.3.3
Tuusso Solar Project Site Location
P(2-yr)= 1.0"
OKANOGAN
FERRY
STEVENS
PEND OREILLE
CHELAN
DOUGLAS
LINCOLN
SPOKANE
KITTITAS
GRANT
ADAMS
WHITMAN
YAKIMA
BENTON
FRANKLIN
GARFIELD
COLUMBIA
WALLA WALLA
ASOTIN
KLICKITAT



Eastern Washington Stormwater Manual



10-Year 24-Hour Isopluvials
Source: NOAA Atlas 2, Volume IX, 1973
Precipitation in inches

- County(2003, 1:24,000)
- City(2003, 1:24,000)
- Latitude/Longitude(1/10 degree)
- Isopluvial(1973, 1:2,000,000)
- NOAA/NWS Station(1931-1998)

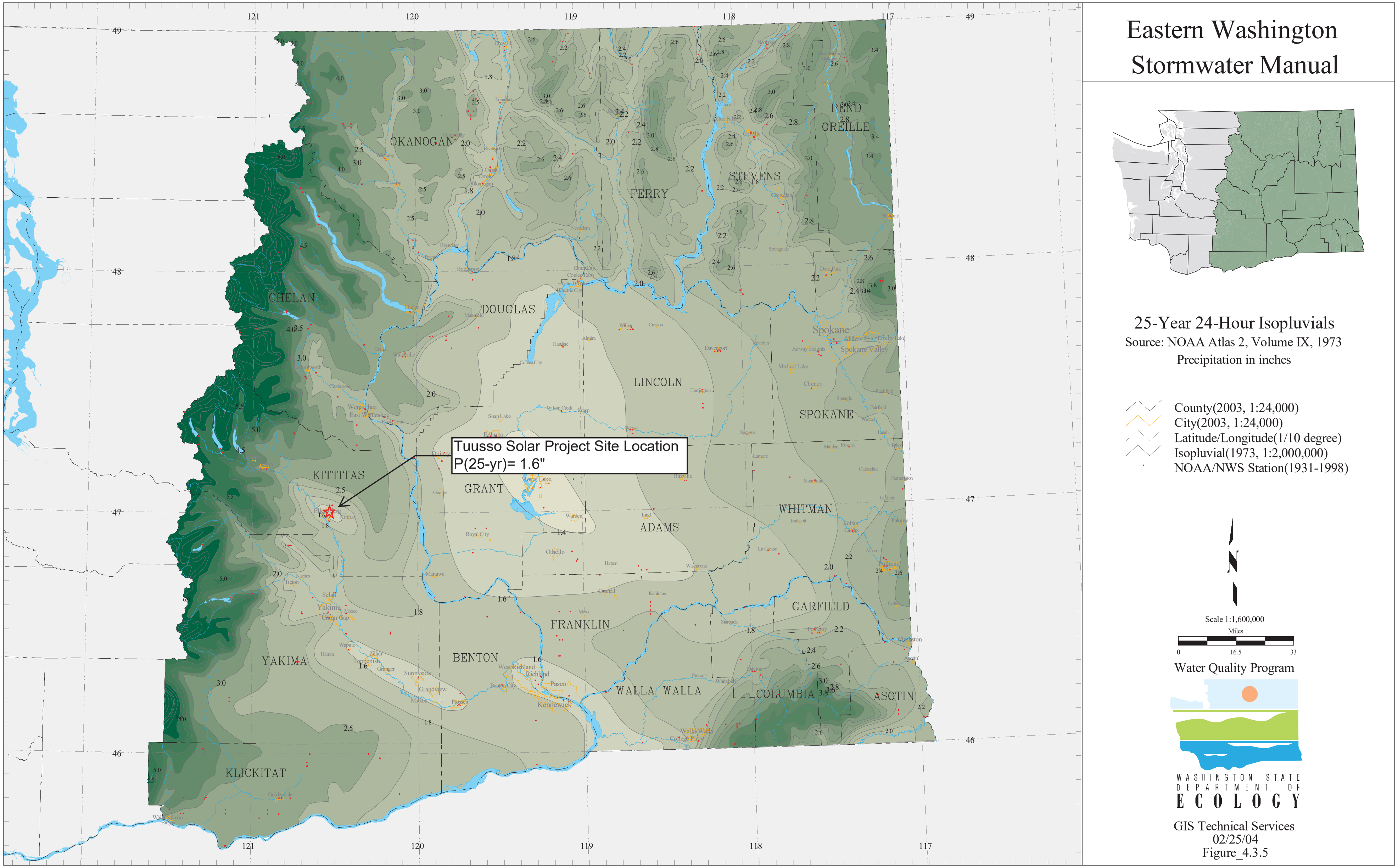
N

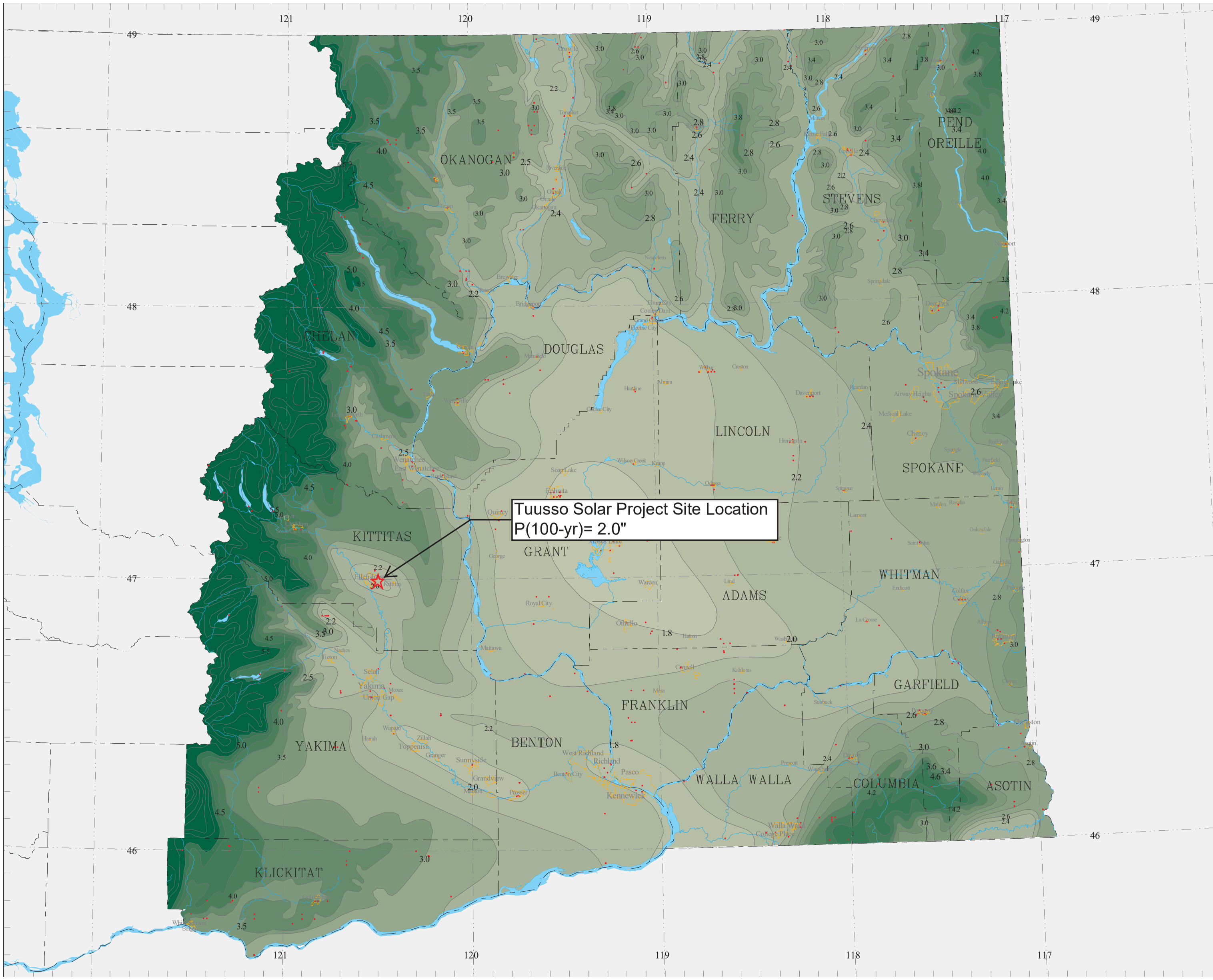
Scale 1:1,600,000
Miles
0 16.5 33

Water Quality Program

WASHINGTON STATE DEPARTMENT OF ECOLOGY

GIS Technical Services
02/25/04
Figure_4.3.4


Eastern Washington
Stormwater Manual
25-Year 24-Hour Isopluvials
Source: NOAA Atlas 2, Volume IX, 1973
Precipitation in inches
County(2003, 1:24,000)
City(2003, 1:24,000)
Latitude/Longitude(1/10 degree)
Isopluvial(1973, 1:2,000,000)
NOAA/NWS Station(1931-1998)
Scale 1:1,600,000
Miles
0
16.5
33
Water Quality Program
WASHINGTON STATE DEPARTMENT OF ECOLOGY
GIS Technical Services
02/25/04
Figure_4.3.5
Tuusso Solar Project Site Location
P(25-yr)= 1.6"
OKANOGAN
FERRY
STEVENS
PEND OREILLE
CHELAN
DOUGLAS
LINCOLN
SPOKANE
KITTITAS
GRANT
ADAMS
WHITMAN
GARFIELD
FRANKLIN
BENTON
YAKIMA
WALLA WALLA
COLUMBIA
ASOTIN
KLICKITAT
Spokane
Spokane Valley
Kennewick
Pasco
Richland
Yakima
121
120
119
118
117
49
48
47
46



Eastern Washington Stormwater Manual

100-Year 24-Hour Isopluvials
Source: NOAA Atlas 2, Volume IX, 1973
Precipitation in inches

County(2003, 1:24,000)
City(2003, 1:24,000)
Latitude/Longitude(1/10 degree)
Isopluvial(1973, 1:2,000,000)
NOAA/NWS Station(1931-1998)

Scale 1:1,600,000
Miles
0 16.5 33

Water Quality Program

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GIS Technical Services
02/25/04
Figure_4.3.7

Appendix C:

CURVE NUMBER CALCULATIONS

Predevelopment Conditions																
Basin Name	Total Area (sf)	Total Area (ac)	Impervious Area (sf)	Impervious Area (ac)	HSG	CN	Meadow (sf)	Meadow (ac)	HSG	CN	Meadow (sf)	Meadow (ac)	HSG	CN	**Composite CN**
Existing Basin 1	2006809.2	46.07	2540	0.06	C	98	1602833.8	36.80	C	71	401361.84	9.21	D	78	**72**
Existing Basin 2	223852	5.14	0	0.00	C	98	220718	5.07	C	71	3133.9	0.07	D	78	**71**

Postdevelopment Conditions															
Basin Name	Total Area (sf)	Total Area (ac)	Impervious Area (sf)	Impervious Area (ac)	HSG	CN	Meadow (sf)	Meadow (ac)	HSG	CN	Meadow (sf)	Meadow (ac)	HSG	CN	**Composite CN**
Proposed Basin 1	2006809.2	46.07	81487.75	1.87	D	93	1538331.8	35.32	C	71	386989.6	8.88	D	78	**73**
Proposed Basin 2	223852	5.14	8385.75	0.19	D	93	212332.3	4.87	C	71	3133.9	0.0719	D	78	**72**

Impervious Area Break Down							Basin 1 Post Area					Basin 2 Post Area				
	Basin 1			Basin 2			Solar Trackers	Length	Width	#	area (sf)	Solar Trackers	Length	Width	#	area (sf)
Lot or Tract	Area (sf)	CN classification	CN	Area (sf)	CN classification	CN	72 ft trackers	248	6.5	197	317564	72 ft trackers	248	6.5	2	3224
Road	56020	Gravel	91	5800	Gravel	91	52 ft trackers	188	6.5	32	39104	52 ft trackers	188	6.5	26	31772
Inverters	3600	Impervious	98	600	Impervious	98	36 ft traclers	121	6.5	38	29887	36 ft traclers	121	6.5	6	4719
Post	19328	Impervious	98	1986	Impervious	98				Total	386555				Total	39715
Building	2540	Impervious	98	0	Impervious	98				assumed % impervious (posts)	5%				assumed % impervious (posts)	5%
		Composite CN	93		Composite CN	93				impervious area	19327.75				impervious area	1985.75

Appendix D:

HydroCAD REPORT:
EXISTING BASINS

Area Listing (selected nodes)

Area (acres)	CN	Description (subcatchment-numbers)
0.060	98	Impervious (1S)
36.800	71	Meadow: HSG C (1S)
9.210	78	Meadow: HSG D (1S)
46.070	**72**	**TOTAL AREA**

Ground Covers (selected nodes)

HSG-A (acres)	HSG-B (acres)	HSG-C (acres)	HSG-D (acres)	Other (acres)	Total (acres)	Ground Cover	Subcatchment Numbers
0.000	0.000	0.000	0.000	0.060	0.060	Impervious	1S
0.000	0.000	36.800	9.210	0.000	46.010	Meadow:	1S
0.000	**0.000**	**36.800**	**9.210**	**0.060**	**46.070**	**TOTAL AREA**	

Summary for Subcatchment 1S: Existing Drainage Basin 1

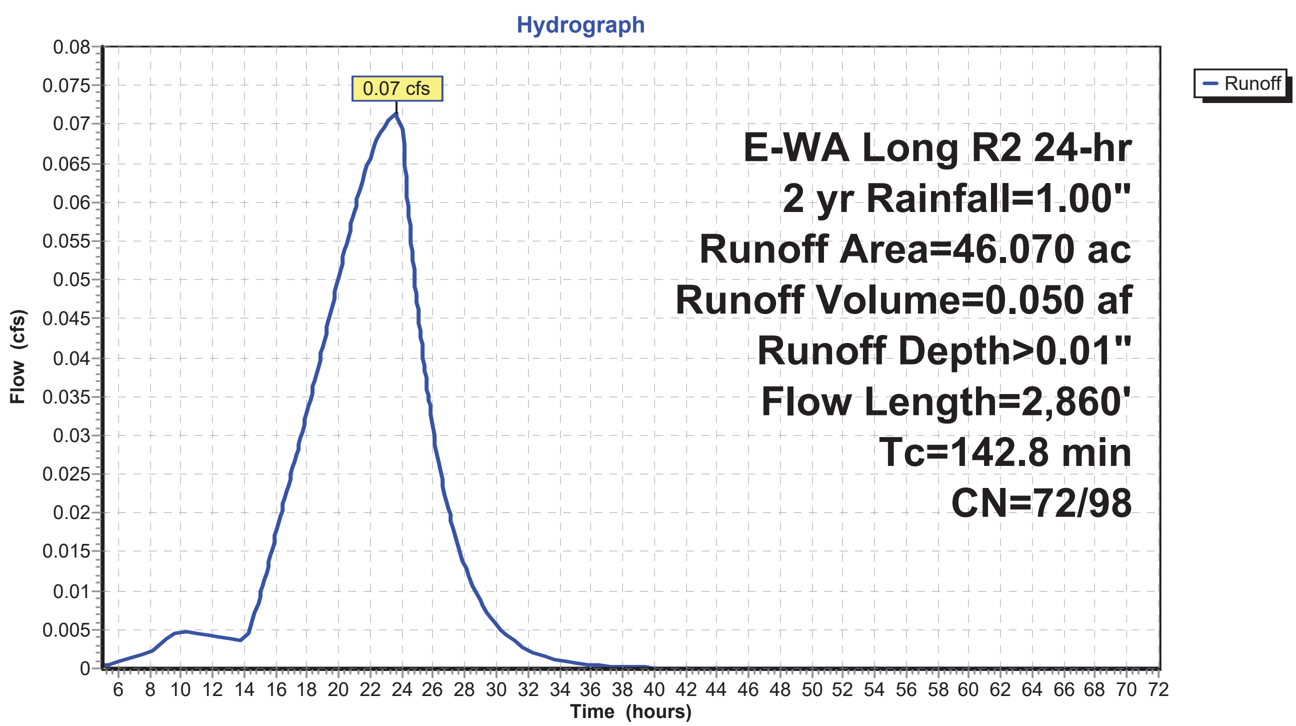
Runoff = 0.07 cfs @ 23.60 hrs, Volume= 0.050 af, Depth> 0.01"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 5.00-72.00 hrs, dt= 0.05 hrs
E-WA Long R2 24-hr 2 yr Rainfall=1.00"

	Area (ac)	CN	Description
*	36.800	71	Meadow: HSG C
*	9.210	78	Meadow: HSG D
*	0.060	98	Impervious
	46.070	72	Weighted Average
	46.010	72	99.87% Pervious Area
	0.060	98	0.13% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
67.2	300	0.0047	0.07		**Sheet Flow,** Range n= 0.130 P2= 1.00"
75.6	2,560	0.0065	0.56		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
142.8	2,860	Total			

Subcatchment 1S: Existing Drainage Basin 1



Summary for Subcatchment 1S: Existing Drainage Basin 1

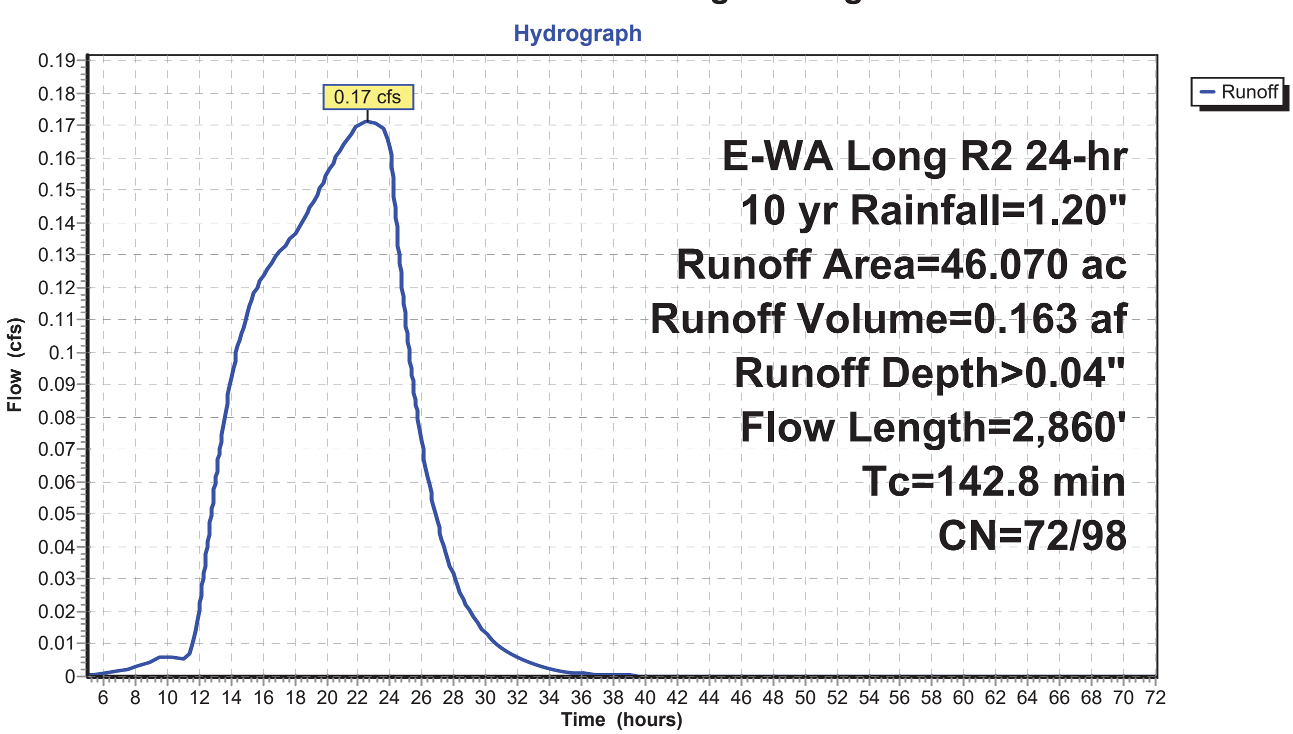
Runoff = 0.17 cfs @ 22.60 hrs, Volume= 0.163 af, Depth> 0.04"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 5.00-72.00 hrs, dt= 0.05 hrs
E-WA Long R2 24-hr 10 yr Rainfall=1.20"

	Area (ac)	CN	Description
*	36.800	71	Meadow: HSG C
*	9.210	78	Meadow: HSG D
*	0.060	98	Impervious
	46.070	72	Weighted Average
	46.010	72	99.87% Pervious Area
	0.060	98	0.13% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
67.2	300	0.0047	0.07		**Sheet Flow,** Range n= 0.130 P2= 1.00"
75.6	2,560	0.0065	0.56		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
142.8	2,860	Total			

Subcatchment 1S: Existing Drainage Basin 1



Summary for Subcatchment 1S: Existing Drainage Basin 1

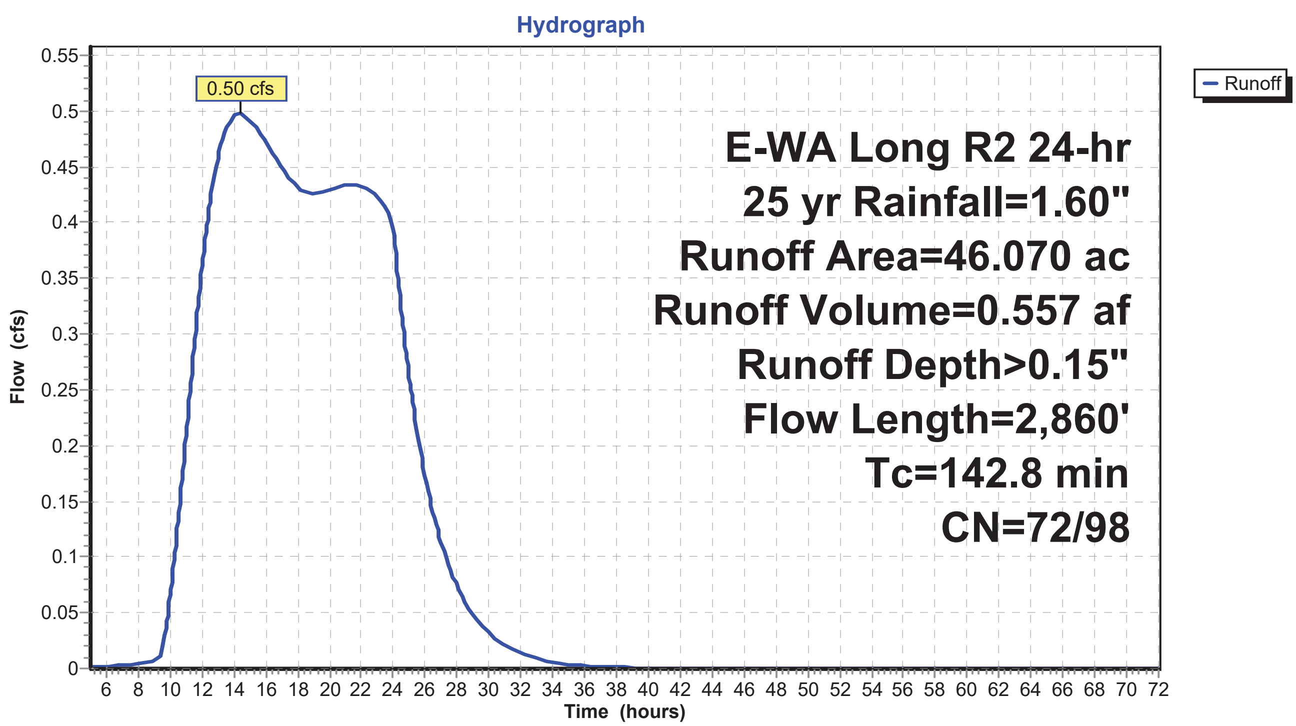
Runoff = 0.50 cfs @ 14.35 hrs, Volume= 0.557 af, Depth> 0.15"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 5.00-72.00 hrs, dt= 0.05 hrs
E-WA Long R2 24-hr 25 yr Rainfall=1.60"

	Area (ac)	CN	Description
*	36.800	71	Meadow: HSG C
*	9.210	78	Meadow: HSG D
*	0.060	98	Impervious
	46.070	72	Weighted Average
	46.010	72	99.87% Pervious Area
	0.060	98	0.13% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
67.2	300	0.0047	0.07		**Sheet Flow,** Range n= 0.130 P2= 1.00"
75.6	2,560	0.0065	0.56		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
142.8	2,860	Total			

Subcatchment 1S: Existing Drainage Basin 1



Summary for Subcatchment 1S: Existing Drainage Basin 1

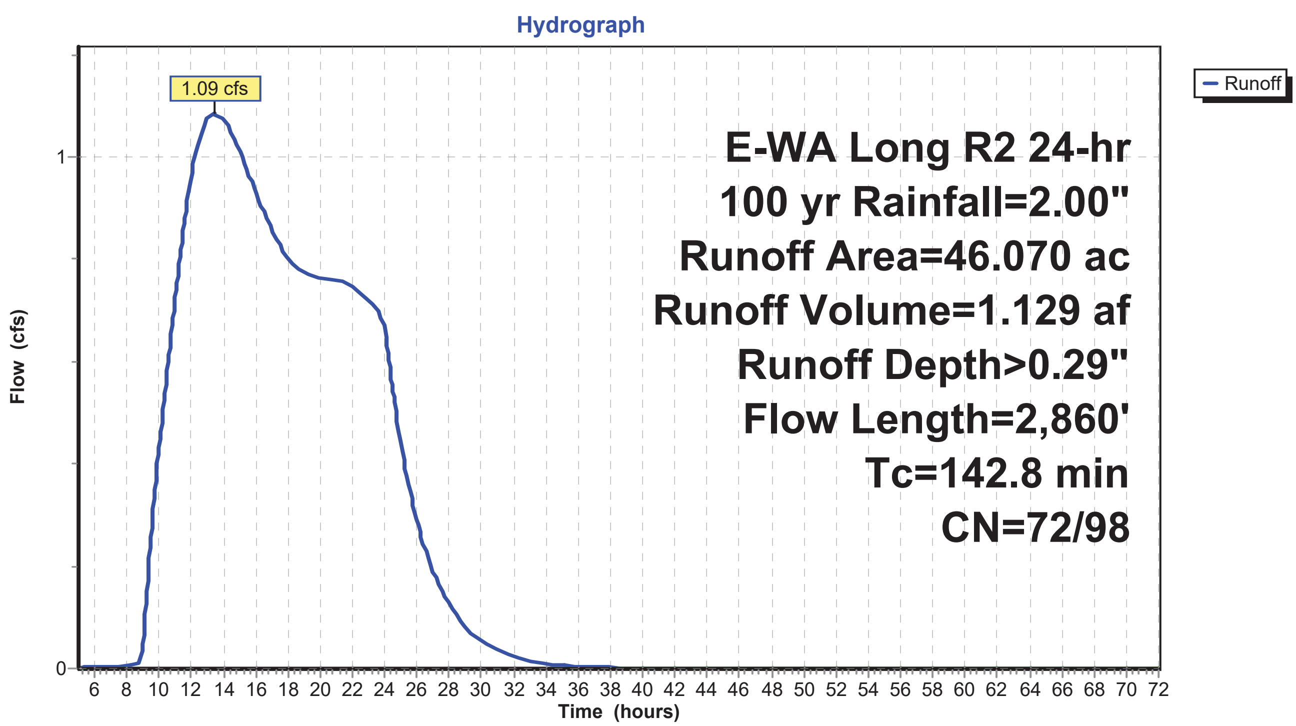
Runoff = 1.09 cfs @ 13.45 hrs, Volume= 1.129 af, Depth> 0.29"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 5.00-72.00 hrs, dt= 0.05 hrs
E-WA Long R2 24-hr 100 yr Rainfall=2.00"

	Area (ac)	CN	Description
*	36.800	71	Meadow: HSG C
*	9.210	78	Meadow: HSG D
*	0.060	98	Impervious
	46.070	72	Weighted Average
	46.010	72	99.87% Pervious Area
	0.060	98	0.13% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
67.2	300	0.0047	0.07		**Sheet Flow,** Range n= 0.130 P2= 1.00"
75.6	2,560	0.0065	0.56		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
142.8	2,860	Total			

Subcatchment 1S: Existing Drainage Basin 1



Area Listing (selected nodes)

Area (acres)	CN	Description (subcatchment-numbers)
5.070	71	Meadow: HSG C (3S)
0.070	78	Meadow: HSG D (3S)
5.140	**71**	**TOTAL AREA**

Ground Covers (selected nodes)

HSG-A (acres)	HSG-B (acres)	HSG-C (acres)	HSG-D (acres)	Other (acres)	Total (acres)	Ground Cover	Subcatchment Numbers
0.000	0.000	5.070	0.070	0.000	5.140	Meadow:	3S
0.000	**0.000**	**5.070**	**0.070**	**0.000**	**5.140**	**TOTAL AREA**	

Summary for Subcatchment 3S: Existing Drainage Basin 2

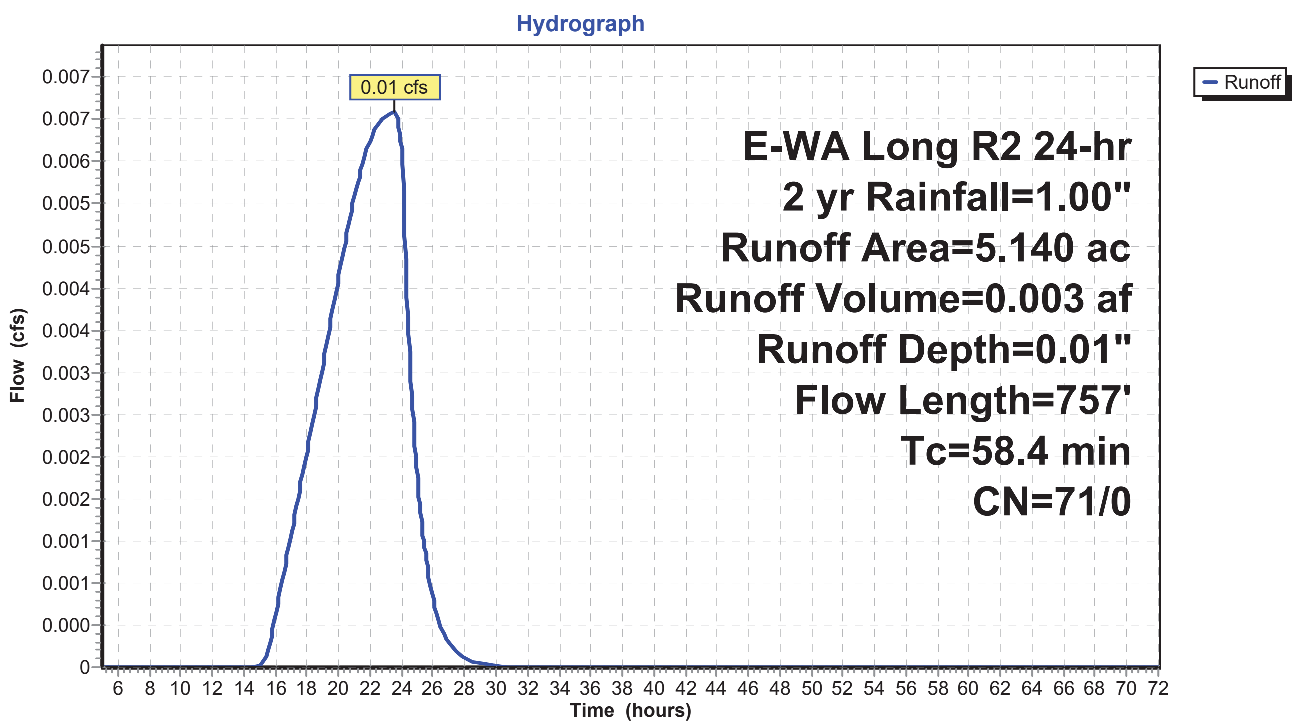
Runoff = 0.01 cfs @ 23.48 hrs, Volume= 0.003 af, Depth= 0.01"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 5.00-72.00 hrs, dt= 0.05 hrs
E-WA Long R2 24-hr 2 yr Rainfall=1.00"

	Area (ac)	CN	Description
*	5.070	71	Meadow: HSG C
*	0.070	78	Meadow: HSG D
	5.140	71	Weighted Average
	5.140	71	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
43.0	300	0.0143	0.12		**Sheet Flow,** Range n= 0.130 P2= 1.00"
15.4	457	0.0050	0.49		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
58.4	757	Total			

Subcatchment 3S: Existing Drainage Basin 2



Summary for Subcatchment 3S: Existing Drainage Basin 2

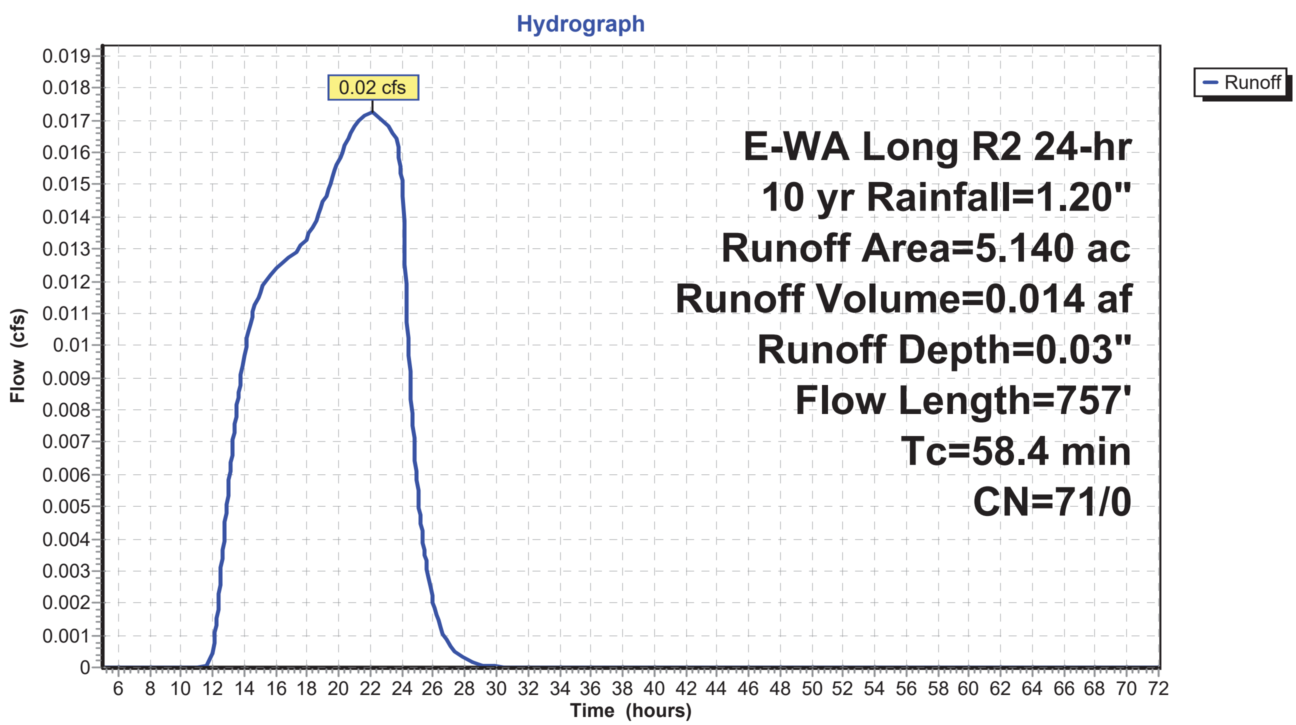
Runoff = 0.02 cfs @ 22.10 hrs, Volume= 0.014 af, Depth= 0.03"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 5.00-72.00 hrs, dt= 0.05 hrs
E-WA Long R2 24-hr 10 yr Rainfall=1.20"

	Area (ac)	CN	Description
*	5.070	71	Meadow: HSG C
*	0.070	78	Meadow: HSG D
	5.140	71	Weighted Average
	5.140	71	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
43.0	300	0.0143	0.12		**Sheet Flow,** Range n= 0.130 P2= 1.00"
15.4	457	0.0050	0.49		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
58.4	757	Total			

Subcatchment 3S: Existing Drainage Basin 2



Summary for Subcatchment 3S: Existing Drainage Basin 2

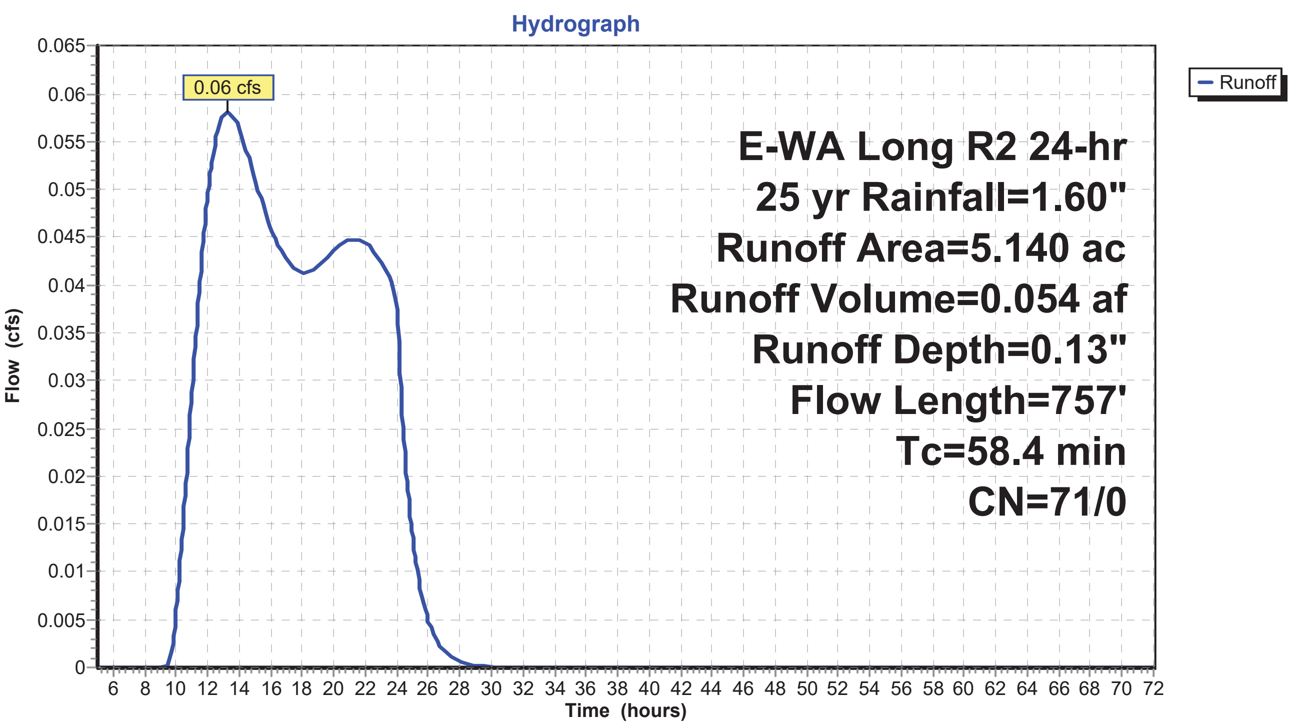
Runoff = 0.06 cfs @ 13.27 hrs, Volume= 0.054 af, Depth= 0.13"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 5.00-72.00 hrs, dt= 0.05 hrs
E-WA Long R2 24-hr 25 yr Rainfall=1.60"

	Area (ac)	CN	Description
*	5.070	71	Meadow: HSG C
*	0.070	78	Meadow: HSG D
	5.140	71	Weighted Average
	5.140	71	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
43.0	300	0.0143	0.12		**Sheet Flow,** Range n= 0.130 P2= 1.00"
15.4	457	0.0050	0.49		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
58.4	757	Total			

Subcatchment 3S: Existing Drainage Basin 2



Summary for Subcatchment 3S: Existing Drainage Basin 2

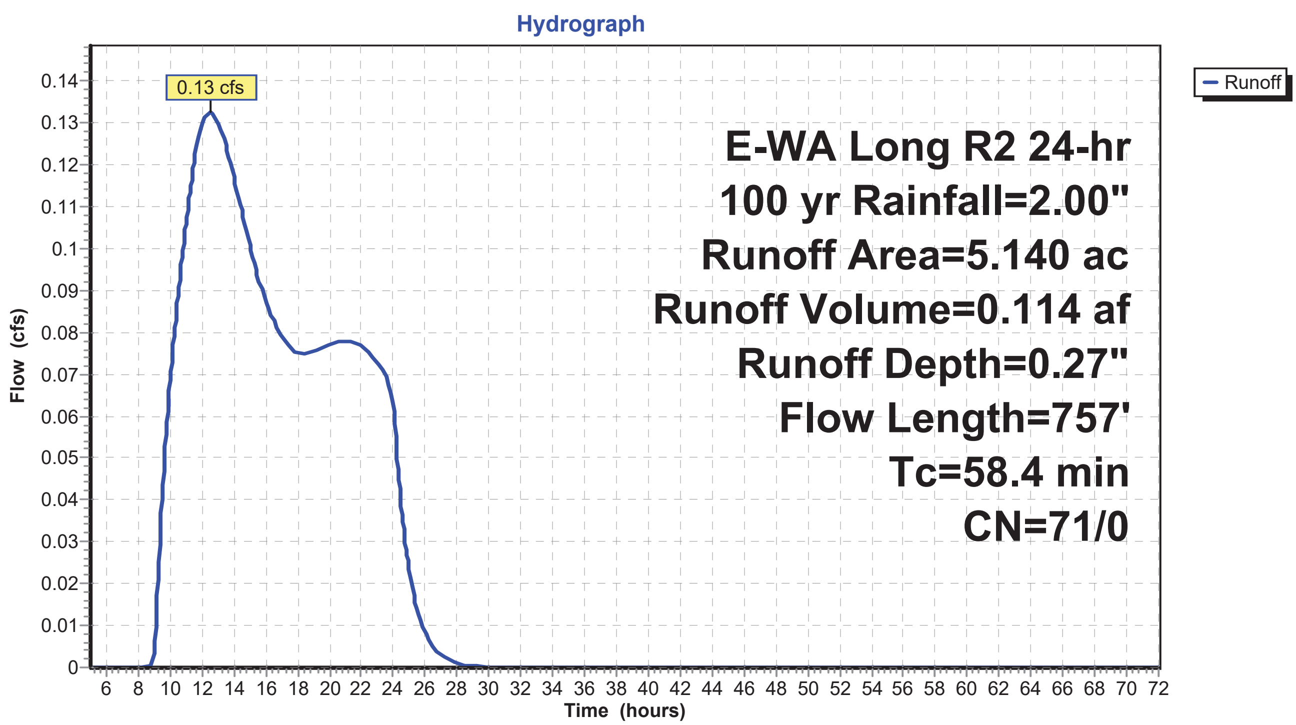
Runoff = 0.13 cfs @ 12.48 hrs, Volume= 0.114 af, Depth= 0.27"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 5.00-72.00 hrs, dt= 0.05 hrs
E-WA Long R2 24-hr 100 yr Rainfall=2.00"

	Area (ac)	CN	Description
*	5.070	71	Meadow: HSG C
*	0.070	78	Meadow: HSG D
	5.140	71	Weighted Average
	5.140	71	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
43.0	300	0.0143	0.12		**Sheet Flow,** Range n= 0.130 P2= 1.00"
15.4	457	0.0050	0.49		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
58.4	757	Total			

Subcatchment 3S: Existing Drainage Basin 2



Appendix E:

HydroCAD REPORT:
PROPOSED BASINS

Area Listing (selected nodes)

Area (acres)	CN	Description (subcatchment-numbers)
1.870	93	Impervious Area (2S)
35.320	71	Meadow: HSG C (2S)
8.880	78	Meadow: HSG D (2S)
46.070	**73**	**TOTAL AREA**

Ground Covers (selected nodes)

HSG-A (acres)	HSG-B (acres)	HSG-C (acres)	HSG-D (acres)	Other (acres)	Total (acres)	Ground Cover	Subcatchment Numbers
0.000	0.000	0.000	0.000	1.870	1.870	Impervious Area	2S
0.000	0.000	35.320	8.880	0.000	44.200	Meadow:	2S
0.000	**0.000**	**35.320**	**8.880**	**1.870**	**46.070**	**TOTAL AREA**	

Summary for Subcatchment 2S: Proposed Drainage Basin 1

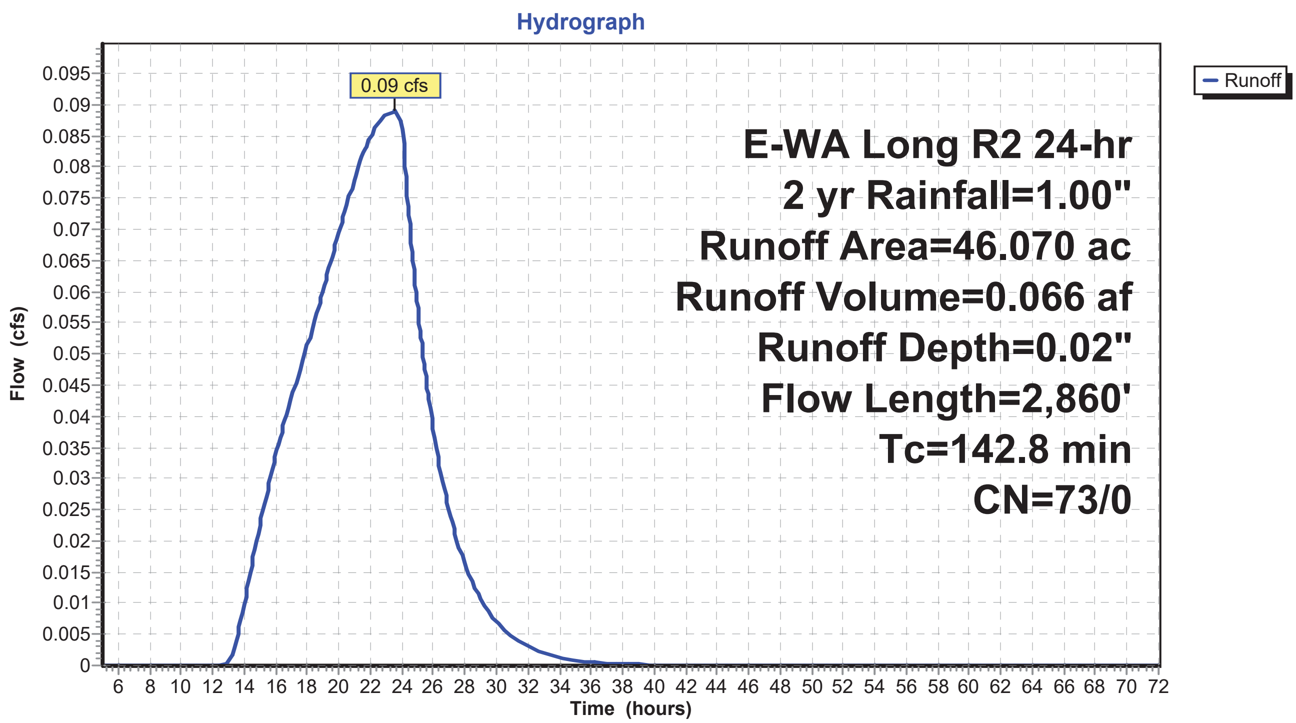
Runoff = 0.09 cfs @ 23.54 hrs, Volume= 0.066 af, Depth= 0.02"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 5.00-72.00 hrs, dt= 0.05 hrs
E-WA Long R2 24-hr 2 yr Rainfall=1.00"

	Area (ac)	CN	Description
*	1.870	93	Impervious Area
*	35.320	71	Meadow: HSG C
*	8.880	78	Meadow: HSG D
	46.070	73	Weighted Average
	46.070	73	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
67.2	300	0.0047	0.07		**Sheet Flow,** Range n= 0.130 P2= 1.00"
75.6	2,560	0.0065	0.56		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
142.8	2,860	Total			

Subcatchment 2S: Proposed Drainage Basin 1



Summary for Subcatchment 2S: Proposed Drainage Basin 1

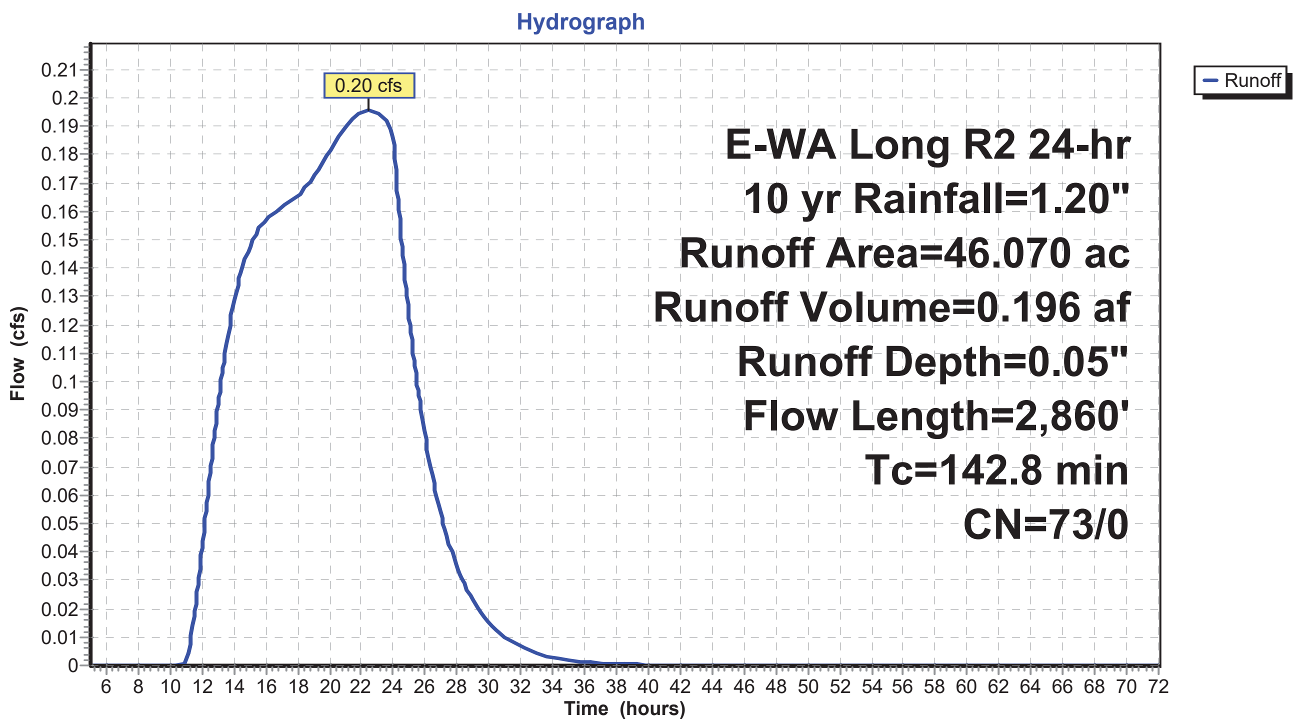
Runoff = 0.20 cfs @ 22.38 hrs, Volume= 0.196 af, Depth= 0.05"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 5.00-72.00 hrs, dt= 0.05 hrs
E-WA Long R2 24-hr 10 yr Rainfall=1.20"

	Area (ac)	CN	Description
*	1.870	93	Impervious Area
*	35.320	71	Meadow: HSG C
*	8.880	78	Meadow: HSG D
	46.070	73	Weighted Average
	46.070	73	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
67.2	300	0.0047	0.07		**Sheet Flow,** Range n= 0.130 P2= 1.00"
75.6	2,560	0.0065	0.56		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
142.8	2,860	Total			

Subcatchment 2S: Proposed Drainage Basin 1



Summary for Subcatchment 2S: Proposed Drainage Basin 1

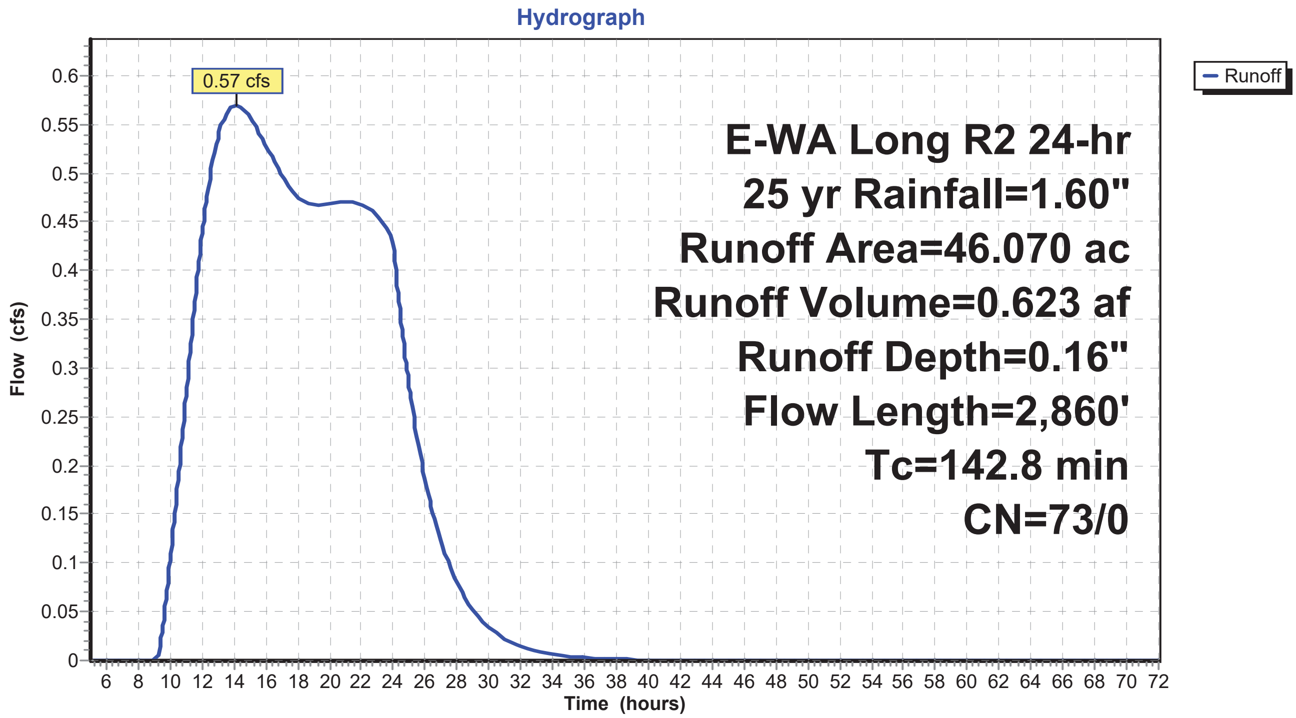
Runoff = 0.57 cfs @ 14.12 hrs, Volume= 0.623 af, Depth= 0.16"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 5.00-72.00 hrs, dt= 0.05 hrs
E-WA Long R2 24-hr 25 yr Rainfall=1.60"

	Area (ac)	CN	Description
*	1.870	93	Impervious Area
*	35.320	71	Meadow: HSG C
*	8.880	78	Meadow: HSG D
	46.070	73	Weighted Average
	46.070	73	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
67.2	300	0.0047	0.07		**Sheet Flow,** Range n= 0.130 P2= 1.00"
75.6	2,560	0.0065	0.56		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
142.8	2,860	Total			

Subcatchment 2S: Proposed Drainage Basin 1



Summary for Subcatchment 2S: Proposed Drainage Basin 1

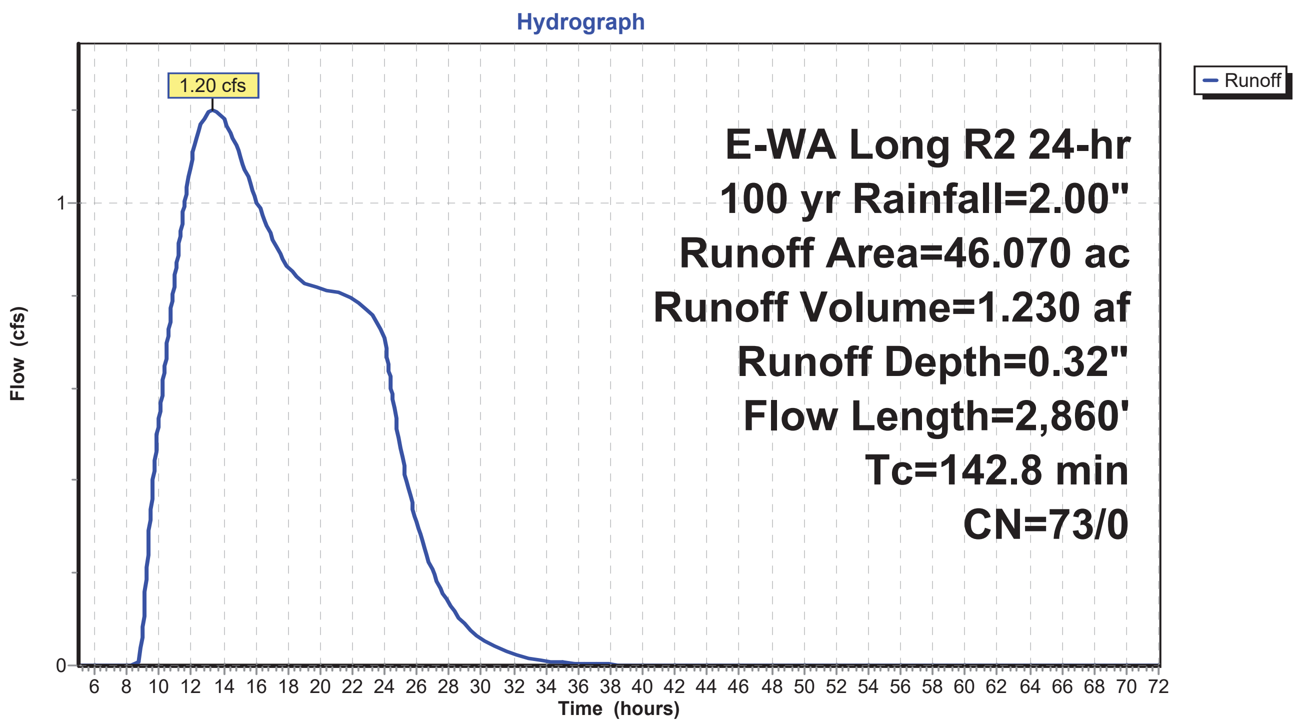
Runoff = 1.20 cfs @ 13.33 hrs, Volume= 1.230 af, Depth= 0.32"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 5.00-72.00 hrs, dt= 0.05 hrs
E-WA Long R2 24-hr 100 yr Rainfall=2.00"

	Area (ac)	CN	Description
*	1.870	93	Impervious Area
*	35.320	71	Meadow: HSG C
*	8.880	78	Meadow: HSG D
	46.070	73	Weighted Average
	46.070	73	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
67.2	300	0.0047	0.07		**Sheet Flow,** Range n= 0.130 P2= 1.00"
75.6	2,560	0.0065	0.56		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
142.8	2,860	Total			

Subcatchment 2S: Proposed Drainage Basin 1



Area Listing (selected nodes)

Area (acres)	CN	Description (subcatchment-numbers)
0.193	93	Impervious Area (4S)
4.874	71	Meadow: HSG C (4S)
0.072	78	Meadow: HSG D (4S)
5.139	**72**	**TOTAL AREA**

Ground Covers (selected nodes)

HSG-A (acres)	HSG-B (acres)	HSG-C (acres)	HSG-D (acres)	Other (acres)	Total (acres)	Ground Cover	Subcatchment Numbers
0.000	0.000	0.000	0.000	0.193	0.193	Impervious Area	4S
0.000	0.000	4.874	0.072	0.000	4.946	Meadow:	4S
0.000	**0.000**	**4.874**	**0.072**	**0.193**	**5.139**	**TOTAL AREA**	

Summary for Subcatchment 4S: Proposed Drainage Basin 2

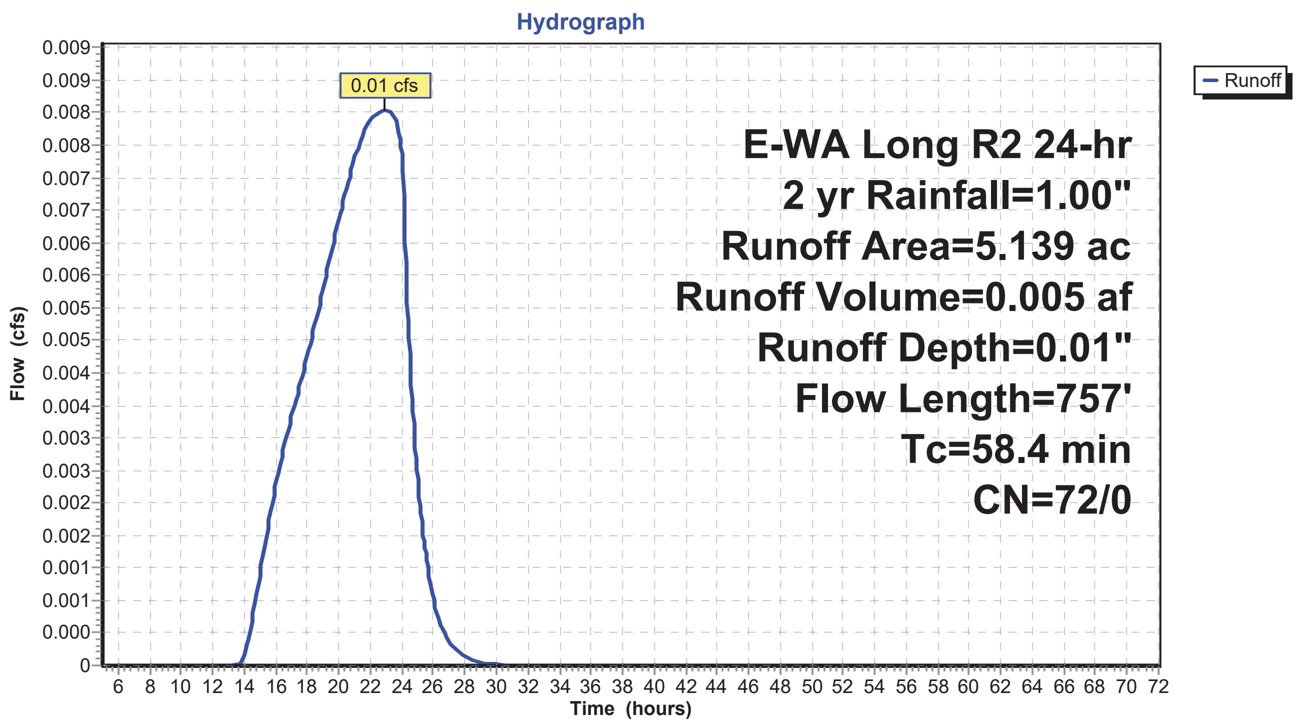
Runoff = 0.01 cfs @ 22.94 hrs, Volume= 0.005 af, Depth= 0.01"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 5.00-72.00 hrs, dt= 0.05 hrs
E-WA Long R2 24-hr 2 yr Rainfall=1.00"

	Area (ac)	CN	Description
*	4.874	71	Meadow: HSG C
*	0.072	78	Meadow: HSG D
*	0.193	93	Impervious Area
	5.139	72	Weighted Average
	5.139	72	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
43.0	300	0.0143	0.12		**Sheet Flow,** Range n= 0.130 P2= 1.00"
15.4	457	0.0050	0.49		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
58.4	757	Total			

Subcatchment 4S: Proposed Drainage Basin 2



Summary for Subcatchment 4S: Proposed Drainage Basin 2

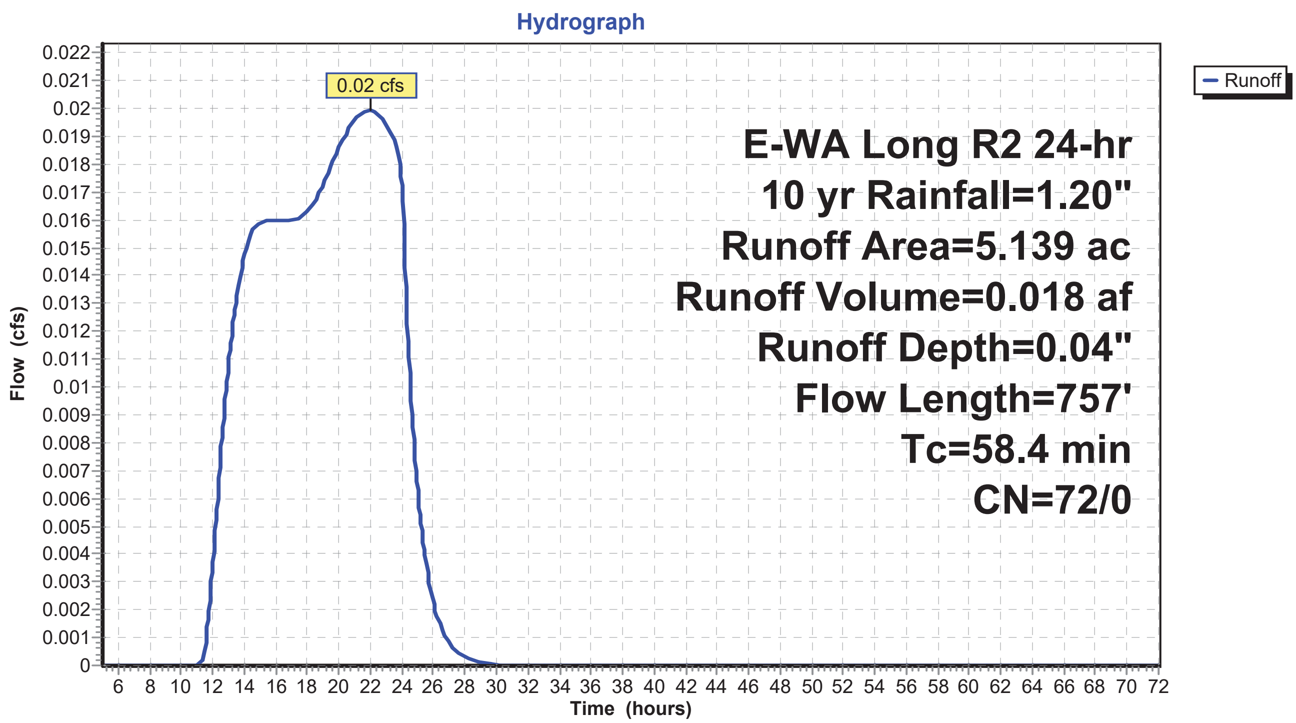
Runoff = 0.02 cfs @ 21.96 hrs, Volume= 0.018 af, Depth= 0.04"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 5.00-72.00 hrs, dt= 0.05 hrs
E-WA Long R2 24-hr 10 yr Rainfall=1.20"

	Area (ac)	CN	Description
*	4.874	71	Meadow: HSG C
*	0.072	78	Meadow: HSG D
*	0.193	93	Impervious Area
	5.139	72	Weighted Average
	5.139	72	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
43.0	300	0.0143	0.12		**Sheet Flow,** Range n= 0.130 P2= 1.00"
15.4	457	0.0050	0.49		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
58.4	757	Total			

Subcatchment 4S: Proposed Drainage Basin 2



Summary for Subcatchment 4S: Proposed Drainage Basin 2

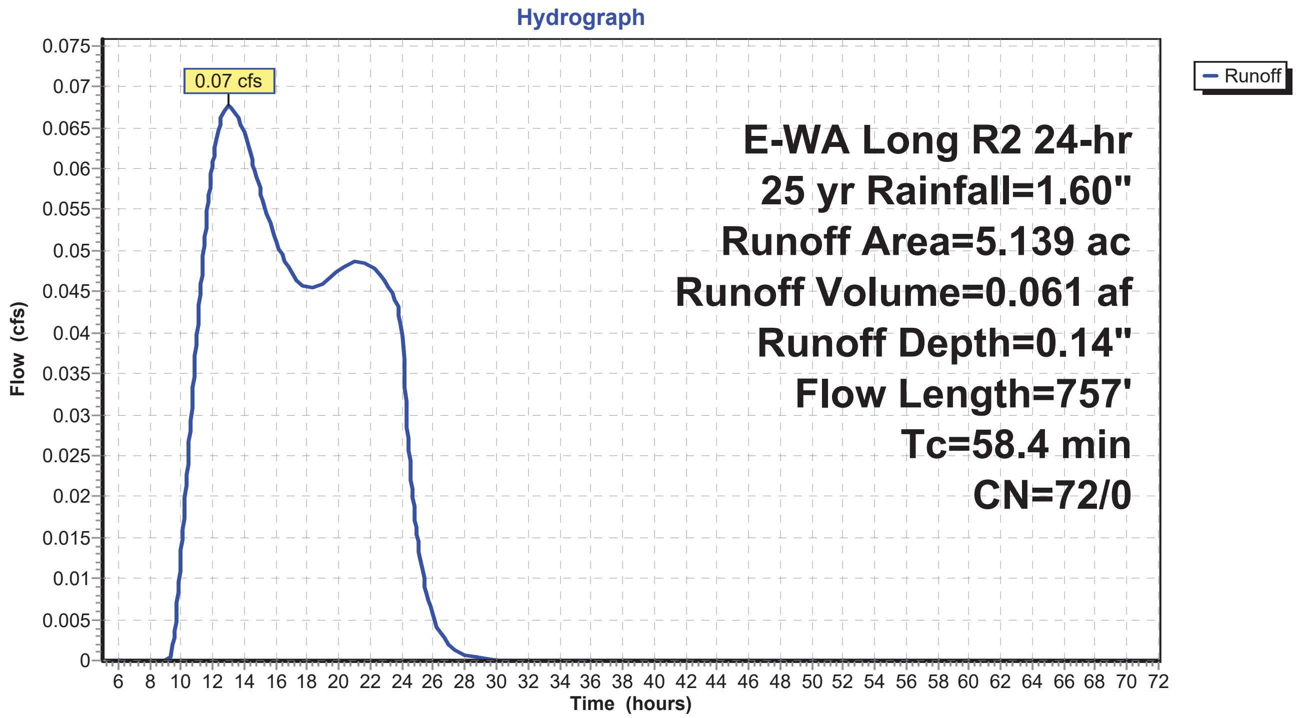
Runoff = 0.07 cfs @ 13.05 hrs, Volume= 0.061 af, Depth= 0.14"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 5.00-72.00 hrs, dt= 0.05 hrs
E-WA Long R2 24-hr 25 yr Rainfall=1.60"

	Area (ac)	CN	Description
*	4.874	71	Meadow: HSG C
*	0.072	78	Meadow: HSG D
*	0.193	93	Impervious Area
	5.139	72	Weighted Average
	5.139	72	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
43.0	300	0.0143	0.12		**Sheet Flow,** Range n= 0.130 P2= 1.00"
15.4	457	0.0050	0.49		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
58.4	757	Total			

Subcatchment 4S: Proposed Drainage Basin 2



Summary for Subcatchment 4S: Proposed Drainage Basin 2

Runoff = 0.15 cfs @ 12.36 hrs, Volume= 0.125 af, Depth= 0.29"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 5.00-72.00 hrs, dt= 0.05 hrs
E-WA Long R2 24-hr 100 yr Rainfall=2.00"

	Area (ac)	CN	Description
*	4.874	71	Meadow: HSG C
*	0.072	78	Meadow: HSG D
*	0.193	93	Impervious Area
	5.139	72	Weighted Average
	5.139	72	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
43.0	300	0.0143	0.12		**Sheet Flow,** Range n= 0.130 P2= 1.00"
15.4	457	0.0050	0.49		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
58.4	757	Total			

Subcatchment 4S: Proposed Drainage Basin 2