# Appendix I-5: Penstemon Solar Project Drainage Report

# Tuusso Energy
# Penstemon Solar Project:
# DRAINAGE REPORT

Date: July 2017

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## I. INTRODUCTION

Per Kittitas County assessor records the Tuusso Energy: Penstemon Solar Project site is located within Tax Parcel No. 840233, at the intersection of Tjossem Road and Moe Road in Ellensburg, WA, in the NE ¼ of the SE ¼ of Section 17, Township 17 North, Range 19 East W.M. The project site is 39.38 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 a 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 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. This runoff is captured in an irrigation ditch along the southern property line. The ditch flows to the east and into Coleman creek at the southeast corner 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 a single drainage basin since all runoff is either infiltrated or captured in the existing irrigation ditch at the southern border of the site. The existing drainage contains no impervious surfaces, meaning the entire 39.38 acres is pervious.

### b. Downstream Analysis

As noted above, all runoff from the site flows into the existing irrigation ditch at the southern end of the site. This ditch is currently maintained by the landowner. The irrigation ditch is part of a larger irrigation network that serves the rural areas south of Ellensburg, and the flow rates are currently controlled as needed. The ditch discharges into Coleman Creek, immediately to the southeast of the project site. Coleman Creek is well defined, with thick vegetation on its edges, and flows south along Moe road for 0.5 miles. It then flows southeast, ultimately joining Wilson Creek, before discharging into the Yakima River. 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 report 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 Tanaha ashy loam (0-2% slopes), Nack-Brickmill complex (0-5% slopes), Opnish ashy loam (0-2% slopes), Nanum ashy sandy clay loam (0-2% slopes), Deedale clay loam (0-2% slopes), and Mitta ashy silt loam (0-2% slopes). Tanaha ashy loam, Opnish ashy loam, and Mitta ashy silt loam all belong to Hydrologic Soil Group C. Deedale clay loam belongs to group D. Nack-Brickmill complex and Nanum ashy sandy clay both have a dual classification of C when drained and D when undrained. For this report, they are classified as 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 north/south 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 as well as the utility disconnect, resides on its own concrete pad. The access roads were conservatively modeled as gravel roads.

a. Solar Panel Array

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. Drainage Basin

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 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 basin encompasses the same area as the existing drainage basin. 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. Precipitation

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 north of Ellensburg are seen below:

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

b. Curve Number

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 Computations**

| Q (cfs) | | | | |
|---|---|---|---|---|
| Time Span | **2-yr** | 10-yr | **25-yr** | 100-yr |
| Existing | **0.14** | 0.28 | **0.83** | 1.58 |
| Proposed | **0.14** | 0.28 | **0.83** | 1.58 |

V. HYDROLOGIC ANALYSIS

As seen in the calculated peak flow rates, the increase in impervious surfaces with the proposed conditions is not enough to alter the existing runoff rates. Both the 2-yr and 25-yr flow rates remain unchanged. 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. The site is meeting the flow requirement for the 25-yr storm, however the proposed 2-yr storm event is greater than one half of the existing 2-yr storm event.

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, "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 Penstemon project will use full dispersion to handle stormwater runoff. 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 Penstemon site, the impervious areas may conservatively make up to 3.3% 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 Penstemon 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 Penstemon site meets the exemption requirement, therefore no treatment measures will be necessary or put in place.

While analyzing the effects of increased impervious surfaces and stormwater 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 Penstemon 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 effects of increased impervious areas due to the proposed solar panel farm. Therefore, the increased impervious area 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: Penstemon Solar Project, and exemptions are noted when applicable.

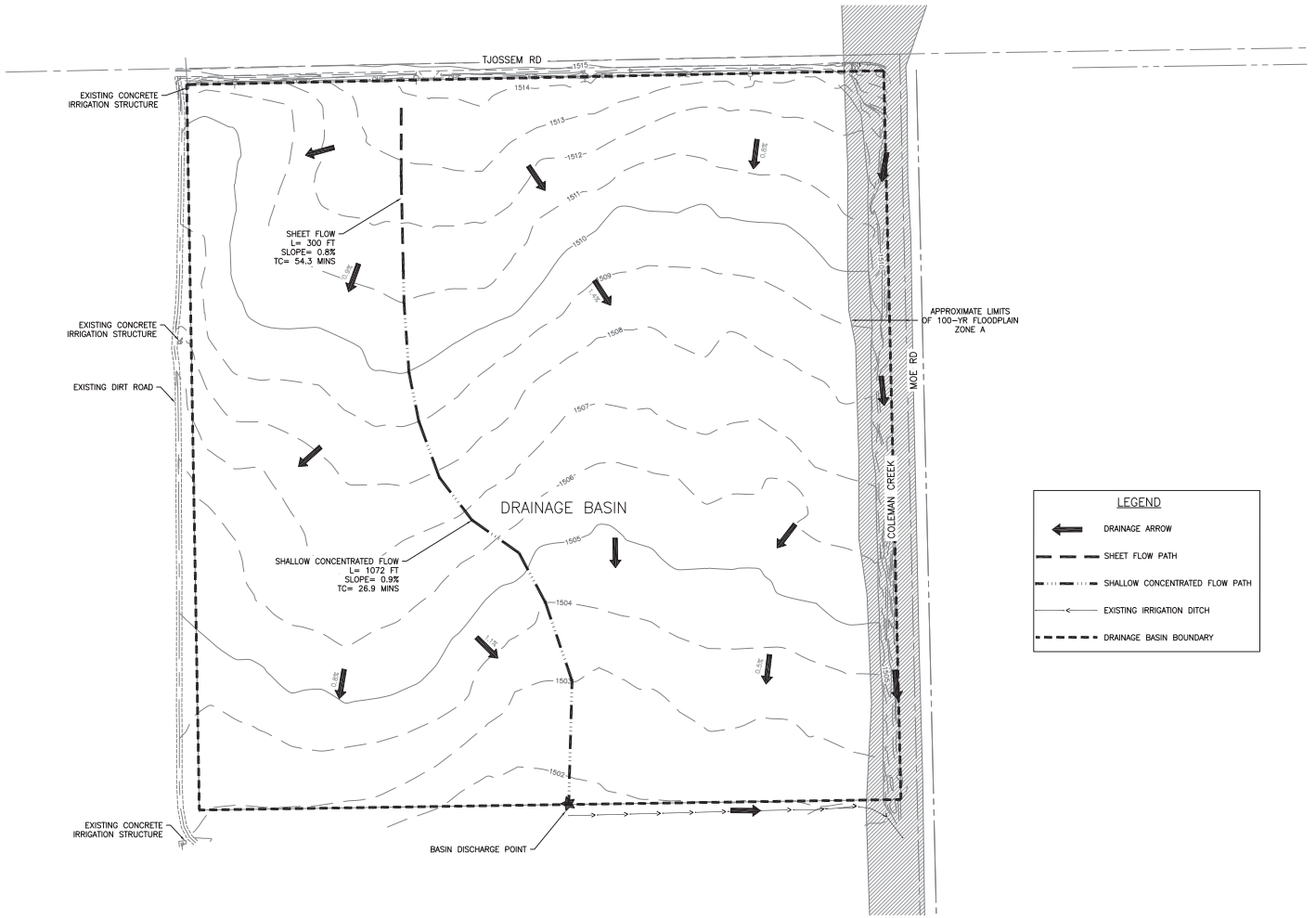
1. Preparation of a Stormwater Site Plan:
    - This can be seen in Figure 2- Proposed Drainage Basin Map, and will be included in the civil plans.
2. Construction Stormwater Pollution Prevention:
    - This will be included as part of the SWPPP submittal.
3. Source Control Pollution
    - The only potential 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: Penstemon Solar Project involves transforming 39.38 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 1.31 acres into impervious surfaces in the form of all-weather access roads, electrical infrastructure, and posts for the solar trackers. 1.31 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 tracker modules. 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 and 25-yr storm remained the same at 0.14 cfs and 0.83 cfs respectively. The runoff can be handled by full dispersion throughout the site, due to maintaining a majority of the existing pervious area with minimal grading. The runoff is also considered negligible, due to the reduction of flood irrigation to the site which will accompany the project.

# TUUSSO ENERGY - PENSTEMON SITE

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




0 100 200
SCALE: 1" = 100'

I-5-9

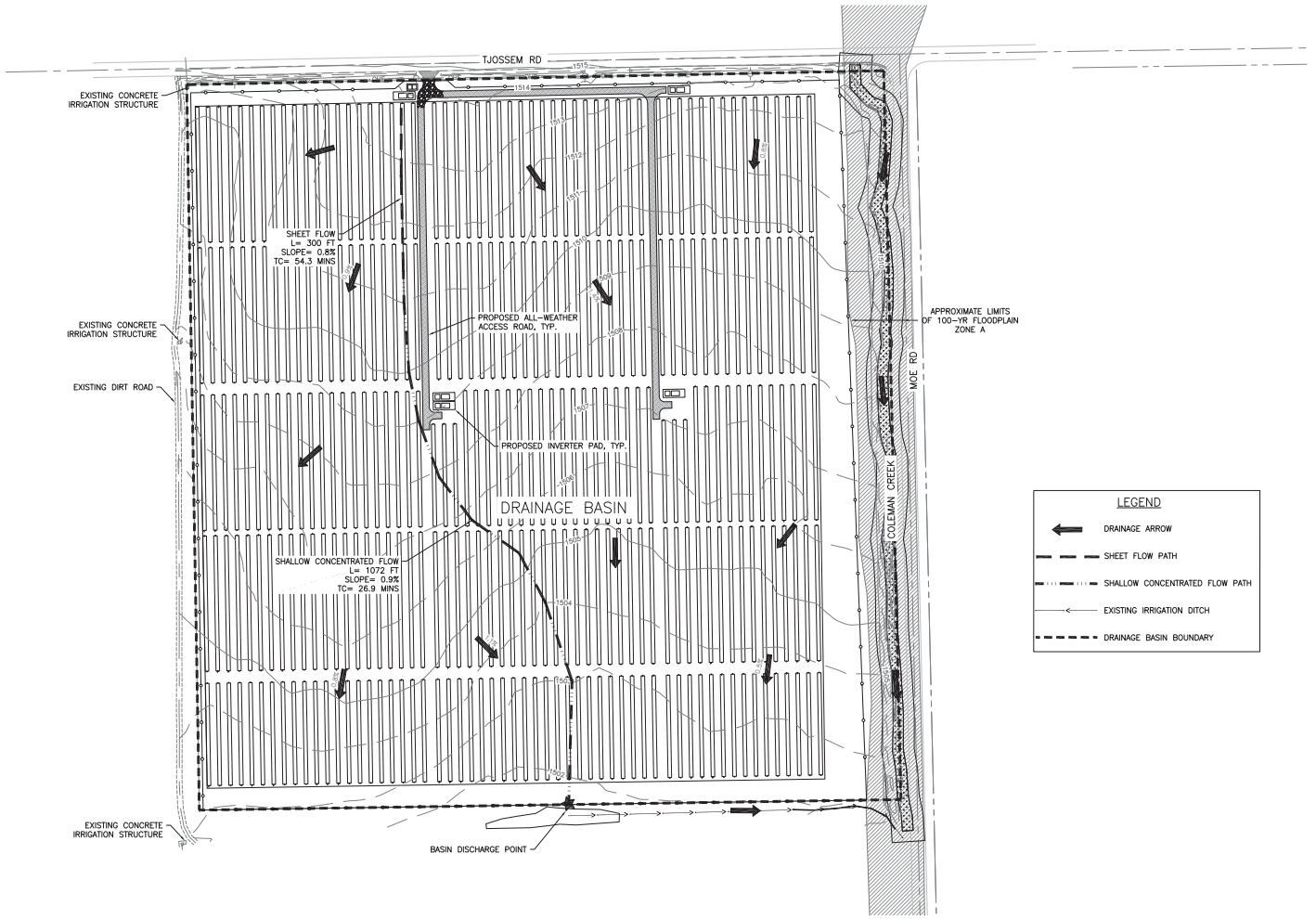
TUUSSO ENERGY, LLC
PENSTEMON SITE
EXISTING DRAINAGE CONDITIONS


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 Southwater Blvd. ▪ Ste Elum, WA 98922 ▪ Phone: (509) 674-7433 ▪ Fax: (509) 674-7419


| | |
|---|---|
| JOB NO. | 17016 |
| DATE | July 2017 |
| SCALE | AS SHOWN |
| DESIGNED | SF |
| DRAWN | SF |
| CHECKED | TML |
| APPROVED | TML |
| SHEET | FIG-1 |

# TUUSSO ENERGY - PENSTEMON SITE

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




0 100 200
SCALE: 1" = 100'

I-5-10

TUUSSO ENERGY, LLC
PENSTEMON SITE
PROPOSED DRAINAGE CONDITIONS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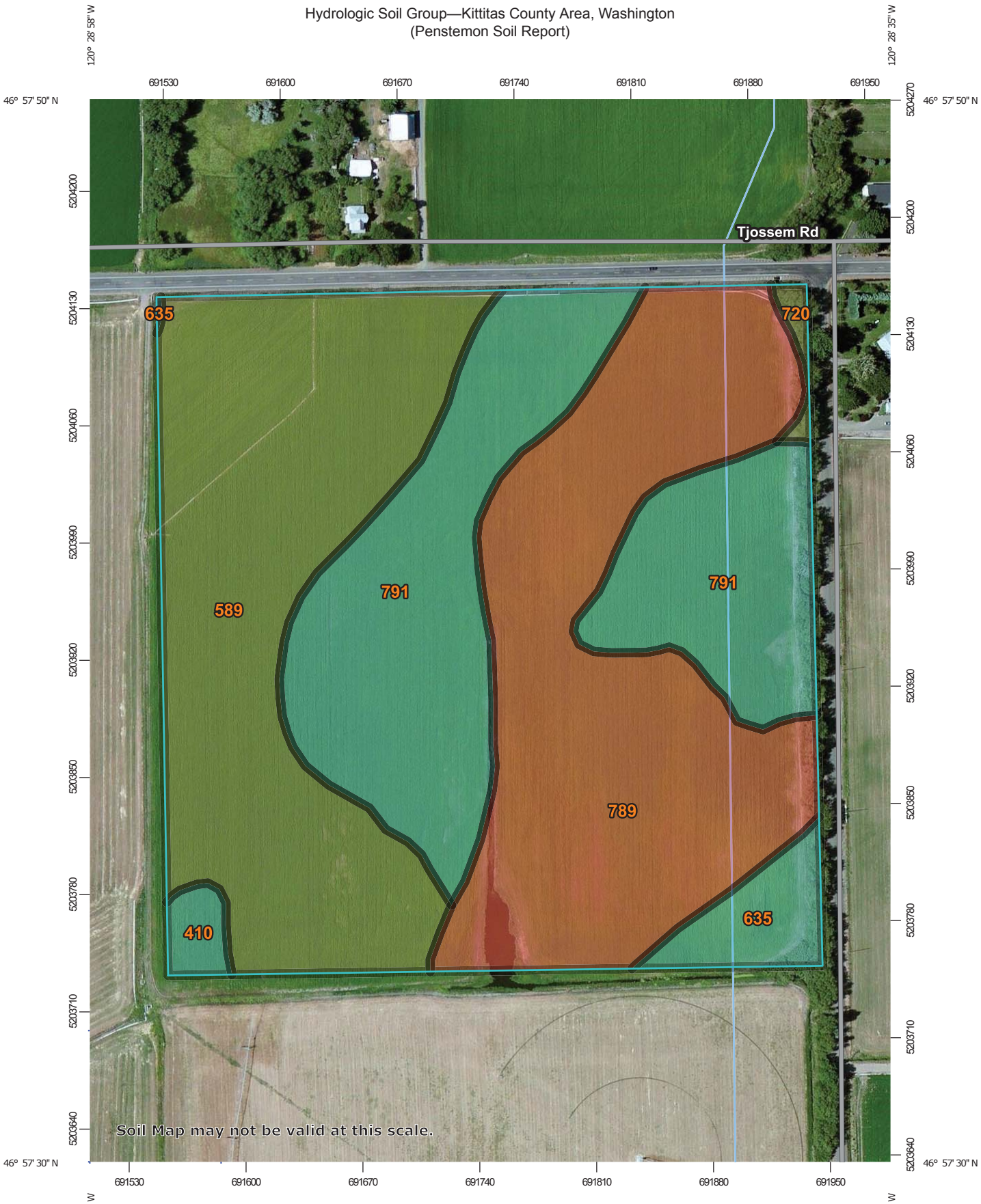
| | |
|---|---|
| JOB NO. | 17016 |
| DATE | July 2017 |
| SCALE | AS SHOWN |
| DESIGNED | SF |
| DRAWN | SF |
| CHECKED | TML |
| APPROVED | TML |
| SHEET | FIG-2 |

# Appendix A:

# NRCS WEB SOIL SURVEY




Map Scale: 1:3,090 if printed on A portrait (8.5" x 11") sheet.

N

Meters: 0 45 90 180 270

Feet: 0 150 300 600 900

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** |
| 410 | Tanaha ashy loam, 0 to 2 percent slopes | C | 0.5 | 1.2% |
| 589 | Nack-Brickmill complex, 0 to 5 percent slopes | C/D | 12.7 | 32.1% |
| 635 | Opnish ashy loam, 0 to 2 percent slopes | C | 1.3 | 3.2% |
| 720 | Nanum ashy sandy clay loam, 0 to 2 percent slopes | C/D | 0.2 | 0.6% |
| 789 | Deedale clay loam, 0 to 2 percent slopes | D | 13.1 | 33.2% |
| 791 | Mitta ashy silt loam, drained, 0 to 2 percent slopes | C | 11.7 | 29.7% |
| **Totals for Area of Interest** | | | **39.4** | **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

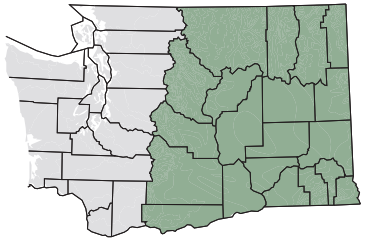
*Component Percent Cutoff: None Specified*

*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)

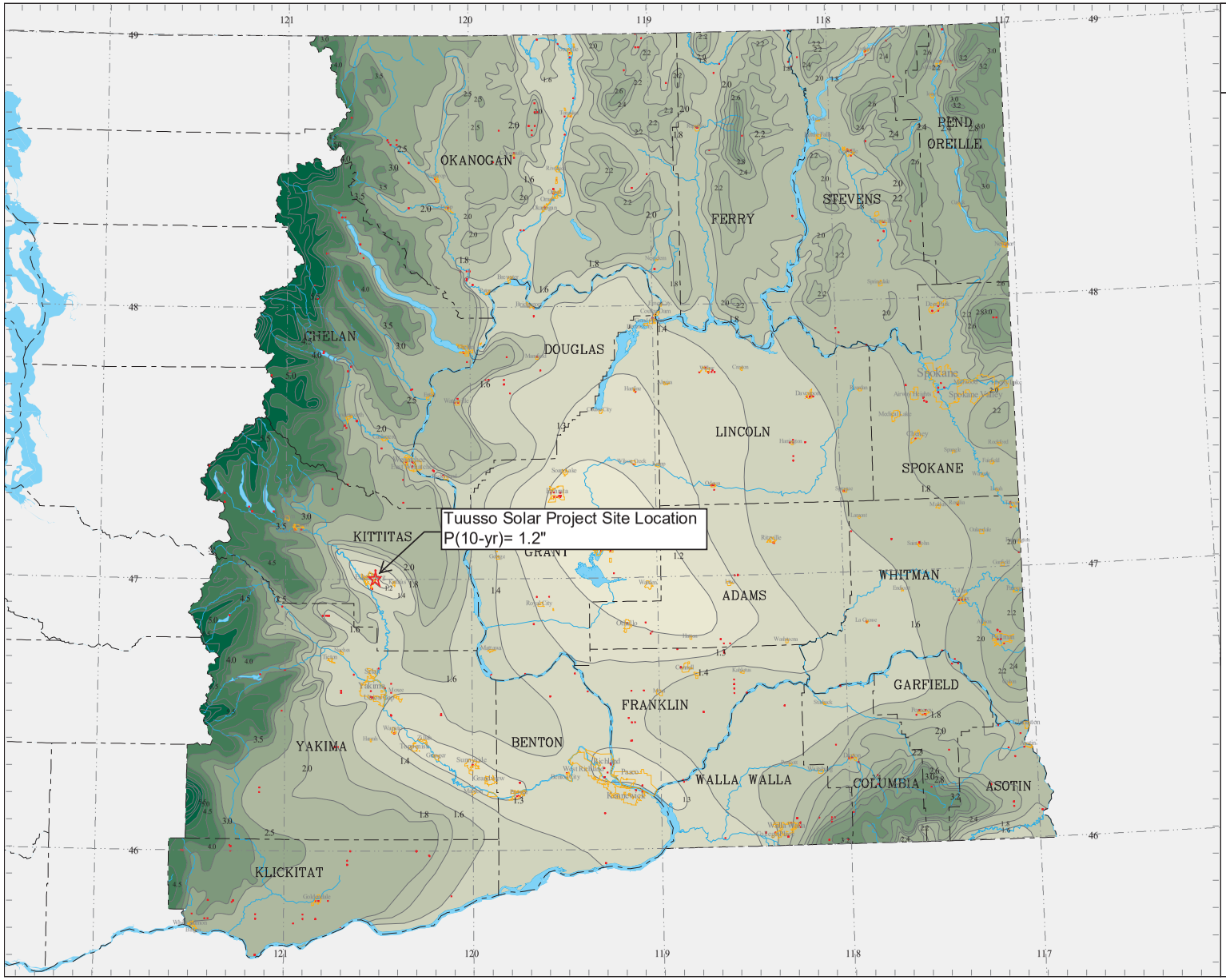
N

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

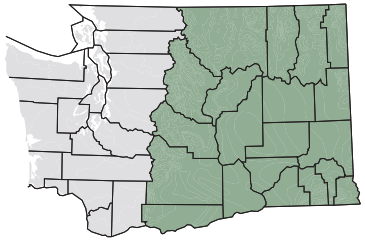
Water Quality Program

WASHINGTON STATE DEPARTMENT OF ECOLOGY

GIS Technical Services
02/25/04
Figure_4.3.3




# 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

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GIS Technical Services
02/25/04
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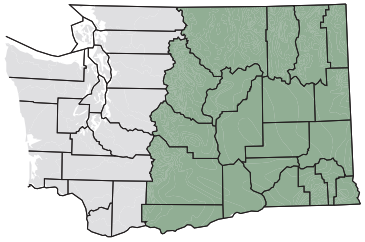
# Eastern Washington Stormwater Manual



## 25-Year 24-Hour Isopluvials

Source: NOAA Atlas 2, Volume IX, 1973
Precipitation in inches

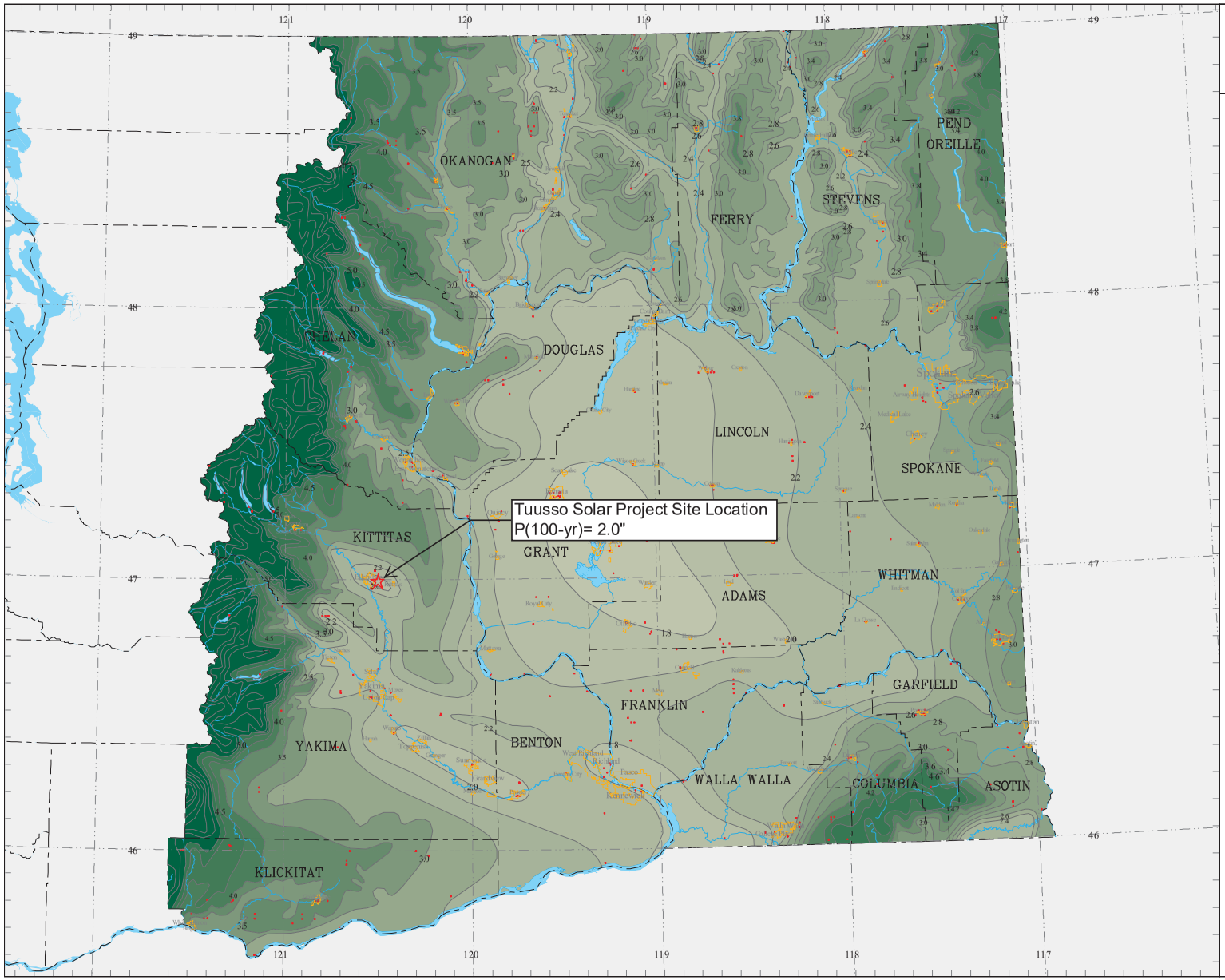
- County(2003, 1:24,000)
- City(2003, 1:24,000)
- Latitude/Longitude(1/10 degree)
- Isopluvial(1973, 1:2,000,000)
- NOAA/NWS Station(1931-1998)

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

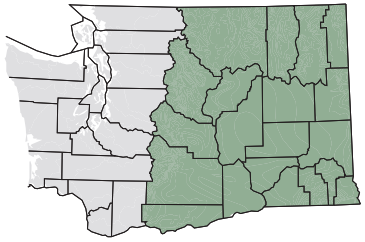
Water Quality Program

WASHINGTON STATE DEPARTMENT OF ECOLOGY

GIS Technical Services
02/25/04
Figure_4.3.5




# 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

WASHINGTON STATE DEPARTMENT OF ECOLOGY

GIS Technical Services
02/25/04
Figure_4.3.7

# Appendix C:

# CURVE NUMBER CALCULATIONS

| Predeveloped Conditions | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Basin Name | Total Area (sf) | Total Area (ac) | Meadow (sf) | Meadow (ac) | HSG | CN | Meadow (sf) | Meadow (ac) | HSG | CN | **Composite Curve Number** |
| Exisiting Basin | 1716264 | 39.40 | 588066 | 13.50 | C | 71 | 1128198 | 25.90 | D | 78 | **76** |

| Postdeveloped 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 Curve Number** |
| Proposed Basin | 1716264 | 39.40 | 57181.3 | 1.31 | D | 94 | 569005.57 | 13.06 | C | 71 | 1090077.13 | 25.02 | D | 78 | **76** |

| Impervious Area Break Down | | | |
|---|---|---|---|
| Lot or Tract | Area (sf) | CN classification | CN |
| Road | 32000 | Gravel | 91 |
| Inverters | 3600 | Impervious | 98 |
| Post | 21581.3 | Impervious | 98 |
| | | | |
| | | Composite CN | 94 |

Post Area

| Solar Trackers | Length | Width | # | area (sf) |
|---|---|---|---|---|
| 72 ft trackers | 248 | 6.5 | 220 | 354640 |
| 52 ft trackers | 188 | 6.5 | 63 | 76986 |
| 36 ft traclers | 121 | 6.5 | 0 | 0 |
| | | | Total | 431626 |
| | | | assumed % impervious (posts) | 5% |
| | | | impervious area | 21581.3 |

# Appendix D:

# HydroCAD REPORT:
# EXISTING BASIN

## Area Listing (selected nodes)

| Area (acres) | CN | Description (subcatchment-numbers) |
|---|---|---|
| 13.500 | 71 | HSG C Meadow (1S) |
| 25.900 | 78 | HSG D Meadow (1S) |
| **39.400** | **76** | **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 | 13.500 | 25.900 | 0.000 | 39.400 | | 1S |
| **0.000** | **0.000** | **13.500** | **25.900** | **0.000** | **39.400** | **TOTAL AREA** | |

## Summary for Subcatchment 1S: Existing

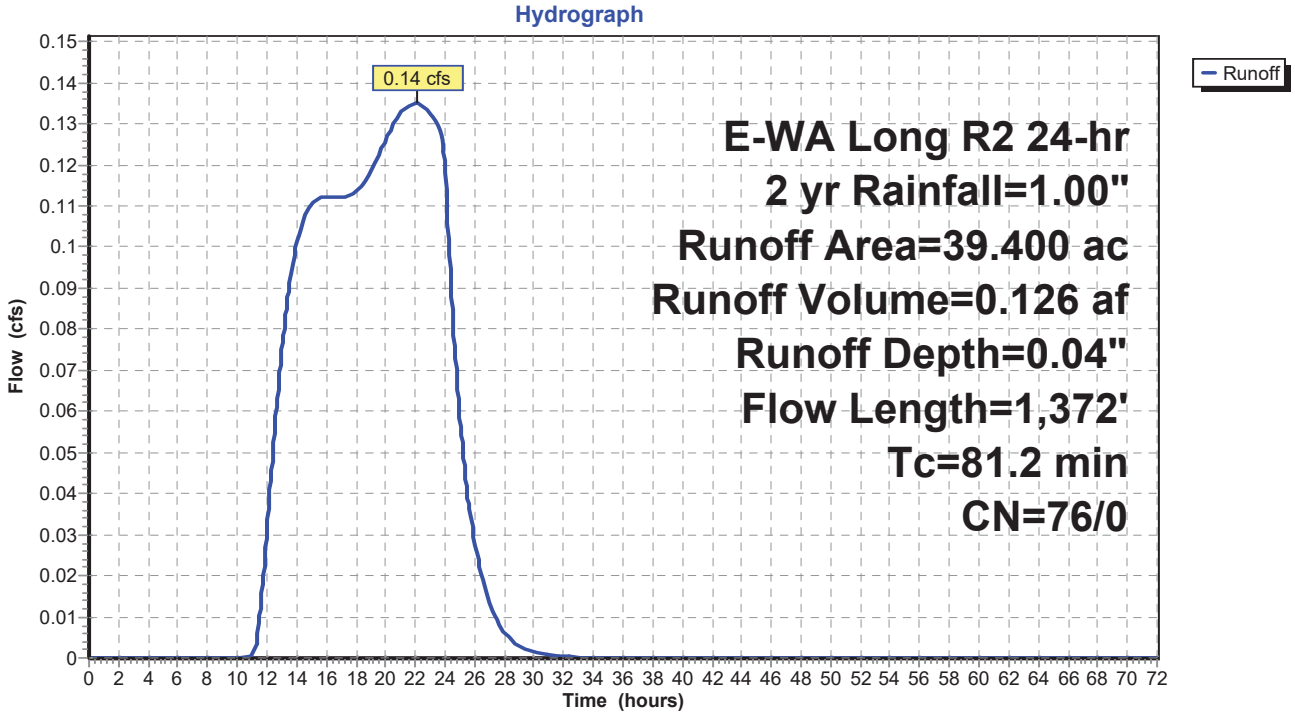
Runoff = 0.14 cfs @ 22.08 hrs, Volume= 0.126 af, Depth= 0.04"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
E-WA Long R2 24-hr 2 yr Rainfall=1.00"

| | Area (ac) | CN | Description |
|---|---|---|---|
| * | 13.500 | 71 | HSG C Meadow |
| * | 25.900 | 78 | HSG D Meadow |
| | 39.400 | 76 | Weighted Average |
| | 39.400 | 76 | 100.00% Pervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 54.3 | 300 | 0.0080 | 0.09 | | **Sheet Flow,** Range n= 0.130 P2= 1.00" |
| 26.9 | 1,072 | 0.0090 | 0.66 | | **Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps |
| 81.2 | 1,372 | Total | | | |

## Subcatchment 1S: Existing



## Summary for Subcatchment 1S: Existing

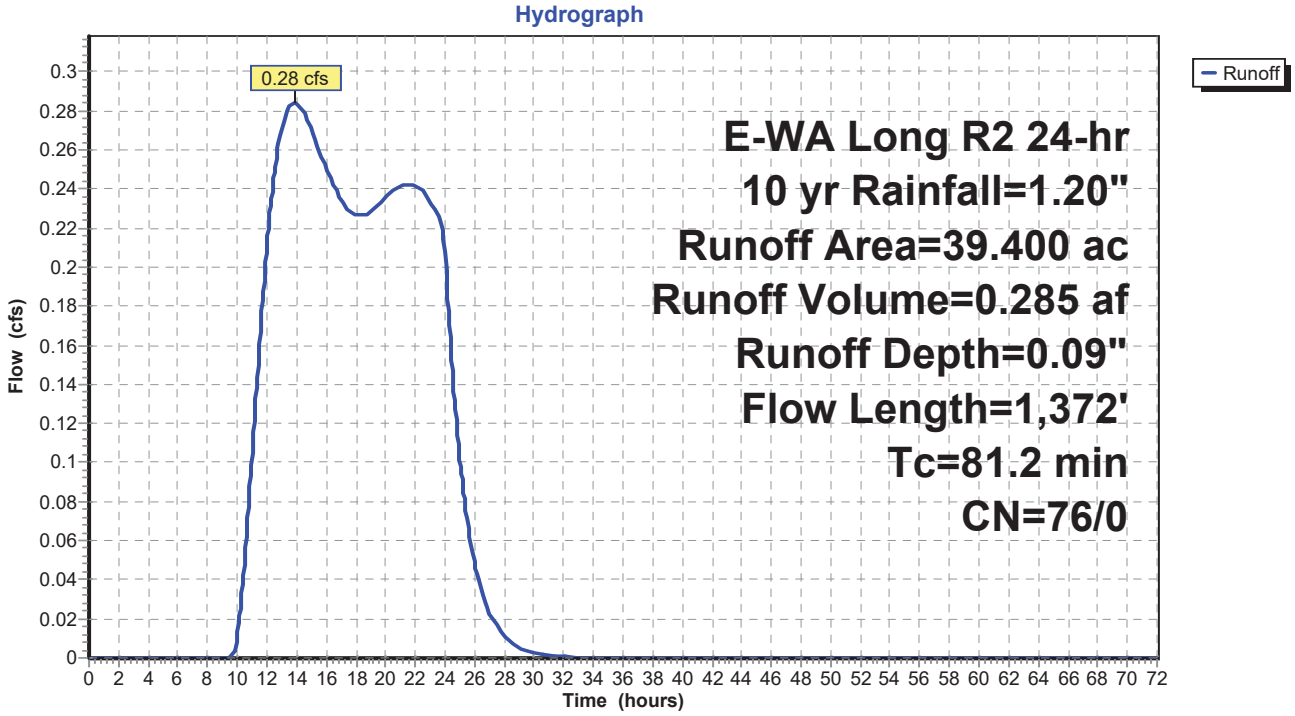
Runoff = 0.28 cfs @ 13.84 hrs, Volume= 0.285 af, Depth= 0.09"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
E-WA Long R2 24-hr 10 yr Rainfall=1.20"

| | Area (ac) | CN | Description |
|---|---|---|---|
| * | 13.500 | 71 | HSG C Meadow |
| * | 25.900 | 78 | HSG D Meadow |
| | 39.400 | 76 | Weighted Average |
| | 39.400 | 76 | 100.00% Pervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 54.3 | 300 | 0.0080 | 0.09 | | **Sheet Flow,** Range n= 0.130 P2= 1.00" |
| 26.9 | 1,072 | 0.0090 | 0.66 | | **Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps |
| 81.2 | 1,372 | Total | | | |

## Subcatchment 1S: Existing



## Summary for Subcatchment 1S: Existing

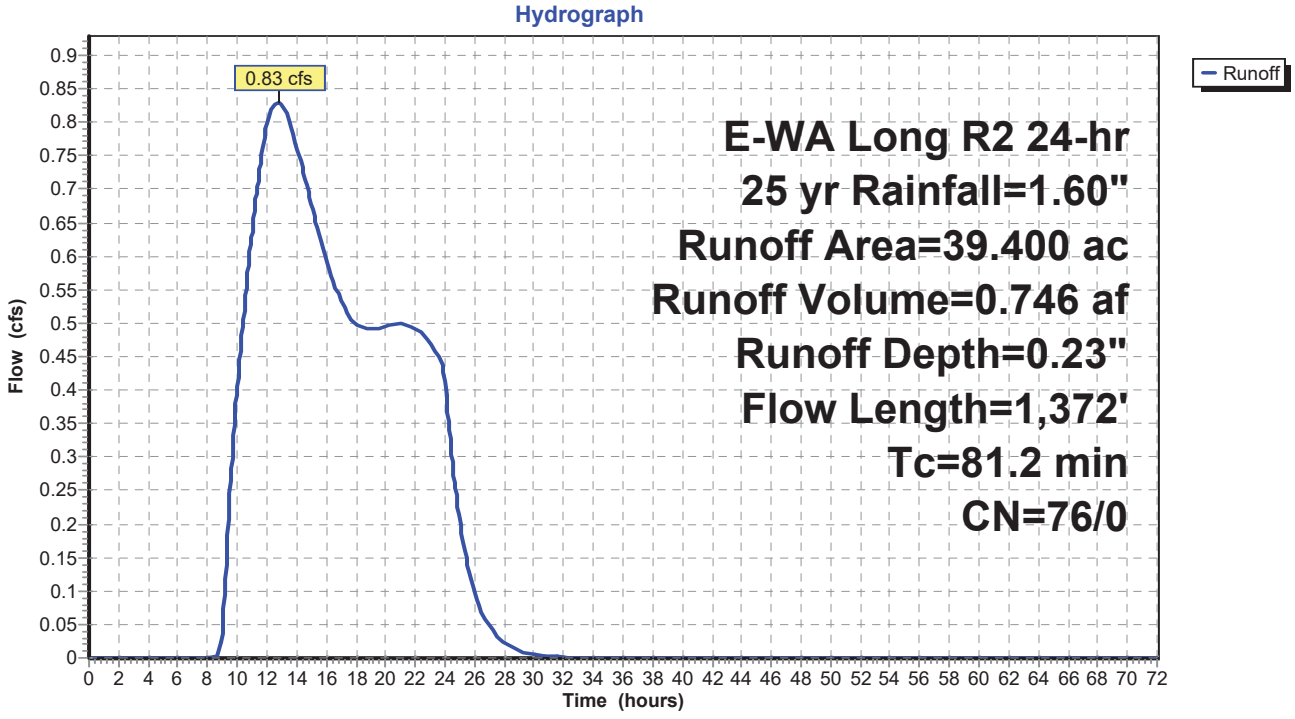
Runoff = 0.83 cfs @ 12.75 hrs, Volume= 0.746 af, Depth= 0.23"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
E-WA Long R2 24-hr 25 yr Rainfall=1.60"

| | Area (ac) | CN | Description |
|---|---|---|---|
| * | 13.500 | 71 | HSG C Meadow |
| * | 25.900 | 78 | HSG D Meadow |
| | 39.400 | 76 | Weighted Average |
| | 39.400 | 76 | 100.00% Pervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 54.3 | 300 | 0.0080 | 0.09 | | **Sheet Flow,** Range n= 0.130 P2= 1.00" |
| 26.9 | 1,072 | 0.0090 | 0.66 | | **Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps |
| 81.2 | 1,372 | Total | | | |

## Subcatchment 1S: Existing



## Summary for Subcatchment 1S: Existing

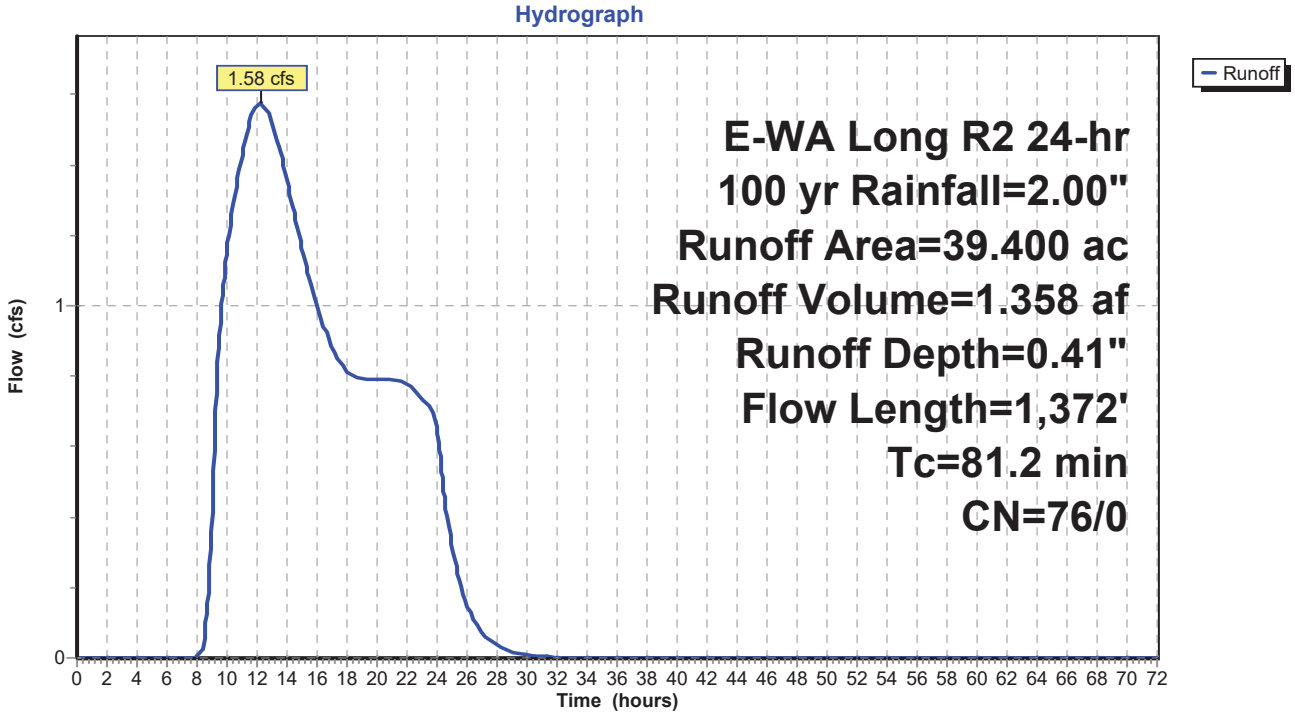
Runoff = 1.58 cfs @ 12.21 hrs, Volume= 1.358 af, Depth= 0.41"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
E-WA Long R2 24-hr 100 yr Rainfall=2.00"

| | Area (ac) | CN | Description |
|---|---|---|---|
| * | 13.500 | 71 | HSG C Meadow |
| * | 25.900 | 78 | HSG D Meadow |
| | 39.400 | 76 | Weighted Average |
| | 39.400 | 76 | 100.00% Pervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 54.3 | 300 | 0.0080 | 0.09 | | **Sheet Flow,** Range n= 0.130 P2= 1.00" |
| 26.9 | 1,072 | 0.0090 | 0.66 | | **Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps |
| 81.2 | 1,372 | Total | | | |

## Subcatchment 1S: Existing



# Appendix E:

# HydroCAD REPORT:
# PROPOSED BASIN

## Area Listing (selected nodes)

| Area (acres) | CN | Description (subcatchment-numbers) |
|---|---|---|
| 13.060 | 71 | HSG C Meadow (3S) |
| 25.020 | 78 | HSG D Meadow (3S) |
| 1.310 | 94 | Impervious (3S) |
| **39.390** | **76** | **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 | 13.060 | 25.020 | 0.000 | 38.080 | | 3S |
| 0.000 | 0.000 | 0.000 | 0.000 | 1.310 | 1.310 | Impervious | 3S |
| **0.000** | **0.000** | **13.060** | **25.020** | **1.310** | **39.390** | **TOTAL AREA** | |

## Summary for Subcatchment 3S: Proposed

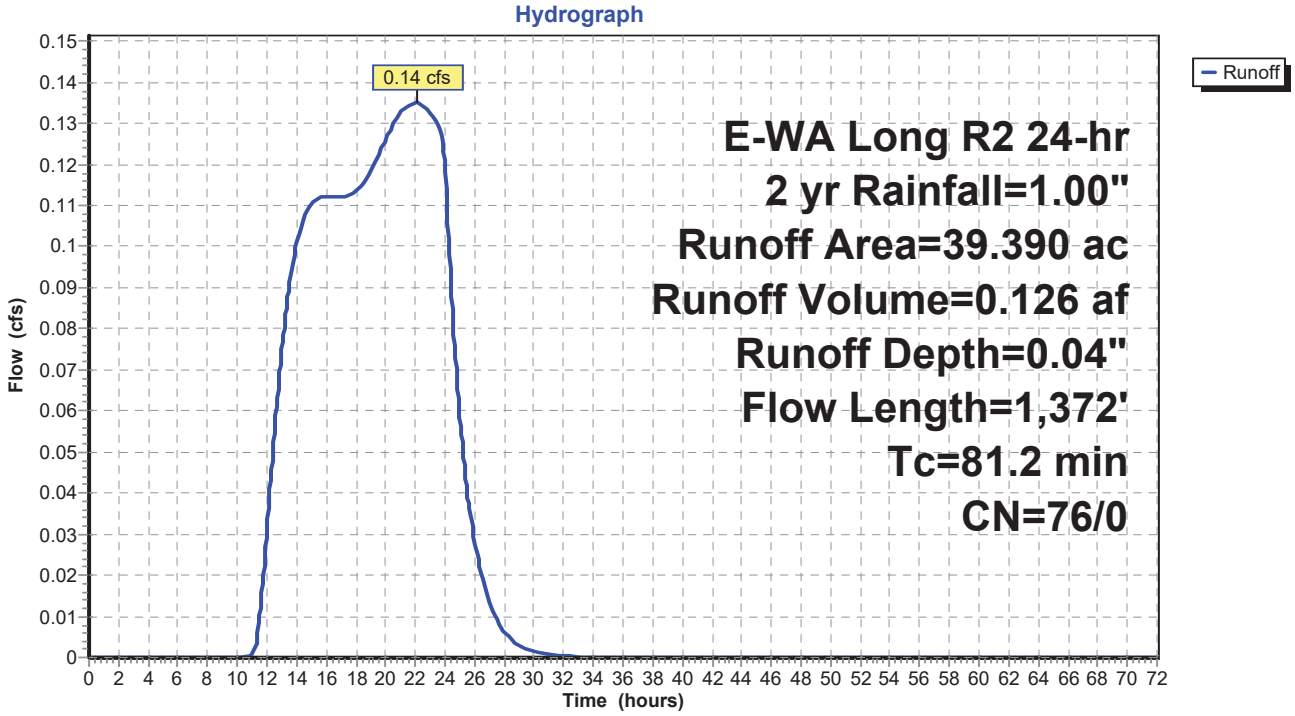
Runoff = 0.14 cfs @ 22.08 hrs, Volume= 0.126 af, Depth= 0.04"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
E-WA Long R2 24-hr 2 yr Rainfall=1.00"

| | Area (ac) | CN | Description |
|---|---|---|---|
| * | 1.310 | 94 | Impervious |
| * | 13.060 | 71 | HSG C Meadow |
| * | 25.020 | 78 | HSG D Meadow |
| | 39.390 | 76 | Weighted Average |
| | 39.390 | 76 | 100.00% Pervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 54.3 | 300 | 0.0080 | 0.09 | | **Sheet Flow,** Range n= 0.130 P2= 1.00" |
| 26.9 | 1,072 | 0.0090 | 0.66 | | **Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps |
| 81.2 | 1,372 | Total | | | |

## Subcatchment 3S: Proposed



## Summary for Subcatchment 3S: Proposed

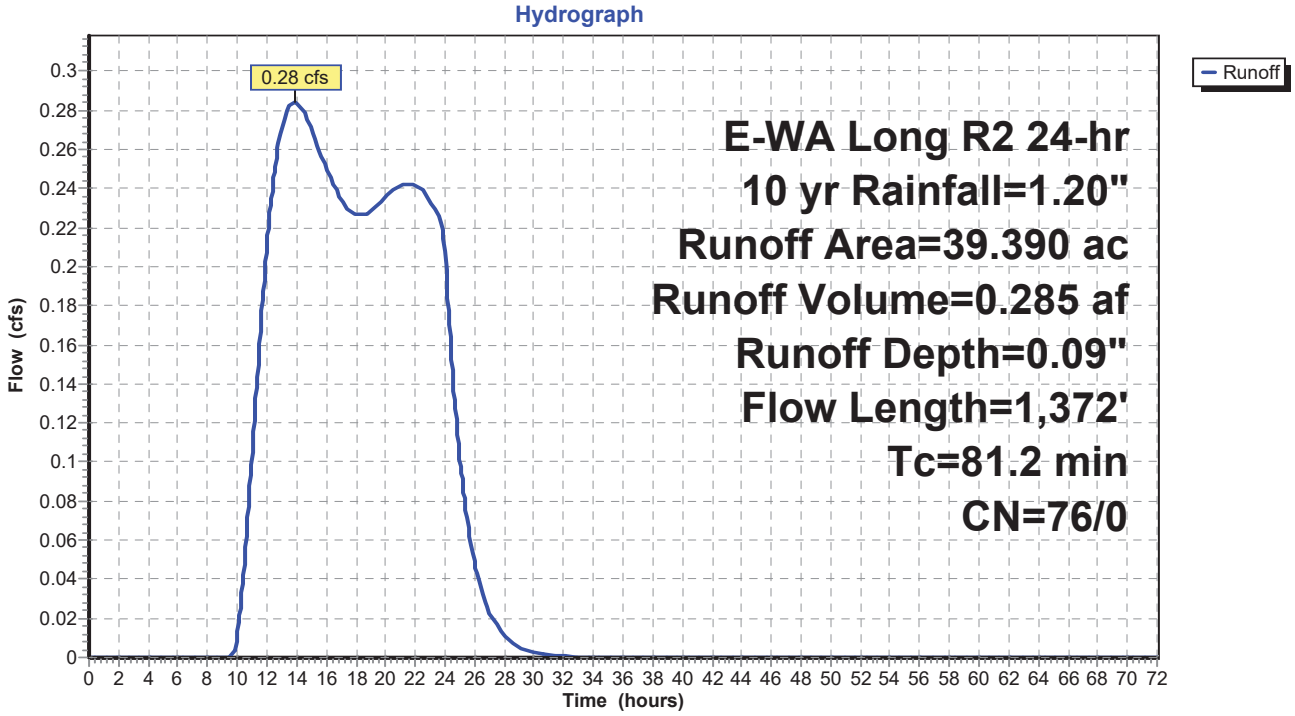
Runoff = 0.28 cfs @ 13.84 hrs, Volume= 0.285 af, Depth= 0.09"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
E-WA Long R2 24-hr 10 yr Rainfall=1.20"

| | Area (ac) | CN | Description |
|---|---|---|---|
| * | 1.310 | 94 | Impervious |
| * | 13.060 | 71 | HSG C Meadow |
| * | 25.020 | 78 | HSG D Meadow |
| | 39.390 | 76 | Weighted Average |
| | 39.390 | 76 | 100.00% Pervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 54.3 | 300 | 0.0080 | 0.09 | | **Sheet Flow,** Range n= 0.130 P2= 1.00" |
| 26.9 | 1,072 | 0.0090 | 0.66 | | **Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps |
| 81.2 | 1,372 | Total | | | |

## Subcatchment 3S: Proposed



## Summary for Subcatchment 3S: Proposed

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Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
E-WA Long R2 24-hr 25 yr Rainfall=1.60"

| | Area (ac) | CN | Description |
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| * | 13.060 | 71 | HSG C Meadow |
| * | 25.020 | 78 | HSG D Meadow |
| | 39.390 | 76 | Weighted Average |
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| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
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| 54.3 | 300 | 0.0080 | 0.09 | | **Sheet Flow,** Range n= 0.130 P2= 1.00" |
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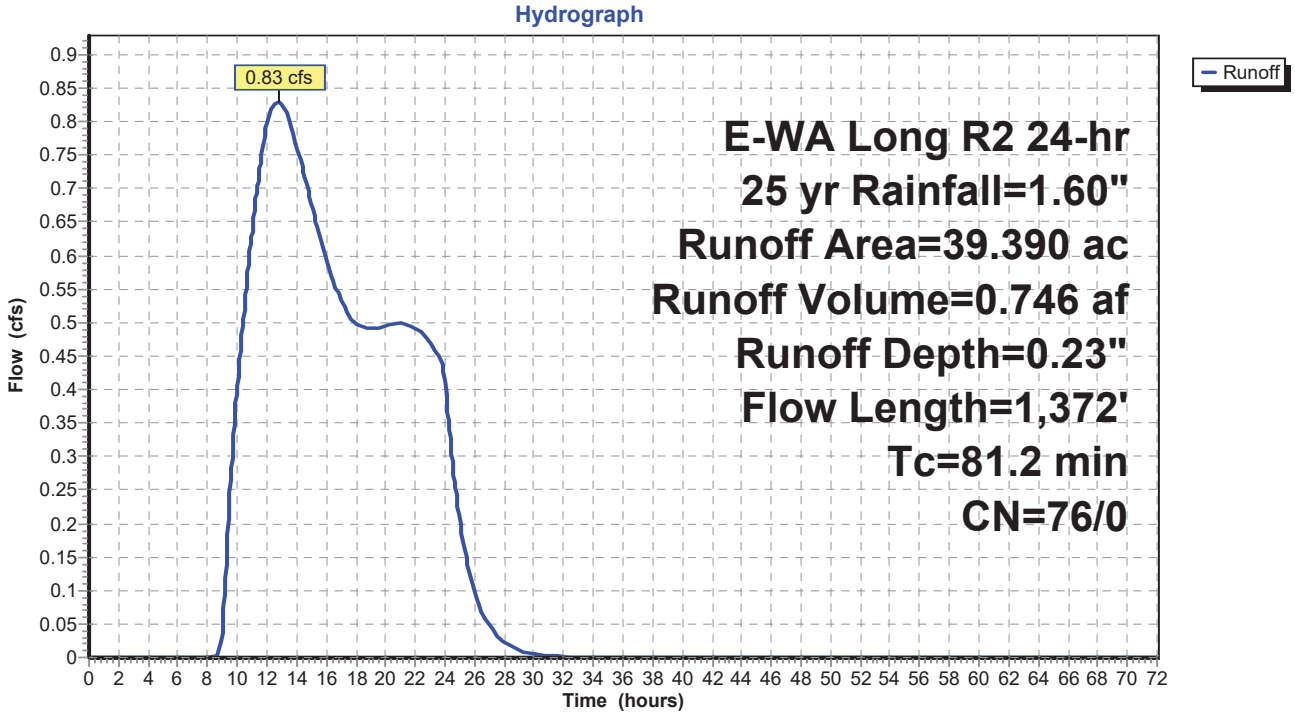
| 81.2 | 1,372 | Total | | | |

## Subcatchment 3S: Proposed



## Summary for Subcatchment 3S: Proposed

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Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
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| | Area (ac) | CN | Description |
|---|---|---|---|
| * | 1.310 | 94 | Impervious |
| * | 13.060 | 71 | HSG C Meadow |
| * | 25.020 | 78 | HSG D Meadow |
| | 39.390 | 76 | Weighted Average |
| | 39.390 | 76 | 100.00% Pervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 54.3 | 300 | 0.0080 | 0.09 | | **Sheet Flow,** Range n= 0.130 P2= 1.00" |
| 26.9 | 1,072 | 0.0090 | 0.66 | | **Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps |
| 81.2 | 1,372 | Total | | | |

## Subcatchment 3S: Proposed