October 17, 2022

Keith McDaniels
Juniper Energy, LLC
818 Crystal Springs Rd
Hillsborough , CA 94010

Subject: Project Lockhart Solar
Hydrology and Hydraulics Report
315 Rox Road
Hinkley, CA 92347
Partner Project No. 22-358548.12

Dear Mr. McDaniels

Partner Engineering and Science, Inc. (Partner) is pleased to provide this Hydrology and Hydraulics Report for Project Lockhart Solar.

We appreciate the opportunity to provide these services to you. If you have any questions concerning this report, or if we can assist you in any other matter, please contact me at 732-221-8066.

Sincerely,

Jeffrey C. Szabo, PE
Senior Project Manager

**PARTNER ENGINEERING AND SCIENCE, INC.**
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# HYDROLOGY AND HYDRAULICS REPORT

## LOCKHART SOLAR PROJECT
## HINKLEY, CA

**Prepared For:**

**PARTNER ENGINEERING AND SCIENCE, Inc.**
**100 DEERFIELD LANE, SUITE 200**
**MALVERN, PENNSYLVANIA 19355**

**Prepared By:**

**CIVIL & ENVIRONMENTAL CONSULTANTS, INC.**
**GOLD RIVER, CALIFORNIA**

**CEC Project 326-160**

**OCTOBER 2022**



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## EXECUTIVE SUMMARY

This executive summary is provided for convenience and should not substitute for review of the complete report, including all attachments. Based on the available data, record review, and corresponding engineering analysis, the findings of Civil and Environmental Consultants, Inc. (CEC) are summarized below.

### General Site Information

The project site is located on the southerly half of an approximately 80-acre parcel of land located north of Roy Street in Hinkley, California. The northerly half of the site is a future proposed Lockhart 2 development. The northern limits of the property are bounded by Roy Road. An unnamed ephemeral stream (aka combined stream) runs through the southern half (Lockhart 1) of the project site, after which the streambanks are not discernable from the existing topography. Partner Engineering and Science, Inc. (Partner) seeks to determine the risk of flooding to, and any expected downstream impacts from, the construction of a photovoltaic farm.

### Site Specific Flood Hazard

According to the Federal Emergency Management Agency (FEMA), the project site is located in an Area of Undetermined Flood Hazard (Zone D). The drainage area to the project site is approximately 4.7 square miles.

### Conclusions

CEC performed a limited hydrologic and hydraulic analysis of the unnamed ephemeral stream for the proposed site development in general accordance with the San Bernardino County Hydrology Manual and standard engineering practices. Based on the analysis, CEC does not anticipate that construction of the photovoltaic farm will be impacted by stream flooding or contribute downstream impacts.

# 1.0 PURPOSE

## 1.1 GENERAL SITE INFORMATION

This hydrology report was prepared by CEC for Partner on behalf of the proposed photovoltaic farm site (Project Lockhart, the project site) in Hinkley, California. The project site is approximately 80 acres of land located north of Roy Street in unincorporated San Bernardino County. The site contains an unnamed ephemeral stream.

## 1.2 INTRODUCTION AND OBJECTIVE

Partner seeks to understand the risk of flooding at the site and perform a feasibility analysis for a proposed photovoltaic farm development within the stream area. To determine the peak water depth, a hydrologic and hydraulic analysis was performed to determine the 10, 25, 50, and 100-year peak discharges to the stream and the resulting peak depths before and after construction of the photovoltaic farm.

# 2.0 DESCRIPTION OF WATERSHED

## 2.1 SETTING

The project site lies within a sparsely vegetated desert landscape in northeastern San Bernardino County. The area is generally flat with slopes less than 1% on average. The watershed contains two unnamed ephemeral streams that converge near the project site's southern boundary. The combined stream flows for approximately 1,000 feet through the project site before dissipating and losing its stream features (see Figure 2). The streams are generally wide and shallow and composed primarily of Cajon Sand. Hills to the east and west mark the boundaries of the - approximately 4.7 square mile watershed. Topographic data for the project site was sourced from the United States Geological Survey (USGS) 3D Elevation Program website.

## 2.2 GEOLOGY

Watershed soils information was sourced from the USGS web soil survey (Appendix A). The web soil survey shows that the two primary soils in the watershed are Norob-Halloran Complex, a loamy sand in hydrologic soil group C, and Cajon loamy sand in hydrologic soil group A. The ephemeral stream beds are composed of primarily Cajon Sand, which has a high hydraulic conductivity in the range of 5-20 inches per hour.

## 2.3 PRECIPITATION

Hinkley, California has a hot, arid climate. The project site receives very little precipitation on an annual basis. Precipitation data for the site was sourced from the National Oceanographic and Atmospheric Administration Atlas 14 Precipitation Frequency Data Server (Appendix B). The 5, 10, 25, and 100-year 24-hour rainfall amounts from Atlas 14 were used to perform the hydrologic and hydraulic analyses.

# 3.0 METHODOLOGY

## 3.1 HYDROLOGY

### 3.1.1 Subbasins

The U.S. Army Corps of Engineers Hydrologic Engineering Center Hydrologic Modeling System (HEC-HMS) version 4.10 was used to model the 10, 25, 50, and 100-year 24-hour storm event hydrologic conditions at the project site. The watershed was divided into three subbasins, one for each tributary stream (west and east streams) before the confluence and one for the combined stream north of the confluence (see Figures 1 and 2).

### 3.1.2 Curve Number

The SCS curve number method was used to model the runoff from the subbasins. Based on the mostly uniform sandy loam geology of the watershed, a curve number of 79 was used for each subbasin. While there are impervious areas such as roads through the watershed, the impervious portion of the watershed is nominal; therefore, the impervious percentage was set to 0%.

### 3.1.3 Lag and Time of Concentration

The United States Department of Agriculture Technical Release 55 (USDA, 1986) was used to calculate the times of concentration for each subbasin. It was assumed that sheet flow is a maximum of 300 feet of the time of concentration flow path before the flow regime switched to shallow concentrated flow. The channel flow time was calculated for full-flow conditions per the San Bernardino County Hydrology Manual (the Manual) guidance. Per the Manual, the times of concentration were multiplied by 0.8 to approximate the lag time. The calculated lag times were used in the HEC-HMS model to produce a hydrograph. Subbasin characteristics, time of concentration calculations, and lag calculations are included in the attached Table 1.

### 3.1.4 Losses

Cajon Sand is “somewhat excessively drained” according to the USGS web soil survey description (Appendix A). The hydraulic conductivity ranges from approximately 5 to 20 inches per hour. To be conservative, a hydraulic conductivity of 5 inches per hour (5 cubic feet per second per acre) was used to model the losses due to percolation in the streams.

## 3.2 HYDRAULICS

10 sections were cut at 100-feet intervals in the combined stream using AutoCAD Civil 3D 2022. From the stream sections, profiles were created and the stream characteristics (e.g., depth and width) were averaged. Similarly, three sections each were cut in the west and east streams. The Manning's equations for channel flow were used to calculate the peak depth in each stream based on the average characteristics and the 10, 25, 50, and 100-year peak flows from HEC-HMS. Sections cut through the north half of the project site indicated no stream geometry.

### 3.2.1 Manning's Roughness Coefficients

Manning's n values for the streams were determined from the USGS Guide for Selecting Manning's Roughness Coefficients for Natural Channels and Flood Plains (USGS, 1989). It was assumed that the streams are mostly uniform in composition. No information is available on the median size of bed material in the streams; therefore, a conservative value was chosen for the base n value. The degree of irregularity is assumed to be severe per the example given in Table 2 of the USGS guide. It was assumed that the size and shape of the streams change gradually, resulting in conversative value for $n_2$. Minor obstructions are assumed to be present in each stream. The amount of vegetation is assumed to be limited and sparse. Finally, the degree of meandering (ratio of stream length to valley length) is minor. The manning's roughness coefficient calculations are included in Table 6.

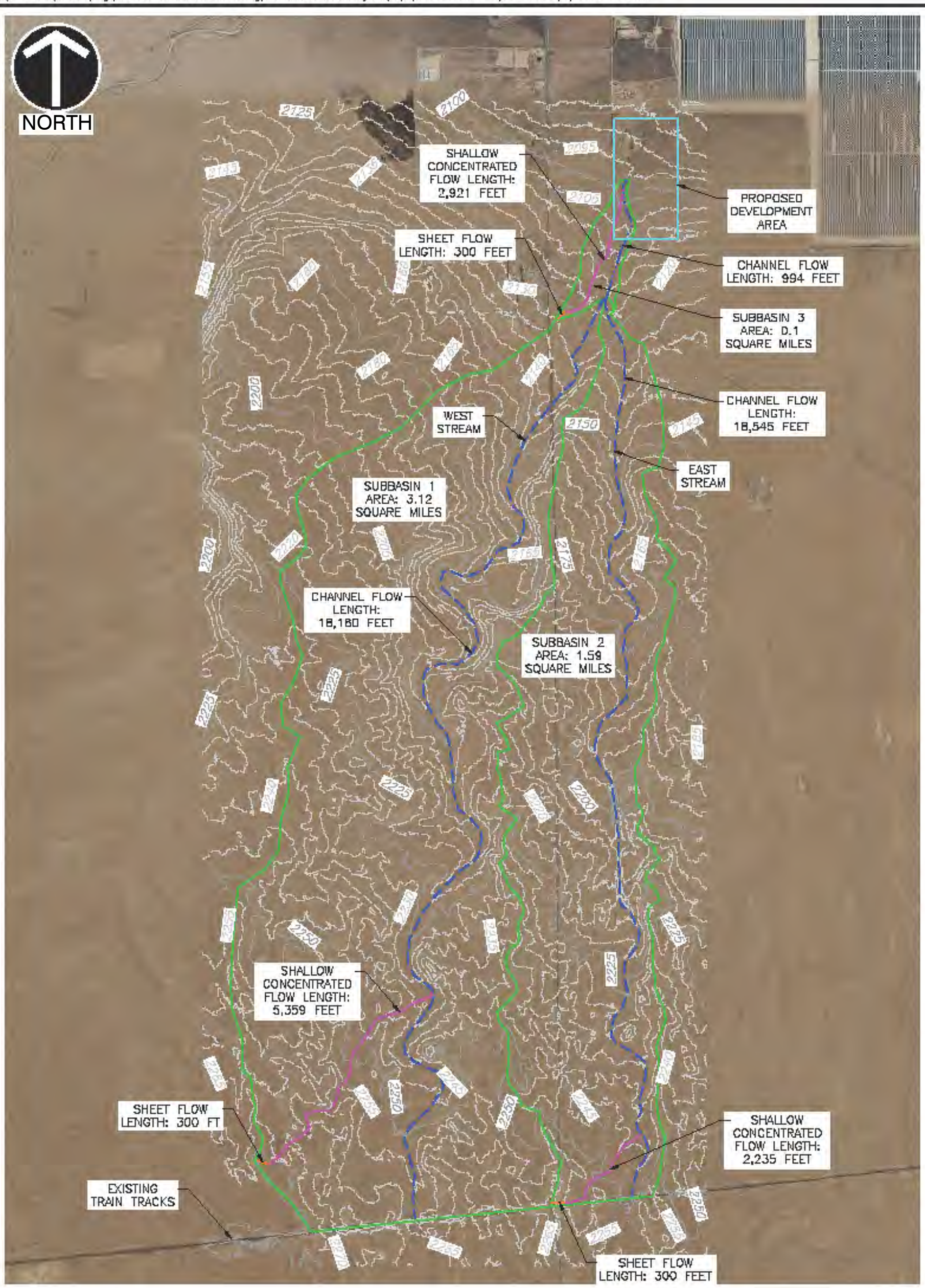
## 4.0 SUMMARY

A hydrologic and hydraulic analysis was performed for the project site comparing the peak discharge and peak depth in the combined stream before and after construction of the proposed photovoltaic farm. The photovoltaic panels are not considered impervious areas for the purpose of this study since the panels are raised and drain directly to the pervious ground below. Proposed roads within the project site will be aggregate. The intent of the site design is to use existing grades to the extent practicable and to minimize required grading.

The batteries and electrolyte tanks were considered new impervious area and therefore contributed additional runoff to the combined stream. Since the tanks and batteries are relatively small compared to the watershed area, this additional impervious area increased the curve number from 79 to 79.2. As a result, the proposed conditions stream peak flow is approximately equal to the existing conditions stream peak flow.

On average, the stream is approximately 1.17 feet deep. The 100-year, 24-hour peak depth in the stream is 0.71 feet for both the existing and proposed conditions. The combined stream ends approximately in the middle of the project site just to the north of the solar arrays. Based on analysis of available topographic data, CEC assumes discharges from the combined stream flow will spread out over a wide area toward the northeast, away from the existing concrete areas on the northwest side of the project site. CEC also assumes that given the consistent and predominantly sandy terrain -portions of sheet flow should quickly infiltrate and reduce potential for surface flow. Therefore, the proposed photovoltaic farm and associated equipment are not expected to impact the stream flow or result in impacts to downstream conditions during the 100-year, 24-hour event. HEC-HMS model printouts are included as Appendix C. Results of the hydraulic analysis are included in Tables 2-5.

# FIGURES




## LEGEND

- OVERLAND FLOW
- SHALLOW CONCENTRATED FLOW
- COMBINED STREAM CENTERLINE
- STREAM
- SUBBASIN BOUNDARY
- PROPOSED DEVELOPMENT AREA
- 2366 EXISTING MAJOR CONTOUR
- EXISTING MINOR CONTOUR

NOTE:

1. TOTAL WATERSHED AREA: 4.78 SQUARE MILES

SCALE IN FEET

0 2000 4000

## REFERENCE

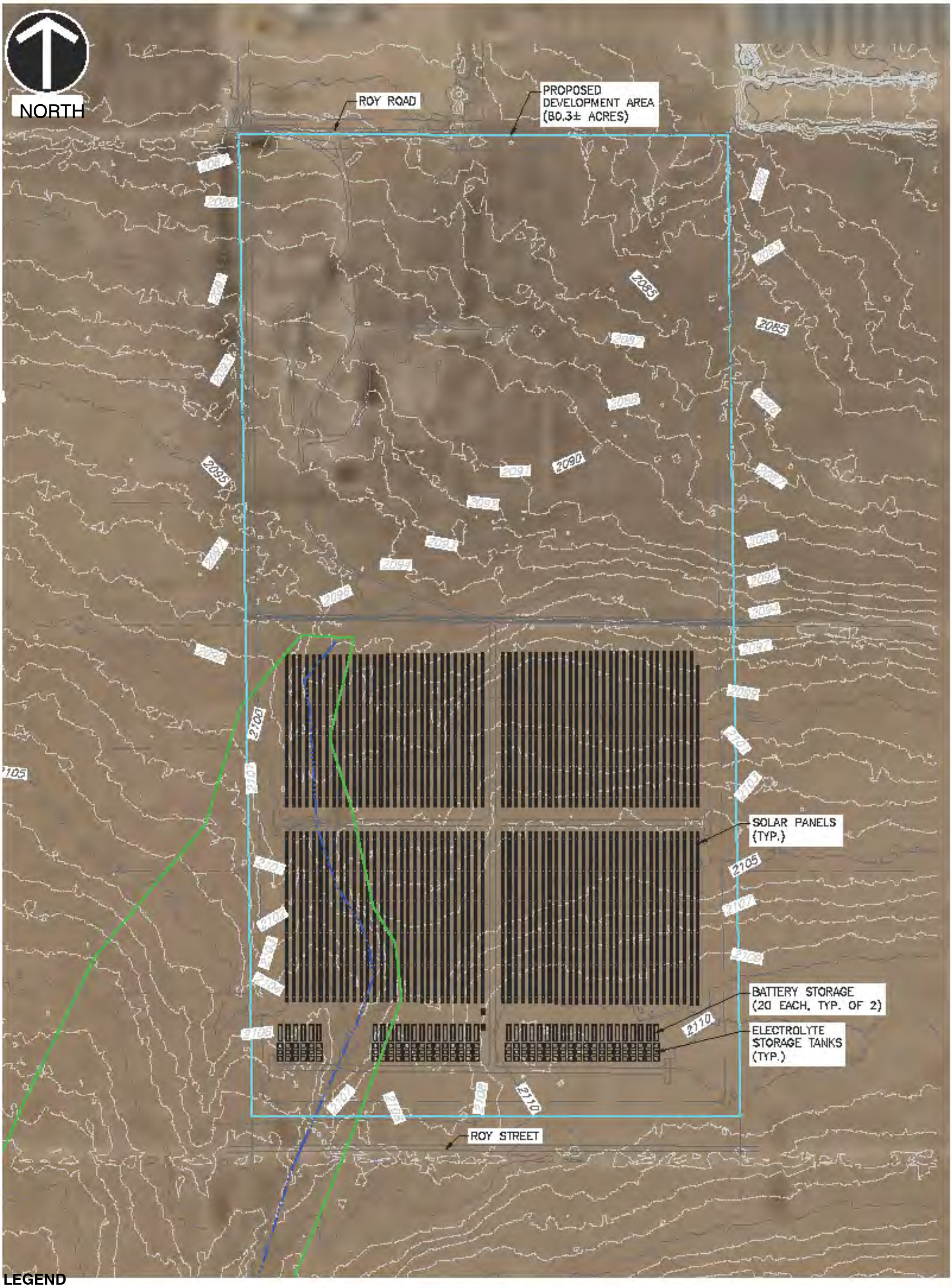
1. TOPOGRAPHIC INFORMATION BASED UPON USGS 3D ELEVATION PROGRAM POINT CLOUD DATA ACESSED ON 9/16/2022

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LOCKHART SOLAR PROJECT
HINKLEY, CA

WATERSHED OVERVIEW

| DRAWN BY: | ELD | CHECKED BY: | NEB | APPROVED BY: | SMR | FIGURE NO.: |
|---|---|---|---|---|---|---|
| DATE: | 10/07/2022 | DWG SCALE: | AS SHOWN | PROJECT NO: | 326-160 | 1 |




**LEGEND**

- COMBINED STREAM CENTERLINE
- DRAINAGE AREA BOUNDARY
- PROPOSED DEVELOPMENT AREA
- 2265 EXISTING MAJOR CONTOUR
- 2266 EXISTING MINOR CONTOUR

SCALE IN FEET
0 250 500

**REFERENCE**

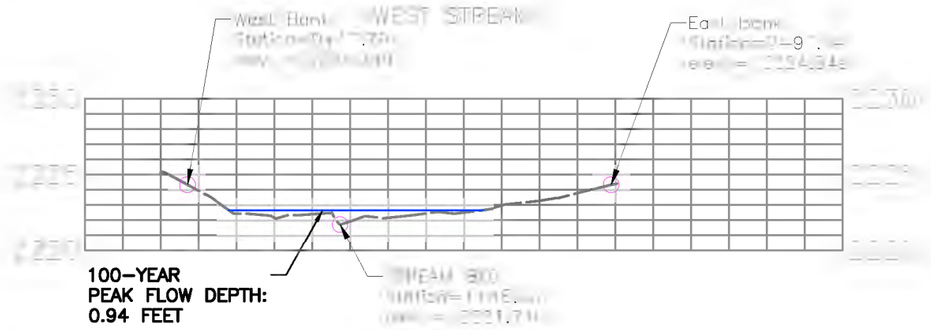
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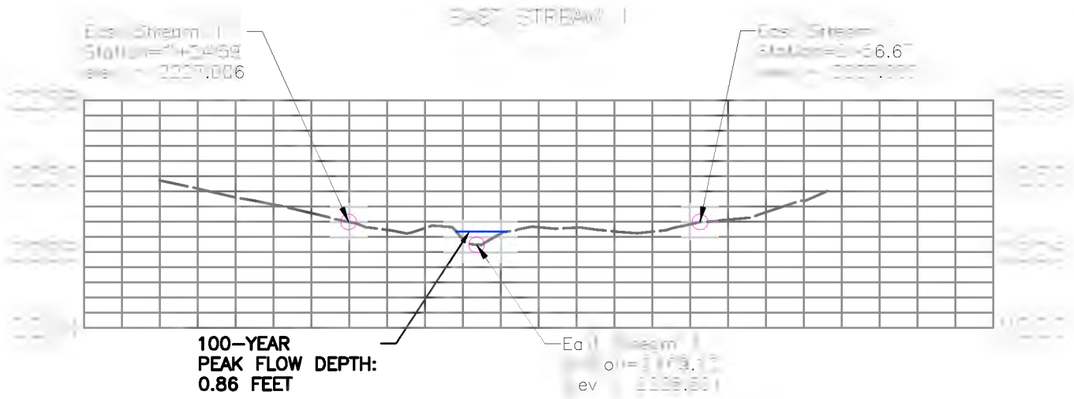
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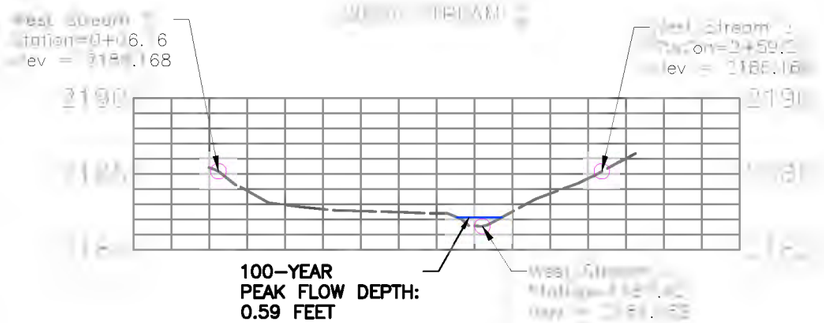
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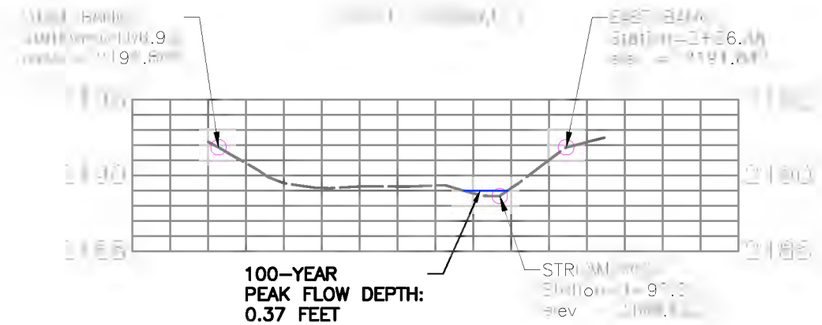
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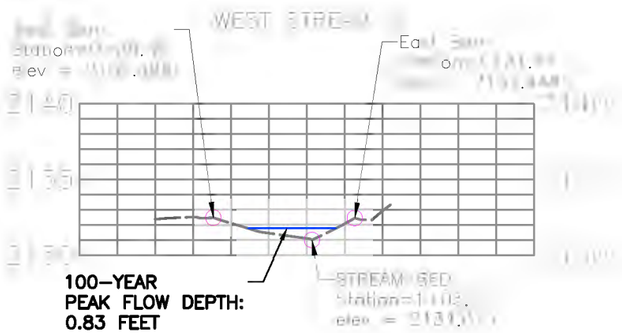
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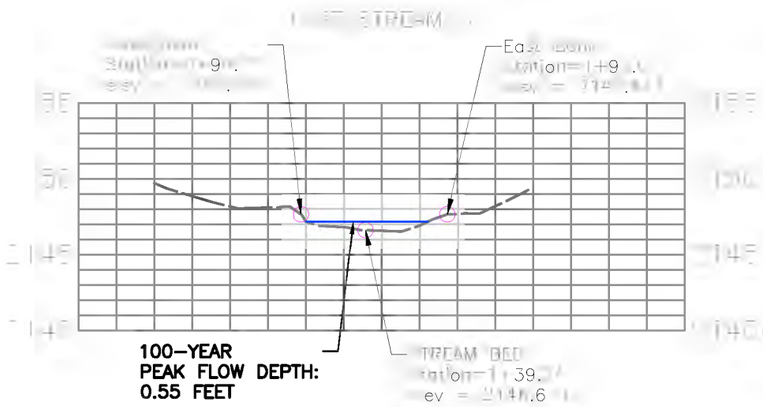



SCALE IN FEET

0 100 200

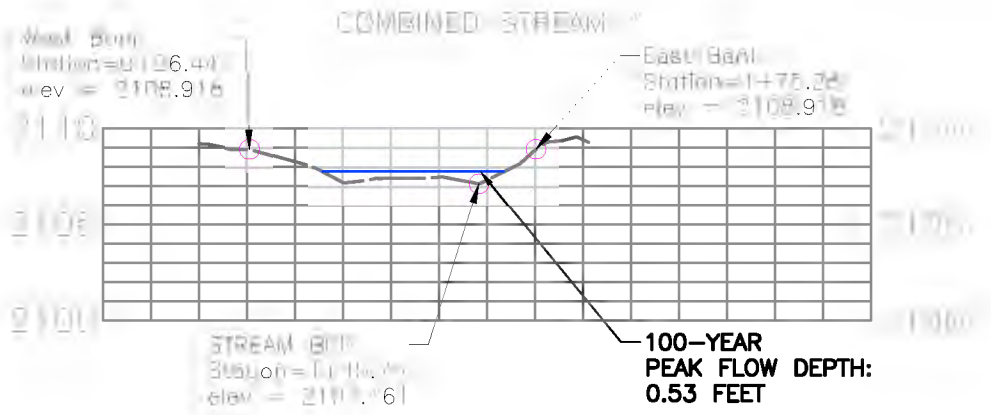
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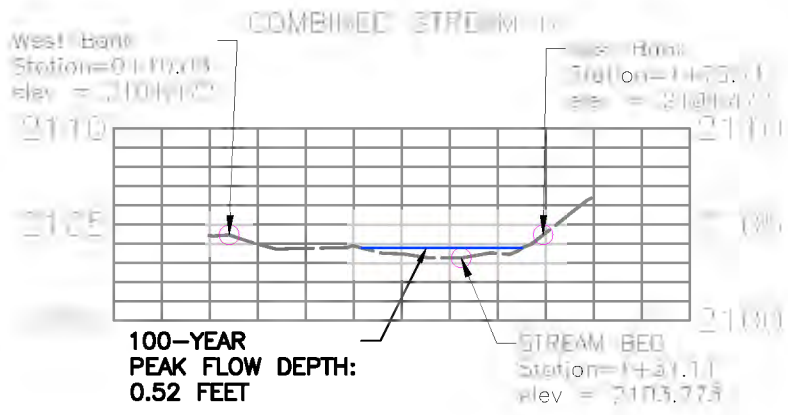
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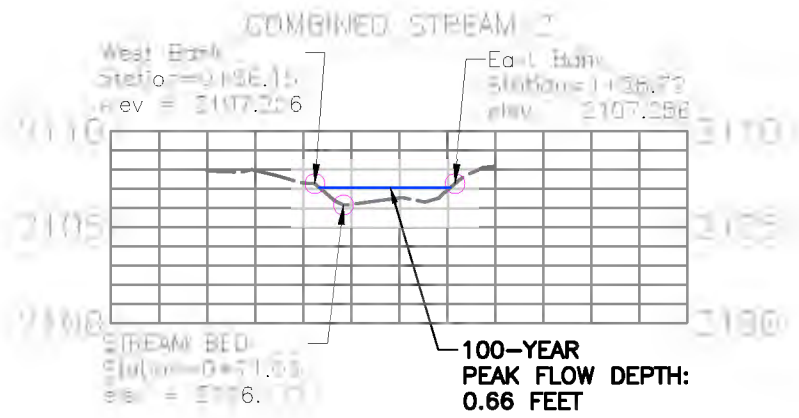
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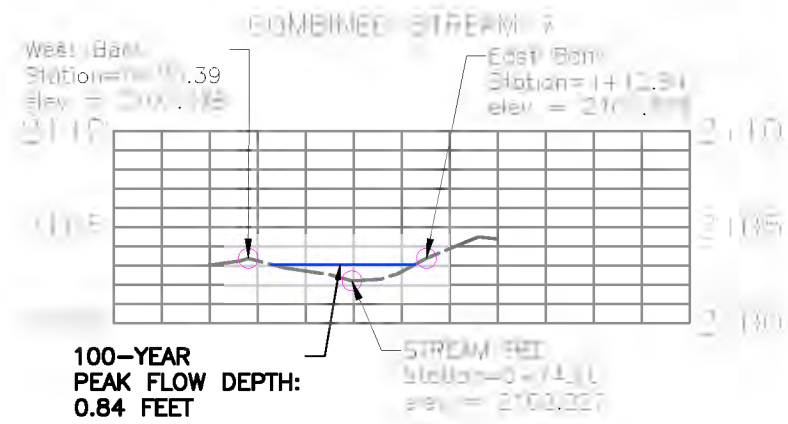
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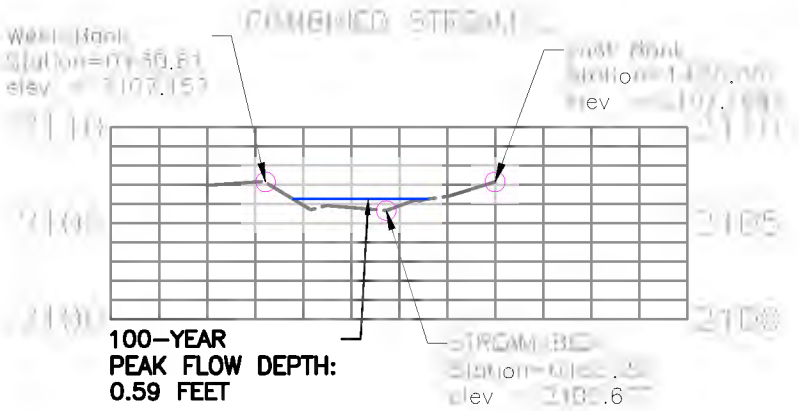
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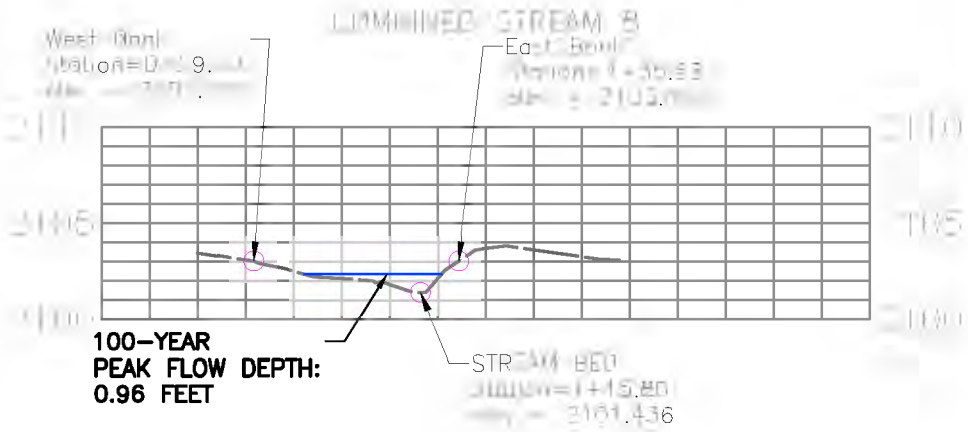


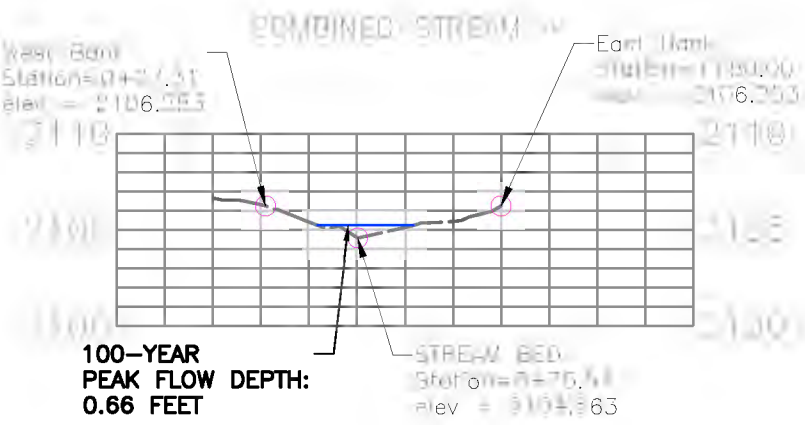



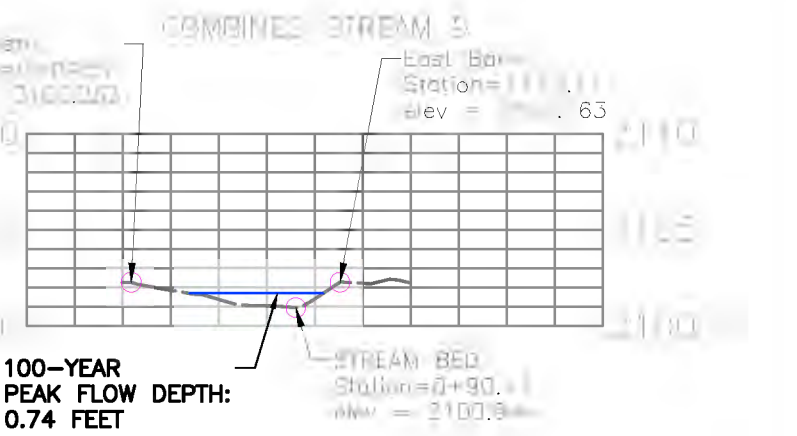



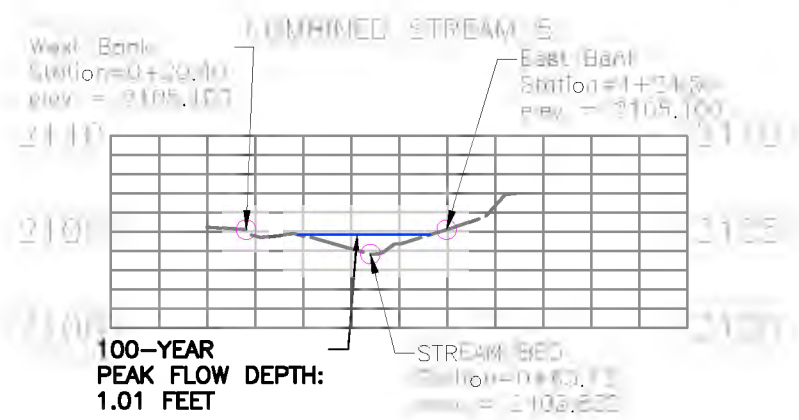



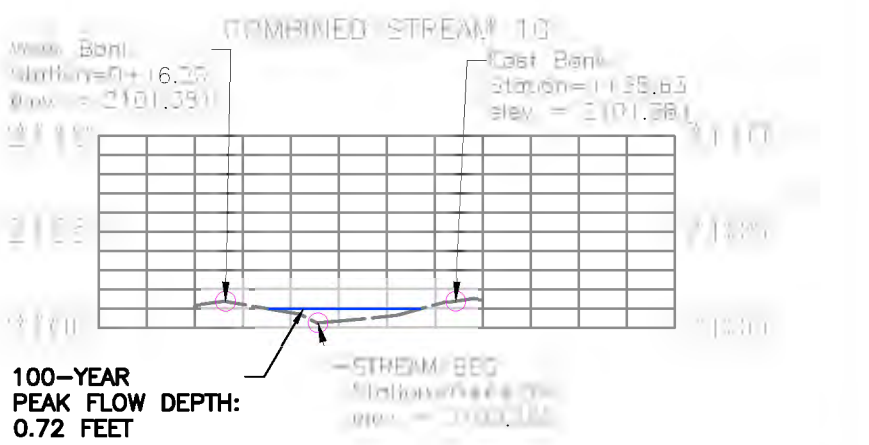




SCALE IN FEET

0 100 200

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COMBINED STREAM SECTIONS

| | | | | | | | |
|---|---|---|---|---|---|---|---|
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| DATE: | 10/07/2022 | DWG SCALE: | AS SHOWN | PROJECT NO: | 326-160 | | |

# TABLES

**Table 1. Time of Concentration and Lag Calculations**

| Characteristics | | | | Sheet Flow | | | | Shallow Concentrated | | | Channel Flow[3] | | | | | | | Time of Concentration (min) | | | Lag (min) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Subbasin | Area (sq. mi.) | CN | Ia (in) | Length (ft) | Slope (ft/ft) | Manning's n[1] | P2 (in)[2] | Length (ft) | Slope (ft/ft) | Velocity (ft/s) | X-section area[4] (sf) | Wetted Perimeter (ft) | Hydraulic Radius (ft) | Slope (ft/ft) | Manning's n | Velocity (ft/s) | Length (ft) | Sheet Flow | Shallow Concentrated | Channel | |
| 1 | 3.12 | 79 | 0.53 | 300 | 0.02 | 0.15 | 1.01 | 5,359 | 0.01 | 1.6 | 716 | 601 | 1.19 | 0.006 | 0.038 | 3.41 | 18,160 | 42 | 56 | 89 | 149 |
| 2 | 1.59 | 79 | 0.53 | 300 | 0.03 | 0.15 | 1.01 | 2,235 | 0.005 | 1.15 | 370 | 376 | 0.98 | 0.007 | 0.038 | 3.17 | 18,545 | 36 | 32 | 97 | 132 |
| 3 (Exist.) | 0.07 | 79 | 0.53 | 300 | 0.01 | 0.15 | 1.01 | 2,921 | 0.010 | 1.6 | 734 | 562 | 1.31 | 0.008 | 0.038 | 4.19 | 994 | 49 | 30 | 4 | 67 |
| 3 (Prop.) | 0.07 | 79.2 | 0.53 | 300 | 0.01 | 0.15 | 1.01 | 2,921 | 0.01 | 1.6 | 734 | 562 | 1.31 | 0.008 | 0.038 | 4.19 | 994 | 49 | 30 | 4 | 67 |

Notes:

1. Manning's n based on TR-55 Table 3-1 value for short grass prairie
2. 2-year precipitation depth based on NOAA Atlas 14 point precipitation frequency estimates
3. Channel flow is based on full-flow conditions per guidance in TR-55
4. Cross sectional areas are averaged from the stream profiles as shown in Figures 3 and 4

Table 2. 10-Year Hydraulic Calculations

| | Inputs | | | | | | Calculations | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Conveyance** | **Bottom Width (ft)** | **Depth (ft)** | **Side Slopes (xH:1V)** | **Peak Flow (cfs)** | **Slope (%)** | **n[1]** | **Flow depth[2] (ft)** | **A (ft2)** | **P (ft)** | **Rh** | **Velocity (ft/s)** | **Q (cfs)** |
| West Stream | 65 | 2.44 | 50 | 1.1 | 0.60 | 0.038 | 0.04 | 2.96 | 69.41 | 0.04 | 0.37 | 1.1 |
| East Stream | 56 | 2.14 | 16 | 1.0 | 0.67 | 0.038 | 0.04 | 2.51 | 57.42 | 0.04 | 0.40 | 1.0 |
| Combined Stream (Existing) | 37 | 1.17 | 34 | 3.8 | 0.80 | 0.038 | 0.12 | 4.81 | 44.98 | 0.11 | 0.79 | 3.8 |
| Combined Stream (Proposed) | 37 | 1.17 | 34 | 3.9 | 0.80 | 0.038 | 0.12 | 4.89 | 45.10 | 0.11 | 0.80 | 3.9 |

Table 3. 25-Year Hydraulic Calculations

| | Inputs | | | | | | Calculations | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Conveyance** | **Bottom Width (ft)** | **Depth (ft)** | **Side Slopes (xH:1V)** | **Peak Flow (cfs)** | **Slope (%)** | **n[1]** | **Flow depth[2] (ft)** | **A (ft2)** | **P (ft)** | **Rh** | **Velocity (ft/s)** | **Q (cfs)** |
| West Stream | 65 | 2.44 | 50 | 4.2 | 0.60 | 0.038 | 0.10 | 6.82 | 74.76 | 0.09 | 0.62 | 4.2 |
| East Stream | 56 | 2.14 | 16 | 3.0 | 0.67 | 0.038 | 0.09 | 4.90 | 58.74 | 0.08 | 0.61 | 3.0 |
| Combined Stream (Existing) | 37 | 1.17 | 34 | 8.7 | 0.80 | 0.038 | 0.19 | 8.24 | 49.90 | 0.17 | 1.06 | 8.7 |
| Combined Stream (Proposed) | 37 | 1.17 | 34 | 8.7 | 0.80 | 0.038 | 0.19 | 8.24 | 49.90 | 0.17 | 1.06 | 8.7 |

Table 4. 50-Year Hydraulic Calculations

| | Inputs | | | | | | Calculations | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Conveyance** | **Bottom Width (ft)** | **Depth (ft)** | **Side Slopes (xH:1V)** | **Peak Flow (cfs)** | **Slope (%)** | **n[1]** | **Flow depth[2] (ft)** | **A (ft2)** | **P (ft)** | **Rh** | **Velocity (ft/s)** | **Q (cfs)** |
| West Stream | 30 | 2.44 | 50 | 15.9 | 0.60 | 0.038 | 0.31 | 13.96 | 60.76 | 0.23 | 1.14 | 15.9 |
| East Stream | 17 | 2.14 | 16 | 9.9 | 0.67 | 0.038 | 0.33 | 7.42 | 27.66 | 0.27 | 1.33 | 9.9 |
| Combined Stream (Existing) | 37 | 1.17 | 34 | 26.3 | 0.80 | 0.038 | 0.35 | 17.35 | 61.07 | 0.28 | 1.52 | 26.3 |
| Combined Stream (Proposed) | 37 | 1.17 | 34 | 26.3 | 0.80 | 0.038 | 0.35 | 17.35 | 61.07 | 0.28 | 1.52 | 26.3 |

Table 5. 100-Year Hydraulic Calculations

| | Inputs | | | | | | Calculations | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Conveyance** | **Bottom Width (ft)** | **Depth (ft)** | **Side Slopes (xH:1V)** | **Peak Flow (cfs)** | **Slope (%)** | **n[1]** | **Flow depth[2] (ft)** | **A (ft2)** | **P (ft)** | **Rh** | **Velocity (ft/s)** | **Q (cfs)** |
| West Stream | 65 | 2.44 | 50 | 60.9 | 0.60 | 0.038 | 0.45 | 39.65 | 110.26 | 0.36 | 1.54 | 60.9 |
| East Stream | 56 | 2.14 | 16 | 37.5 | 0.67 | 0.038 | 0.38 | 23.67 | 68.22 | 0.35 | 1.58 | 37.5 |
| Combined Stream (Existing) | 37 | 1.17 | 34 | 95.8 | 0.80 | 0.038 | 0.71 | 43.01 | 84.98 | 0.51 | 2.23 | 95.8 |
| Combined Stream (Proposed) | 37 | 1.17 | 34 | 95.8 | 0.80 | 0.038 | 0.71 | 43.01 | 84.98 | 0.51 | 2.23 | 95.8 |

Notes:

1. Refer to Table 6 for Manning's roughness coefficients
2. Flow depth determined by iteratively solving the Manning's equation
3. Stream widths, depths, and side slopes are averaged from the stream profiles included in Figures 3 and 4

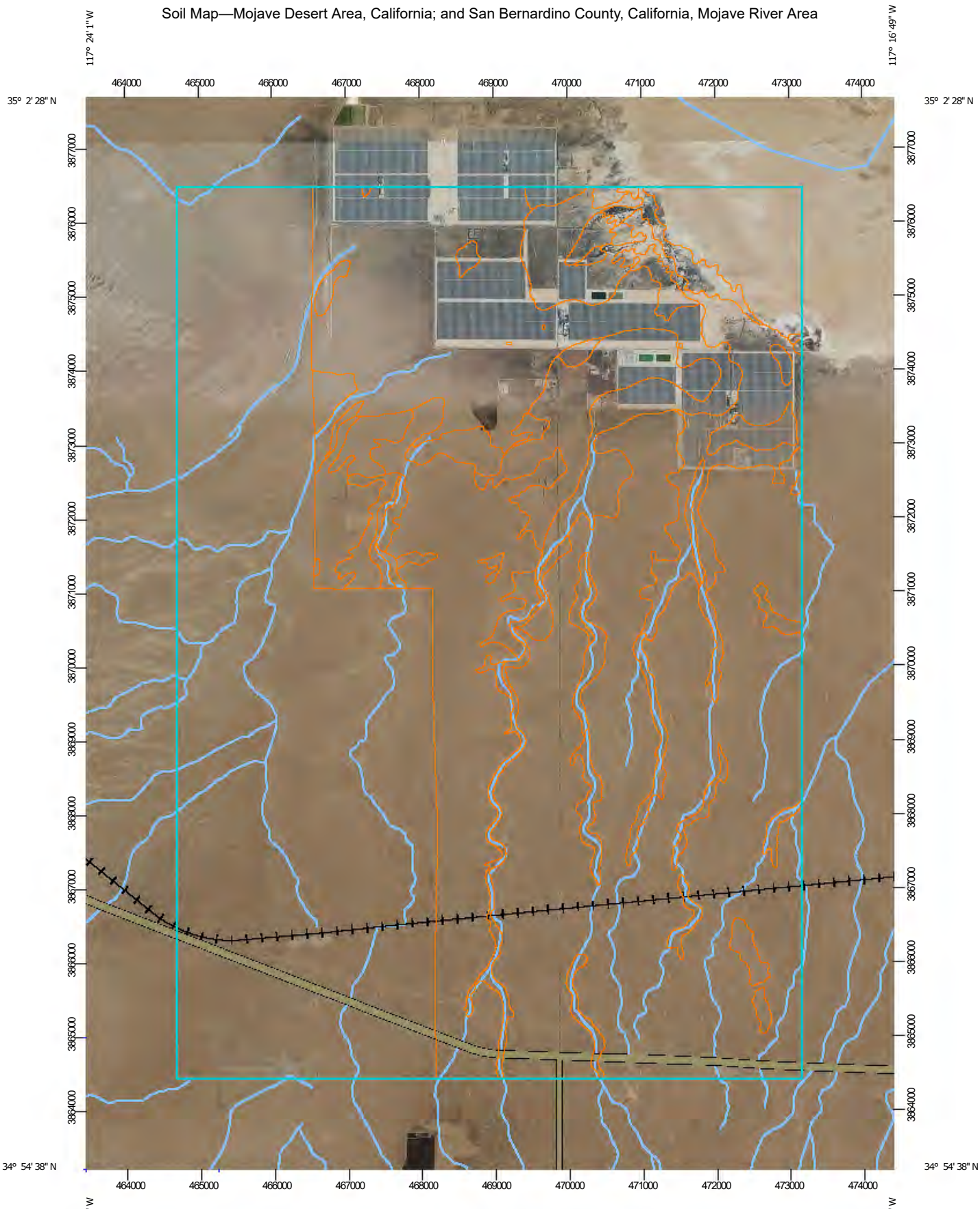
Table 6. Stream Manning's Roughness Coefficients

| Channel | nb | n1 | n2 | n3 | n4 | m | n, total[1] |
|---|---|---|---|---|---|---|---|
| West | 0.02 | 0.011 | 0 | 0.005 | 0.002 | 1 | 0.038 |
| East | 0.02 | 0.011 | 0 | 0.005 | 0.002 | 1 | 0.038 |
| Combined | 0.02 | 0.011 | 0 | 0.005 | 0.002 | 1 | 0.038 |

Notes:

1. Channel n values based on "USGS Guide for Selecting Manning's Roughness Coefficients for Natural Channels and Flood Plains", 1989

# APPENDIX A




Map Scale: 1:70,600 if printed on A portrait (8.5" x 11") sheet.

N

Meters: 0 1000 2000 4000 6000

Feet: 0 3000 6000 12000 18000

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 11N WGS84

## MAP LEGEND

**Area of Interest (AOI)**

- Area of Interest (AOI)

**Soils**

- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

**Special Point Features**

- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

**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.

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: Mojave Desert Area, California
Survey Area Data: Version 19, Sep 13, 2021

Soil Survey Area: San Bernardino County, California, Mojave River Area
Survey Area Data: Version 13, Sep 13, 2021

Your area of interest (AOI) includes more than one soil survey area. These survey areas may have been mapped at different scales, with a different land use in mind, at different times, or at different levels of detail. This may result in map unit symbols, soil properties, and interpretations that do not completely agree across soil survey area boundaries.

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

Date(s) aerial images were photographed: Jul 6, 2019—Jun 12, 2022

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.

# Map Unit Legend

| Map Unit Symbol | Map Unit Name | Acres in AOI | Percent of AOI |
|---|---|---|---|
| NOTCOM | No Digital Data Available | 8,242.4 | 32.6% |
| **Subtotals for Soil Survey Area** | | **8,242.4** | **32.6%** |
| **Totals for Area of Interest** | | **25,318.1** | **100.0%** |

| Map Unit Symbol | Map Unit Name | Acres in AOI | Percent of AOI |
|---|---|---|---|
| 112 | CAJON SAND, 0 TO 2 PERCENT SLOPES | 3,166.7 | 12.5% |
| 113 | CAJON SAND, 2 TO 9 PERCENT SLOPES | 335.4 | 1.3% |
| 117 | CAJON LOAMY SAND, LOAMY SUBSTRATUM, 0 TO 2 PERCENT SLOPES | 2,250.3 | 8.9% |
| 137 | KIMBERLINA LOAMY FINE SAND, COOL, 0 TO 2 PERCENT SLOPES | 654.8 | 2.6% |
| 150 | MOHAVE VARIANT LOAMY SAND, 0 TO 2 PERCENT SLOPES | 79.4 | 0.3% |
| 152 | NOROB-HALLORAN COMPLEX, 0 TO 5 PERCENT SLOPES* | 9,770.2 | 38.6% |
| 156 | PLAYAS | 666.8 | 2.6% |
| 178 | WATER | 150.6 | 0.6% |
| **Subtotals for Soil Survey Area** | | **17,074.4** | **67.4%** |
| **Totals for Area of Interest** | | **25,318.1** | **100.0%** |

# San Bernardino County, California, Mojave River Area

## 117—CAJON LOAMY SAND, LOAMY SUBSTRATUM, 0 TO 2 PERCENT SLOPES

### Map Unit Setting

*National map unit symbol:* hkrp
*Elevation:* 1,800 to 2,300 feet
*Mean annual precipitation:* 3 to 6 inches
*Mean annual air temperature:* 59 to 66 degrees F
*Frost-free period:* 180 to 290 days
*Farmland classification:* Prime farmland if irrigated

### Map Unit Composition

*Cajon, loamy substratum, and similar soils:* 85 percent
*Minor components:* 15 percent
*Estimates are based on observations, descriptions, and transects of the mapunit.*

### Description of Cajon, Loamy Substratum

#### Setting

*Landform:* Alluvial fans
*Landform position (two-dimensional):* Backslope
*Landform position (three-dimensional):* Tread
*Down-slope shape:* Linear
*Across-slope shape:* Linear
*Parent material:* Alluvium derived from granite sources

#### Typical profile

*H1 - 0 to 7 inches:* loamy sand
*H2 - 7 to 20 inches:* sand
*H3 - 20 to 42 inches:* loamy sand
*H4 - 42 to 60 inches:* stratified sand to clay loam

#### Properties and qualities

*Slope:* 0 to 2 percent
*Depth to restrictive feature:* More than 80 inches
*Drainage class:* Somewhat excessively drained
*Capacity of the most limiting layer to transmit water (Ksat):* Moderately high to high (0.57 to 1.98 in/hr)
*Depth to water table:* More than 80 inches
*Frequency of flooding:* None
*Frequency of ponding:* None
*Calcium carbonate, maximum content:* 1 percent
*Maximum salinity:* Very slightly saline to moderately saline (2.0 to 8.0 mmhos/cm)
*Available water supply, 0 to 60 inches:* Low (about 4.9 inches)

#### Interpretive groups

*Land capability classification (irrigated):* 3e
*Land capability classification (nonirrigated):* 7e

*Hydrologic Soil Group:* A
*Ecological site:* R030XF012CA - Sandy
*Hydric soil rating:* No

**Minor Components**

**Cajon**
*Percent of map unit:* 8 percent

**Halloran**
*Percent of map unit:* 5 percent

**Torrifluvents**
*Percent of map unit:* 2 percent
*Landform:* Playas
*Hydric soil rating:* Yes

# Data Source Information

Soil Survey Area: Mojave Desert Area, California
Survey Area Data: Version 19, Sep 13, 2021

Soil Survey Area: San Bernardino County, California, Mojave River Area
Survey Area Data: Version 13, Sep 13, 2021

# San Bernardino County, California, Mojave River Area

## 112—CAJON SAND, 0 TO 2 PERCENT SLOPES

### Map Unit Setting

*National map unit symbol:* hkrj
*Elevation:* 1,800 to 3,200 feet
*Mean annual precipitation:* 3 to 6 inches
*Mean annual air temperature:* 59 to 66 degrees F
*Frost-free period:* 180 to 290 days
*Farmland classification:* Farmland of statewide importance

### Map Unit Composition

*Cajon and similar soils:* 85 percent
*Minor components:* 15 percent
*Estimates are based on observations, descriptions, and transects of the mapunit.*

### Description of Cajon

#### Setting

*Landform:* Alluvial fans
*Landform position (two-dimensional):* Backslope
*Landform position (three-dimensional):* Tread
*Down-slope shape:* Linear
*Across-slope shape:* Linear
*Parent material:* Alluvium derived from granite sources

#### Typical profile

*H1 - 0 to 7 inches:* sand
*H2 - 7 to 25 inches:* sand
*H3 - 25 to 45 inches:* gravelly sand
*H4 - 45 to 60 inches:* stratified sand to loamy fine sand

#### Properties and qualities

*Slope:* 0 to 2 percent
*Depth to restrictive feature:* More than 80 inches
*Drainage class:* Somewhat excessively drained
*Capacity of the most limiting layer to transmit water (Ksat):* High to very high (5.95 to 19.98 in/hr)
*Depth to water table:* More than 80 inches
*Frequency of flooding:* None
*Frequency of ponding:* None
*Calcium carbonate, maximum content:* 1 percent
*Available water supply, 0 to 60 inches:* Low (about 4.1 inches)

#### Interpretive groups

*Land capability classification (irrigated):* 3e
*Land capability classification (nonirrigated):* 7e
*Hydrologic Soil Group:* A
*Ecological site:* R030XF012CA - Sandy
*Hydric soil rating:* No

**Minor Components**

**Manet**
*Percent of map unit:* 5 percent
*Landform:* Playas
*Hydric soil rating:* Yes

**Kimberlina**
*Percent of map unit:* 5 percent

**Helendale**
*Percent of map unit:* 5 percent

# Data Source Information

Soil Survey Area: Mojave Desert Area, California
Survey Area Data: Version 19, Sep 13, 2021

Soil Survey Area: San Bernardino County, California, Mojave River Area
Survey Area Data: Version 13, Sep 13, 2021

# San Bernardino County, California, Mojave River Area

## 152—NOROB-HALLORAN COMPLEX, 0 TO 5 PERCENT SLOPES*

### Map Unit Setting

*National map unit symbol:* hkst
*Elevation:* 1,800 to 2,600 feet
*Mean annual precipitation:* 3 to 5 inches
*Mean annual air temperature:* 63 to 66 degrees F
*Frost-free period:* 200 to 290 days
*Farmland classification:* Not prime farmland

### Map Unit Composition

*Norob and similar soils:* 60 percent
*Halloran and similar soils:* 20 percent
*Minor components:* 20 percent
*Estimates are based on observations, descriptions, and transects of the mapunit.*

### Description of Norob

#### Setting

*Landform:* Fan remnants
*Landform position (two-dimensional):* Summit
*Landform position (three-dimensional):* Interfluve
*Down-slope shape:* Linear
*Across-slope shape:* Linear
*Parent material:* Alluvium derived from granite sources

#### Typical profile

*H1 - 0 to 5 inches:* loamy sand
*H2 - 5 to 33 inches:* sandy clay loam
*H3 - 33 to 60 inches:* stratified gravelly loamy sand to sandy clay loam

#### Properties and qualities

*Slope:* 0 to 5 percent
*Depth to restrictive feature:* More than 80 inches
*Drainage class:* Moderately well drained
*Capacity of the most limiting layer to transmit water (Ksat):* Moderately low to moderately high (0.06 to 0.20 in/hr)
*Depth to water table:* More than 80 inches
*Frequency of flooding:* None
*Frequency of ponding:* None
*Calcium carbonate, maximum content:* 5 percent
*Maximum salinity:* Slightly saline to strongly saline (4.0 to 16.0 mmhos/cm)
*Available water supply, 0 to 60 inches:* Moderate (about 7.5 inches)

**Interpretive groups**

*Land capability classification (irrigated):* None specified
*Land capability classification (nonirrigated):* 7s
*Hydrologic Soil Group:* C
*Ecological site:* R030XF013CA - ALKALI SANDY
*Hydric soil rating:* No

## Description of Halloran

**Setting**

*Landform:* Fan remnants
*Landform position (two-dimensional):* Backslope
*Landform position (three-dimensional):* Side slope
*Down-slope shape:* Linear
*Across-slope shape:* Linear
*Parent material:* Alluvium derived from granite sources

**Typical profile**

*H1 - 0 to 2 inches:* sand
*H2 - 2 to 21 inches:* sandy loam
*H3 - 21 to 33 inches:* loamy sand
*H4 - 33 to 60 inches:* stratified sand to sandy loam

**Properties and qualities**

*Slope:* 0 to 2 percent
*Depth to restrictive feature:* More than 80 inches
*Drainage class:* Moderately well drained
*Capacity of the most limiting layer to transmit water (Ksat):* Moderately high (0.20 to 0.57 in/hr)
*Depth to water table:* More than 80 inches
*Frequency of flooding:* None
*Frequency of ponding:* None
*Calcium carbonate, maximum content:* 10 percent
*Gypsum, maximum content:* 1 percent
*Maximum salinity:* Slightly saline to strongly saline (4.0 to 16.0 mmhos/cm)
*Sodium adsorption ratio, maximum:* 60.0
*Available water supply, 0 to 60 inches:* Very low (about 3.0 inches)

**Interpretive groups**

*Land capability classification (irrigated):* 4s
*Land capability classification (nonirrigated):* 7s
*Hydrologic Soil Group:* C
*Ecological site:* R030XF013CA - ALKALI SANDY
*Hydric soil rating:* No

## Minor Components

**Unnamed soils**

*Percent of map unit:* 18 percent
*Hydric soil rating:* No

**Unnamed**

*Percent of map unit:* 2 percent

*Landform:* Playas
*Hydric soil rating:* Yes

## Data Source Information

Soil Survey Area: Mojave Desert Area, California
Survey Area Data: Version 19, Sep 13, 2021

Soil Survey Area: San Bernardino County, California, Mojave River Area
Survey Area Data: Version 13, Sep 13, 2021

# APPENDIX B

**NOAA Atlas 14, Volume 6, Version 2**
**Location name: Hinkley, California, USA***
**Latitude: 34.977°, Longitude: -117.3431°**
**Elevation: m/ft****
* source: ESRI Maps
** source: USGS

**POINT PRECIPITATION FREQUENCY ESTIMATES**

Sanja Perica, Sarah Dietz, Sarah Heim, Lillian Hiner, Kazungu Maitaria, Deborah Martin, Sandra Pavlovic, Ishani Roy, Carl Trypaluk, Dale Unruh, Fenglin Yan, Michael Yekta, Tan Zhao, Geoffrey Bonnin, Daniel Brewer, Li-Chuan Chen, Tye Parzybok, John Yarchoan

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

## PF tabular

**PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)[1]**

| Duration | Average recurrence interval (years) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 5 | 10 | 25 | 50 | 100 | 200 | 500 | 1000 |
| 5-min | **0.077** (0.063-0.095) | **0.109** (0.089-0.135) | **0.153** (0.125-0.189) | **0.190** (0.154-0.237) | **0.243** (0.190-0.313) | **0.285** (0.219-0.375) | **0.330** (0.248-0.444) | **0.378** (0.277-0.523) | **0.447** (0.314-0.642) | **0.502** (0.341-0.746) |
| 10-min | **0.110** (0.090-0.136) | **0.156** (0.128-0.193) | **0.219** (0.179-0.271) | **0.272** (0.220-0.340) | **0.348** (0.273-0.448) | **0.409** (0.314-0.537) | **0.473** (0.356-0.637) | **0.542** (0.397-0.750) | **0.640** (0.450-0.921) | **0.720** (0.489-1.07) |
| 15-min | **0.134** (0.109-0.165) | **0.189** (0.154-0.233) | **0.265** (0.216-0.328) | **0.329** (0.266-0.411) | **0.421** (0.330-0.542) | **0.495** (0.380-0.650) | **0.573** (0.430-0.770) | **0.656** (0.480-0.906) | **0.775** (0.544-1.11) | **0.871** (0.592-1.29) |
| 30-min | **0.184** (0.150-0.227) | **0.260** (0.212-0.321) | **0.364** (0.297-0.451) | **0.453** (0.366-0.565) | **0.579** (0.454-0.745) | **0.680** (0.523-0.894) | **0.787** (0.591-1.06) | **0.902** (0.659-1.25) | **1.07** (0.748-1.53) | **1.20** (0.814-1.78) |
| 60-min | **0.248** (0.203-0.306) | **0.351** (0.287-0.433) | **0.491** (0.401-0.609) | **0.611** (0.495-0.763) | **0.781** (0.612-1.01) | **0.918** (0.706-1.21) | **1.06** (0.798-1.43) | **1.22** (0.890-1.68) | **1.44** (1.01-2.07) | **1.62** (1.10-2.40) |
| 2-hr | **0.341** (0.279-0.421) | **0.464** (0.380-0.574) | **0.634** (0.517-0.785) | **0.779** (0.630-0.972) | **0.985** (0.772-1.27) | **1.15** (0.885-1.51) | **1.33** (0.997-1.79) | **1.52** (1.11-2.10) | **1.78** (1.25-2.57) | **2.00** (1.36-2.97) |
| 3-hr | **0.398** (0.326-0.491) | **0.537** (0.439-0.663) | **0.727** (0.593-0.900) | **0.890** (0.720-1.11) | **1.12** (0.879-1.45) | **1.31** (1.01-1.72) | **1.51** (1.13-2.03) | **1.72** (1.26-2.37) | **2.02** (1.42-2.90) | **2.26** (1.54-3.36) |
| 6-hr | **0.498** (0.408-0.615) | **0.669** (0.548-0.827) | **0.904** (0.737-1.12) | **1.10** (0.893-1.38) | **1.39** (1.09-1.79) | **1.61** (1.24-2.12) | **1.85** (1.39-2.49) | **2.11** (1.54-2.91) | **2.47** (1.73-3.55) | **2.76** (1.87-4.10) |
| 12-hr | **0.580** (0.475-0.716) | **0.797** (0.652-0.984) | **1.09** (0.891-1.35) | **1.34** (1.08-1.67) | **1.69** (1.32-2.17) | **1.96** (1.51-2.58) | **2.25** (1.69-3.03) | **2.55** (1.87-3.53) | **2.97** (2.09-4.27) | **3.31** (2.25-4.91) |
| 24-hr | **0.711** (0.631-0.817) | **1.01** (0.892-1.16) | **1.40** (1.24-1.62) | **1.73** (1.52-2.01) | **2.18** (1.85-2.63) | **2.54** (2.11-3.12) | **2.90** (2.35-3.66) | **3.28** (2.58-4.25) | **3.80** (2.87-5.14) | **4.21** (3.07-5.89) |
| 2-day | **0.824** (0.732-0.948) | **1.18** (1.05-1.36) | **1.66** (1.46-1.91) | **2.04** (1.79-2.38) | **2.57** (2.18-3.09) | **2.98** (2.47-3.66) | **3.40** (2.75-4.28) | **3.83** (3.01-4.96) | **4.41** (3.33-5.95) | **4.86** (3.54-6.79) |
| 3-day | **0.881** (0.782-1.01) | **1.27** (1.13-1.46) | **1.78** (1.58-2.06) | **2.20** (1.93-2.56) | **2.77** (2.35-3.33) | **3.20** (2.66-3.93) | **3.64** (2.95-4.58) | **4.09** (3.22-5.29) | **4.69** (3.54-6.34) | **5.16** (3.77-7.22) |
| 4-day | **0.926** (0.822-1.06) | **1.34** (1.19-1.54) | **1.88** (1.66-2.17) | **2.32** (2.04-2.70) | **2.91** (2.47-3.51) | **3.36** (2.79-4.13) | **3.82** (3.09-4.81) | **4.28** (3.37-5.55) | **4.91** (3.71-6.63) | **5.39** (3.93-7.53) |
| 7-day | **0.991** (0.880-1.14) | **1.43** (1.27-1.65) | **2.02** (1.78-2.33) | **2.49** (2.18-2.89) | **3.12** (2.65-3.76) | **3.60** (2.99-4.42) | **4.08** (3.30-5.14) | **4.56** (3.59-5.91) | **5.20** (3.93-7.03) | **5.68** (4.15-7.95) |
| 10-day | **1.03** (0.918-1.19) | **1.50** (1.33-1.72) | **2.11** (1.87-2.44) | **2.61** (2.29-3.04) | **3.28** (2.78-3.95) | **3.79** (3.15-4.66) | **4.29** (3.48-5.41) | **4.80** (3.78-6.22) | **5.48** (4.14-7.40) | **5.98** (4.37-8.37) |
| 20-day | **1.18** (1.04-1.35) | **1.73** (1.53-1.99) | **2.47** (2.19-2.85) | **3.08** (2.70-3.59) | **3.92** (3.32-4.71) | **4.55** (3.78-5.60) | **5.19** (4.21-6.54) | **5.84** (4.60-7.57) | **6.69** (5.06-9.04) | **7.33** (5.35-10.2) |
| 30-day | **1.32** (1.17-1.52) | **1.96** (1.74-2.26) | **2.83** (2.50-3.26) | **3.55** (3.11-4.13) | **4.55** (3.86-5.48) | **5.32** (4.42-6.54) | **6.10** (4.94-7.69) | **6.89** (5.43-8.93) | **7.94** (6.00-10.7) | **8.71** (6.36-12.2) |
| 45-day | **1.53** (1.35-1.75) | **2.27** (2.02-2.62) | **3.31** (2.92-3.82) | **4.18** (3.66-4.86) | **5.41** (4.59-6.51) | **6.38** (5.29-7.84) | **7.36** (5.96-9.27) | **8.36** (6.58-10.8) | **9.70** (7.33-13.1) | **10.7** (7.81-15.0) |
| 60-day | **1.66** (1.48-1.91) | **2.49** (2.20-2.86) | **3.64** (3.22-4.20) | **4.63** (4.06-5.38) | **6.03** (5.11-7.25) | **7.14** (5.93-8.78) | **8.30** (6.72-10.4) | **9.47** (7.46-12.3) | **11.1** (8.35-14.9) | **12.2** (8.94-17.1) |

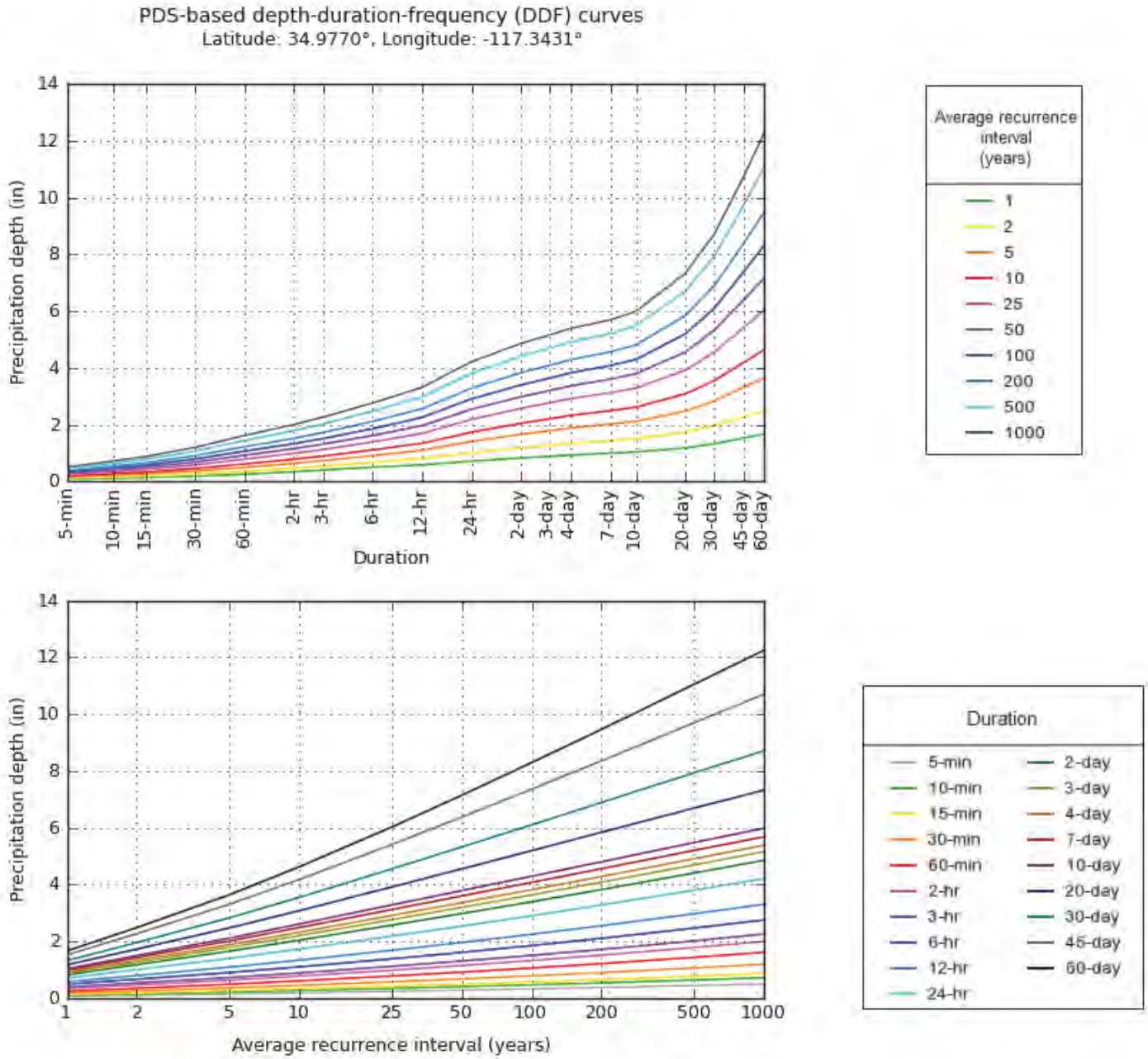
[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

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## PF graphical



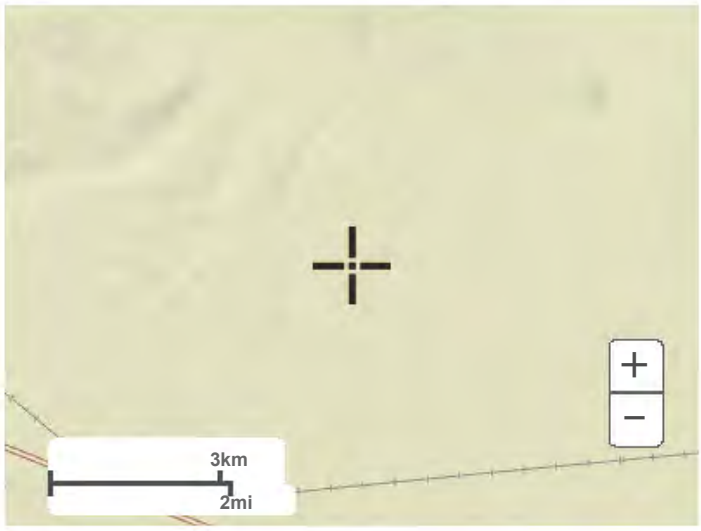

NOAA Atlas 14, Volume 6, Version 2

Created (GMT): Mon Sep 19 19:09:05 2022

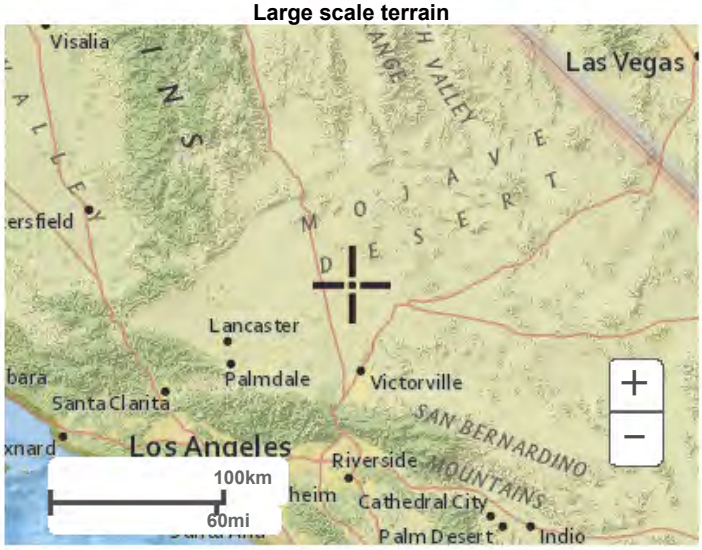
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## Maps & aerials

**Small scale terrain**




**Large scale terrain**




**Large scale map**




**Large scale aerial**




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US Department of Commerce
National Oceanic and Atmospheric Administration
National Weather Service
National Water Center
1325 East West Highway
Silver Spring, MD 20910
Questions?: HDSC.Questions@noaa.gov

Disclaimer

# APPENDIX C

**Project:** Lockhart_Solar_Existing
**Simulation Run:** 10-Year
**Simulation Start:** 31 December 2021, 24:00
**Simulation End:** 2 January 2022, 00:15

**HMS Version:** 4.10
**Executed:** 17 October 2022, 17:01

## Global Parameter Summary - Subbasin

**Area (MI2)**

| Element Name | Area (MI2) |
|---|---|
| Subbasin - 2 | 1.59 |
| Subbasin - 1 | 3.12 |
| Subbasin - 3 | 0.07 |

**Downstream**

| Element Name | Downstream |
|---|---|
| Subbasin - 2 | East Stream |
| Subbasin - 1 | West Stream |
| Subbasin - 3 | Junction - 1 |

**Loss Rate: Scs**

| Element Name | Percent Impervious Area | Curve Number |
|---|---|---|
| Subbasin - 2 | 0 | 79 |
| Subbasin - 1 | 0 | 79 |
| Subbasin - 3 | 0 | 79 |

**Transform: Scs**

| Element Name | Lag | Unitgraph Type |
|---|---|---|
| Subbasin - 2 | 132 | Standard |
| Subbasin - 1 | 149 | Standard |
| Subbasin - 3 | 67 | Standard |

## Global Parameter Summary - Reach

**Downstream**

| Element Name | Downstream |
|---|---|
| West Stream | Junction - 1 |
| East Stream | Junction - 1 |
| Combined Stream | Sink - 1 |

**Route: Muskingum Cunge**

| Element Name | Method | Channel | Length (FT) | Energy Slope (FT/FT) | Mannings n | Bottom Width (FT) | Side Slope (FT/FT) | Initial Variable | Space - Time Method | Index Parameter Type | Index Flow | Maximum Depth Iterations |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| West Stream | Muskingum Cunge | 5 | 18160 | 0.01 | 0.04 | 65 | 48 | Combined Inflow | Automatic DX and DT | Index Flow | 180 | 20 |
| East Stream | Muskingum Cunge | 5 | 18545 | 0.01 | 0.04 | 56 | 15 | Combined Inflow | Automatic DX and DT | Index Flow | 100 | 20 |
| Combined Stream | Muskingum Cunge | 5 | 994 | 0.01 | 0.04 | 32 | 35 | Combined Inflow | Automatic DX and DT | Index Flow | 10 | 20 |

## Global Results Summary

| Hydrologic Element | Drainage Area (MI2) | Peak Discharge (CFS) | Time of Peak | Volume (IN) |
|---|---|---|---|---|
| Subbasin - 2 | 1.59 | 57.41 | 01Jan2022, 15:00 | 0.33 |
| Subbasin - 1 | 3.12 | 104.35 | 01Jan2022, 15:15 | 0.33 |
| West Stream | 3.12 | 1.09 | 01Jan2022, 18:00 | 0 |
| East Stream | 1.59 | 1 | 01Jan2022, 17:15 | 0.01 |
| Subbasin - 3 | 0.07 | 3.84 | 01Jan2022, 13:30 | 0.35 |
| Junction - 1 | 4.78 | 3.84 | 01Jan2022, 13:30 | 0.01 |
| Combined Stream | 4.78 | 1.62 | 01Jan2022, 13:45 | 0 |
| Sink - 1 | 4.78 | 1.62 | 01Jan2022, 13:45 | 0 |

# Subbasin: Subbasin-2

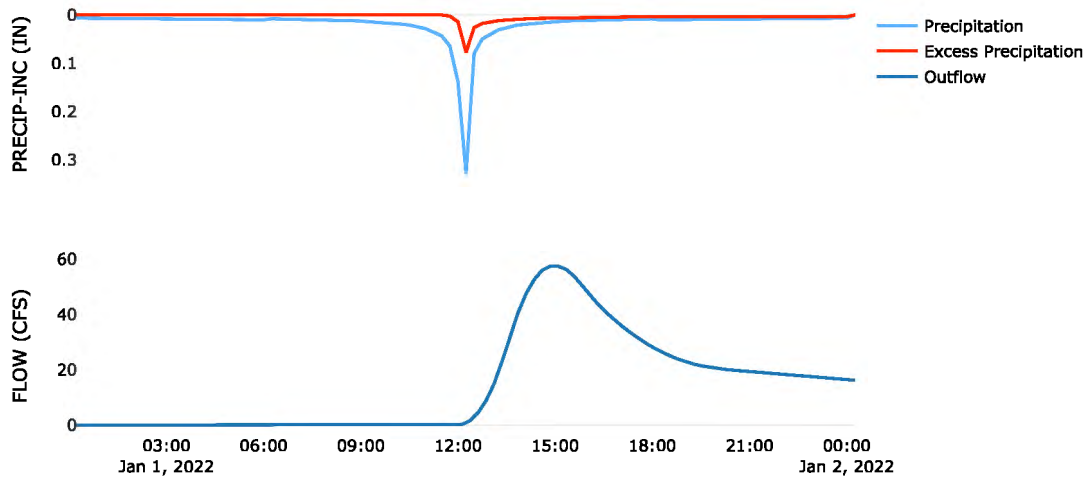
**Area (MI2)** : 1.59
**Downstream** : East Stream

| Loss Rate: Scs | |
|---|---|
| Percent Impervious Area | 0 |
| Curve Number | 79 |

| Transform: Scs | |
|---|---|
| Lag | 132 |
| Unitgraph Type | Standard |

| Results: Subbasin-2 | |
|---|---|
| Peak Discharge (CFS) | 57.41 |
| Time of Peak Discharge | 01Jan2022, 15:00 |
| Volume (IN) | 0.33 |
| Precipitation Volume (AC - FT) | 146.89 |
| Loss Volume (AC - FT) | 115.27 |
| Excess Volume (AC - FT) | 31.62 |
| Direct Runoff Volume (AC - FT) | 28.23 |
| Baseflow Volume (AC - FT) | 0 |

Precipitation and Outflow



# Subbasin: Subbasin-1

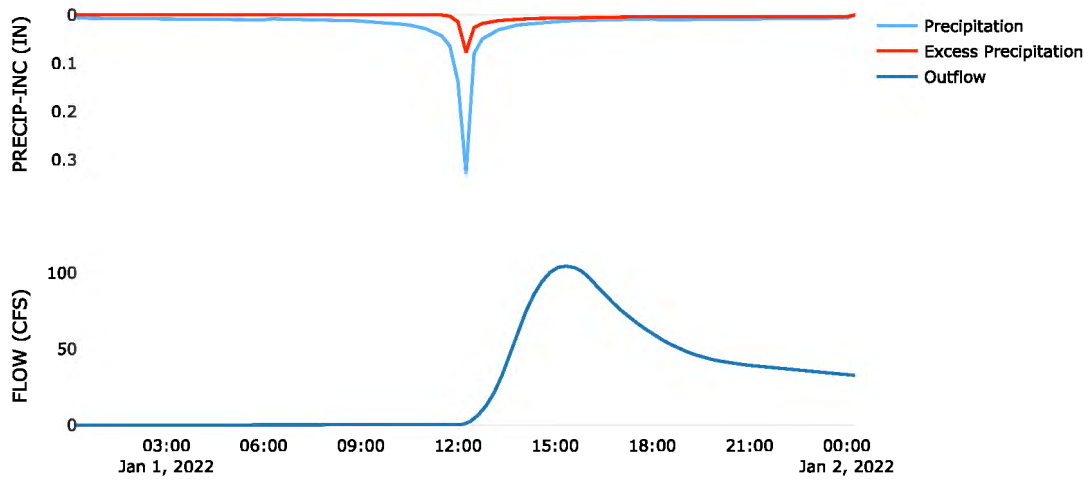
**Area (MI2)** : 3.12
**Downstream** : West Stream

| Loss Rate: Scs | |
|---|---|
| Percent Impervious Area | 0 |
| Curve Number | 79 |

| Transform: Scs | |
|---|---|
| Lag | 149 |
| Unitgraph Type | Standard |

| Results: Subbasin-1 | |
|---|---|
| Peak Discharge (CFS) | 104.35 |
| Time of Peak Discharge | 01Jan2022, 15:15 |
| Volume (IN) | 0.33 |
| Precipitation Volume (AC - FT) | 287.78 |
| Loss Volume (AC - FT) | 225.84 |
| Excess Volume (AC - FT) | 61.94 |
| Direct Runoff Volume (AC - FT) | 54.28 |
| Baseflow Volume (AC - FT) | 0 |

Precipitation and Outflow



# Reach: West Stream

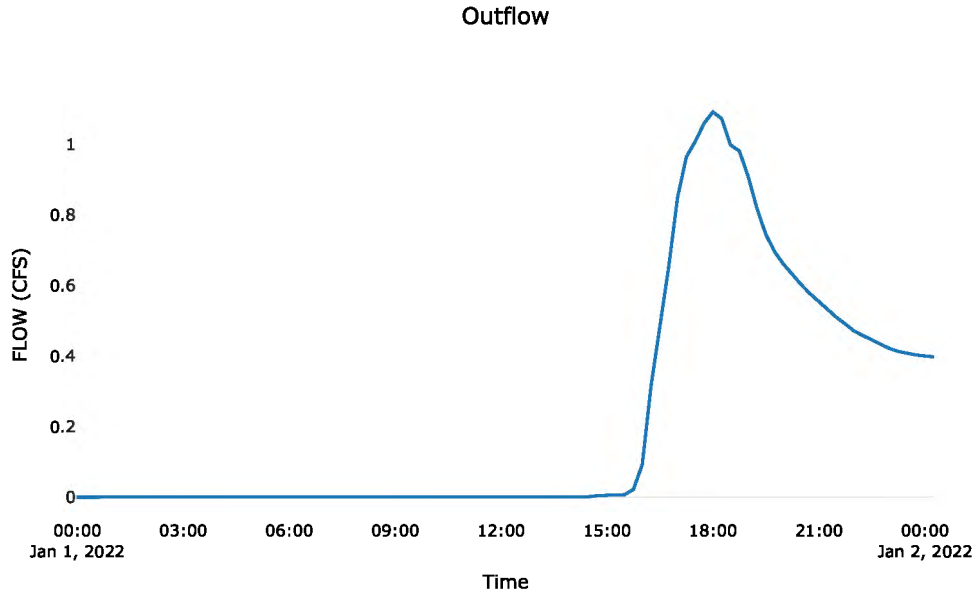
**Downstream** : Junction - 1

**Route: Muskingum Cunge**

| | |
|---|---|
| Method | Muskingum Cunge |
| Channel | Trapezoid |
| Length (FT) | 18160 |
| Energy Slope (FT/FT) | 0.01 |
| Mannings n | 0.04 |
| Bottom Width (FT) | 65 |
| Side Slope (FT/FT) | 48 |
| Initial Variable | Combined Inflow |
| Space - Time Method | Automatic DX and DT |
| Index Parameter Type | Index Flow |
| Index Flow | 180 |
| Maximum Depth Iterations | 20 |
| Maximum Route Step Iterations | 30 |
| Channel Loss | Percolation |
| Channel Loss Percolation Rate | 5 |
| End Channel Loss | |

**Results: West Stream**

| | |
|---|---|
| Peak Discharge (CFS) | 1.09 |
| Time of Peak Discharge | 01Jan2022, 18:00 |
| Volume (IN) | 0 |
| Peak Inflow (CFS) | 104.35 |
| Inflow Volume (AC - FT) | 54.28 |



# Reach: East Stream

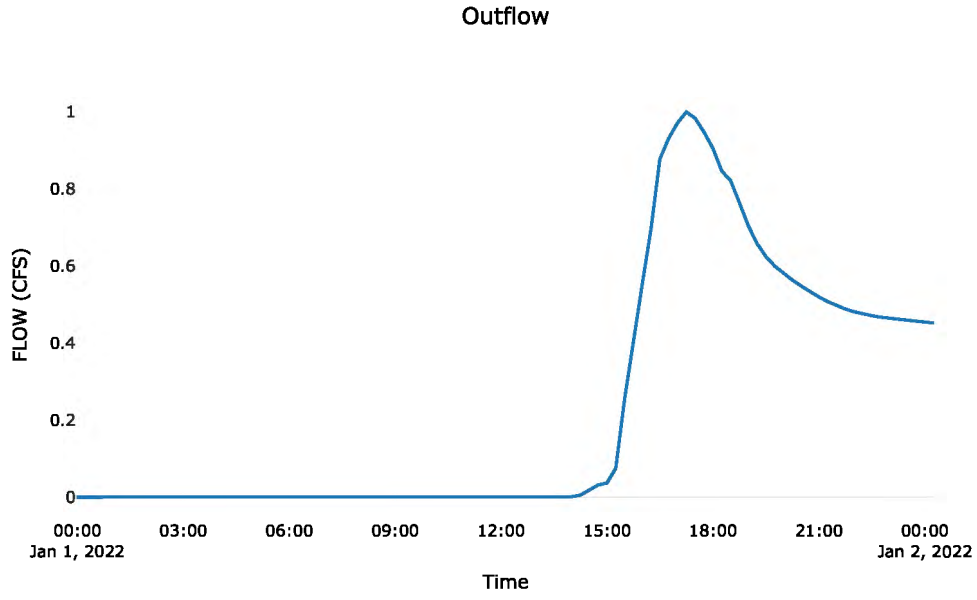
**Downstream** : Junction - 1

**Route: Muskingum Cunge**

| | |
|---|---|
| Method | Muskingum Cunge |
| Channel | Trapezoid |
| Length (FT) | 18545 |
| Energy Slope (FT/FT) | 0.01 |
| Mannings n | 0.04 |
| Bottom Width (FT) | 56 |
| Side Slope (FT/FT) | 15 |
| Initial Variable | Combined Inflow |
| Space - Time Method | Automatic DX and DT |
| Index Parameter Type | Index Flow |
| Index Flow | 100 |
| Maximum Depth Iterations | 20 |
| Maximum Route Step Iterations | 30 |
| Channel Loss | Percolation |
| Channel Loss Percolation Rate | 5 |
| End Channel Loss | |

**Results: East Stream**

| | |
|---|---|
| Peak Discharge (CFS) | 1 |
| Time of Peak Discharge | 01Jan2022, 17:15 |
| Volume (IN) | 0.01 |
| Peak Inflow (CFS) | 57.41 |
| Inflow Volume (AC - FT) | 28.23 |



# Subbasin: Subbasin-3

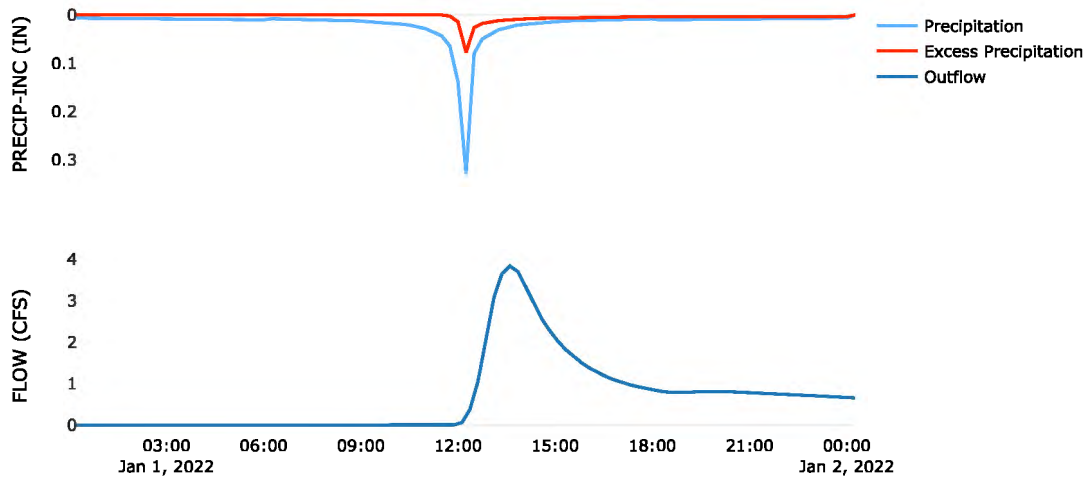
**Area (MI2)** : 0.07
**Downstream** : Junction - 1

| Loss Rate: Scs | |
|---|---|
| Percent Impervious Area | 0 |
| Curve Number | 79 |

| Transform: Scs | |
|---|---|
| Lag | 67 |
| Unitgraph Type | Standard |

| Results: Subbasin-3 | |
|---|---|
| Peak Discharge (CFS) | 3.84 |
| Time of Peak Discharge | 01Jan2022, 13:30 |
| Volume (IN) | 0.35 |
| Precipitation Volume (AC - FT) | 6.46 |
| Loss Volume (AC - FT) | 5.07 |
| Excess Volume (AC - FT) | 1.39 |
| Direct Runoff Volume (AC - FT) | 1.32 |
| Baseflow Volume (AC - FT) | 0 |

Precipitation and Outflow



# Reach: Combined Stream

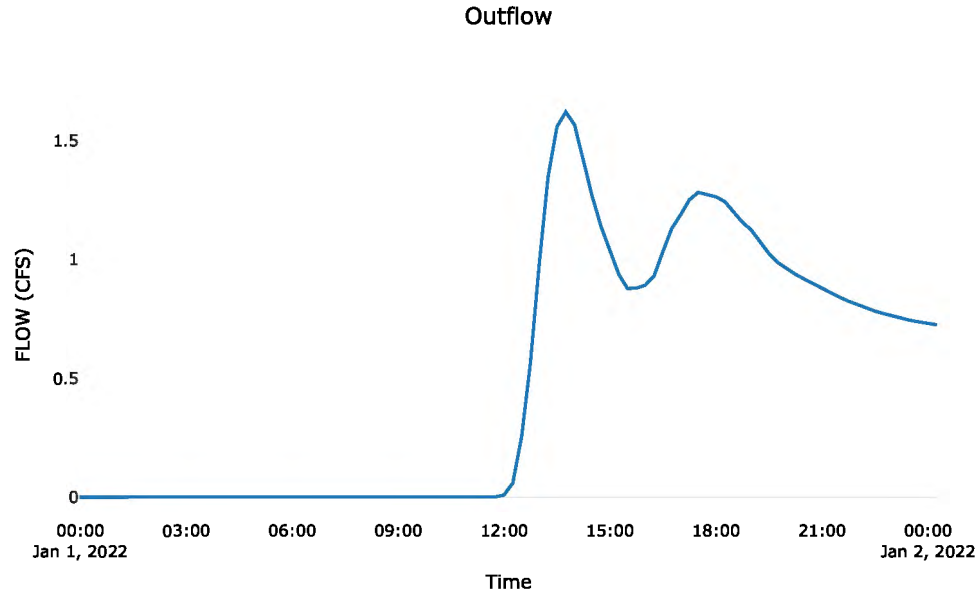
**Downstream** : Sink - 1

**Route: Muskingum Cunge**

| | |
|---|---|
| Method | Muskingum Cunge |
| Channel | Trapezoid |
| Length (FT) | 994 |
| Energy Slope (FT/FT) | 0.01 |
| Mannings n | 0.04 |
| Bottom Width (FT) | 32 |
| Side Slope (FT/FT) | 35 |
| Initial Variable | Combined Inflow |
| Space - Time Method | Automatic DX and DT |
| Index Parameter Type | Index Flow |
| Index Flow | 10 |
| Maximum Depth Iterations | 20 |
| Maximum Route Step Iterations | 30 |
| Channel Loss | Percolation |
| Channel Loss Percolation Rate | 5 |
| End Channel Loss | |

**Results: Combined Stream**

| | |
|---|---|
| Peak Discharge (CFS) | 1.62 |
| Time of Peak Discharge | 01Jan2022, 13:45 |
| Volume (IN) | 0 |
| Peak Inflow (CFS) | 3.84 |
| Inflow Volume (AC - FT) | 2.23 |



**Project:** Lockhart_Solar_Existing
**Simulation Run:** 25-Year
**Simulation Start:** 31 December 2021, 24:00
**Simulation End:** 2 January 2022, 00:15

**HMS Version:** 4.10
**Executed:** 17 October 2022, 17:02

## Global Parameter Summary - Subbasin

**Area (MI2)**

| Element Name | Area (MI2) |
|---|---|
| Subbasin - 2 | 1.59 |
| Subbasin - 1 | 3.12 |
| Subbasin - 3 | 0.07 |

**Downstream**

| Element Name | Downstream |
|---|---|
| Subbasin - 2 | East Stream |
| Subbasin - 1 | West Stream |
| Subbasin - 3 | Junction - 1 |

**Loss Rate: Scs**

| Element Name | Percent Impervious Area | Curve Number |
|---|---|---|
| Subbasin - 2 | 0 | 79 |
| Subbasin - 1 | 0 | 79 |
| Subbasin - 3 | 0 | 79 |

**Transform: Scs**

| Element Name | Lag | Unitgraph Type |
|---|---|---|
| Subbasin - 2 | 132 | Standard |
| Subbasin - 1 | 149 | Standard |
| Subbasin - 3 | 67 | Standard |

## Global Parameter Summary - Reach

**Downstream**

| Element Name | Downstream |
|---|---|
| West Stream | Junction - 1 |
| East Stream | Junction - 1 |
| Combined Stream | Sink - 1 |

**Route: Muskingum Cunge**

| Element Name | Method | Channel | Length (FT) | Energy Slope (FT/FT) | Mannings n | Bottom Width (FT) | Side Slope (FT/FT) | Initial Variable | Space - Time Method | Index Parameter Type | Index Flow | Maximum Depth Iterations |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| West Stream | Muskingum Cunge | 5 | 18160 | 0.01 | 0.04 | 65 | 48 | Combined Inflow | Automatic DX and DT | Index Flow | 180 | 20 |
| East Stream | Muskingum Cunge | 5 | 18545 | 0.01 | 0.04 | 56 | 15 | Combined Inflow | Automatic DX and DT | Index Flow | 100 | 20 |
| Combined Stream | Muskingum Cunge | 5 | 994 | 0.01 | 0.04 | 32 | 35 | Combined Inflow | Automatic DX and DT | Index Flow | 10 | 20 |

## Global Results Summary

| Hydrologic Element | Drainage Area (MI2) | Peak Discharge (CFS) | Time of Peak | Volume (IN) |
|---|---|---|---|---|
| Subbasin - 2 | 1.59 | 105.62 | 01Jan2022, 14:45 | 0.57 |
| Subbasin - 1 | 3.12 | 190.91 | 01Jan2022, 15:00 | 0.56 |
| West Stream | 3.12 | 4.2 | 01Jan2022, 17:15 | 0.01 |
| East Stream | 1.59 | 3.04 | 01Jan2022, 17:00 | 0.01 |
| Subbasin - 3 | 0.07 | 7.15 | 01Jan2022, 13:30 | 0.6 |
| Junction - 1 | 4.78 | 8.72 | 01Jan2022, 17:00 | 0.02 |
| Combined Stream | 4.78 | 4.21 | 01Jan2022, 17:15 | 0.01 |
| Sink - 1 | 4.78 | 4.21 | 01Jan2022, 17:15 | 0.01 |

# Subbasin: Subbasin-2

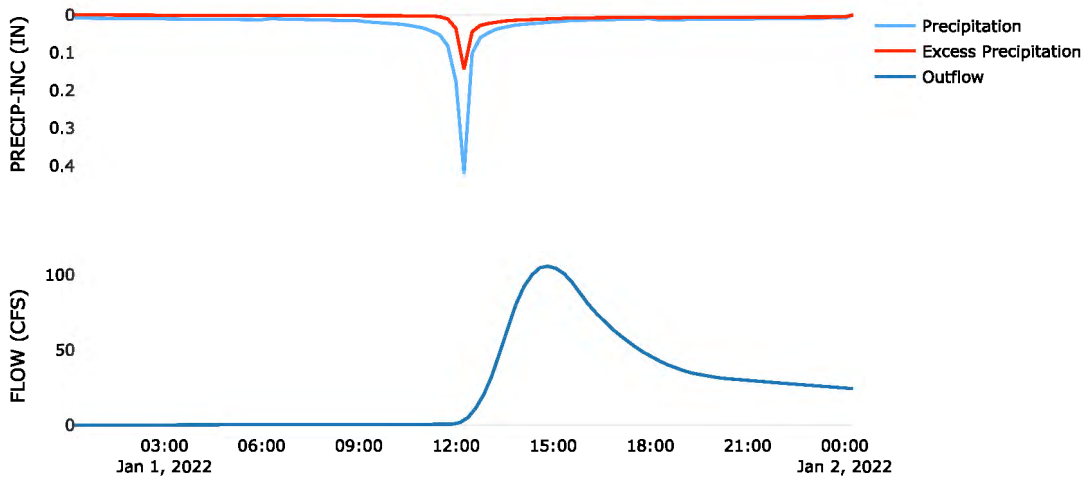
**Area (MI2)** : 1.59
**Downstream** : East Stream

| Loss Rate: Scs | |
|---|---|
| Percent Impervious Area | 0 |
| Curve Number | 79 |

| Transform: Scs | |
|---|---|
| Lag | 132 |
| Unitgraph Type | Standard |

| Results: Subbasin-2 | |
|---|---|
| Peak Discharge (CFS) | 105.62 |
| Time of Peak Discharge | 01Jan2022, 14:45 |
| Volume (IN) | 0.57 |
| Precipitation Volume (AC - FT) | 185.1 |
| Loss Volume (AC - FT) | 131.53 |
| Excess Volume (AC - FT) | 53.57 |
| Direct Runoff Volume (AC - FT) | 48.52 |
| Baseflow Volume (AC - FT) | 0 |

Precipitation and Outflow



# Subbasin: Subbasin-1

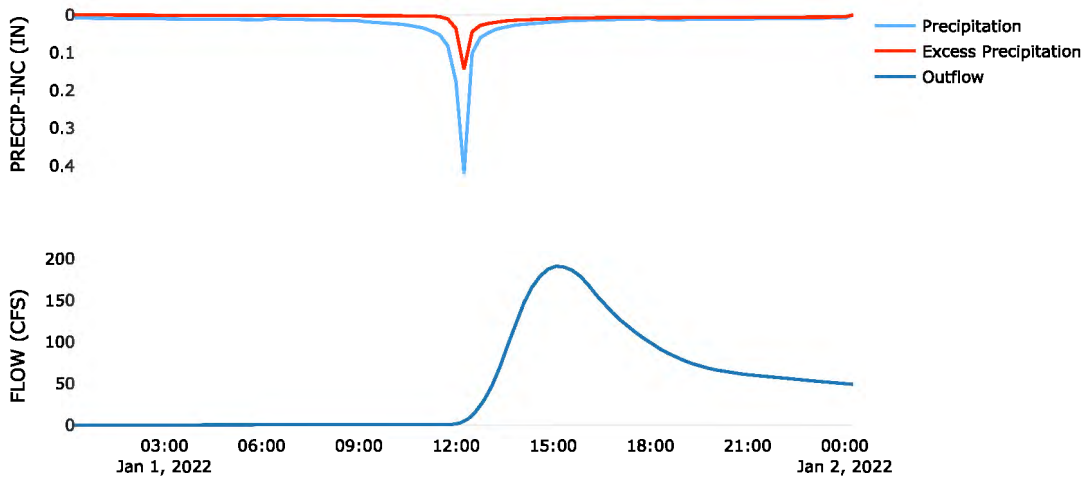
**Area (MI2)** : 3.12
**Downstream** : West Stream

| Loss Rate: Scs | |
|---|---|
| Percent Impervious Area | 0 |
| Curve Number | 79 |

| Transform: Scs | |
|---|---|
| Lag | 149 |
| Unitgraph Type | Standard |

| Results: Subbasin-1 | |
|---|---|
| Peak Discharge (CFS) | 190.91 |
| Time of Peak Discharge | 01Jan2022, 15:00 |
| Volume (IN) | 0.56 |
| Precipitation Volume (AC - FT) | 362.64 |
| Loss Volume (AC - FT) | 257.69 |
| Excess Volume (AC - FT) | 104.95 |
| Direct Runoff Volume (AC - FT) | 93.51 |
| Baseflow Volume (AC - FT) | 0 |

Precipitation and Outflow



# Reach: West Stream

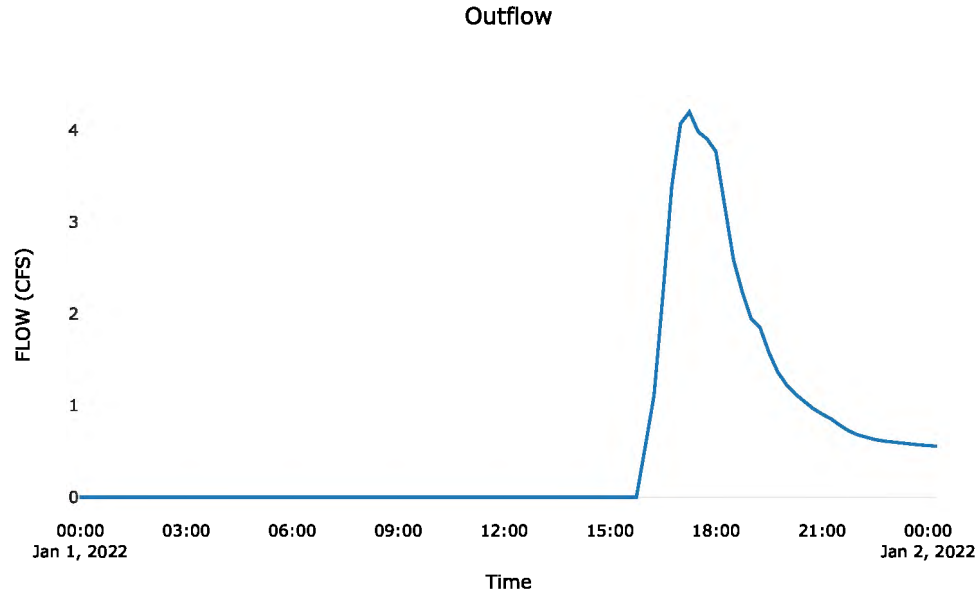
**Downstream** : Junction - 1

**Route: Muskingum Cunge**

| | |
|---|---|
| Method | Muskingum Cunge |
| Channel | Trapezoid |
| Length (FT) | 18160 |
| Energy Slope (FT/FT) | 0.01 |
| Mannings n | 0.04 |
| Bottom Width (FT) | 65 |
| Side Slope (FT/FT) | 48 |
| Initial Variable | Combined Inflow |
| Space - Time Method | Automatic DX and DT |
| Index Parameter Type | Index Flow |
| Index Flow | 180 |
| Maximum Depth Iterations | 20 |
| Maximum Route Step Iterations | 30 |
| Channel Loss | Percolation |
| Channel Loss Percolation Rate | 5 |
| End Channel Loss | |

**Results: West Stream**

| | |
|---|---|
| Peak Discharge (CFS) | 4.2 |
| Time of Peak Discharge | 01Jan2022, 17:15 |
| Volume (IN) | 0.01 |
| Peak Inflow (CFS) | 190.91 |
| Inflow Volume (AC - FT) | 93.51 |



# Reach: East Stream

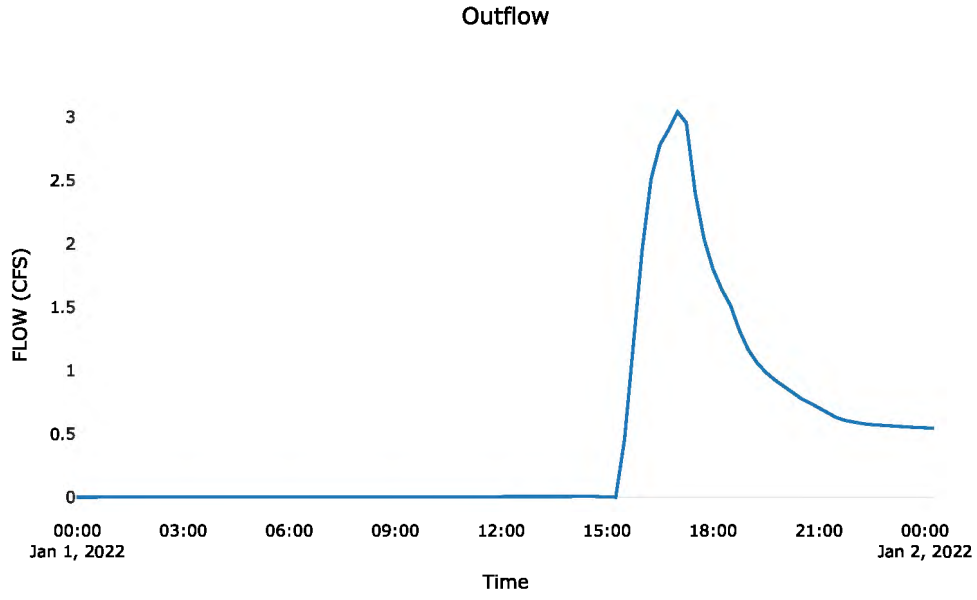
**Downstream** : Junction - 1

**Route: Muskingum Cunge**

| | |
|---|---|
| Method | Muskingum Cunge |
| Channel | Trapezoid |
| Length (FT) | 18545 |
| Energy Slope (FT/FT) | 0.01 |
| Mannings n | 0.04 |
| Bottom Width (FT) | 56 |
| Side Slope (FT/FT) | 15 |
| Initial Variable | Combined Inflow |
| Space - Time Method | Automatic DX and DT |
| Index Parameter Type | Index Flow |
| Index Flow | 100 |
| Maximum Depth Iterations | 20 |
| Maximum Route Step Iterations | 30 |
| Channel Loss | Percolation |
| Channel Loss Percolation Rate | 5 |
| End Channel Loss | |

**Results: East Stream**

| | |
|---|---|
| Peak Discharge (CFS) | 3.04 |
| Time of Peak Discharge | 01Jan2022, 17:00 |
| Volume (IN) | 0.01 |
| Peak Inflow (CFS) | 105.62 |
| Inflow Volume (AC - FT) | 48.52 |



# Subbasin: Subbasin-3

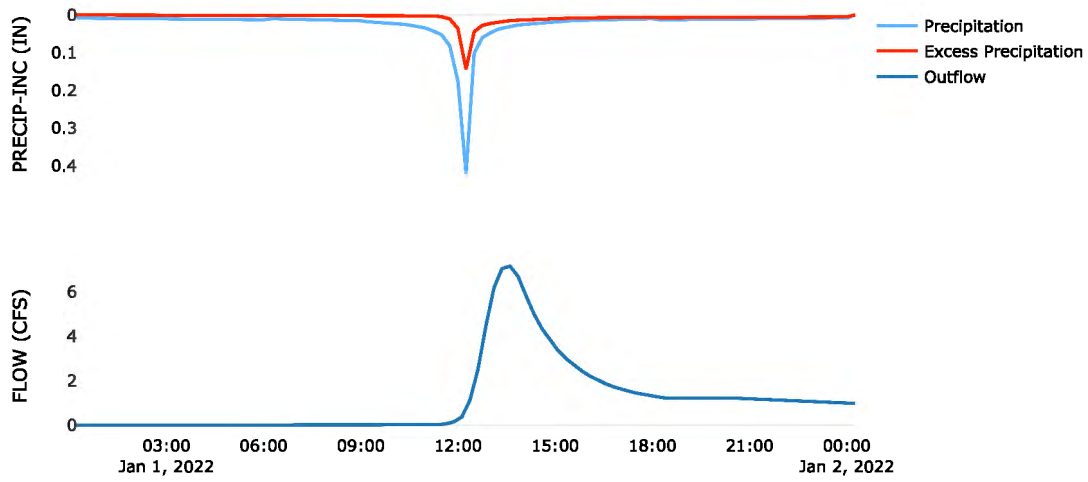
**Area (MI2)** : 0.07
**Downstream** : Junction - 1

| Loss Rate: Scs | |
|---|---|
| Percent Impervious Area | 0 |
| Curve Number | 79 |

| Transform: Scs | |
|---|---|
| Lag | 67 |
| Unitgraph Type | Standard |

| Results: Subbasin-3 | |
|---|---|
| Peak Discharge (CFS) | 7.15 |
| Time of Peak Discharge | 01Jan2022, 13:30 |
| Volume (IN) | 0.6 |
| Precipitation Volume (AC - FT) | 8.14 |
| Loss Volume (AC - FT) | 5.78 |
| Excess Volume (AC - FT) | 2.36 |
| Direct Runoff Volume (AC - FT) | 2.26 |
| Baseflow Volume (AC - FT) | 0 |

Precipitation and Outflow



# Reach: Combined Stream

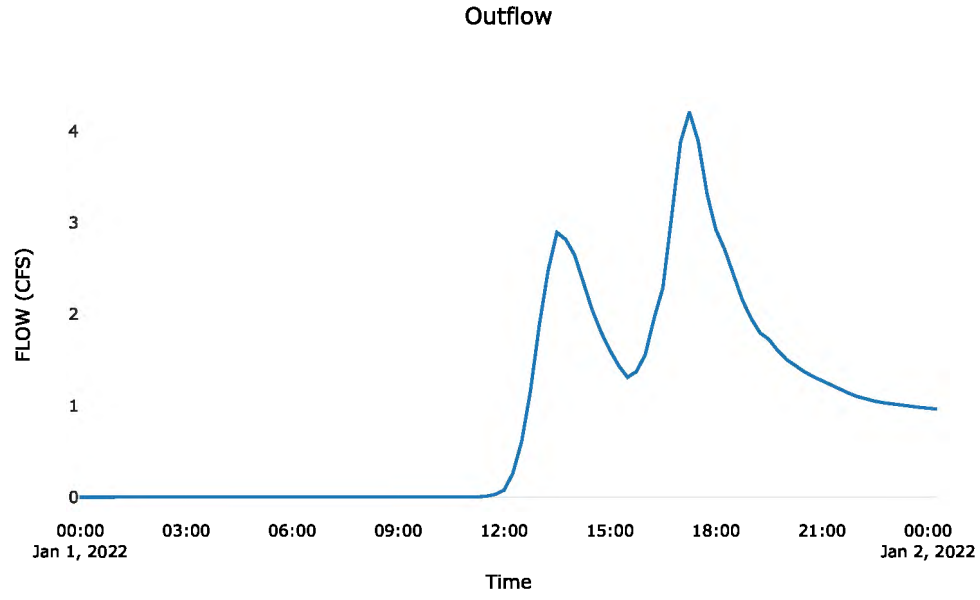
**Downstream** : Sink - 1

**Route: Muskingum Cunge**

| | |
|---|---|
| Method | Muskingum Cunge |
| Channel | Trapezoid |
| Length (FT) | 994 |
| Energy Slope (FT/FT) | 0.01 |
| Mannings n | 0.04 |
| Bottom Width (FT) | 32 |
| Side Slope (FT/FT) | 35 |
| Initial Variable | Combined Inflow |
| Space - Time Method | Automatic DX and DT |
| Index Parameter Type | Index Flow |
| Index Flow | 10 |
| Maximum Depth Iterations | 20 |
| Maximum Route Step Iterations | 30 |
| Channel Loss | Percolation |
| Channel Loss Percolation Rate | 5 |
| End Channel Loss | |

**Results: Combined Stream**

| | |
|---|---|
| Peak Discharge (CFS) | 4.21 |
| Time of Peak Discharge | 01Jan2022, 17:15 |
| Volume (IN) | 0.01 |
| Peak Inflow (CFS) | 8.72 |
| Inflow Volume (AC - FT) | 4.3 |



**Project:** Lockhart_Solar_Existing
**Simulation Run:** 50-Year
**Simulation Start:** 31 December 2021, 24:00
**Simulation End:** 2 January 2022, 00:15

**HMS Version:** 4.10
**Executed:** 17 October 2022, 17:04

## Global Parameter Summary - Subbasin

**Area (MI2)**

| Element Name | Area (MI2) |
|---|---|
| Subbasin - 2 | 1.59 |
| Subbasin - 1 | 3.12 |
| Subbasin - 3 | 0.07 |

**Downstream**

| Element Name | Downstream |
|---|---|
| Subbasin - 2 | East Stream |
| Subbasin - 1 | West Stream |
| Subbasin - 3 | Junction - 1 |

**Loss Rate: Scs**

| Element Name | Percent Impervious Area | Curve Number |
|---|---|---|
| Subbasin - 2 | 0 | 79 |
| Subbasin - 1 | 0 | 79 |
| Subbasin - 3 | 0 | 79 |

**Transform: Scs**

| Element Name | Lag | Unitgraph Type |
|---|---|---|
| Subbasin - 2 | 132 | Standard |
| Subbasin - 1 | 149 | Standard |
| Subbasin - 3 | 67 | Standard |

## Global Parameter Summary - Reach

**Downstream**

| Element Name | Downstream |
|---|---|
| West Stream | Junction - 1 |
| East Stream | Junction - 1 |
| Combined Stream | Sink - 1 |

**Route: Muskingum Cunge**

| Element Name | Method | Channel | Length (FT) | Energy Slope (FT/FT) | Mannings n | Bottom Width (FT) | Side Slope (FT/FT) | Initial Variable | Space - Time Method | Index Parameter Type | Index Flow | Maximum Depth Iterations |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| West Stream | Muskingum Cunge | 5 | 18160 | 0.01 | 0.04 | 65 | 48 | Combined Inflow | Automatic DX and DT | Index Flow | 180 | 20 |
| East Stream | Muskingum Cunge | 5 | 18545 | 0.01 | 0.04 | 56 | 15 | Combined Inflow | Automatic DX and DT | Index Flow | 100 | 20 |
| Combined Stream | Muskingum Cunge | 5 | 994 | 0.01 | 0.04 | 32 | 35 | Combined Inflow | Automatic DX and DT | Index Flow | 10 | 20 |

## Global Results Summary

| Hydrologic Element | Drainage Area (MI2) | Peak Discharge (CFS) | Time of Peak | Volume (IN) |
|---|---|---|---|---|
| Subbasin - 2 | 1.59 | 149.77 | 01Jan2022, 14:45 | 0.79 |
| Subbasin - 1 | 3.12 | 270.92 | 01Jan2022, 15:00 | 0.78 |
| West Stream | 3.12 | 15.86 | 01Jan2022, 17:00 | 0.02 |
| East Stream | 1.59 | 9.91 | 01Jan2022, 16:15 | 0.02 |
| Subbasin - 3 | 0.07 | 10.17 | 01Jan2022, 13:30 | 0.83 |
| Junction - 1 | 4.78 | 26.28 | 01Jan2022, 16:45 | 0.03 |
| Combined Stream | 4.78 | 19.49 | 01Jan2022, 17:00 | 0.02 |
| Sink - 1 | 4.78 | 19.49 | 01Jan2022, 17:00 | 0.02 |

# Subbasin: Subbasin-2

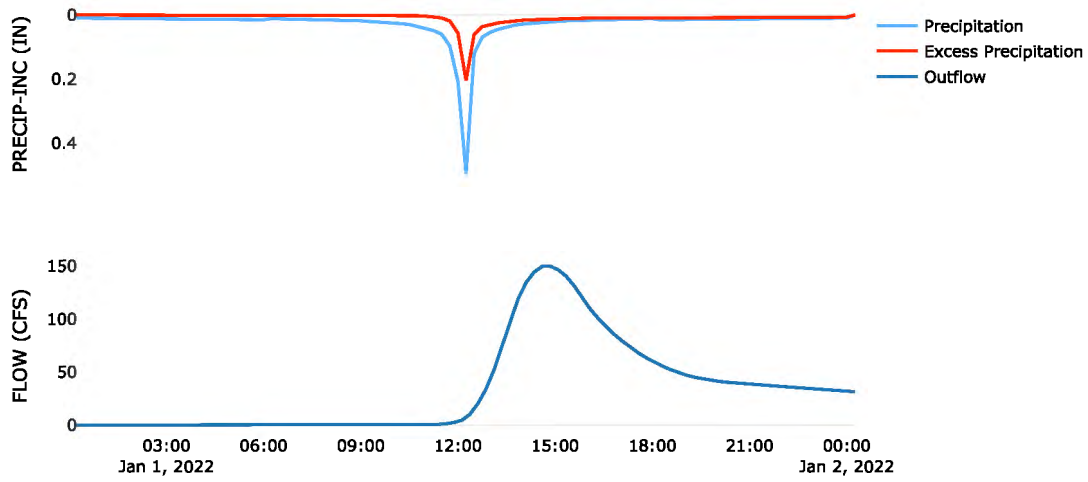
**Area (MI2)** : 1.59
**Downstream** : East Stream

| Loss Rate: Scs | |
|---|---|
| Percent Impervious Area | 0 |
| Curve Number | 79 |

| Transform: Scs | |
|---|---|
| Lag | 132 |
| Unitgraph Type | Standard |

| Results: Subbasin-2 | |
|---|---|
| Peak Discharge (CFS) | 149.77 |
| Time of Peak Discharge | 01Jan2022, 14:45 |
| Volume (IN) | 0.79 |
| Precipitation Volume (AC - FT) | 215.66 |
| Loss Volume (AC - FT) | 142.28 |
| Excess Volume (AC - FT) | 73.39 |
| Direct Runoff Volume (AC - FT) | 66.84 |
| Baseflow Volume (AC - FT) | 0 |

Precipitation and Outflow



# Subbasin: Subbasin-1

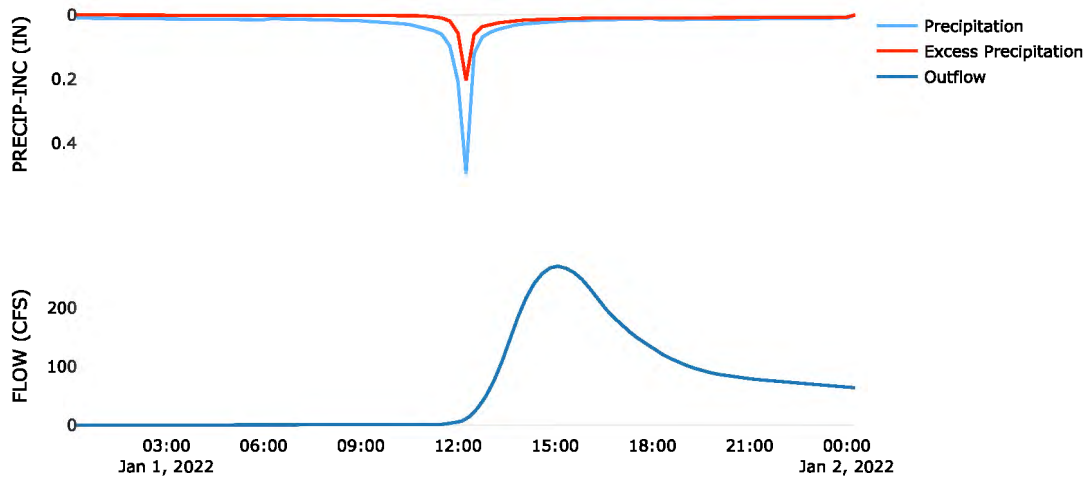
**Area (MI2)** : 3.12
**Downstream** : West Stream

| Loss Rate: Scs | |
|---|---|
| Percent Impervious Area | 0 |
| Curve Number | 79 |

| Transform: Scs | |
|---|---|
| Lag | 149 |
| Unitgraph Type | Standard |

| Results: Subbasin-1 | |
|---|---|
| Peak Discharge (CFS) | 270.92 |
| Time of Peak Discharge | 01Jan2022, 15:00 |
| Volume (IN) | 0.78 |
| Precipitation Volume (AC - FT) | 422.52 |
| Loss Volume (AC - FT) | 278.74 |
| Excess Volume (AC - FT) | 143.78 |
| Direct Runoff Volume (AC - FT) | 128.95 |
| Baseflow Volume (AC - FT) | 0 |

Precipitation and Outflow



# Reach: West Stream

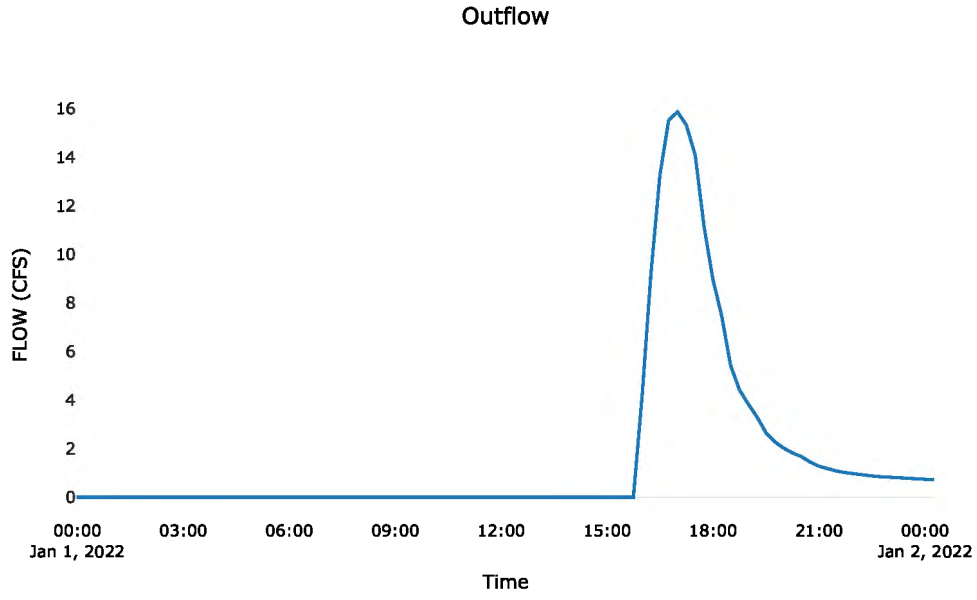
**Downstream** : Junction - 1

**Route: Muskingum Cunge**

| | |
|---|---|
| Method | Muskingum Cunge |
| Channel | Trapezoid |
| Length (FT) | 18160 |
| Energy Slope (FT/FT) | 0.01 |
| Mannings n | 0.04 |
| Bottom Width (FT) | 65 |
| Side Slope (FT/FT) | 48 |
| Initial Variable | Combined Inflow |
| Space - Time Method | Automatic DX and DT |
| Index Parameter Type | Index Flow |
| Index Flow | 180 |
| Maximum Depth Iterations | 20 |
| Maximum Route Step Iterations | 30 |
| Channel Loss | Percolation |
| Channel Loss Percolation Rate | 5 |
| End Channel Loss | |

**Results: West Stream**

| | |
|---|---|
| Peak Discharge (CFS) | 15.86 |
| Time of Peak Discharge | 01Jan2022, 17:00 |
| Volume (IN) | 0.02 |
| Peak Inflow (CFS) | 270.92 |
| Inflow Volume (AC - FT) | 128.95 |



# Reach: East Stream

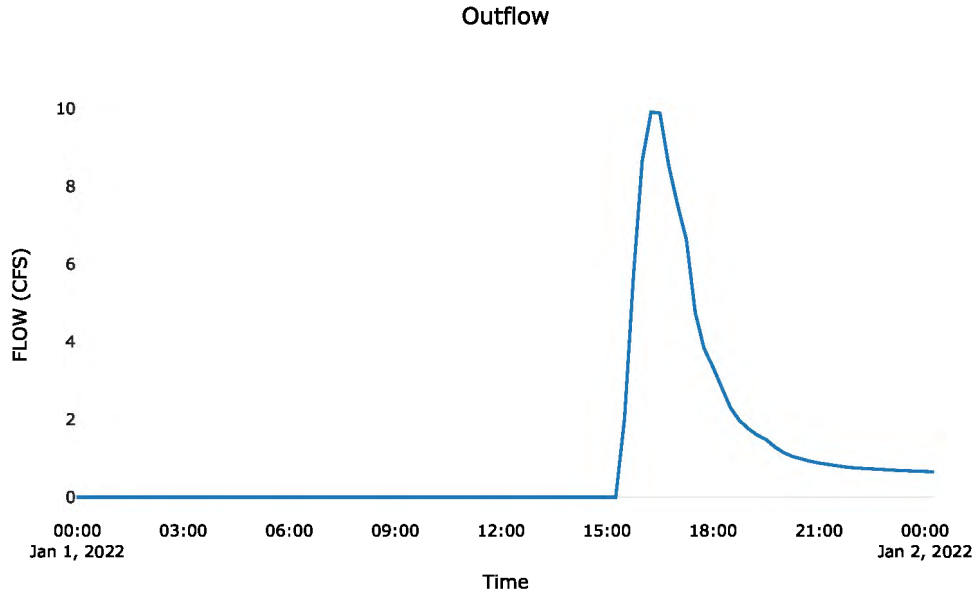
**Downstream** : Junction - 1

**Route: Muskingum Cunge**

| | |
|---|---|
| Method | Muskingum Cunge |
| Channel | Trapezoid |
| Length (FT) | 18545 |
| Energy Slope (FT/FT) | 0.01 |
| Mannings n | 0.04 |
| Bottom Width (FT) | 56 |
| Side Slope (FT/FT) | 15 |
| Initial Variable | Combined Inflow |
| Space - Time Method | Automatic DX and DT |
| Index Parameter Type | Index Flow |
| Index Flow | 100 |
| Maximum Depth Iterations | 20 |
| Maximum Route Step Iterations | 30 |
| Channel Loss | Percolation |
| Channel Loss Percolation Rate | 5 |
| End Channel Loss | |

**Results: East Stream**

| | |
|---|---|
| Peak Discharge (CFS) | 9.91 |
| Time of Peak Discharge | 01Jan2022, 16:15 |
| Volume (IN) | 0.02 |
| Peak Inflow (CFS) | 149.77 |
| Inflow Volume (AC - FT) | 66.84 |



# Subbasin: Subbasin-3

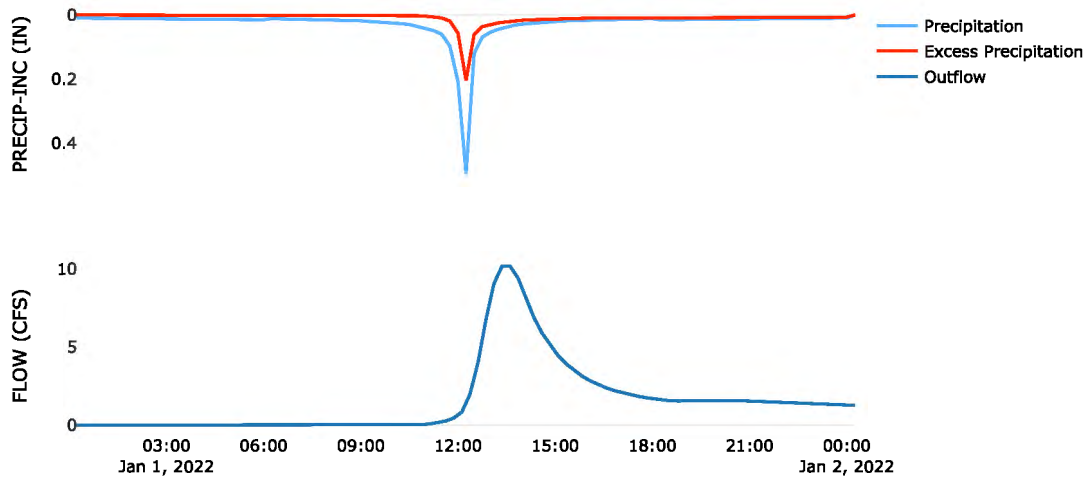
**Area (MI2)** : 0.07
**Downstream** : Junction - 1

| Loss Rate: Scs | |
|---|---|
| Percent Impervious Area | 0 |
| Curve Number | 79 |

| Transform: Scs | |
|---|---|
| Lag | 67 |
| Unitgraph Type | Standard |

| Results: Subbasin-3 | |
|---|---|
| Peak Discharge (CFS) | 10.17 |
| Time of Peak Discharge | 01Jan2022, 13:30 |
| Volume (IN) | 0.83 |
| Precipitation Volume (AC - FT) | 9.48 |
| Loss Volume (AC - FT) | 6.26 |
| Excess Volume (AC - FT) | 3.23 |
| Direct Runoff Volume (AC - FT) | 3.1 |
| Baseflow Volume (AC - FT) | 0 |

Precipitation and Outflow



# Reach: Combined Stream

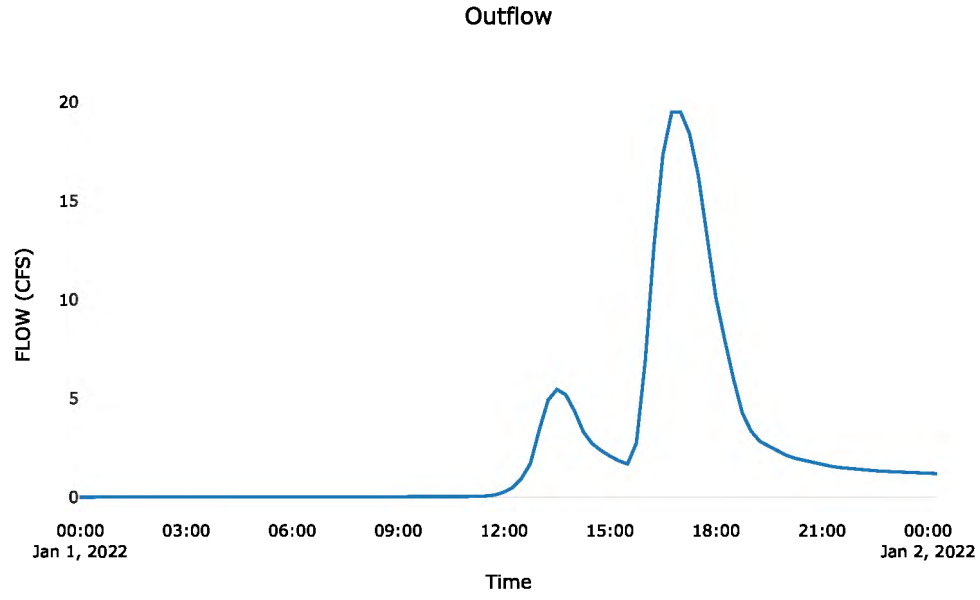
**Downstream** : Sink - 1

**Route: Muskingum Cunge**

| | |
|---|---|
| Method | Muskingum Cunge |
| Channel | Trapezoid |
| Length (FT) | 994 |
| Energy Slope (FT/FT) | 0.01 |
| Mannings n | 0.04 |
| Bottom Width (FT) | 32 |
| Side Slope (FT/FT) | 35 |
| Initial Variable | Combined Inflow |
| Space - Time Method | Automatic DX and DT |
| Index Parameter Type | Index Flow |
| Index Flow | 10 |
| Maximum Depth Iterations | 20 |
| Maximum Route Step Iterations | 30 |
| Channel Loss | Percolation |
| Channel Loss Percolation Rate | 5 |
| End Channel Loss | |

**Results: Combined Stream**

| | |
|---|---|
| Peak Discharge (CFS) | 19.49 |
| Time of Peak Discharge | 01Jan2022, 17:00 |
| Volume (IN) | 0.02 |
| Peak Inflow (CFS) | 26.28 |
| Inflow Volume (AC - FT) | 8.36 |



**Project:** Lockhart_Solar_Existing
**Simulation Run:** 100-Year
**Simulation Start:** 31 December 2021, 24:00
**Simulation End:** 2 January 2022, 00:15

**HMS Version:** 4.10
**Executed:** 17 October 2022, 17:05

## Global Parameter Summary - Subbasin

**Area (MI2)**

| Element Name | Area (MI2) |
|---|---|
| Subbasin - 2 | 1.59 |
| Subbasin - 1 | 3.12 |
| Subbasin - 3 | 0.07 |

**Downstream**

| Element Name | Downstream |
|---|---|
| Subbasin - 2 | East Stream |
| Subbasin - 1 | West Stream |
| Subbasin - 3 | Junction - 1 |

**Loss Rate: Scs**

| Element Name | Percent Impervious Area | Curve Number |
|---|---|---|
| Subbasin - 2 | 0 | 79 |
| Subbasin - 1 | 0 | 79 |
| Subbasin - 3 | 0 | 79 |

**Transform: Scs**

| Element Name | Lag | Unitgraph Type |
|---|---|---|
| Subbasin - 2 | 132 | Standard |
| Subbasin - 1 | 149 | Standard |
| Subbasin - 3 | 67 | Standard |

## Global Parameter Summary - Reach

**Downstream**

| Element Name | Downstream |
|---|---|
| West Stream | Junction - 1 |
| East Stream | Junction - 1 |
| Combined Stream | Sink - 1 |

**Route: Muskingum Cunge**

| Element Name | Method | Channel | Length (FT) | Energy Slope (FT/FT) | Mannings n | Bottom Width (FT) | Side Slope (FT/FT) | Initial Variable | Space - Time Method | Index Parameter Type | Index Flow | Maximum Depth Iterations |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| West Stream | Muskingum Cunge | 5 | 18160 | 0.01 | 0.04 | 65 | 48 | Combined Inflow | Automatic DX and DT | Index Flow | 180 | 20 |
| East Stream | Muskingum Cunge | 5 | 18545 | 0.01 | 0.04 | 56 | 15 | Combined Inflow | Automatic DX and DT | Index Flow | 100 | 20 |
| Combined Stream | Muskingum Cunge | 5 | 994 | 0.01 | 0.04 | 32 | 35 | Combined Inflow | Automatic DX and DT | Index Flow | 10 | 20 |

## Global Results Summary

| Hydrologic Element | Drainage Area (MI2) | Peak Discharge (CFS) | Time of Peak | Volume (IN) |
|---|---|---|---|---|
| Subbasin - 2 | 1.59 | 199.75 | 01Jan2022, 14:30 | 1.02 |
| Subbasin - 1 | 3.12 | 360.16 | 01Jan2022, 15:00 | 1.01 |
| West Stream | 3.12 | 60.88 | 01Jan2022, 16:45 | 0.07 |
| East Stream | 1.59 | 37.52 | 01Jan2022, 16:00 | 0.07 |
| Subbasin - 3 | 0.07 | 13.62 | 01Jan2022, 13:15 | 1.07 |
| Junction - 1 | 4.78 | 95.82 | 01Jan2022, 16:30 | 0.08 |
| Combined Stream | 4.78 | 85.47 | 01Jan2022, 16:30 | 0.06 |
| Sink - 1 | 4.78 | 85.47 | 01Jan2022, 16:30 | 0.06 |

# Subbasin: Subbasin-2

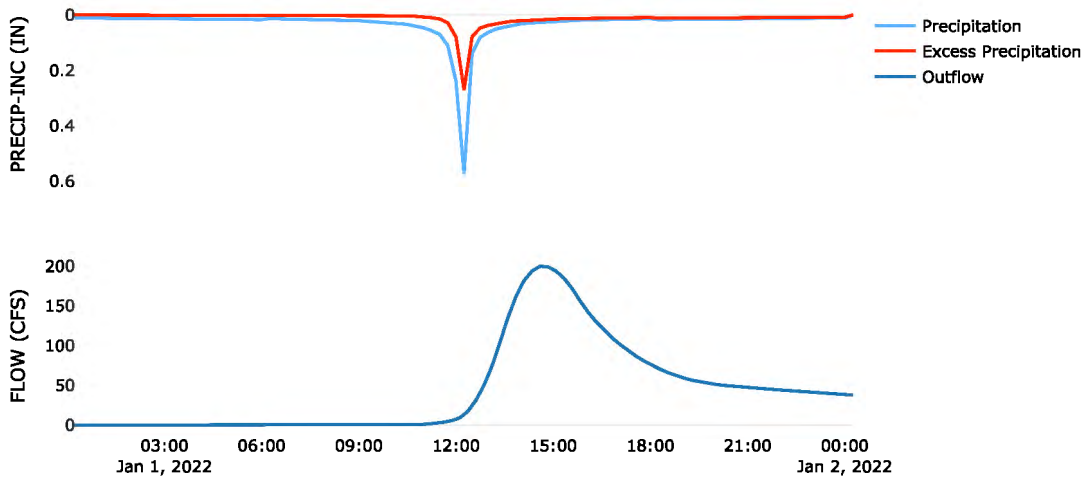
**Area (MI2)** : 1.59
**Downstream** : East Stream

| Loss Rate: Scs | |
|---|---|
| Percent Impervious Area | 0 |
| Curve Number | 79 |

| Transform: Scs | |
|---|---|
| Lag | 132 |
| Unitgraph Type | Standard |

| Results: Subbasin-2 | |
|---|---|
| Peak Discharge (CFS) | 199.75 |
| Time of Peak Discharge | 01Jan2022, 14:30 |
| Volume (IN) | 1.02 |
| Precipitation Volume (AC - FT) | 246.23 |
| Loss Volume (AC - FT) | 151.48 |
| Excess Volume (AC - FT) | 94.75 |
| Direct Runoff Volume (AC - FT) | 86.91 |
| Baseflow Volume (AC - FT) | 0 |

Precipitation and Outflow



# Subbasin: Subbasin-1

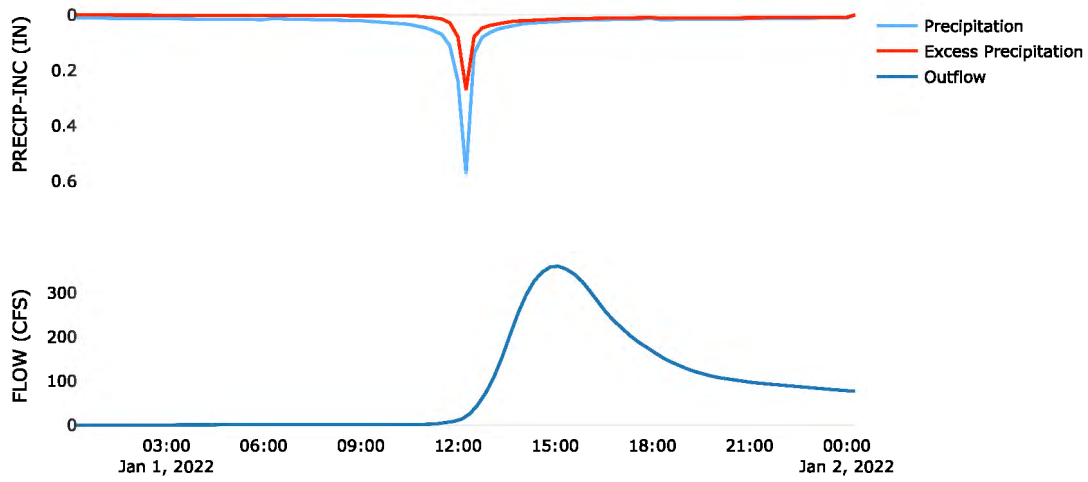
**Area (MI2)** : 3.12
**Downstream** : West Stream

| Loss Rate: Scs | |
|---|---|
| Percent Impervious Area | 0 |
| Curve Number | 79 |

| Transform: Scs | |
|---|---|
| Lag | 149 |
| Unitgraph Type | Standard |

| Results: Subbasin-1 | |
|---|---|
| Peak Discharge (CFS) | 360.16 |
| Time of Peak Discharge | 01Jan2022, 15:00 |
| Volume (IN) | 1.01 |
| Precipitation Volume (AC - FT) | 482.41 |
| Loss Volume (AC - FT) | 296.78 |
| Excess Volume (AC - FT) | 185.62 |
| Direct Runoff Volume (AC - FT) | 167.84 |
| Baseflow Volume (AC - FT) | 0 |

Precipitation and Outflow



# Reach: West Stream

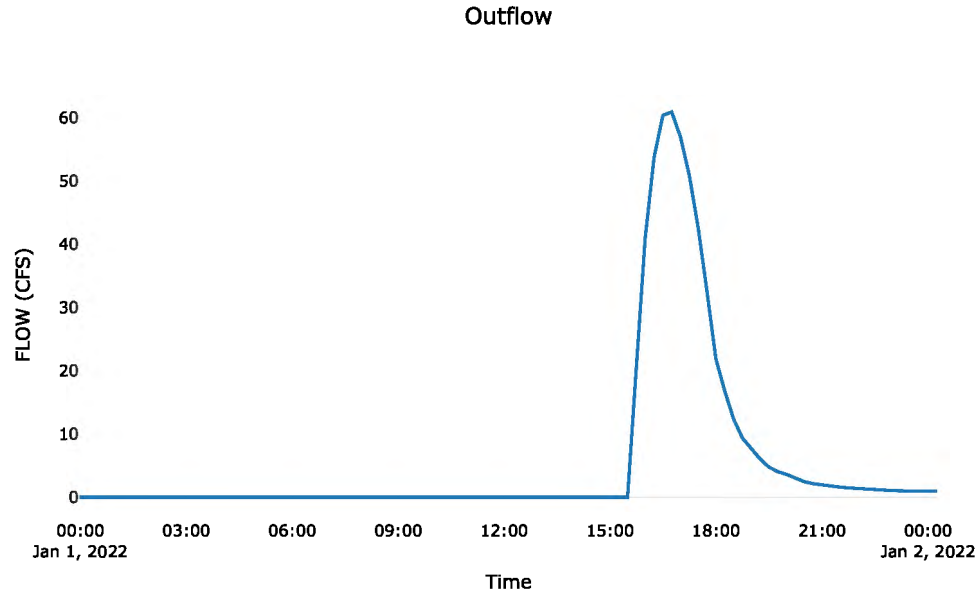
**Downstream** : Junction - 1

**Route: Muskingum Cunge**

| | |
|---|---|
| Method | Muskingum Cunge |
| Channel | Trapezoid |
| Length (FT) | 18160 |
| Energy Slope (FT/FT) | 0.01 |
| Mannings n | 0.04 |
| Bottom Width (FT) | 65 |
| Side Slope (FT/FT) | 48 |
| Initial Variable | Combined Inflow |
| Space - Time Method | Automatic DX and DT |
| Index Parameter Type | Index Flow |
| Index Flow | 180 |
| Maximum Depth Iterations | 20 |
| Maximum Route Step Iterations | 30 |
| Channel Loss | Percolation |
| Channel Loss Percolation Rate | 5 |
| End Channel Loss | |

**Results: West Stream**

| | |
|---|---|
| Peak Discharge (CFS) | 60.88 |
| Time of Peak Discharge | 01Jan2022, 16:45 |
| Volume (IN) | 0.07 |
| Peak Inflow (CFS) | 360.16 |
| Inflow Volume (AC - FT) | 167.84 |



# Reach: East Stream

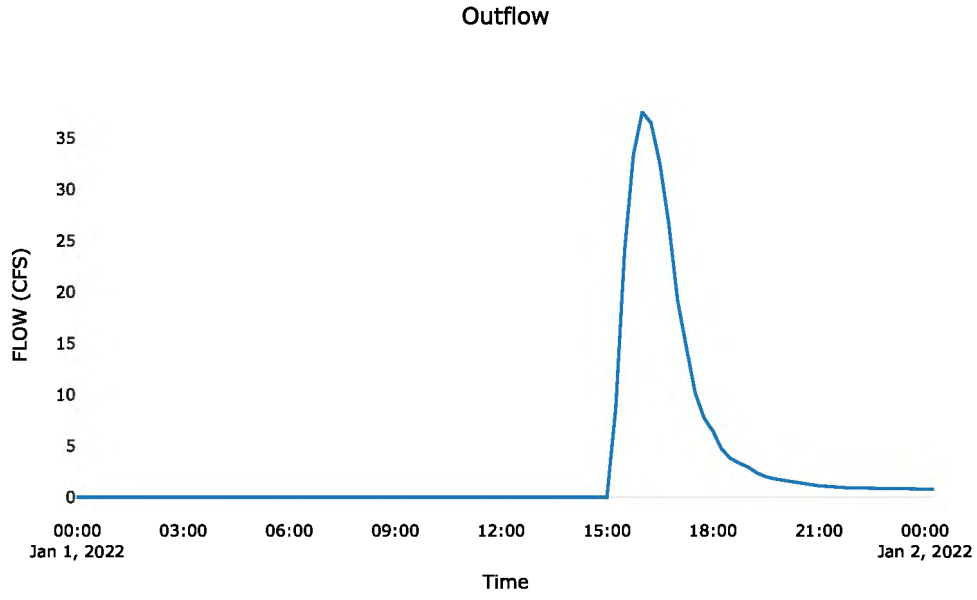
**Downstream** : Junction - 1

**Route: Muskingum Cunge**

| | |
|---|---|
| Method | Muskingum Cunge |
| Channel | Trapezoid |
| Length (FT) | 18545 |
| Energy Slope (FT/FT) | 0.01 |
| Mannings n | 0.04 |
| Bottom Width (FT) | 56 |
| Side Slope (FT/FT) | 15 |
| Initial Variable | Combined Inflow |
| Space - Time Method | Automatic DX and DT |
| Index Parameter Type | Index Flow |
| Index Flow | 100 |
| Maximum Depth Iterations | 20 |
| Maximum Route Step Iterations | 30 |
| Channel Loss | Percolation |
| Channel Loss Percolation Rate | 5 |
| End Channel Loss | |

**Results: East Stream**

| | |
|---|---|
| Peak Discharge (CFS) | 37.52 |
| Time of Peak Discharge | 01Jan2022, 16:00 |
| Volume (IN) | 0.07 |
| Peak Inflow (CFS) | 199.75 |
| Inflow Volume (AC - FT) | 86.91 |



# Subbasin: Subbasin-3

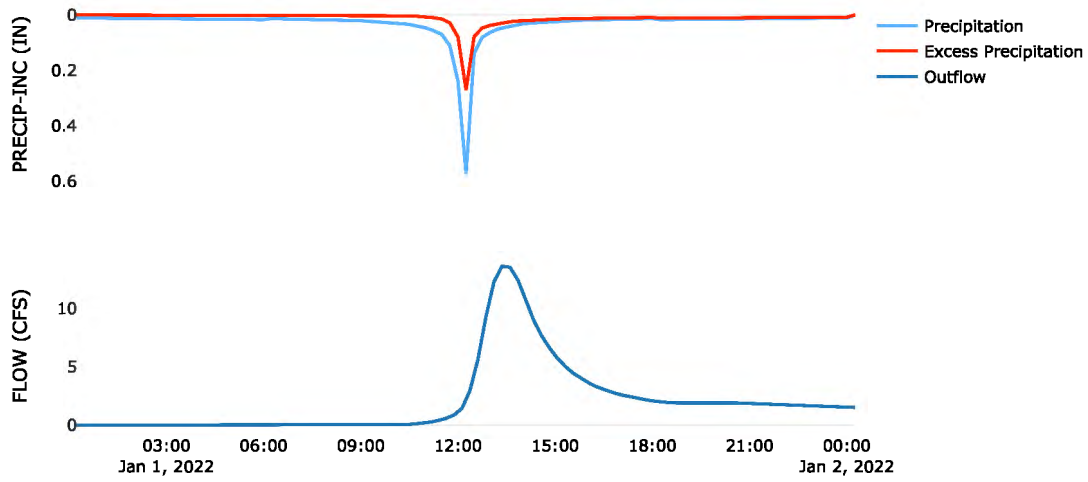
**Area (MI2)** : 0.07
**Downstream** : Junction - 1

| Loss Rate: Scs | |
|---|---|
| Percent Impervious Area | 0 |
| Curve Number | 79 |

| Transform: Scs | |
|---|---|
| Lag | 67 |
| Unitgraph Type | Standard |

| Results: Subbasin-3 | |
|---|---|
| Peak Discharge (CFS) | 13.62 |
| Time of Peak Discharge | 01Jan2022, 13:15 |
| Volume (IN) | 1.07 |
| Precipitation Volume (AC - FT) | 10.83 |
| Loss Volume (AC - FT) | 6.66 |
| Excess Volume (AC - FT) | 4.17 |
| Direct Runoff Volume (AC - FT) | 4.01 |
| Baseflow Volume (AC - FT) | 0 |

Precipitation and Outflow



# Reach: Combined Stream

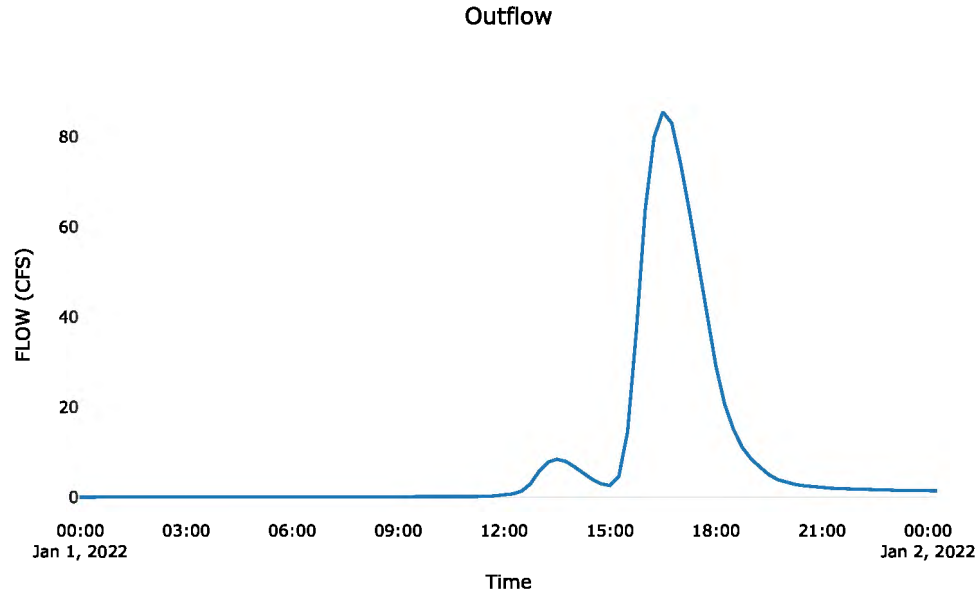
**Downstream** : Sink - 1

**Route: Muskingum Cunge**

| | |
|---|---|
| Method | Muskingum Cunge |
| Channel | Trapezoid |
| Length (FT) | 994 |
| Energy Slope (FT/FT) | 0.01 |
| Mannings n | 0.04 |
| Bottom Width (FT) | 32 |
| Side Slope (FT/FT) | 35 |
| Initial Variable | Combined Inflow |
| Space - Time Method | Automatic DX and DT |
| Index Parameter Type | Index Flow |
| Index Flow | 10 |
| Maximum Depth Iterations | 20 |
| Maximum Route Step Iterations | 30 |
| Channel Loss | Percolation |
| Channel Loss Percolation Rate | 5 |
| End Channel Loss | |

**Results: Combined Stream**

| | |
|---|---|
| Peak Discharge (CFS) | 85.47 |
| Time of Peak Discharge | 01Jan2022, 16:30 |
| Volume (IN) | 0.06 |
| Peak Inflow (CFS) | 95.82 |
| Inflow Volume (AC - FT) | 21.08 |



**Project:** Lockhart_Solar_Proposed_alt1
**Simulation Run:** 10-Year
**Simulation Start:** 31 December 2021, 24:00
**Simulation End:** 2 January 2022, 00:15

**HMS Version:** 4.10
**Executed:** 15 October 2022, 00:03

## Global Parameter Summary - Subbasin

**Area (MI2)**

| Element Name | Area (MI2) |
|---|---|
| Subbasin - 2 | 1.59 |
| Subbasin - 1 | 3.12 |
| Subbasin - 3 | 0.07 |

**Downstream**

| Element Name | Downstream |
|---|---|
| Subbasin - 2 | East Stream |
| Subbasin - 1 | West Stream |
| Subbasin - 3 | Junction - 1 |

**Loss Rate: Scs**

| Element Name | Percent Impervious Area | Curve Number |
|---|---|---|
| Subbasin - 2 | 0 | 79 |
| Subbasin - 1 | 0 | 79 |
| Subbasin - 3 | 0 | 79.2 |

**Transform: Scs**

| Element Name | Lag | Unitgraph Type |
|---|---|---|
| Subbasin - 2 | 132 | Standard |
| Subbasin - 1 | 149 | Standard |
| Subbasin - 3 | 67 | Standard |

## Global Parameter Summary - Reach

**Downstream**

| Element Name | Downstream |
|---|---|
| West Stream | Junction - 1 |
| East Stream | Junction - 1 |
| Combined Stream | Sink - 1 |

**Route: Muskingum Cunge**

| Element Name | Method | Channel | Length (FT) | Energy Slope (FT/FT) | Mannings n | Bottom Width (FT) | Side Slope (FT/FT) | Initial Variable | Space - Time Method | Index Parameter Type | Index Flow | Maximum Depth Iterations |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| West Stream | Muskingum Cunge | 5 | 18160 | 0.01 | 0.04 | 65 | 48 | Combined Inflow | Automatic DX and DT | Index Flow | 180 | 20 |
| East Stream | Muskingum Cunge | 5 | 18545 | 0.01 | 0.04 | 56 | 15 | Combined Inflow | Automatic DX and DT | Index Flow | 100 | 20 |
| Combined Stream | Muskingum Cunge | 5 | 994 | 0.01 | 0.04 | 32 | 35 | Combined Inflow | Automatic DX and DT | Index Flow | 10 | 20 |

## Global Results Summary

| Hydrologic Element | Drainage Area (MI2) | Peak Discharge (CFS) | Time of Peak | Volume (IN) |
|---|---|---|---|---|
| Subbasin - 2 | 1.59 | 57.41 | 01Jan2022, 15:00 | 0.33 |
| Subbasin - 1 | 3.12 | 104.35 | 01Jan2022, 15:15 | 0.33 |
| West Stream | 3.12 | 1.09 | 01Jan2022, 18:00 | 0 |
| East Stream | 1.59 | 1 | 01Jan2022, 17:15 | 0.01 |
| Subbasin - 3 | 0.07 | 3.93 | 01Jan2022, 13:30 | 0.36 |
| Junction - 1 | 4.78 | 3.93 | 01Jan2022, 13:30 | 0.01 |
| Combined Stream | 4.78 | 1.65 | 01Jan2022, 13:45 | 0 |
| Sink - 1 | 4.78 | 1.65 | 01Jan2022, 13:45 | 0 |

# Subbasin: Subbasin-2

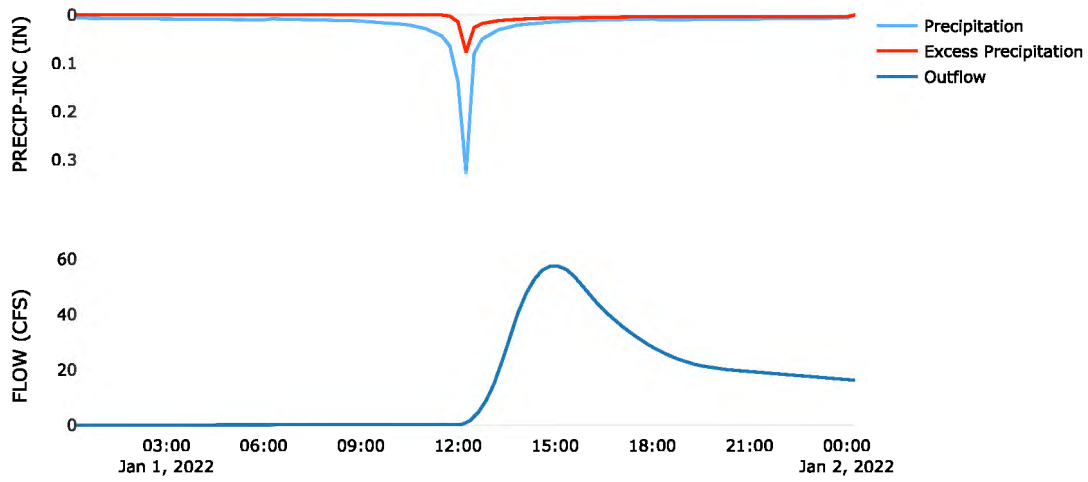
**Area (MI2)** : 1.59
**Downstream** : East Stream

| Loss Rate: Scs | |
|---|---|
| Percent Impervious Area | 0 |
| Curve Number | 79 |

| Transform: Scs | |
|---|---|
| Lag | 132 |
| Unitgraph Type | Standard |

| Results: Subbasin-2 | |
|---|---|
| Peak Discharge (CFS) | 57.41 |
| Time of Peak Discharge | 01Jan2022, 15:00 |
| Volume (IN) | 0.33 |
| Precipitation Volume (AC - FT) | 146.89 |
| Loss Volume (AC - FT) | 115.27 |
| Excess Volume (AC - FT) | 31.62 |
| Direct Runoff Volume (AC - FT) | 28.23 |
| Baseflow Volume (AC - FT) | 0 |

Precipitation and Outflow



# Subbasin: Subbasin-1

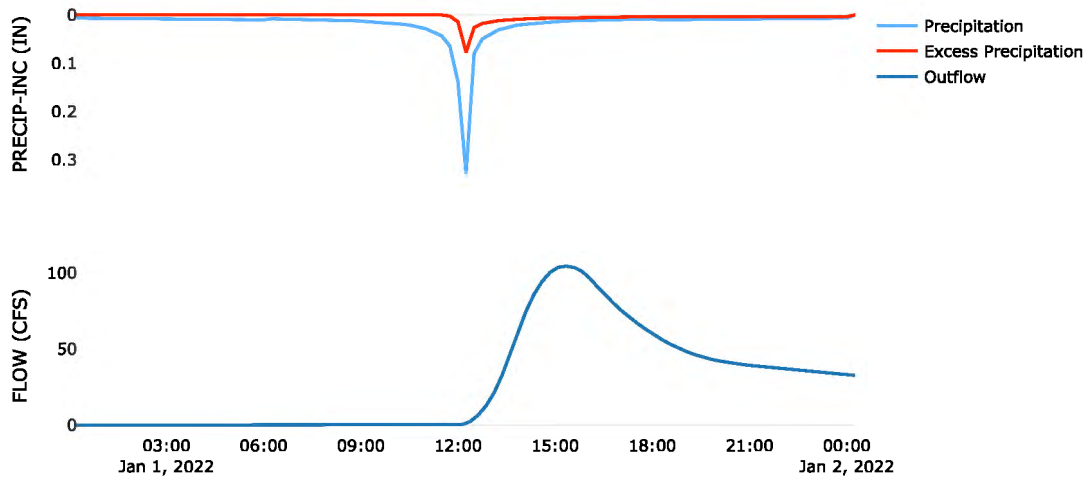
**Area (MI2)** : 3.12
**Downstream** : West Stream

| Loss Rate: Scs | |
|---|---|
| Percent Impervious Area | 0 |
| Curve Number | 79 |

| Transform: Scs | |
|---|---|
| Lag | 149 |
| Unitgraph Type | Standard |

| Results: Subbasin-1 | |
|---|---|
| Peak Discharge (CFS) | 104.35 |
| Time of Peak Discharge | 01Jan2022, 15:15 |
| Volume (IN) | 0.33 |
| Precipitation Volume (AC - FT) | 287.78 |
| Loss Volume (AC - FT) | 225.84 |
| Excess Volume (AC - FT) | 61.94 |
| Direct Runoff Volume (AC - FT) | 54.28 |
| Baseflow Volume (AC - FT) | 0 |

Precipitation and Outflow



# Reach: West Stream

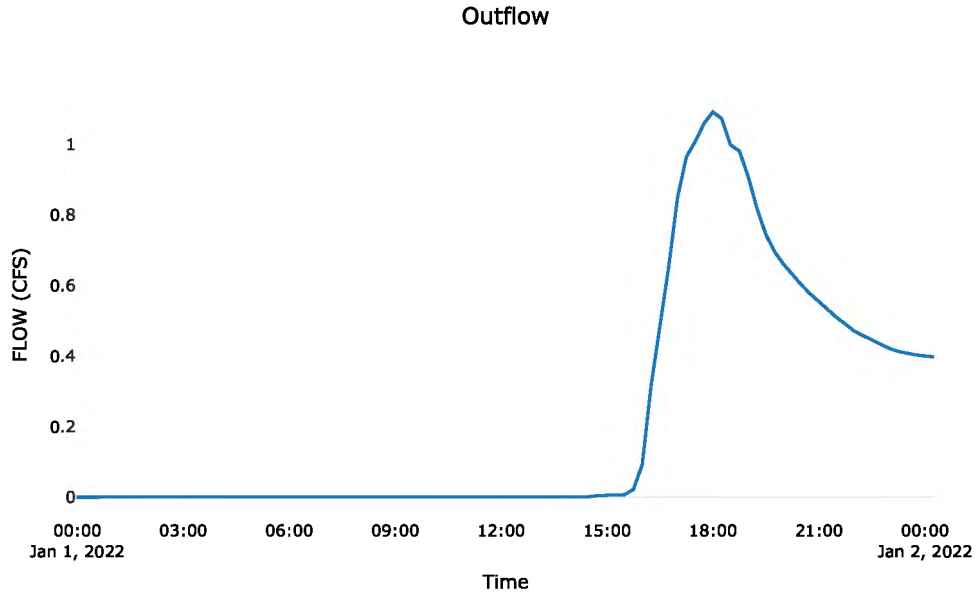
**Downstream** : Junction - 1

**Route: Muskingum Cunge**

| | |
|---|---|
| Method | Muskingum Cunge |
| Channel | Trapezoid |
| Length (FT) | 18160 |
| Energy Slope (FT/FT) | 0.01 |
| Mannings n | 0.04 |
| Bottom Width (FT) | 65 |
| Side Slope (FT/FT) | 48 |
| Initial Variable | Combined Inflow |
| Space - Time Method | Automatic DX and DT |
| Index Parameter Type | Index Flow |
| Index Flow | 180 |
| Maximum Depth Iterations | 20 |
| Maximum Route Step Iterations | 30 |
| Channel Loss | Percolation |
| Channel Loss Percolation Rate | 5 |
| End Channel Loss | |

**Results: West Stream**

| | |
|---|---|
| Peak Discharge (CFS) | 1.09 |
| Time of Peak Discharge | 01Jan2022, 18:00 |
| Volume (IN) | 0 |
| Peak Inflow (CFS) | 104.35 |
| Inflow Volume (AC - FT) | 54.28 |



# Reach: East Stream

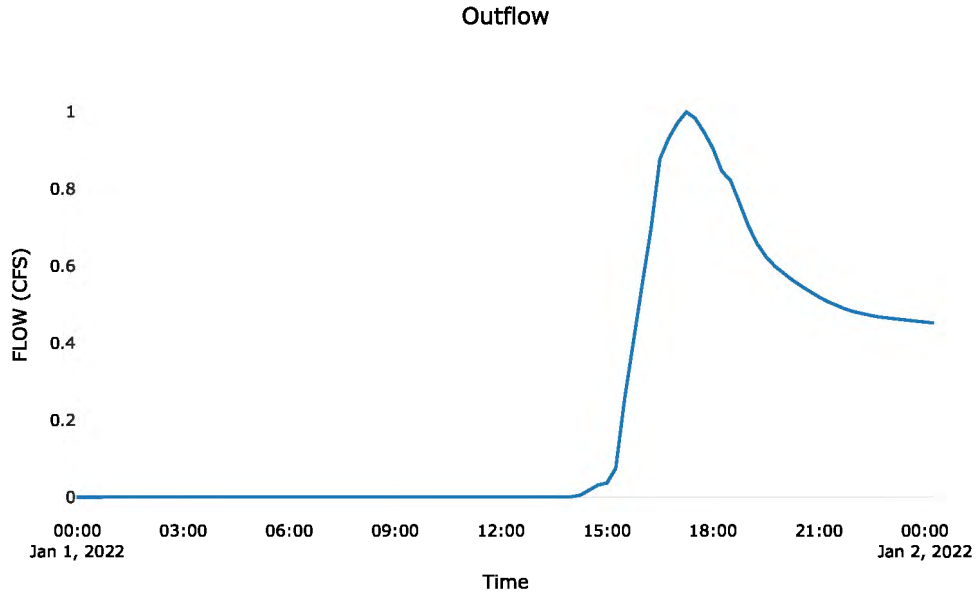
**Downstream** : Junction - 1

**Route: Muskingum Cunge**

| | |
|---|---|
| Method | Muskingum Cunge |
| Channel | Trapezoid |
| Length (FT) | 18545 |
| Energy Slope (FT/FT) | 0.01 |
| Mannings n | 0.04 |
| Bottom Width (FT) | 56 |
| Side Slope (FT/FT) | 15 |
| Initial Variable | Combined Inflow |
| Space - Time Method | Automatic DX and DT |
| Index Parameter Type | Index Flow |
| Index Flow | 100 |
| Maximum Depth Iterations | 20 |
| Maximum Route Step Iterations | 30 |
| Channel Loss | Percolation |
| Channel Loss Percolation Rate | 5 |
| End Channel Loss | |

**Results: East Stream**

| | |
|---|---|
| Peak Discharge (CFS) | 1 |
| Time of Peak Discharge | 01Jan2022, 17:15 |
| Volume (IN) | 0.01 |
| Peak Inflow (CFS) | 57.41 |
| Inflow Volume (AC - FT) | 28.23 |



# Subbasin: Subbasin-3

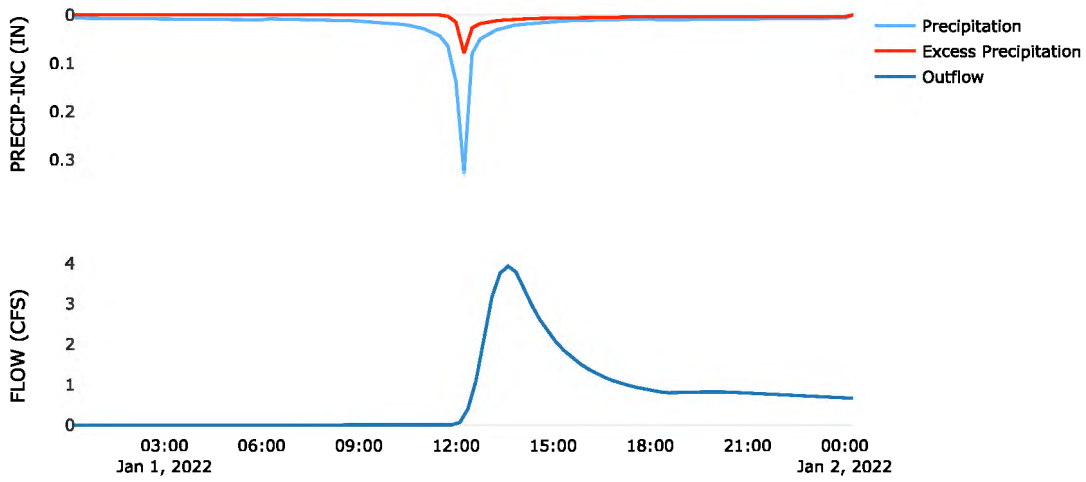
**Area (MI2)** : 0.07
**Downstream** : Junction - 1

| Loss Rate: Scs | |
|---|---|
| Percent Impervious Area | 0 |
| Curve Number | 79.2 |

| Transform: Scs | |
|---|---|
| Lag | 67 |
| Unitgraph Type | Standard |

| Results: Subbasin-3 | |
|---|---|
| Peak Discharge (CFS) | 3.93 |
| Time of Peak Discharge | 01Jan2022, 13:30 |
| Volume (IN) | 0.36 |
| Precipitation Volume (AC - FT) | 6.46 |
| Loss Volume (AC - FT) | 5.04 |
| Excess Volume (AC - FT) | 1.41 |
| Direct Runoff Volume (AC - FT) | 1.35 |
| Baseflow Volume (AC - FT) | 0 |

Precipitation and Outflow



# Reach: Combined Stream

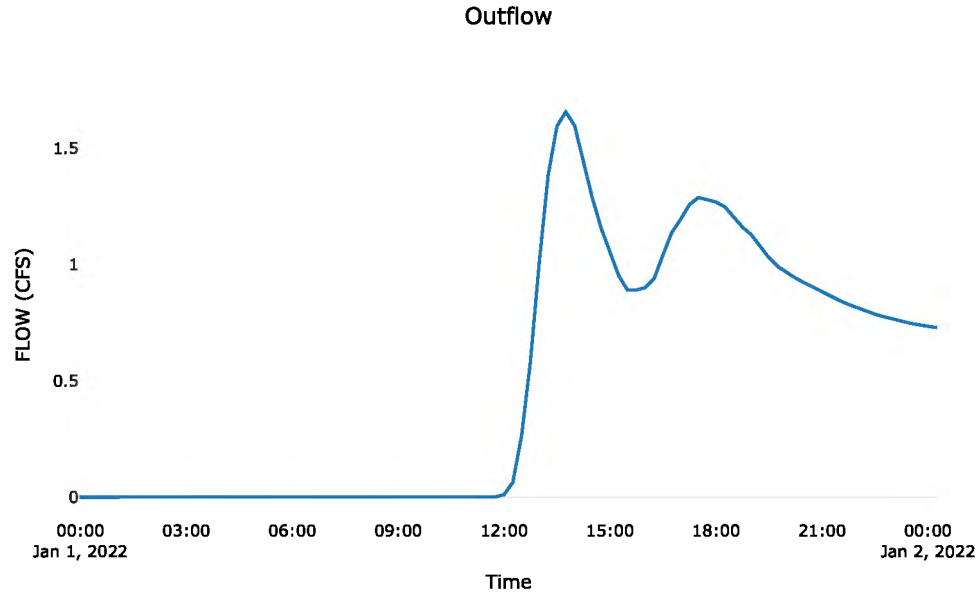
**Downstream** : Sink - 1

**Route: Muskingum Cunge**

| | |
|---|---|
| Method | Muskingum Cunge |
| Channel | Trapezoid |
| Length (FT) | 994 |
| Energy Slope (FT/FT) | 0.01 |
| Mannings n | 0.04 |
| Bottom Width (FT) | 32 |
| Side Slope (FT/FT) | 35 |
| Initial Variable | Combined Inflow |
| Space - Time Method | Automatic DX and DT |
| Index Parameter Type | Index Flow |
| Index Flow | 10 |
| Maximum Depth Iterations | 20 |
| Maximum Route Step Iterations | 30 |
| Channel Loss | Percolation |
| Channel Loss Percolation Rate | 5 |
| End Channel Loss | |

**Results: Combined Stream**

| | |
|---|---|
| Peak Discharge (CFS) | 1.65 |
| Time of Peak Discharge | 01Jan2022, 13:45 |
| Volume (IN) | 0 |
| Peak Inflow (CFS) | 3.93 |
| Inflow Volume (AC - FT) | 2.25 |



**Project:** Lockhart_Solar_Proposed_alt1
**Simulation Run:** 25-Year
**Simulation Start:** 31 December 2021, 24:00
**Simulation End:** 2 January 2022, 00:15

**HMS Version:** 4.10
**Executed:** 15 October 2022, 00:05

## Global Parameter Summary - Subbasin

**Area (MI2)**

| Element Name | Area (MI2) |
|---|---|
| Subbasin - 2 | 1.59 |
| Subbasin - 1 | 3.12 |
| Subbasin - 3 | 0.07 |

**Downstream**

| Element Name | Downstream |
|---|---|
| Subbasin - 2 | East Stream |
| Subbasin - 1 | West Stream |
| Subbasin - 3 | Junction - 1 |

**Loss Rate: Scs**

| Element Name | Percent Impervious Area | Curve Number |
|---|---|---|
| Subbasin - 2 | 0 | 79 |
| Subbasin - 1 | 0 | 79 |
| Subbasin - 3 | 0 | 79.2 |

**Transform: Scs**

| Element Name | Lag | Unitgraph Type |
|---|---|---|
| Subbasin - 2 | 132 | Standard |
| Subbasin - 1 | 149 | Standard |
| Subbasin - 3 | 67 | Standard |

## Global Parameter Summary - Reach

**Downstream**

| Element Name | Downstream |
|---|---|
| West Stream | Junction - 1 |
| East Stream | Junction - 1 |
| Combined Stream | Sink - 1 |

**Route: Muskingum Cunge**

| Element Name | Method | Channel | Length (FT) | Energy Slope (FT/FT) | Mannings n | Bottom Width (FT) | Side Slope (FT/FT) | Initial Variable | Space - Time Method | Index Parameter Type | Index Flow | Maximum Depth Iterations |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| West Stream | Muskingum Cunge | 5 | 18160 | 0.01 | 0.04 | 65 | 48 | Combined Inflow | Automatic DX and DT | Index Flow | 180 | 20 |
| East Stream | Muskingum Cunge | 5 | 18545 | 0.01 | 0.04 | 56 | 15 | Combined Inflow | Automatic DX and DT | Index Flow | 100 | 20 |
| Combined Stream | Muskingum Cunge | 5 | 994 | 0.01 | 0.04 | 32 | 35 | Combined Inflow | Automatic DX and DT | Index Flow | 10 | 20 |

## Global Results Summary

| Hydrologic Element | Drainage Area (MI2) | Peak Discharge (CFS) | Time of Peak | Volume (IN) |
|---|---|---|---|---|
| Subbasin - 2 | 1.59 | 105.62 | 01Jan2022, 14:45 | 0.57 |
| Subbasin - 1 | 3.12 | 190.91 | 01Jan2022, 15:00 | 0.56 |
| West Stream | 3.12 | 4.2 | 01Jan2022, 17:15 | 0.01 |
| East Stream | 1.59 | 3.04 | 01Jan2022, 17:00 | 0.01 |
| Subbasin - 3 | 0.07 | 7.27 | 01Jan2022, 13:30 | 0.61 |
| Junction - 1 | 4.78 | 8.73 | 01Jan2022, 17:00 | 0.02 |
| Combined Stream | 4.78 | 4.22 | 01Jan2022, 17:15 | 0.01 |
| Sink - 1 | 4.78 | 4.22 | 01Jan2022, 17:15 | 0.01 |

# Subbasin: Subbasin-2

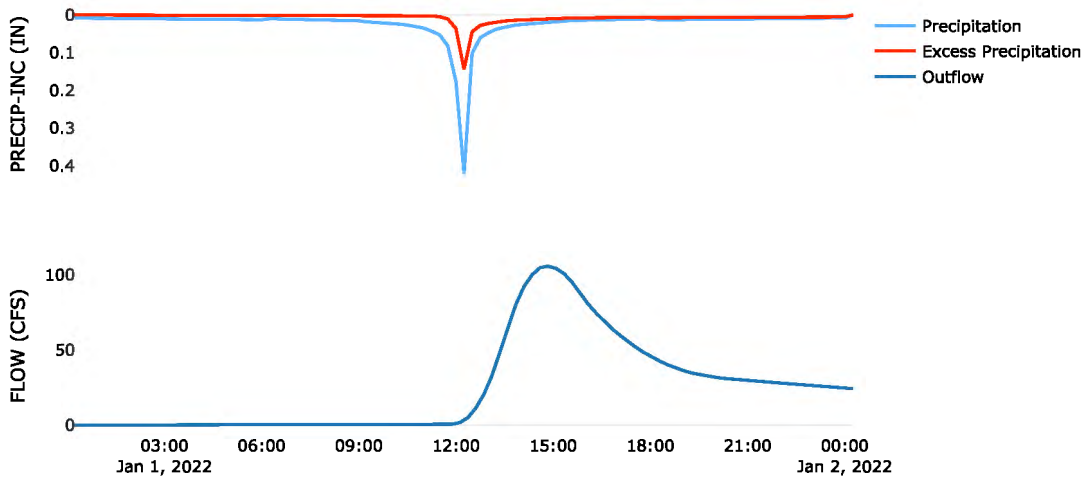
**Area (MI2)** : 1.59
**Downstream** : East Stream

| Loss Rate: Scs | |
|---|---|
| Percent Impervious Area | 0 |
| Curve Number | 79 |

| Transform: Scs | |
|---|---|
| Lag | 132 |
| Unitgraph Type | Standard |

| Results: Subbasin-2 | |
|---|---|
| Peak Discharge (CFS) | 105.62 |
| Time of Peak Discharge | 01Jan2022, 14:45 |
| Volume (IN) | 0.57 |
| Precipitation Volume (AC - FT) | 185.1 |
| Loss Volume (AC - FT) | 131.53 |
| Excess Volume (AC - FT) | 53.57 |
| Direct Runoff Volume (AC - FT) | 48.52 |
| Baseflow Volume (AC - FT) | 0 |

Precipitation and Outflow



# Subbasin: Subbasin-1

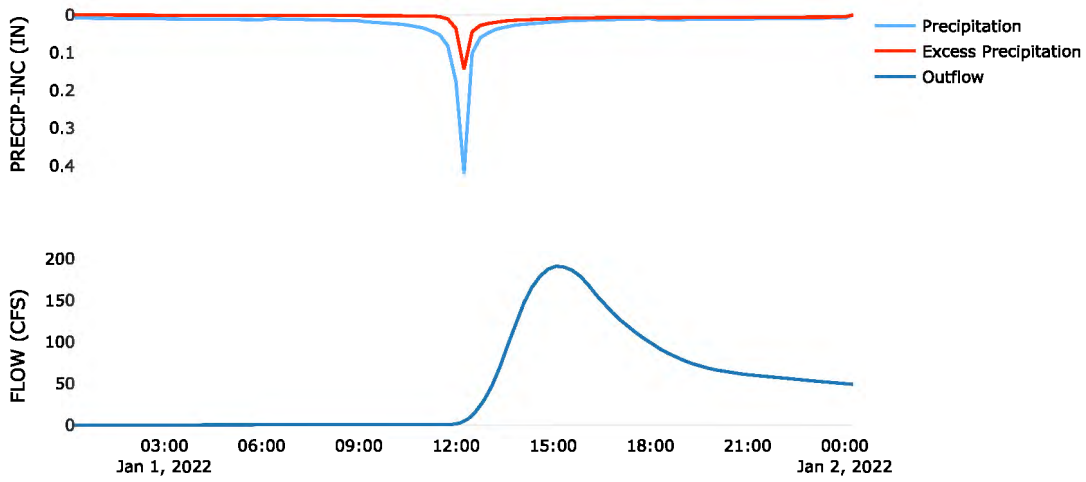
**Area (MI2)** : 3.12
**Downstream** : West Stream

| Loss Rate: Scs | |
|---|---|
| Percent Impervious Area | 0 |
| Curve Number | 79 |

| Transform: Scs | |
|---|---|
| Lag | 149 |
| Unitgraph Type | Standard |

| Results: Subbasin-1 | |
|---|---|
| Peak Discharge (CFS) | 190.91 |
| Time of Peak Discharge | 01Jan2022, 15:00 |
| Volume (IN) | 0.56 |
| Precipitation Volume (AC - FT) | 362.64 |
| Loss Volume (AC - FT) | 257.69 |
| Excess Volume (AC - FT) | 104.95 |
| Direct Runoff Volume (AC - FT) | 93.51 |
| Baseflow Volume (AC - FT) | 0 |

Precipitation and Outflow



# Reach: West Stream

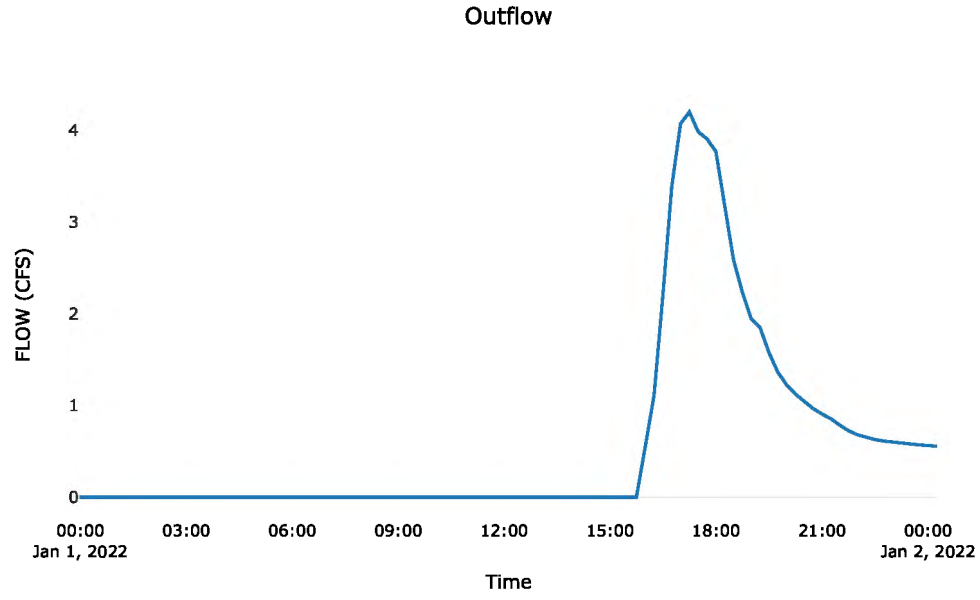
**Downstream** : Junction - 1

**Route: Muskingum Cunge**

| | |
|---|---|
| Method | Muskingum Cunge |
| Channel | Trapezoid |
| Length (FT) | 18160 |
| Energy Slope (FT/FT) | 0.01 |
| Mannings n | 0.04 |
| Bottom Width (FT) | 65 |
| Side Slope (FT/FT) | 48 |
| Initial Variable | Combined Inflow |
| Space - Time Method | Automatic DX and DT |
| Index Parameter Type | Index Flow |
| Index Flow | 180 |
| Maximum Depth Iterations | 20 |
| Maximum Route Step Iterations | 30 |
| Channel Loss | Percolation |
| Channel Loss Percolation Rate | 5 |
| End Channel Loss | |

**Results: West Stream**

| | |
|---|---|
| Peak Discharge (CFS) | 4.2 |
| Time of Peak Discharge | 01Jan2022, 17:15 |
| Volume (IN) | 0.01 |
| Peak Inflow (CFS) | 190.91 |
| Inflow Volume (AC - FT) | 93.51 |



# Reach: East Stream

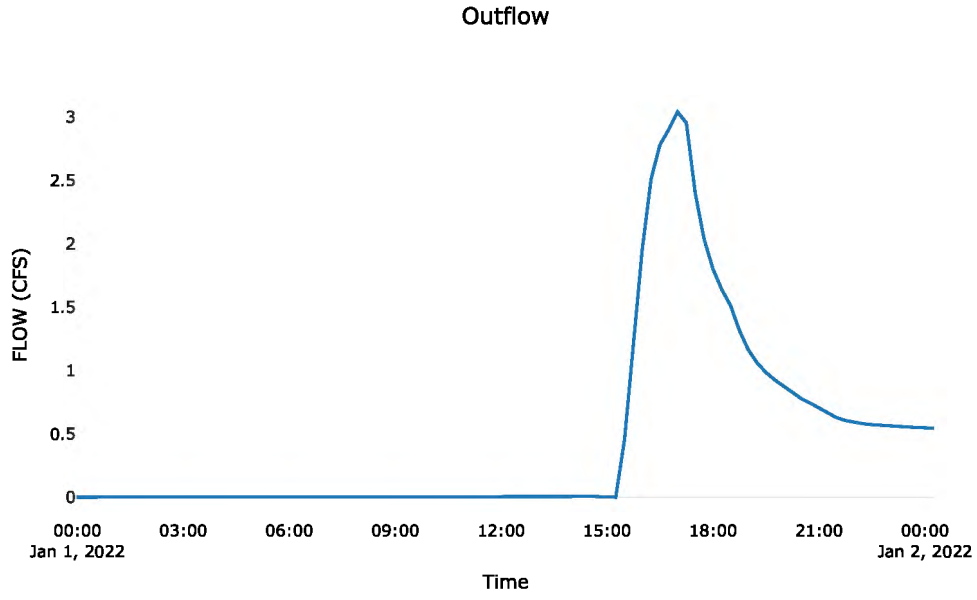
**Downstream** : Junction - 1

**Route: Muskingum Cunge**

| | |
|---|---|
| Method | Muskingum Cunge |
| Channel | Trapezoid |
| Length (FT) | 18545 |
| Energy Slope (FT/FT) | 0.01 |
| Mannings n | 0.04 |
| Bottom Width (FT) | 56 |
| Side Slope (FT/FT) | 15 |
| Initial Variable | Combined Inflow |
| Space - Time Method | Automatic DX and DT |
| Index Parameter Type | Index Flow |
| Index Flow | 100 |
| Maximum Depth Iterations | 20 |
| Maximum Route Step Iterations | 30 |
| Channel Loss | Percolation |
| Channel Loss Percolation Rate | 5 |
| End Channel Loss | |

**Results: East Stream**

| | |
|---|---|
| Peak Discharge (CFS) | 3.04 |
| Time of Peak Discharge | 01Jan2022, 17:00 |
| Volume (IN) | 0.01 |
| Peak Inflow (CFS) | 105.62 |
| Inflow Volume (AC - FT) | 48.52 |



# Subbasin: Subbasin-3

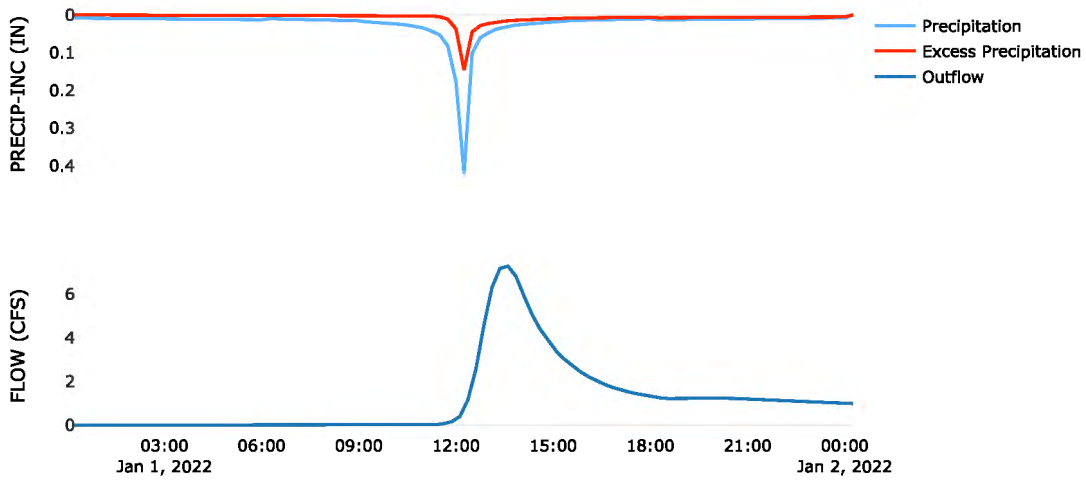
**Area (MI2)** : 0.07
**Downstream** : Junction - 1

| Loss Rate: Scs | |
|---|---|
| Percent Impervious Area | 0 |
| Curve Number | 79.2 |

| Transform: Scs | |
|---|---|
| Lag | 67 |
| Unitgraph Type | Standard |

| Results: Subbasin-3 | |
|---|---|
| Peak Discharge (CFS) | 7.27 |
| Time of Peak Discharge | 01Jan2022, 13:30 |
| Volume (IN) | 0.61 |
| Precipitation Volume (AC - FT) | 8.14 |
| Loss Volume (AC - FT) | 5.75 |
| Excess Volume (AC - FT) | 2.39 |
| Direct Runoff Volume (AC - FT) | 2.29 |
| Baseflow Volume (AC - FT) | 0 |

Precipitation and Outflow



# Reach: Combined Stream

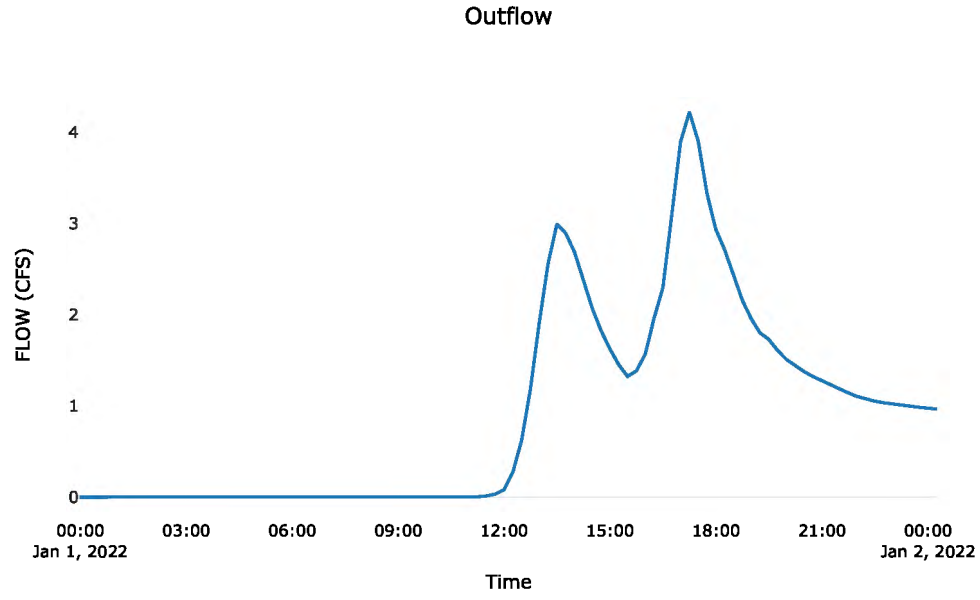
**Downstream** : Sink - 1

**Route: Muskingum Cunge**

| | |
|---|---|
| Method | Muskingum Cunge |
| Channel | Trapezoid |
| Length (FT) | 994 |
| Energy Slope (FT/FT) | 0.01 |
| Mannings n | 0.04 |
| Bottom Width (FT) | 32 |
| Side Slope (FT/FT) | 35 |
| Initial Variable | Combined Inflow |
| Space - Time Method | Automatic DX and DT |
| Index Parameter Type | Index Flow |
| Index Flow | 10 |
| Maximum Depth Iterations | 20 |
| Maximum Route Step Iterations | 30 |
| Channel Loss | Percolation |
| Channel Loss Percolation Rate | 5 |
| End Channel Loss | |

**Results: Combined Stream**

| | |
|---|---|
| Peak Discharge (CFS) | 4.22 |
| Time of Peak Discharge | 01Jan2022, 17:15 |
| Volume (IN) | 0.01 |
| Peak Inflow (CFS) | 8.73 |
| Inflow Volume (AC - FT) | 4.34 |



**Project:** Lockhart_Solar_Proposed_alt1
**Simulation Run:** 50-Year
**Simulation Start:** 31 December 2021, 24:00
**Simulation End:** 2 January 2022, 00:15

**HMS Version:** 4.10
**Executed:** 15 October 2022, 00:06

## Global Parameter Summary - Subbasin

**Area (MI2)**

| Element Name | Area (MI2) |
|---|---|
| Subbasin - 2 | 1.59 |
| Subbasin - 1 | 3.12 |
| Subbasin - 3 | 0.07 |

**Downstream**

| Element Name | Downstream |
|---|---|
| Subbasin - 2 | East Stream |
| Subbasin - 1 | West Stream |
| Subbasin - 3 | Junction - 1 |

**Loss Rate: Scs**

| Element Name | Percent Impervious Area | Curve Number |
|---|---|---|
| Subbasin - 2 | 0 | 79 |
| Subbasin - 1 | 0 | 79 |
| Subbasin - 3 | 0 | 79.2 |

**Transform: Scs**

| Element Name | Lag | Unitgraph Type |
|---|---|---|
| Subbasin - 2 | 132 | Standard |
| Subbasin - 1 | 149 | Standard |
| Subbasin - 3 | 67 | Standard |

## Global Parameter Summary - Reach

**Downstream**

| Element Name | Downstream |
|---|---|
| West Stream | Junction - 1 |
| East Stream | Junction - 1 |
| Combined Stream | Sink - 1 |

**Route: Muskingum Cunge**

| Element Name | Method | Channel | Length (FT) | Energy Slope (FT/FT) | Mannings n | Bottom Width (FT) | Side Slope (FT/FT) | Initial Variable | Space - Time Method | Index Parameter Type | Index Flow | Maximum Depth Iterations |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| West Stream | Muskingum Cunge | 5 | 18160 | 0.01 | 0.04 | 65 | 48 | Combined Inflow | Automatic DX and DT | Index Flow | 180 | 20 |
| East Stream | Muskingum Cunge | 5 | 18545 | 0.01 | 0.04 | 56 | 15 | Combined Inflow | Automatic DX and DT | Index Flow | 100 | 20 |
| Combined Stream | Muskingum Cunge | 5 | 994 | 0.01 | 0.04 | 32 | 35 | Combined Inflow | Automatic DX and DT | Index Flow | 10 | 20 |

## Global Results Summary

| Hydrologic Element | Drainage Area (MI2) | Peak Discharge (CFS) | Time of Peak | Volume (IN) |
|---|---|---|---|---|
| Subbasin - 2 | 1.59 | 149.77 | 01Jan2022, 14:45 | 0.79 |
| Subbasin - 1 | 3.12 | 270.92 | 01Jan2022, 15:00 | 0.78 |
| West Stream | 3.12 | 15.86 | 01Jan2022, 17:00 | 0.02 |
| East Stream | 1.59 | 9.91 | 01Jan2022, 16:15 | 0.02 |
| Subbasin - 3 | 0.07 | 10.31 | 01Jan2022, 13:30 | 0.84 |
| Junction - 1 | 4.78 | 26.3 | 01Jan2022, 16:45 | 0.03 |
| Combined Stream | 4.78 | 19.5 | 01Jan2022, 17:00 | 0.02 |
| Sink - 1 | 4.78 | 19.5 | 01Jan2022, 17:00 | 0.02 |

# Subbasin: Subbasin-2

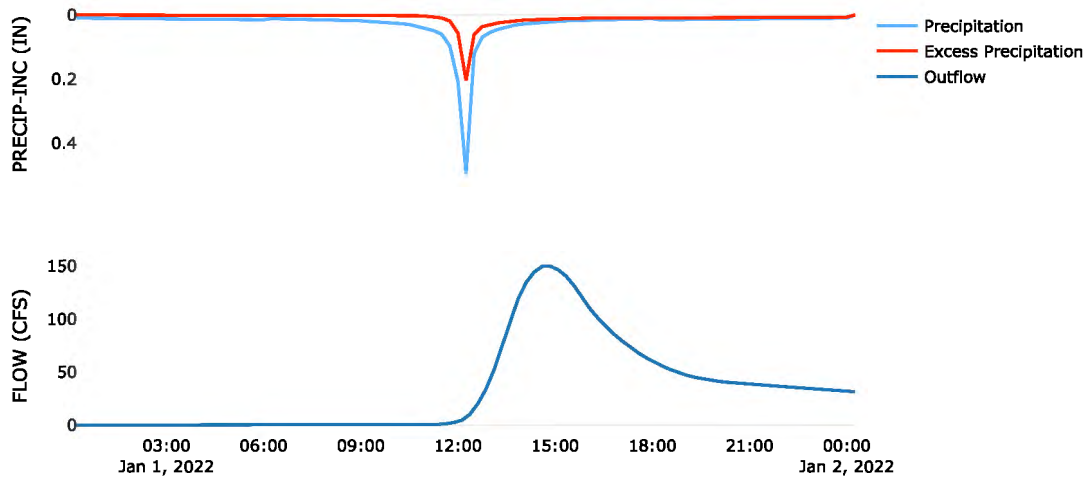
**Area (MI2)** : 1.59
**Downstream** : East Stream

| Loss Rate: Scs | |
|---|---|
| Percent Impervious Area | 0 |
| Curve Number | 79 |

| Transform: Scs | |
|---|---|
| Lag | 132 |
| Unitgraph Type | Standard |

| Results: Subbasin-2 | |
|---|---|
| Peak Discharge (CFS) | 149.77 |
| Time of Peak Discharge | 01Jan2022, 14:45 |
| Volume (IN) | 0.79 |
| Precipitation Volume (AC - FT) | 215.66 |
| Loss Volume (AC - FT) | 142.28 |
| Excess Volume (AC - FT) | 73.39 |
| Direct Runoff Volume (AC - FT) | 66.84 |
| Baseflow Volume (AC - FT) | 0 |

Precipitation and Outflow



# Subbasin: Subbasin-1

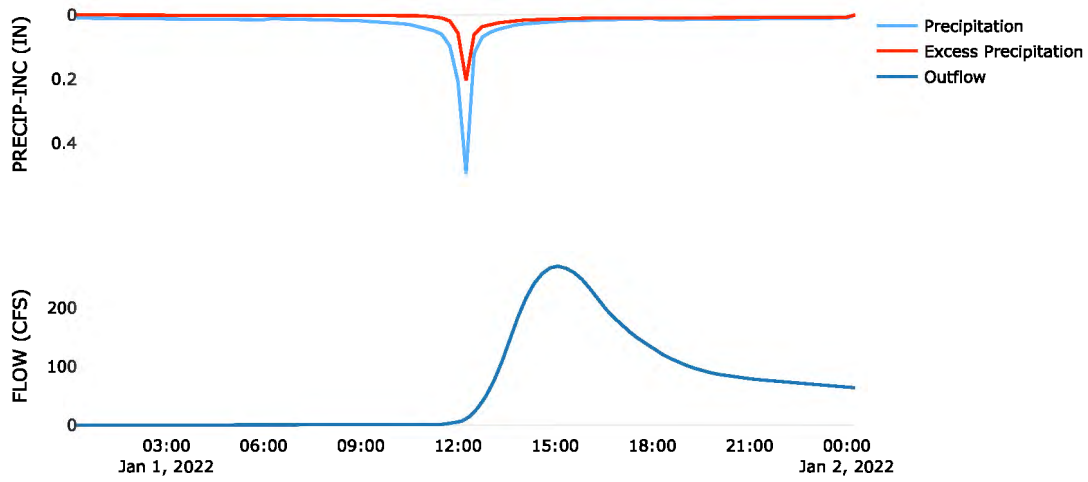
**Area (MI2)** : 3.12
**Downstream** : West Stream

| Loss Rate: Scs | |
|---|---|
| Percent Impervious Area | 0 |
| Curve Number | 79 |

| Transform: Scs | |
|---|---|
| Lag | 149 |
| Unitgraph Type | Standard |

| Results: Subbasin-1 | |
|---|---|
| Peak Discharge (CFS) | 270.92 |
| Time of Peak Discharge | 01Jan2022, 15:00 |
| Volume (IN) | 0.78 |
| Precipitation Volume (AC - FT) | 422.52 |
| Loss Volume (AC - FT) | 278.74 |
| Excess Volume (AC - FT) | 143.78 |
| Direct Runoff Volume (AC - FT) | 128.95 |
| Baseflow Volume (AC - FT) | 0 |

Precipitation and Outflow



# Reach: West Stream

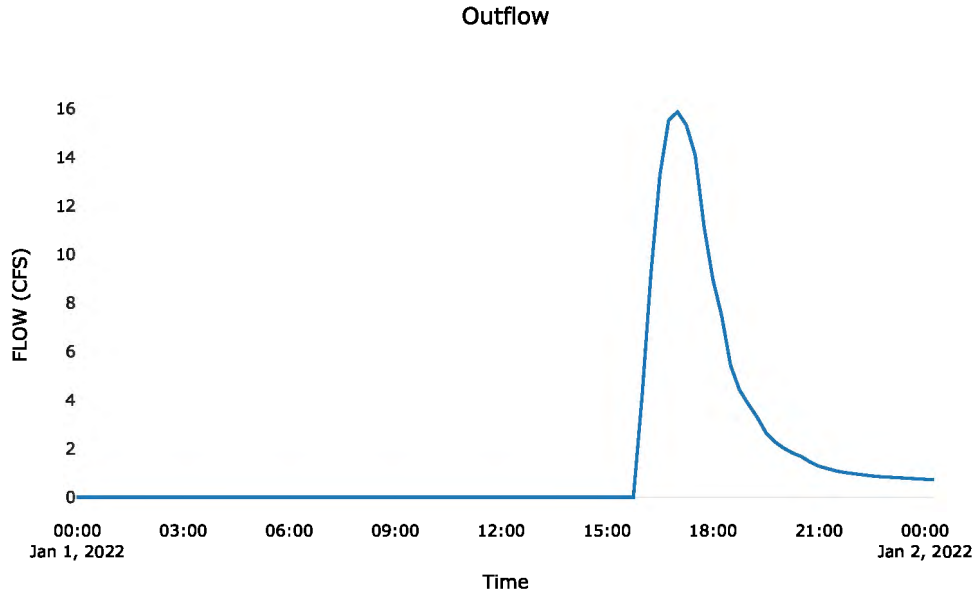
**Downstream** : Junction - 1

**Route: Muskingum Cunge**

| | |
|---|---|
| Method | Muskingum Cunge |
| Channel | Trapezoid |
| Length (FT) | 18160 |
| Energy Slope (FT/FT) | 0.01 |
| Mannings n | 0.04 |
| Bottom Width (FT) | 65 |
| Side Slope (FT/FT) | 48 |
| Initial Variable | Combined Inflow |
| Space - Time Method | Automatic DX and DT |
| Index Parameter Type | Index Flow |
| Index Flow | 180 |
| Maximum Depth Iterations | 20 |
| Maximum Route Step Iterations | 30 |
| Channel Loss | Percolation |
| Channel Loss Percolation Rate | 5 |
| End Channel Loss | |

**Results: West Stream**

| | |
|---|---|
| Peak Discharge (CFS) | 15.86 |
| Time of Peak Discharge | 01Jan2022, 17:00 |
| Volume (IN) | 0.02 |
| Peak Inflow (CFS) | 270.92 |
| Inflow Volume (AC - FT) | 128.95 |



# Reach: East Stream

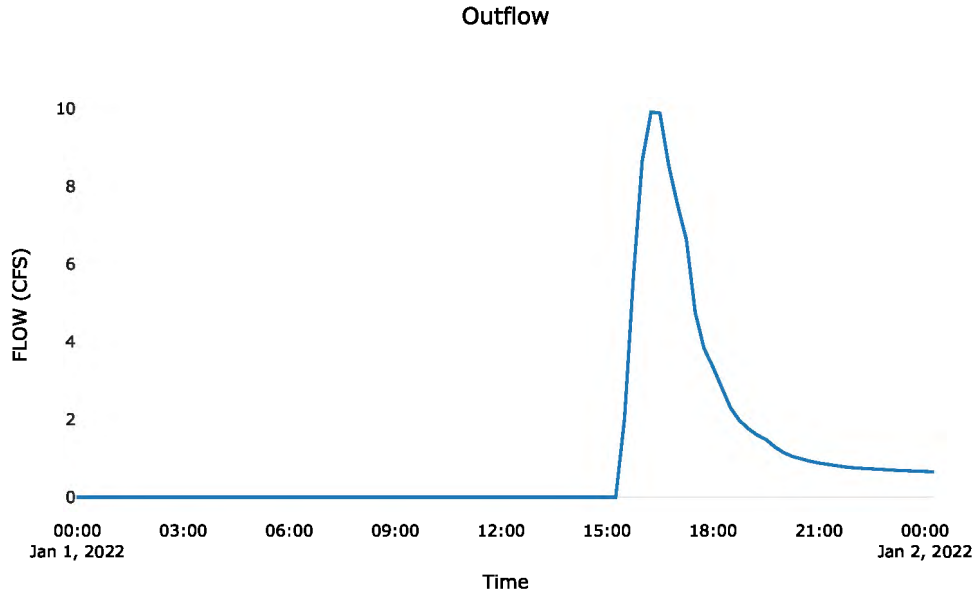
**Downstream** : Junction - 1

**Route: Muskingum Cunge**

| | |
|---|---|
| Method | Muskingum Cunge |
| Channel | Trapezoid |
| Length (FT) | 18545 |
| Energy Slope (FT/FT) | 0.01 |
| Mannings n | 0.04 |
| Bottom Width (FT) | 56 |
| Side Slope (FT/FT) | 15 |
| Initial Variable | Combined Inflow |
| Space - Time Method | Automatic DX and DT |
| Index Parameter Type | Index Flow |
| Index Flow | 100 |
| Maximum Depth Iterations | 20 |
| Maximum Route Step Iterations | 30 |
| Channel Loss | Percolation |
| Channel Loss Percolation Rate | 5 |
| End Channel Loss | |

**Results: East Stream**

| | |
|---|---|
| Peak Discharge (CFS) | 9.91 |
| Time of Peak Discharge | 01Jan2022, 16:15 |
| Volume (IN) | 0.02 |
| Peak Inflow (CFS) | 149.77 |
| Inflow Volume (AC - FT) | 66.84 |



# Subbasin: Subbasin-3

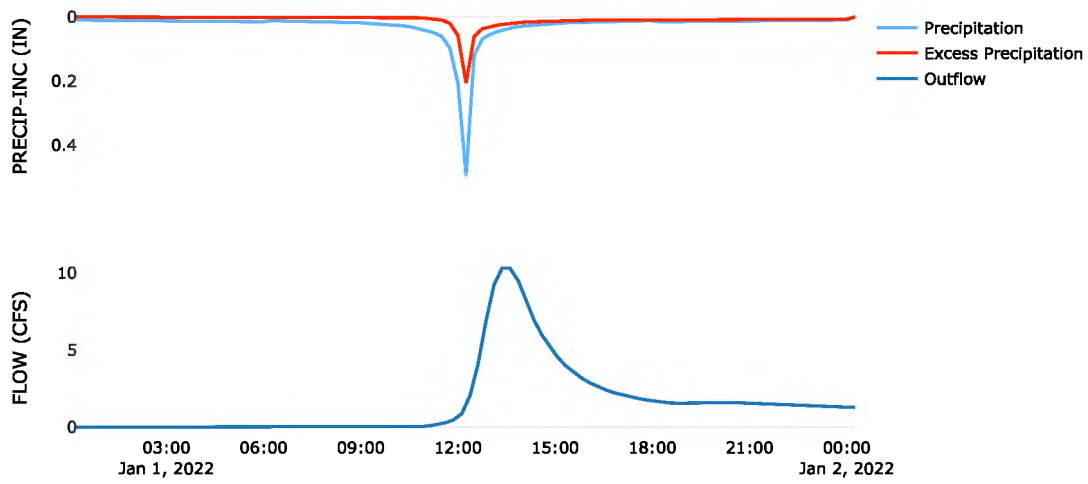
**Area (MI2)** : 0.07
**Downstream** : Junction - 1

| Loss Rate: Scs | |
|---|---|
| Percent Impervious Area | 0 |
| Curve Number | 79.2 |

| Transform: Scs | |
|---|---|
| Lag | 67 |
| Unitgraph Type | Standard |

| Results: Subbasin-3 | |
|---|---|
| Peak Discharge (CFS) | 10.31 |
| Time of Peak Discharge | 01Jan2022, 13:30 |
| Volume (IN) | 0.84 |
| Precipitation Volume (AC - FT) | 9.48 |
| Loss Volume (AC - FT) | 6.22 |
| Excess Volume (AC - FT) | 3.27 |
| Direct Runoff Volume (AC - FT) | 3.14 |
| Baseflow Volume (AC - FT) | 0 |

Precipitation and Outflow



# Reach: Combined Stream

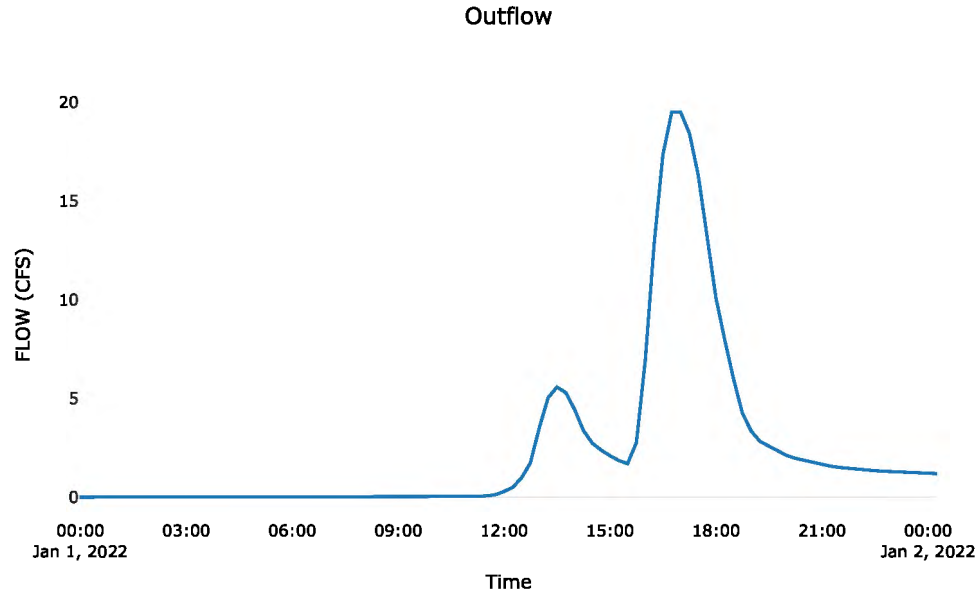
**Downstream** : Sink - 1

**Route: Muskingum Cunge**

| | |
|---|---|
| Method | Muskingum Cunge |
| Channel | Trapezoid |
| Length (FT) | 994 |
| Energy Slope (FT/FT) | 0.01 |
| Mannings n | 0.04 |
| Bottom Width (FT) | 32 |
| Side Slope (FT/FT) | 35 |
| Initial Variable | Combined Inflow |
| Space - Time Method | Automatic DX and DT |
| Index Parameter Type | Index Flow |
| Index Flow | 10 |
| Maximum Depth Iterations | 20 |
| Maximum Route Step Iterations | 30 |
| Channel Loss | Percolation |
| Channel Loss Percolation Rate | 5 |
| End Channel Loss | |

**Results: Combined Stream**

| | |
|---|---|
| Peak Discharge (CFS) | 19.5 |
| Time of Peak Discharge | 01Jan2022, 17:00 |
| Volume (IN) | 0.02 |
| Peak Inflow (CFS) | 26.3 |
| Inflow Volume (AC - FT) | 8.39 |



**Project:** Lockhart_Solar_Proposed_alt1
**Simulation Run:** 100-Year
**Simulation Start:** 31 December 2021, 24:00
**Simulation End:** 2 January 2022, 00:15

**HMS Version:** 4.10
**Executed:** 15 October 2022, 00:08

## Global Parameter Summary - Subbasin

**Area (MI2)**

| Element Name | Area (MI2) |
|---|---|
| Subbasin - 2 | 1.59 |
| Subbasin - 1 | 3.12 |
| Subbasin - 3 | 0.07 |

**Downstream**

| Element Name | Downstream |
|---|---|
| Subbasin - 2 | East Stream |
| Subbasin - 1 | West Stream |
| Subbasin - 3 | Junction - 1 |

**Loss Rate: Scs**

| Element Name | Percent Impervious Area | Curve Number |
|---|---|---|
| Subbasin - 2 | 0 | 79 |
| Subbasin - 1 | 0 | 79 |
| Subbasin - 3 | 0 | 79.2 |

**Transform: Scs**

| Element Name | Lag | Unitgraph Type |
|---|---|---|
| Subbasin - 2 | 132 | Standard |
| Subbasin - 1 | 149 | Standard |
| Subbasin - 3 | 67 | Standard |

## Global Parameter Summary - Reach

**Downstream**

| Element Name | Downstream |
|---|---|
| West Stream | Junction - 1 |
| East Stream | Junction - 1 |
| Combined Stream | Sink - 1 |

**Route: Muskingum Cunge**

| Element Name | Method | Channel | Length (FT) | Energy Slope (FT/FT) | Mannings n | Bottom Width (FT) | Side Slope (FT/FT) | Initial Variable | Space - Time Method | Index Parameter Type | Index Flow | Maximum Depth Iterations |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| West Stream | Muskingum Cunge | 5 | 18160 | 0.01 | 0.04 | 65 | 48 | Combined Inflow | Automatic DX and DT | Index Flow | 180 | 20 |
| East Stream | Muskingum Cunge | 5 | 18545 | 0.01 | 0.04 | 56 | 15 | Combined Inflow | Automatic DX and DT | Index Flow | 100 | 20 |
| Combined Stream | Muskingum Cunge | 5 | 994 | 0.01 | 0.04 | 32 | 35 | Combined Inflow | Automatic DX and DT | Index Flow | 10 | 20 |

## Global Results Summary

| Hydrologic Element | Drainage Area (MI2) | Peak Discharge (CFS) | Time of Peak | Volume (IN) |
|---|---|---|---|---|
| Subbasin - 2 | 1.59 | 199.75 | 01Jan2022, 14:30 | 1.02 |
| Subbasin - 1 | 3.12 | 360.16 | 01Jan2022, 15:00 | 1.01 |
| West Stream | 3.12 | 60.88 | 01Jan2022, 16:45 | 0.07 |
| East Stream | 1.59 | 37.52 | 01Jan2022, 16:00 | 0.07 |
| Subbasin - 3 | 0.07 | 13.79 | 01Jan2022, 13:15 | 1.09 |
| Junction - 1 | 4.78 | 95.84 | 01Jan2022, 16:30 | 0.08 |
| Combined Stream | 4.78 | 85.49 | 01Jan2022, 16:30 | 0.06 |
| Sink - 1 | 4.78 | 85.49 | 01Jan2022, 16:30 | 0.06 |

# Subbasin: Subbasin-2

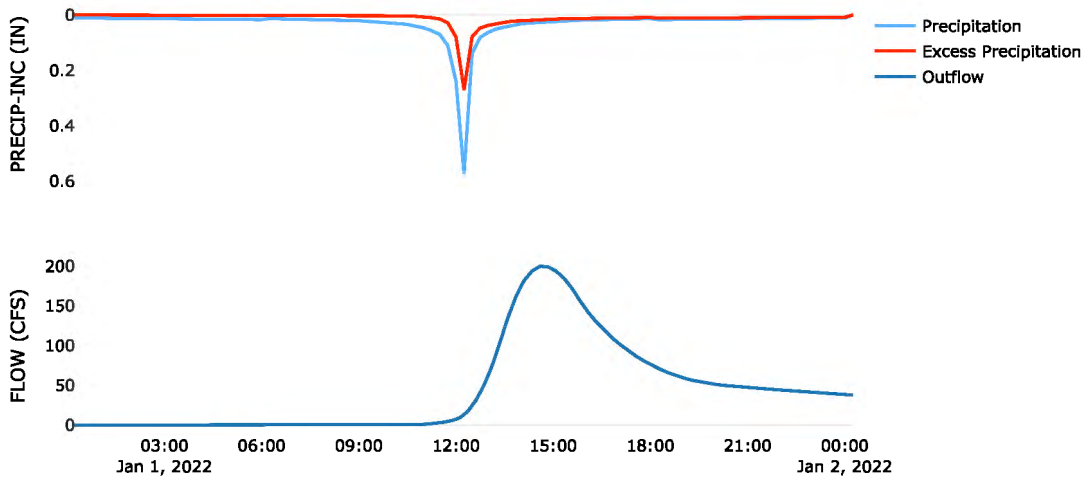
**Area (MI2)** : 1.59
**Downstream** : East Stream

| Loss Rate: Scs | |
|---|---|
| Percent Impervious Area | 0 |
| Curve Number | 79 |

| Transform: Scs | |
|---|---|
| Lag | 132 |
| Unitgraph Type | Standard |

| Results: Subbasin-2 | |
|---|---|
| Peak Discharge (CFS) | 199.75 |
| Time of Peak Discharge | 01Jan2022, 14:30 |
| Volume (IN) | 1.02 |
| Precipitation Volume (AC - FT) | 246.23 |
| Loss Volume (AC - FT) | 151.48 |
| Excess Volume (AC - FT) | 94.75 |
| Direct Runoff Volume (AC - FT) | 86.91 |
| Baseflow Volume (AC - FT) | 0 |

Precipitation and Outflow



# Subbasin: Subbasin-1

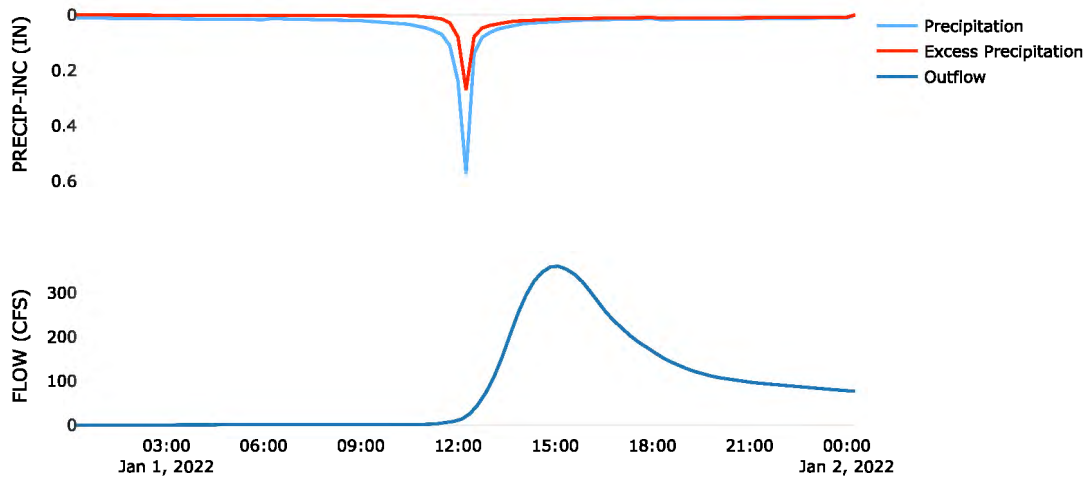
**Area (MI2)** : 3.12
**Downstream** : West Stream

| Loss Rate: Scs | |
|---|---|
| Percent Impervious Area | 0 |
| Curve Number | 79 |

| Transform: Scs | |
|---|---|
| Lag | 149 |
| Unitgraph Type | Standard |

| Results: Subbasin-1 | |
|---|---|
| Peak Discharge (CFS) | 360.16 |
| Time of Peak Discharge | 01Jan2022, 15:00 |
| Volume (IN) | 1.01 |
| Precipitation Volume (AC - FT) | 482.41 |
| Loss Volume (AC - FT) | 296.78 |
| Excess Volume (AC - FT) | 185.62 |
| Direct Runoff Volume (AC - FT) | 167.84 |
| Baseflow Volume (AC - FT) | 0 |

Precipitation and Outflow



# Reach: West Stream

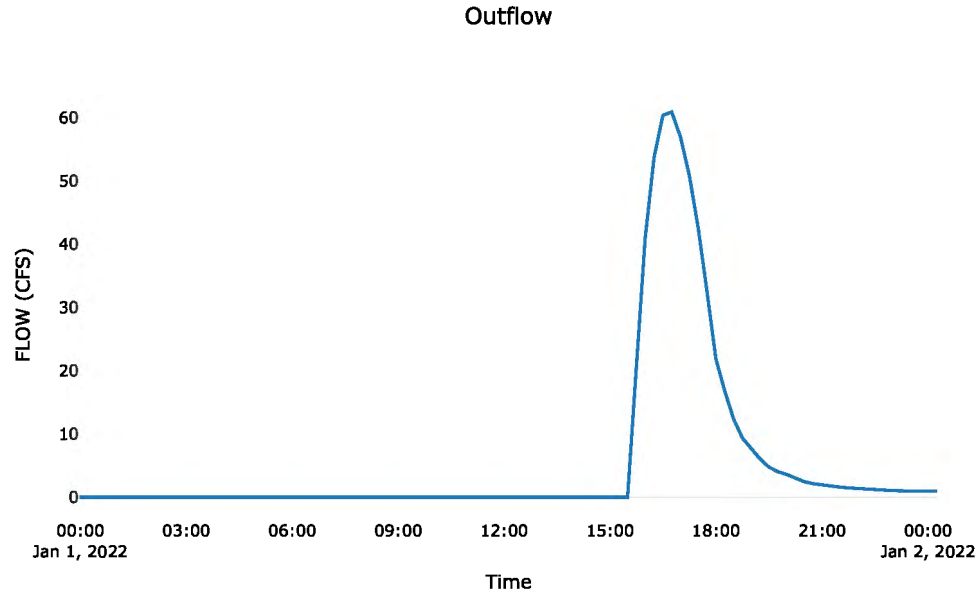
**Downstream** : Junction - 1

**Route: Muskingum Cunge**

| | |
|---|---|
| Method | Muskingum Cunge |
| Channel | Trapezoid |
| Length (FT) | 18160 |
| Energy Slope (FT/FT) | 0.01 |
| Mannings n | 0.04 |
| Bottom Width (FT) | 65 |
| Side Slope (FT/FT) | 48 |
| Initial Variable | Combined Inflow |
| Space - Time Method | Automatic DX and DT |
| Index Parameter Type | Index Flow |
| Index Flow | 180 |
| Maximum Depth Iterations | 20 |
| Maximum Route Step Iterations | 30 |
| Channel Loss | Percolation |
| Channel Loss Percolation Rate | 5 |
| End Channel Loss | |

**Results: West Stream**

| | |
|---|---|
| Peak Discharge (CFS) | 60.88 |
| Time of Peak Discharge | 01Jan2022, 16:45 |
| Volume (IN) | 0.07 |
| Peak Inflow (CFS) | 360.16 |
| Inflow Volume (AC - FT) | 167.84 |



# Reach: East Stream

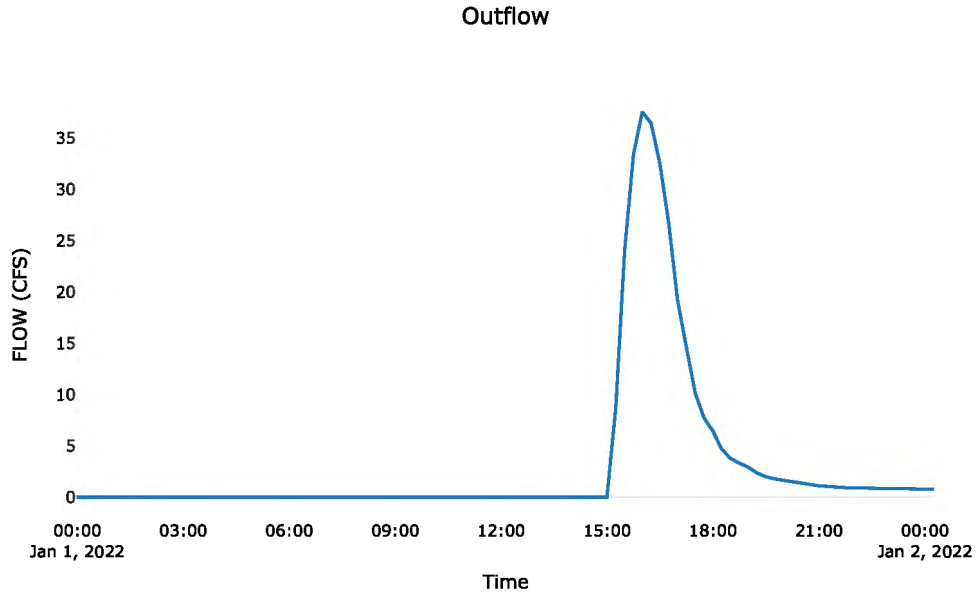
**Downstream** : Junction - 1

**Route: Muskingum Cunge**

| | |
|---|---|
| Method | Muskingum Cunge |
| Channel | Trapezoid |
| Length (FT) | 18545 |
| Energy Slope (FT/FT) | 0.01 |
| Mannings n | 0.04 |
| Bottom Width (FT) | 56 |
| Side Slope (FT/FT) | 15 |
| Initial Variable | Combined Inflow |
| Space - Time Method | Automatic DX and DT |
| Index Parameter Type | Index Flow |
| Index Flow | 100 |
| Maximum Depth Iterations | 20 |
| Maximum Route Step Iterations | 30 |
| Channel Loss | Percolation |
| Channel Loss Percolation Rate | 5 |
| End Channel Loss | |

**Results: East Stream**

| | |
|---|---|
| Peak Discharge (CFS) | 37.52 |
| Time of Peak Discharge | 01Jan2022, 16:00 |
| Volume (IN) | 0.07 |
| Peak Inflow (CFS) | 199.75 |
| Inflow Volume (AC - FT) | 86.91 |



# Subbasin: Subbasin-3

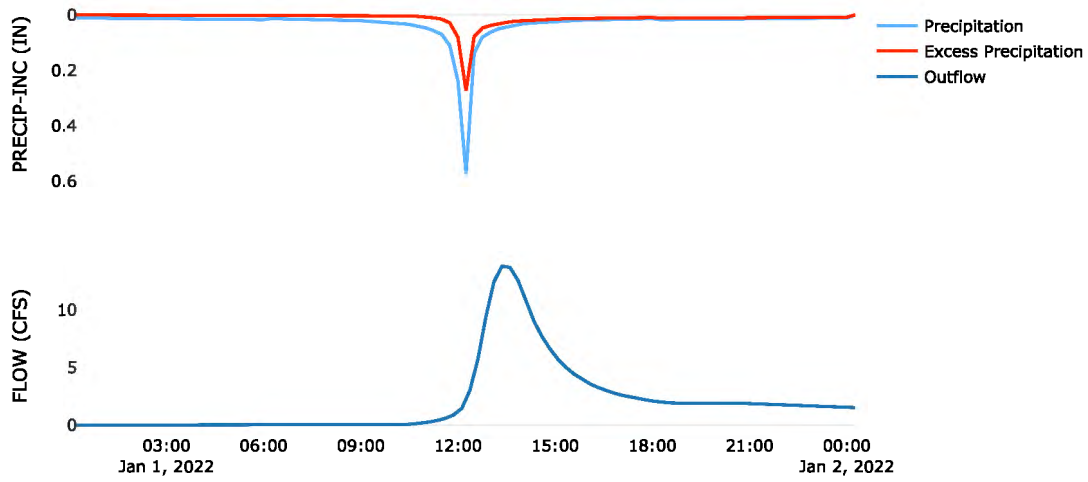
**Area (MI2)** : 0.07
**Downstream** : Junction - 1

| Loss Rate: Scs | |
|---|---|
| Percent Impervious Area | 0 |
| Curve Number | 79.2 |

| Transform: Scs | |
|---|---|
| Lag | 67 |
| Unitgraph Type | Standard |

| Results: Subbasin-3 | |
|---|---|
| Peak Discharge (CFS) | 13.79 |
| Time of Peak Discharge | 01Jan2022, 13:15 |
| Volume (IN) | 1.09 |
| Precipitation Volume (AC - FT) | 10.83 |
| Loss Volume (AC - FT) | 6.62 |
| Excess Volume (AC - FT) | 4.21 |
| Direct Runoff Volume (AC - FT) | 4.06 |
| Baseflow Volume (AC - FT) | 0 |

Precipitation and Outflow



# Reach: Combined Stream

**Downstream** : Sink - 1

**Route: Muskingum Cunge**

| | |
|---|---|
| Method | Muskingum Cunge |
| Channel | Trapezoid |
| Length (FT) | 994 |
| Energy Slope (FT/FT) | 0.01 |
| Mannings n | 0.04 |
| Bottom Width (FT) | 32 |
| Side Slope (FT/FT) | 35 |
| Initial Variable | Combined Inflow |
| Space - Time Method | Automatic DX and DT |
| Index Parameter Type | Index Flow |
| Index Flow | 10 |
| Maximum Depth Iterations | 20 |
| Maximum Route Step Iterations | 30 |
| Channel Loss | Percolation |
| Channel Loss Percolation Rate | 5 |
| End Channel Loss | |

**Results: Combined Stream**

| | |
|---|---|
| Peak Discharge (CFS) | 85.49 |
| Time of Peak Discharge | 01Jan2022, 16:30 |
| Volume (IN) | 0.06 |
| Peak Inflow (CFS) | 95.84 |
| Inflow Volume (AC - FT) | 21.13 |

