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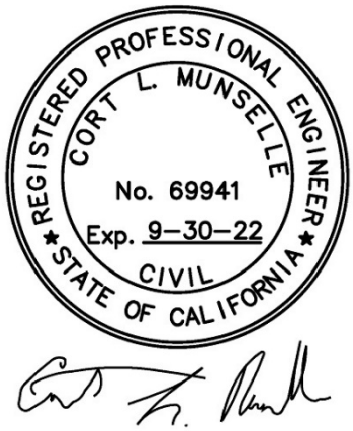
# DRAINAGE REPORT

## for

# ELK MOUNTAIN RESERVOIR

11502 Elk Mountain
Upper Lake, CA
APN 002-048-03

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Report Date: November 17, 2020

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## Project Narrative

The property proposed for reservoir development is located at 11501 Elk Mountain in Upper Lake California. The property consists primarily of open space, indigenous grasses/vegetation, and an existing orchard. The surrounding properties consist of orchards and residences. No tree removal is proposed. This project proposes to construct the following under this grading permit:

- Grading and drainage improvements for the construction of an agricultural reservoir.

The property is relatively flat and drains west to Middle Creek and east to a USGS Blue Line Stream. Within the areas proposed for development the average slope is 4.18%. During the 100-year storm event stormwater runoff from the reservoir is designed to outlet through the 18-in culvert and discharge into Middle Creek at non-erosive velocities. The proposed outlet structures hydrology and hydraulic analysis are located in Appendix A. Runoff enters Middle Creek where it continues along its existing drainage course to Clear Lake. USDA-Sonoma County Soil Survey maps the project area as 99.1% 158-Lupoyoma silt loam protected (Hydrologic soil group C), and 0.9% 199-River Wash.

The reservoir outlet structure was placed through the embankment of the reservoir. Velocities during large storm events are reduced by the rock outlet structure before letting into Middle Creek. The project civil engineer designed the outlet structure to ensure adequate capacity, and flow will be conveyed without erosive velocities that would be detrimental to the embankment. The proposed reservoir is designed to be filled by two onsite wells.

Drainage analysis is required to:

- Size the overflow outlet culvert for the 100-year storm events.
- Size the rock outlet to ensure runoff leaving the proposed drainage improvements will not have erosive flow velocities.

## Hydrologic Analysis Methodology and Assumptions

For the purposes of this drainage report, we used the Lake County Hydrology Design Standards as a guideline for estimating the runoff. The hydrology calculations are shown in Appendix A.

Review of the Lake County Hydrology Design Standards provides the following mathematical models and constant values used in the hydrologic analysis:

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| Description | Value | Source |
|---|---|---|
| Runoff Coefficient, Cv | 1.0<br>0.42 | Vegetated Area<br>Impervious Area<br>Table 1, Appendix A |
| Annual Precipitation, P | 45” | Figure 3, Appendix A |
| K-factor | 1.29 | Figure 3, Appendix A |
| 25-yr rainfall intensity | 1.8 in/hr | Figure 1 (Worst Case Scenario), Appendix A |
| 100-yr rainfall intensity | 2.2 in/hr | Figure 1 (Worst Case Scenario), Appendix A |
| Min. Time of concentration, Tc | 10 min | Worst Case Scenario |

## Hydraulic Analysis Methodology and Assumptions

### *Overflow Outlet Structure Calculations*

To ensure the overflow outlet structure has capacity during 100-year rain events Hydraflow Express Extensions for Autodesk was used to determine the required culvert size. Stormwater runoff during 100-year events and the flowrate from both onsite wells were used to size the outlet structure. Including the onsite wells flowrate results in a culvert that is conservatively sized. A channel analysis of the outlet structure and sizing of the riprap apron was prepared and is located in Appendix A. The riprap apron has adequate length and minimum d50 rock size to reduce flow velocity below the erosive threshold, before discharging into Middle Creek. Therefore, no erosion downstream of the riprap apron is anticipate

## Pre/Post Development Analysis

In accordance with the Lake County Grading Ordinance, the project has been designed to maintain off-site natural drainage patterns and limit post-development stormwater levels. Limiting post-development stormwater levels include maintaining the pre-project runoff quantities and minimizing pollutant discharges.

### *Runoff Quality*

There are several pollutants of concern for this project. Erosion is expected from grading activities and will be addressed by placing straw wattles along the bank, at the toe of the reservoir embankment, and by seeding and strawing all disturbed areas. Additionally, most of the stormwater will be directed into the reservoir which acts as a natural sediment basin.

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### *Runoff Quantity*

The runoff quantity will not increase due to the proposed reservoir since there would be an increase in water capture. Therefore, the surrounding water bodies will not be impacted.

## Conclusion

Drainage calculations demonstrate that the proposed outlet structure has been designed with sufficient capacity to convey the 100-year storm event. The reservoir is designed to be filled by both onsite wells, and only during large storm events will surface runoff from the pond overtop the overflow spillway. The quantity of stormwater runoff from the site will not increase, and the stormwater should not be impaired.

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# Appendix A

Hydrology Calculations, Hydraulic Reports

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# POST-CONSTRUCTION HYDROLOGY

Date: 11/17/2020

Job Name: Elk Mountain Reservoir

Job # 143-20

| | | | |
|---|---|---|---|
| Average Annual Precipitation: | 45 " | k factor: | 1.286 |
| Water Surface Impervious Area C-Value (Cp): | 1.00 | Vegetated Area C-Value (Cv): | 0.42 |

| Tributary ID | Impervious Surface Area (sf) | Pervious Surface Area (sf) | Total Area (sf) | Total Area (ac.) | Composite C-Value | CxA | Tc (min.) | i25 | i100 | Q25 | Q100 (CFS) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 63211 | 0 | 63211 | 1.45 | 1.00 | 1.45 | 5 | 2.40 | 2.93 | 4.48 | 5.46 |

| WELLS DISCHARGING INTO RESERVOIR | | Well Flowrate (GPM) | Q100 (CFS) |
|---|---|---|---|
| Well-1 | | 250 | 0.56 |
| Well-2 | | 500 | 1.11 |
| Total | | | 7.13 |

# HYDRAULIC INPUT PARAMETERS

Date: 11/17/2020

Job Name: Elk Mountain Reservoir

Job # 143-20

| Mannings "n" Value Table | |
|---|---|
| Description | n value |
| Concrete, steel trowled or smooth-form finish | 0.013 |
| Concrete pipe, precast or cast-in-place | 0.014 |
| Concrete, wood float or broomed finish | 0.015 |
| Asphaltic Concrete | 0.017 |
| Corrugated metal pipe (non-spiral) | 0.024 |
| Grouted rock riprap | 0.030 |
| Loose rock riprap | 0.035 |
| Grassed Channels | 0.035 |
| Plastic Pipe | 0.012 |
| Mannings "n" Values are based on Sonoma County Water Agency's Flood Design Criteria. | |

**Worst-Case Drainage Feature Calculations**

| Drainage Feature ID | Worst Case Scenario | n-value | Slope | Tribs Contributing to Flow | Q10 (cfs) | Q100 (cfs) |
|---|---|---|---|---|---|---|
| Overflow Outlet Culvert | Largest Flow and Smallest Slope | 0.012 | 2.0% | Trib 1 | - | 7.13 |

# Channel Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. Tuesday, Nov 17 2020

## 100-YEAR CLOSED CONDUIT- OVERFLOW STRUCTURE

**Circular**

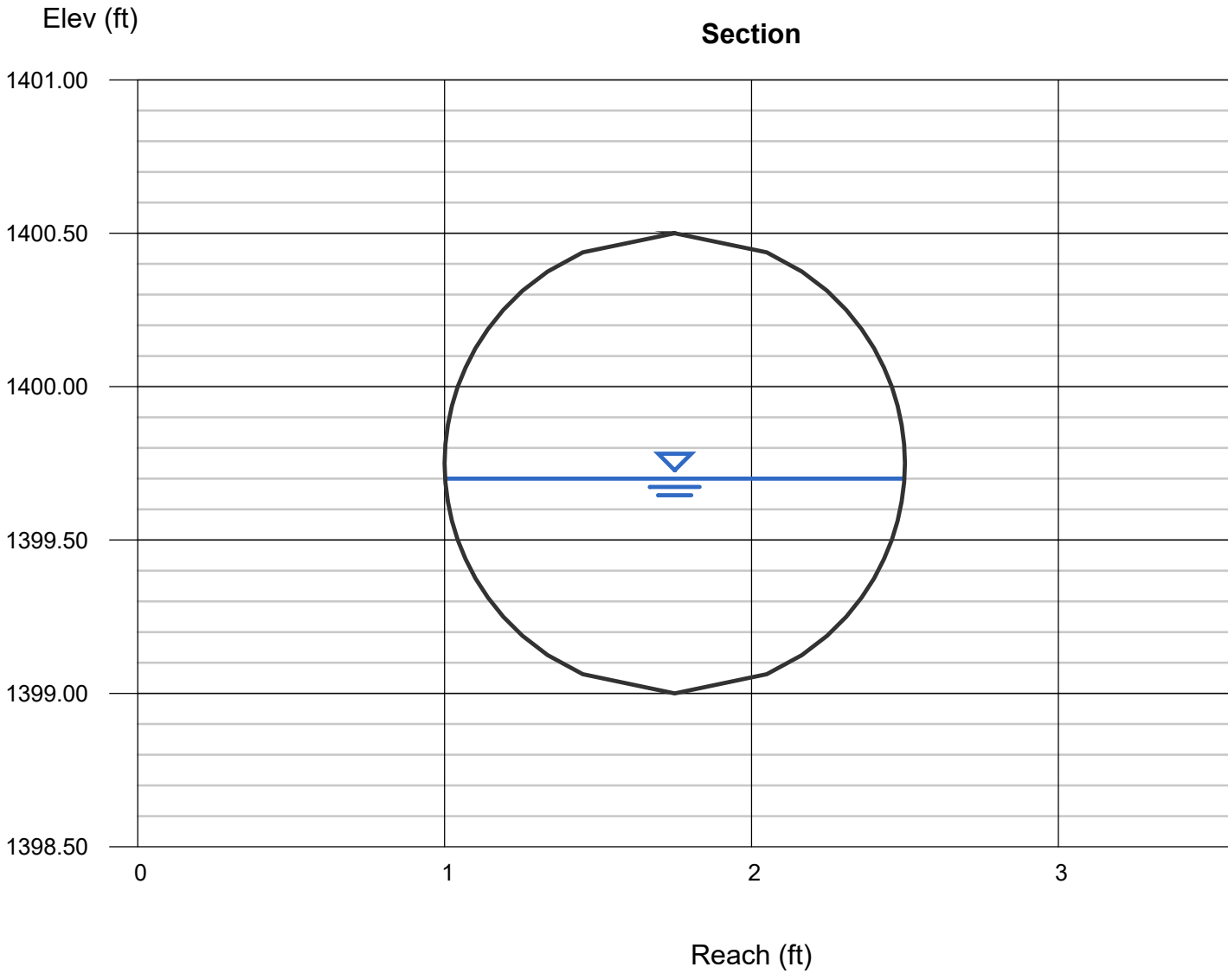
| | |
|---|---|
| Diameter (ft) | = 1.50 |
| Invert Elev (ft) | = 1399.00 |
| Slope (%) | = 2.00 |
| N-Value | = 0.012 |

**Calculations**

| | |
|---|---|
| Compute by: | Known Q |
| Known Q (cfs) | = 7.13 |

**Highlighted**

| | |
|---|---|
| Depth (ft) | = 0.70 |
| Q (cfs) | = 7.130 |
| Area (sqft) | = 0.81 |
| Velocity (ft/s) | = 8.81 |
| Wetted Perim (ft) | = 2.26 |
| Crit Depth, Yc (ft) | = 1.04 |
| Top Width (ft) | = 1.50 |
| EGL (ft) | = 1.91 |



# RIPRAP APRON SIZING

Date: 11/17/2020

Job Name: Elk Mountain Reservoir

Job # 143-20

detail for sizing riprap aprons (see Section 10.2). Q, D, TW, and Critical Depth were determined from the hydraulic calculations.

$$D_{50} = 0.2\,D\left(\frac{Q}{\sqrt{g}D^{2.5}}\right)^{4/3}\left(\frac{D}{TW}\right) \qquad (10.4)$$

where,

- $D_{50}$ = riprap size, m (ft)
- Q = design discharge, $m^3/s$ ($ft^3/s$)
- D = culvert diameter (circular), m (ft)
- TW = tailwater depth, m (ft)
- g = acceleration due to gravity, 9.81 $m/s^2$ (32.2 $ft/s^2$)

Tailwater depth for Equation 10.4 should be limited to between 0.4D and 1.0D. If tailwater is unknown, use 0.4D.

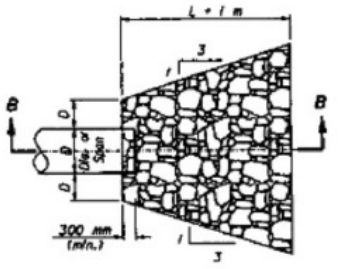
Whenever the flow is supercritical in the culvert, the culvert diameter is adjusted as follows:

$$D' = \frac{D + y_n}{2} \qquad (10.5)$$

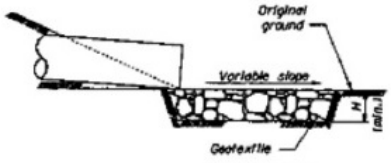
where,

- D' = adjusted culvert rise, m (ft)
- $y_n$ = normal (supercritical) depth in the culvert, m (ft)

Equation 10.4 assumes that the rock specific gravity is 2.65. If the actual specific gravity differs significantly from this value, the $D_{50}$ should be adjusted inversely to specific gravity.



PLAN VIEW



SECTION B-B

CULVERT WITHOUT STANDARD END SECTION

**Table 10.1. Example Riprap Classes and Apron Dimensions**

| Class | $D_{50}$ (mm) | $D_{50}$ (in) | Apron Length[1] | Apron Depth |
|---|---|---|---|---|
| 1 | 125 | 5 | 4D | $3.5D_{50}$ |
| 2 | 150 | 6 | 4D | $3.3D_{50}$ |
| 3 | 250 | 10 | 5D | $2.4D_{50}$ |
| 4 | 350 | 14 | 6D | $2.2D_{50}$ |
| 5 | 500 | 20 | 7D | $2.0D_{50}$ |
| 6 | 550 | 22 | 8D | $2.0D_{50}$ |

[1]D is the culvert rise.

| Outlet ID | Actual Pipe Diameter (ft.) | Q (cfs) | TW (ft.) | Critical Depth (ft.) | Calculated D50 (ft.) | Calculated D50 (in.) | Actual D50 Used (in.) | Minimum Riprap Class* | Apron Length (L) (ft.) | Total Apron Length (L+3') (ft.) | Apron Width (ft) | Apron Depth (in) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1.50 | 7.36 | 1.13 | 1.05 | 0.15 | 1.7 | 6 | 2 | 6.0 | 9.0 | 11.0 | 20 |

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# Appendix B

Lake County Hydrology Design Standards Tables and Figures

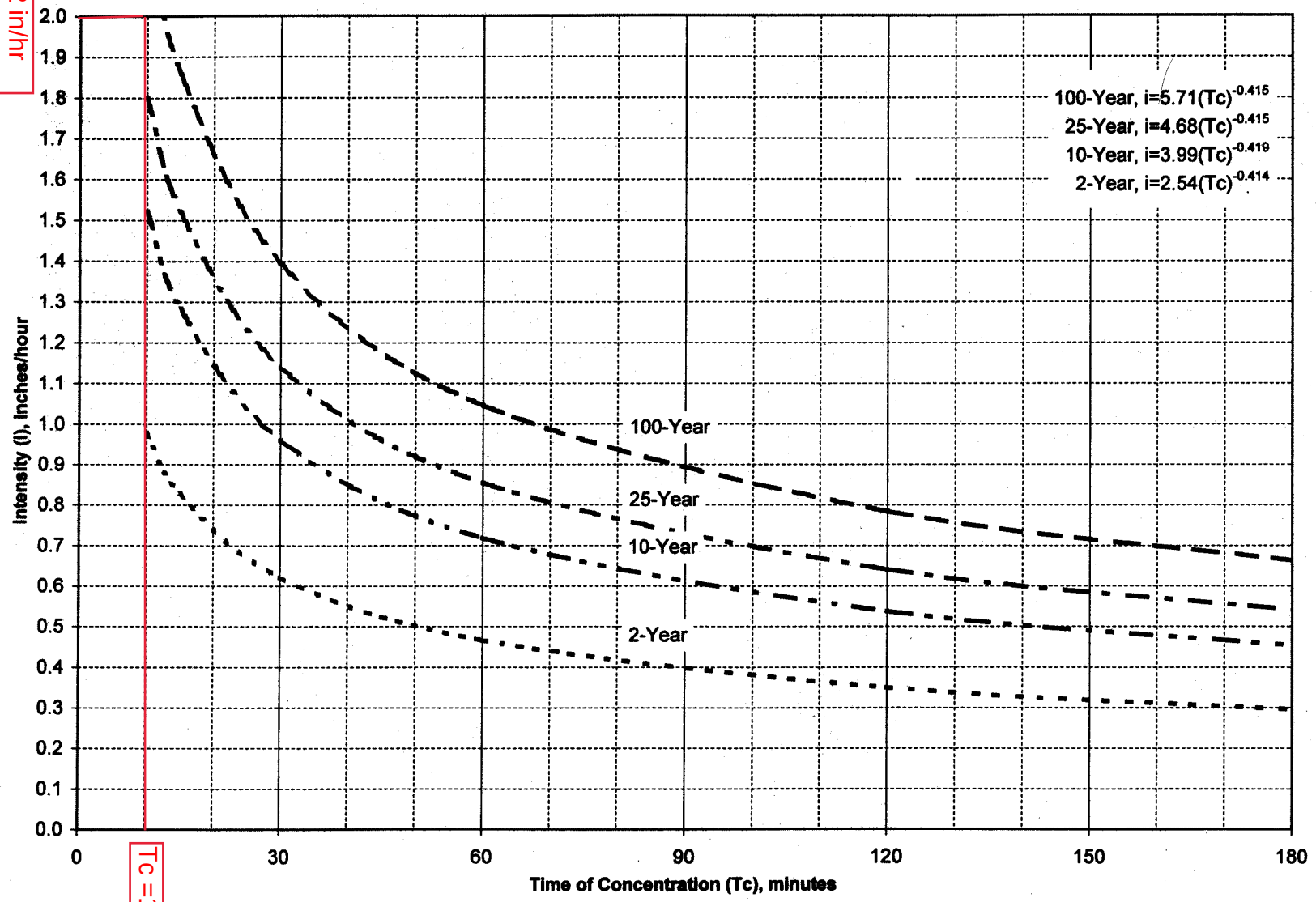



Figure 1: Rainfall D ation-Intensity Curves

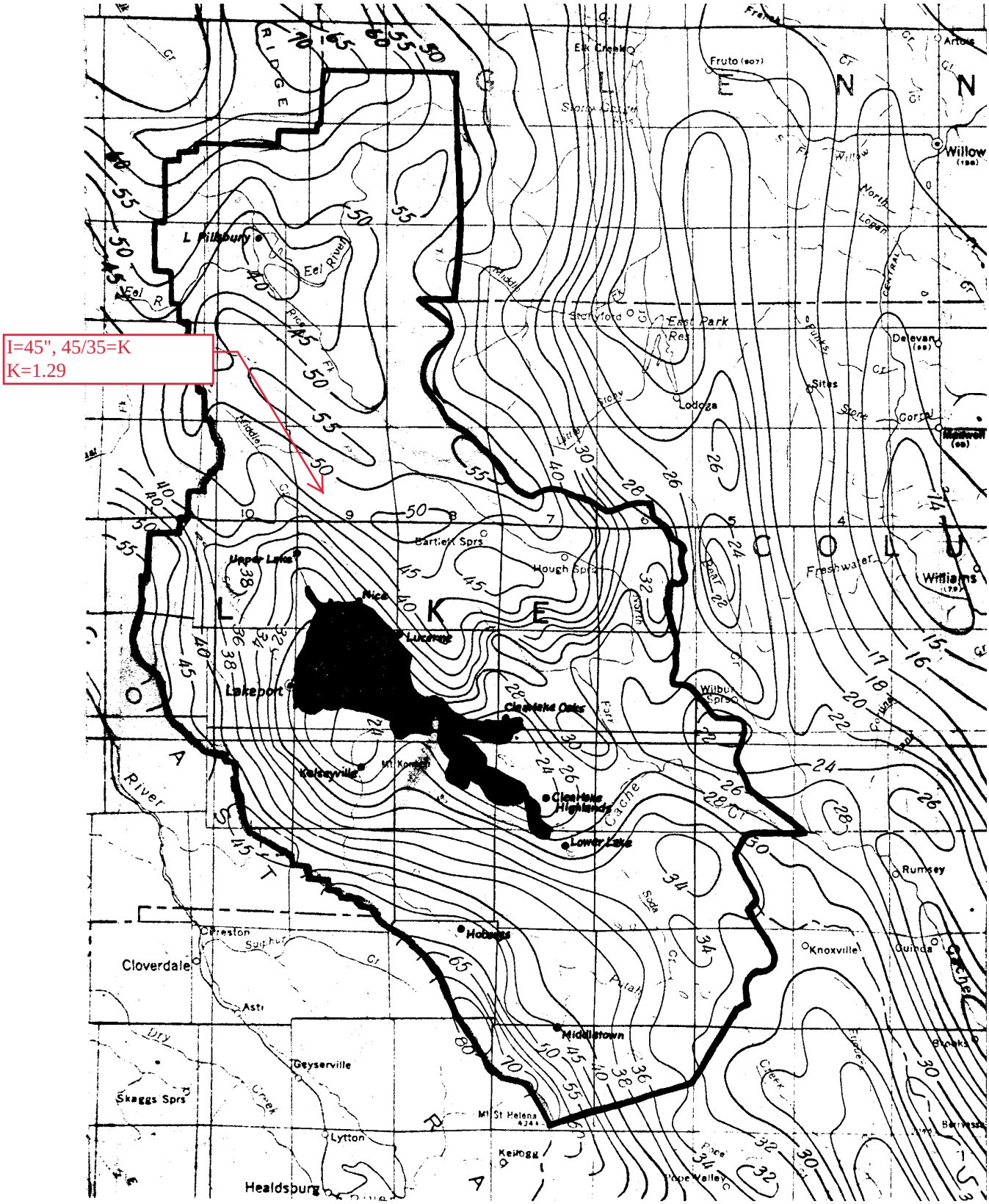
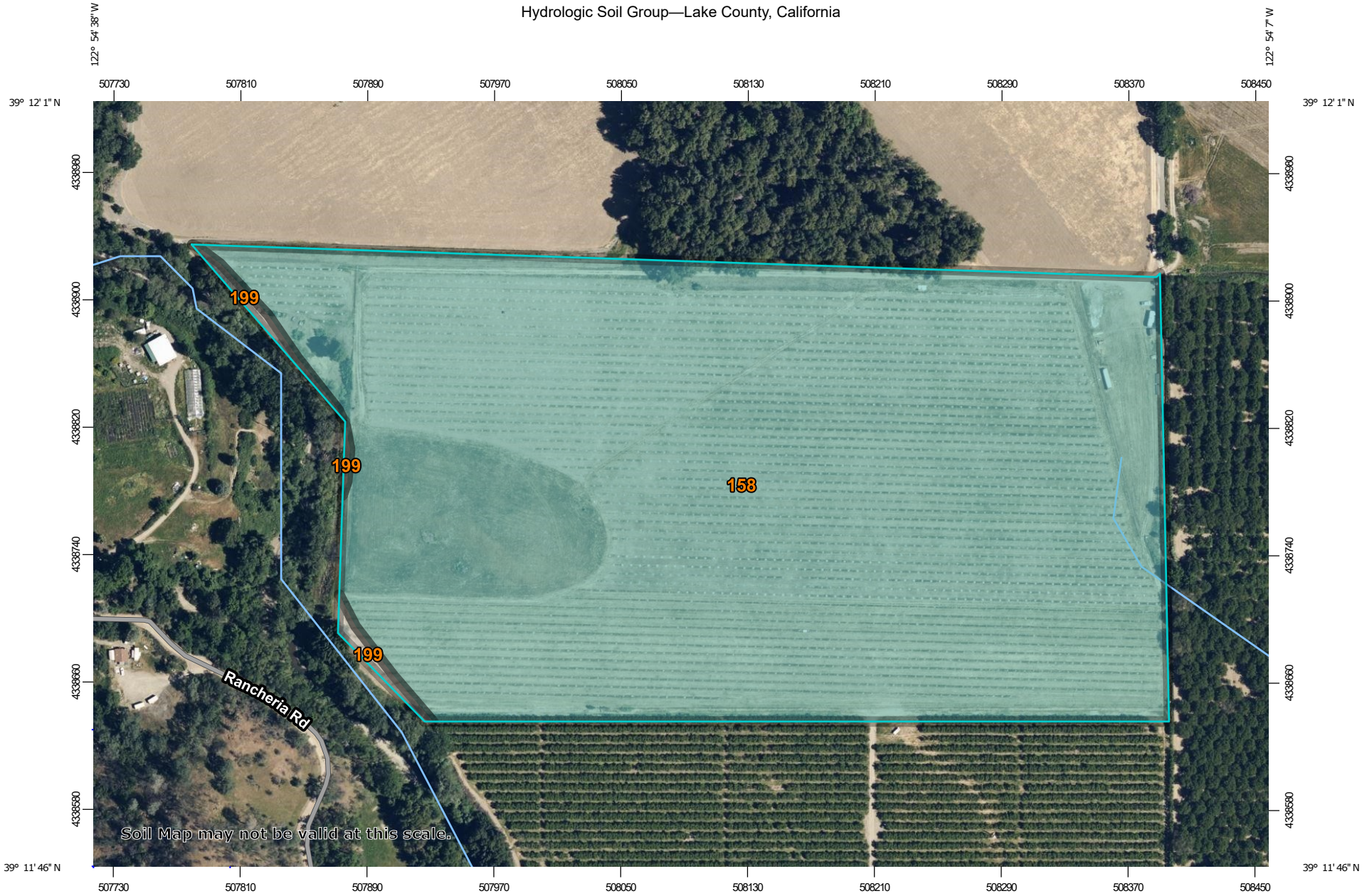



Figure 3: Average Annual Precipitation for Lake County

From: Calif. Department of Water Resources, Lines of Average Yearly Precipitation in the Central Valley, April 1966




Map Scale: 1:3,390 if printed on A landscape (11" x 8.5") sheet.

N

Meters: 0 50 100 200 300

Feet: 0 150 300 600 900

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 10N WGS84

## MAP LEGEND

**Area of Interest (AOI)**

Area of Interest (AOI)

**Soils**

**Soil Rating Polygons**

A

A/D

B

B/D

C

C/D

D

Not rated or not available

**Soil Rating Lines**

A

A/D

B

B/D

C

C/D

D

Not rated or not available

**Soil Rating Points**

A

A/D

B

B/D

C

C/D

D

Not rated or not available

**Water Features**

Streams and Canals

**Transportation**

Rails

Interstate Highways

US Routes

Major Roads

Local Roads

**Background**

Aerial Photography

## MAP INFORMATION

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

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

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

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

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

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

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

Soil Survey Area: Lake County, California
Survey Area Data: Version 17, Jun 1, 2020

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

Date(s) aerial images were photographed: May 8, 2019—May 10, 2019

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

# Hydrologic Soil Group

| Map unit symbol | Map unit name | Rating | Acres in AOI | Percent of AOI |
|---|---|---|---|---|
| 158 | Lupoyoma silt loam, protected | C | 37.6 | 99.1% |
| 199 | Riverwash | | 0.4 | 0.9% |
| **Totals for Area of Interest** | | | **38.0** | **100.0%** |

## Description

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

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

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

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

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

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

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

## Rating Options

*Aggregation Method:* Dominant Condition

*Component Percent Cutoff: None Specified*

*Tie-break Rule:* Higher

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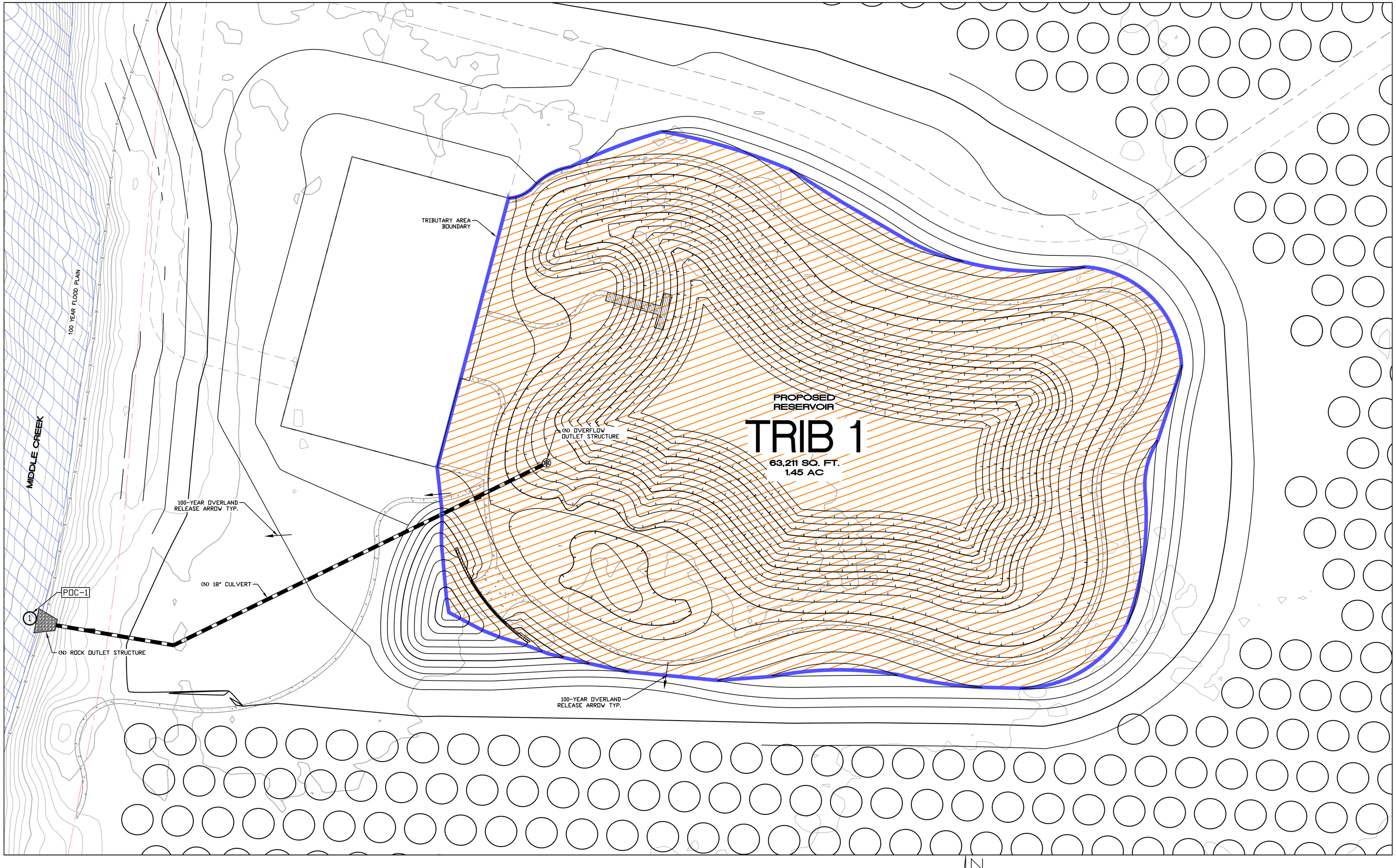
# Appendix C

Hydrology Map




## LEGEND

POC-X ① — POINT OF CONCENTRATION

TRIBUTARY BOUNDARY

IMPERVIOUS SURFACE/EXTENTS OF RESERVOIR LINER

*NOTE:*

1. SEE SHEET C3 AND C5 FOR OVERFLOW SPILLWAY SECTIONS AND DETAILS.

## HYDROLOGY AND HYDRAULIC CAPACITY MAP

SCALE: 1" = 20'

0 20 40 60

(GRAPHIC SCALE IN FEET)

N W E S

P:\MCE JOBS\2020\143-20 11501 ELK MOUNTAIN RD\DWGS\143-20 HYDRO_1_13503_5C008C02.SV8.DWG 11/17/2020 3:55 PM WE

| REVISION | DESCRIPTION | BY | DATE |
|---|---|---|---|
| | | | |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REGISTERED PROFESSIONAL ENGINEER * CORT L. MUNSELLE * No. 69941 Exp. 9-30-22 CIVIL * STATE OF CALIFORNIA

CORT L. MUNSELLE DATE
RCE 69941

# ELK MOUNTAIN RESERVOIR
## POST-CONSTRUCTION HYDROLOGY MAP

APN 002-048-03
11501 ELK MOUNTAIN
UPPER LAKE, CA 95485

11/17/2020

JOB NO.
143-20

SHEET NO.
H1
OF 1 SHEETS