

RUMSEY RANCHERIA FLOOD INUNDATION

Eric W. Larsen

2008

Technical Memorandum

Prepared for

James Zanetto, Architect & Planner
2459 Creekhollow Ln
Davis, CA 95616

and

Rumsey Indian Rancheria
of Wintun Indians
P.O. Box 18
Brooks, CA 95606

Prepared by

Eric W. Larsen
Landscape Architecture Program
Department of Environmental Design
University of California
Davis, California

Contents

Executive Summary	4
Introduction.....	5
Methods.....	5
Site description.....	5
Flood inundation mapping	7
Input data for HEC GeoRAS and HEC RAS.....	7
Aerial photography	7
Digital terrain model.....	7
Landuse map	7
Flow data.....	7
Results.....	8
Discussion.....	14
Appendices.....	15
Appendix 1 Land use categories and Manning n values.....	15
Appendix 2 Calibration of HEC-RAS model	16
Adjusting cross sections with USGS data.....	16
Appendix 3 Flood inundation maps	18
100-year	18
200-year	20
500-year	22

List of figures

Figure 1 Rumsey Indian Rancheria extent of modeled project.....	6
Figure 2 Recurrence interval graph for flows up to 100 cfs (Kamman Hydrology and Engineering).....	8
Figure 3 Flood inundation maps for the 5-, 100-, 200-, and 50- year recurrence interval flows (transparent overlay map colors appear distorted).....	10
Figure 4 Flood inundation maps (close up) for the study flows (transparent overlay map colors appear distorted).....	11
Figure 5 Flood inundation map 100 and 500 year recurrence interval flows compared (transparent overlay map colors appear distorted).....	12
Figure 6 USGS 1984 cross section number 12 used for model calibration	16
Figure 7 HEC-RAS cross section number 3288 used for model calibration	16
Figure 8 USGS 1984 cross section number 13 used for model calibration	17
Figure 9 HEC-RAS cross section number 8136 used for model calibration	17
Figure 10 USGS 1984 cross section number 14 used for model calibration	17
Figure 11 HEC-RAS cross section number 9673 used for model calibration	17
Figure 12 100-year flood inundation level in the vicinity of the Rancheria.....	18
Figure 13 100-year flood inundation level in the vicinity of the Rancheria.....	19
Figure 14 200-year flood inundation level in the vicinity of the Rancheria.....	20
Figure 15 200-year flood inundation level (close up) in the vicinity of the Rancheria	21
Figure 16 500-year flood inundation level close up of the Rancheria.....	22
Figure 17 500-year flood inundation level close up of the Rancheria.....	23

List of tables

Table 1 Flood flow discharges used in the study.....	8
Table 2 Water surface elevations of flood flows in the vicinity of the Rancheria.....	13
Table 3 Average difference in flood levels near the Rancheria.....	14
Table 4 Land use categories and Manning n values	15
Table 5 Calibration data for the water surface elevations at the calibrated cross sections	16

Executive Summary

Hydraulic modeling was used to determine the extent of flood water inundation in the vicinity of the Rumsey Indian Rancheria near Cache Creek. HEC-RAS (Hydrologic Engineering Center River Analysis System) and HEC GeoRAS (used with ArcGIS software) hydraulic models were used to estimate the areal extent of the 100-, 200-, and 500-year recurrence interval flooding. This report documents the data used, the calibration, and provides maps of the extent of the water for the chosen floods.

The model was calibrated using water surface elevations from USGS (United States Geological Survey) cross sections which show the water surface elevation at 26,000 cfs, which is approximately the 5-year recurrence interval flow. The 100-, 200-, and 500-year flood levels were then estimated based on the calibrated model. The extent of flooding for the 100-, 200-, and 500-year flood levels is very similar, with a large percentage of the Rancheria being inundated by all of these flows. The inundation patterns are similar because the flows, as estimated by the US Army Corps of Engineers, are relatively similar. Because the differences between 100- and 500-year inundations are relatively small, one could estimate that any variance due to different calibrations might be small, and that the levels of flooding can be used to consider land use planning at the Rancheria. For comparison purposes, the 50-year recurrence interval flow was also modeled. The difference in water surface elevations near the Rancheria buildings between flows (comparing 50 to 100, 100 to 200, and 200 to 500) was less than 6 inches for each interval. Because of the small difference in water surface elevations between flood events, it is expected that the level of uncertainty in modeling would not make a large difference in water surface elevations for planning purposes at the Rancheria.

Introduction

Rumsey Rancheria is interested in considering flood levels in considering building design and construction. Cache Creek is located adjacent to the Rancheria property. Some of the buildings and surrounding areas lie within the potential flood-prone areas of the Rancheria property. The Rumsey Indian Tribe working with architect Jim Zanetto requires flood inundation levels in order to consider existing and design floor surface elevations for structures.

HEC-RAS used in conjunction with HEC GeoRAS is a US Army Corps of Engineers hydraulic model that allows one to model the flow of water in a river, and to estimate the extent of overbank flooding in flood events. The model can be used with best engineering judgment without calibration, or can be calibrated to known flows. In the case of the current modeling, calibration was done with data from 1984 cross sections which show the water surface elevation at a flow of 26,000 cfs, which is approximately a 5-year recurrence interval flow. There was reasonable agreement between observed 26,000 flows and modeled 26,000 flows.

Based on the calibrated values in the HEC-RAS program, estimations were made for the 100-, 200-, and 500-year recurrence interval flows, and flood inundation maps were prepared for each flow, as well as maps which showed comparisons between the flows. In addition, a table of water surface elevations near the Rancheria was prepared for the various floods.

Methods

Site description

The Rumsey Rancheria is located on Cache Creek in Yolo County, upstream from the Capay Diversion Dam. Figure 1 shows the site of the modeling with the extent of the digital terrain model (DTM) and hydraulic model shown in red.



Figure 1 Rumsey Indian Rancheria extent of modeled project

Flood inundation mapping

Flood inundation mapping requires that the flow of runoff water be modeled to understand what elevations the water surface reaches in floods of different magnitudes. The standard method for modeling those flows is the US Army Corps of Engineers (USACOE) HEC-RAS¹ hydrologic model. HEC-RAS uses mathematical modeling of river flow and known calibration data to predict the level of water that various flood events will reach.

HEC-RAS predicts the water surface elevation that will fill chosen cross sections, which are located across the landscape. In order to extend this information to a 2-dimensional area, HEC GeoRAS is an add-on to ArcGIS that allows areas of flood inundation to be delineated.

Input data for HEC GeoRAS and HEC RAS

Aerial photography

The area of concern is visualized using digitized and ortho-rectified aerial photography. These aerial photos are also used, in conjunction with the digital terrain model (DTM) to draw the centerline of the channel and the location of the channel cross sections. Two aerial photos were used for these purposes, a 2005 photo, with complete coverage, and a set of 2007 photos, which were used for digitization, but not for visualization, because some of the areas were missing.

Digital terrain model

A digital terrain model was used, which was developed from LIDAR² data that was gathered in 2007.³

Landuse map

A Geographic Information System (GIS) coverage of vegetation type along Cache Creek⁴ was used to determine the land use in the vicinity of the Rancheria. Each land use type was assigned a Manning roughness coefficient for the purposes of modeling the flows. The HEC-RAS model was calibrated so that the observed water surface elevations matched the modeled water surface elevations at 26,000 cfs. The roughness coefficients required for that calibration are shown in Appendix 1 Land use categories and Manning n values). The Manning n values in Appendix 1 are calibrated values that not only relate to the specified land use, but also incorporate other factors that constitute the calibration.

Flow data

Flow data are available for Cache Creek from the *Technical Studies and Recommendations for the Lower Cache Creek Resource Management Plan*⁵, which summarize various studies that have been done to establish a flood recurrence interval analysis. Values used in the modeling were taken from the US Army Corps of Engineers flood recurrence interval analysis reported in the *Technical Report*. Figure 2 shows the recurrence interval analysis up to the 100-year flood as summarized by Kamman Engineering and Technology. Table 1 shows the discharge values used

¹ Hydrologic Engineering Center River Analysis System

² LIDAR = Light Detection and Ranging

³ Kamman Hydrology and Engineering. Greg Kammon and Shawn Higgins, pers. Com 2009.

⁴ KHE, 2009.

⁵ October, 1995, EIP Associates, Northwest Hydraulic Consultants, and David Todd, Consulting Engineers.

in this study. This table also shows a comparison of the relative magnitude of the flood discharges as a percentage of the 100-year flow.

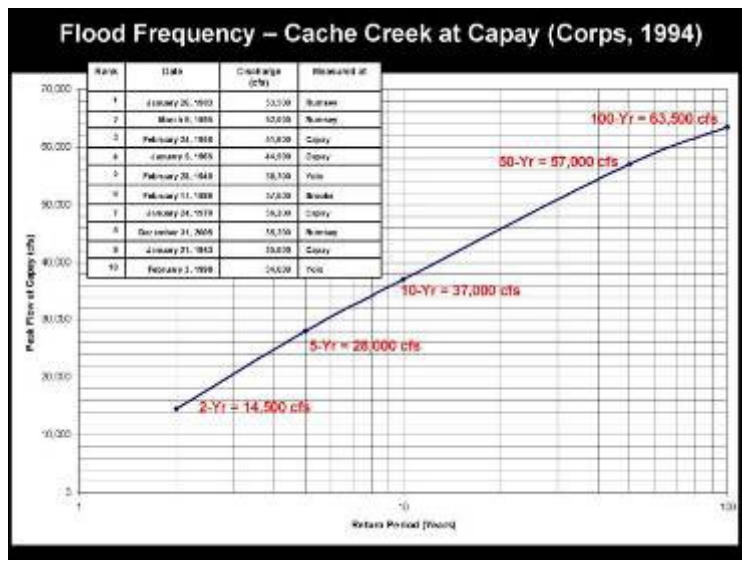


Figure 2 Recurrence interval graph for flows up to 100 cfs (Kamman Hydrology and Engineering)

Recurrence interval	Discharge (cfs)	Percentage of 100-yr flow	Notes
5	28,000	44%	From KHE/USACOE
50	57,000	90%	From KHE/USACOE
100	63,500	100%	From KHE/USACOE
200	69,000	109%	Estimate (this study)
500	75,000	118%	From table 6 ⁶ Rumsey gage

Table 1 Flood flow discharges used in the study

Results

Based on the HEC-RAS flow modeling, the flood inundation maps were prepared for the chosen flows. Figure 3 and Figure 4 show the flood inundation maps for the 5-, 100-, 200-, and 500-year

⁶ Cache Creek Technical Studies, section 6, Hydrology

recurrence interval flows. The colored areas represent the areas inundated at the specified flows.

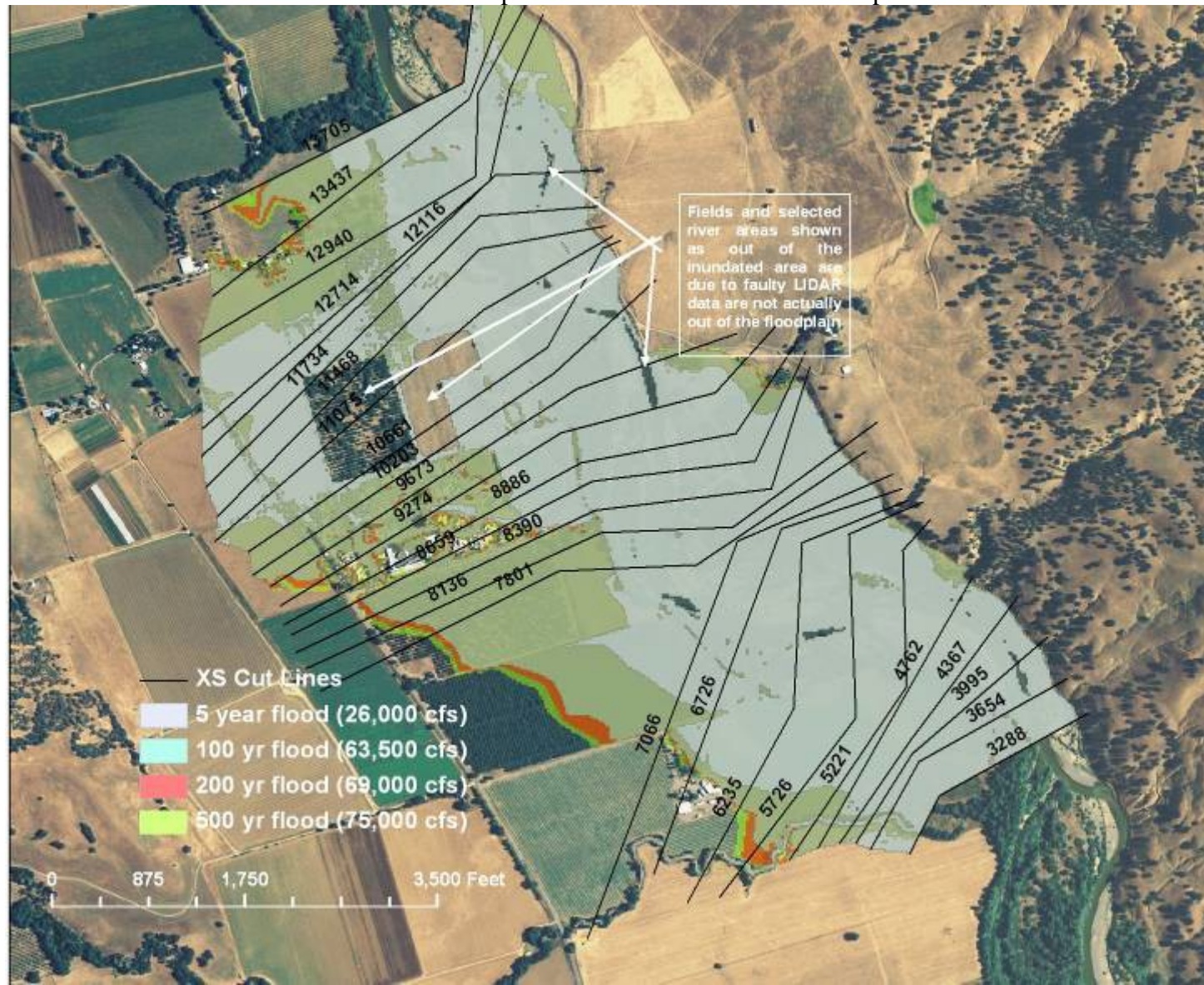


Figure 3 shows that the 100-, 200-, and 500-year flows inundate most of the Rancheria property, with certain buildings perched out of the floodplain. The 5-year flow, which was used for calibration, does not inundate the Rancheria where the buildings are located. The black lines in the two figures are cross section “cut lines”, which are the location of the cross section profiles that were used in the HEC-RAS modeling.

Note that in the maps there are some areas that are shown as not in the flood areas that are, in fact, in the flood zones. This discrepancy is due to flaws in the original LIDAR data that failed to map certain areas. All of the areas where this occurs are not critical to flood evaluation at the Rancheria. The two rectangular fields that are located north of the Rancheria building properties and certain small areas in the channel of Cache Creek are shown on the maps as if they are out of the flood zones. This is not the case, but is the result of the faulty LIDAR data. Note also that the colors on the maps appear distorted. This is because the flood maps are shown as transparent

overlays. As the separate maps overlay each other, the original color is distorted, but the legends cannot reflect this fact.

Figure 4 shows the same inundation mapping in a close up view that shows the building area of the Rancheria. There are select buildings that are not inundated, even at the 500-year flood. The figure shows areas in light green that are inundated at the 200-year flow and in red that are inundated at the 100-year flow. Although there are slight differences in the patterns, the difference in the extent of inundation is slight. This is because the discharges for the various flood levels do not differ to a large extent. Table 1 shows that the difference between the 100-year flow and the 500-year flow is only 18%.

Table 2 gives the water surface elevations for the cross sections on the maps. The water surface elevations are tabulated in two different geographic datum references, North American Datum (NAD) 83 and NAD 27. The original analysis was done in the NAD 83 datum, and the results were then also tabulated in the NAD 27 datum because the Rancheria property surveys are done in the NAD 27 datum.

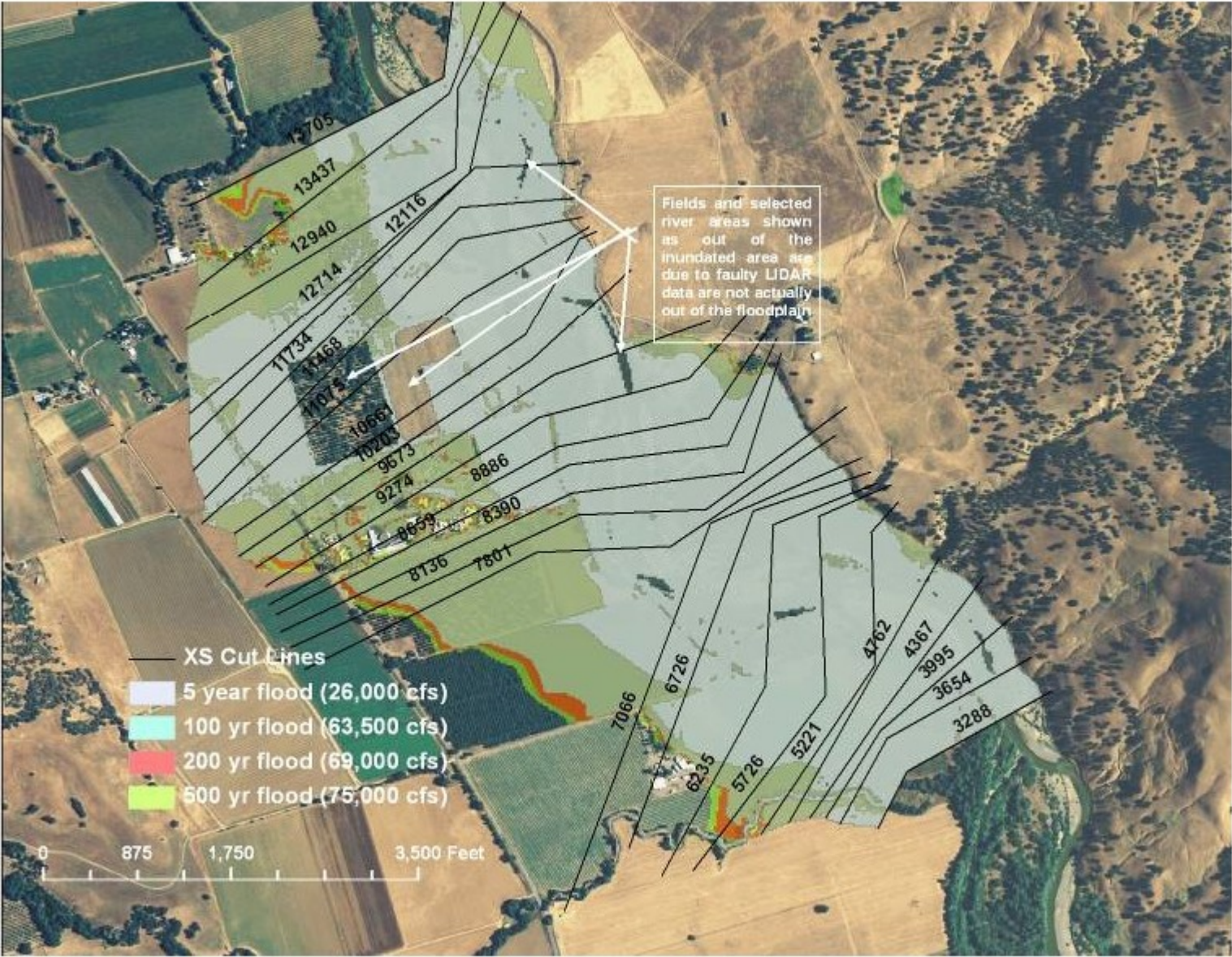


Figure 3 Flood inundation maps for the 5-, 100-, 200-, and 50-year return inter<al &w<s (trarparenl o<erhy map <olors appear distorted)

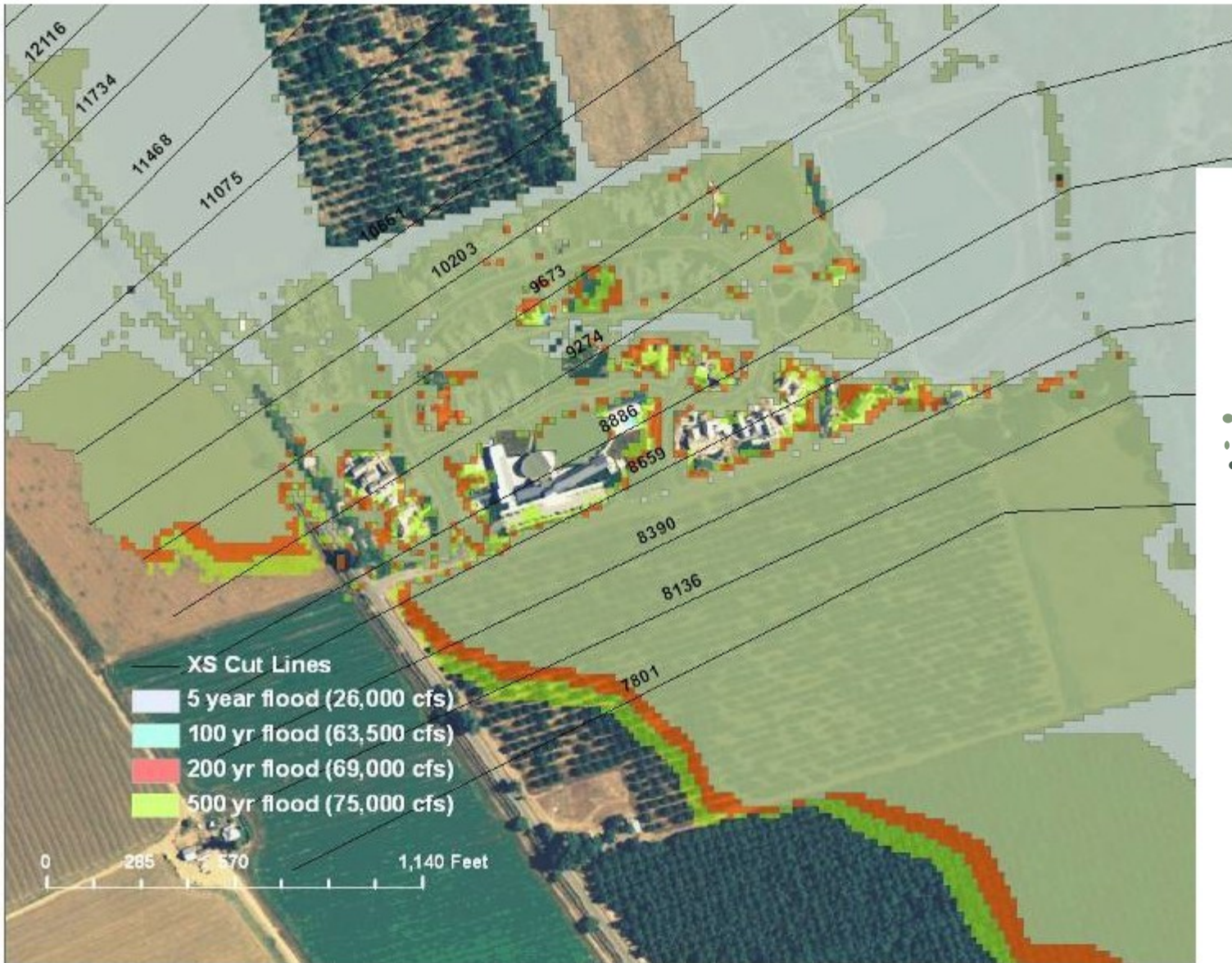


Figure 4 Flood inundation maps (close up) for the study flows (transparent overlay map colors appear distorted)



Figure 5 Flood inundation map 100 and 500 year recurrence interval flows compared (transparent overlay map colors appear distorted)

Table 2 Water surface elevations of flood flows in the vicinity of the Rancheria

River Sta	Profile	Q Total	W.S. Elev (ft)	W.S. Elev (ft)
		(cfs)	(NAD 83)	(NAD 27)
10661	5-yr flow	26000	294.67	291.97
10661	50-yr flow	57000	297.62	294.92
10661	100-yr flow	63500	298.06	295.36
10661	200-yr flow	69000	298.41	295.71
10661	500-yr flow	75000	298.77	296.07
10203	5-yr flow	26000	293.82	291.12
10203	50-yr flow	57000	296.91	294.21
10203	100-yr flow	63500	297.36	294.66
10203	200-yr flow	69000	297.72	295.02
10203	500-yr flow	75000	298.08	295.38
9673	5-yr flow	26000	292.51	289.81
9673	50-yr flow	57000	295.41	292.71
9673	100-yr flow	63500	295.88	293.18
9673	200-yr flow	69000	296.25	293.55
9673	500-yr flow	75000	296.64	293.94
9274	5-yr flow	26000	291.84	289.14
9274	50-yr flow	57000	294.63	291.93
9274	100-yr flow	63500	295.09	292.39
9274	200-yr flow	69000	295.46	292.76
9274	500-yr flow	75000	295.85	293.15
8886	5-yr flow	26000	291.14	288.44
8886	50-yr flow	57000	293.86	291.16
8886	100-yr flow	63500	294.32	291.62
8886	200-yr flow	69000	294.69	291.99
8886	500-yr flow	75000	295.09	292.39
8659	5-yr flow	26000	290.75	288.05
8659	50-yr flow	57000	293.49	290.79
8659	100-yr flow	63500	293.95	291.25
8659	200-yr flow	69000	294.33	291.63
8659	500-yr flow	75000	294.74	292.04
8390	5-yr flow	26000	290.27	287.57
8390	50-yr flow	57000	293.08	290.38
8390	100-yr flow	63500	293.55	290.85
8390	200-yr flow	69000	293.95	291.25
8390	500-yr flow	75000	294.36	291.66
8136	5-yr flow	26000	289.72	287.02
8136	50-yr flow	57000	292.60	289.90
8136	100-yr flow	63500	293.09	290.39
8136	200-yr flow	69000	293.50	290.80
8136	500-yr flow	75000	293.94	291.24

Discussion

One of the most important questions in this flood inundation study is to consider the level of uncertainty of the results. In the vicinity of the Rancheria (Cross sections 8136 to 10661) the average difference in water surface elevations between the various flows is about 5 inches (Table 3). Because of the small difference in water surface elevations between flood events, it is expected that the level of uncertainty in modeling would not make a large difference in water surface elevations for planning purposes at the Rancheria.

Average difference in flood levels near the Rancheria	
Years	Inches
50 to 100	5.6
100 to 200	4.6
200 to 500	4.8

Table 3 Average difference in flood levels near the Rancheria

Appendices

Appendix 1 Land use categories and Manning n values

Vegetation classification	N_value
Barren - Gravel and Sand Bars	0.060
Blue Oak Alliance	0.075
California Annual Grasslands Alliance	0.070
Deciduous Fruits/Nuts	0.075
Eucalyptus Alliance	0.090
Field Crops	0.080
Fremont Cottonwood - Valley Oak - Willow (Ash - S*	0.090
Giant Reed Series	0.090
Grain/Hay Crops	0.080
Intermittently Flooded to Saturated Deciduous Shr*	0.080
Mixed Fremont Cottonwood - Willow spp. NFD Allian*	0.080
Mixed Willow Super Alliance	0.080
Pasture	0.070
Tamarisk Alliance	0.090
Truck/Nursery/Berry Crops	0.090
Upland Annual Grasslands & Forbs Formation	0.070
Urban or Built-up	0.100
Valley Oak Alliance	0.075
Valley Oak Alliance - Riparian	0.075
Water	0.060

Table 4 Land use categories and Manning n values

Appendix 2 Calibration of HEC-RAS model

Adjusting cross sections with USGS data

The LIDAR data was not able to penetrate the water surface, and therefore the actual bed topography was not documented. The LIDAR, and therefore the DTM data from which the cross sections were made, record the water surface as a line from one bank to the other. In order to get a sense of the bed topography, cross sections on the HEC-RAS model were compared with measured cross sections from USGS measured data⁷. In addition, the recorded water surface elevations on these cross sections were used to calibrate the model.

The cross sections on the HEC-RAS model that correspond with USGS cross sections are given in Table 5, along with the observed and calibrated water surface elevations (WSE) at the 26,000 cfs flow.

HEC-RAS cross section number	USGS cross section number	Datum adjustment Add 2.7 ft to USGS value	WSE (USGS)	WSE (Our datum)	Calibrated WSE in HEC-RAS
3288	12		281.0	283.7	283.3
8136	13		284.5	287.2	289.72
9673	14		290	292.7	292.51

Table 5 Calibration data for the water surface elevations at the calibrated cross sections

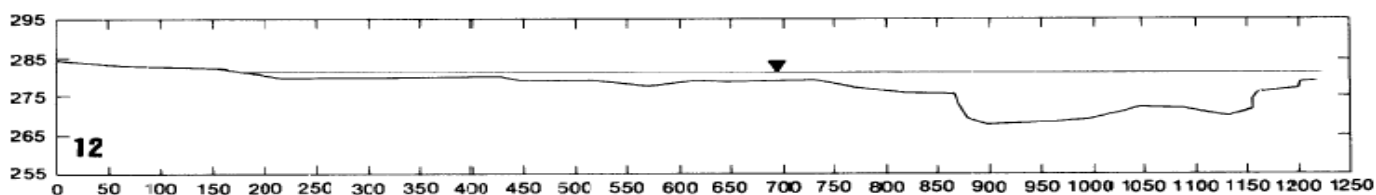


Figure 6 USGS 1984 cross section number 12 used for model calibration

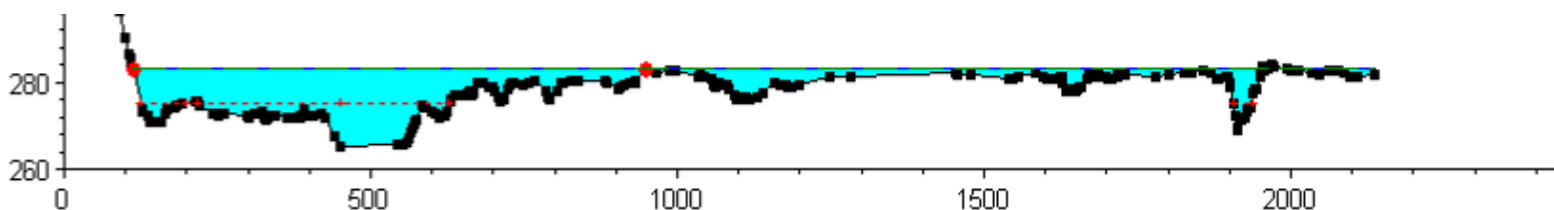


Figure 7 HEC-RAS cross section number 3288 used for model calibration

⁷ Harmon, J.G. , 1989. *Streamflow, Sediment Discharge, and Streambank Erosion in Cache Creek, Yolo County, California, 1953-1986*. USGS Water-Resources Investigations Report 88-4188.

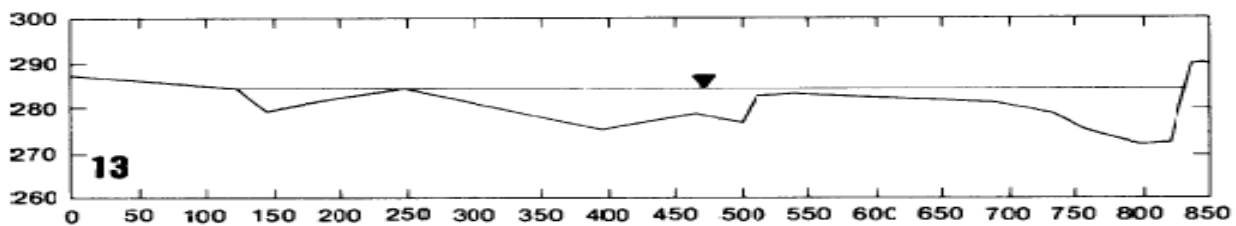


Figure 8 USGS 1984 cross section number 13 used for model calibration

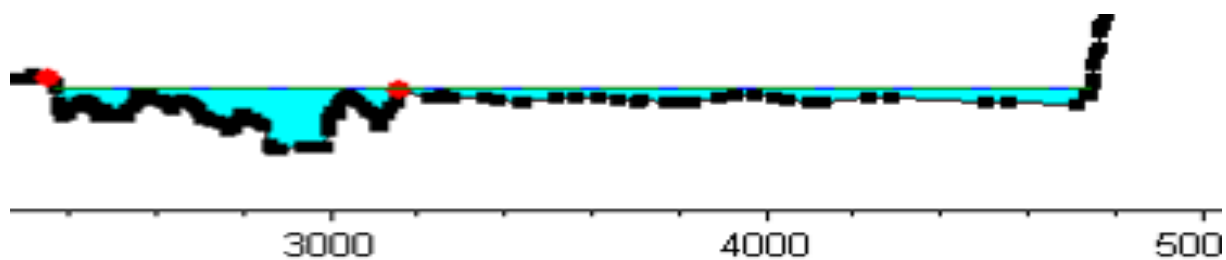


Figure 9 HEC-RAS cross section number 8136 used for model calibration

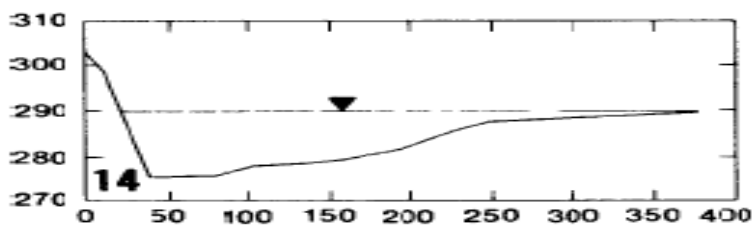


Figure 10 USGS 1984 cross section number 14 used for model calibration

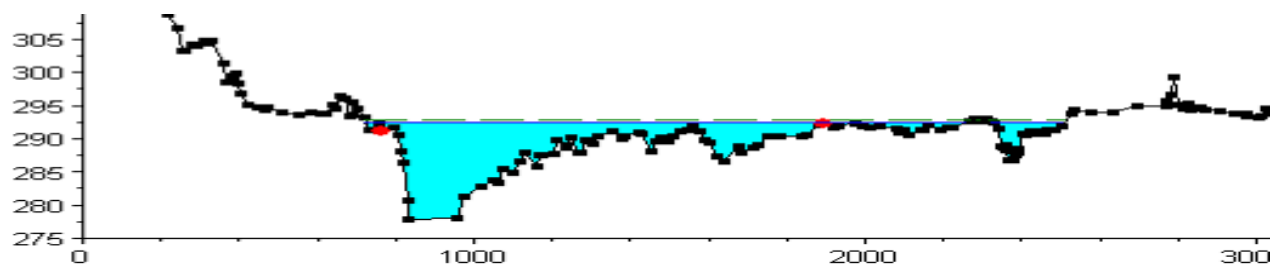


Figure 11 HEC-RAS cross section number 9673 used for model calibration

Appendix 3 Flood inundation maps

100-year

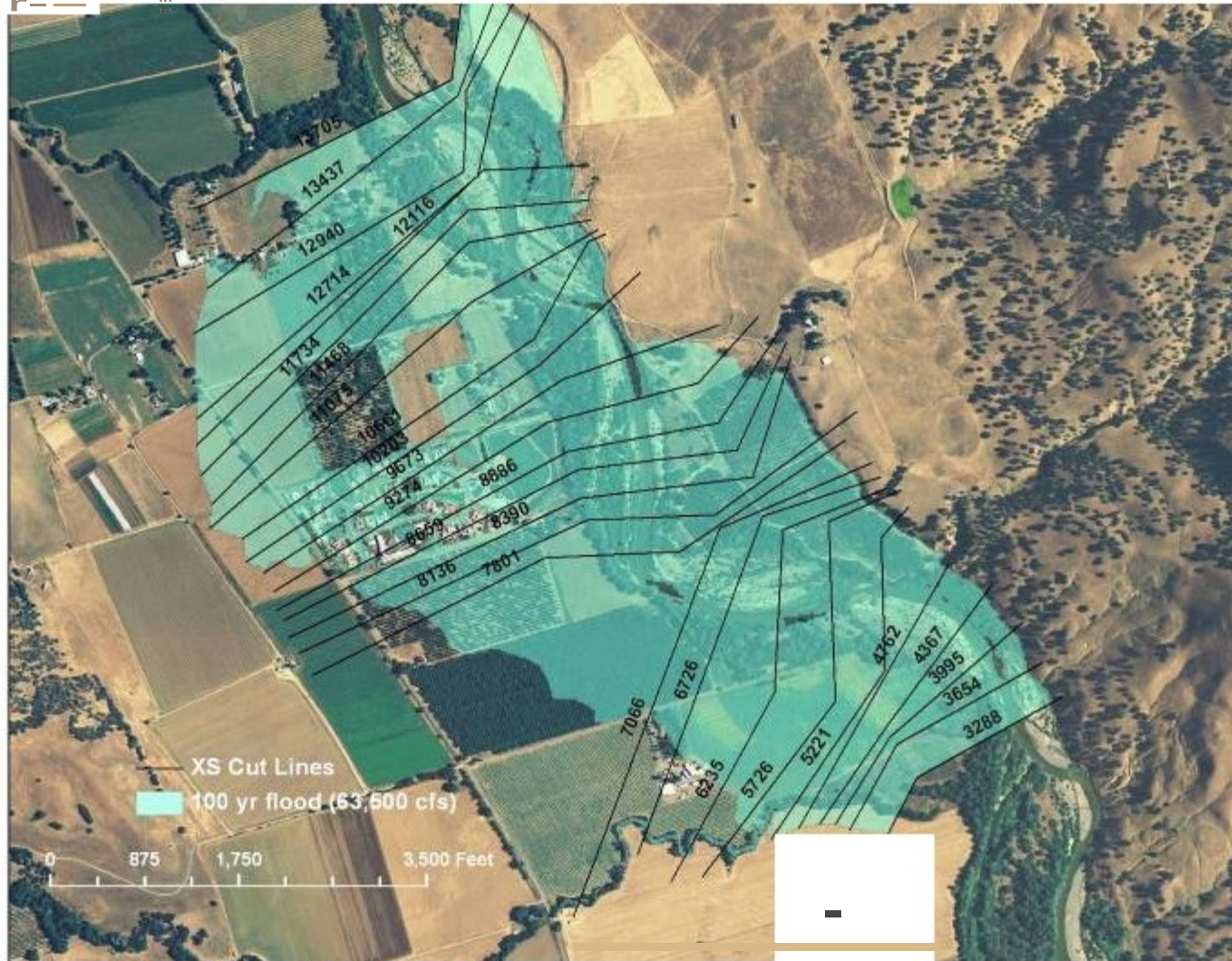


Figure 12 100-year flood inundation level in the vicinity of the Rancharia



Figure 13 100-year flood inundation level in the vicinity of the Rancharia

200-year

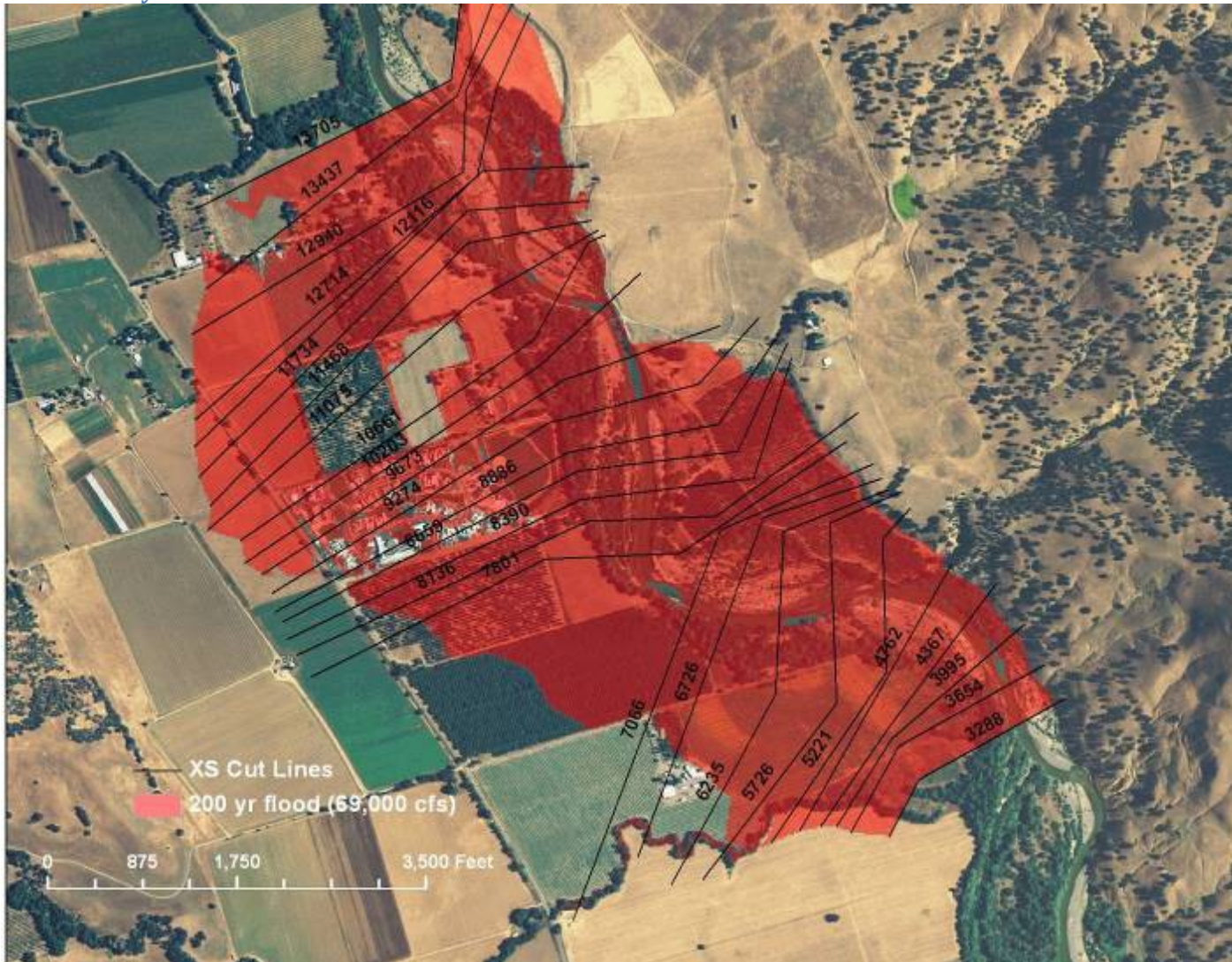


Figure 14 200-year flood inundation level in the vicinity of the Rancheria



Figure 15 200-year flood inundation level in the vicinity of the Rancheria

500-year

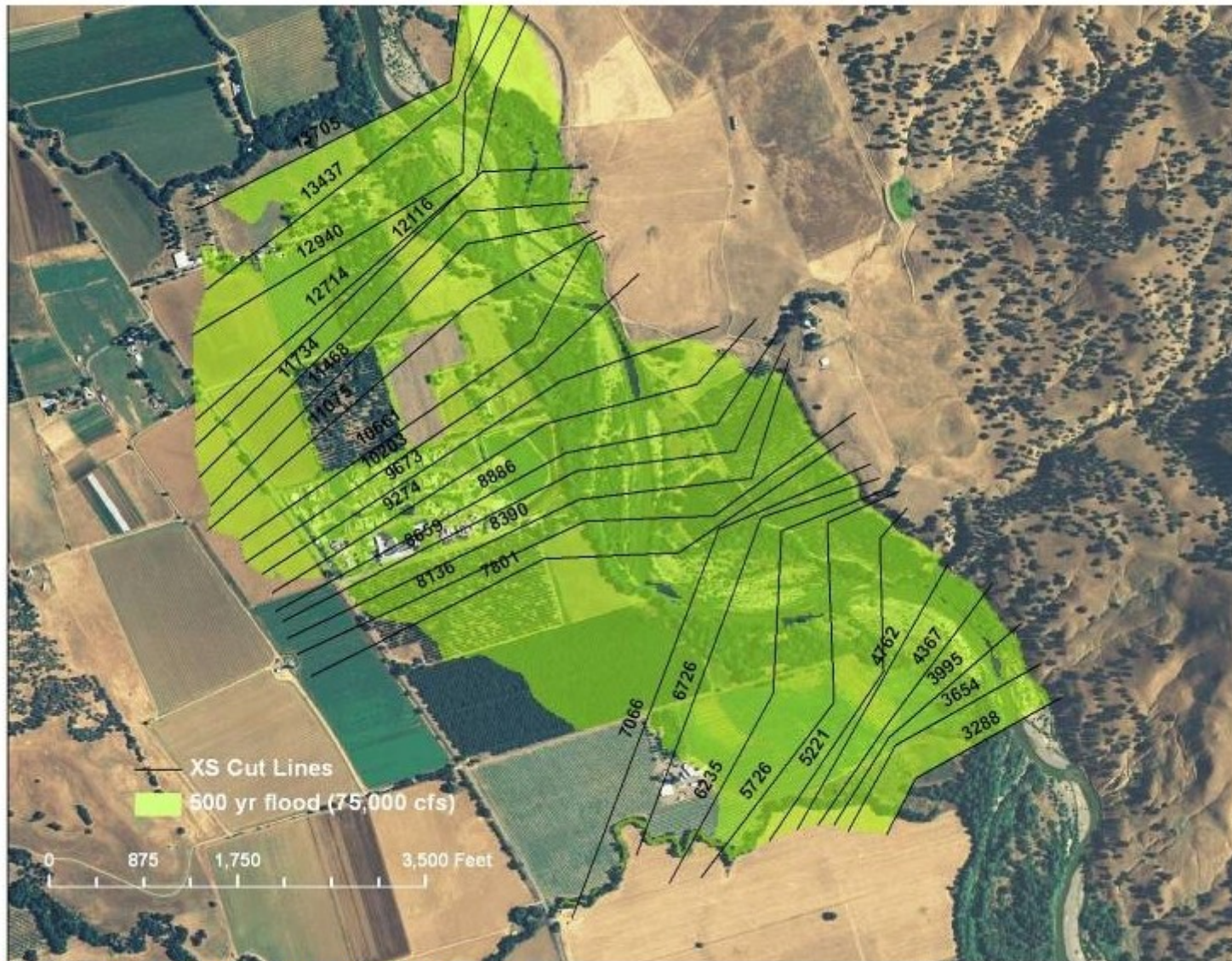


Figure 16 500-year flood inundation level close up of the Rancharia



Figure 17 500-year flood inundation level in the vicinity of the Rancheria