TECHNICAL REPORT ◦ FEBRUARY 2020

Matilija Dam Removal 65% Design Subtask 2.3: Hydraulic Studies to Determine 100-year Water Surface Elevations

PREPARED FOR

AECOM Technical Services, Inc.
1999 Avenue of the Stars, Suite 2600
Los Angeles, CA 90067

PREPARED BY

Stillwater Sciences
2855 Telegraph Ave., Suite 400
Berkeley, CA 94705

Stillwater Sciences

Suggested citation:
Stillwater Sciences. 2020. Matilija Dam Removal 65% Design Subtask 2.3: Hydraulic Studies to Determine 100-year Water Surface Elevations. Prepared by Stillwater Sciences, Berkeley, California for AECOM Technical Services, Inc., Los Angeles, California, February.

Cover photos: Matilija Dam, Ventura County, California, November 2019, photo taken by Paul Jenkins, Surfrider Foundation.

I hereby certify that all work described in this report follows accepted engineering practices and was completed under my direction. Future use of the information presented herein should consider the limitations of this analyses including inherent uncertainties associated with sediment transport modeling results that provided input data for future conditions hydraulic modeling and the coarse nature of the hydraulic modeling approach.

REGISTERED PROFESSIONAL ENGINEER
JOEL MONSCHKE
C 79688
EXP. 9/20
CIVIL
STATE OF CALIFORNIA

2/6/20

Joel Monschke P.E. Date
Civil Engineer
Stillwater Sciences

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1 EXECUTIVE SUMMARY

Located on Matilija Creek within the Ventura River watershed in southern California, Matilija Dam was 198 ft (60 m) tall upon its completion in 1948, with a storage capacity of 7,018 acre-ft (8.7 million m^3). Through subsequent modifications and sediment deposition within the reservoir area, that volume has now been reduced to less than 10% of its original value. Because of the diminishing functionality of Matilija Dam, Ventura County decided to pursue dam removal in 1998, and studies of dam removal effects and alternatives began in 2000. Removing Matilija Dam would not only eliminate a public safety liability but also provide access to valuable steelhead habitat in Matilija Creek and its tributaries.

AECOM and Stillwater Sciences are currently working on 65% Design Plans for Matilija Dam Removal (Project). This technical report describes the hydraulic analyses used to determine potential increases in flood risk associated with future conditions following dam removal, along Matilija Creek and Ventura River, from the dam to the estuary. To accomplish this, steady-state flood modeling was conducted using 1-D hydraulic modeling in HEC-RAS, focused on comparing the current 100-year floodplain to the 100-year floodplain that would result from sediment deposition following dam removal. The "Current" condition was based on 2005 topography, judged most suitable for this application, and a reanalysis of peak flow recurrences. Although multiple peak flow events were modeled, this technical report focuses primarily on the current and future 100-year event, and the resulting areas of floodplain inundation following dam removal.

To model future flood risk associated with dam removal, new profile and cross section geometries of the river channel were based on predicted aggradation generated by the DREAM-2 sediment transport model (Stillwater Sciences 2020). The difference in maximum bed aggradation between existing conditions (i.e., with dam) and future conditions (without dam) was used to define the impacts of dam removal on channel bed elevations. Next, HEC-RAS modeling was conducted utilizing the updated channel bed elevations generated by DREAM-2 to predict water surface elevation (WSE) increases and associated floodplain inundation increases with a primary focus on two scenarios:

1. The maximum increases in 100-yr WSEs expected to occur post-dam removal as the coarse sediment released from the Matilija Dam impoundment moves through the study reach.
2. The long-term average increases in 100-yr WSEs expected to occur after the released impoundment sediment pulse has flushed and/or stabilized and the natural sediment transport regime from upstream of the dam has been restored.

The findings generated by this modeling effort provide an overview of likely outcomes, but subsequent site-specific infrastructure design and risk assessments should also include more focused analyses to identify and quantify sources of uncertainty and site-specific risk. With that caveat, key findings from this modeling are:

1. As the released coarse sediment pulse moves downstream immediately following dam removal, the area upstream from Robles Diversion Dam is expected to experience increases in 100-year WSEs of 2 to 6 feet (above current conditions with the dam in place). During this period, smaller storm events such as 10- and 20-yr events may also generate WSEs that are several feet higher than 100-yr WSEs under current conditions.
2. The reach downstream from Robles Diversion Dam will likely see maximum 100-year WSE increases of 0 to 2 feet, with up to three feet at several locations (above current

conditions with the dam in place). However, the probability of reaching these maximum predicted increases in WSEs significantly decreases with distance downstream based on observations following Marmot Dam Removal (Cui et al. 2014).

3. As the released impoundment sediment stabilizes and the natural sediment transport regime from upstream of the Matilija Dam is restored, the main long-term impacts are predicted to occur 1 to 2 miles downstream from Robles Diversion Dam, where increases in 100-year WSEs are likely to persist due to permanent rebounding of the channel bed. Within this reach, long-term WSE increases of 2 to 3 feet (above current conditions with the dam in place) should be expected while the rest of the study reach should expect minimal long-term changes in WSEs.
4. Increased 100-yr WSEs of approximately 1 foot are predicted for both maximum and long-term average future conditions at the downstream extent of the study area near the estuary.

These modeled increases in WSEs result directly from channel aggradation associated with dam removal as predicted by DREAM-2 simulations. Considering the inherent uncertainty associated with coarse sediment transport dynamics and actual hydrologic conditions following dam removal, the following risk management actions are strongly recommended:

1. Conduct detailed monitoring of post-dam removal sediment deposition following all significant storm events.
2. Develop an adaptive management strategy to address actual sediment deposition patterns that may differ from the modeled results.

2 INTRODUCTION

Located on Matilija Creek within the Ventura River watershed in southern California, Matilija Dam was 198 ft (60 m) tall upon its completion in 1948, with a storage capacity of 7,018 acre-ft (8.7 million m^3). It was notched twice (in 1965 and 1977) to the current height of 168 ft (51 m) to lessen the risk of dam failure[1]. As a result of both sedimentation and notching, the Matilija Reservoir storage capacity had been reduced to less than 10% of its original design capacity by 2000, completely losing its design functionality for water storage and flood control (e.g., Bureau of Reclamations [BOR] 2006). The stored sediment volume was approximately 6–7 million cubic yards (CY) (4.5–5.4 million m^3) by 2005 (BOR 2006, Stillwater Sciences 2014). Because of the diminishing functionality of Matilija Dam, Ventura County decided to pursue dam removal in 1998, and studies of dam removal effects and alternatives began in 2000. Removing Matilija Dam would not only eliminate a public safety liability but also provide access to valuable steelhead habitat in Matilija Creek and its tributaries. The expanded steelhead habitat could potentially improve the fish population throughout the Ventura River watershed. The release of the stored sediment upon dam removal, however, may impact the extensive infrastructure located along Matilija Creek/Ventura River (Figure 1).

Several studies have examined sediment transport dynamics following proposed Matilija Dam removal under various dam removal alternatives. The most comprehensive of these studies was BOR (2006), which examined a suite of dam removal-related determinants and issues such as geology, climate, flood frequency, past projects in the watershed, ground water, sediment accumulation in the reservoir, sediment yield, sediment load in streams, river morphology, and improvement to downstream infrastructure. Proposed potential downstream infrastructure

[1] http://www.matilijadam.org/facts.htm

improvements included constructing a high-flow sediment bypass (HFSB) structure at the Robles Diversion Dam to reduce the amount of sediment deposition in Robles Diversion forebay. The BOR (2006) study also provided hydraulics and sediment transport modeling using HEC-RAS and GSTARS-1D (Yang et al. 2003), respectively. Relying mostly on information provided in BOR (2006), URS and Stillwater Sciences (2014) provided an empirical analysis of fine sediment transport for two potential alternatives that would quickly release the sediment stored in the impoundment during a large storm event (also see Cui et al. 2017 for details), and AECOM and Stillwater Sciences (2015) developed a preliminary DREAM-2 model that simulates coarse sediment (gravel and coarse sand) transport dynamics following Matilija Dam removal.

AECOM and Stillwater Sciences are currently working on 65% Design Plans for Matilija Dam Removal (Project). This technical report addresses Subtask 2.3 of the Project, describing the hydraulic analyses used to determine potential increases in flood risk associated with future conditions with and without dam removal along Matilija Creek and Ventura River, from the dam to the Pacific Ocean. The first step of this process was to review the existing conditions Bureau of Reclamations HEC-RAS model (BOR 2006) to ensure that the model was still generally applicable and functioning properly. Then, steady-state flood modeling was conducted in HEC-RAS focused on comparing the current 100-year floodplain with 100-year floodplains resulting from future conditions with dam removal. Input data for the future conditions HEC-RAS modeling was based on new channel bed profiles resulting from the sediment transport modeling conducted under Subtask 2.2 of the Project (Stillwater Sciences 2020).

Figure 1. Map of the Ventura River watershed (modified from Figure 2.1 of BOR 2006), showing the major crossings of the river and the four USGS gaging stations used for sediment transport modeling.

3 EXISTING CONDITIONS HYDRAULIC MODELING

3.1 Overview

The existing HEC-RAS model developed by the BOR (2006) was utilized for this project. The U.S. Army Corps of Engineers' (USACE) *Hydrologic Engineering Center's River Analysis System (*HEC-RAS) is a one-dimensional hydraulic model that is widely used for floodplain mapping and estimating general flow characteristics. This one-dimensional model assumes that flow velocity across the channel and floodplains is uniform at each cross section. Flow is modeled based on topography at individual channel cross sections without considering the effects of channel topography between cross sections. It is important that these limitations are closely considered during hydraulic model setup, calibration, and application.

Manning's n roughness values used in HEC-RAS were left unchanged from the existing BOR model. Main channel n-values decreased from upstream to downstream, from 0.06 (Stations 16.2879 to 14.9621, in miles, as discussed below), 0.05 (Stations 14.8674 to 14.2992) to 0.04 (Stations 14.2045 to 0.0947). Overbank n-values were set at a constant of 0.08 throughout the entire project reach. Flow was modeled in HEC-RAS using a subcritical regime, and with a fixed water surface elevation of 10 feet used as the downstream boundary condition at the Pacific Ocean. This downstream boundary condition is conservative, representing mean high tide with an elevation of approximately seven feet plus an additional three feet to account for sea-level rise and/or storm surge during a high-flow event.

Stationing for the HEC-RAS model is shown on Figure 2, representing river miles increasing from mile 0 at the river mouth (where Ventura River outlets to the Pacific Ocean) to mile 16.3 at Matilija Dam. Note that this figure also indicates the stationing used in the sediment transport model for all "points of interest," which is in kilometers and runs in the opposite direction (i.e., from Matilija Dam at 0.0 km downstream to the river mouth at 26.2 km). Figure 2 can be used to cross-reference results from the sediment transport modeling and hydraulic modeling.

Figure 2 also shows the nine project subreaches that were created during the sediment transport analyses (Stillwater Sciences 2020) to facilitate the discussion of sediment transport modeling results, and they are also referenced here to present and discuss the hydraulic modeling results.

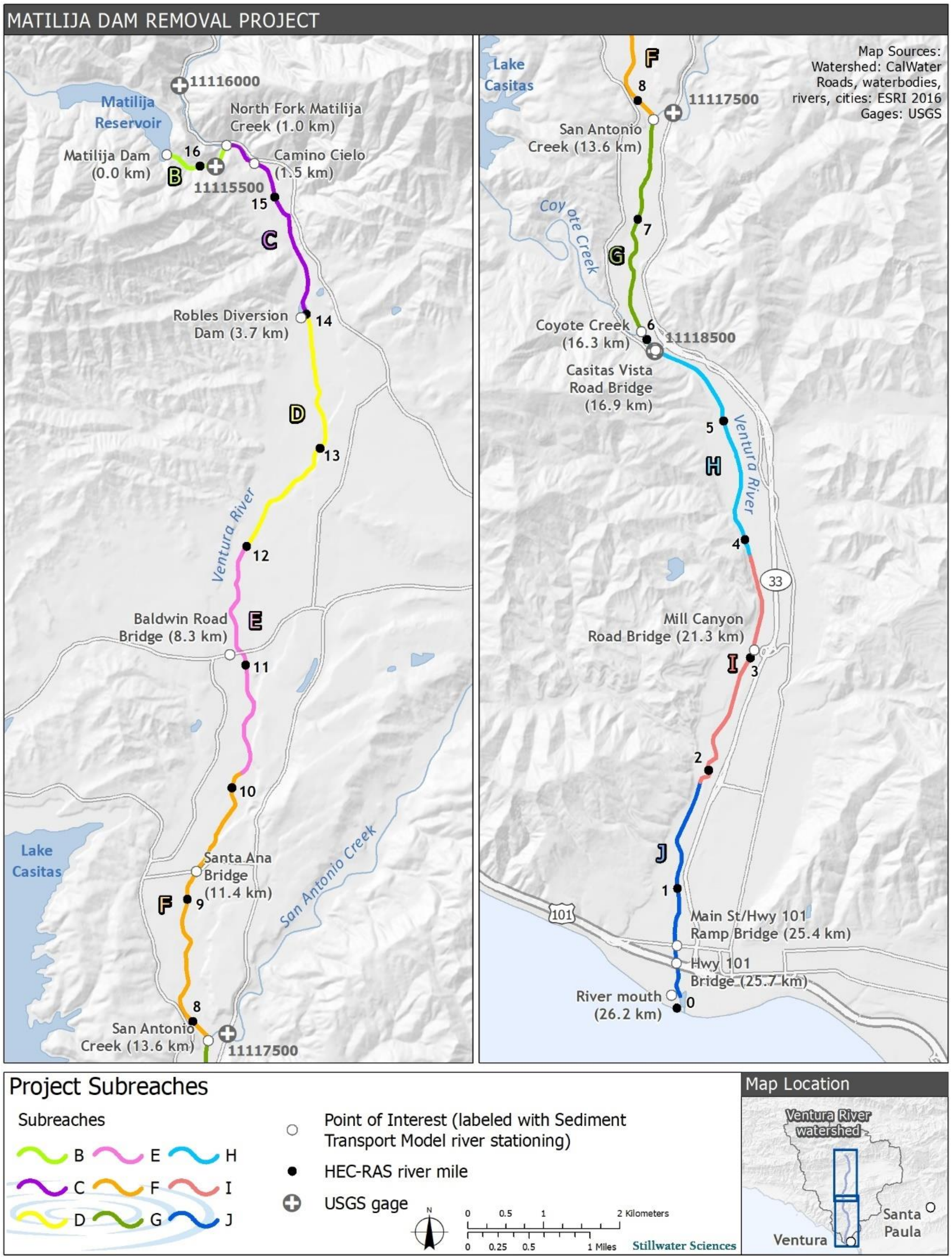

Figure 2. Project reaches, HEC-RAS river stations and important infrastructure along Matilija Creek and the Ventura River. Numbers 0 to 16 from the river mouth to Matilija Dam correspond to the HEC-RAS river miles.

3.2 Topographic Data

Cross sections for the HEC-RAS model are based on the 2005 LiDAR Digital Terrain Model (DTM), which has 10-foot grid resolution. More recent LiDAR was collected in 2018 with 0.25-meter grid resolution DTM. However, after extensive comparison of the two datasets (Appendix D), Stillwater Sciences selected the 2005 LiDAR to use for this project because it has less patchy dense vegetation in the active channel and floodplains compared to the 2018 LiDAR, thereby providing more accurate bare earth topography.

The 2005 LiDAR is not a perfect representation of the terrain, however. In part this is due to changes in topography, particularly along the channel and on active river bars, that have occurred in the intervening 13 years. In addition, minor sensing or processing artifacts are evident in the 2005 LiDAR that introduce localized changes of approximately 1.0 foot in the represented topography that are not reflected in the actual topography (see pages 7 and 8 in Appendix D for four wave-like features traversing the LiDAR comparison maps between HEC-RAS stations 7.29 and 7.95). These shortcomings are not judged to influence significantly the hydraulic or sediment-transport model results, however, and they are less problematic than the more pervasive limitations of the 2018 LiDAR described above.

A map set comparing the 2005 and 2018 LiDAR topography is shown in Appendix D. This comparison identified specific differences between the two datasets, reflecting both differences between the data and changes along the Ventura River:

1. The vertical datums for the two surveys are not identical; stable areas (orchards, residential neighborhoods, etc.) tend to display as light- to (less commonly) medium-blue, indicating that the 2018 LiDAR surfaces tends to register “lower” by a fraction of a foot. The primary exceptions to this pattern are in areas of dense vegetation (as described above) and in building footprints, because buildings were not filtered out of the 2018 LiDAR (but were filtered out of the 2005 LiDAR).
2. The differing resolutions create artifacts in the calculated elevation differences along some sharp boundaries. For example, individual pixels along the (immovable) downstream lip of Matilija Dam locally display more than 60 feet of elevation difference between the two datasets.
3. Some notable anthropogenic channel modifications implemented between 2005 and 2018 are evident in the LiDAR comparison:
    a. Significant excavation of the bay upstream of Robles Diversion Dam, commonly 6–10 feet, and a roughly equivalent magnitude of aggradation immediately downstream;
    b. Significant left bank stabilization and subsequent aggradation upstream of Santa Ana Bridge with the use of boulder weir/baffle structures;
    c. Linear right bank stabilization features along the Ventura River upstream and downstream from the San Antonio Creek confluence (HEC-RAS stations 8.14 to 8.24 and 7.01 to 7.1, respectively); and
    d. Levee improvements on the left bank downstream from San Antonio Creek (HEC-RAS stations 6.82 to 7.67).
4. Significant channel migration between 2005 and 2018 is evident at some locations.
5. Despite the systematic “depression” of the 2018 LiDAR surface and the problems with an accurate bare-earth representation of densely vegetated areas, there do appear to be some general trends in aggradation and degradation between 2005 to 2018:

a. The channel bed has degraded one to a few feet between Matilija Dam and Robles Diversion Dam, even after compensating for the systematic differences in datasets (light to medium blues, Appendix D pages 14 and 15);
b. The channel has been fairly stable between Robles Diversion Dam and Santa Ana Bridge (mix of light orange and light blues, Appendix D pages 9 to 14);
c. Bar aggradation downstream of the San Antonio Creek confluence continues for at least 4 miles (Subreaches G and H); this pattern may continue even farther downstream, but bars become narrower and more heavily vegetated, compromising any LiDAR-based quantification of elevation changes (light to medium orange, Appendix D pages 4–8); and
d. Downstream from Casitas Vista Road Bridge, the 2018 LiDAR suggests abundant vegetation in the channel, with significant increase in 2018 elevations downstream of US 101 corresponding to both recently established dense vegetation and high lagoon levels at the river mouth.

3.3 Hydrologic Data

The Bureau of Reclamation (BOR) conducted extensive analyses related to typical peak flows for the project area (i.e., Bullard 2002a, BOR 2006). BOR found that the commonly used Log-Pearson Type III distribution did not provide accurate peak flow estimates for the watershed. Instead, they adopted a simple plotting position method for more frequent peak flow events (below 10-year return interval) and used a regression equation fit to the seven highest peak flows to derive 10-year, 20-year, 50-year, 100-year, and 500-year discharges. Stillwater's review found that the BOR analyses are technically sound. As a result, this analysis utilized the peak flows recommended by BOR (2006) (Table 1), which were provided in BOR's existing conditions HEC-RAS model for the project area. The modeled water-surface elevations (WSEs) resulting from this extreme event will primarily be used during Subtask 2.4 of the Project (Re-evaluation of Downstream Project Infrastructure).

Stillwater also reviewed hydrologic information from the Federal Emergency Management Agency (FEMA) Flood Insurance Study (FIS) for the Ventura River and vicinity (FEMA 2015). Peak flows from the FEMA FIS are shown on Table 2. For the portion of the project area downstream from Baldwin Road Bridge there is close consistency between the BOR and FEMA discharges. However, from Baldwin Road Bridge and extending to the upstream extent of the project area, the FEMA discharges are significantly higher for the 50- and 100-year events. The FEMA FIS does not provide exact details explaining how their peak discharges were calculated, but based on the general information in the FIS, it appears that the discharges were determined based on proration by drainage area. BOR's discharges for the upstream portion of the project area are based on individual gage records and are therefore more accurate and appropriate for use in this study.

Table 1. BOR (2006) recommended peak flows for the Ventura River at existing stream gage sites under current conditions for this study.

Return period (year)	Peak flood flows at selected locations (cfs)					
	Upstream of confluence with N. Fork Matilija Creek (HEC-RAS Station 16.29)	Matilija Creek downstream of confluence with N. Fork Matilija Creek (HEC-RAS Station 15.67)	Baldwin Road (HEC-RAS Station 11.46)	Casitas Springs (HEC-RAS Station 7.86)	Casitas Road Bridge (HEC-RAS Station 6.54)	Shell Chemical Plant (HEC-RAS Station 4.45)
2	3,060	3,250	3,380	4,130	4,520	5,080
5	7,090	7,580	7,910	9,820	11,060	12,250
10	12,500	15,000	16,000	35,200	36,400	41,300
20	15,200	18,800	19,800	44,400	46,400	52,700
25[a]	15,800	19,670	20,630	46,430	48,620	55,230
50	18,800	24,000	24,800	56,600	59,700	67,900
100	21,600	27,100	28,300	66,600	69,700	78,900

[a] 25-year return period peak flow determined through linear interpolation between 20- and 50-year return period peak flows.

Table 2. FEMA Flood Insurance Study (2015) summary of discharges for project.

Return period (year)	Peak flood flows at selected locations (cfs)					
	Upstream of confluence with N. Fork Matilija Creek (HEC-RAS Station 16.29)	Matilija Creek downstream of confluence with N. Fork Matilija Creek (HEC-RAS Station 15.67)	Baldwin Road (HEC-RAS Station 11.46)	Casitas Springs (HEC-RAS Station 7.86)	Casitas Road Bridge (HEC-RAS Station 6.54)	Shell Chemical Plant (HEC-RAS Station 4.45)
10	12,000	15,000	16,000	29,000	30,000	34,000
50	23,500	30,000	31,000	55,000	58,000	66,000
100	27,500	34,500	36,000	65,000	68,000	77,000

3.4 Existing Conditions HEC-RAS Modeling Results

One-dimensional hydraulic modeling was conducted based on the input data described above. Although all peak flow events described in Table 1 were modeled, this technical report focuses primarily on the 100-year event. Hydraulic modeling results are summarized in Section 3.5 below and described in detail in Appendices A–C. A table summarizing 100-year WSEs is included in Appendix A and flood inundation maps are shown in Appendices B and C. Note that the figures in Appendices A to C also show results from the future conditions hydraulic modeling (as discussed later in this technical report). Source files for all HEC-RAS models will be delivered to Ventura County Watershed Protection District upon completion of the project.

Appendices B and C show floodplain inundation maps across all nine project subreaches shown on Figure 2. These subreaches were created during the sediment transport analyses (Stillwater Sciences 2020) to facilitate the discussion of sediment transport modeling results. The same subreaches are also used in this technical report to facilitate integrated discussion between the hydraulic and sediment transport modeling results. The subreach delineation was partly based on geomorphic features (e.g., the selection of dams and river confluences as boundaries) and partly arbitrary (e.g., the selection of whole km numbers as boundaries), with the guidance that each subreach should not exceed 4 km.

The subreaches are as follows:

- Subreach A: Upstream of Matilija Dam (not included in the HEC-RAS model);
- Subreach B: 0–1.05 km downstream of Matilija Dam (HEC-RAS Stations 15.67 to 16.29), where the downstream boundary corresponds to the North Fork Matilija Creek confluence;
- Subreach C: 1.05–3.74 km downstream of Matilija Dam (HEC-RAS Stations 14.02 to 15.67), where the downstream boundary corresponds to Robles Diversion Dam;
- Subreach D: 3.74–7 km downstream of Matilija Dam (HEC-RAS Stations 12.03 to 14.02), where the downstream boundary corresponds to the westward extension of Ferrara Drive in the City of Mira Monte;
- Subreach E: 7–10 km downstream of Matilija Dam (HEC-RAS Stations 10.13 to 12.03), where the downstream boundary approximately corresponds to the border between the communities of Mira Monte and Oak View;
- Subreach F: 10–13.6 km downstream of Matilija Dam (HEC-RAS Stations 7.86 to 10.13), where the downstream boundary corresponds to the San Antonio Creek confluence;
- Subreach G: 13.6–16.3 km downstream of Matilija Dam (HEC-RAS Stations 6.06 to 7.86), where the downstream boundary corresponds to the Coyote Creek confluence;
- Subreach H: 16.3–20 km downstream of Matilija Dam (HEC-RAS Stations 3.88 to 6.06), where the downstream boundary corresponds to the westward extension of Los Cabos Lane in the City of Ventura;
- Subreach I: 20–23 km downstream of Matilija Dam (HEC-RAS Stations 1.89 to 3.88), where the downstream boundary corresponds to roughly the westward extension of West Stanley Avenue in the City of Ventura;
- Subreach J: 23 km downstream of Matilija Dam to the Ventura River mouth (HEC-RAS Stations 0.09 to 1.89).

The floodplain extents in Appendices B and C show 100-year WSEs projected onto the 2005 LiDAR DTM. Stillwater Sciences also analyzed the results of the 100-year WSEs projected onto the 2018 LiDAR DTM; results were generally consistent, with the exception of those floodplain areas where recent grading activities (cut or fill) had occurred between 2005 and 2018. This was most notable along the left bank downstream from the San Antonio Creek confluence, where extensive levee work occurred after 2005 (see additional discussion above in Section 2.2).

Additionally, the figures in Appendices B and C show FEMA 100-year floodplain. Overall, the existing conditions hydraulic model results for this project are consistent with the FEMA floodplain extent. As discussed in Section 2.3 above, the FEMA and BOR studies utilized different peak flow, so some inconsistencies with the floodplain boundaries are expected. Additionally, there are notable differences in floodplain extents adjacent to major tributary confluences. At these locations the outer edge of the FEMA 100-year floodplain veers away from the mainstem channel to incorporate the 100-year floodplain from the tributaries, whereas the BOR HEC-RAS model ignores the 100-year floodplain of the tributaries.

To better depict expected floodplain extent, Stillwater Sciences manually edited the HEC-RAS-generated floodplain maps within three critical project areas to more accurately show backwater inundation:

- Just downstream from Robles Diversion Dam between HEC-RAS Cross Sections 13.83 and 13.92.
- At Santa Ana Bridge between HEC-RAS Cross Sections 9.25 and 9.38.
- Within the community of Casitas Springs between HEC-RAS Cross Sections 6.82 and 6.91.

As shown on the floodplain maps in Appendices B and C, inundation extents appear more realistic compared to previous versions of the maps that showed inundation extents being cut off along HEC-RAS cross section lines. However, it is important to note that these revised floodplain boundaries are still approximate and don't account for flow contributions from tributaries or two-dimensional flow paths within the river and floodplains. To more accurately assess risk in flood-prone communities within the project area, it is recommended that detailed 2-D hydraulic modeling is conducted within critical areas.

4 FUTURE CONDITIONS HYDRAULIC MODELING

4.1 Overview

For future conditions HEC-RAS modeling, the existing conditions HEC-RAS model described above was modified with new profile and cross section geometries based on DREAM-2 sediment transport model results (Stillwater Sciences 2020). A total of ten runs (Runs 1a, 1b, 1c, 1d, 1e, 2a, 2b, 2c, 2d, and 2e) were conducted to simulate sediment transport dynamics in Ventura River, of which five (Runs 1a, 1b, 1c, 1d, and 1e) are simulation under the current condition, assuming Matilija Dam is not removed and continues to trap all the coarse sediment coming from Upper Matilija Creek over the duration of the simulation. The remaining runs (i.e., Runs 2a, 2b, 2c, 2d, and 2e) simulate the period following dam removal. The five alternative model runs for the two scenarios begin at different points in the 68-year discharge record used for this modeling exercise to explore whether flow sequencing influences the downstream patterns of sediment erosion and deposition. Each simulation lasted for 204 years, or three cycles of the 68-year discharge records.

As discussed in the Matilija Dam Removal Sediment Transport Modeling Technical Report (Stillwater Sciences 2020), 204 years will likely be more than sufficient for the sediment to fill to the top of the dam if no removal occurs, and so coarse sediment would pass over the dam to reestablish sediment transport continuity between the upstream and downstream of the dam. For modeling purposes, however, Runs 1a through 1e assume that the dam will continue to trap coarse sediment through the entire duration of the run, so that general trends in aggradation with and without the dam can be more easily distinguished from changes in response to variations in hydrology.

Based on the ten DREAM-2 model runs (Runs 1a, 1b, 1c, 1d, 1e, 2a, 2b, 2c, 2d, and 2e), five different future condition scenarios were modeled in HEC-RAS as described in Section 3.2.

4.2 Topographic Data

4.2.1 Translation of DREAM-2 simulation results to HEC-RAS cross sections

The translation from DREAM-2 to HEC-RAS is carried out by increasing the bed elevation of HEC-RAS cross sections by the thickness of sediment deposition predicted by DREAM-2 relative to current condition (i.e., results shown in Figure 4 and Figure 5). For cross sections upstream of Robles Diversion Dam, the amount of deposition is extended to the floodplain area to ensure the results will be more conservative, as long as the cross section elevation is below the highest bank station (demonstrated in Figure 3). Downstream of Robles Diversion Dam, the amount of sediment deposition is minor and unlikely be occurring in floodplain area, and thus, deposition is allowed only within the main channel area (i.e., between the two red dots shown on Figure 3). Note the translation above is conservative in nature only for the reach upstream of Robles Diversion Dam. The aggraded cross sections produced as described above are for HEC-RAS modeling purpose only and should not be assumed to represent the true pattern of sediment aggradation in the future.

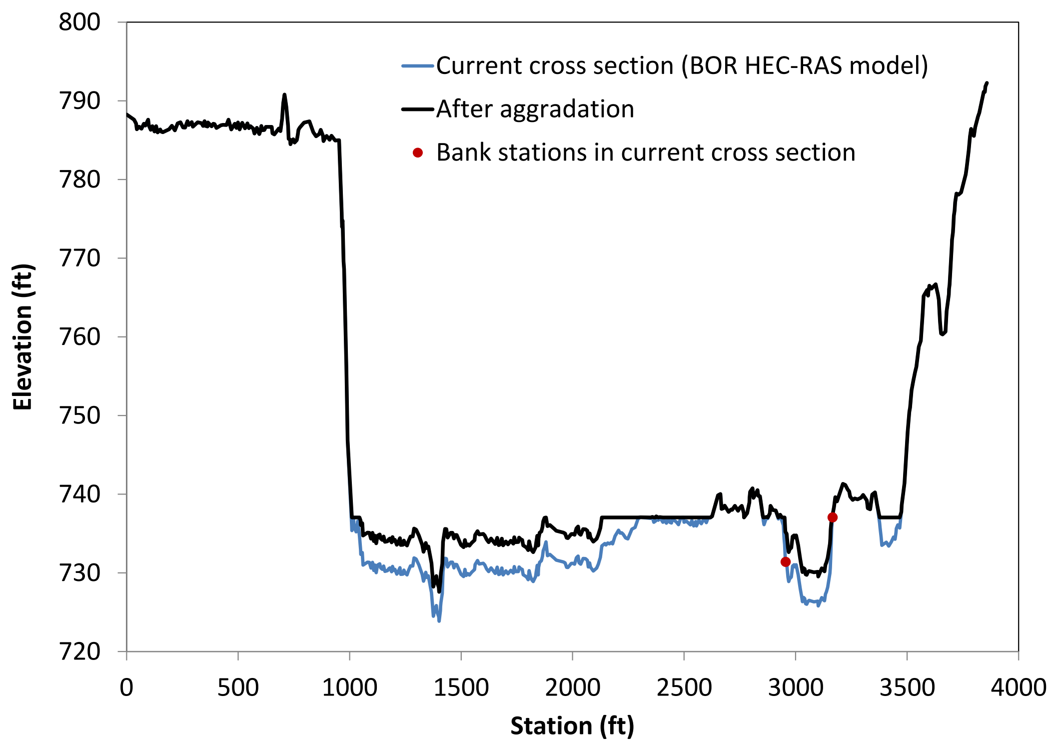

Figure 3. A demonstration of how channel aggradation predicted by DREAM-2 is transferred to HEC-RAS cross sections. The channel is allowed to aggrade uniformly unless the elevation after aggradation exceeds the highest bank station (the red dot on the right side), at which point the aggraded channel takes the elevation of the highest bank station (e.g., the flat line between approximately Station 2,200 and 2,700 ft).

4.2.2 Profiles representing future conditions with dam removal

A total of five post-dam-removal channel profiles shown in Figure 4 and Figure 5 were modeled using HEC-RAS to determine future changes in WSEs resulting from Dam Removal.

- Profile 1: The maximum sediment deposition during the day of the January 1969 flood simulated with Runs 2a through 2e relative to that from Runs 1a through 1e (labeled as "*During 100-year flow*" in Figure 4 legend). The January 1969 event is the recorded maximum flood event in Matilija Creek. This profile will be used for 100-year event HEC-RAS simulation in Task 2.3 of this Project to evaluate maximum flood risks associated with sediment deposition expected in the future with dam removal. Although there is more channel aggradation predicted by several other profiles as shown on Figure 4, the maximum 100-year WSEs were simulated using Profile 1 based on the reasoning that during 100-year storm events maximum channel aggradation is not expected because the high flows leading up to the peak 100-year flow will more evenly redistribute areas of peak aggradation.
- Profile 2: The maximum sediment deposition during the March 1, 1983 event simulated with Runs 2a through 2e relative to that from Runs 1a through 1e (labeled as "*During 50-year flow*" in Figure 4 legend): This profile will be used for 50-year event HEC-RAS simulation in Task 2.3 of this Project.
- Profile 3: The maximum sediment deposition after the day Matilija Creek daily average discharge first exceeded the design flow of 1,700 cfs following dam removal, simulated with Runs 2a through 2e relative to that from Runs 1a through 1e (labeled as "*All events after Matilija Creek discharge exceeds the design flow*" in Figure 4 legend): This profile applies to all events with magnitude from 10-year to 25-year recurrence interval. Simulation of the 5-year and smaller events should be applied to the profile 4 described below.
- Profile 4: The maximum sediment deposition throughout the run simulated with Runs 2a through 2e relative to that from Runs 1a through 1e (labeled as "*All events, including days before Matilija Creek discharge exceeds the design flow*" in Figure 4 legend): This profile is different from profile 3 discussed above because there is extensive sediment deposition in subreach B during the first day that the flow in Matilija Creek exceeds the design flow of 1,700 cfs. This profile applies only for HEC-RAS simulation for 5-year or smaller events, because the large sediment deposits in subreach B that is predicted to occur during the first day following dam removal would have been eroded when the flow becomes higher than a 5-year event, making the application of profile 3 appropriate.
- Profile 5: Quasi-equilibrium sediment deposition presented in Figure 5: This profile represents conditions within the project area after all impounded sediment is released from behind Matilija Dam been transported out of the system. This profile represents the impact due to the re-establishment of sediment continuity due to the removal of Matilija Dam. It also represents the ultimate quasi-equilibrium profile once Matilija impoundment is filled with sediment and sediment continuity is reestablished at the dam site if the dam is not removed.

Additional description of these profiles and sediment transport modeling approach is described in the Matilija Dam Removal Sediment Transport Modeling Technical Report (Stillwater Sciences 2020).

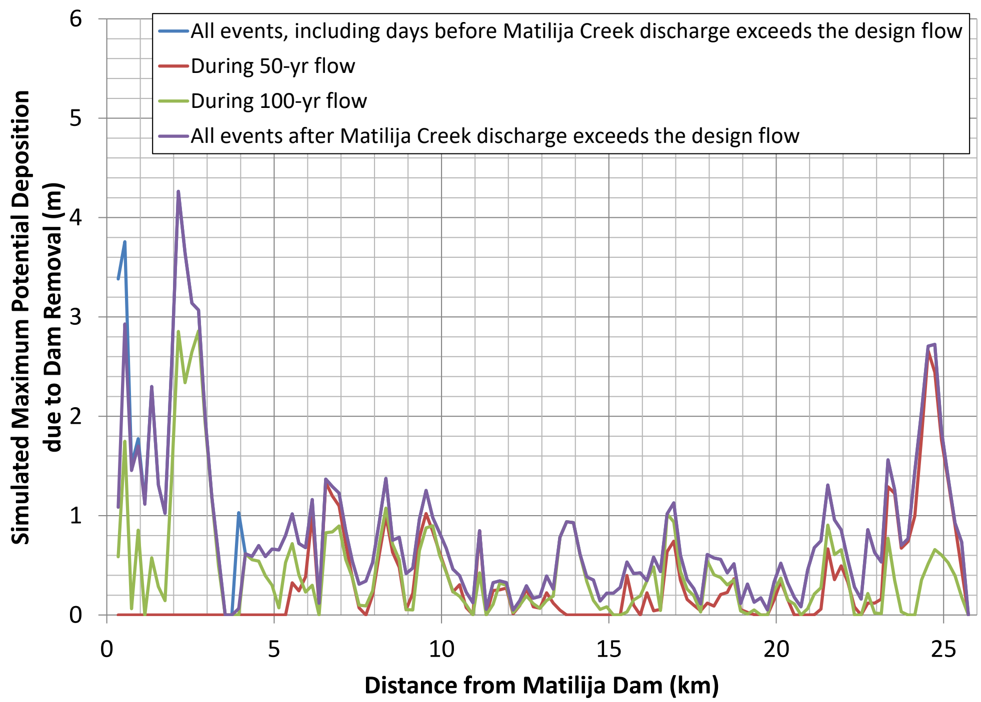

Figure 4. Simulated maximum sediment deposition following dam removal relative to the maximum deposition under current conditions.

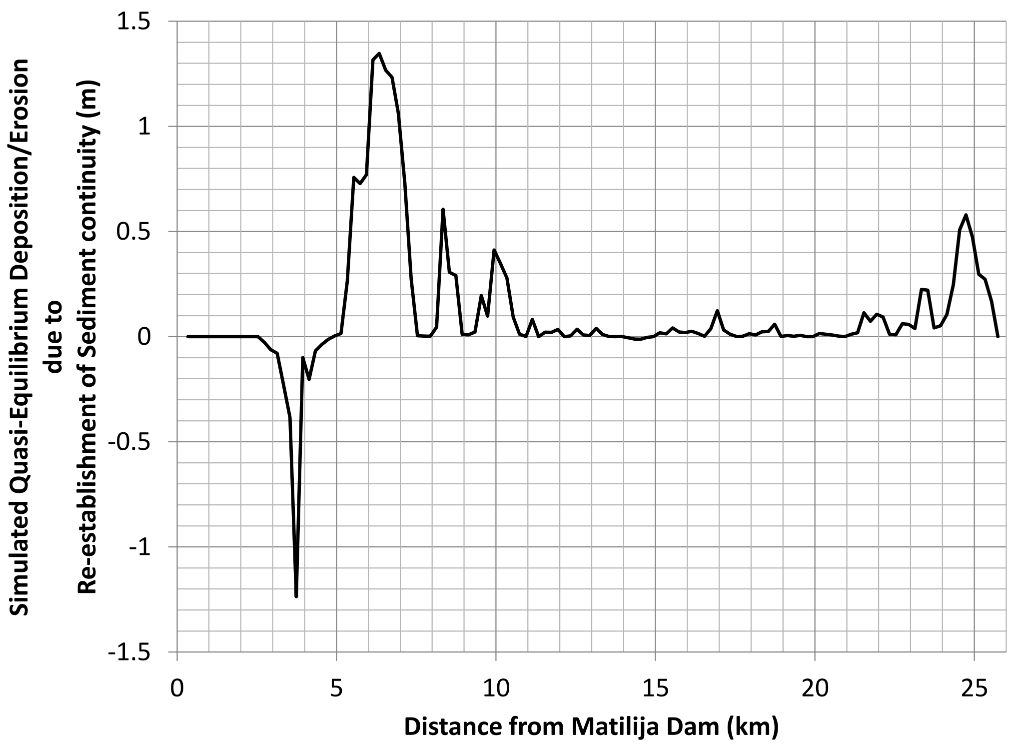

Figure 5. Average sediment erosion/deposition during the 2nd 68-year hydrological cycle compared to the current condition, representing the impact of re-establishment of sediment supply at Matilija Dam site following dam removal.

4.3 Hydrologic Data

No changes were made to the hydrologic input data for the future conditions hydraulic model because the Matilija Dam impoundment has minimal storage capacity and therefore peak flows are considered to be identical to the existing conditions peak flows described in Table 1.

4.4 Other Modifications to Future Conditions HEC-RAS Model

A significant hydraulic feature in the upper Ventura River, the Robles Diversion Dam, will likely have to be modified prior to dam removal. One project alternative is installation of a high flow sediment bypass (HFSB). Stillwater Sciences obtained 90% design plans for the proposed HFSB structure at the Robles Diversion Dam from Tetra Tech. Based on the 90% design plans, the proposed diversion dam inline structure was updated in the existing conditions HEC-RAS model to reflect the proposed project features, which include a high flow bypass, fishway, and rock armored embankment. Note that the HEC-RAS model does not include flow diversion out of the Ventura River at this structure considering that no diversion would likely be occurring during the extreme discharge events described herein. The proposed diversion structure cross section used in the updated HEC-RAS model is shown on Figure 6. The invert elevation of the proposed gates is significantly lower than the current channel elevation upstream from the Robles Diversion Dam to encourage sediment to flush out of the forebay during high flow events.

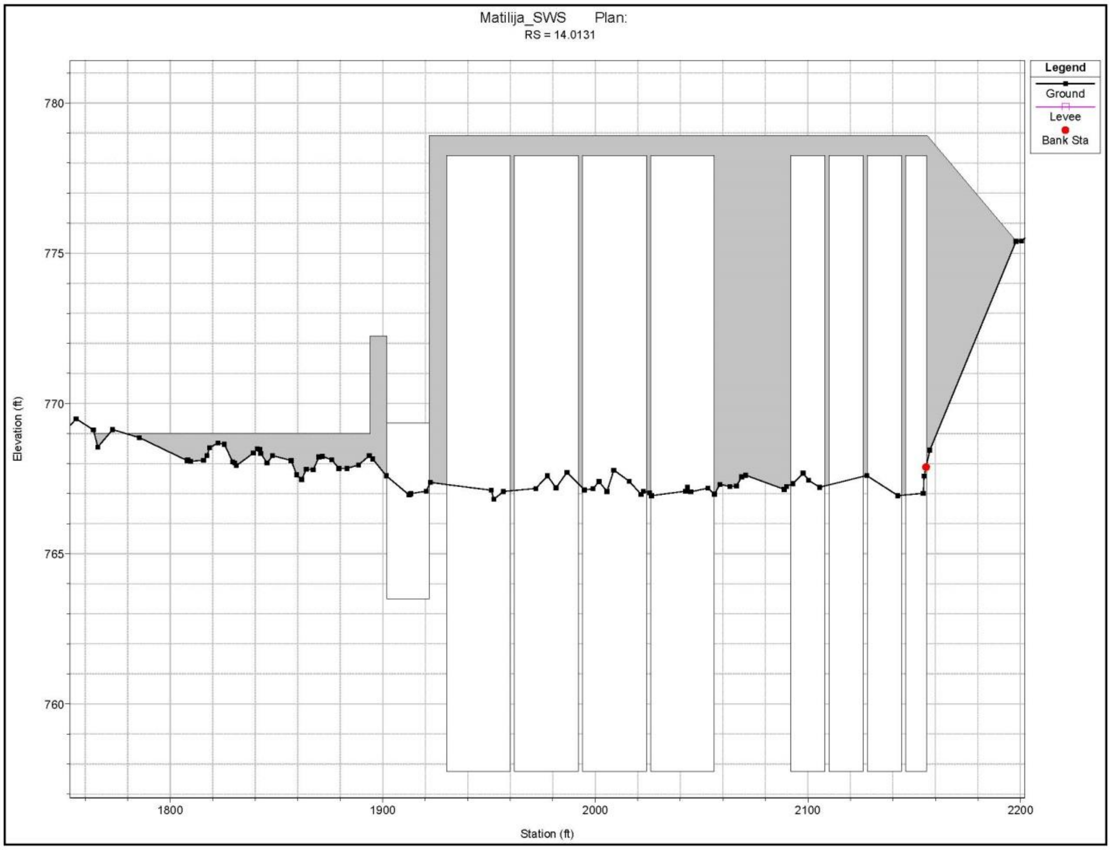

Figure 6. Updated HEC-RAS Cross Section at Robles Diversion Dam (looking downstream). The black line represents the channel cross section, the vertical white rectangles are the high flow sediment bypass openings (four openings to the right are the existing spillway, four openings in the middle are proposed HFSBs, and the small opening to the left is the fishway), and the gray areas are impervious concrete portions of the dam.

In addition to the Robles Diversion Dam HFSB and the revised channel profiles described in Section 3.2 above, the existing Camino Cielo Bridge structure located 1.5 km downstream from the Matilija Dam was removed from the future conditions HEC-RAS models due to model simulations showing major sediment deposition at the current bridge location. This bridge is scheduled for replacement prior to dam removal, with early stages of the planning process already underway to design a new bridge with greater capacity to pass expected sediment loads and flows during peak events. No other existing infrastructure was modified in the future conditions HEC-RAS model.

4.5 Future Conditions HEC-RAS Modeling Results

One-dimensional hydraulic modeling was conducted based on the future conditions input data described above. Longitudinal profiles showing the expected changes in water surface elevations are shown in Figure 7 and Figure 8, a summary of predicted increases in WSEs is tabulated in Appendix A, and flood inundation maps are included in Appendices B and C. Source files for all HEC-RAS models are included with this report.

The floodplain extents in Appendices B and C are based on 100-year WSEs projected onto the 2005 LiDAR DTM. Appendix B shows current 100-year WSEs compared to future maximum 100-year WSEs with dam removal, and Appendix C shows current 100-year WSEs compared to future quasi-equilibrium 100-year WSEs with dam removal. Future maximum and quasi-equilibrium 100-year floodplain extents result from HEC-RAS modeling of Profiles 1 and 5 respectively (as defined above in Section 3.2).

As expected, the proposed conditions hydraulic modeling results are well aligned with the DREAM-2 sediment transport modeling results described in Stillwater Sciences (2020). That is, in locations where sediment deposition is predicted by the DREAM-2 model, increased flooding is predicted by the hydraulic model. These results are summarized in Figure 7 and Figure 8 as well as Appendix A. Section 4 includes additional discussion of hydraulic modeling results.

Hydraulic conditions were also modeled in HEC-RAS for the other future channel profiles described above in Section 3.2. However, for these profiles, different discharges were analyzed:

- For Profile 2 WSEs for the 50-year discharge were analyzed.
- For Profile 3 WSEs for the 10-year and 20-year discharges were analyzed.
- For Profile 4 WSEs for the 2-year and 5-year discharge were analyzed.

The resulting maximum WSEs determined by these three additional model runs were then compared to the 100-year WSEs resulting from Profile 1. Throughout most of the project reach, the 100-year WSEs resulting from Profile 1 were higher than the WSEs generated by the other HEC-RAS simulations for smaller storm events combined with Profiles 2-4. There are several exceptions including a portion of Subreach J where the 20-year and 50-year WSEs were higher due to more channel aggradation than during the 100-year event. There were also several HEC-RAS stations scattered throughout the project area where the 20- and 50-year discharge events modeled on Profiles 2 and 3 respectively resulted in marginally higher WSEs (1 foot or less) when compared to the 100-yr discharge modeled on Profile 1.

Comparisons of the 20-, 50-, and 100-year WSEs are shown in Appendix E for reaches where the smaller storm events may result in higher WSEs. These results are also included in the 6^{th} and 7^{th} columns in Appendix A.

Additionally, the 5-year discharge modeled on Profile 4 (including aggradation during day of sediment release) resulted in higher water surface elevations than the 100-year discharge within the first 500 feet downstream from the dam.

The 100-year WSE inundation maps presented in Appendices B and C provide appropriate depictions of the expected maximum WSEs resulting from all future storm events, with the exceptions described in Appendix E. In these areas, future project activities should take into consideration these worst-case scenario inundations generated from smaller storm events by accounting for the maximum WSEs as defined in Appendix A.

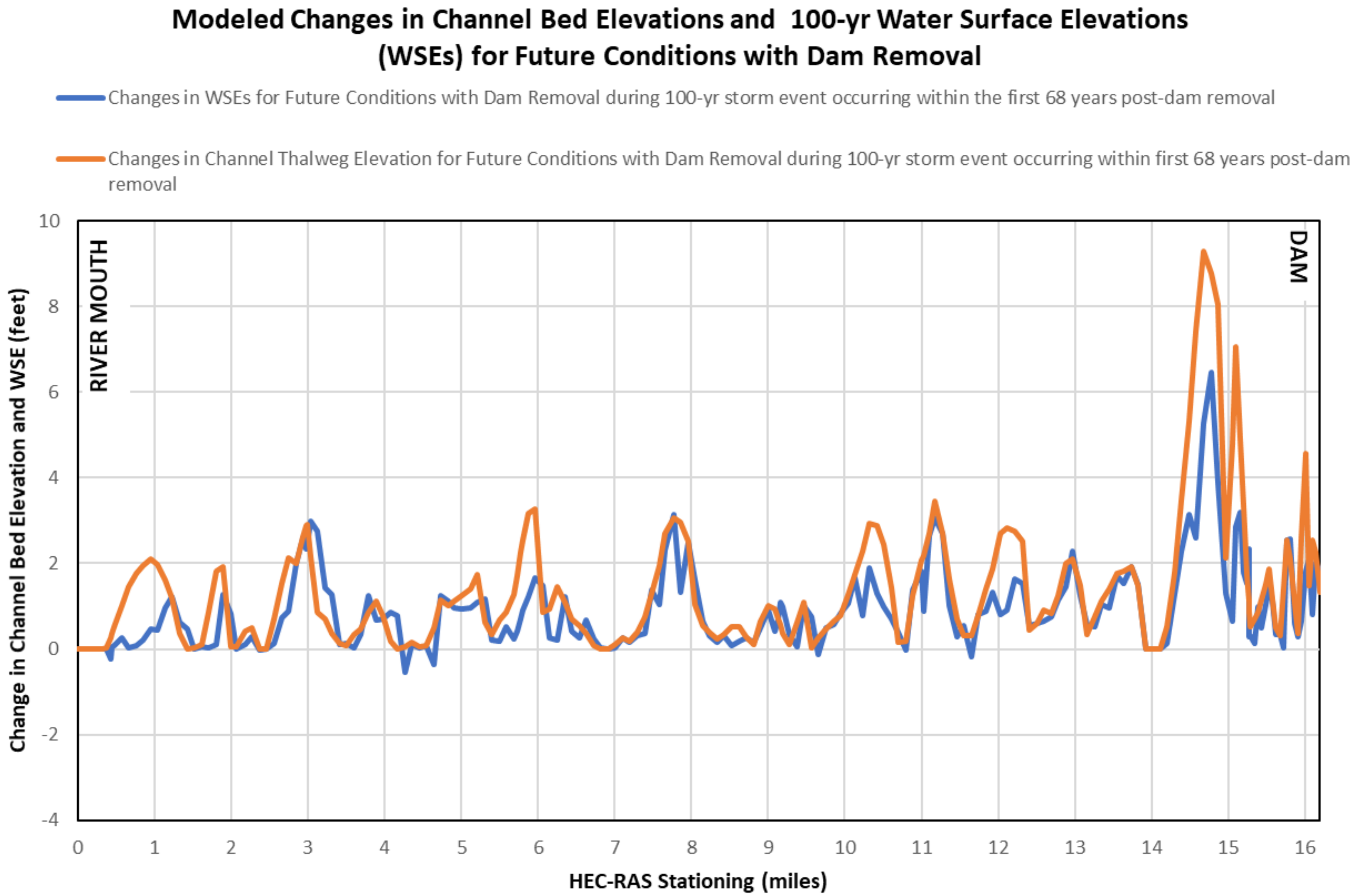

Figure 7. Maximum changes in WSEs expected during future 100-year event during the first 68 years following dam removal.

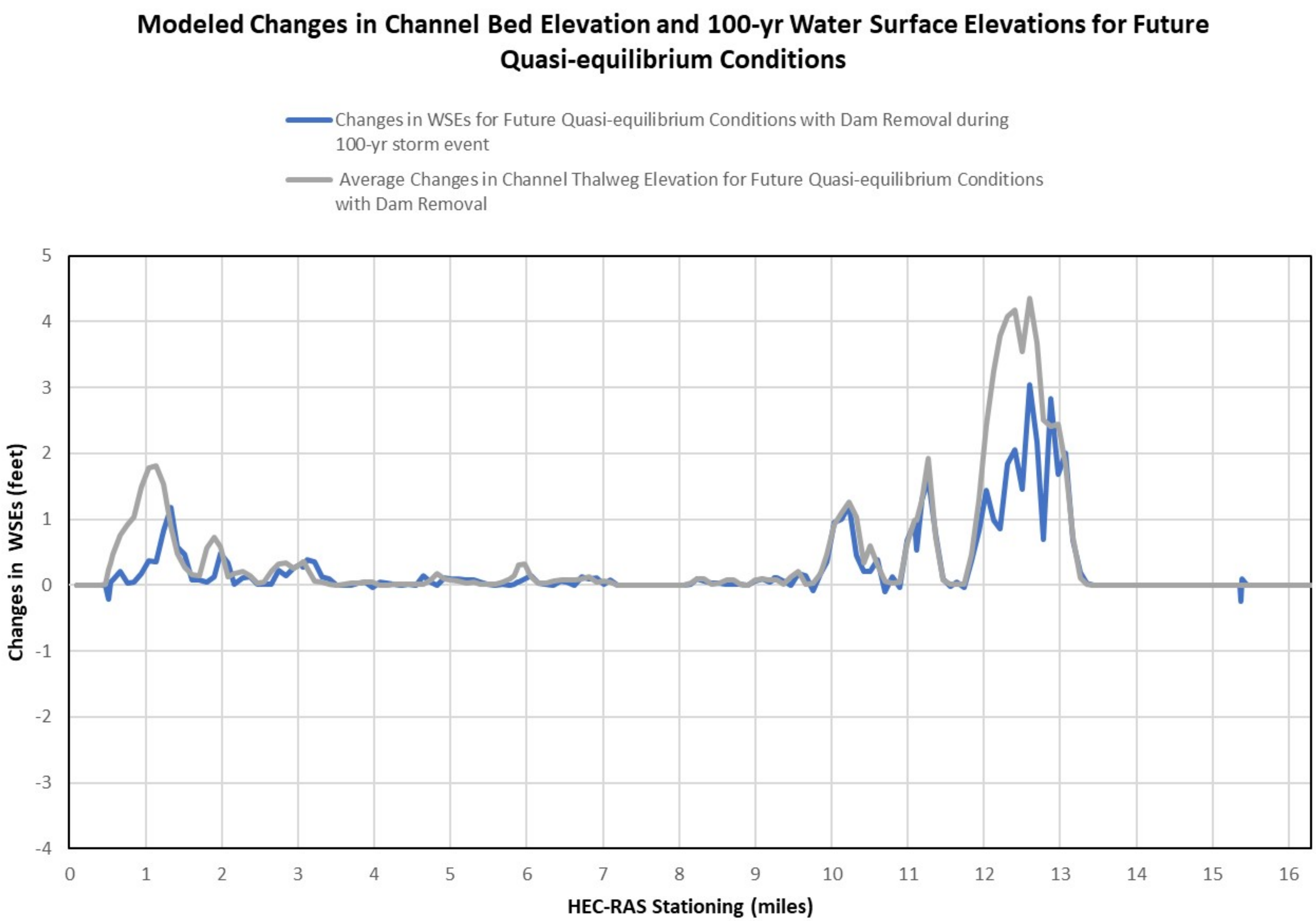

Figure 8. Average changes in 100-year WSEs expected in future quasi-equilibrium condition.

5 SUMMARY OF MAJOR FINDINGS AND RECOMMENDATIONS

5.1 General Results

Appendix A provides a tabular summary of project results. Figure 7, Figure 8, Appendix B, and Appendix C provide visual depictions of estimated increases in WSEs caused by dam removal. As expected, the channel reaches where 100-year WSEs are predicted to increase under future conditions are closely aligned with reaches where significant sediment aggradation is predicted by DREAM-2. There are several general results to highlight:

1. As shown on Figure 7, the area just upstream from Robles Diversion Dam (located at approximately RM 14) is expected to experience the greatest increases in 100-year WSEs of just over 6 feet as compared to current conditions with the dam in place. The rest of the study reach will likely see maximum 100-year WSE increases of 0 to 2 feet, with up to three feet at several additional locations (as compared to current conditions with the dam in place).
2. As shown on Figure 8, the most significant increase in long-term post-dam removal increases in WSEs is predicted to occur 1 to 2 miles downstream from Robles Diversion Dam, where increases in 100-year WSEs are likely to persist due to permanent rebounding of the channel bed as a more natural sediment supply is restored. Within this reach, long-term WSE increases of 2 to 3 feet should be expected (as compared to current conditions with the dam in place) while the rest of the study reach should expect minimal long-term changes.
3. As shown in Appendices B and C, most of the areas where increased flooding is predicted are already within the FEMA 100-year floodplain. While this does not change the implications of anticipated dam removal effects, it does highlight the fact that expected project impacts are mainly constrained to the portion of the river corridor that are already at risk of flooding under existing conditions.

5.2 Site-specific Results

Below is a summary of reach-specific results.

1. Reach B (immediately downstream of Matilija Dam): Under future conditions with dam removal, 100-year WSEs within Subreach B are expected to increase by ~3 feet at several locations, most notably between stations 16.0 and 16.1 where aerial imagery showed buildings within the floodplain (note that all structures were burned in the Thomas Fire in 2017). This is also an area where the HEC-RAS existing conditions model is predicting 100-year inundation outside of the FEMA 100-year floodplain extent. Additionally, Reach B is expected to experience extreme short-term channel aggradation immediately following dam removal during smaller storm events. Hydraulic modeling of the 20-yr event suggests that WSEs may be higher in smaller events than during the 100-yr event at some locations.
2. Reach C (upstream from Robles Diversion Dam): Under future conditions with dam removal, Subreach C will experience significant channel aggradation, leading to elevated flood risk. Following dam removal, 3 to 6 feet of WSE increases are expected at locations throughout the reach. Most of the predicted increases in future conditions flooding is contained within the FEMA 100-year floodplain, with the primary infrastructure concerns located between HEC-RAS stations 15 to 15.4. As previously discussed in Section 3.4, design for the replacement of the Camino Cielo Bridge, located at HEC-RAS station 15.36, is already in progress.

3. Reach D (downstream from Robles Diversion Dam): Just downstream from Robles Diversion Dam, there is extensive infrastructure located within the FEMA 100-year floodplain. Under future conditions with dam removal and with the construction of the HFSB at Robles Diversion Dam, 100-year WSEs within Subreach D are expected to increase by several feet, resulting in an increase in inundated floodplain area and flood risk for existing infrastructure. The channel aggradation within Subreach D is likely to be permanent, with 2 to 3 feet of long-term WSE increases predicted throughout much of this reach as shown on Figure 8. In addition to the proposed upgrades to the Robles Diversion Dam, channel and floodplain management actions are likely needed to reduce flood risk in this subreach. In addition to investigating engineering approaches to address this risk, a cost-benefit analyses should also be conducted that examines non-structural floodplain management alternatives (i.e. acquisition of vulnerable properties, flood control easements, and flood-proofing of individual structures) that reduce intrusion into the riverine and riparian corridor.

   Within the downriver portion of Subreach D, predicted flood increases resulting from the project are generally constrained to the active floodplain with minimal infrastructure risks associated with the increases in WSEs.

4. Subreach E (upstream and downstream of Baldwin Road Bridge): Under future conditions with dam removal minor aggradation throughout the reach does not lead to any significant increases in WSEs or flooding outside of the existing floodplain area.

5. Subreach F (upstream from San Antonio Creek confluence): Under future conditions with dam removal minor aggradation just downstream from the Santa Ana Bridge leads to minor WSEs increases at the bridge, which has the potential to increase flood risk. Under current conditions this bridge has already been identified as having insufficient freeboard during a 100-year discharge, so planning is already underway to design a new bridge with sufficient freeboard to allow passage of sediment and 100-year flows. Note that current conditions at this bridge crossing were modeled in HEC-RAS. The proposed bridge upgrade was not modeled.

6. Subreach G (San Antonio Creek confluence to Coyote Creek confluence): Under future conditions with dam removal, channel aggradation is predicted beginning at the San Antonio Creek confluence and extending downstream approximately 0.5 miles. This has the potential to increase WSEs by up to 3 feet. Fortunately, there is no extensive infrastructure in the immediate vicinity, and the primary area where flood risk will increase is for development on the right bank of the river along Hollingsworth Ranch Rd. Note that further analyses may be needed to determine the backwater effect of these predicted increases in WSEs on flooding along the lower reaches of San Antonio Creek.

   Farther downstream from the San Antonio Creek confluence, HEC-RAS model simulations for future conditions with dam removal are predicting increased 100-year WSEs of up to 1.65 feet around HEC-RAS Station 6. These increases in WSEs would lead to higher flood risk in Casitas Springs, a neighborhood already at risk according to the FEMA floodplain extents shown on Appendices B and C. There is also potential for increased flooding risk for residences along Santa Ana Road just upstream from the Coyote Creek confluence.

7. Subreaches H, I, & J (Coyote Creek confluence to Pacific Ocean): Under future conditions with dam removal, maximum 100-year WSE increases of up to 3 feet are expected around HEC-RAS Station 3.2 and maximum 50-year WSE increases of up to 3.6 feet (above existing 100-yr WSE) are expected around HEC-RAS Station 1.2. Other than that, WSE increases of 0 to 2 feet are expected. However, as discussed in Section 5.3, the probability of reaching the maximum predicted WSE increases within these reaches is significantly lower than upstream reaches.

5.3 Uncertainty and Risk Assessment

As described in the Sediment Transport Technical Report (Stillwater Sciences 2020), there are numerous uncertainties associated with sediment transport modeling. This is especially true for the downstream project reaches farther from Matilija Dam. As such, a critical risk management approach for this Project should be detailed monitoring of post-dam removal sediment deposition within the project reach and an adaptive management strategy to address unexpected sediment deposition patterns.

Based on these considerations, an initial analysis of uncertainty and risk has been applied to the hydraulic modeling results described in Figure 7 and Figure 8 and has resulted in the following recommendations:

- Upstream from the San Antonio Creek confluence (HEC-RAS Station 7.9), the 100-year WSEs shown in Figure 7 and Figure 8 have yearly occurrence likelihoods of approximately 1 in 100. This is based on proximity to the Matilija Dam removal project and consistency with past scientific study results (BOR 2006, Cui et al. 2014).
- Downstream from the San Antonio Creek confluence, the 100-year WSEs shown on Figure 7 and Figure 8 are expected to have yearly occurrence likelihoods of significantly less than 1 in 100. This is based on the improbability of peak sediment pulses within this reach coinciding exactly with a 100-year flow event and monitoring results from the Marmot Dam removal project (Cui et al. 2014) showing that predicted sediment deposits farther from the dam did not occur. Furthermore, being farther away from the Matilija Dam will allow for the monitoring and adaptive management strategy described above to be more competent at reducing risk within this reach.

These preliminary guidelines for risk assessment provide an overview framework, but it is recommended that site-specific infrastructure design activities also include a more detailed uncertainty and risk assessment that identifies and quantifies sources of uncertainty and site-specific risk to develop appropriate engineering designs.

5.4 Next Steps

The next phase of the Project will involve focused analyses to further quantify flood risk to existing and proposed infrastructure including bridges, levees, structures, and property. Specifically, AECOM is assessing downstream property risk and Tetra Tech and other consultants are designing levee and bridge improvements.

The findings presented herein should guide these efforts, but it is important to acknowledge the relatively coarse nature of the sediment transport and hydraulic modeling approaches completed to date that provide results aimed to support planning but are not suitable for infrastructure design. At critical locations where further focused studies are needed, additional site-specific hydraulic modeling is recommended:

1. 2D hydraulic modeling should be utilized to accurately capture flow splits, backwater areas and to generally provide more accurate modeling results.
2. Current LiDAR and/or field-based topographic surveys should be utilized to verify current channel conditions including ground surface elevations within the channel and floodplains as well as the specific extent, elevation, and condition of adjacent infrastructure (levees, bridges, culverts, etc.).

3. A more detailed hydrologic and hydraulic analyses of tributary flow inputs should be conducted as applicable. As described previously in Section 2.4, results in this technical report included only a simplified backwater analyses of three critical communities.
4. Sediment deposition predicted by DREAM-2 should be incorporated into the future-conditions 2-D hydraulic model to simulate post-dam removal channel aggradation.

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Appendices

Appendix A

Table Summarizing Increases in Water Surface Elevations

Summary of Changes in Channel Bed Elevation & Water Surface Elevation (WSE)								
HEC-RAS River Station (mi)	**Existing Conditions**		**Future Dam Removal**				**Future Quasi-equilibrium**	
	Channel Bed Elevation (ft)	100-yr WSE (ft)	Change in Channel Bed Elevation (ft)	Change in 100-yr WSE (ft)	Increase in WSE during 20-yr event above Existing 100-yr WSE if >Future 100-yr WSE (ft)	Increase in WSE during 50-yr event above Existing 100-yr WSE if >Future 100-yr WSE (ft)	Change in Channel Bed Elevation (ft)	Change in 100-yr WSE (ft)
16.2879	981.08	995.75	1.32	1.79			0	0
16.2382	975.25	988.94	2.25	2.02			0	0
16.1932	969.66	983.37	2.55	0.81			0	0
16.1495	962.95	977.15	1.48	2.11			0	0
16.0984	956.23	972.42	4.58	1.83			0	0
16.054	949.18	966.38	2.6	0.66			0	0
16.0038	939.92	956.18	0.37	0.3	1.04		0	0
15.9593	935.46	950.35	1.06	0.6			0	0
15.9091	931.99	944.96	2.11	2.58			0	0
15.8642	927.06	938.71	2.54	2.54	3.33		0	0
15.8144	918.67	932.11	1.41	0.03	1.21		0	0
15.7658	910.58	926.05	0.32	0.35	0.86		0	0
15.7197	905.9	921.78	0.49	0.33			0	0
15.6746	902.99	916.87	1.17	1.12	2.26		0	0
15.625	896.78	910.26	1.87	1.47	2.7		0	0
15.5766	892.71	903.49	1.5	1.04	1.13		0	0
15.5303	883.64	897.41	1.15	0.5			0	0
15.4789	880.99	893.44	0.85	0.99			0	-0.01
15.436	875.25	888.27	0.69	0.14	1.57		0	0.02
15.3873	870.79	886.35	0.51	0.32			0	0.09
15.3675	870.18	883.7	0.85	0.29	1.38		0	-0.25
15.3591	868.08	881.87	1.13	2.33	2.9		0	0
15.3409	867.46	880.15	1.73	1.53			0	0
15.2917	864.85	875.64	3.35	1.78			0	0
15.2462	858.93	870.23	4.9	3.19			0	0
15.1901	852.89	863.82	7.06	2.85			0	0
15.1515	850.53	860.94	4.77	0.66			0	0
15.0568	839.11	849.92	2.12	1.29			0	0
14.9621	826.55	841.04	8.03	3.87			0	0
14.8674	817.59	831.78	8.76	6.47			0	0
14.7727	811.81	824.63	9.3	5.27			0	0
14.678	804.96	818.27	7.42	2.6			0	0
14.5833	794.57	810.51	5.33	3.14			0	0
14.4886	788.62	803.84	3.49	2.28			0	0
14.3939	783.8	797.7	1.78	1.3			0	0
14.2992	776.1	789.25	0.51	0.13			0	0
14.2045	771.83	782.5	0	0			0	0
14.1098	766.89	777.61	0	-0.01			0	0
14.0152	766.81	772.8	0	0			0	0
13.9205	746.96	757.29	1.49	1.5			0	0
13.8258	736.73	748.27	1.93	1.93			0	0
13.7311	726.93	741.32	1.82	1.53			0	0
13.6364	725.8	736.4	1.77	1.71			0	0
13.5417	719.47	729.58	1.4	0.96			0	0
13.447	711.25	721.21	1.13	1.03			0	0

Summary of Changes in Channel Bed Elevation & Water Surface Elevation (WSE)

HEC-RAS River Station (mi)	Existing Conditions		Future Dam Removal				Future Quasi-equilibrium	
	Channel Bed Elevation (ft)	100-yr WSE (ft)	Change in Channel Bed Elevation (ft)	Change in 100-yr WSE (ft)	Increase in WSE during 20-yr event above Existing 100-yr WSE if >Future 100-yr WSE (ft)	Increase in WSE during 50-yr event above Existing 100-yr WSE if >Future 100-yr WSE (ft)	Change in Channel Bed Elevation (ft)	Change in 100-yr WSE (ft)
13.3523	704.61	714.19	0.76	0.52			0.02	0.03
13.2576	691.97	705.06	0.34	0.57			0.11	0.19
13.1629	687.2	698.26	1.48	1.24			0.73	0.68
13.0682	675.25	688.08	2.11	2.28			1.83	2
12.9735	667.34	680.4	2	1.46			2.45	1.68
12.8788	663.11	672.95	1.26	1.14			2.41	2.83
12.7841	657.14	665.2	0.83	0.75			2.51	0.7
12.6894	650.15	658.28	0.9	0.64	1.23	1.34	3.68	2.17
12.5947	644.07	649.76	0.59	0.6	1.72	1.87	4.36	3.04
12.5	635.81	641.46	0.45	0.54		0.66	3.54	1.46
12.4053	624.03	632.58	2.52	1.53		1.77	4.18	2.06
12.3106	618.32	624.86	2.74	1.63			4.08	1.85
12.2159	607.01	617.64	2.83	0.9			3.79	0.85
12.1212	604.05	610.33	2.71	0.8			3.25	0.99
12.0265	593.51	603.11	1.86	1.32			2.42	1.43
11.9318	587.36	596.87	1.4	0.89			1.3	0.83
11.8371	583	590.19	0.78	0.81			0.46	0.37
11.7424	574.91	582.77	0.32	-0.17			0.01	-0.03
11.6477	568.53	575.43	0.31	0.55			0.01	0.04
11.553	560.25	567.87	0.69	0.28			0.01	-0.02
11.4583	552.05	559.78	1.64	1.02			0.08	0.09
11.3636	544.21	551.08	2.71	2.71	2.77		0.72	0.78
11.2689	535.38	543.56	3.45	3.05			1.92	1.62
11.1895	527.91	537.78	2.69	2.64			1.29	1.29
11.1181	525.42	534.19	2.19	0.89			0.99	0.53
11.0926	521.1	529.52	2.09	1.83			0.98	0.96
10.9848	514.17	521.49	1.24	1.38			0.63	0.67
10.8902	506.13	515.36	0.18	-0.03	0.19		0.04	-0.04
10.7955	501.57	509	0.17	0.39	0.49	0.45	0.03	0.12
10.7008	494.88	503.03	1.43	0.7			0.06	-0.1
10.6061	489.13	496.59	2.43	1			0.3	0.39
10.5114	481.09	490.11	2.89	1.29			0.59	0.21
10.4167	472.86	481.95	2.94	1.9			0.34	0.2
10.322	466.72	476.02	2.29	0.79			1.03	0.45
10.2273	460.79	468.64	1.73	1.65			1.26	1.21
10.1326	454.16	461.99	1.27	1.07			1.09	1
10.0379	446.22	455.64	0.79	0.82			0.92	0.95
9.9432	439.85	448.6	0.66	0.57			0.47	0.36
9.8485	435.45	442.06	0.48	0.5			0.17	0.17
9.7538	427.53	435.55	0.25	-0.12			0.03	-0.08
9.6591	417.72	428.88	0.03	0.76		1.05	0.01	0.14
9.5644	412.61	424.82	1.1	1.01		1.26	0.21	0.18
9.4697	407.52	419.78	0.63	0.06			0.12	0
9.375	405.26	413.99	0.11	0.33			0.02	0.06
9.2871	395.34	410.48	0.37	0.98			0.07	0.11

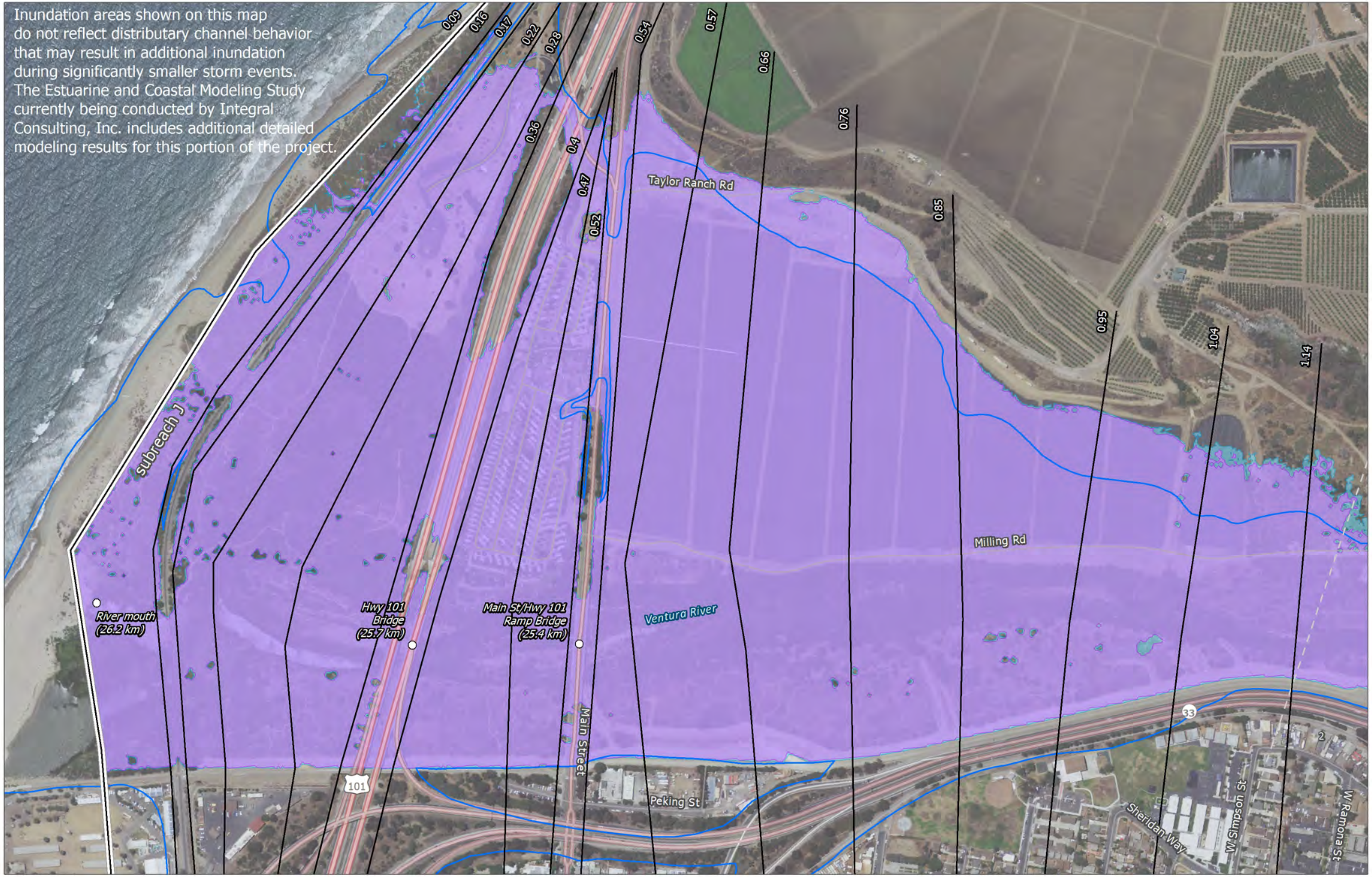
Summary of Changes in Channel Bed Elevation & Water Surface Elevation (WSE)								
HEC-RAS River Station (mi)	**Existing Conditions**		**Future Dam Removal**				**Future Quasi-equilibrium**	
	Channel Bed Elevation (ft)	100-yr WSE (ft)	Change in Channel Bed Elevation (ft)	Change in 100-yr WSE (ft)	Increase in WSE during 20-yr event above Existing 100-yr WSE if >Future 100-yr WSE (ft)	Increase in WSE during 50-yr event above Existing 100-yr WSE if >Future 100-yr WSE (ft)	Change in Channel Bed Elevation (ft)	Change in 100-yr WSE (ft)
9.2507	393.17	409.41	0.57	1.1			0.07	0.11
9.2297	393.25	405.43	0.69	0.7			0.07	0.08
9.1856	392.07	403.55	0.94	0.42			0.07	0.04
9.0909	386.68	395.68	1.01	0.9			0.1	0.09
8.9962	380.95	388.46	0.66	0.5			0.07	0.06
8.9015	371.36	380.81	0.11	0.17			0	0
8.8068	367.28	374.95	0.3	0.25			0.01	0.02
8.7121	358.5	368.07	0.52	0.19			0.08	0.02
8.6174	353.19	360.14	0.53	0.07			0.08	0.02
8.5227	346.46	352.35	0.35	0.32			0.03	0.03
8.428	337.62	346.44	0.23	0.16			0.02	0.03
8.3333	331.71	340.52	0.4	0.32			0.1	0.06
8.2386	324.54	332.95	0.55	0.66			0.09	0.09
8.1439	318.73	327.47	1.05	1.6			0.03	0.02
8.0492	312.07	322.14	2.53	2.48			0	0
7.9545	307.56	321.14	2.95	1.33			0	0
7.8598	302.13	315.16	3.07	3.14			0	0
7.7558	295.23	310.01	2.69	2.3			0	0
7.6705	291.26	307.1	1.96	1.05			0	0
7.5758	287.96	302.13	1.3	1.38			0	0
7.4811	287.26	299.86	0.76	0.37			0	0
7.3864	281.83	294.97	0.39	0.31			0	0
7.2917	276.66	290.37	0.19	0.17			0	0
7.197	275.78	285.1	0.26	0.26			0	0
7.1023	269.64	279.87	0.11	0.04			0.04	0.08
7.0076	262.36	275.38	0	-0.01			0.06	0.02
6.9129	257.38	270.95	0.01	0.03		0.33	0.05	0.11
6.8182	255.53	267.21	0.09	0.23			0.13	0.09
6.7235	250.31	263.6	0.36	0.68			0.1	0.12
6.6288	246.84	258.25	0.55	0.25			0.07	0
6.5341	244.45	256.25	0.71	0.41			0.07	0.04
6.4394	241.36	251.64	1.1	1.22			0.08	0.06
6.3447	235.1	246.71	1.45	0.22			0.06	0
6.25	229.7	243.67	0.93	0.25			0.03	0.02
6.1553	226.72	238.38	0.85	1.48			0.03	0.03
6.0606	222.57	237.76	3.28	1.65			0.12	0.14
5.9723	215.68	236.6	3.16	1.22			0.32	0.09
5.8932	210.87	235.68	2.54	0.92			0.31	0.04
5.8716	210.28	235.22	2.25	0.71			0.25	0.04
5.83	208.05	232.65	1.71	0.43			0.15	0.02
5.7765	206.2	229.25	1.28	0.23			0.09	-0.01
5.6818	203.87	225.41	0.85	0.53			0.04	0.02
5.5871	202.45	221.11	0.68	0.19			0.01	0
5.4924	199.58	217.7	0.34	0.22			0.01	0.01
5.3977	191.56	209.51	0.63	1.16			0.02	0.04

Summary of Changes in Channel Bed Elevation & Water Surface Elevation (WSE)								
	Existing Conditions		**Future Dam Removal**				**Future Quasi-equilibrium**	
HEC-RAS River Station (mi)	Channel Bed Elevation (ft)	100-yr WSE (ft)	Change in Channel Bed Elevation (ft)	Change in 100-yr WSE (ft)	Increase in WSE during 20-yr event above Existing 100-yr WSE if >Future 100-yr WSE (ft)	Increase in WSE during 50-yr event above Existing 100-yr WSE if >Future 100-yr WSE (ft)	Change in Channel Bed Elevation (ft)	Change in 100-yr WSE (ft)
5.303	190.9	209.46	1.75	1.1			0.04	0.08
5.2083	182.32	208.54	1.4	0.97			0.03	0.08
5.0959	178.92	205.65	1.26	0.93			0.06	0.1
5.0045	174.25	204.12	1.12	0.95			0.08	0.09
4.9242	173.91	195.92	1.02	1.11			0.1	0.11
4.8295	170.42	192.18	1.15	1.25			0.18	-0.01
4.7349	168.72	190.78	0.5	-0.35			0.07	0.04
4.6402	164.82	186.53	0.09	0.08			0.01	0.15
4.5512	162.59	182.57	0.05	0.02			0.02	0
4.4508	155.86	176.49	0.16	0.11			0.01	0.01
4.3561	151.25	173.39	0.05	-0.54			0.02	0
4.2614	149.91	168.23	0	0.78			0.01	0.01
4.1667	143.02	167.47	0.18	0.85			0	0.03
4.072	140.62	165.59	0.79	0.69			0	0.04
3.9773	135.2	158.25	1.12	0.67			0.04	-0.03
3.8826	133.69	150.83	0.85	1.26			0.04	0.05
3.7879	127.71	148.66	0.46	0.34			0.03	0.03
3.6932	124.95	145.55	0.35	0.03			0.03	0
3.5985	123.01	142.85	0.08	0.13			0.01	0
3.5038	120.9	137.15	0.12	0.11			0	0
3.4091	112.87	132.02	0.36	1.27			0.01	0.1
3.3144	106.75	131.23	0.71	1.43			0.04	0.12
3.2197	102.99	126.99	0.87	2.74			0.06	0.35
3.125	100.51	122.55	2.15	2.99			0.25	0.38
3.0799	98.33	122.44	2.9	2.46			0.36	0.31
3.0651	97.49	121.38	2.89	2.33			0.36	0.28
3.0303	96.88	116.72	2.61	2.6			0.32	0.32
2.9356	88.37	109.91	2.01	1.99			0.25	0.25
2.8409	85.66	107.2	2.14	0.89			0.34	0.14
2.7462	82.87	105.24	1.54	0.73			0.32	0.22
2.6515	81.97	100.19	0.71	0.14			0.2	0.02
2.5568	80.68	96.22	0	0			0.04	0.02
2.4621	79.84	91.37	0	-0.03			0.03	0.01
2.3674	72.84	84.08	0.5	0.29			0.15	0.12
2.2727	68.13	79.57	0.41	0.11			0.2	0.11
2.165	59.45	76.14	0.06	0			0.17	0.02
2.0833	58.5	72.93	0.05	0.84		0.87	0.13	0.34
1.9886	56.39	70.18	1.91	1.28		2.3	0.58	0.48
1.8939	50.14	68.69	1.83	0.1		0.16	0.73	0.13
1.7992	45.08	67.52	0.86	0.03			0.57	0.05
1.7045	42.88	61.95	0.1	0.06			0.14	0.07
1.6098	41.17	57.1	0.02	0.01		0.52	0.16	0.07
1.5152	37.77	55.16	0	0.48		0.69	0.27	0.47
1.4205	37.44	53.94	0.37	0.63		0.66	0.49	0.58
1.3258	30.45	51.61	1.2	1.22		1.99	0.88	1.18

Summary of Changes in Channel Bed Elevation & Water Surface Elevation (WSE)								
HEC-RAS River Station (mi)	**Existing Conditions**		**Future Dam Removal**				**Future Quasi-equilibrium**	
	Channel Bed Elevation (ft)	100-yr WSE (ft)	Change in Channel Bed Elevation (ft)	Change in 100-yr WSE (ft)	Increase in WSE during 20-yr event above Existing 100-yr WSE if >Future 100-yr WSE (ft)	Increase in WSE during 50-yr event above Existing 100-yr WSE if >Future 100-yr WSE (ft)	Change in Channel Bed Elevation (ft)	Change in 100-yr WSE (ft)
1.2311	28.25	47.3	1.61	0.96	2.48	3.59	1.53	0.83
1.1364	23.51	46.51	1.98	0.45		0.96	1.81	0.36
1.0417	22.08	43.73	2.1	0.47		1.09	1.77	0.37
0.947	19.03	41.61	1.95	0.22			1.48	0.17
0.8523	18.47	37.65	1.76	0.07			1.04	0.04
0.7576	18.17	33.48	1.45	0.03			0.92	0.03
0.6629	16.29	29.75	1.01	0.26			0.75	0.21
0.5713	12.3	28.05	0.51	0.08			0.47	0.08
0.5436	11.33	27.91	0.37	0.05			0.34	0.05
0.5198	10.82	25.64	0.26	-0.23			0.24	-0.22
0.4708	9.36	24.86	0.02	0			0.02	0
0.4011	4.9	24.85	0	0			0	0
0.359	4.97	20.13	0	0			0	0
0.2841	4.25	18.34	0	0			0	0
0.2164	2.69	16.4	0	0			0	0
0.175	2.67	16.08	0	0			0	0
0.1569	2.74	13.14	0	0			0	0
0.0947	2.32	10	0	0			0	0

Appendix B

Floodplain Maps Showing Maximum Expected Inundation During 100-year Storm Event During the First 68 Years Following Dam Removal



VENTURA RIVER, CALIFORNIA

100 YEAR FLOODPLAIN
Subreach J

DATA SOURCES
Current & Dam Removal 100-year FP: Stillwater Sciences 2019, with 2005 USBR LiDAR
FEMA 100 year FP: FEMA
Imagery: NAIP 2016
Roads, cities, streams, and waterbodies: ESRI 2016

LEGEND

- Adjacent tile
- Point of Interest (labeled with Sediment Transport Model river stationing)
- HEC-RAS cross section
- Subreach break
- FEMA 100-year floodplain extent
- Future (Dam Removal) maximum 100-year floodplain extent
- Current 100-year floodplain from HEC-RAS

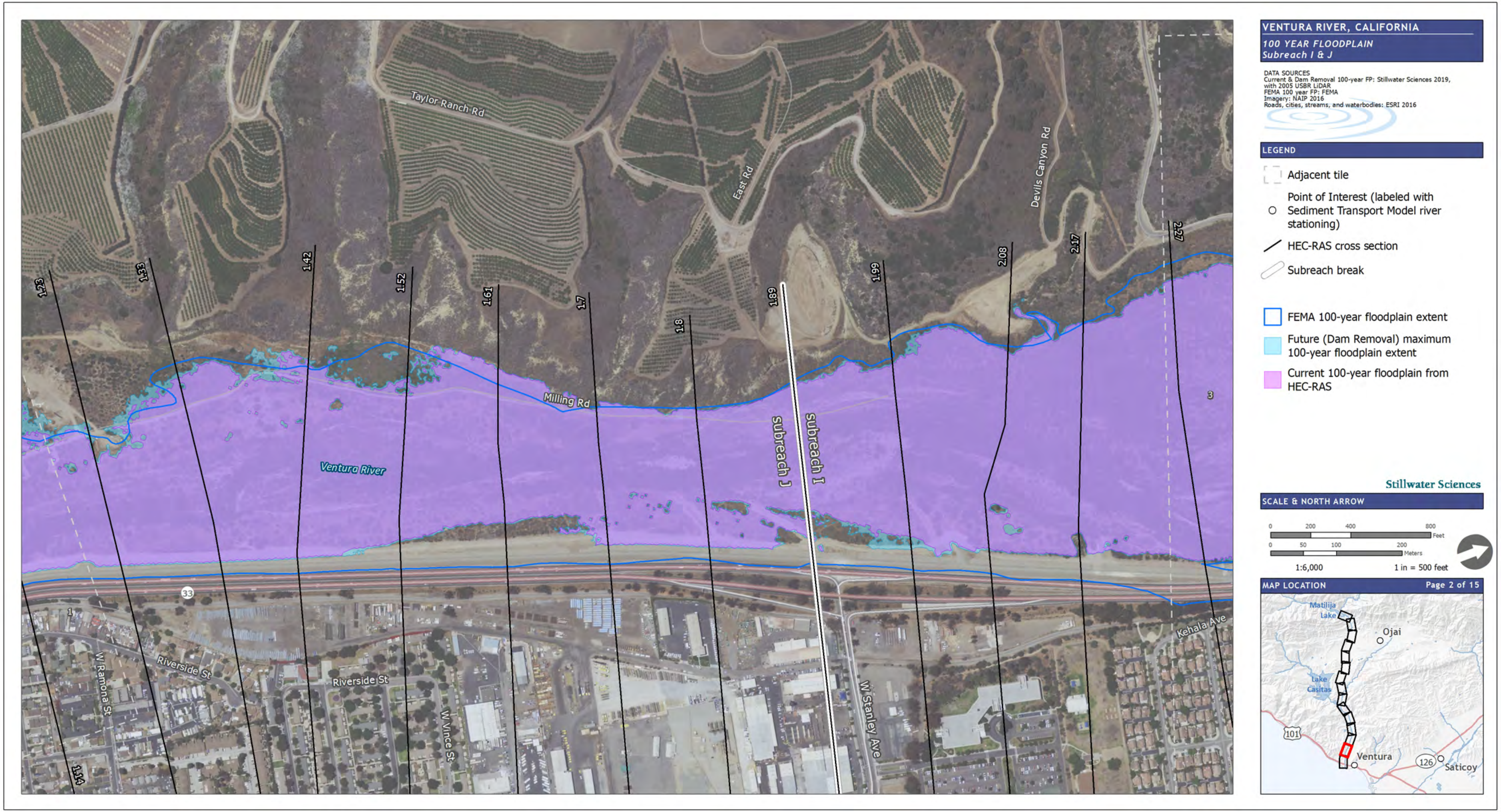
Stillwater Sciences

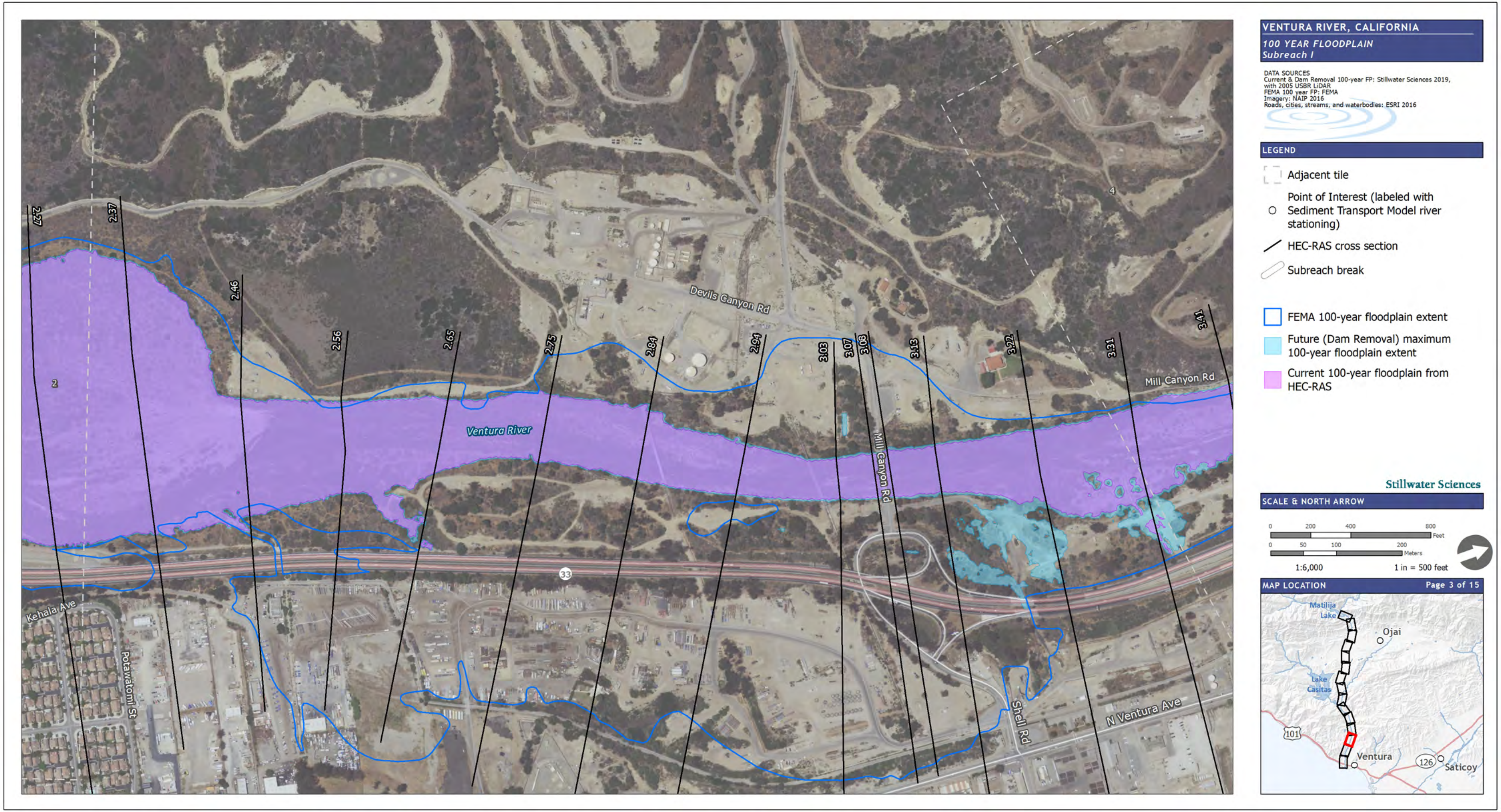
SCALE & NORTH ARROW

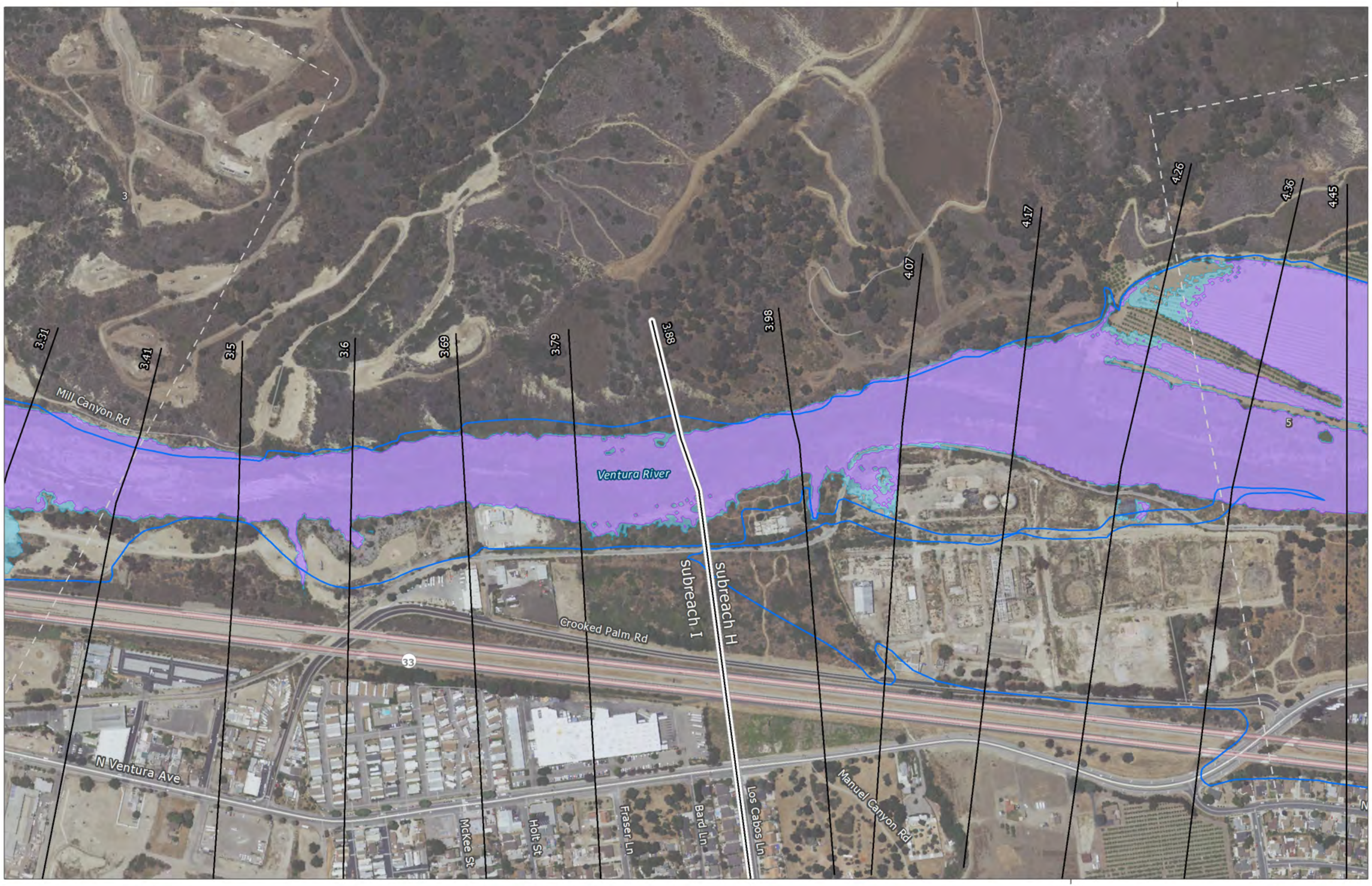
0 200 400 800 Feet
0 50 100 200 Meters

1:6,000 1 in = 500 feet

MAP LOCATION


VENTURA RIVER, CALIFORNIA
100 YEAR FLOODPLAIN
Subreach I & J
DATA SOURCES
Current & Dam Removal 100-year FP: Stillwater Sciences 2019, with 2005 USBR LiDAR
FEMA 100 year FP: FEMA
Imagery: NAIP 2016
Roads, cities, streams, and waterbodies: ESRI 2016
LEGEND
Adjacent tile
Point of Interest (labeled with Sediment Transport Model river stationing)
HEC-RAS cross section
Subreach break
FEMA 100-year floodplain extent
Future (Dam Removal) maximum 100-year floodplain extent
Current 100-year floodplain from HEC-RAS
Stillwater Sciences
SCALE & NORTH ARROW
0 200 400 800 Feet
0 50 100 200 Meters
1:6,000
1 in = 500 feet
MAP LOCATION
Page 2 of 15
Matilija Lake
Ojai
Lake Casitas
Ventura
Saticoy
101
126
Taylor Ranch Rd
East Rd
Devils Canyon Rd
Milling Rd
Ventura River
subreach J
subreach I
Riverside St
W Ramona St
W Vince St
W Stanley Ave
Kehala Ave
33
1.14
1.23
1.33
1.42
1.52
1.61
1.7
1.8
1.89
1.99
2.08
2.17
2.27
1
3


VENTURA RIVER, CALIFORNIA
100 YEAR FLOODPLAIN
Subreach I
DATA SOURCES
Current & Dam Removal 100-year FP: Stillwater Sciences 2019, with 2005 USBR LiDAR
FEMA 100 year FP: FEMA
Imagery: NAIP 2016
Roads, cities, streams, and waterbodies: ESRI 2016
LEGEND
Adjacent tile
Point of Interest (labeled with Sediment Transport Model river stationing)
HEC-RAS cross section
Subreach break
FEMA 100-year floodplain extent
Future (Dam Removal) maximum 100-year floodplain extent
Current 100-year floodplain from HEC-RAS
Stillwater Sciences
SCALE & NORTH ARROW
0 200 400 800 Feet
0 50 100 200 Meters
1:6,000
1 in = 500 feet
MAP LOCATION
Page 3 of 15
Matilija Lake
Ojai
Lake Casitas
101
Ventura
126
Saticoy
2.27
2.37
2.46
2.56
2.65
2.75
2.84
2.94
3.03
3.07
3.08
3.13
3.22
3.31
3.41
2
4
Devils Canyon Rd
Mill Canyon Rd
Ventura River
33
Kehala Ave
Potawatomi St
Shell Rd
N Ventura Ave



VENTURA RIVER, CALIFORNIA

100 YEAR FLOODPLAIN
Subreach H & I

DATA SOURCES
Current & Dam Removal 100-year FP: Stillwater Sciences 2019, with 2005 USBR LiDAR
FEMA 100 year FP: FEMA
Imagery: NAIP 2016
Roads, cities, streams, and waterbodies: ESRI 2016

LEGEND

- Adjacent tile
- Point of Interest (labeled with Sediment Transport Model river stationing)
- HEC-RAS cross section
- Subreach break
- FEMA 100-year floodplain extent
- Future (Dam Removal) maximum 100-year floodplain extent
- Current 100-year floodplain from HEC-RAS

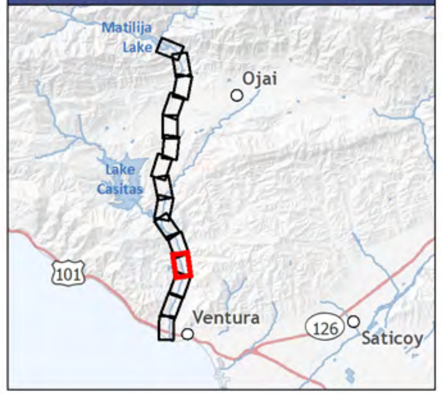
Stillwater Sciences

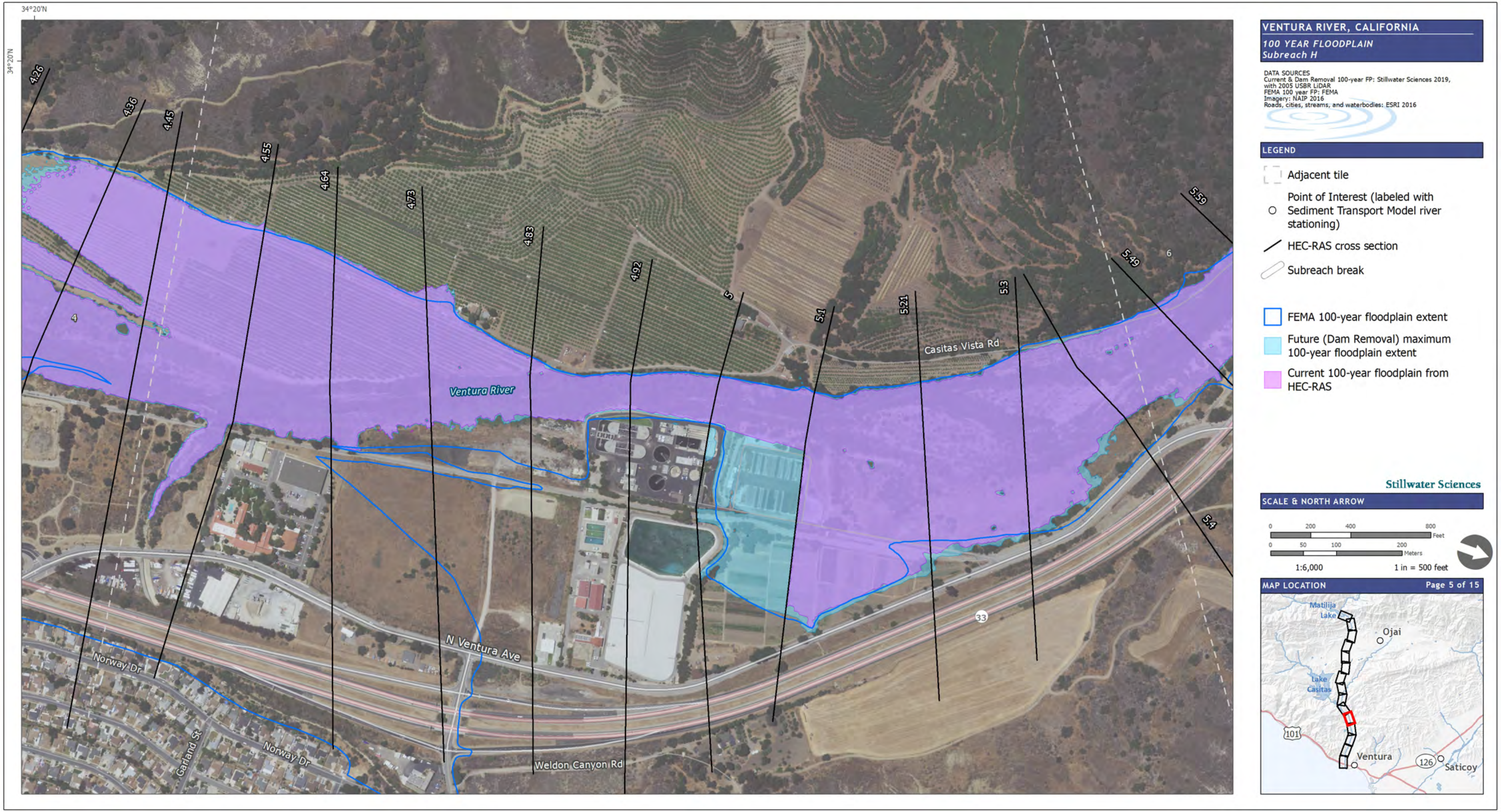
SCALE & NORTH ARROW

0 200 400 800 Feet
0 50 100 200 Meters
1:6,000
1 in = 500 feet

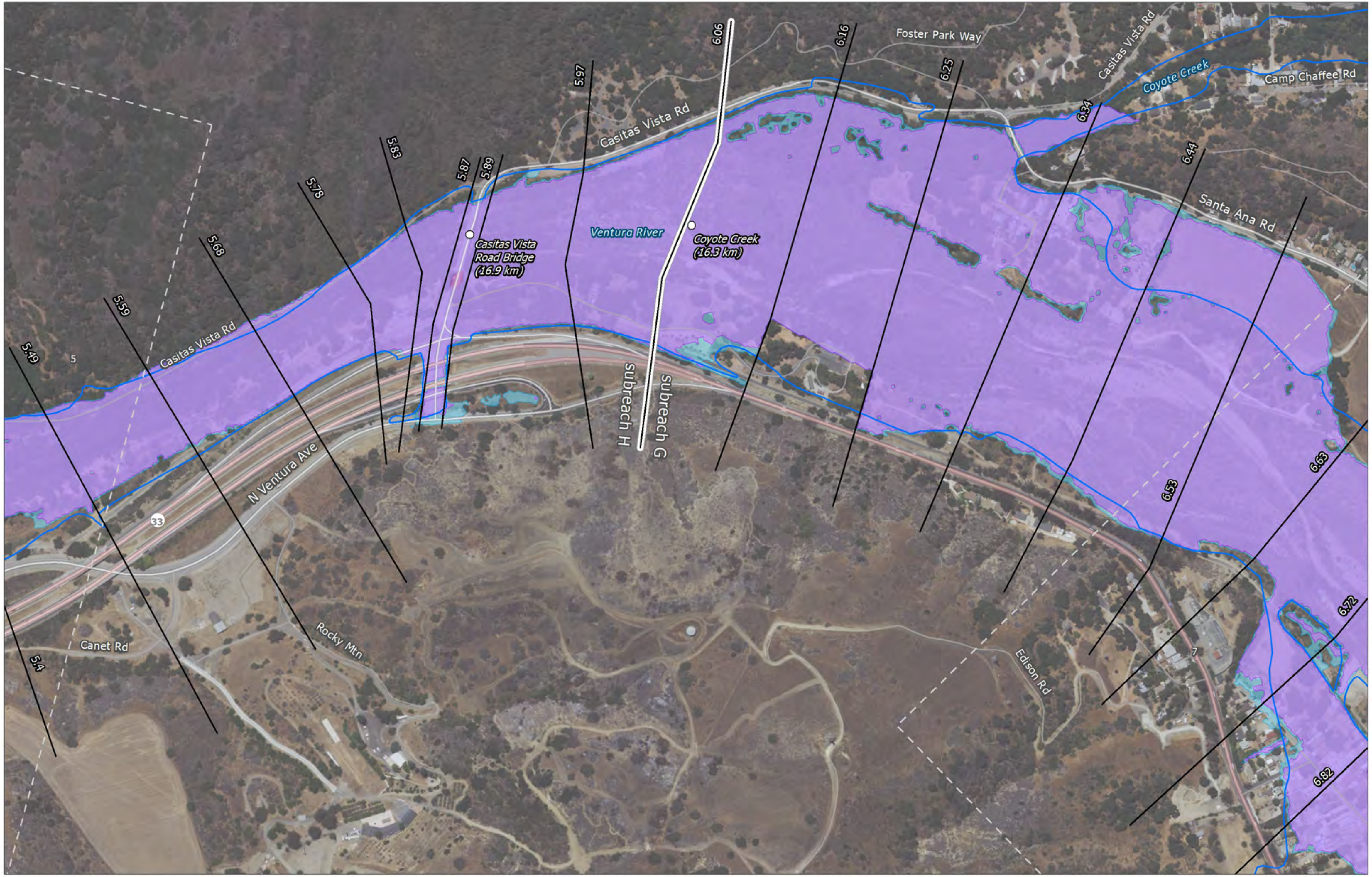
MAP LOCATION

Page 4 of 15





VENTURA RIVER, CALIFORNIA
100 YEAR FLOODPLAIN
Subreach H
DATA SOURCES
Current & Dam Removal 100-year FP: Stillwater Sciences 2019, with 2005 USBR LiDAR
FEMA 100 year FP: FEMA
Imagery: NAIP 2016
Roads, cities, streams, and waterbodies: ESRI 2016
LEGEND
Adjacent tile
Point of Interest (labeled with Sediment Transport Model river stationing)
HEC-RAS cross section
Subreach break
FEMA 100-year floodplain extent
Future (Dam Removal) maximum 100-year floodplain extent
Current 100-year floodplain from HEC-RAS
Stillwater Sciences
SCALE & NORTH ARROW
0 200 400 800 Feet
0 50 100 200 Meters
1:6,000
1 in = 500 feet
MAP LOCATION
Page 5 of 15
Matilija Lake
Ojai
Lake Casitas
101
Ventura
126
Saticoy
34°20'N
4.26
4.36
4.45
4.55
4.64
4.73
4.83
4.92
5
5.1
5.21
5.3
5.49
5.59
5.4
4
6
Ventura River
Casitas Vista Rd
N Ventura Ave
Norway Dr
Garland St
Weldon Canyon Rd
33



VENTURA RIVER, CALIFORNIA

100 YEAR FLOODPLAIN
Subreach G & H

DATA SOURCES
Current & Dam Removal 100-year FP: Stillwater Sciences 2019, with 2005 USBR LiDAR
FEMA 100 year FP: FEMA
Imagery: NAIP 2016
Roads, cities, streams, and waterbodies: ESRI 2016

LEGEND

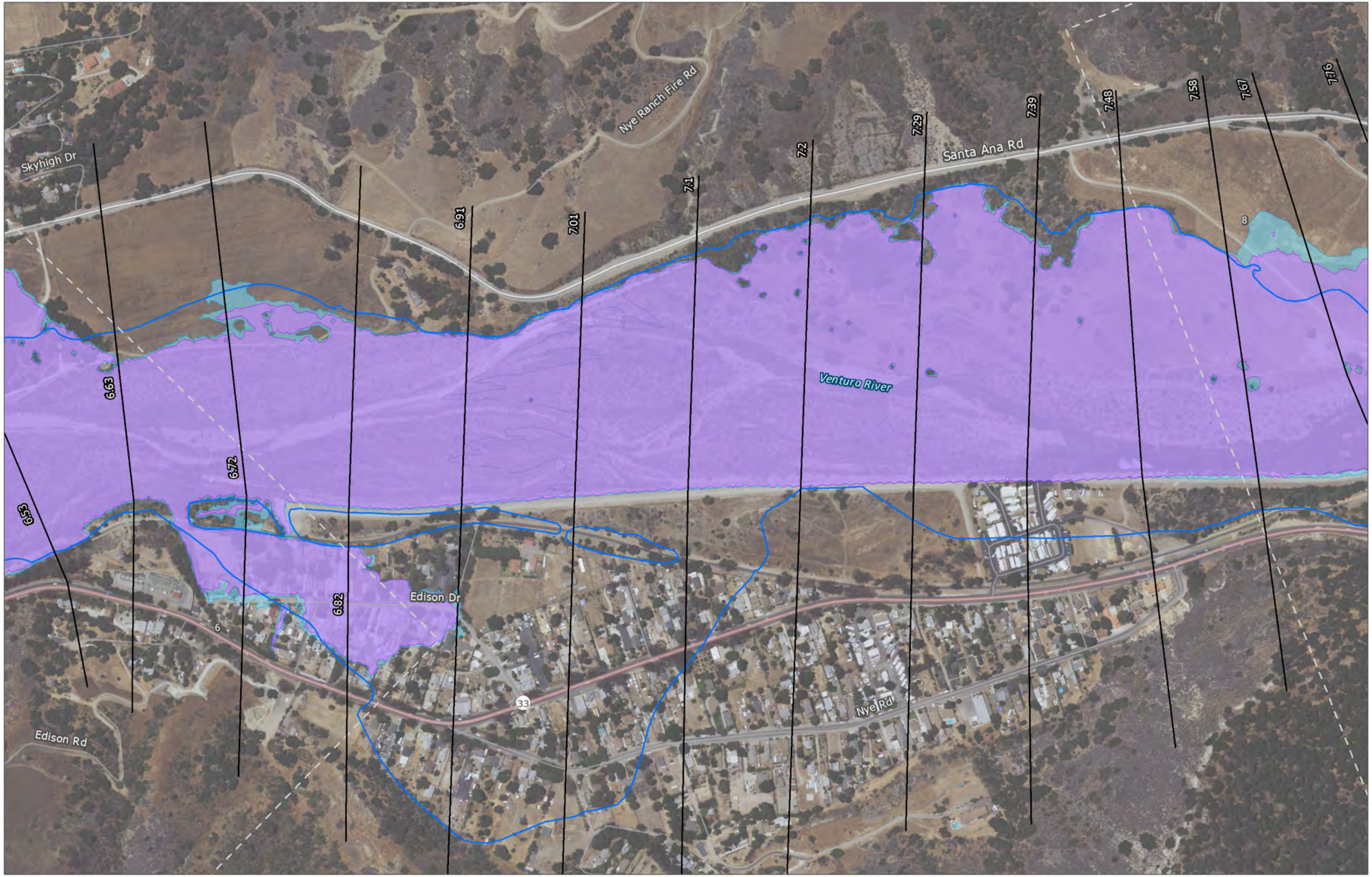
- Adjacent tile
- Point of Interest (labeled with Sediment Transport Model river stationing)
- HEC-RAS cross section
- Subreach break
- FEMA 100-year floodplain extent
- Future (Dam Removal) maximum 100-year floodplain extent
- Current 100-year floodplain from HEC-RAS

Stillwater Sciences

SCALE & NORTH ARROW

0 200 400 800 Feet
0 50 100 200 Meters
1:6,000
1 in = 500 feet

MAP LOCATION



VENTURA RIVER, CALIFORNIA

100 YEAR FLOODPLAIN
Subreach G

DATA SOURCES
Current & Dam Removal 100-year FP: Stillwater Sciences 2019, with 2005 USBR LiDAR
FEMA 100 year FP: FEMA
Imagery: NAIP 2016
Roads, cities, streams, and waterbodies: ESRI 2016

LEGEND

- Adjacent tile
- Point of Interest (labeled with Sediment Transport Model river stationing)
- HEC-RAS cross section
- Subreach break
- FEMA 100-year floodplain extent
- Future (Dam Removal) maximum 100-year floodplain extent
- Current 100-year floodplain from HEC-RAS

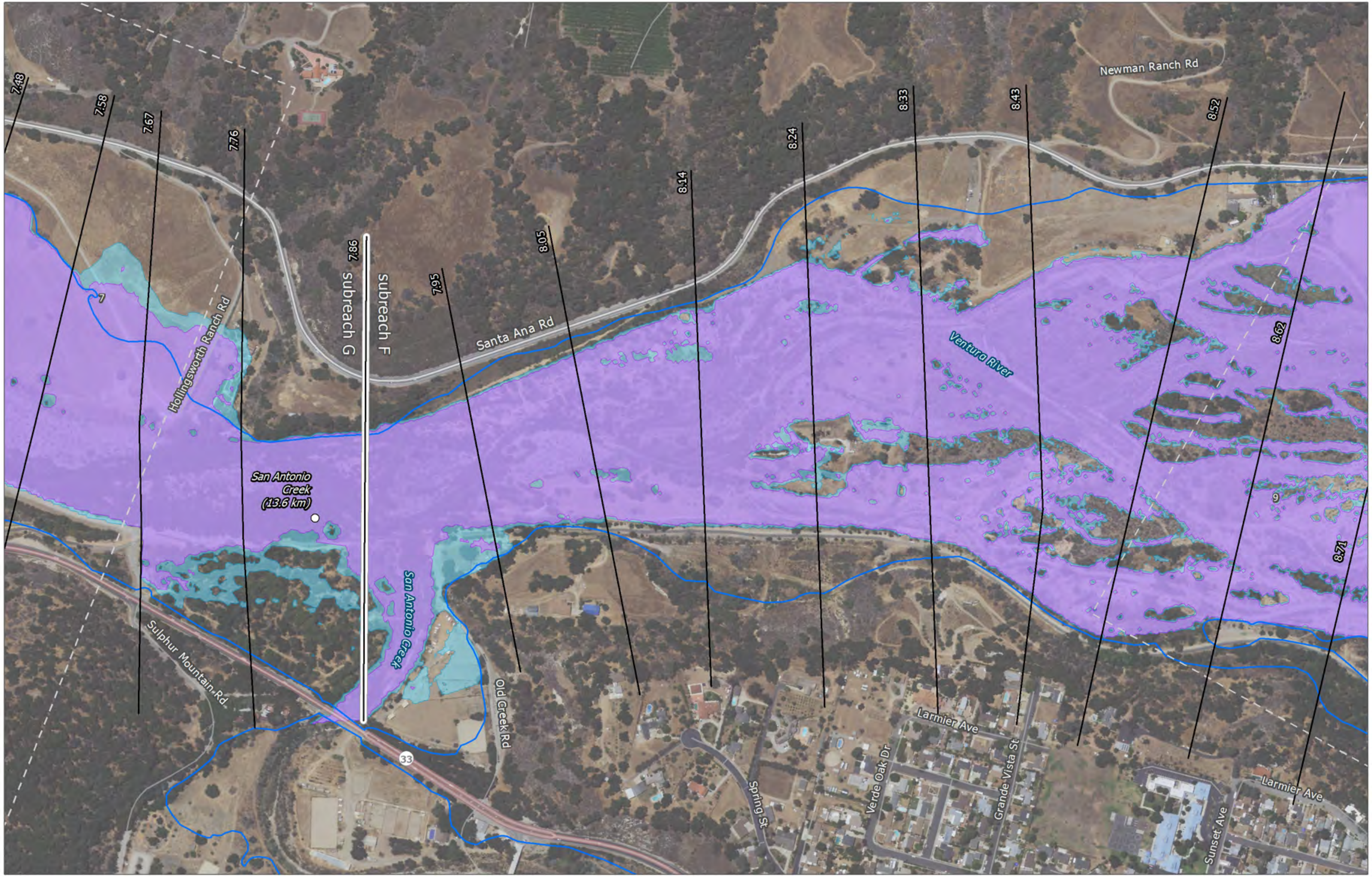
Stillwater Sciences

SCALE & NORTH ARROW

0 200 400 800 Feet
0 50 100 200 Meters

1:6,000 1 in = 500 feet

MAP LOCATION



VENTURA RIVER, CALIFORNIA

100 YEAR FLOODPLAIN
Subreach F

DATA SOURCES
Current & Dam Removal 100-year FP: Stillwater Sciences 2019, with 2005 USBR LiDAR
FEMA 100 year FP: FEMA
Imagery: NAIP 2016
Roads, cities, streams, and waterbodies: ESRI 2016

LEGEND

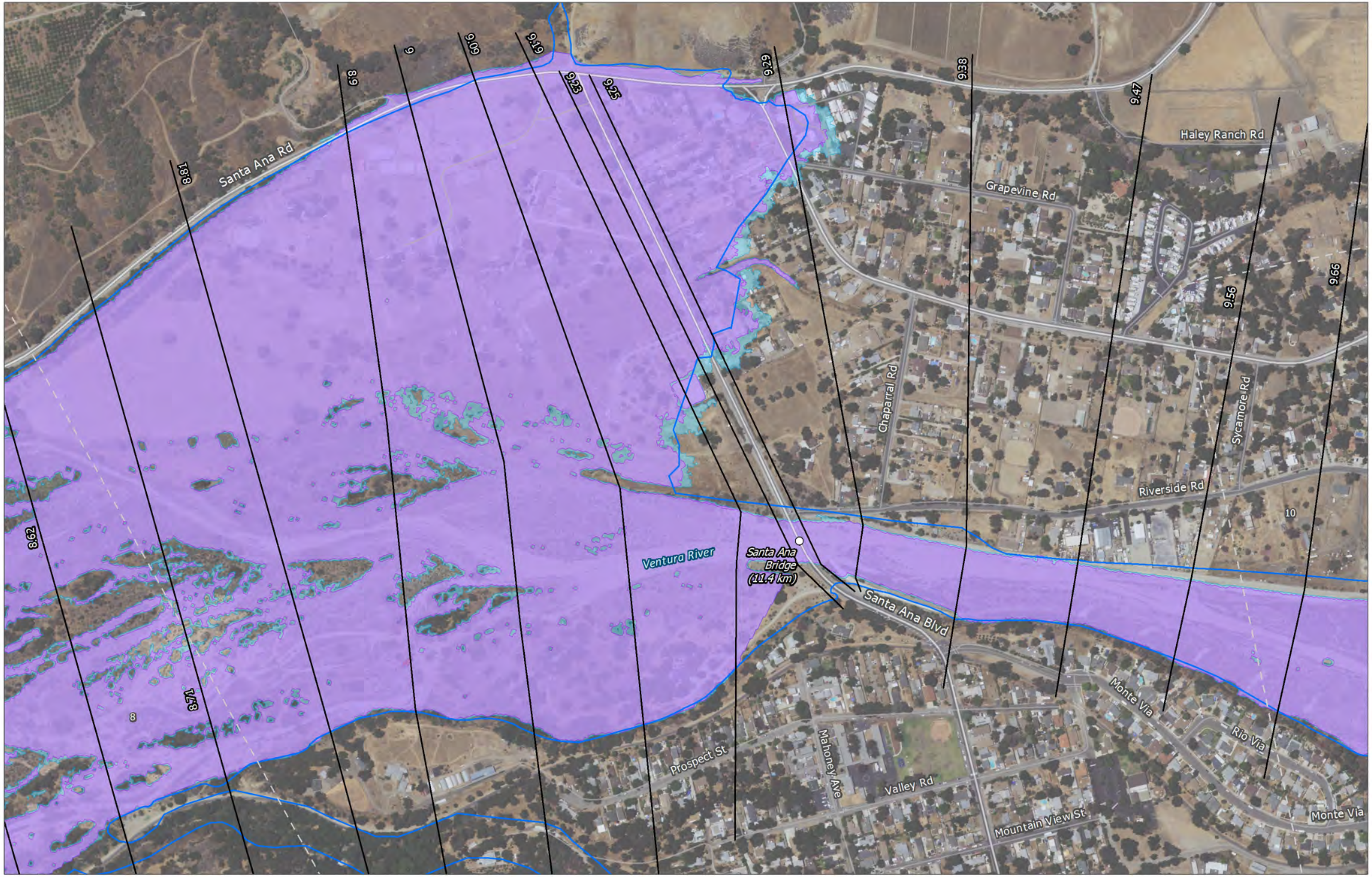
- Adjacent tile
- Point of Interest (labeled with Sediment Transport Model river stationing)
- HEC-RAS cross section
- Subreach break
- FEMA 100-year floodplain extent
- Future (Dam Removal) maximum 100-year floodplain extent
- Current 100-year floodplain from HEC-RAS

Stillwater Sciences

SCALE & NORTH ARROW

0 200 400 800 Feet
0 50 100 200 Meters
1:6,000
1 in = 500 feet

MAP LOCATION



VENTURA RIVER, CALIFORNIA

100 YEAR FLOODPLAIN
Subreach F

DATA SOURCES
Current & Dam Removal 100-year FP: Stillwater Sciences 2019, with 2005 USBR LiDAR
FEMA 100 year FP: FEMA
Imagery: NAIP 2016
Roads, cities, streams, and waterbodies: ESRI 2016

LEGEND

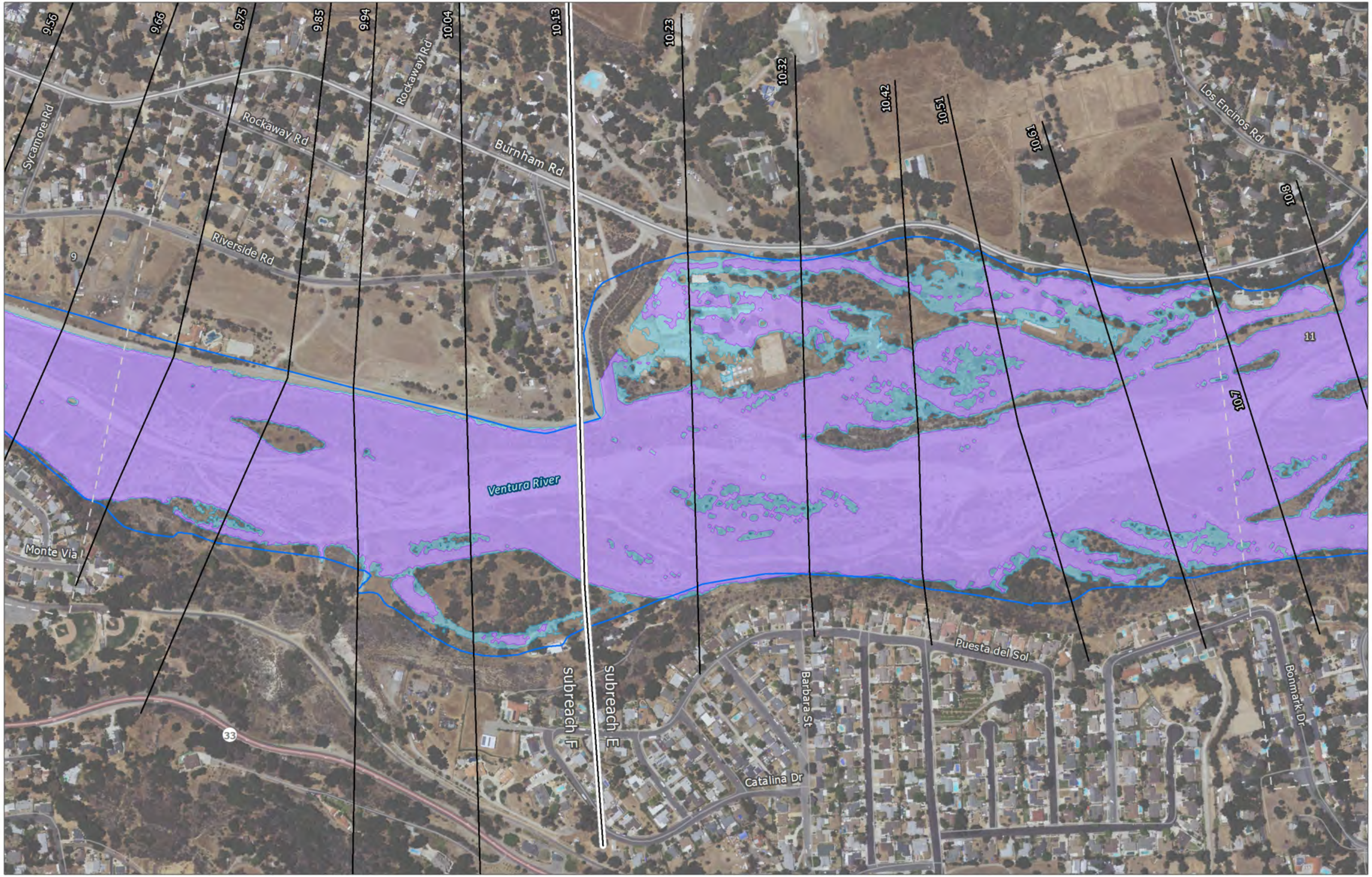
- Adjacent tile
- Point of Interest (labeled with Sediment Transport Model river stationing)
- HEC-RAS cross section
- Subreach break
- FEMA 100-year floodplain extent
- Future (Dam Removal) maximum 100-year floodplain extent
- Current 100-year floodplain from HEC-RAS

Stillwater Sciences

SCALE & NORTH ARROW

0 200 400 800 Feet
0 50 100 200 Meters
1:6,000
1 in = 500 feet

MAP LOCATION



VENTURA RIVER, CALIFORNIA

100 YEAR FLOODPLAIN
Subreach E & F

DATA SOURCES
Current & Dam Removal 100-year FP: Stillwater Sciences 2019, with 2005 USBR LiDAR
FEMA 100 year FP: FEMA
Imagery: NAIP 2016
Roads, cities, streams, and waterbodies: ESRI 2016

LEGEND

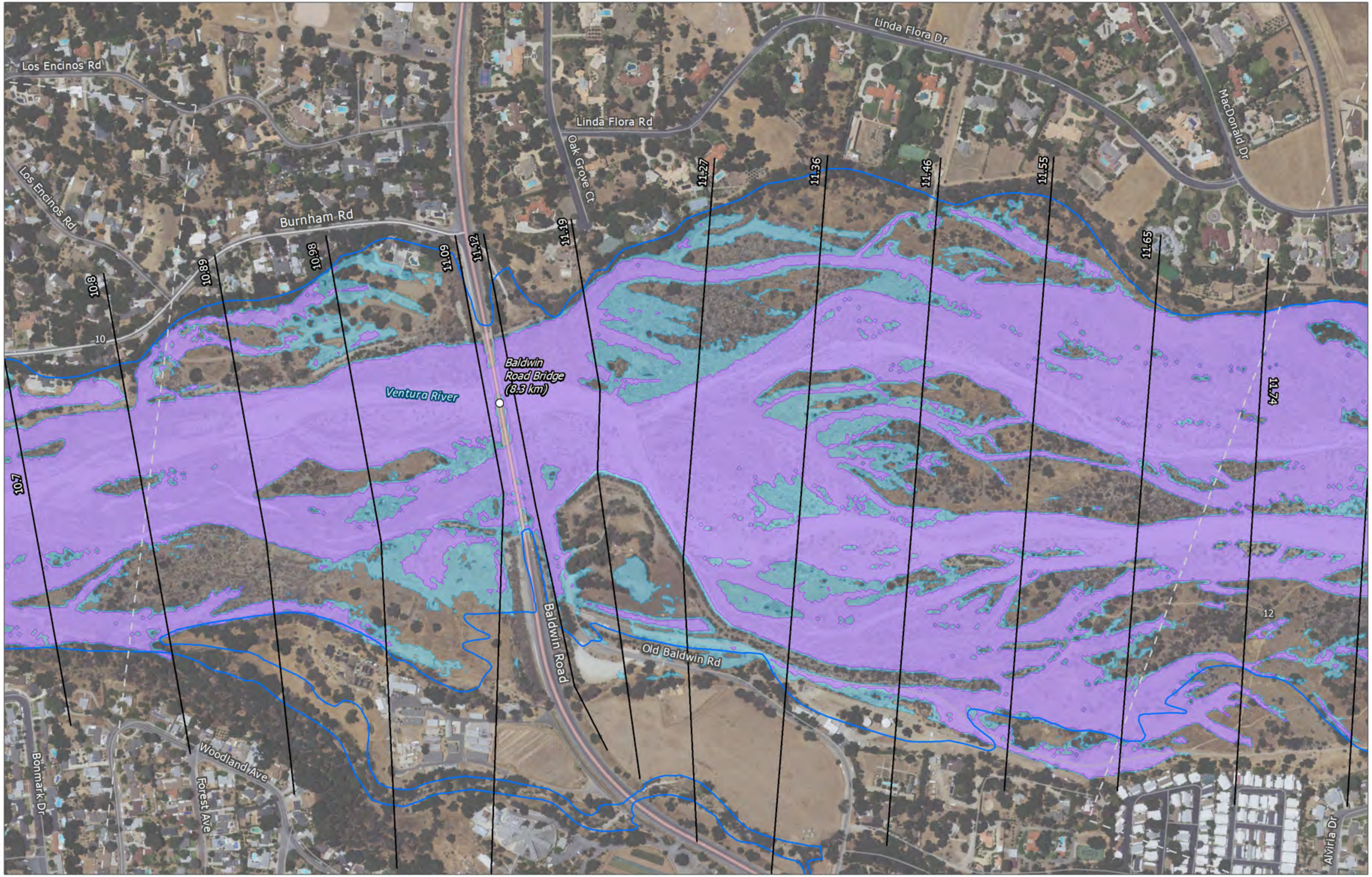
Adjacent tile
Point of Interest (labeled with Sediment Transport Model river stationing)
HEC-RAS cross section
Subreach break
FEMA 100-year floodplain extent
Future (Dam Removal) maximum 100-year floodplain extent
Current 100-year floodplain from HEC-RAS

Stillwater Sciences

SCALE & NORTH ARROW

0 200 400 800 Feet
0 50 100 200 Meters
1:6,000
1 in = 500 feet

MAP LOCATION



VENTURA RIVER, CALIFORNIA

100 YEAR FLOODPLAIN
Subreach E

DATA SOURCES
Current & Dam Removal 100-year FP: Stillwater Sciences 2019, with 2005 USBR LiDAR
FEMA 100 year FP: FEMA
Imagery: NAIP 2016
Roads, cities, streams, and waterbodies: ESRI 2016

LEGEND

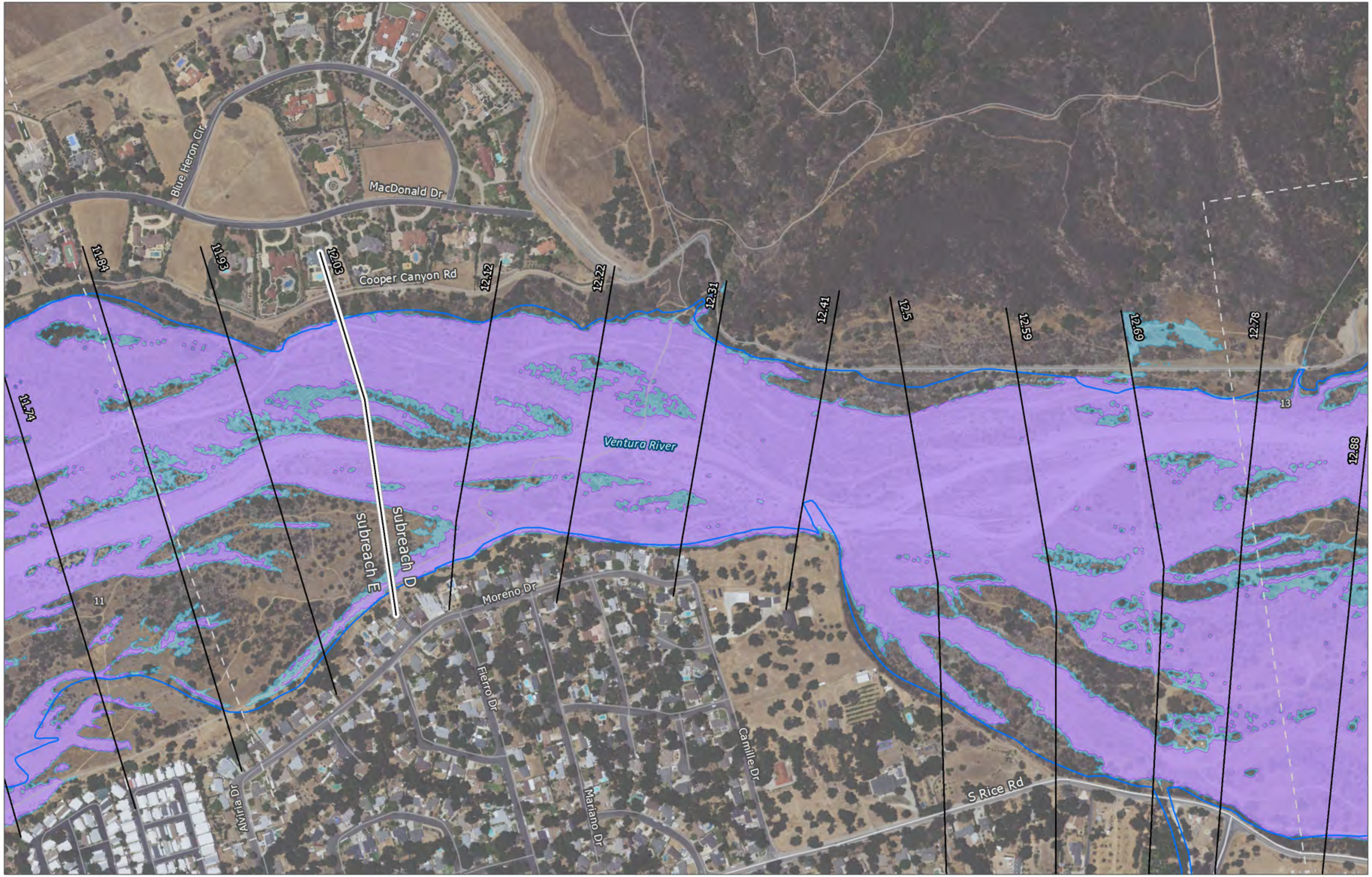
- Adjacent tile
- Point of Interest (labeled with Sediment Transport Model river stationing)
- HEC-RAS cross section
- Subreach break
- FEMA 100-year floodplain extent
- Future (Dam Removal) maximum 100-year floodplain extent
- Current 100-year floodplain from HEC-RAS

Stillwater Sciences

SCALE & NORTH ARROW

0 200 400 800 Feet
0 50 100 200 Meters
1:6,000
1 in = 500 feet

MAP LOCATION



VENTURA RIVER, CALIFORNIA

100 YEAR FLOODPLAIN
Subreach D

DATA SOURCES
Current & Dam Removal 100-year FP: Stillwater Sciences 2019, with 2005 USBR LiDAR
FEMA 100 year FP: FEMA
Imagery: NAIP 2016
Roads, cities, streams, and waterbodies: ESRI 2016

LEGEND

Adjacent tile

Point of Interest (labeled with Sediment Transport Model river stationing)

HEC-RAS cross section

Subreach break

FEMA 100-year floodplain extent

Future (Dam Removal) maximum 100-year floodplain extent

Current 100-year floodplain from HEC-RAS

Stillwater Sciences

SCALE & NORTH ARROW

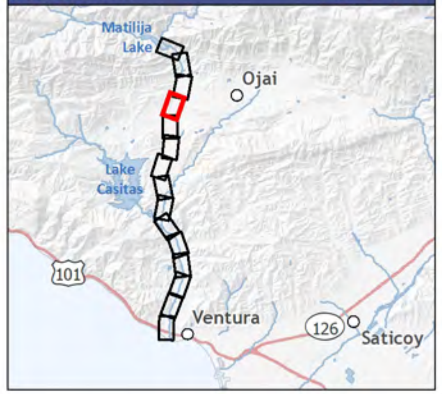
0 200 400 800 Feet

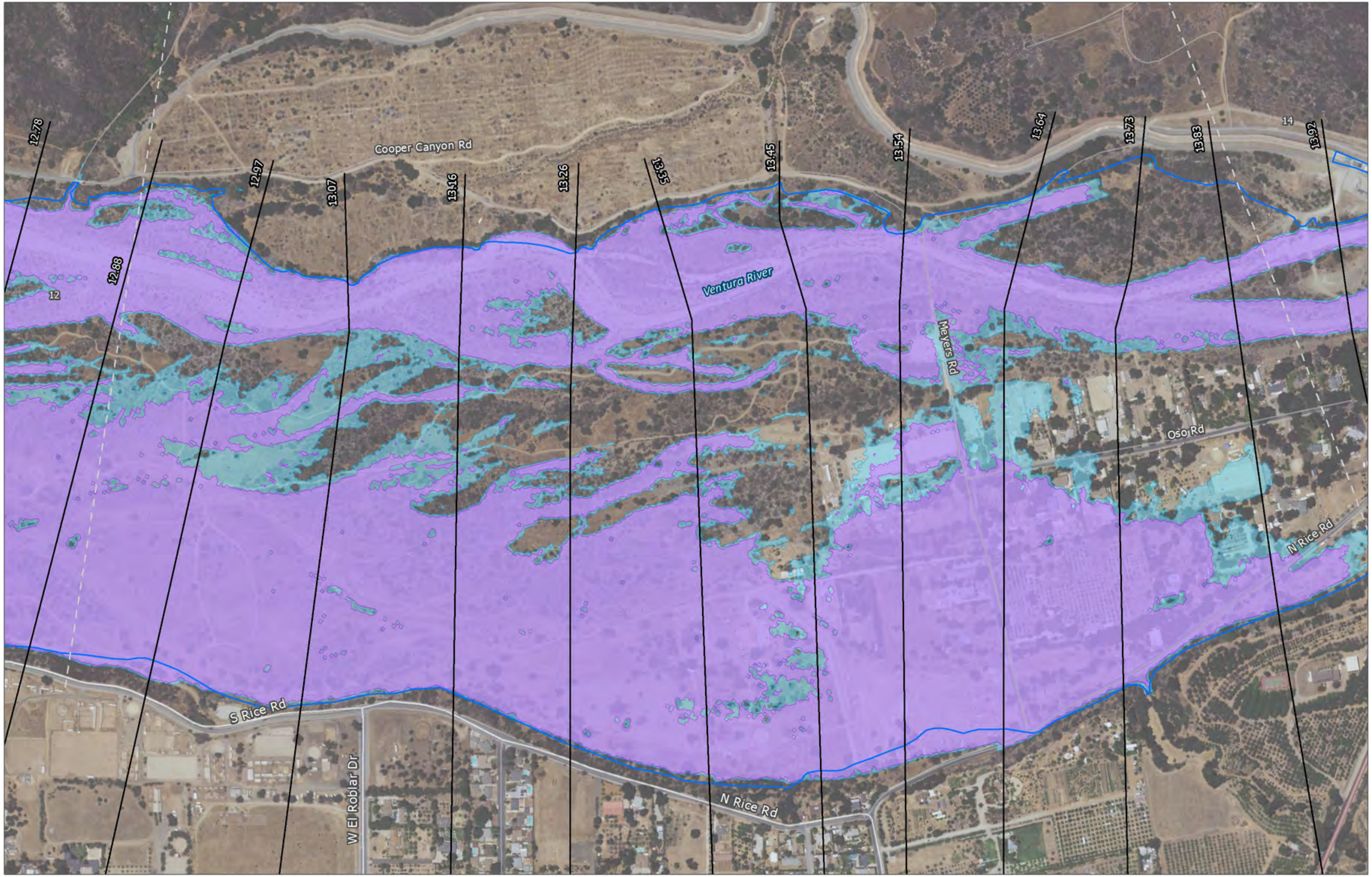
0 50 100 200 Meters

1:6,000

1 in = 500 feet

MAP LOCATION





VENTURA RIVER, CALIFORNIA

100 YEAR FLOODPLAIN
Subreach D

DATA SOURCES
Current & Dam Removal 100-year FP: Stillwater Sciences 2019, with 2005 USBR LiDAR
FEMA 100 year FP: FEMA
Imagery: NAIP 2016
Roads, cities, streams, and waterbodies: ESRI 2016

LEGEND

- Adjacent tile
- Point of Interest (labeled with Sediment Transport Model river stationing)
- HEC-RAS cross section
- Subreach break
- FEMA 100-year floodplain extent
- Future (Dam Removal) maximum 100-year floodplain extent
- Current 100-year floodplain from HEC-RAS

Stillwater Sciences

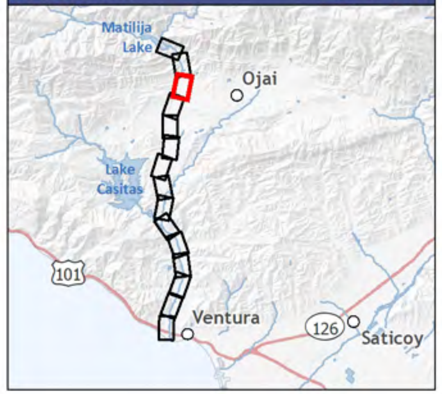
SCALE & NORTH ARROW

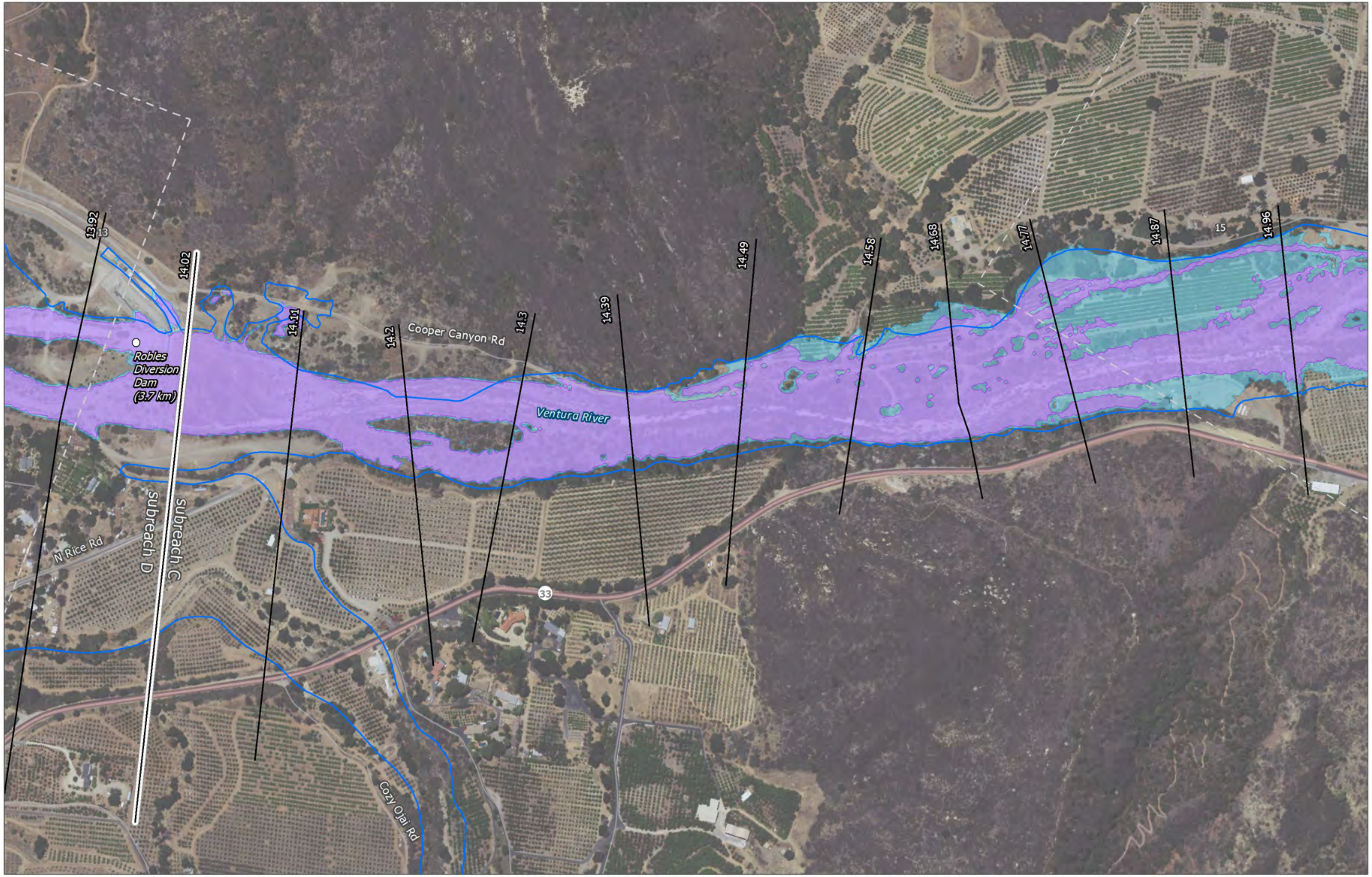
0 200 400 800 Feet
0 50 100 200 Meters

1:6,000

1 in = 500 feet

MAP LOCATION





VENTURA RIVER, CALIFORNIA

100 YEAR FLOODPLAIN
Subreach C

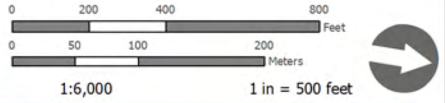
DATA SOURCES
Current & Dam Removal 100-year FP: Stillwater Sciences 2019, with 2005 USBR LiDAR
FEMA 100 year FP: FEMA
Imagery: NAIP 2016
Roads, cities, streams, and waterbodies: ESRI 2016

LEGEND

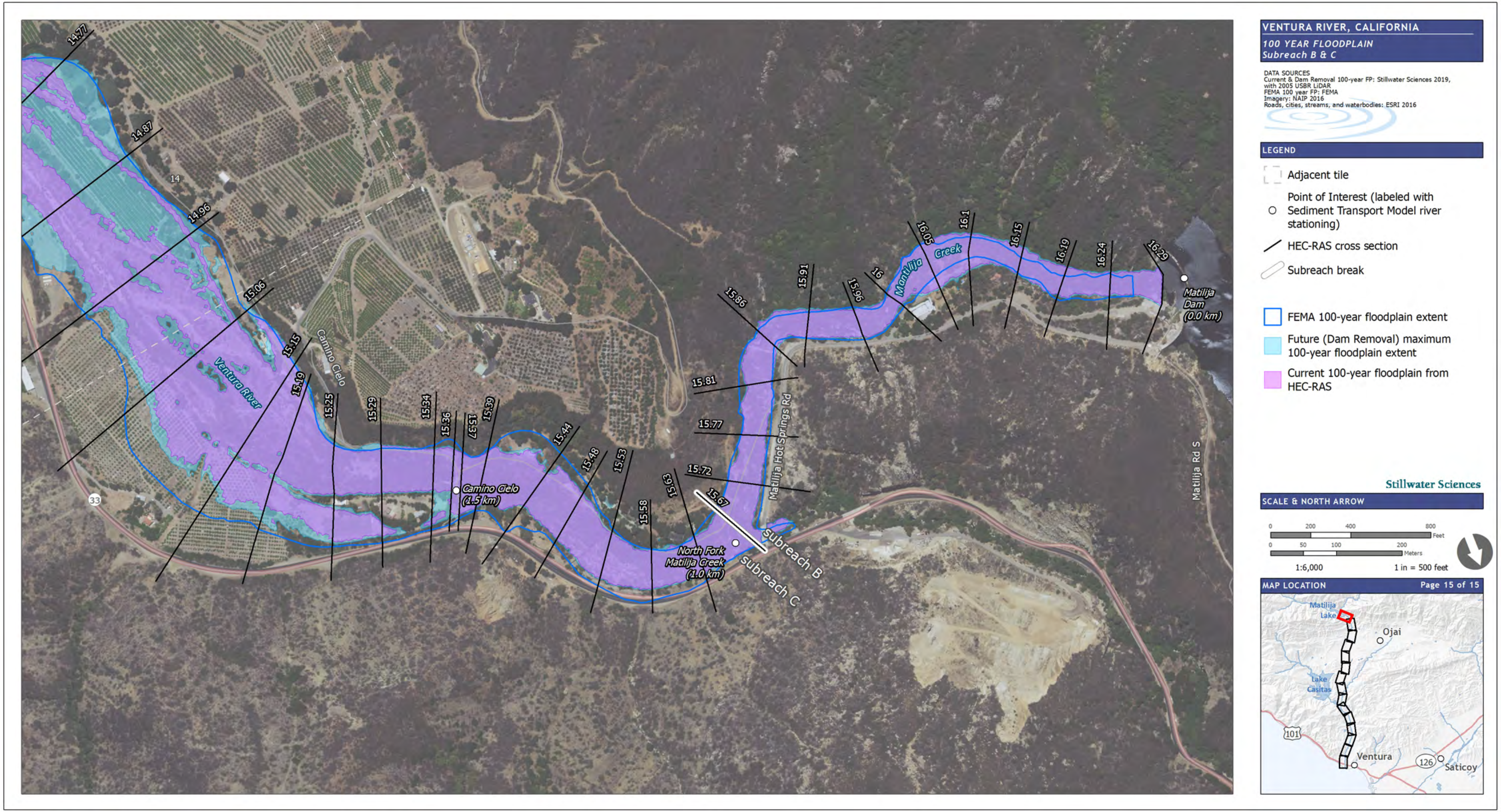
- Adjacent tile
- Point of Interest (labeled with Sediment Transport Model river stationing)
- HEC-RAS cross section
- Subreach break
- FEMA 100-year floodplain extent
- Future (Dam Removal) maximum 100-year floodplain extent
- Current 100-year floodplain from HEC-RAS

Stillwater Sciences

SCALE & NORTH ARROW



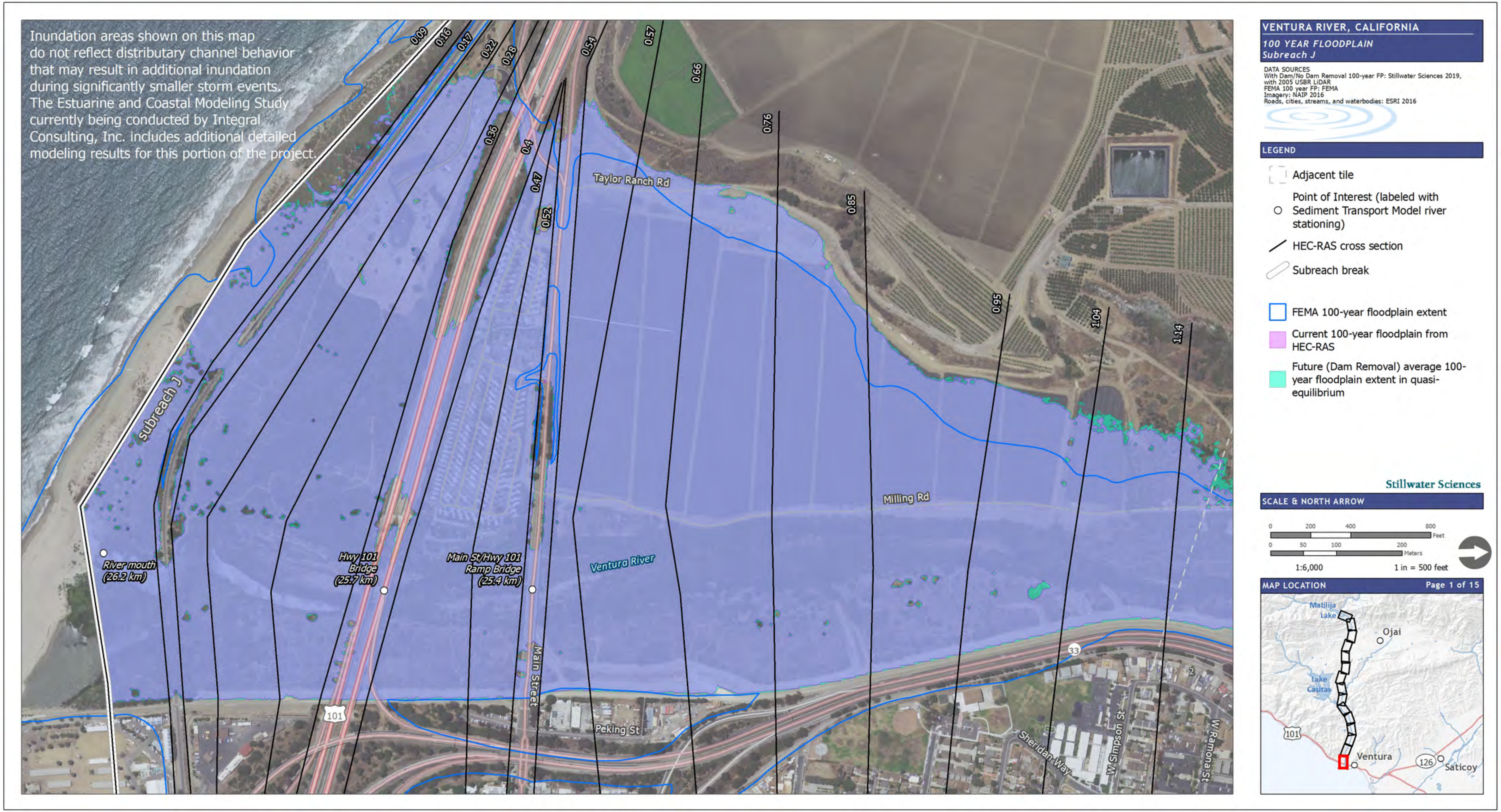
MAP LOCATION



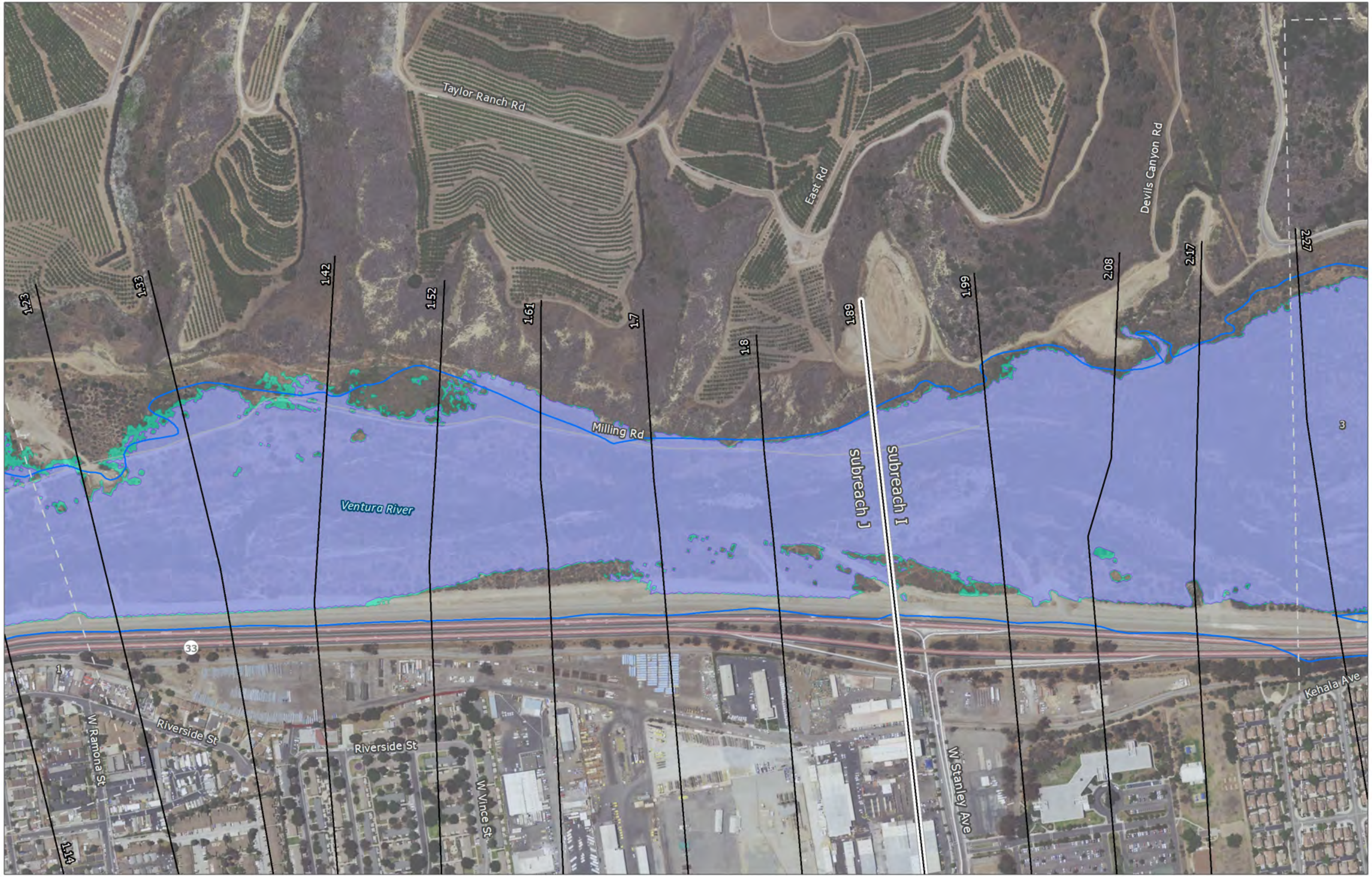
VENTURA RIVER, CALIFORNIA
100 YEAR FLOODPLAIN
Subreach B & C
DATA SOURCES
Current & Dam Removal 100-year FP: Stillwater Sciences 2019, with 2005 USBR LiDAR
FEMA 100 year FP: FEMA
Imagery: NAIP 2016
Roads, cities, streams, and waterbodies: ESRI 2016
LEGEND
Adjacent tile
Point of Interest (labeled with Sediment Transport Model river stationing)
HEC-RAS cross section
Subreach break
FEMA 100-year floodplain extent
Future (Dam Removal) maximum 100-year floodplain extent
Current 100-year floodplain from HEC-RAS
Stillwater Sciences
SCALE & NORTH ARROW
0 200 400 800 Feet
0 50 100 200 Meters
1:6,000
1 in = 500 feet
MAP LOCATION
Page 15 of 15
Matilija Lake
Ojai
Lake Casitas
101
Ventura
126
Saticoy
14.77
14.87
14
14.96
15.06
15.15
15.19
15.25
15.29
15.34
15.36
15.37
15.39
15.44
15.48
15.53
15.58
15.63
15.67
15.72
15.77
15.81
15.86
15.91
15.96
16
16.05
16.1
16.15
16.19
16.24
16.29
Ventura River
Camino Cielo
Camino Cielo (1.5 km)
North Fork Matilija Creek (1.0 km)
Subreach B
Subreach C
Matilija Hot Springs Rd
Matilija Creek
Matilija Dam (0.0 km)
Matilija Rd S
33

Appendix C

Floodplain Maps Showing Average Expected Inundation During 100-year Storm Event in Quasi-equilibrium Conditions



Inundation areas shown on this map do not reflect distributary channel behavior that may result in additional inundation during significantly smaller storm events. The Estuarine and Coastal Modeling Study currently being conducted by Integral Consulting, Inc. includes additional detailed modeling results for this portion of the project.
0.09
0.16
0.17
0.22
0.28
0.36
0.4
0.47
0.52
0.54
0.57
0.66
0.76
0.85
0.95
1.04
1.14
Taylor Ranch Rd
Milling Rd
Ventura River
subreach J
River mouth (26.2 km)
Hwy 101 Bridge (25.7 km)
Main St/Hwy 101 Ramp Bridge (25.4 km)
Main Street
Peking St
Sheridan Way
W Simpson St
W Ramona St
101
33
VENTURA RIVER, CALIFORNIA
100 YEAR FLOODPLAIN
Subreach J
DATA SOURCES
With Dam/No Dam Removal 100-year FP: Stillwater Sciences 2019, with 2005 USBR LiDAR
FEMA 100 year FP: FEMA
Imagery: NAIP 2016
Roads, cities, streams, and waterbodies: ESRI 2016
LEGEND
Adjacent tile
Point of Interest (labeled with Sediment Transport Model river stationing)
HEC-RAS cross section
Subreach break
FEMA 100-year floodplain extent
Current 100-year floodplain from HEC-RAS
Future (Dam Removal) average 100-year floodplain extent in quasi-equilibrium
Stillwater Sciences
SCALE & NORTH ARROW
0 200 400 800 Feet
0 50 100 200 Meters
1:6,000
1 in = 500 feet
MAP LOCATION
Page 1 of 15
Matilija Lake
Ojai
Lake Casitas
101
Ventura
126
Saticoy



VENTURA RIVER, CALIFORNIA

100 YEAR FLOODPLAIN
Subreach I & J

DATA SOURCES
With Dam/No Dam Removal 100-year FP: Stillwater Sciences 2019, with 2005 USBR LiDAR
FEMA 100 year FP: FEMA
Imagery: NAIP 2016
Roads, cities, streams, and waterbodies: ESRI 2016

LEGEND

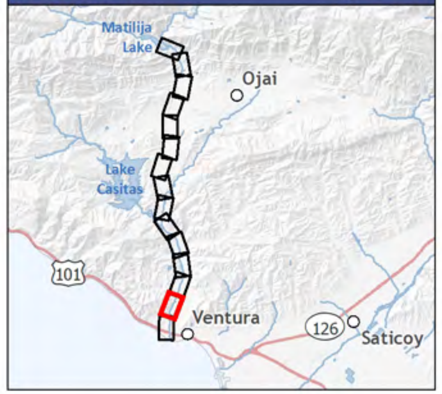
- Adjacent tile
- Point of Interest (labeled with Sediment Transport Model river stationing)
- HEC-RAS cross section
- Subreach break
- FEMA 100-year floodplain extent
- Current 100-year floodplain from HEC-RAS
- Future (Dam Removal) average 100-year floodplain extent in quasi-equilibrium

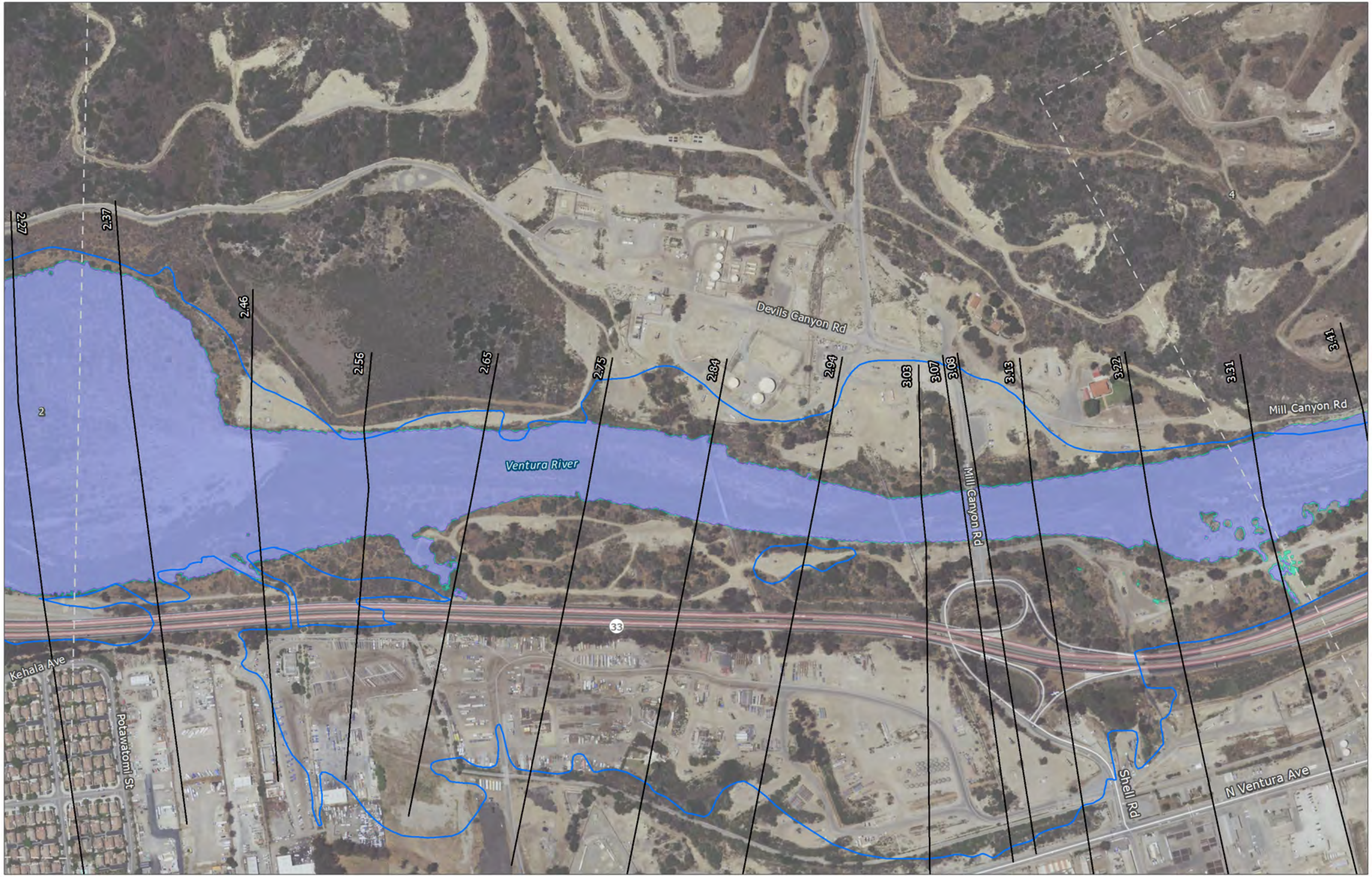
Stillwater Sciences

SCALE & NORTH ARROW

0 200 400 800 Feet
0 50 100 200 Meters
1:6,000
1 in = 500 feet

MAP LOCATION





VENTURA RIVER, CALIFORNIA

100 YEAR FLOODPLAIN
Subreach I

DATA SOURCES
With Dam/No Dam Removal 100-year FP: Stillwater Sciences 2019, with 2005 USBR LiDAR
FEMA 100 year FP: FEMA
Imagery: NAIP 2016
Roads, cities, streams, and waterbodies: ESRI 2016

LEGEND

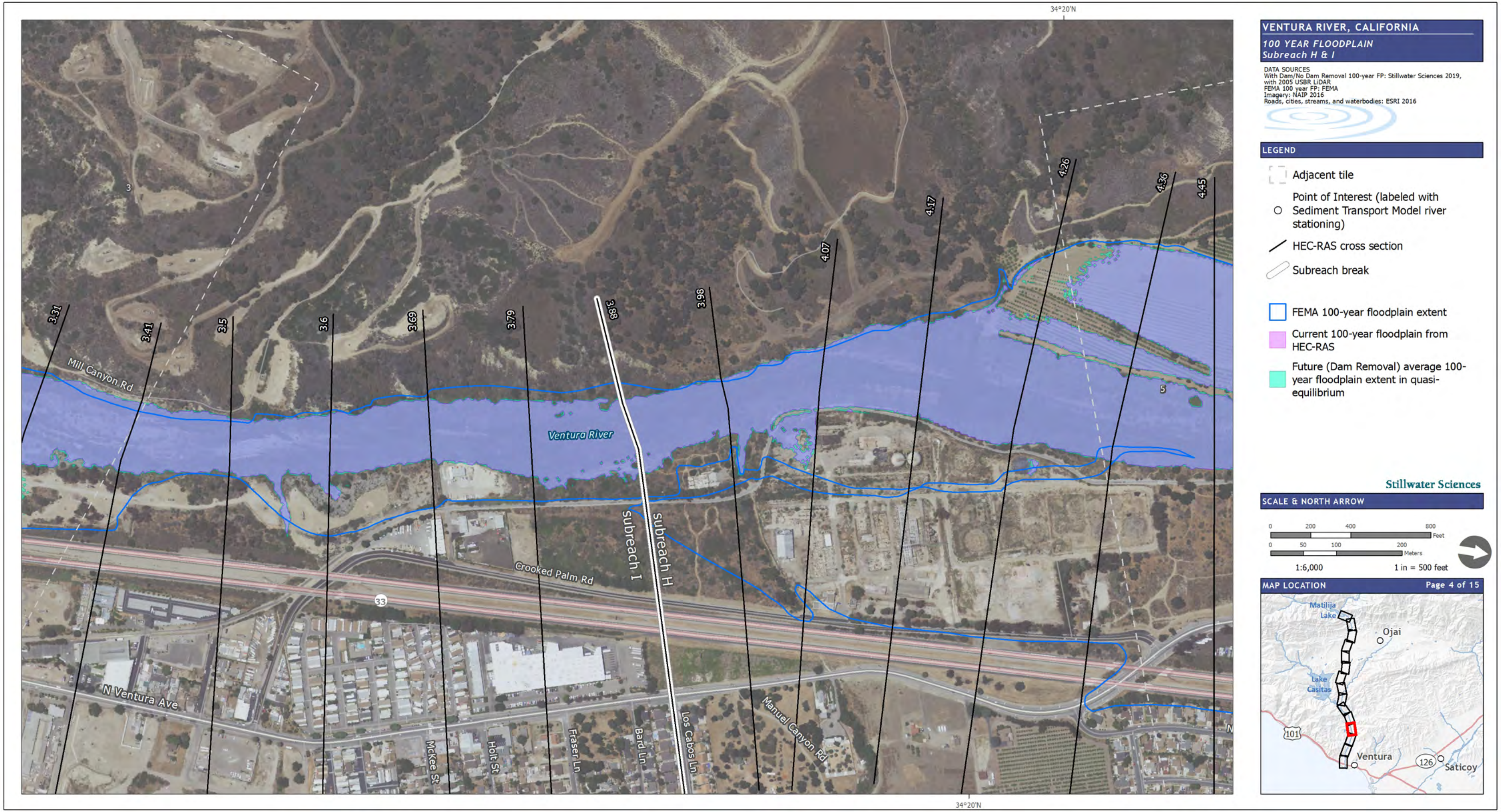
- Adjacent tile
- Point of Interest (labeled with Sediment Transport Model river stationing)
- HEC-RAS cross section
- Subreach break
- FEMA 100-year floodplain extent
- Current 100-year floodplain from HEC-RAS
- Future (Dam Removal) average 100-year floodplain extent in quasi-equilibrium

Stillwater Sciences

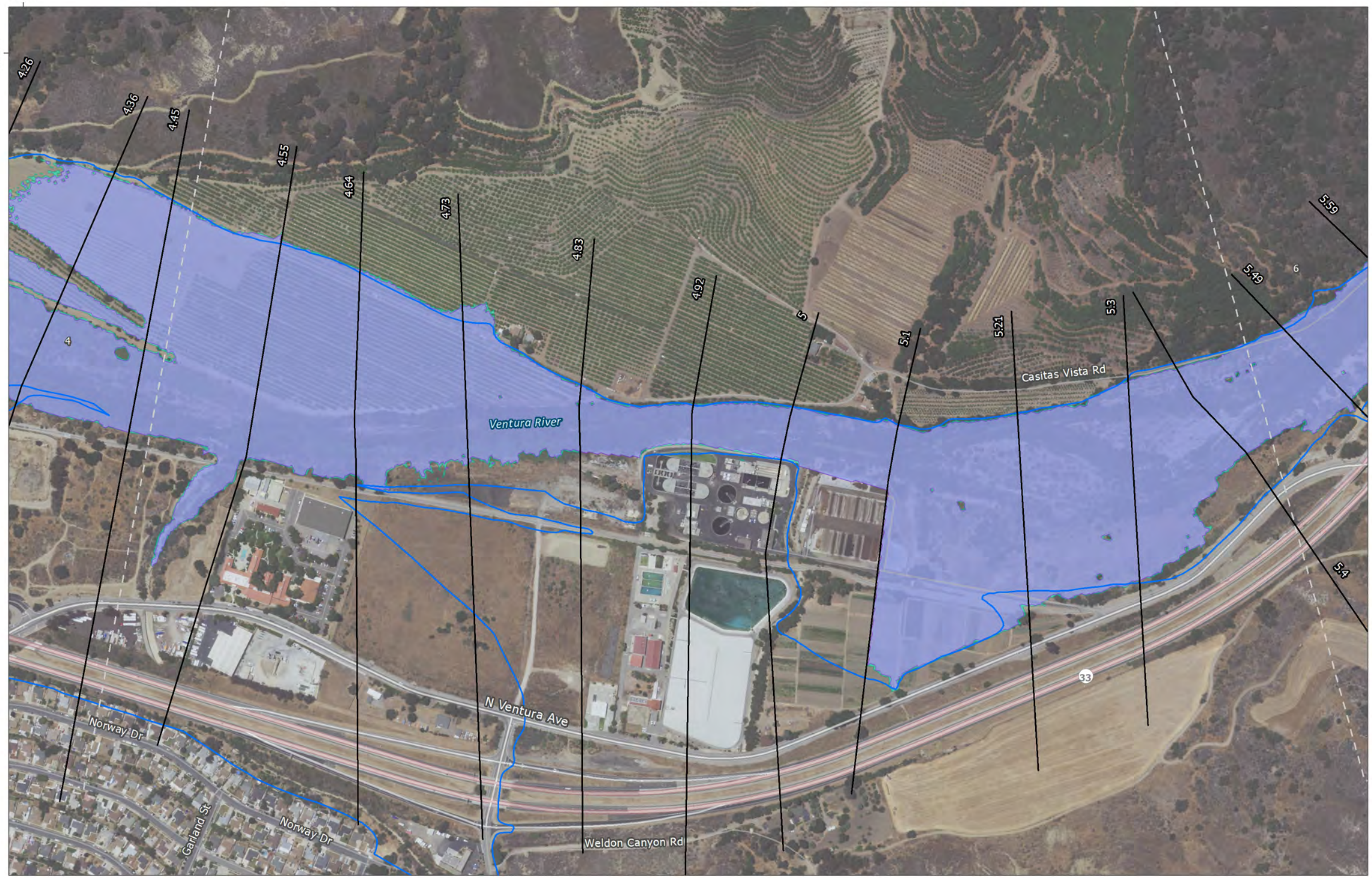
SCALE & NORTH ARROW

0 200 400 800 Feet
0 50 100 200 Meters
1:6,000
1 in = 500 feet

MAP LOCATION



VENTURA RIVER, CALIFORNIA
100 YEAR FLOODPLAIN
Subreach H & I
DATA SOURCES
With Dam/No Dam Removal 100-year FP: Stillwater Sciences 2019, with 2005 USBR LiDAR
FEMA 100 year FP: FEMA
Imagery: NAIP 2016
Roads, cities, streams, and waterbodies: ESRI 2016
LEGEND
Adjacent tile
Point of Interest (labeled with Sediment Transport Model river stationing)
HEC-RAS cross section
Subreach break
FEMA 100-year floodplain extent
Current 100-year floodplain from HEC-RAS
Future (Dam Removal) average 100-year floodplain extent in quasi-equilibrium
Stillwater Sciences
SCALE & NORTH ARROW
0 200 400 800 Feet
0 50 100 200 Meters
1:6,000
1 in = 500 feet
MAP LOCATION
Page 4 of 15
Matilija Lake
Ojai
Lake Casitas
101
Ventura
126
Saticoy
34°20'N
3.31
3.41
3.5
3.6
3.69
3.79
3.88
3.98
4.07
4.17
4.26
4.36
4.45
3
5
Mill Canyon Rd
Ventura River
Subreach I
Subreach H
Crooked Palm Rd
33
N Ventura Ave
Mckee St
Holt St
Fraser Ln
Bard Ln
Los Cabos Ln
Manuel Canyon Rd



VENTURA RIVER, CALIFORNIA

100 YEAR FLOODPLAIN
Subreach H

DATA SOURCES
With Dam/No Dam Removal 100-year FP: Stillwater Sciences 2019, with 2005 USBR LiDAR
FEMA 100 year FP: FEMA
Imagery: NAIP 2016
Roads, cities, streams, and waterbodies: ESRI 2016

LEGEND

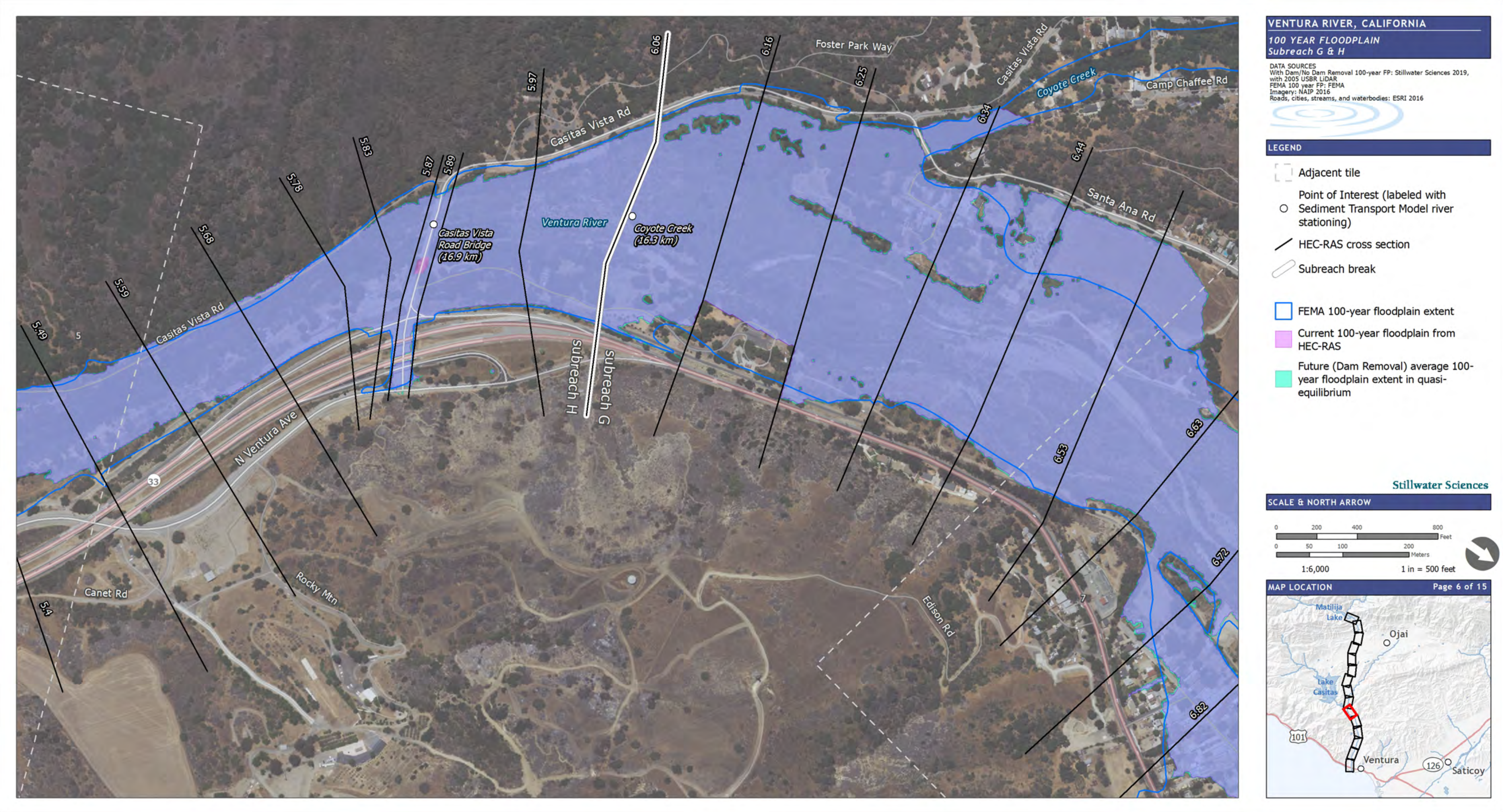
Adjacent tile
Point of Interest (labeled with Sediment Transport Model river stationing)
HEC-RAS cross section
Subreach break
FEMA 100-year floodplain extent
Current 100-year floodplain from HEC-RAS
Future (Dam Removal) average 100-year floodplain extent in quasi-equilibrium

Stillwater Sciences

SCALE & NORTH ARROW

1:6,000 1 in = 500 feet

MAP LOCATION


VENTURA RIVER, CALIFORNIA
100 YEAR FLOODPLAIN
Subreach G & H
DATA SOURCES
With Dam/No Dam Removal 100-year FP: Stillwater Sciences 2019, with 2005 USBR LiDAR
FEMA 100 year FP: FEMA
Imagery: NAIP 2016
Roads, cities, streams, and waterbodies: ESRI 2016
LEGEND
Adjacent tile
Point of Interest (labeled with Sediment Transport Model river stationing)
HEC-RAS cross section
Subreach break
FEMA 100-year floodplain extent
Current 100-year floodplain from HEC-RAS
Future (Dam Removal) average 100-year floodplain extent in quasi-equilibrium
Stillwater Sciences
SCALE & NORTH ARROW
0 200 400 800 Feet
0 50 100 200 Meters
1:6,000
1 in = 500 feet
MAP LOCATION
Page 6 of 15
Matilija Lake
Ojai
Lake Casitas
101
Ventura
126
Saticoy
Foster Park Way
Casitas Vista Rd
Coyote Creek
Camp Chaffee Rd
Santa Ana Rd
Ventura River
Casitas Vista Road Bridge (16.9 km)
Coyote Creek (16.3 km)
Subreach H
Subreach G
N Ventura Ave
33
Canet Rd
Rocky Mtn
Edison Rd
5
7
5.4
5.49
5.59
5.68
5.78
5.83
5.87
5.89
5.97
6.06
6.16
6.25
6.34
6.44
6.53
6.63
6.72
6.82

VENTURA RIVER, CALIFORNIA

100 YEAR FLOODPLAIN
Subreach G

DATA SOURCES
With Dam/No Dam Removal 100-year FP: Stillwater Sciences 2019, with 2005 USBR LiDAR
FEMA 100 year FP: FEMA
Imagery: NAIP 2016
Roads, cities, streams, and waterbodies: ESRI 2016

LEGEND

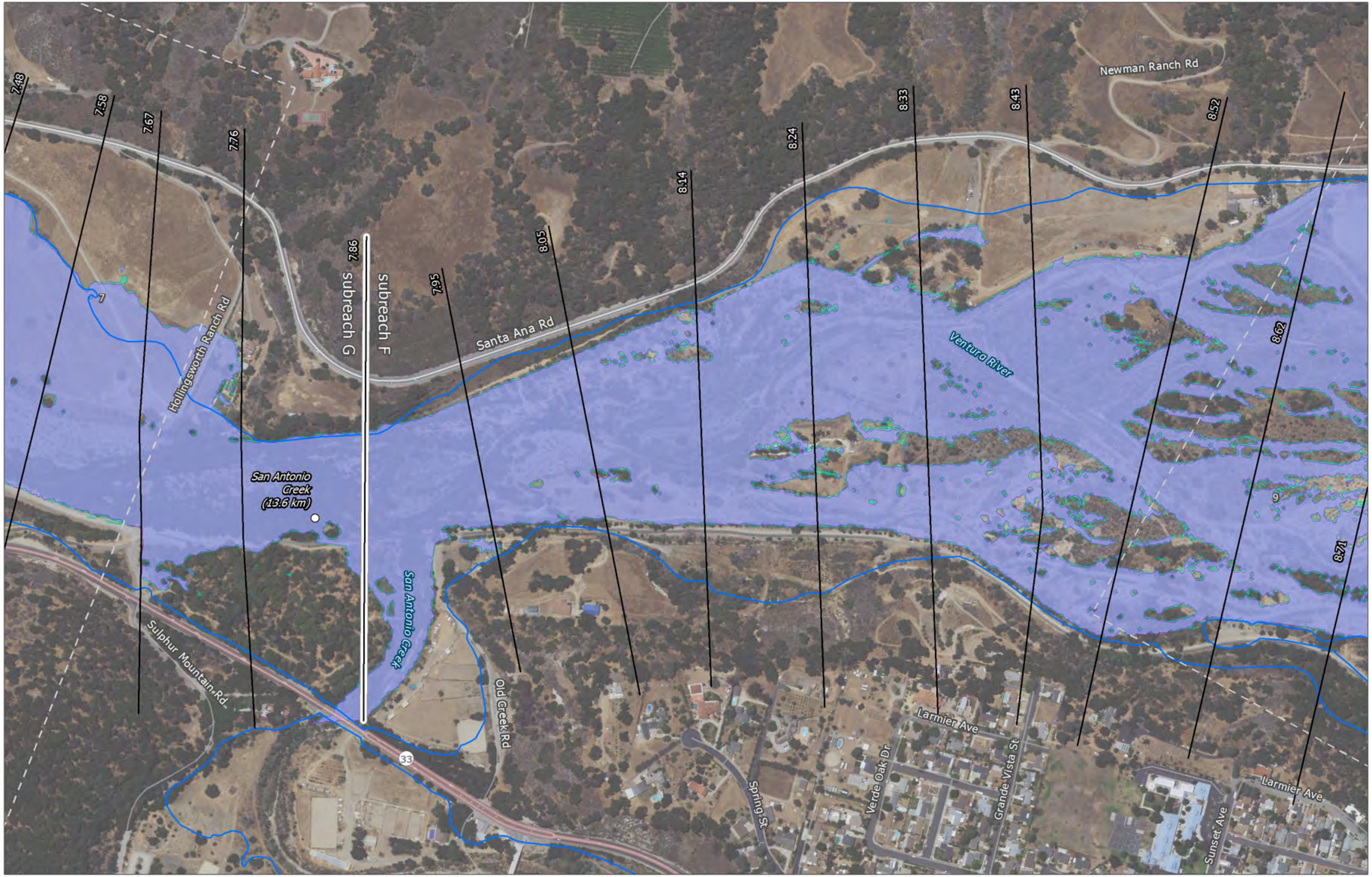
- Adjacent tile
- Point of Interest (labeled with Sediment Transport Model river stationing)
- HEC-RAS cross section
- Subreach break
- FEMA 100-year floodplain extent
- Current 100-year floodplain from HEC-RAS
- Future (Dam Removal) average 100-year floodplain extent in quasi-equilibrium

Stillwater Sciences

SCALE & NORTH ARROW

0 200 400 800 Feet
0 50 100 200 Meters
1:6,000 1 in = 500 feet

MAP LOCATION



VENTURA RIVER, CALIFORNIA

100 YEAR FLOODPLAIN
Subreach F

DATA SOURCES
With Dam/No Dam Removal 100-year FP: Stillwater Sciences 2019, with 2005 USBR LiDAR
FEMA 100 year FP: FEMA
Imagery: NAIP 2016
Roads, cities, streams, and waterbodies: ESRI 2016

LEGEND

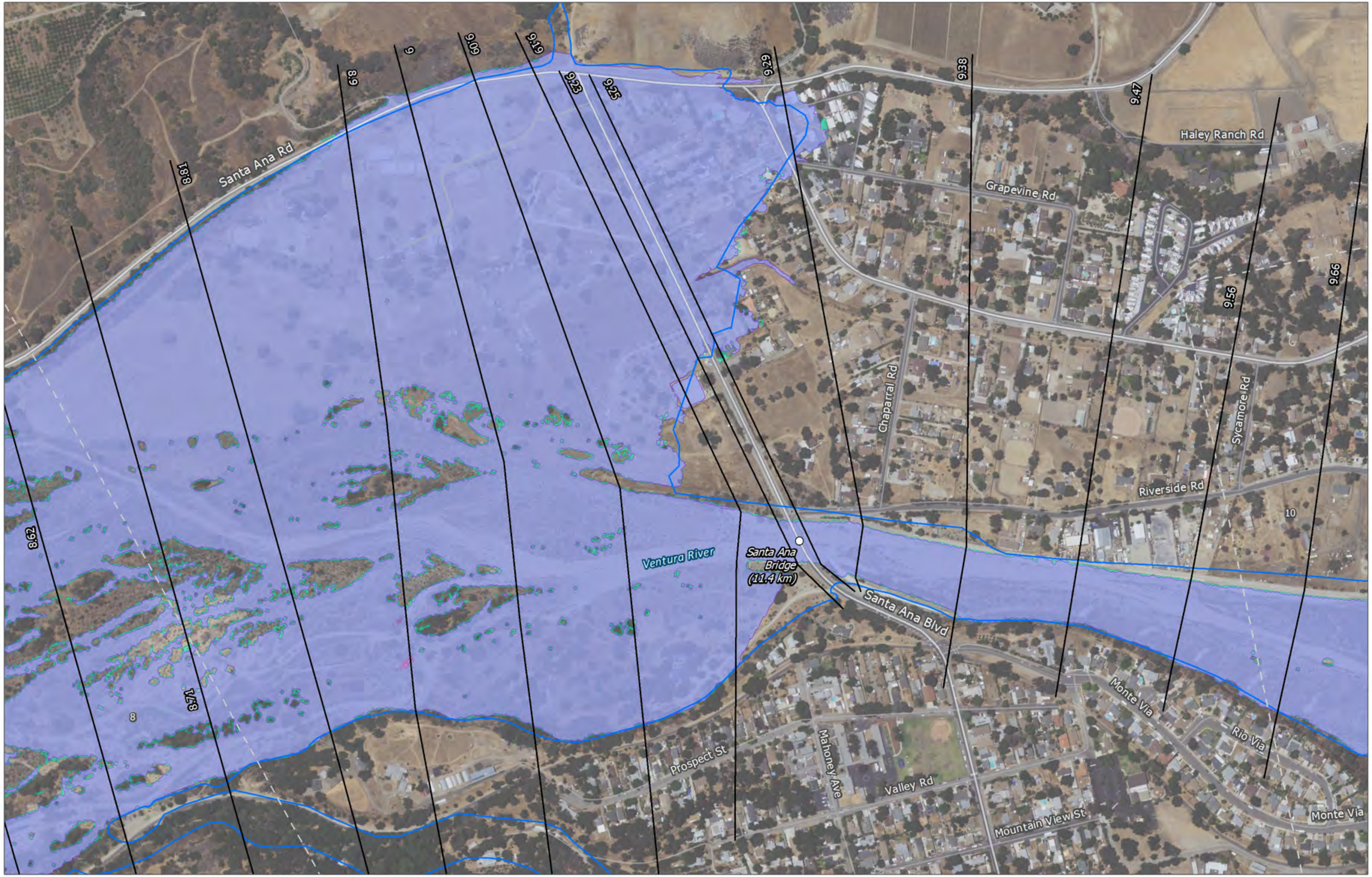
- Adjacent tile
- Point of Interest (labeled with Sediment Transport Model river stationing)
- HEC-RAS cross section
- Subreach break
- FEMA 100-year floodplain extent
- Current 100-year floodplain from HEC-RAS
- Future (Dam Removal) average 100-year floodplain extent in quasi-equilibrium

Stillwater Sciences

SCALE & NORTH ARROW

1:6,000 1 in = 500 feet

MAP LOCATION



VENTURA RIVER, CALIFORNIA

100 YEAR FLOODPLAIN
Subreach F

DATA SOURCES
With Dam/No Dam Removal 100-year FP: Stillwater Sciences 2019, with 2005 USBR LiDAR
FEMA 100 year FP: FEMA
Imagery: NAIP 2016
Roads, cities, streams, and waterbodies: ESRI 2016

LEGEND

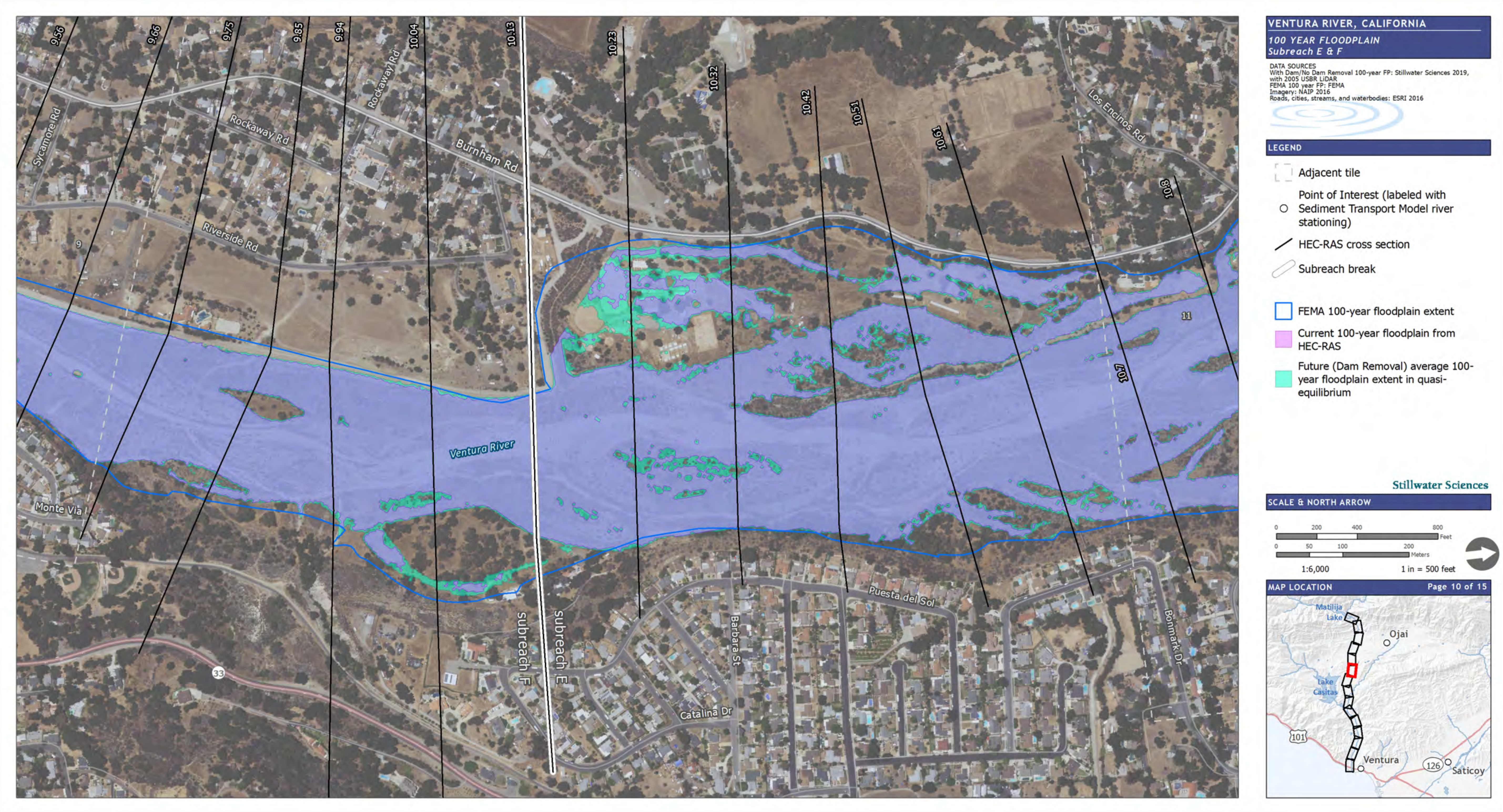
- Adjacent tile
- Point of Interest (labeled with Sediment Transport Model river stationing)
- HEC-RAS cross section
- Subreach break
- FEMA 100-year floodplain extent
- Current 100-year floodplain from HEC-RAS
- Future (Dam Removal) average 100-year floodplain extent in quasi-equilibrium

Stillwater Sciences

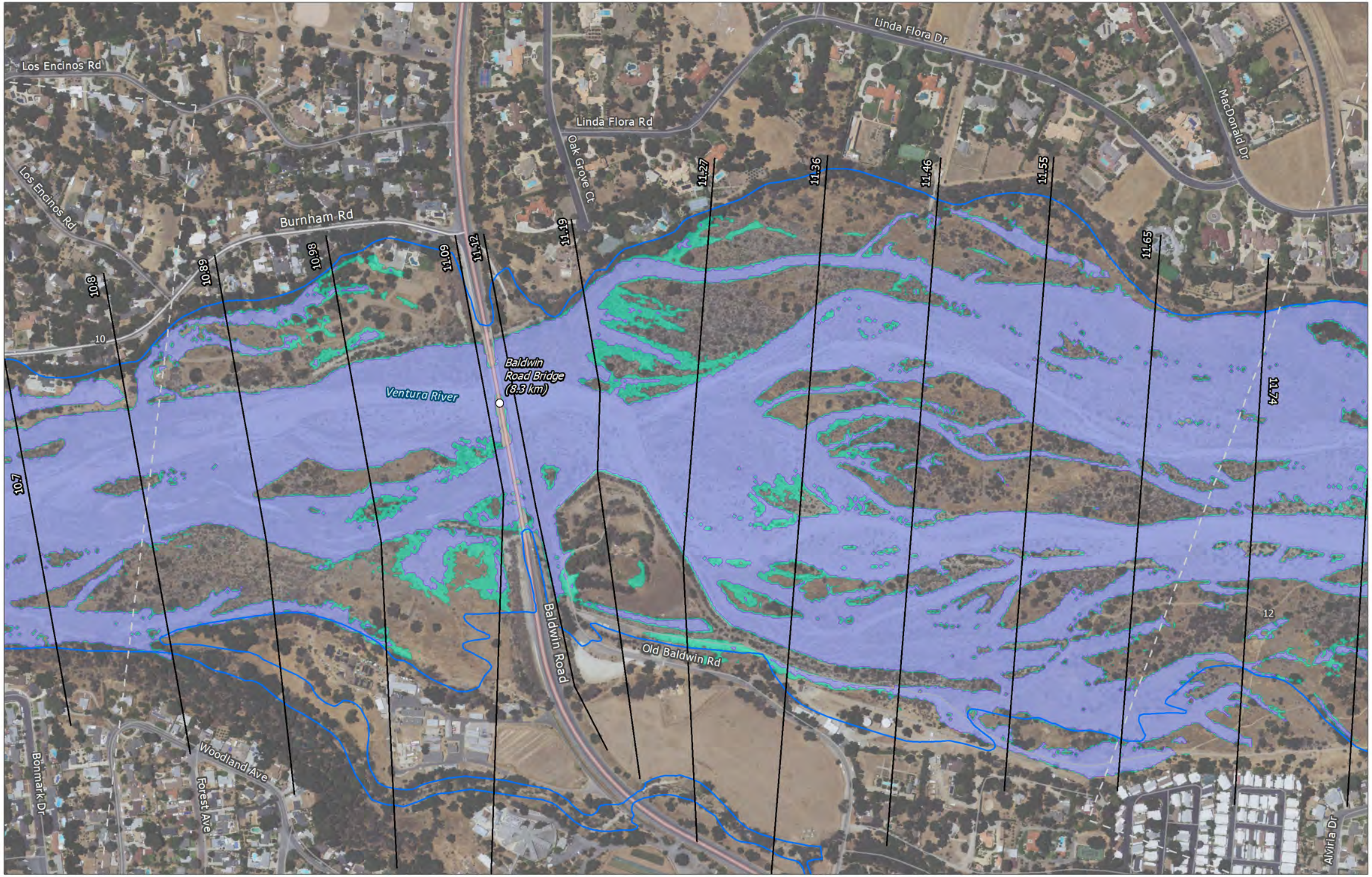
SCALE & NORTH ARROW

0 200 400 800 Feet
0 50 100 200 Meters
1:6,000 1 in = 500 feet

MAP LOCATION



VENTURA RIVER, CALIFORNIA
100 YEAR FLOODPLAIN
Subreach E & F
DATA SOURCES
With Dam/No Dam Removal 100-year FP: Stillwater Sciences 2019, with 2005 USBR LiDAR
FEMA 100 year FP: FEMA
Imagery: NAIP 2016
Roads, cities, streams, and waterbodies: ESRI 2016
LEGEND
Adjacent tile
Point of Interest (labeled with Sediment Transport Model river stationing)
HEC-RAS cross section
Subreach break
FEMA 100-year floodplain extent
Current 100-year floodplain from HEC-RAS
Future (Dam Removal) average 100-year floodplain extent in quasi-equilibrium
Stillwater Sciences
SCALE & NORTH ARROW
0 200 400 800 Feet
0 50 100 200 Meters
1:6,000
1 in = 500 feet
MAP LOCATION
Page 10 of 15
Matilija Lake
Ojai
Lake Casitas
101
Ventura
126
Saticoy
9.56
9.66
9.75
9.85
9.94
10.04
10.13
10.23
10.32
10.42
10.51
10.61
10.7
10.8
9
11
Sycamore Rd
Rockaway Rd
Burnham Rd
Riverside Rd
Los Encinos Rd
Ventura River
Monte Via
33
subreach F
subreach E
Barbara St
Puesta del Sol
Catalina Dr
Bonmark Dr



VENTURA RIVER, CALIFORNIA

100 YEAR FLOODPLAIN
Subreach E

DATA SOURCES
With Dam/No Dam Removal 100-year FP: Stillwater Sciences 2019, with 2005 USBR LiDAR
FEMA 100 year FP: FEMA
Imagery: NAIP 2016
Roads, cities, streams, and waterbodies: ESRI 2016

LEGEND

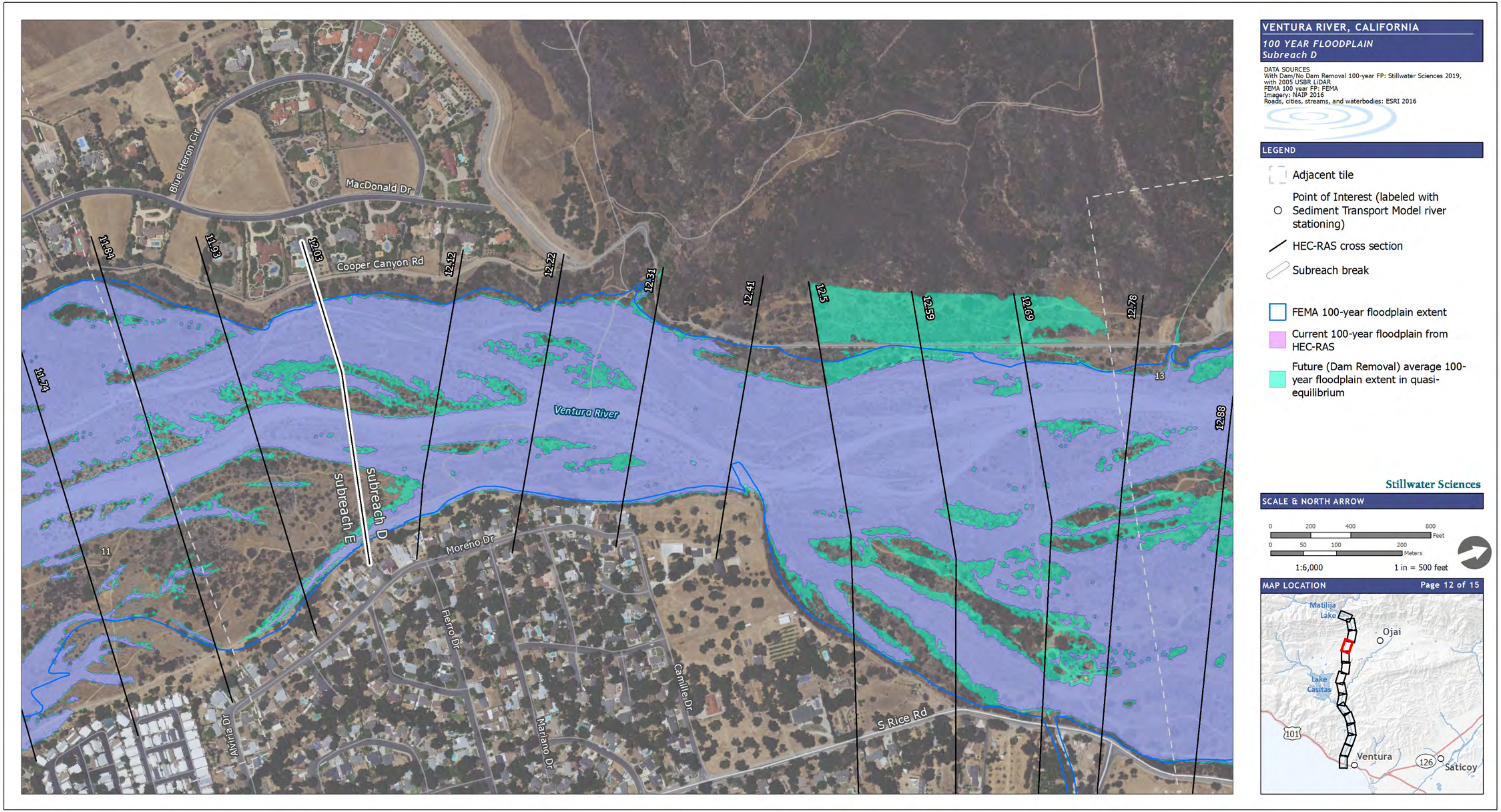
- Adjacent tile
- Point of Interest (labeled with Sediment Transport Model river stationing)
- HEC-RAS cross section
- Subreach break
- FEMA 100-year floodplain extent
- Current 100-year floodplain from HEC-RAS
- Future (Dam Removal) average 100-year floodplain extent in quasi-equilibrium

Stillwater Sciences

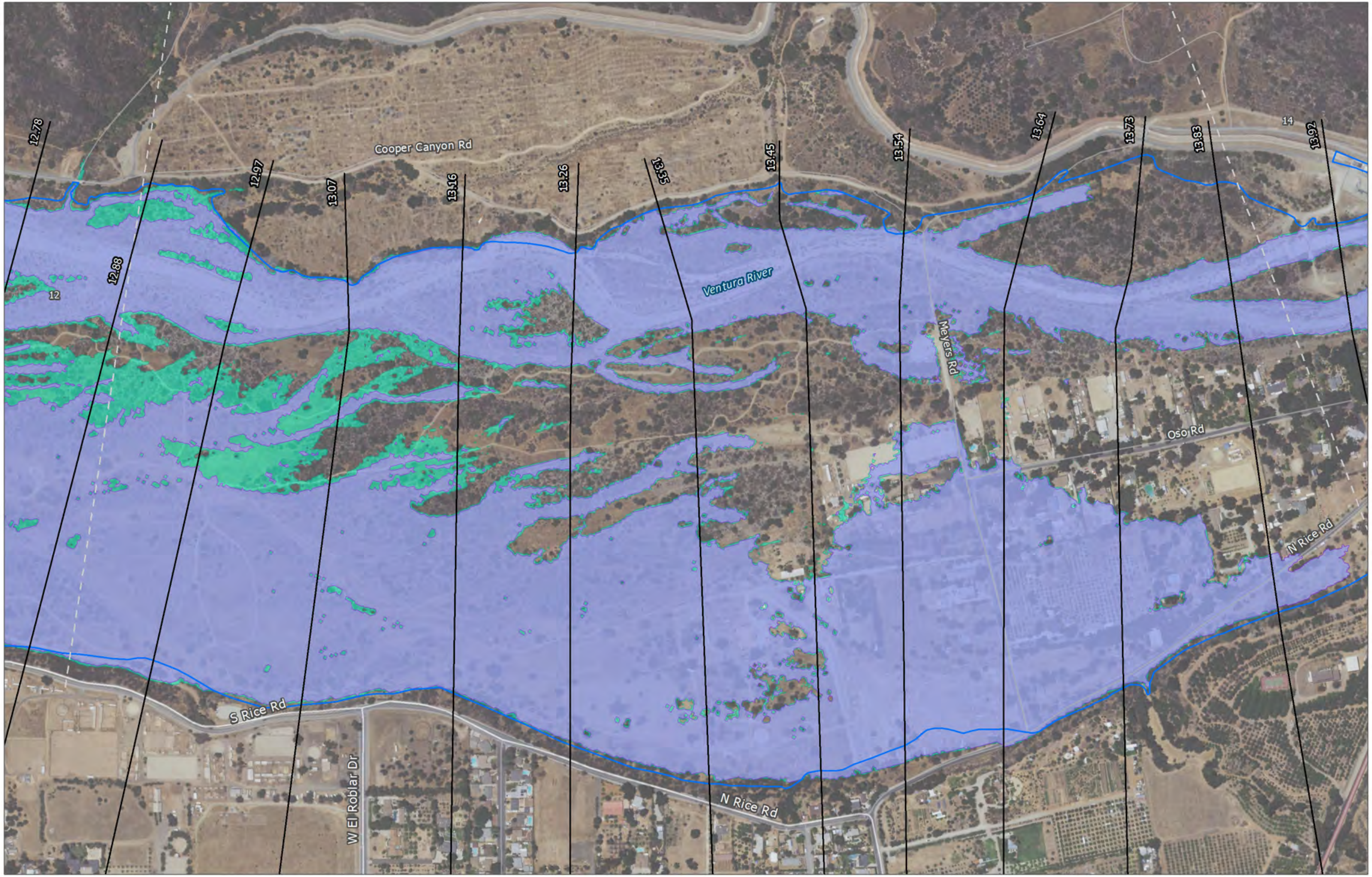
SCALE & NORTH ARROW

0 200 400 800 Feet
0 50 100 200 Meters
1:6,000
1 in = 500 feet

MAP LOCATION



VENTURA RIVER, CALIFORNIA
100 YEAR FLOODPLAIN
Subreach D
DATA SOURCES
With Dam/No Dam Removal 100-year FP: Stillwater Sciences 2019, with 2005 USBR LiDAR
FEMA 100 year FP: FEMA
Imagery: NAIP 2016
Roads, cities, streams, and waterbodies: ESRI 2016
LEGEND
Adjacent tile
Point of Interest (labeled with Sediment Transport Model river stationing)
HEC-RAS cross section
Subreach break
FEMA 100-year floodplain extent
Current 100-year floodplain from HEC-RAS
Future (Dam Removal) average 100-year floodplain extent in quasi-equilibrium
Stillwater Sciences
SCALE & NORTH ARROW
0 200 400 800 Feet
0 50 100 200 Meters
1:6,000
1 in = 500 feet
MAP LOCATION
Page 12 of 15
Matilija Lake
Ojai
Lake Casitas
101
Ventura
126
Saticoy
Blue Heron Cir
MacDonald Dr
Cooper Canyon Rd
Ventura River
subreach D
subreach E
Moreno Dr
Fierro Dr
Mariano Dr
Camille Dr
Aviria Dr
S Rice Rd
11.74
11.84
11.93
12.03
12.12
12.22
12.31
12.41
12.5
12.59
12.69
12.78
12.88
11
13



VENTURA RIVER, CALIFORNIA

100 YEAR FLOODPLAIN
Subreach D

DATA SOURCES
With Dam/No Dam Removal 100-year FP: Stillwater Sciences 2019, with 2005 USBR LiDAR
FEMA 100 year FP: FEMA
Imagery: NAIP 2016
Roads, cities, streams, and waterbodies: ESRI 2016

LEGEND

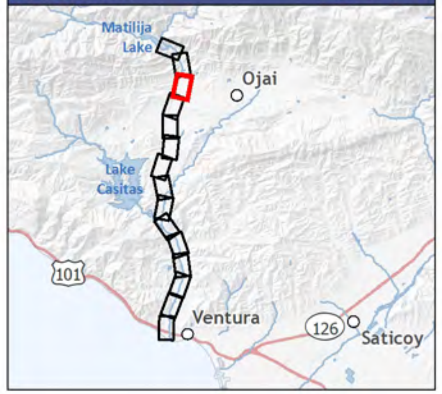
- Adjacent tile
- Point of Interest (labeled with Sediment Transport Model river stationing)
- HEC-RAS cross section
- Subreach break
- FEMA 100-year floodplain extent
- Current 100-year floodplain from HEC-RAS
- Future (Dam Removal) average 100-year floodplain extent in quasi-equilibrium

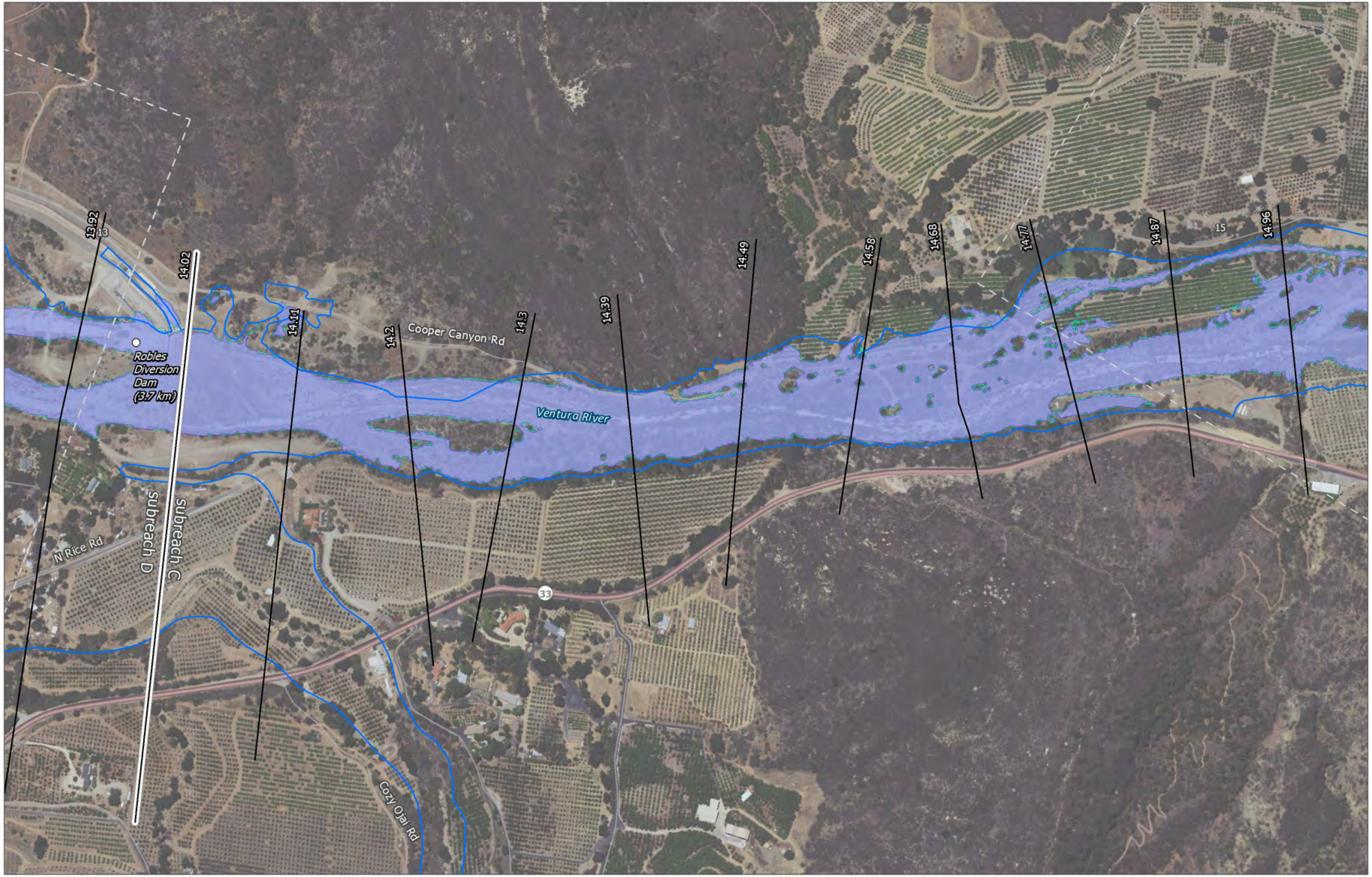
Stillwater Sciences

SCALE & NORTH ARROW

0 200 400 800 Feet
0 50 100 200 Meters
1:6,000 1 in = 500 feet

MAP LOCATION





VENTURA RIVER, CALIFORNIA

100 YEAR FLOODPLAIN
Subreach C

DATA SOURCES
With Dam/No Dam Removal 100-year FP: Stillwater Sciences 2019, with 2005 USBR LiDAR
FEMA 100 year FP: FEMA
Imagery: NAIP 2016
Roads, cities, streams, and waterbodies: ESRI 2016

LEGEND

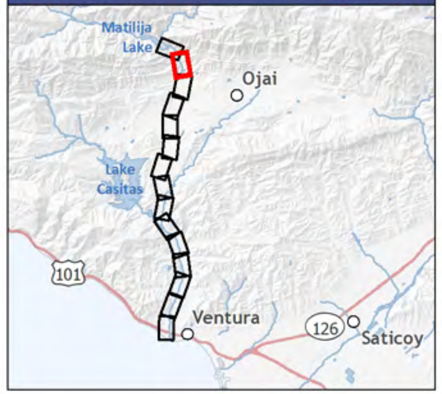
- Adjacent tile
- Point of Interest (labeled with Sediment Transport Model river stationing)
- HEC-RAS cross section
- Subreach break
- FEMA 100-year floodplain extent
- Current 100-year floodplain from HEC-RAS
- Future (Dam Removal) average 100-year floodplain extent in quasi-equilibrium

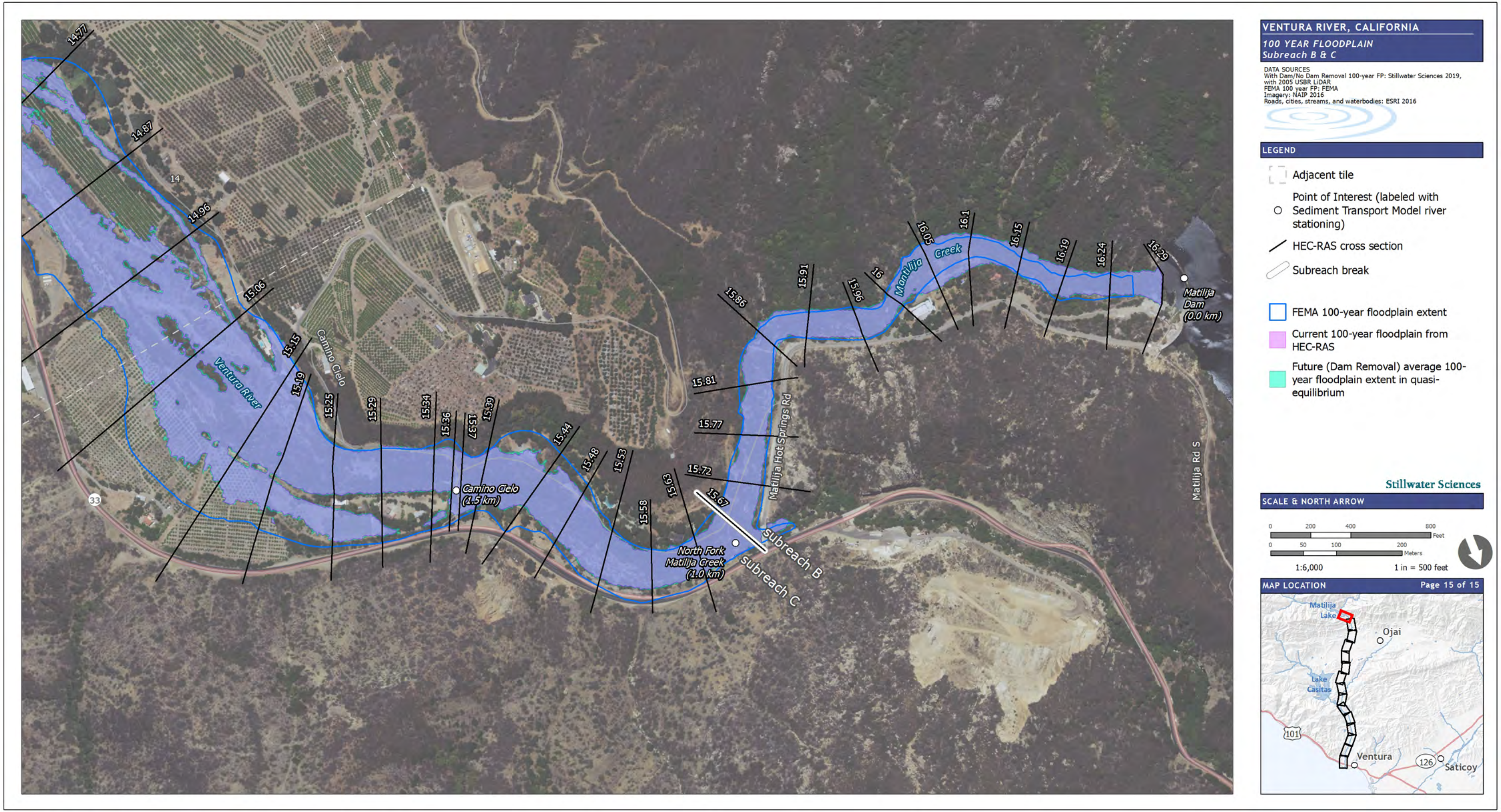
Stillwater Sciences

SCALE & NORTH ARROW

0 200 400 800 Feet
0 50 100 200 Meters
1:6,000 1 in = 500 feet

MAP LOCATION

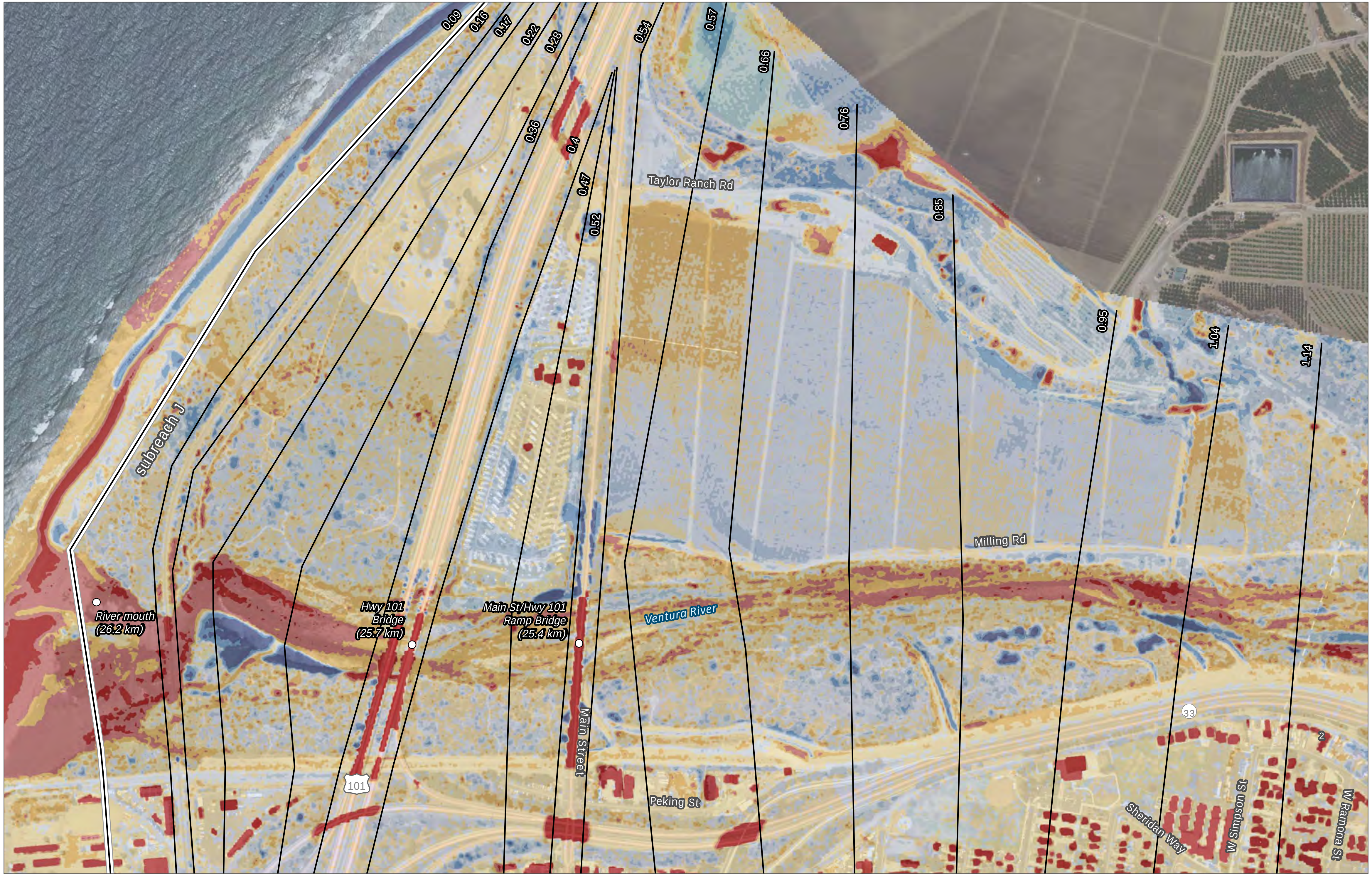




VENTURA RIVER, CALIFORNIA
100 YEAR FLOODPLAIN
Subreach B & C
DATA SOURCES
With Dam/No Dam Removal 100-year FP: Stillwater Sciences 2019, with 2005 USBR LiDAR
FEMA 100 year FP: FEMA
Imagery: NAIP 2016
Roads, cities, streams, and waterbodies: ESRI 2016
LEGEND
Adjacent tile
Point of Interest (labeled with Sediment Transport Model river stationing)
HEC-RAS cross section
Subreach break
FEMA 100-year floodplain extent
Current 100-year floodplain from HEC-RAS
Future (Dam Removal) average 100-year floodplain extent in quasi-equilibrium
Stillwater Sciences
SCALE & NORTH ARROW
0 200 400 800 Feet
0 50 100 200 Meters
1:6,000
1 in = 500 feet
MAP LOCATION
Page 15 of 15
Matilija Lake
Ojai
Lake Casitas
101
Ventura
126
Saticoy
14.77
14.87
14.96
15.06
15.15
15.19
15.25
15.29
15.34
15.36
15.37
15.39
15.44
15.48
15.53
15.58
15.63
15.67
15.72
15.77
15.81
15.86
15.91
15.96
16
16.05
16.1
16.15
16.19
16.24
16.29
14
33
Ventura River
Camino Cielo
Camino Cielo (1.5 km)
North Fork Matilija Creek (1.0 km)
Matilija Creek
Matilija Hot Springs Rd
Matilija Dam (0.0 km)
Matilija Rd S
Subreach B
Subreach C

Appendix D

Comparison of 2005 and 2018 LiDAR DTMs



VENTURA RIVER, CALIFORNIA

LiDAR Comparison
Subreach J

DATA SOURCES
2005 LiDAR: USBR
2018 LiDAR: Ventura County
Imagery: NAIP 2016
Roads, cities, streams, and waterbodies: ESRI 2016

LEGEND

Adjacent tile

Point of Interest (labeled with Sediment Transport Model river stationing)

HEC-RAS cross section

Subreach break

LiDAR comparison (ft)

2018 below 2005	2018 above 2005
<-5.0	0.1 - 1
-4.9 - -2.5	1.1 - 2.5
-2.4 - -1	2.6 - 5
-0.9 - 0.0	> 5.0

Stillwater Sciences

SCALE & NORTH ARROW

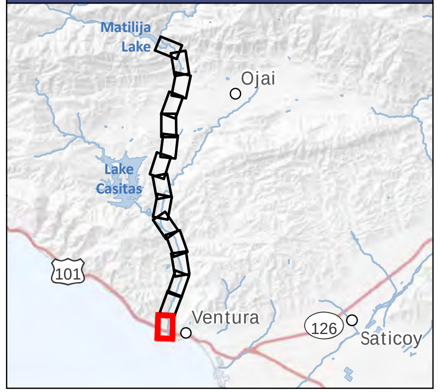
0 200 400 800 Feet

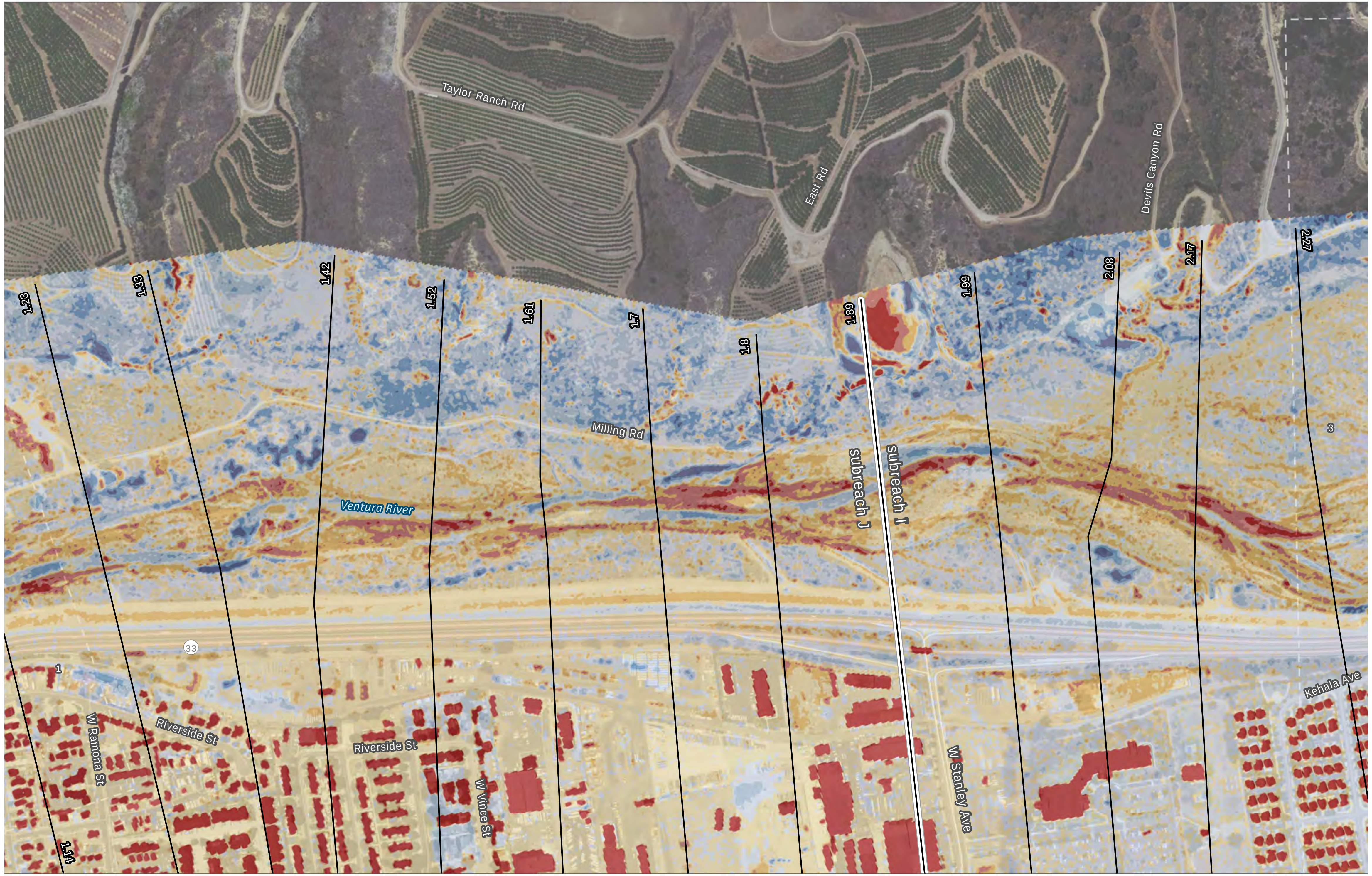
0 50 100 200 Meters

1:6,000

1 in = 500 feet

MAP LOCATION





VENTURA RIVER, CALIFORNIA

LiDAR Comparison
Subreach I & J

DATA SOURCES
2005 LiDAR: USBR
2018 LiDAR: Ventura County
Imagery: NAIP 2016
Roads, cities, streams, and waterbodies: ESRI 2016

LEGEND

Adjacent tile

Point of Interest (labeled with Sediment Transport Model river stationing)

HEC-RAS cross section

Subreach break

LiDAR comparison (ft)

2018 below 2005	2018 above 2005
<-5.0	0.1 - 1
-4.9 - -2.5	1.1 - 2.5
-2.4 - -1	2.6 - 5
-0.9 - 0.0	> 5.0

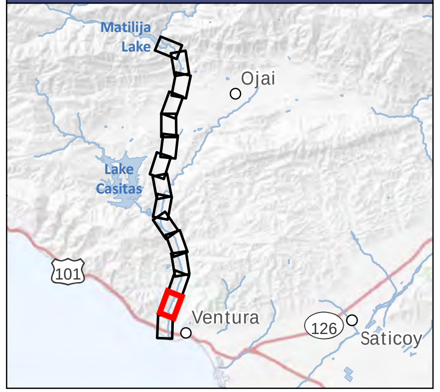
Stillwater Sciences

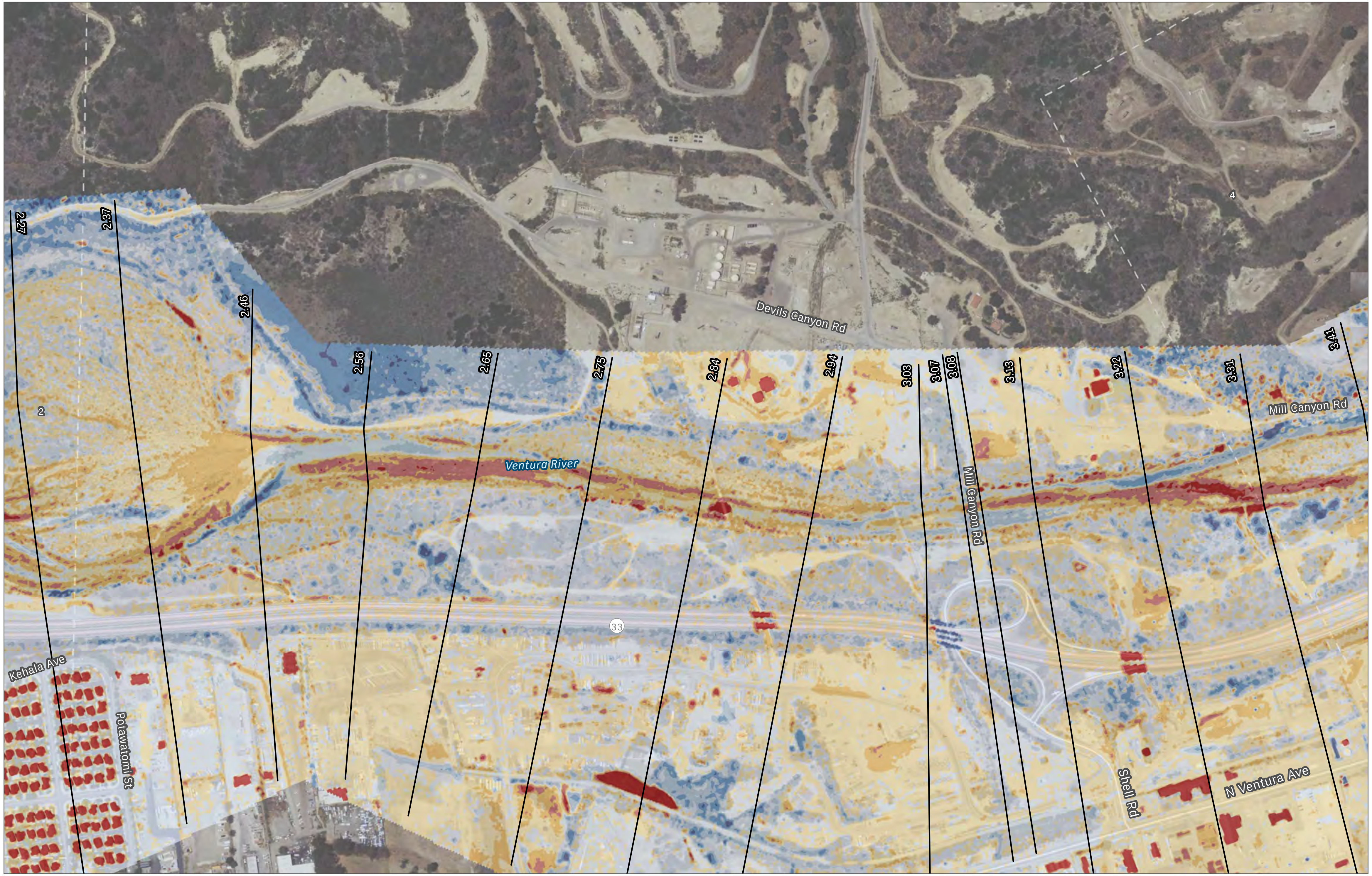
SCALE & NORTH ARROW

0 200 400 800 Feet
0 50 100 200 Meters

1:6,000 1 in = 500 feet

MAP LOCATION





VENTURA RIVER, CALIFORNIA

LiDAR Comparison
Subreach I

DATA SOURCES
2005 LiDAR: USBR
2018 LiDAR: Ventura County
Imagery: NAIP 2016
Roads, cities, streams, and waterbodies: ESRI 2016

LEGEND

Adjacent tile

Point of Interest (labeled with Sediment Transport Model river stationing)

HEC-RAS cross section

Subreach break

LiDAR comparison (ft)

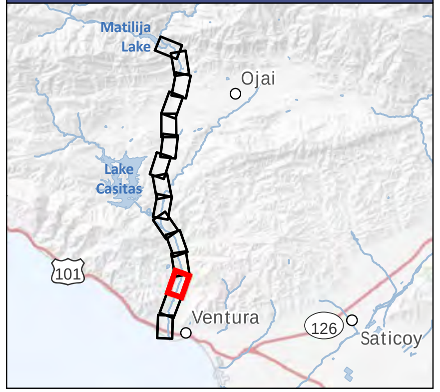
2018 below 2005	2018 above 2005
<-5.0	0.1 - 1
-4.9 - -2.5	1.1 - 2.5
-2.4 - -1	2.6 - 5
-0.9 - 0.0	> 5.0

Stillwater Sciences

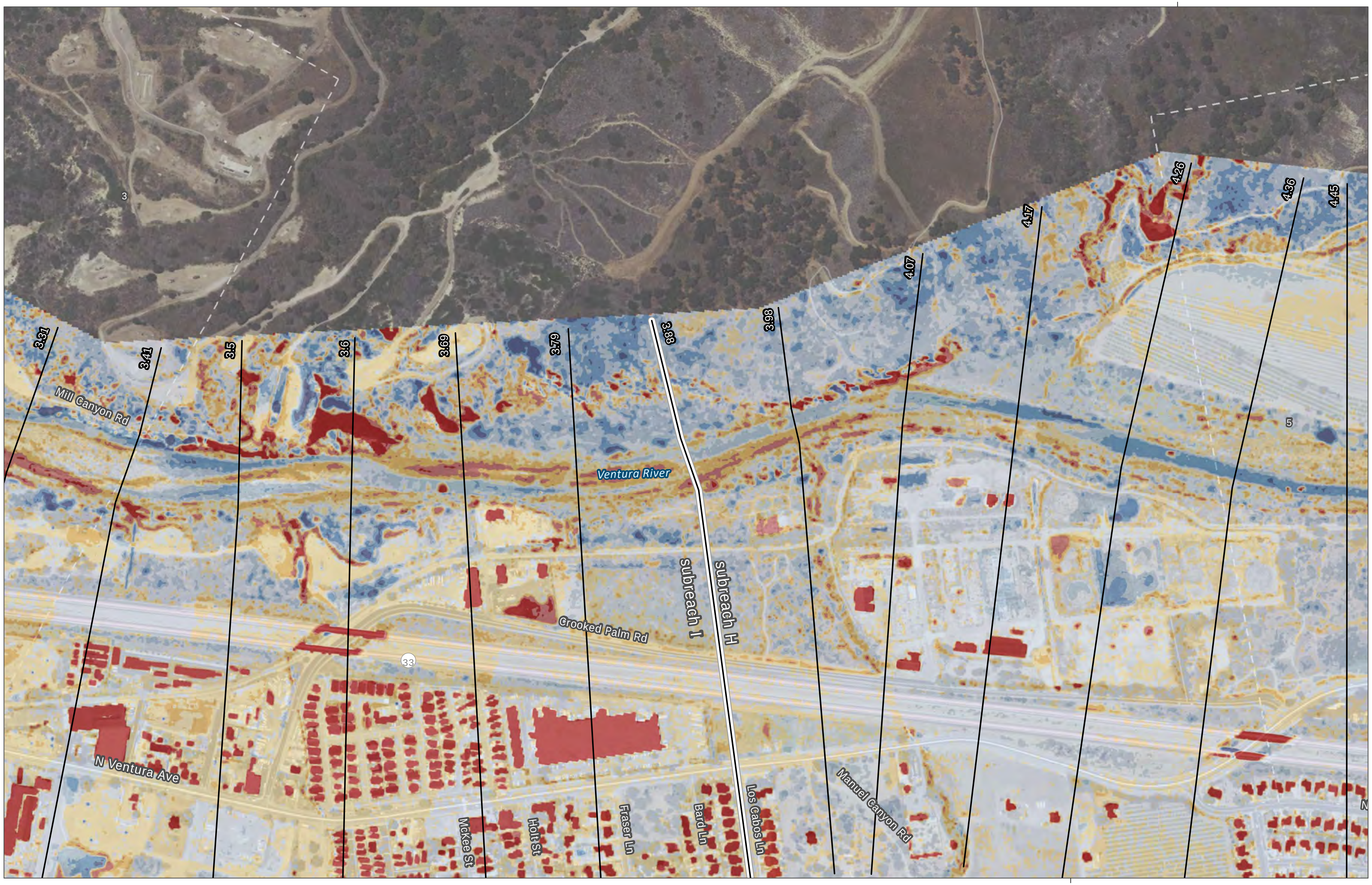
SCALE & NORTH ARROW

0 200 400 800 Feet
0 50 100 200 Meters
1:6,000
1 in = 500 feet

MAP LOCATION



34°20'N



34°20'N

VENTURA RIVER, CALIFORNIA

LiDAR Comparison
Subreach H & I

DATA SOURCES
2005 LiDAR: USBR
2018 LiDAR: Ventura County
Imagery: NAIP 2016
Roads, cities, streams, and waterbodies: ESRI 2016

LEGEND

Adjacent tile

Point of Interest (labeled with Sediment Transport Model river stationing)

HEC-RAS cross section

Subreach break

LiDAR comparison (ft)

2018 below 2005	2018 above 2005
<-5.0	0.1 - 1
-4.9 - -2.5	1.1 - 2.5
-2.4 - -1	2.6 - 5
-0.9 - 0.0	> 5.0

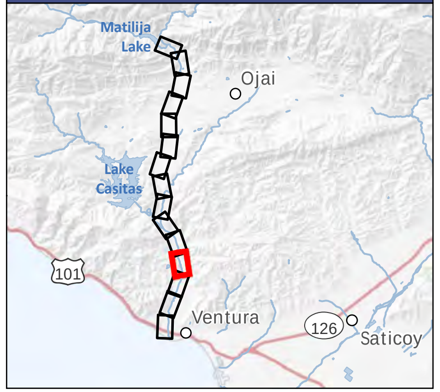
Stillwater Sciences

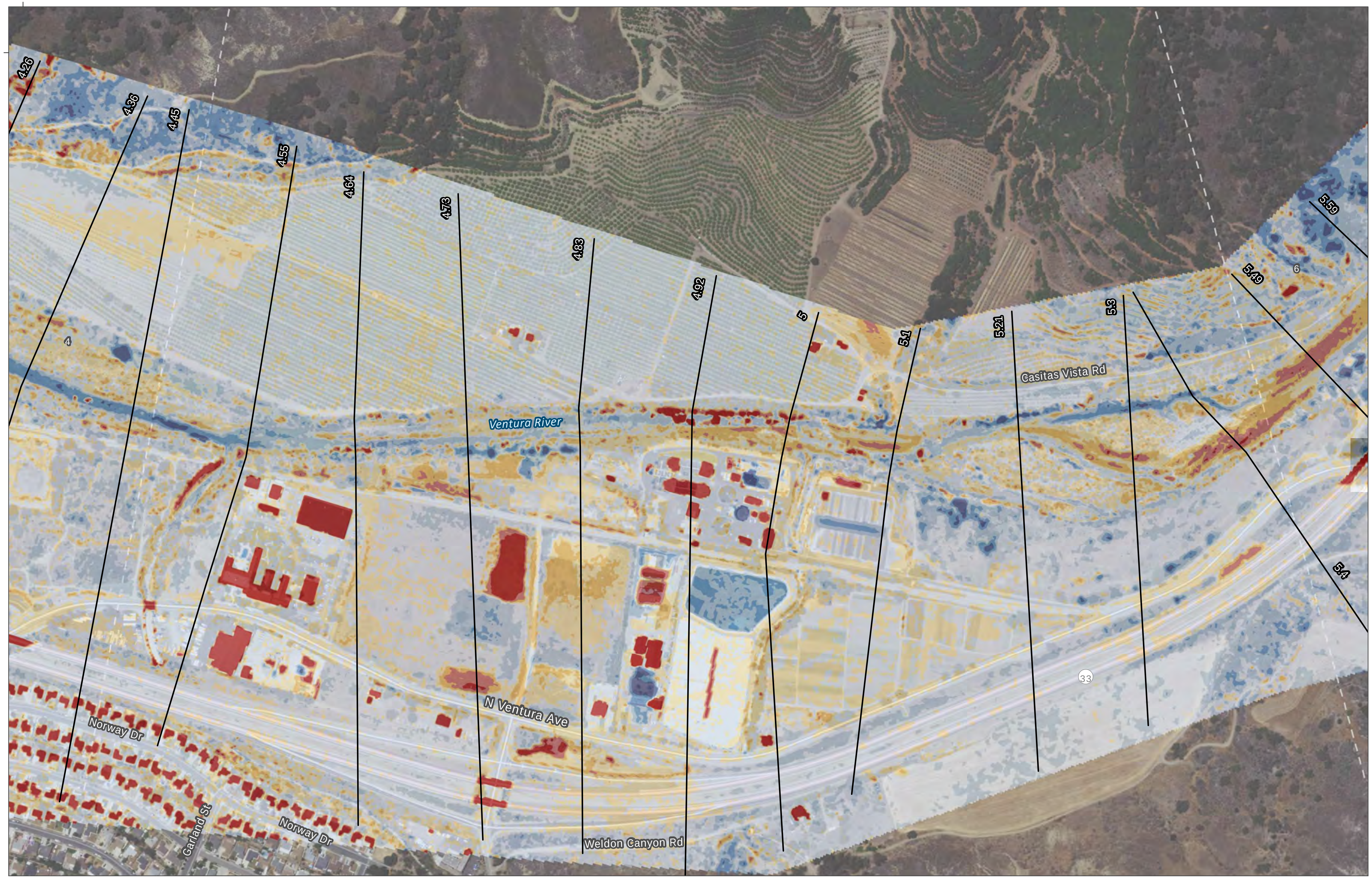
SCALE & NORTH ARROW

0 200 400 800 Feet
0 50 100 200 Meters

1:6,000 1 in = 500 feet

MAP LOCATION





VENTURA RIVER, CALIFORNIA

LiDAR Comparison
Subreach H

DATA SOURCES
2005 LiDAR: USBR
2018 LiDAR: Ventura County
Imagery: NAIP 2016
Roads, cities, streams, and waterbodies: ESRI 2016

LEGEND

Adjacent tile

Point of Interest (labeled with Sediment Transport Model river stationing)

HEC-RAS cross section

Subreach break

LiDAR comparison (ft)

2018 below 2005	2018 above 2005
<-5.0	0.1 - 1
-4.9 - -2.5	1.1 - 2.5
-2.4 - -1	2.6 - 5
-0.9 - 0.0	> 5.0

Stillwater Sciences

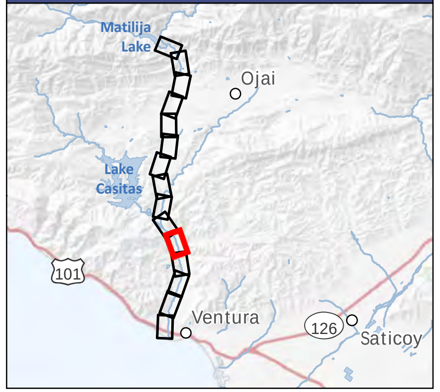
SCALE & NORTH ARROW

0 200 400 800 Feet
0 50 100 200 Meters

1:6,000

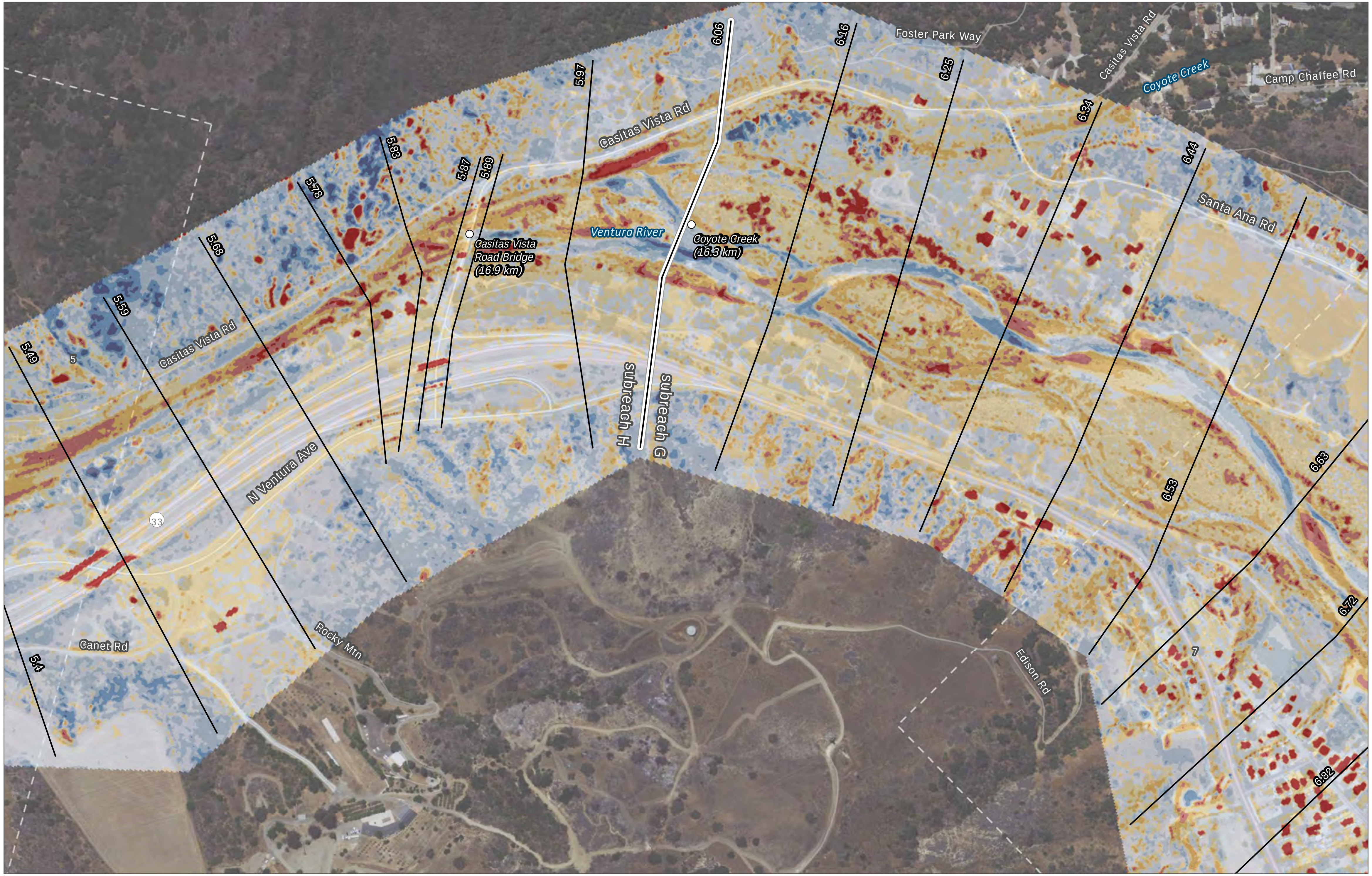
1 in = 500 feet

MAP LOCATION



VENTURA RIVER, CALIFORNIA

LiDAR Comparison
Subreach G & H



DATA SOURCES
2005 LiDAR: USBR
2018 LiDAR: Ventura County
Imagery: NAIP 2016
Roads, cities, streams, and waterbodies: ESRI 2016

LEGEND

Adjacent tile

Point of Interest (labeled with Sediment Transport Model river stationing)

HEC-RAS cross section

Subreach break

LiDAR comparison (ft)

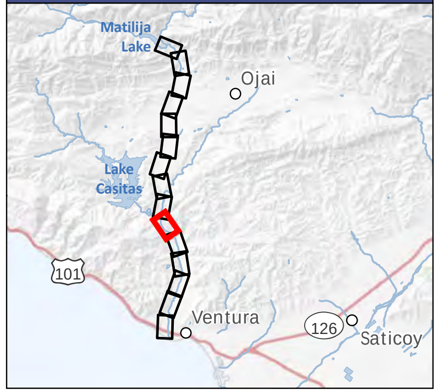
2018 below 2005	2018 above 2005
<-5.0	0.1 - 1
-4.9 - -2.5	1.1 - 2.5
-2.4 - -1	2.6 - 5
-0.9 - 0.0	> 5.0

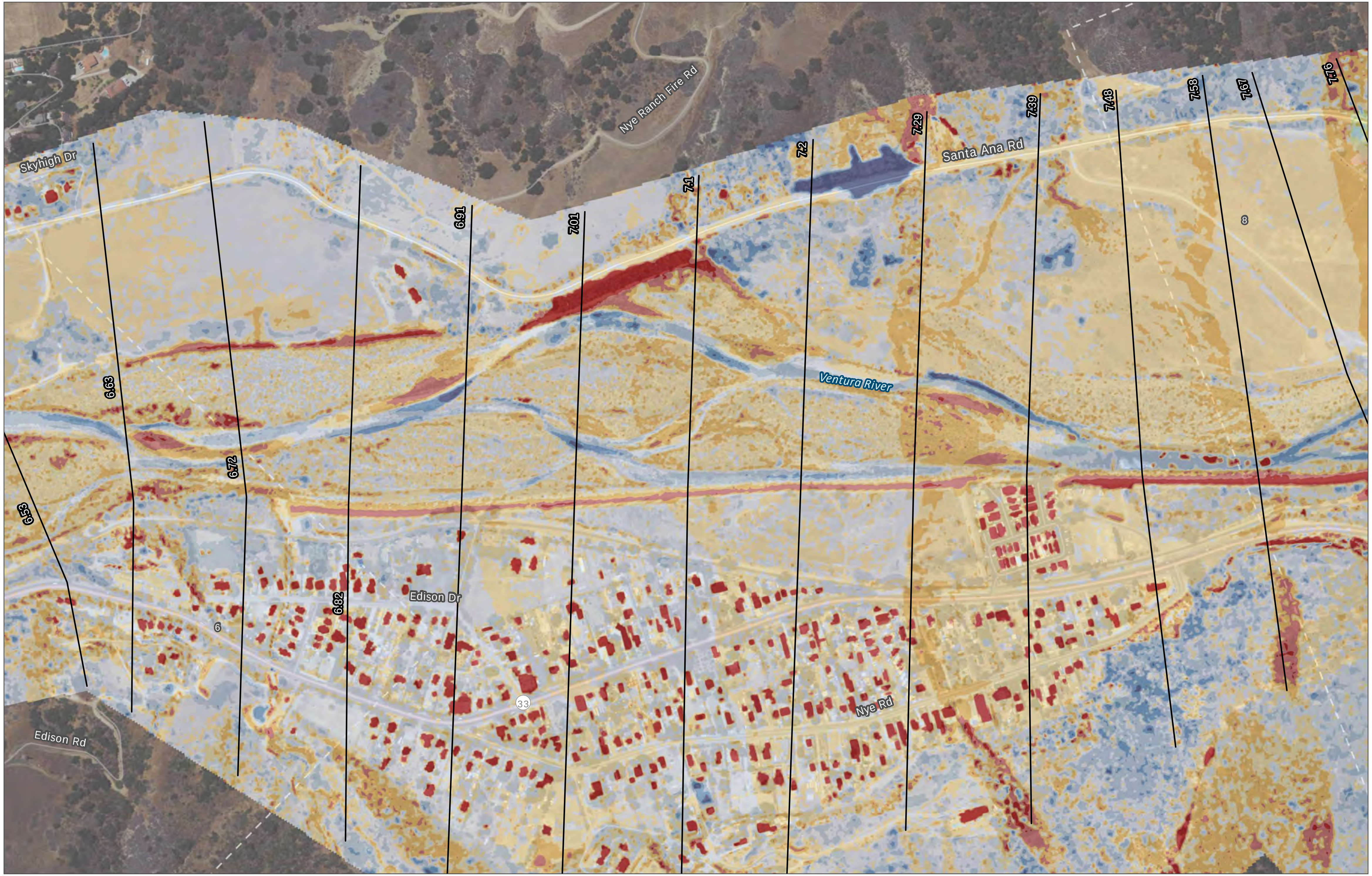
Stillwater Sciences

SCALE & NORTH ARROW

0 200 400 800 Feet
0 50 100 200 Meters
1:6,000 1 in = 500 feet

MAP LOCATION





VENTURA RIVER, CALIFORNIA

LiDAR Comparison
Subreach G

DATA SOURCES
2005 LiDAR: USBR
2018 LiDAR: Ventura County
Imagery: NAIP 2016
Roads, cities, streams, and waterbodies: ESRI 2016

LEGEND

Adjacent tile

Point of Interest (labeled with Sediment Transport Model river stationing)

HEC-RAS cross section

Subreach break

LiDAR comparison (ft)

2018 below 2005	2018 above 2005
<-5.0	0.1 - 1
-4.9 - -2.5	1.1 - 2.5
-2.4 - -1	2.6 - 5
-0.9 - 0.0	> 5.0

Stillwater Sciences

SCALE & NORTH ARROW

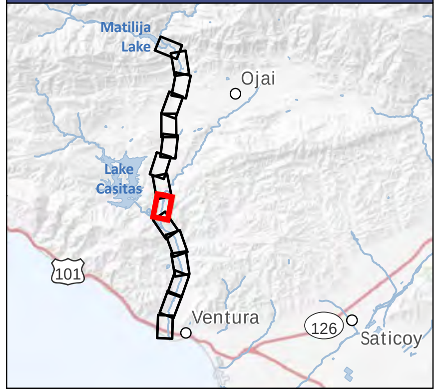
0 200 400 800 Feet

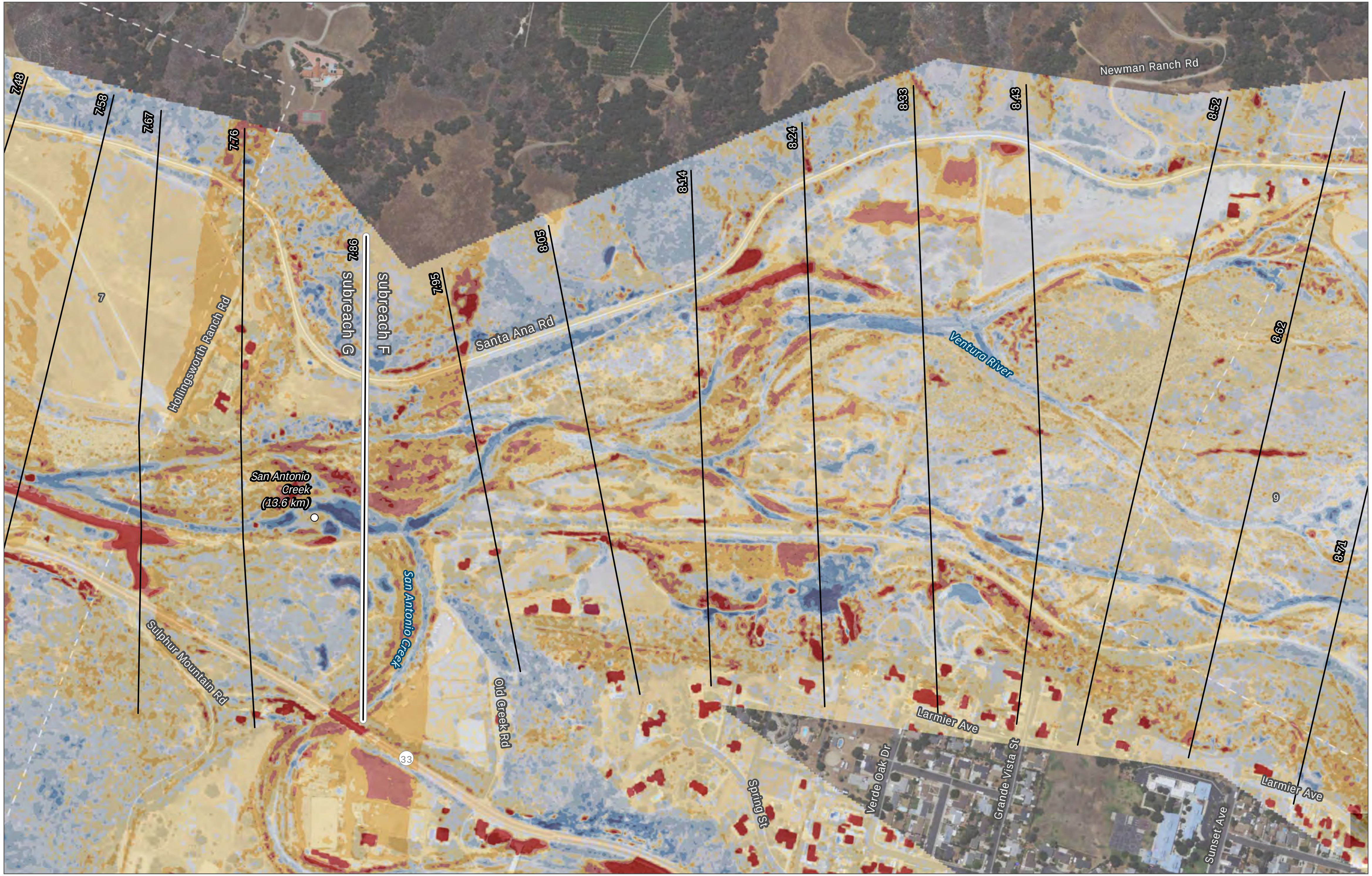
0 50 100 200 Meters

1:6,000

1 in = 500 feet

MAP LOCATION





VENTURA RIVER, CALIFORNIA

LiDAR Comparison
Subreach F

DATA SOURCES
2005 LiDAR: USBR
2018 LiDAR: Ventura County
Imagery: NAIP 2016
Roads, cities, streams, and waterbodies: ESRI 2016

LEGEND

Adjacent tile

Point of Interest (labeled with Sediment Transport Model river stationing)

HEC-RAS cross section

Subreach break

LiDAR comparison (ft)

2018 below 2005	2018 above 2005
<-5.0	0.1 - 1
-4.9 - -2.5	1.1 - 2.5
-2.4 - -1	2.6 - 5
-0.9 - 0.0	> 5.0

Stillwater Sciences

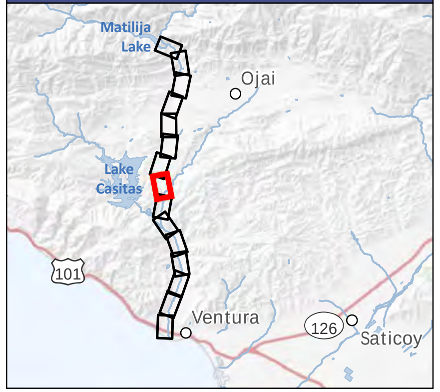
SCALE & NORTH ARROW

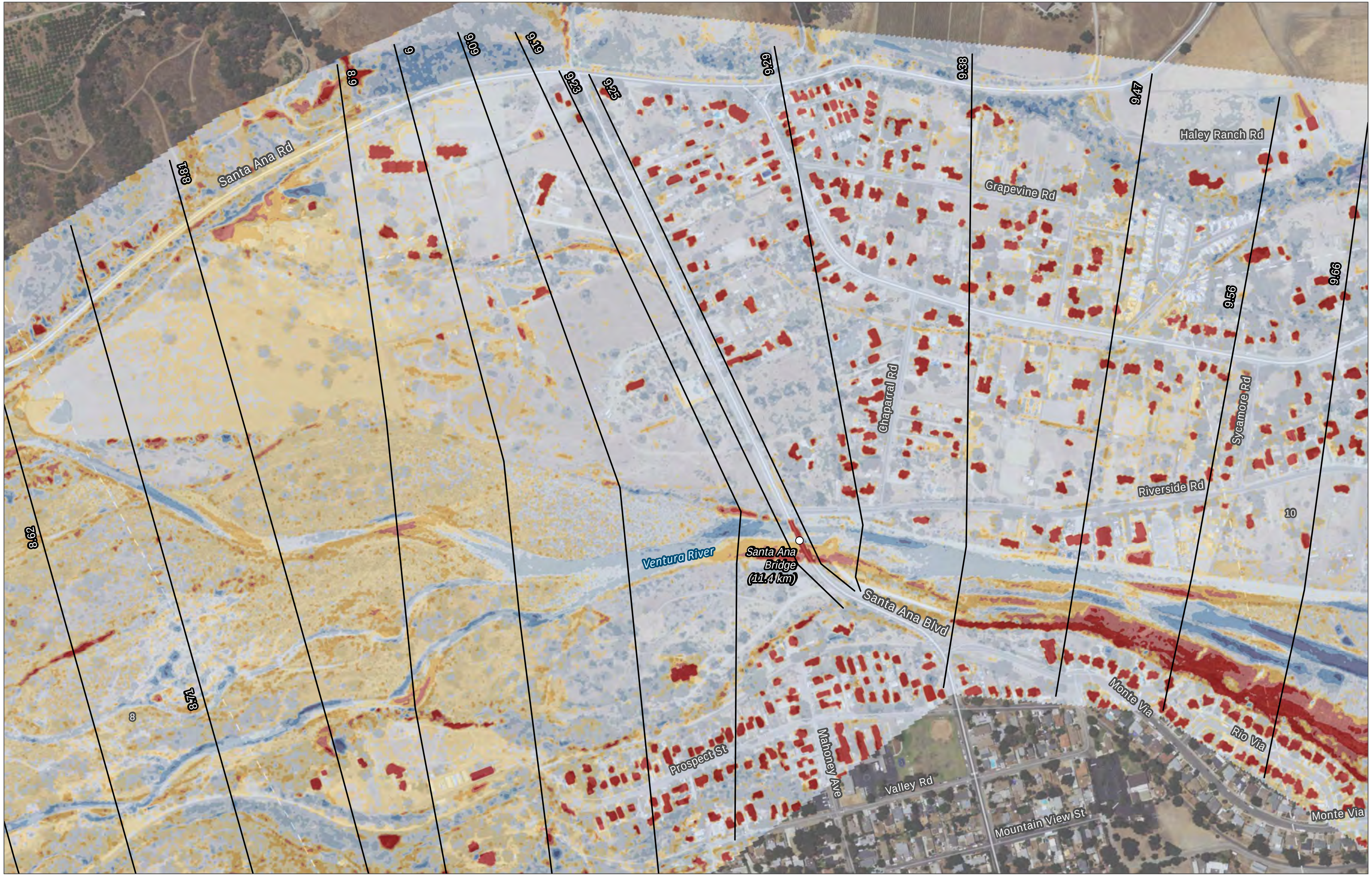
0 200 400 800 Feet

0 50 100 200 Meters

1:6,000 1 in = 500 feet

MAP LOCATION





VENTURA RIVER, CALIFORNIA

LiDAR Comparison
Subreach F

DATA SOURCES
2005 LiDAR: USBR
2018 LiDAR: Ventura County
Imagery: NAIP 2016
Roads, cities, streams, and waterbodies: ESRI 2016

LEGEND

Adjacent tile

Point of Interest (labeled with Sediment Transport Model river stationing)

HEC-RAS cross section

Subreach break

LiDAR comparison (ft)

2018 below 2005	2018 above 2005
<-5.0	0.1 - 1
-4.9 - -2.5	1.1 - 2.5
-2.4 - -1	2.6 - 5
-0.9 - 0.0	> 5.0

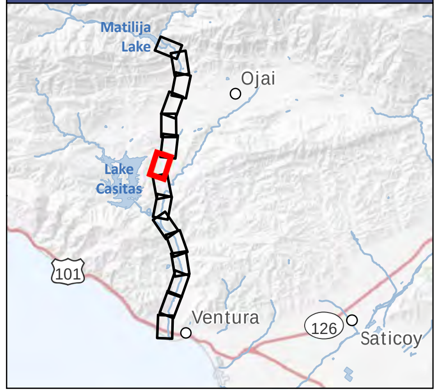
Stillwater Sciences

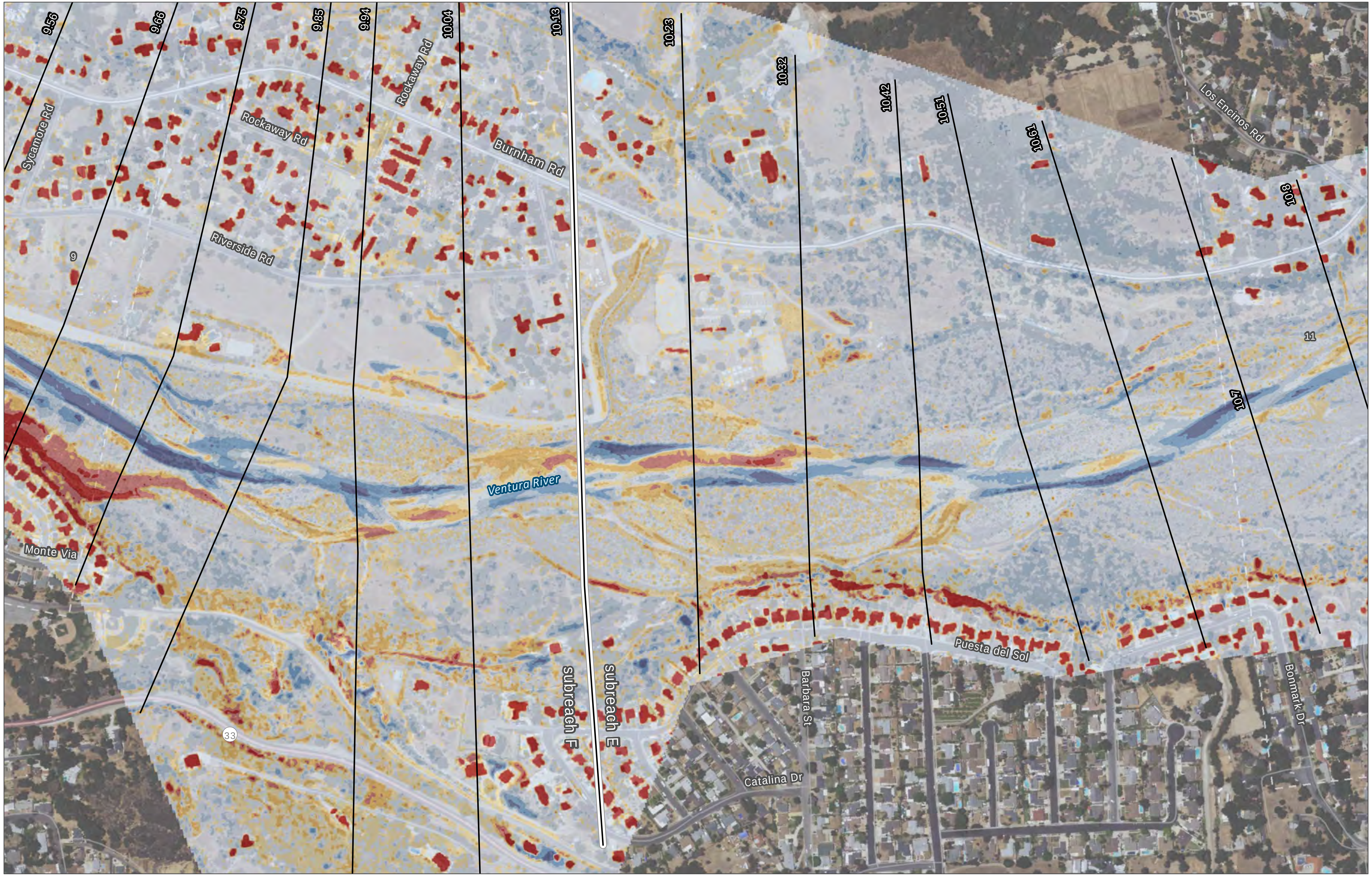
SCALE & NORTH ARROW

0 200 400 800 Feet
0 50 100 200 Meters

1:6,000 1 in = 500 feet

MAP LOCATION





VENTURA RIVER, CALIFORNIA

LiDAR Comparison
Subreach E & F

DATA SOURCES
2005 LiDAR: USBR
2018 LiDAR: Ventura County
Imagery: NAIP 2016
Roads, cities, streams, and waterbodies: ESRI 2016

LEGEND

Adjacent tile

Point of Interest (labeled with Sediment Transport Model river stationing)

HEC-RAS cross section

Subreach break

LiDAR comparison (ft)

2018 below 2005	2018 above 2005
<-5.0	0.1 - 1
-4.9 - -2.5	1.1 - 2.5
-2.4 - -1	2.6 - 5
-0.9 - 0.0	> 5.0

Stillwater Sciences

SCALE & NORTH ARROW

0 200 400 800 Feet

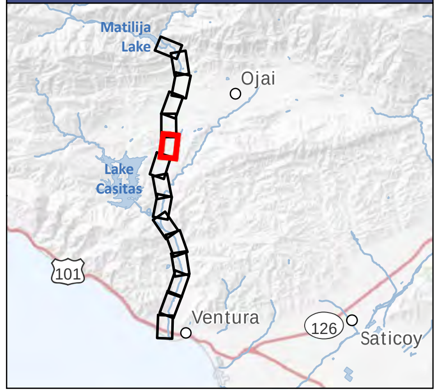
0 50 100 200 Meters

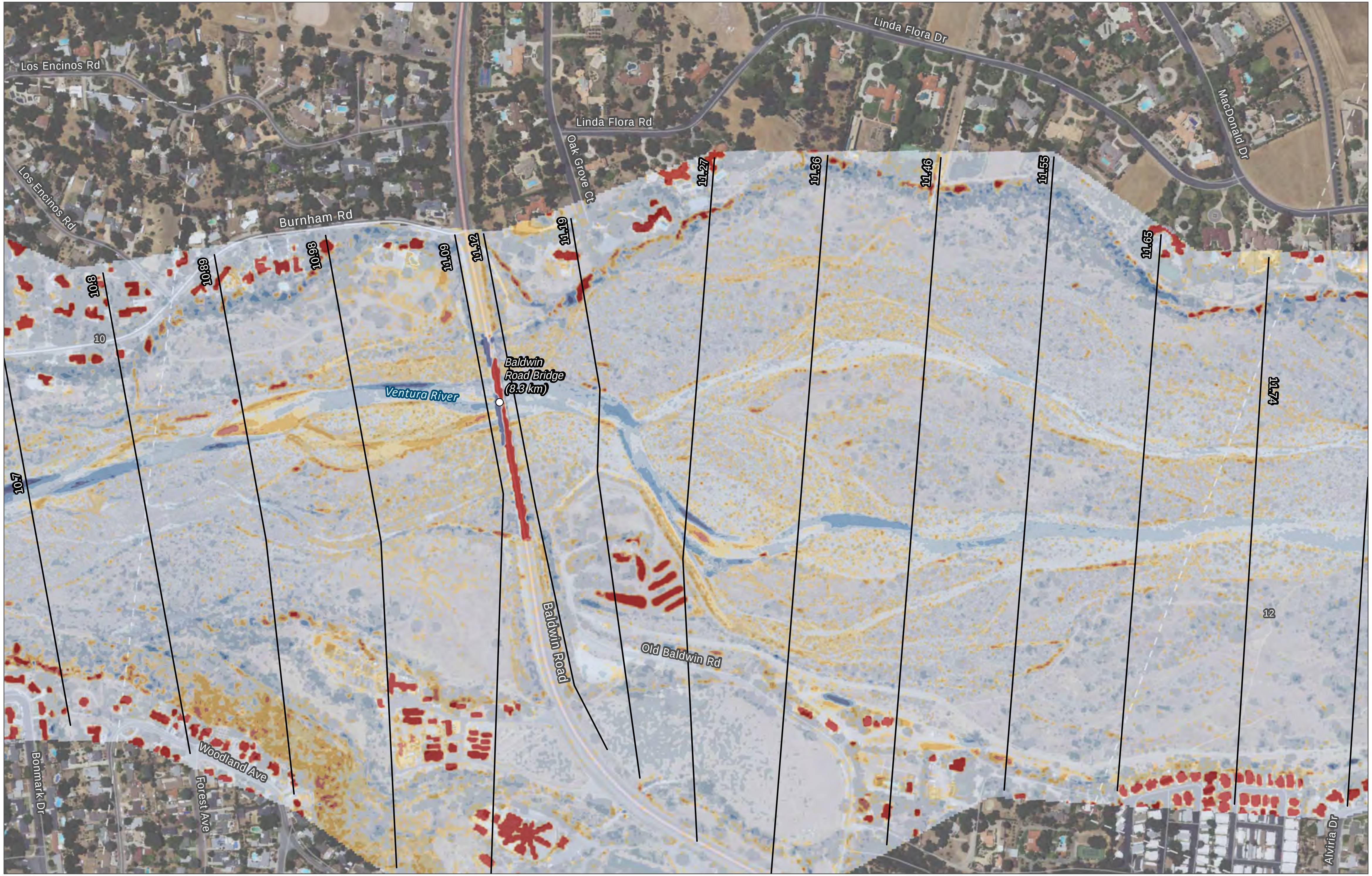
1:6,000

1 in = 500 feet

MAP LOCATION

Page 10 of 15





VENTURA RIVER, CALIFORNIA

LiDAR Comparison
Subreach E

DATA SOURCES
2005 LiDAR: USBR
2018 LiDAR: Ventura County
Imagery: NAIP 2016
Roads, cities, streams, and waterbodies: ESRI 2016

LEGEND

Adjacent tile

Point of Interest (labeled with Sediment Transport Model river stationing)

HEC-RAS cross section

Subreach break

LiDAR comparison (ft)

2018 below 2005	2018 above 2005
<-5.0	0.1 - 1
-4.9 - -2.5	1.1 - 2.5
-2.4 - -1	2.6 - 5
-0.9 - 0.0	> 5.0

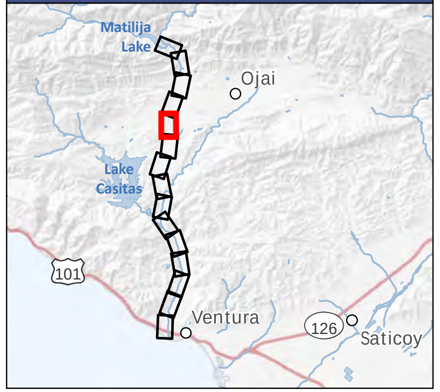
Stillwater Sciences

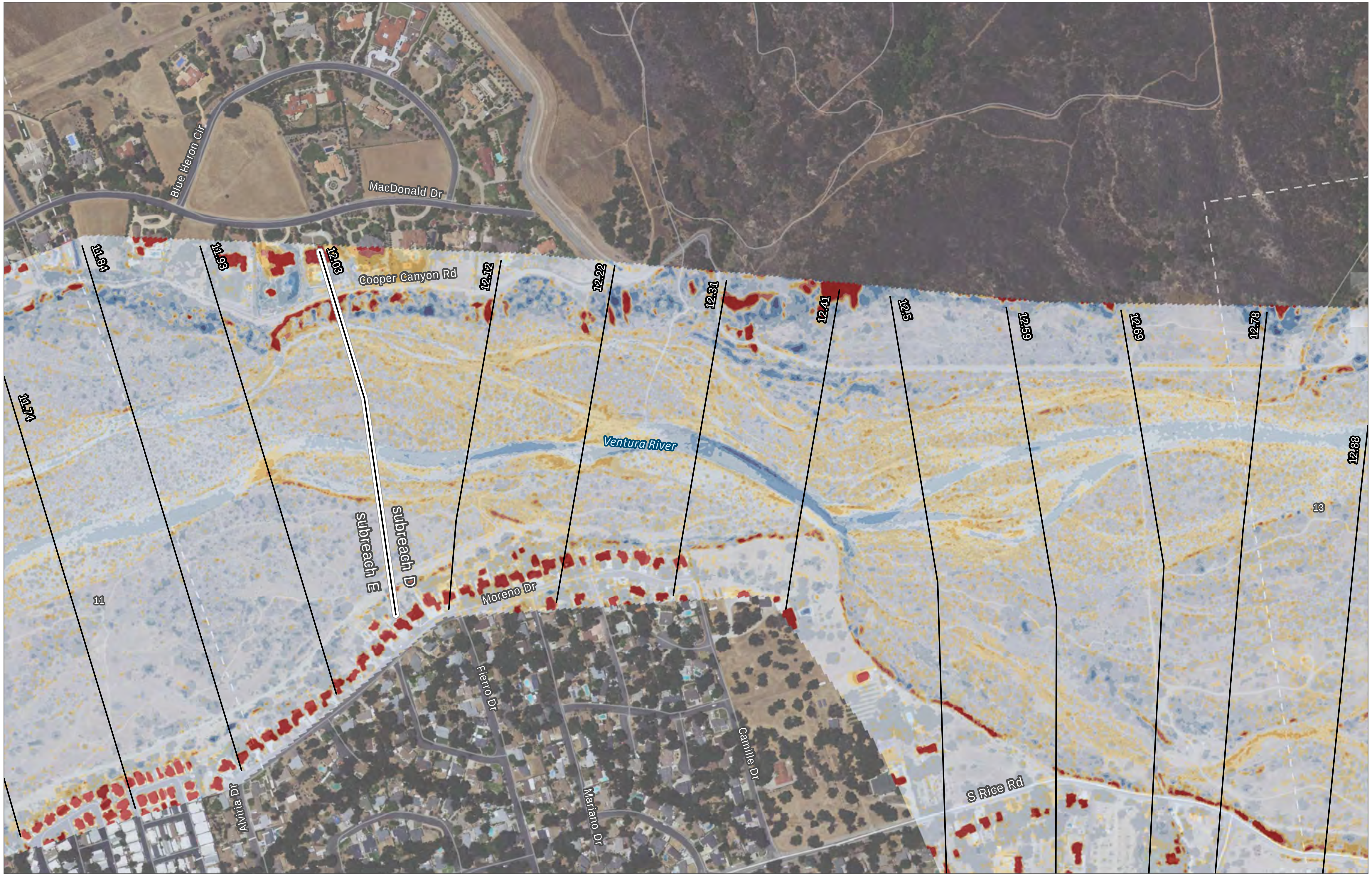
SCALE & NORTH ARROW

0 200 400 800 Feet
0 50 100 200 Meters

1:6,000 1 in = 500 feet

MAP LOCATION





VENTURA RIVER, CALIFORNIA

LiDAR Comparison
Subreach D

DATA SOURCES
2005 LiDAR: USBR
2018 LiDAR: Ventura County
Imagery: NAIP 2016
Roads, cities, streams, and waterbodies: ESRI 2016

LEGEND

Adjacent tile

Point of Interest (labeled with Sediment Transport Model river stationing)

HEC-RAS cross section

Subreach break

LiDAR comparison (ft)

2018 below 2005	2018 above 2005
<-5.0	0.1 - 1
-4.9 - -2.5	1.1 - 2.5
-2.4 - -1	2.6 - 5
-0.9 - 0.0	> 5.0

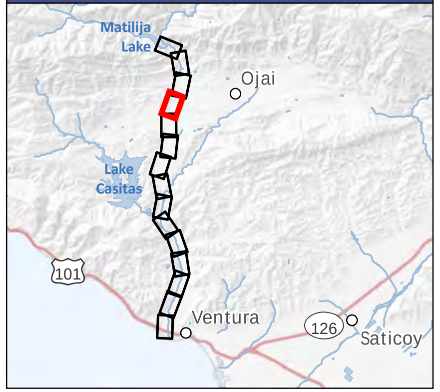
Stillwater Sciences

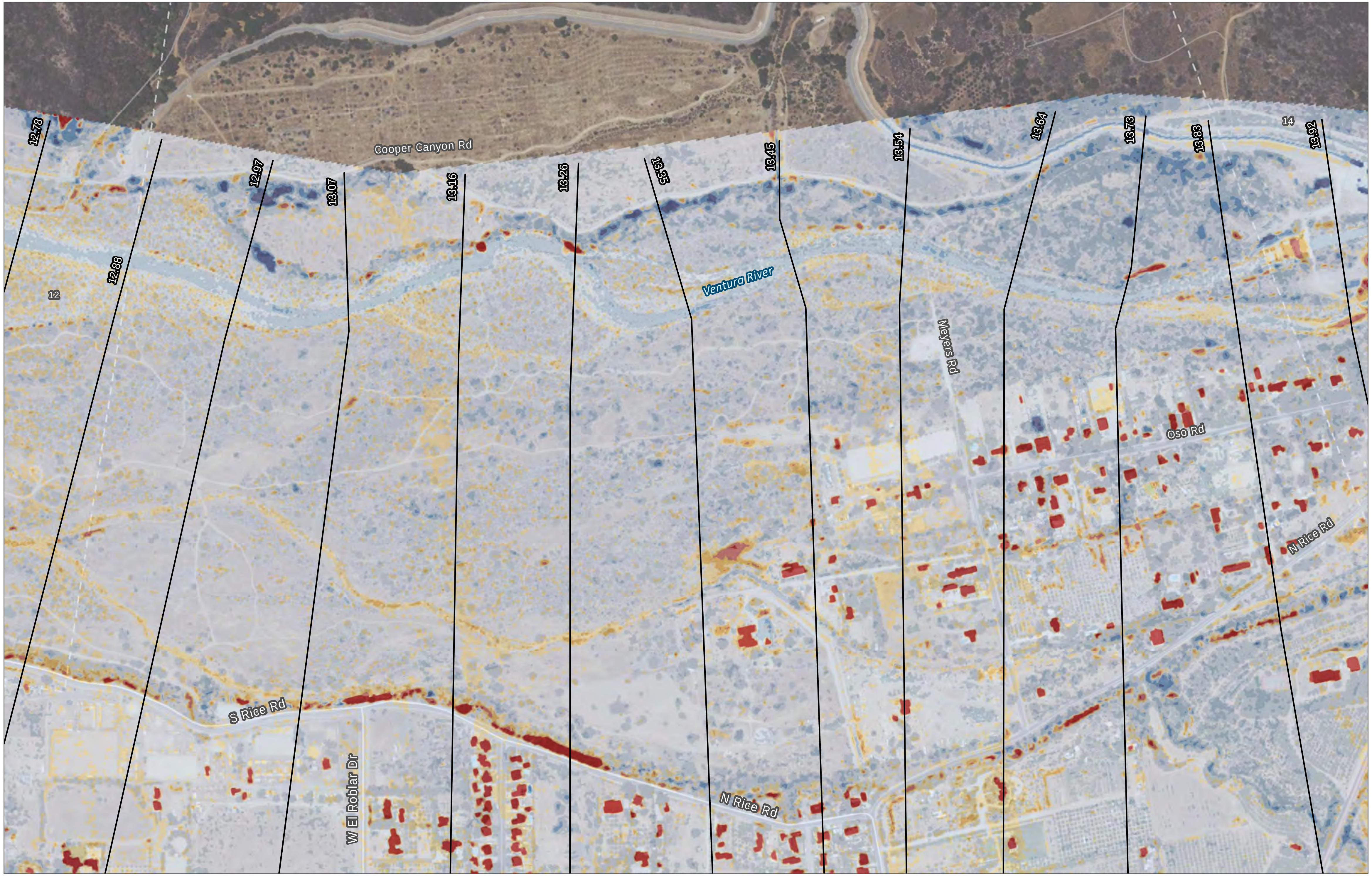
SCALE & NORTH ARROW

0 200 400 800 Feet
0 50 100 200 Meters

1:6,000 1 in = 500 feet

MAP LOCATION





VENTURA RIVER, CALIFORNIA

LiDAR Comparison
Subreach D

DATA SOURCES
2005 LiDAR: USBR
2018 LiDAR: Ventura County
Imagery: NAIP 2016
Roads, cities, streams, and waterbodies: ESRI 2016

LEGEND

Adjacent tile

Point of Interest (labeled with Sediment Transport Model river stationing)

HEC-RAS cross section

Subreach break

LiDAR comparison (ft)

2018 below 2005	2018 above 2005
<-5.0	0.1 - 1
-4.9 - -2.5	1.1 - 2.5
-2.4 - -1	2.6 - 5
-0.9 - 0.0	> 5.0

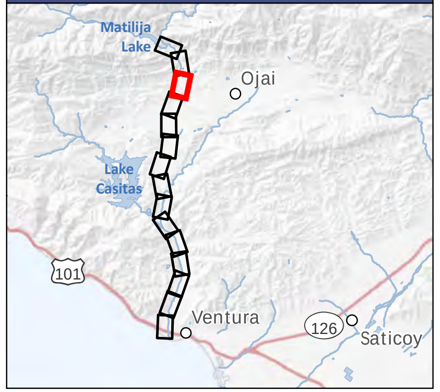
Stillwater Sciences

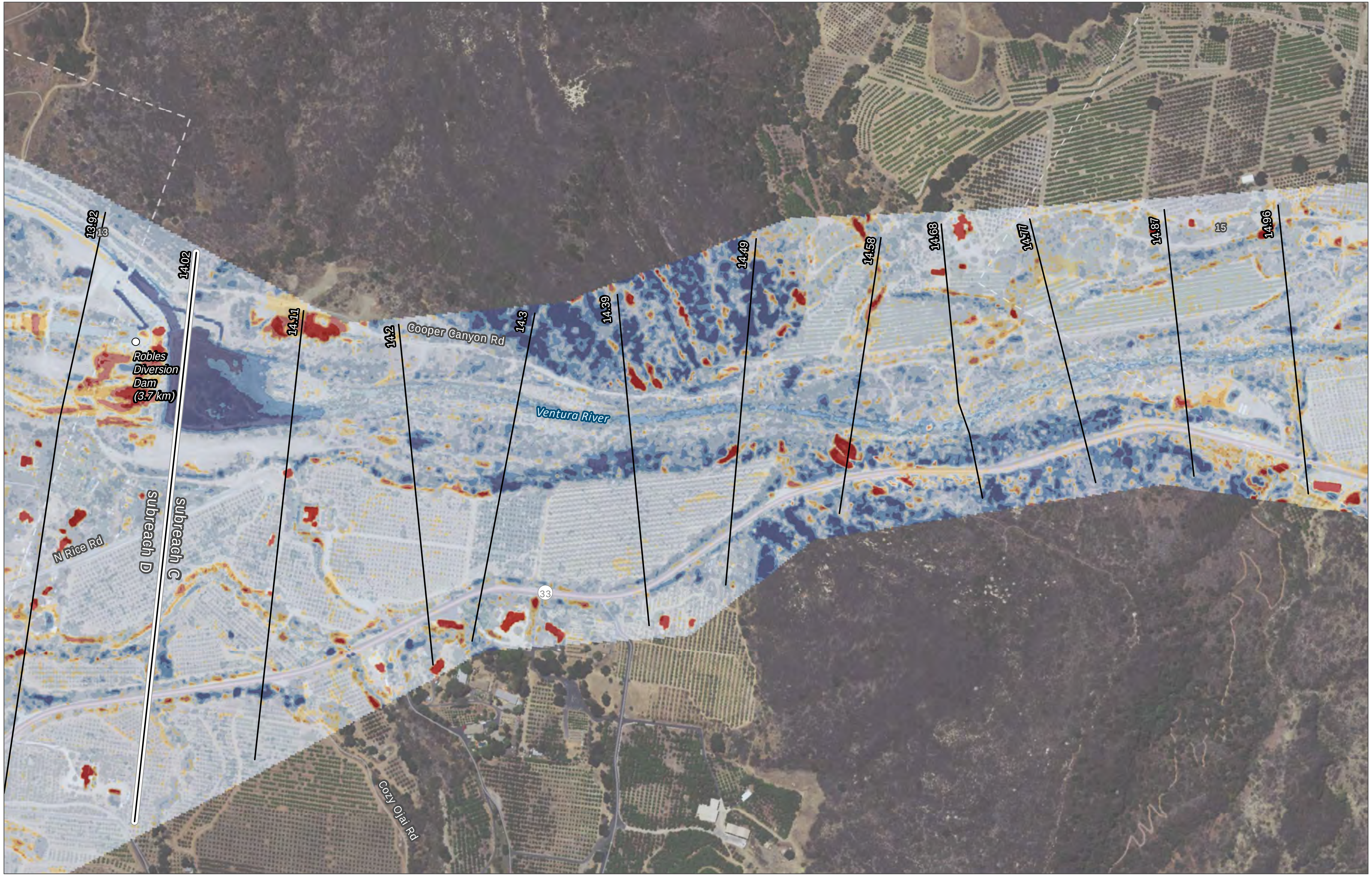
SCALE & NORTH ARROW

0 200 400 800 Feet
0 50 100 200 Meters

1:6,000 1 in = 500 feet

MAP LOCATION





VENTURA RIVER, CALIFORNIA

LiDAR Comparison
Subreach C

DATA SOURCES
2005 LiDAR: USBR
2018 LiDAR: Ventura County
Imagery: NAIP 2016
Roads, cities, streams, and waterbodies: ESRI 2016

LEGEND

Adjacent tile

Point of Interest (labeled with Sediment Transport Model river stationing)

HEC-RAS cross section

Subreach break

LiDAR comparison (ft)

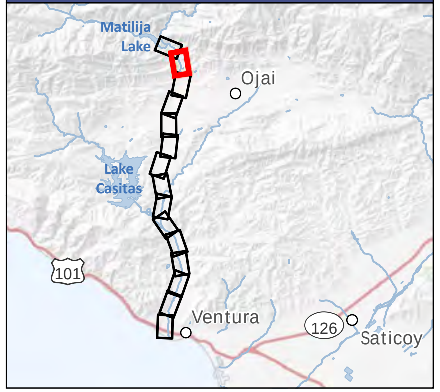
2018 below 2005	2018 above 2005
<-5.0	0.1 - 1
-4.9 - -2.5	1.1 - 2.5
-2.4 - -1	2.6 - 5
-0.9 - 0.0	> 5.0

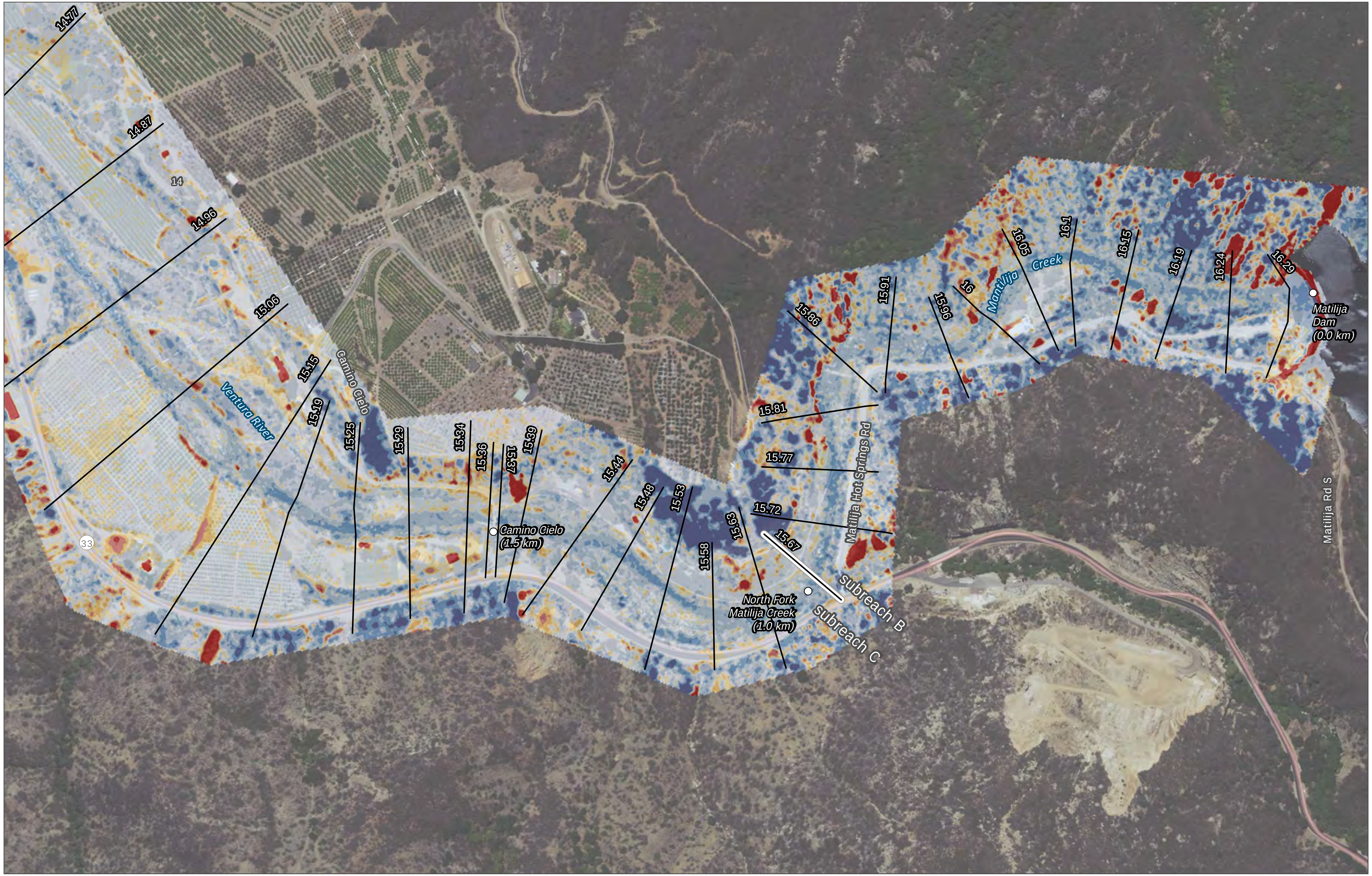
Stillwater Sciences

SCALE & NORTH ARROW

0 200 400 800 Feet
0 50 100 200 Meters
1:6,000 1 in = 500 feet

MAP LOCATION





VENTURA RIVER, CALIFORNIA

LiDAR Comparison
Subreach B & C

DATA SOURCES
2005 LiDAR: USBR
2018 LiDAR: Ventura County
Imagery: NAIP 2016
Roads, cities, streams, and waterbodies: ESRI 2016

LEGEND

Adjacent tile

Point of Interest (labeled with Sediment Transport Model river stationing)

HEC-RAS cross section

Subreach break

LiDAR comparison (ft)

2018 below 2005	2018 above 2005
<-5.0	0.1 - 1
-4.9 - -2.5	1.1 - 2.5
-2.4 - -1	2.6 - 5
-0.9 - 0.0	> 5.0

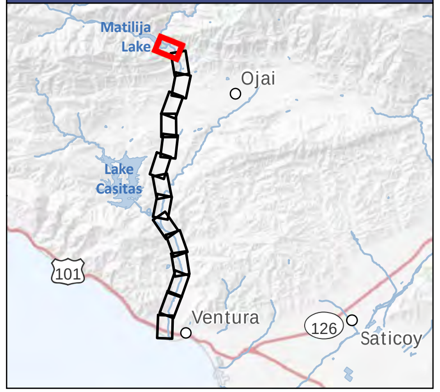
Stillwater Sciences

SCALE & NORTH ARROW

0 200 400 800 Feet
0 50 100 200 Meters

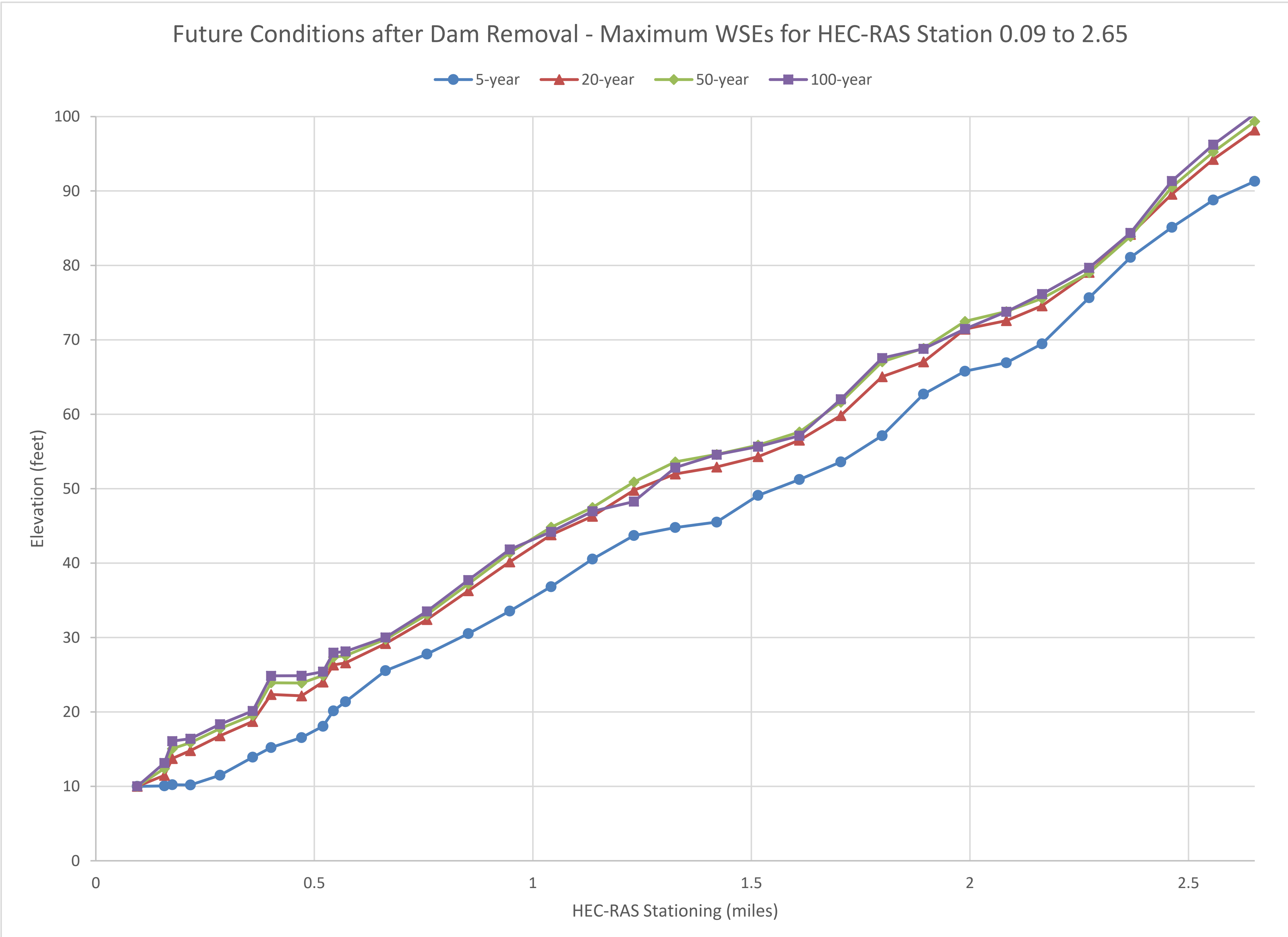
1:6,000 1 in = 500 feet

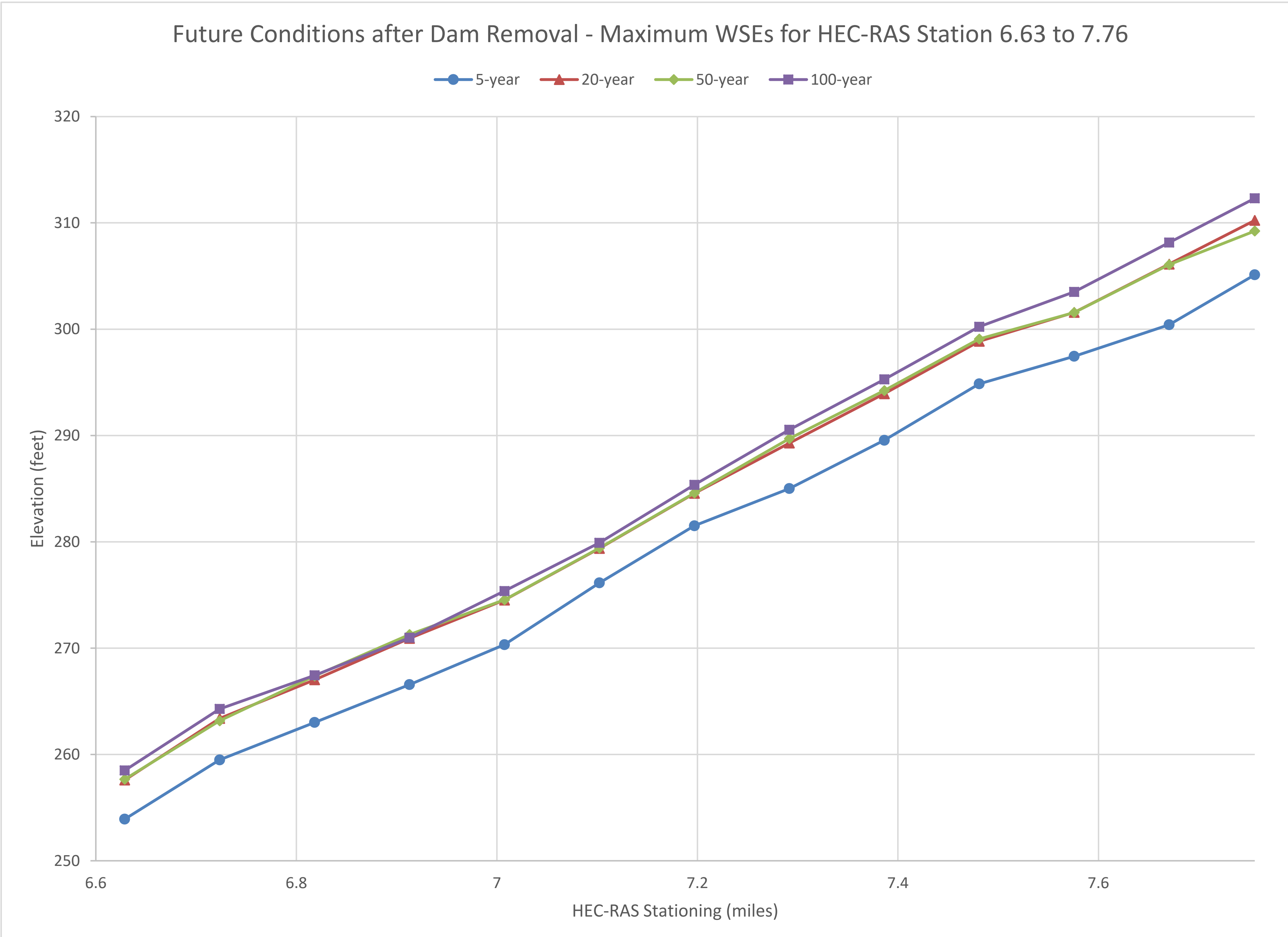
MAP LOCATION



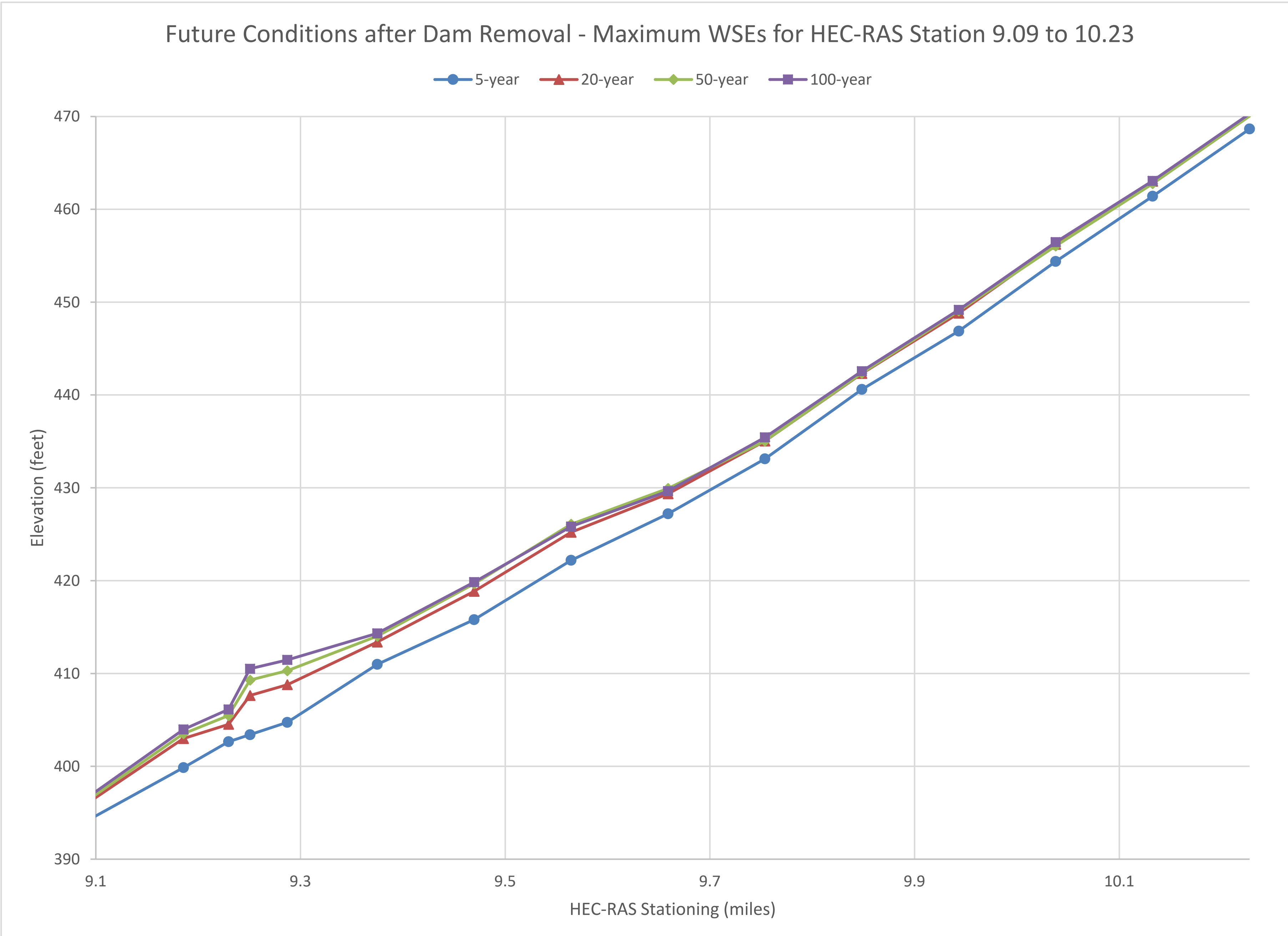
Appendix E

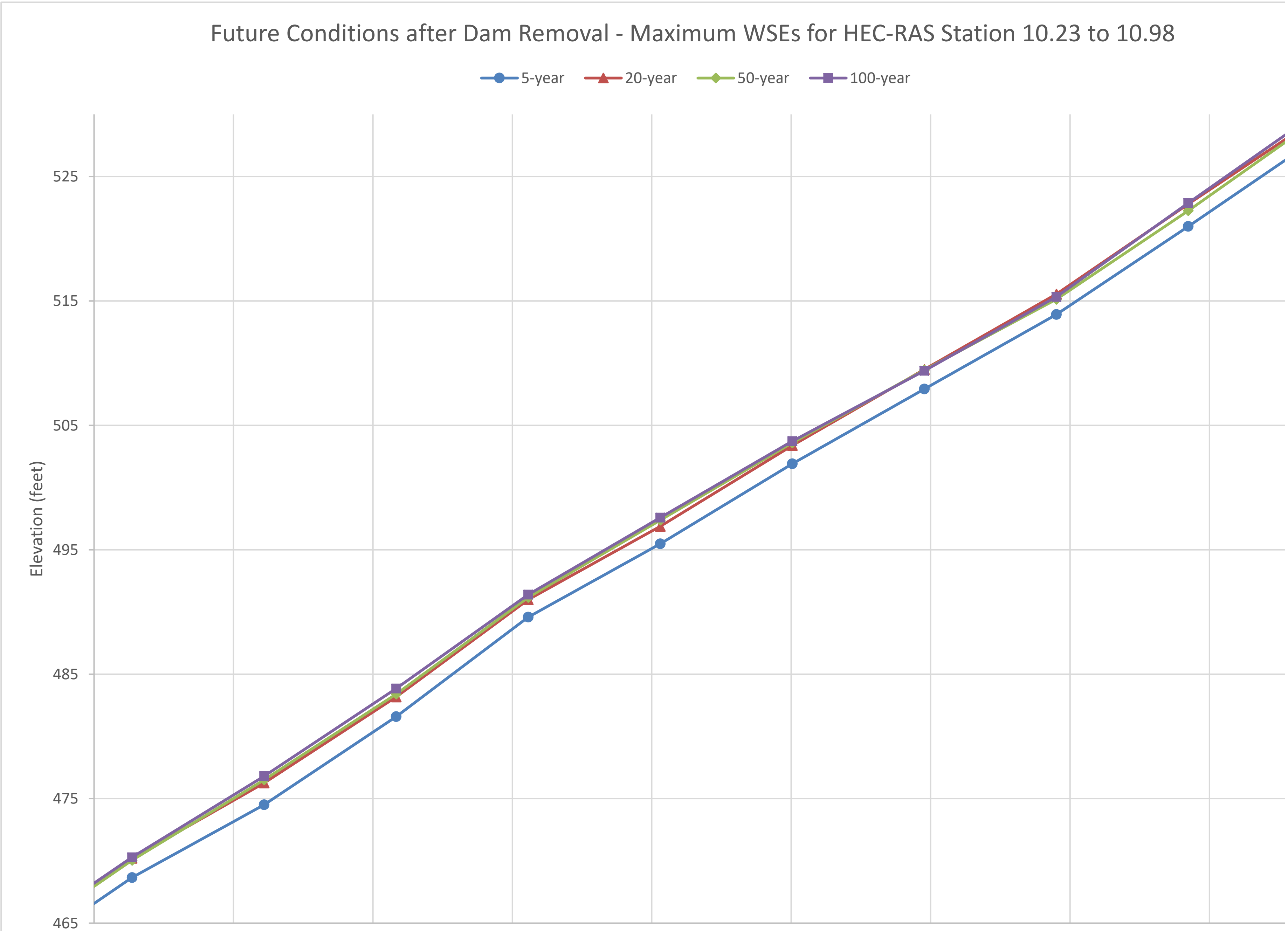
Comparison of 20-, 50- and 100-year WSEs

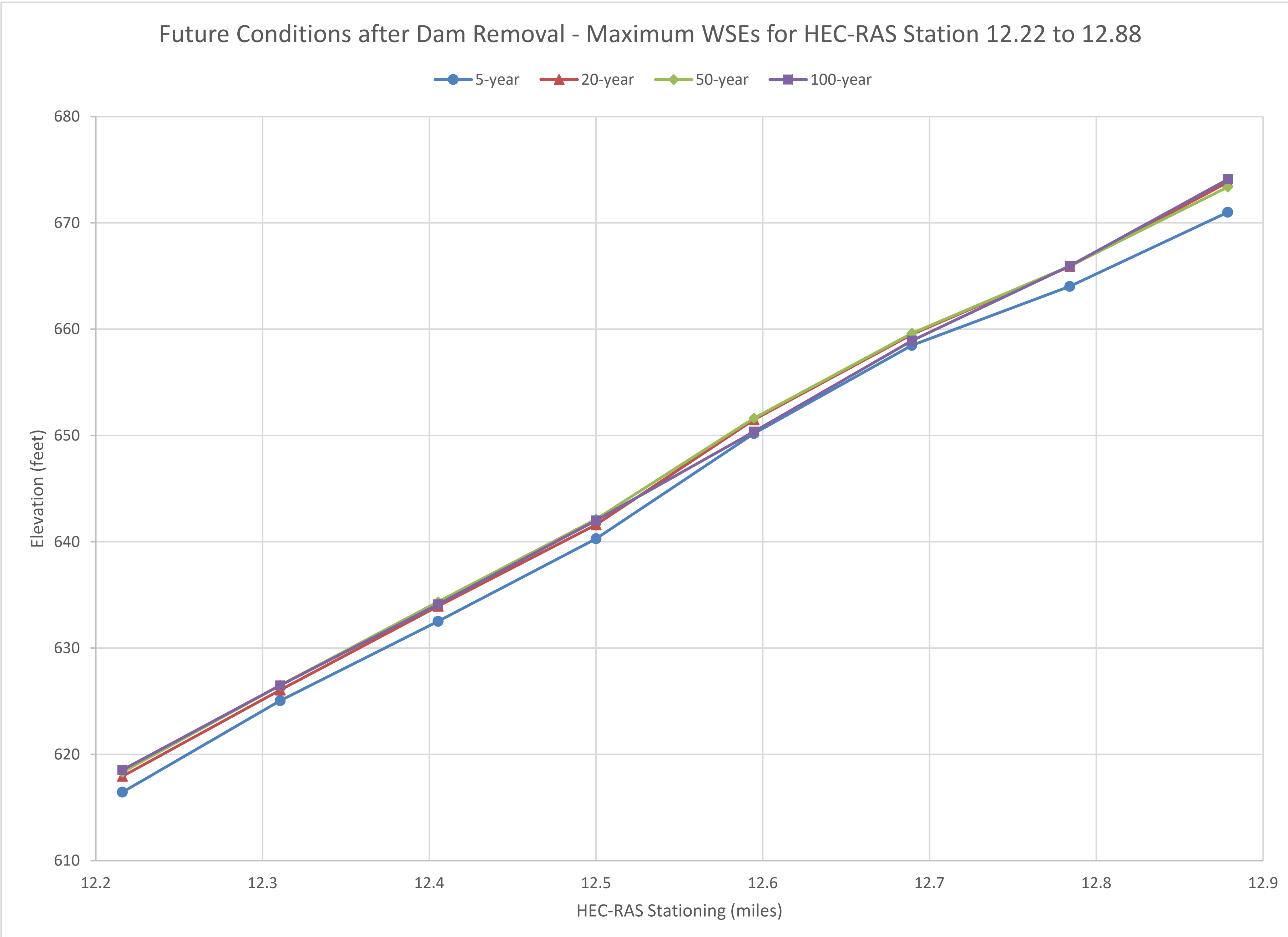

Future Conditions after Dam Removal - Maximum WSEs for HEC-RAS Station 0.09 to 2.65
5-year
20-year
50-year
100-year
Elevation (feet)
HEC-RAS Stationing (miles)
0
10
20
30
40
50
60
70
80
90
100
0
0.5
1
1.5
2
2.5

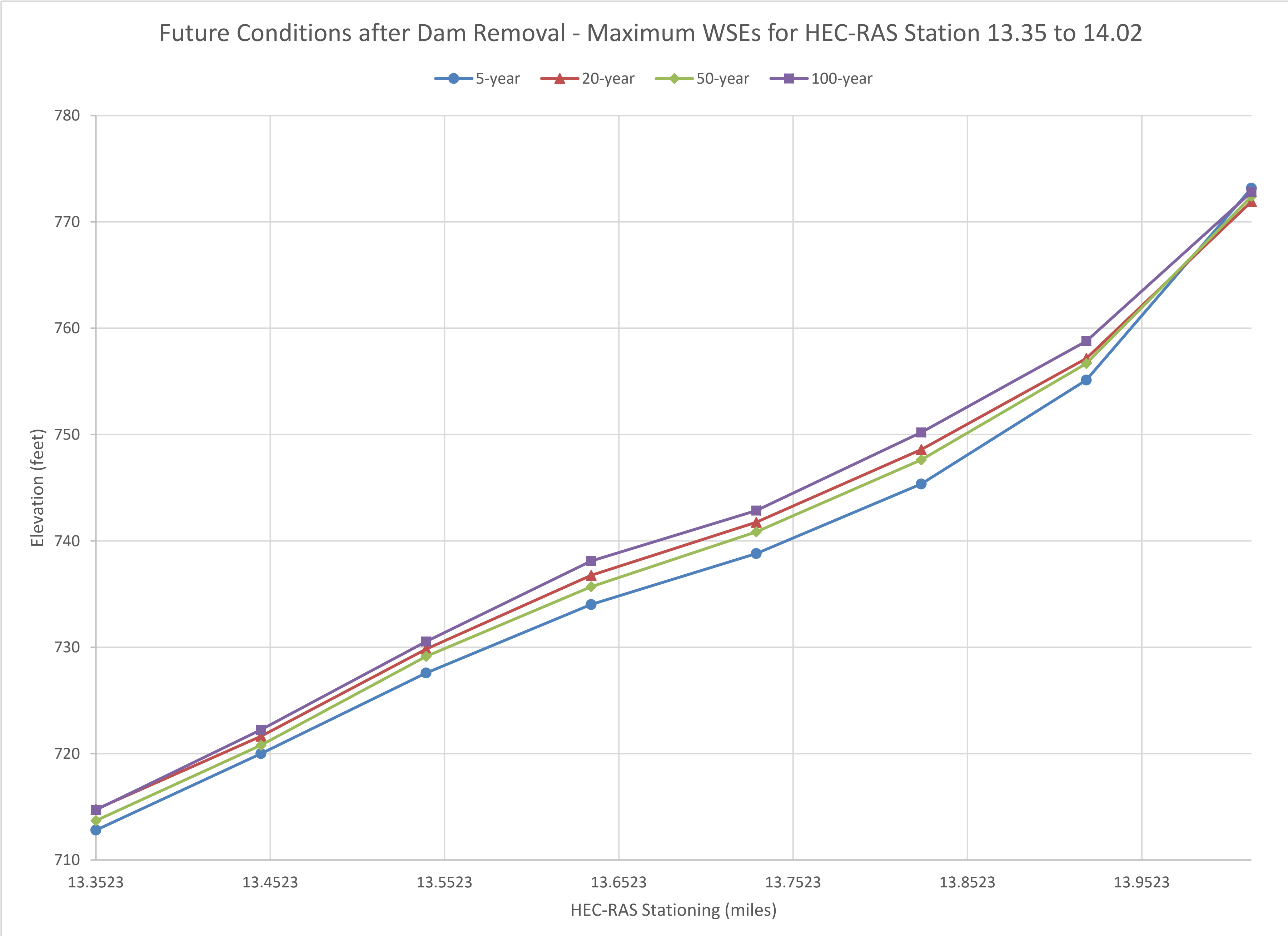


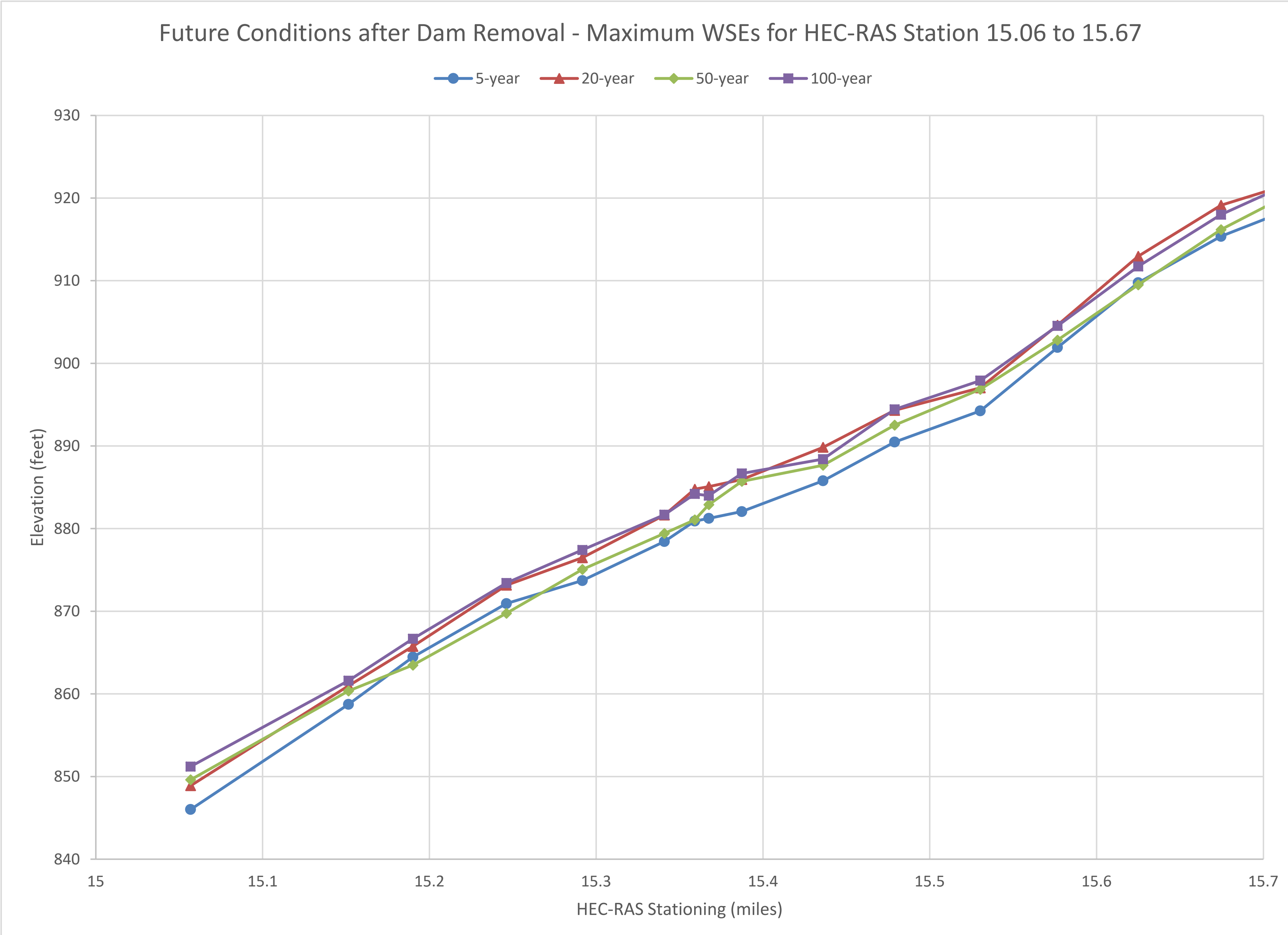
Future Conditions after Dam Removal - Maximum WSEs for HEC-RAS Station 6.63 to 7.76
5-year
20-year
50-year
100-year
Elevation (feet)
320
310
300
290
280
270
260
250
6.6
6.8
7
7.2
7.4
7.6
HEC-RAS Stationing (miles)

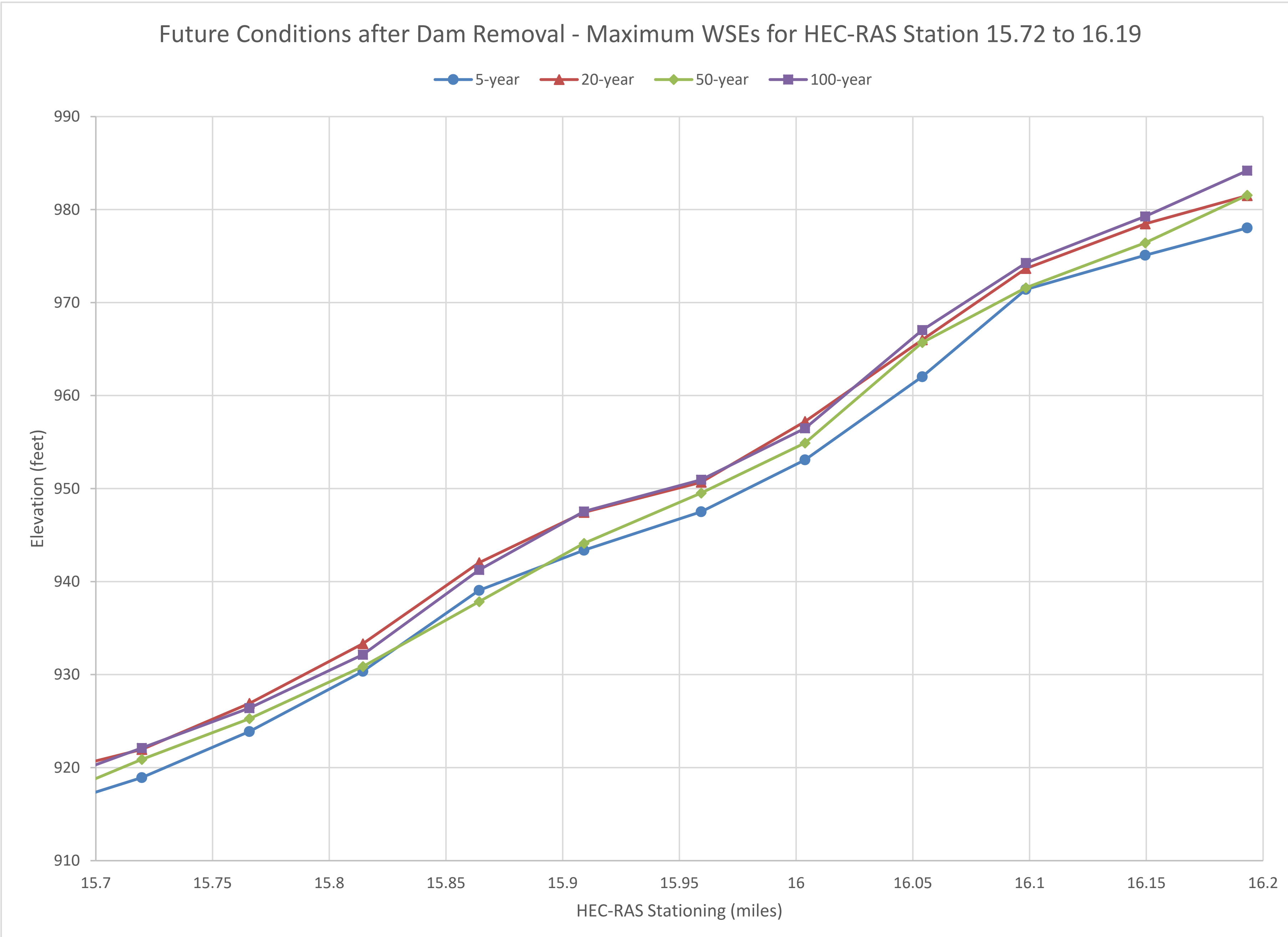

Future Conditions after Dam Removal - Maximum WSEs for HEC-RAS Station 9.09 to 10.23
5-year
20-year
50-year
100-year
Elevation (feet)
HEC-RAS Stationing (miles)
470
460
450
440
430
420
410
400
390
9.1
9.3
9.5
9.7
9.9
10.1


Future Conditions after Dam Removal - Maximum WSEs for HEC-RAS Station 10.23 to 10.98
5-year
20-year
50-year
100-year
Elevation (feet)
525
515
505
495
485
475
465


Future Conditions after Dam Removal - Maximum WSEs for HEC-RAS Station 12.22 to 12.88
5-year
20-year
50-year
100-year
Elevation (feet)
680
670
660
650
640
630
620
610
12.2
12.3
12.4
12.5
12.6
12.7
12.8
12.9
HEC-RAS Stationing (miles)


Future Conditions after Dam Removal - Maximum WSEs for HEC-RAS Station 13.35 to 14.02
5-year
20-year
50-year
100-year
780
770
760
750
740
730
720
710
Elevation (feet)
13.3523
13.4523
13.5523
13.6523
13.7523
13.8523
13.9523
HEC-RAS Stationing (miles)


Future Conditions after Dam Removal - Maximum WSEs for HEC-RAS Station 15.06 to 15.67
5-year
20-year
50-year
100-year
930
920
910
900
890
880
870
860
850
840
Elevation (feet)
15
15.1
15.2
15.3
15.4
15.5
15.6
15.7
HEC-RAS Stationing (miles)



Future Conditions after Dam Removal - Maximum WSEs for HEC-RAS Station 15.72 to 16.19
5-year
20-year
50-year
100-year
990
980
970
960
950
940
930
920
910
Elevation (feet)
15.7
15.75
15.8
15.85
15.9
15.95
16
16.05
16.1
16.15
16.2
HEC-RAS Stationing (miles)