TECHNICAL MEMORANDUM

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City of Lathrop and City of Manteca ULDC Evaluation Design Water Surface Elevation

Prepared for: City of Lathrop & City of Manteca *February 10, 2016*

REGISTERED PROFESSIONAL ENGINEER
DAVID A. PETERSON
No. C 043432
Exp. 6/30/16
CIVIL
STATE OF CALIFORNIA

REGISTERED PROFESSIONAL ENGINEER
MICHAEL J. ROSSITER
No. 80072
Exp. 9-30-16
CIVIL
STATE OF CALIFORNIA

Prepared by: Ryan P. Dunne, EIT

Reviewed by: Mike Rossiter, PE, CFM & Dave Peterson, PE

Introduction

A design water surface elevation (DWSE) is used to evaluate multiple Urban Levee Design Criteria (ULDC) including the minimum top of levee (MTOL), the hydraulic top of levee (HTOL), levee geometry requirements, and for seismic and geotechnical analyses. This Technical Memorandum (TM) briefly outlines the methods used to establish the DWSE and presents the DWSE results.

Model Background

Hydraulic modeling was conducted by Peterson Brustad, Inc. (PBI) and is described in detail in the May 23, 2014 report titled *200-year Freeboard Analysis and Floodplain Mapping within RD 17,* which is provided in Attachment A. Modeling assumptions used in this study match requirements listed in ULDC 7.1.1 without exception. The Central Valley Floodplain Evaluation and Delineation (CVFED) TO-25 HEC-RAS model[1] was used as the base model for the DWSE analysis. Hydrology data was taken from DWR's *Central Valley Hydrology Study*[2] (CVHS).

In addition to modeling the 200-year water surface profile for the DWSE, the 10-year and 500-year water surface profiles were required for other analyses, and were included in the HEC-RAS analysis. The 10-year WSEL is required for evaluation of seismic vulnerability and the 500-year WSEL is needed for evaluation of the HTOL.

Analysis

The ULDC describes two methods for determining the DWSE: the FEMA approach and the USACE approach. One of these two methods must be used to provide a finding of the urban level of protection for the entire levee system. The deterministic FEMA approach requires calculation of the median 200-year water surface profile, while the USACE method further requires calculation of uncertainty in the 200-year median water surface profile. The FEMA approach to determining the DWSE was used in this ULDC evaluation. Section 7.1.1 of the ULDC manual lists assumptions for the hydraulic model which were incorporated in the HEC-RAS analysis.

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[1] *"Task Orders 24 and 25: Technical Memorandum: Lower San Joaquin River System HEC-RAS Model Development"*, DWR, February 2014

[2] *"Central Valley Hydrology Study"*, USACE, November 2015

For initial ULDC analysis and determination of whether work will be required to achieve ULDC, the 200-year water surface was used as the DWSE. The estimated intermediate level of sea level rise by 2050 is 0.5 ft, as discussed in the Sea Level Rise TM of this study. For reaches requiring work to achieve ULDC compliance, the 200-year flood surface profile plus 1 foot is used for the DWSE. This extra foot provides a factor of safety to accommodate uncertainties and future modifications to hydrology applying to both federal and non-federal levees. The 1-foot factor of safety will not be applied if doing so would trigger consequences which could compromise implementation. An example would be unmitigable hydraulic impacts indefinitely delaying 408 permitting.

Results

The 10-year, 200-year, and 500-year water surface profiles are shown in Figure 1. Table 1 lists the water surface profiles in tabular form. A hydraulics summary table is included as Attachment B showing how the DWSE is used to assess the presence of an urban level of protection.

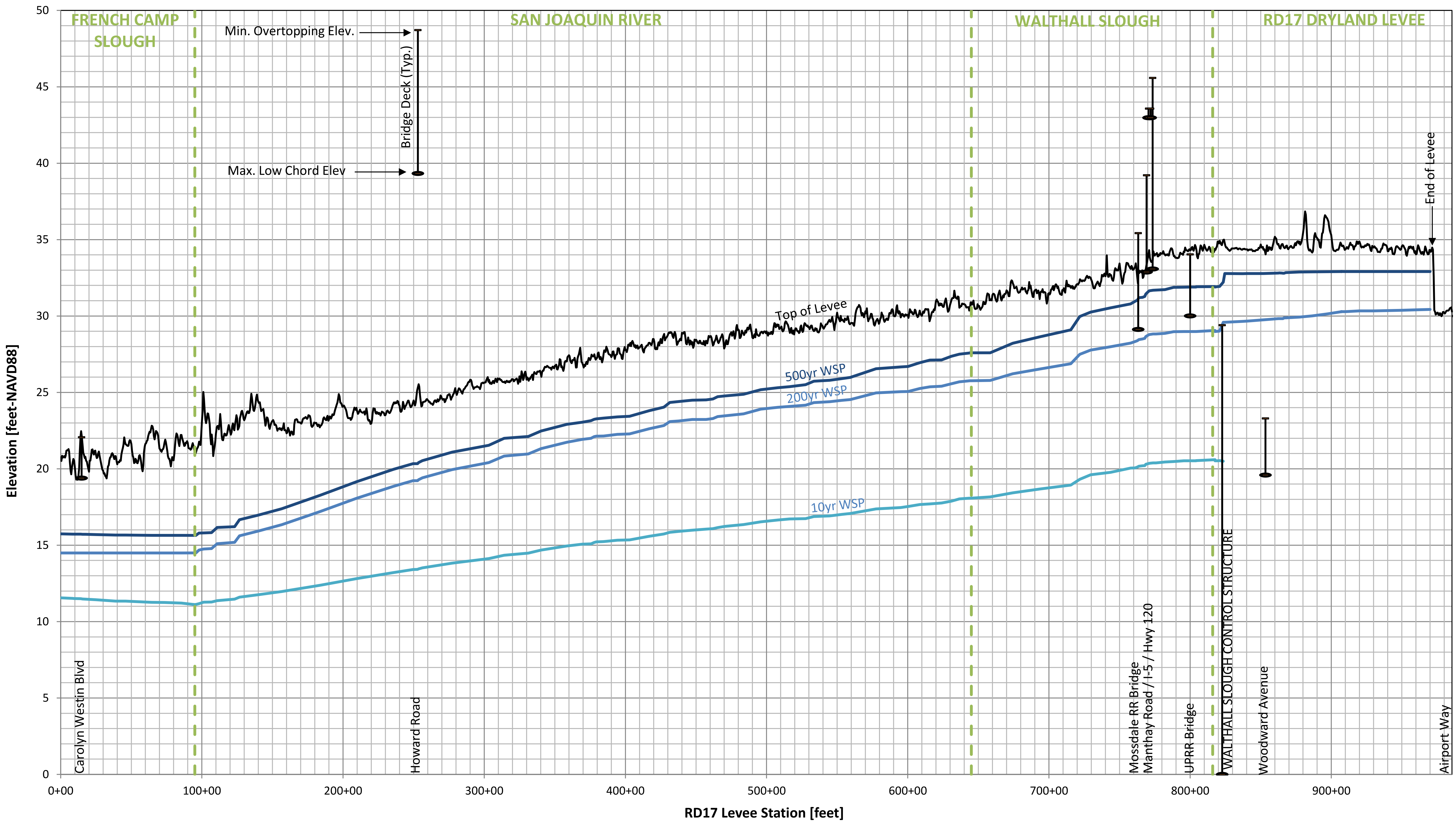

Figure 1: Median Water Surface Profiles

ATTACHMENT A

200-year Freeboard Analysis and Floodplain Mapping within RD-17
Peterson Brustad, Inc. May 2014

200-YEAR FREEBOARD ANALYSIS & FLOODPLAIN MAPPING WITHIN RD 17

May 23, 2014

PREPARED FOR:

CITIES OF LATHROP & MANTECA

PREPARED BY:

PETERSON . BRUSTAD . INC
ENGINEERING . CONSULTING

1180 Iron Point Rd., Suite 260
Folsom, CA 95630
(916) 608-2212

PETERSON . BRUSTAD . INC
ENGINEERING . CONSULTING

ENGINEER'S SIGNATURE PAGE

This report titled:

200-YEAR FREEBOARD ANALYSIS & FLOODPLAIN MAPPING WITHIN RD 17

has been prepared by or under the direct supervision of the following registered Civil Engineers:

All deliverables for this task have undergone quality control appropriate to the level of risk and complexity inherent in the project. This includes review of assumptions, methods, procedures, and material used in the analysis.

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1.0 INTRODUCTION

In 2007, Senate Bill 5 (SB5) was signed into law which will begin to impact development in the Central Valley of California by July 2016.

Furthermore, the Urban Levee Design Criteria (ULDC) and Urban Level of Flood Protection (ULOP) requirements developed pursuant to SB5 make achieving an Urban Level of Protection difficult in many developed areas. For these reasons, it is critical that communities in San Joaquin County begin the process to achieve SB5 compliance to minimize the impact to the local economies.

This report presents Peterson Brustad Inc.'s (PBI's) initial hydraulics study which is intended to provide the Cities of Lathrop and Manteca with the first critical steps toward meeting ULDC and ULOP criteria: (a) identifying 200-year freeboard deficiencies along Reclamation District No. 17 (RD 17) levees and (b) understanding the magnitude (depth and extent) of the without-project 200-year floodplain near the cities' spheres of influence.

Primary resources used to conduct the RD 17 hydraulics study include: (1) hydraulic models developed by the Department of Water Resources' (DWR) Central Valley Floodplain Evaluation and Delineation (CVFED) program, and (2) hydrology developed as a collaborative effort between DWR and the U.S. Army Corps of Engineers (USACE) under the Central Valley Hydrology Study (CVHS). PBI's work included a Quality Control (QC) effort to verify the general reasonableness of the CVFED hydraulic models and the CVHS hydrographs, and the application of those tools to produce riverine water surface profiles and floodplains.

2.0 CVHS HYDROGRAPHS

The Central Valley Hydrology Study (CVHS) is a joint effort between DWR and USACE which includes 200-year hydrographs for the Lower San Joaquin region as part of its deliverables. Before using these hydrographs, PBI researched the methodology behind the CVHS to confirm that it was applicable to the RD 17 hydraulics study.

2.1. CVHS Background and Application

The CVHS is a comprehensive assessment of stream flow frequencies and magnitudes in the Sacramento and San Joaquin river basins. One of the goals of the study was to estimate peak flows and hydrographs for various storm frequencies.

Per CVHS documentation, CVHS products were intended to be used for floodplain mapping as well as other feasibility and project studies. USACE has reviewed and approved all work products following the District Quality Control (DQC) process and Agency Technical Review (ATR).

CVHS hydrographs are concurrent design hydrographs that are patterned off of historical events. The patterns are then scaled up or down to match a particular frequency event.

CVHS design hydrographs were developed in the following steps:

1. Flow-frequency analyses were conducted for unregulated (assuming no reservoirs are present) conditions.
2. Unregulated flow hydrographs were routed through reservoir simulation models to assess the effect of system regulation.
3. HEC-RAS models were used to route modeled reservoir releases through the channel network, accounting for attenuation due to channel and overbank storage.

All flow routing assumes that levees do not fail, even when overtopped. The result of this assumption represents an “upper bound” in terms of flow delivery to the downstream analysis points.

The CVHS routing of flood flow comes in 2 scenarios: (a) existing conditions levee heights and (b) ULDC/ULOP levee heights. The ULDC/ULOP levee height scenario assumes the top of project levees are, at minimum, at 200-year water surface elevation (WSE) plus 3-feet in urban areas and at the 1955 design profile plus 3-feet for non-urban areas.

2.2. CVHS Hydrographs used for the RD 17 Hydraulics Analysis

The CVHS team determined that, for the Lower San Joaquin River near Vernalis, a 200-year hydrograph is the equivalent of the 1997 storm pattern, scaled to 115%. The CVHS HEC-RAS model for the ULDC/ULOP levee height scenario was transmitted to PBI on 3/13/14.

Three (3) CVHS 200yr Flow Hydrographs were used for the RD 17 Hydraulics Study:
1. San Joaquin River In-channel flow at Vernalis (Peak: 83,000cfs)
2. Right Overbank Flow at Vernalis (Peak: 36,000cfs)
3. French Camp Slough entering San Joaquin River (Peak: 2,700cfs)

Right overbank flows include all flows that overtop the right banks of the Stanislaus and San Joaquin Rivers upstream of Vernalis. All hydrographs are shown below in Figure 1.

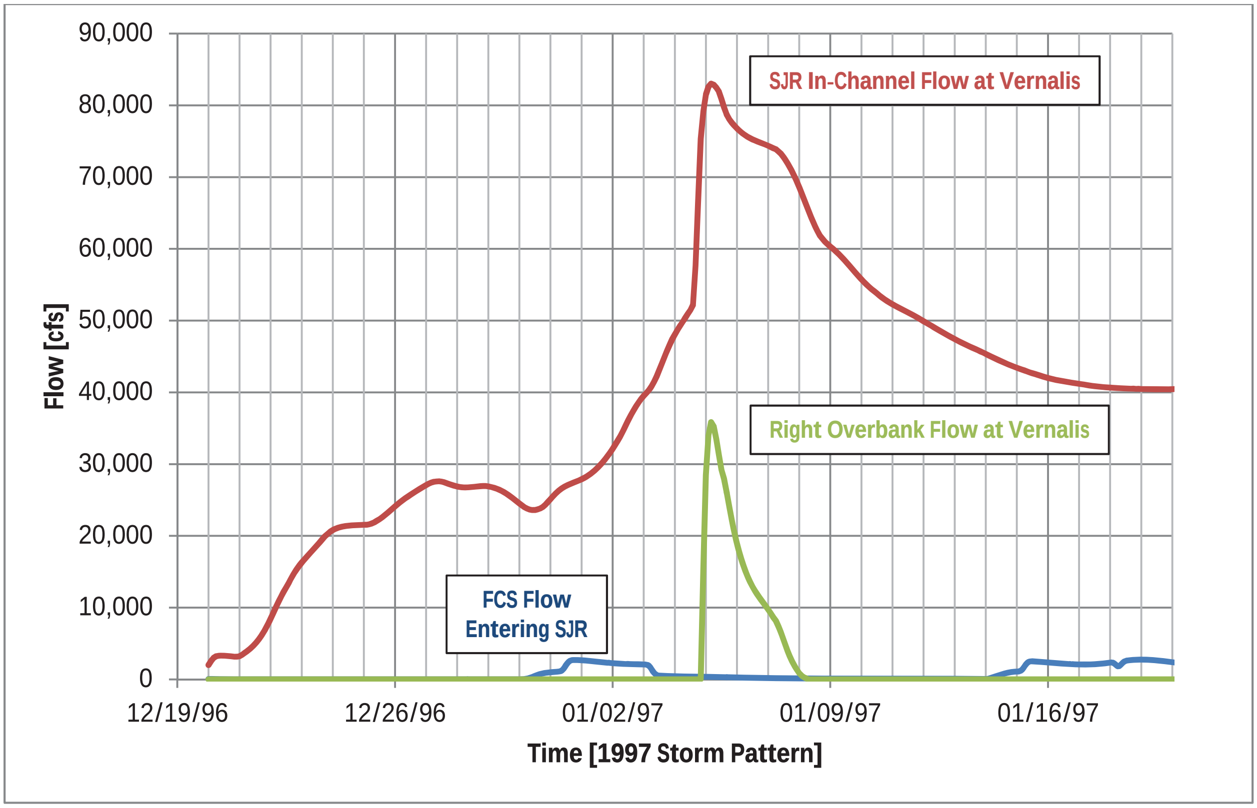


Figure 1. CVHS hydrographs used for the RD 17 Hydraulics Study.

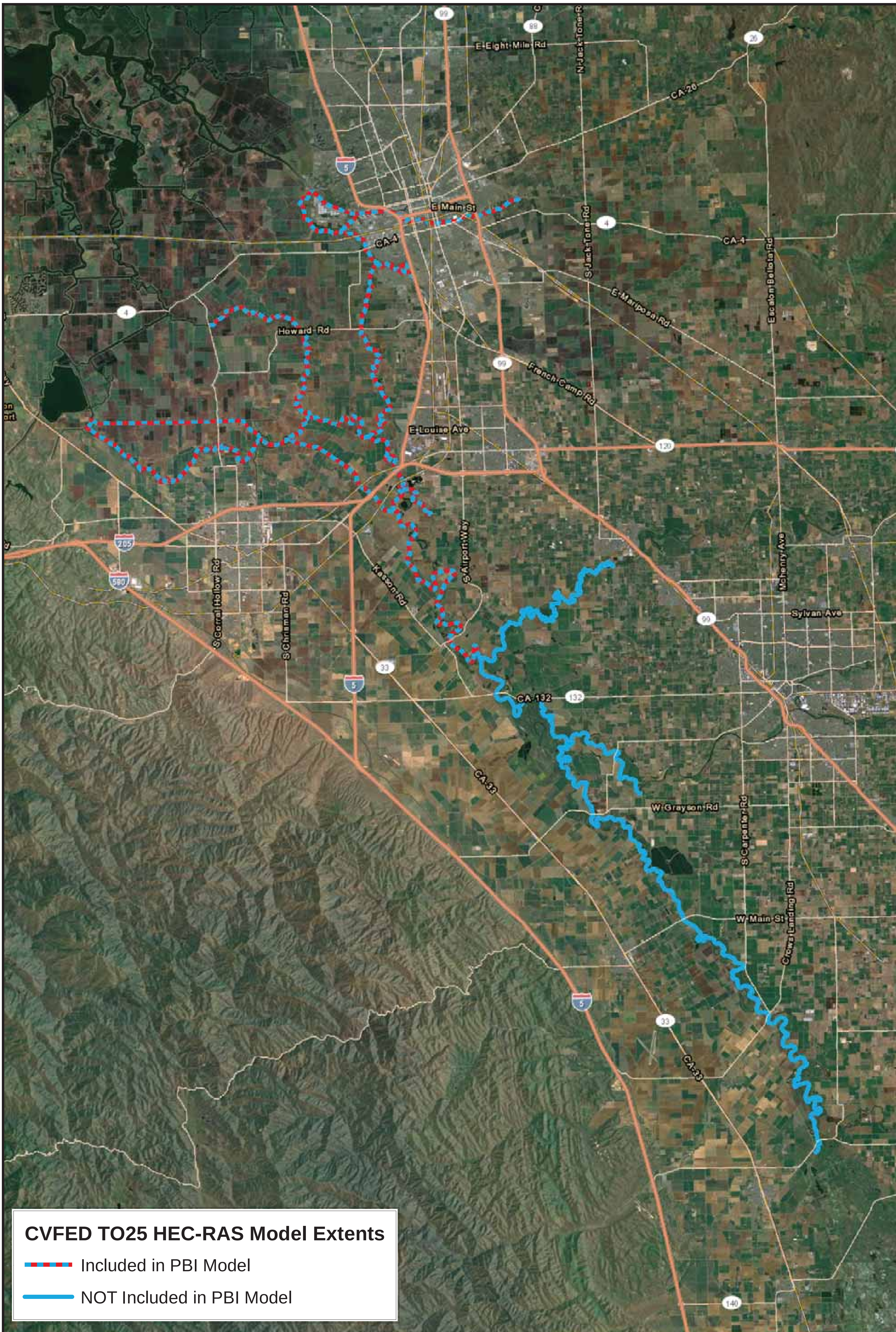
The CVHS hydrographs extend out to March, but the hydrograph time window used for the purposes of the RD 17 hydraulics study was between December 19, 1996 and January 19, 1997. The selected simulation time window includes the peak of the CVHS hydrographs.

3.0 Quality Control (QC) of CVFED HEC-RAS Model

The base HEC-RAS model used for the RD 17 hydraulics study was the CVFED Task Order 25 (TO25) model for the Lower San Joaquin River. Details on the TO25 model setup can be found in the CVFED report titled "Task Orders 24 and 25, Technical Memorandum: Lower San Joaquin River System HEC-RAS Model Development" dated February 10, 2014. Before the model was used for the RD 17 hydraulics study, it was checked for general reasonableness. PBI's review methodologies along with any changes made to the CVFED model are presented in this section.

3.1. Model Extents

The CVFED TO25 HEC-RAS model includes the San Joaquin River from the Stockton Ship Channel to Newman (Figure 2). For the purposes of this study, the model was truncated at Vernalis just below the Stanislaus River confluence. Vernalis serves as a good "hydraulic handoff" point for analyzing the lower portion of the San Joaquin River. Reaches in the French Camp Slough system upstream of Interstate-5 were also removed from the model extents. CVHS hydrographs were only available for French Camp Slough flows entering the San Joaquin River and were not available for the Littlejohns Creek reaches. Figure 2 shows the original and revised extents of the HEC-RAS model.



CVFED TO25 HEC-RAS Model Extents

- Included in PBI Model
- NOT Included in PBI Model

PETERSON . BRUSTAD . INC ENGINEERING . CONSULTING 1180 Iron Point Rd., Suite 260 Folsom, CA 95630 Phone: (916) 608-2212 Fax: (916) 608-2232		0 4 Miles 1 inch = 4 miles APRIL 21, 2014	CITIES OF LATHROP & MANTECA - 200-YEAR PLAN ORIGINAL AND REVISED HEC-RAS MODEL EXTENTS	FIGURE 2

3.2. Bridges

Bridge geometry was reviewed for those bridges crossing the San Joaquin River. The review included (a) a comparison with the HEC-RAS model used for the USACE Lower San Joaquin River Feasibility Study (LSJRFS) as well as with photos[1] of each bridge, where available. There were no major inconsistencies seen during the bridge geometry review. Details on the bridge geometry review are included in Attachment 1.

Also reviewed was the bridge modeling approach for each bridge crossing. Establishing a bridge modeling approach consists of defining which methods/equations the program will use to calculate head losses through bridges for both low flow scenarios (flow below the bridge deck elevation) and high flow scenarios (flow at or above the bridge deck elevation). For the low flow scenario, the CVFED HEC-RAS model was set up to use either the momentum equation or the energy equation, which ever calculated a greater head loss. In previous modeling experiences, PBI has noticed that the momentum equation can result in unreasonably high head losses (1+ feet) during low flow scenarios for bridges with piers. This type of head loss can be expected in instances where flows are up onto a bridge deck and pressure flow controls through the bridge opening, but a 1+ foot drop in water surface elevation is unlikely to occur due to bridge piers alone. The bridge modeling approach for low flow scenarios was therefore changed for each bridge in the model to use only the energy equation.

A sensitivity analysis was done to compare the water surface profiles (WSP) before and after these model changes were made. The analysis showed that the bridge modeling approach edits resulted in minimal changes (less than 0.1’) to the San Joaquin River WSP. Larger WSP changes were seen at bridges in other areas of the model, but this did not impact the San Joaquin River WSP.

3.3. Stream Junctions

Stream confluences and splits are modeled by HEC-RAS junctions in the CVFED model. The junction parameters were reviewed as part of PBI’s QC effort. Junctions can be set to either (a) calculate head losses at each confluence using the energy equation, or to (b) ‘Force Equal’ the water surface elevations at the confluences. The CVFED model had several junctions set to calculate head losses. PBI changed the computation mode for these junctions to the ‘Force Equal’ option where water surfaces were set to be equal at junctions. The slopes across the modeled stream junctions are flat and cross sections are relatively close. The HEC-RAS v4.1 user’s manual recommends the ‘Force Equal’ junction option for these cases. In a large flood event (ie- 200-year), a flat water surface would be expected for these junction transitions.

The junction parameters also include measurements of the junction lengths. This is the distance across the junction (feet) from the upstream cross section to the downstream cross section. GIS measurements of

[1] Several field photos were taken by the CVFED team and included with their model transmittal. Additional bridge photos were gathered through Google Earth images.

these distances were taken and several of the junction lengths were updated. The following table summarizes the edits made to the junctions during this QC effort.

Table 1. HEC-RAS junctions that were modified during the PBI QC effort.

Junction Description	HEC-RAS Junction Name	Unsteady Flow Computation Mode Changed	Junction Length Changed
SJR/Lower Mormon Channel	Junction 14	No	Yes
SJR/Burns Cutoff	Junction 1	Yes	Yes
SJR/French Camp Slough	Junction 13	No	Yes
SJR/Old River	Junction 5	Yes	No
Paradise Cut/Old River	Junction 3	Yes	No
Old River/Middle River	Junction 2	Yes	No
Old River/Grant Line Canal	Junction 4	Yes	No

A sensitivity analysis was done to compare the water surface profiles (WSP) before and after these model changes were made. The analysis showed that the changes to the junction parameters resulted in minimal changes (less than 0.1’) to the San Joaquin River WSP.

3.4. Lateral Structures

CVFED HEC-RAS lateral structures were reviewed as part of the PBI QC effort. Top of levee elevations for the RD 17 levees were compared with elevations surveyed by KSN, Inc. in March 2014. HEC-RAS top of levees were taken from LiDAR data and compared reasonably well with surveyed elevations. This comparison is important for RD 17 levee freeboard discussions, but is not a factor when it comes to modeling given that all water surfaces were well below the RD 17 top of levee elevations.

Lateral structures from the CVFED TO25 model also needed to be updated for the purposes of a ULDC analysis. Modeling for a ULDC study needs to assume that all project levees in and upstream of the study area be raised to a minimum elevation per ULDC standards. In this case, urban project levees were raised to a minimum of the 200-year WSE plus 3-feet and non-urban project levees were raised to a minimum of the 1955 design WSP plus 3-feet.

Much of this effort was completed when the CVFED team set up their TO32 models. CVFED TO32 models were developed for the SB 1278 informational floodplain mapping analysis and differ from TO25 models in several ways, one of which is that their lateral structures reflect the ULDC top of levee standards stated above. Attachment 2 identifies CVFED TO25 lateral structures that were modified by PBI to match the CVFED TO32 models.

The CVFED TO32 model extents, however, do not include the San Joaquin River between Paradise Cut and Vernalis. PBI modified lateral structures in this non-urban reach so that the minimum tops of levees were at the 1955 design WSE plus 3-feet. Modified lateral structure profiles for this reach are also included in Attachment 2.

3.5. Storage Area Connections

HEC-RAS storage areas keep track of any overbank flows in the study area. This is particularly important in the San Joaquin River right overbank area between the Stanislaus River and the RD 17 dryland levee where the CVHS 200-year storm event includes significant overbank flows. Storage area connections represent roads, dryland levees, etc. that divide the floodplain into separate storage segments and regulate flow conveyance in the floodplain. Storage area connection profiles were reviewed and confirmed to match LiDAR profiles. Weir coefficients were also reviewed for the storage area connections. Following review, weir coefficients were increased for many of the storage area connections in the right overbank region between Vernalis and the RD 17 dryland levee.

The following weir coefficient criteria was used in the review and are based on USACE Hydrologic Engineering Center (HEC) recommendations:

Table 2. Criteria used for reviewing weir coefficients.

Description	Range of Weir Coefficients
Levee/Roadway - 3ft or higher	1.5 to 2.2 (2.0 default)
Levee/Roadway - 1 to 3ft	1.0 to 2.0
Natural High Ground Barrier - 1 to 3ft	0.5 to 1.0
Non-elevated Overbank Terrain	0.1 to 0.5

Source: USACE Hydrologic Engineering Center, "Combined 1D and 2D Modeling with HEC-RAS", August 2013.

Many of the storage area connections that represent roadways and levee tops had weir coefficients that were originally set to 0.5-1.0 in the CVFED TO25 HEC-RAS model. PBI increased these coefficients to 2.0 per criteria described in the above table. All changes to storage area connection weir coefficients are documented in Attachment 3.

This model modification altered overbank flow conveyance and increased overbank peak flows in and out of the storage areas. In turn, it also increased overbank flows that return to the San Joaquin River. The net result of this was a slightly raised WSP in the San Joaquin River. The WSP increased by a maximum of 0.1-feet along the RD 17 levee.

3.6. Walthall Slough Control Structure

The Walthall Slough control structure is pictured below and includes a sluice gate that is able to be closed during high water events.

Figure 3. Walthall Slough gate control structure.

The CVFED team did not find any gate operation data for this structure. The TO25 model assumes that the gate is closed unless Walthall Slough stages reach greater than 3-feet above the San Joaquin River stages, in which case the gate opens. The gate then shuts again when the stage differential decreases back down to 1-foot.

Once PBI coded the CVHS 200-year hydrographs into the TO25 model (including the right overbank input hydrograph at Vernalis which travels towards Walthall Slough) the gate was opening and closing continuously due to the fluctuating stage differential between Walthall Slough and the San Joaquin River. The gate operation rules were causing model instabilities and were therefore modified so that the gate would stay shut during the entire flood event.

Assuming no relief cut is made to release the ponding behind the RD17 dryland levee, the control structure ends up acting like a weir during the 200-year scenario. Right overbank flows at Vernalis pond behind the dryland levee and eventually flow over the control structure back into the San Joaquin River.

3.7. Debris Loading at Bridges

The potential for debris loading at bridges needs to be considered per ULDC guidelines. Floating debris was added to each of the modeled bridges assuming a debris pile width of 1.5 times the pier width and a height extending 5-feet below the water surface. The figure below illustrates an example of modeled debris loading at the Mossdale railroad crossing.

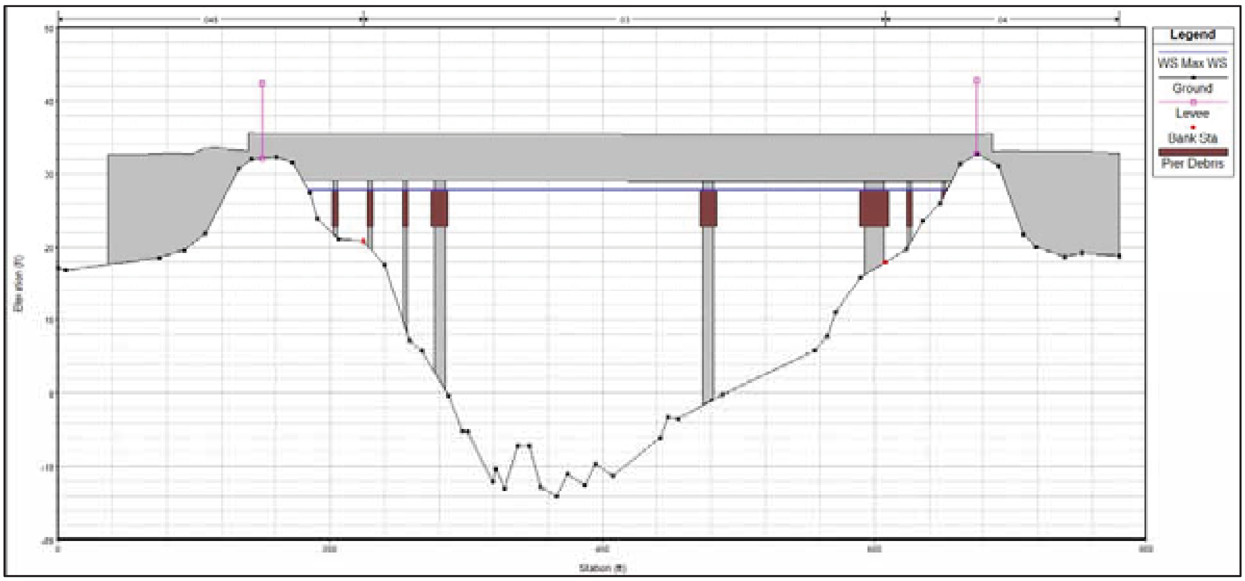


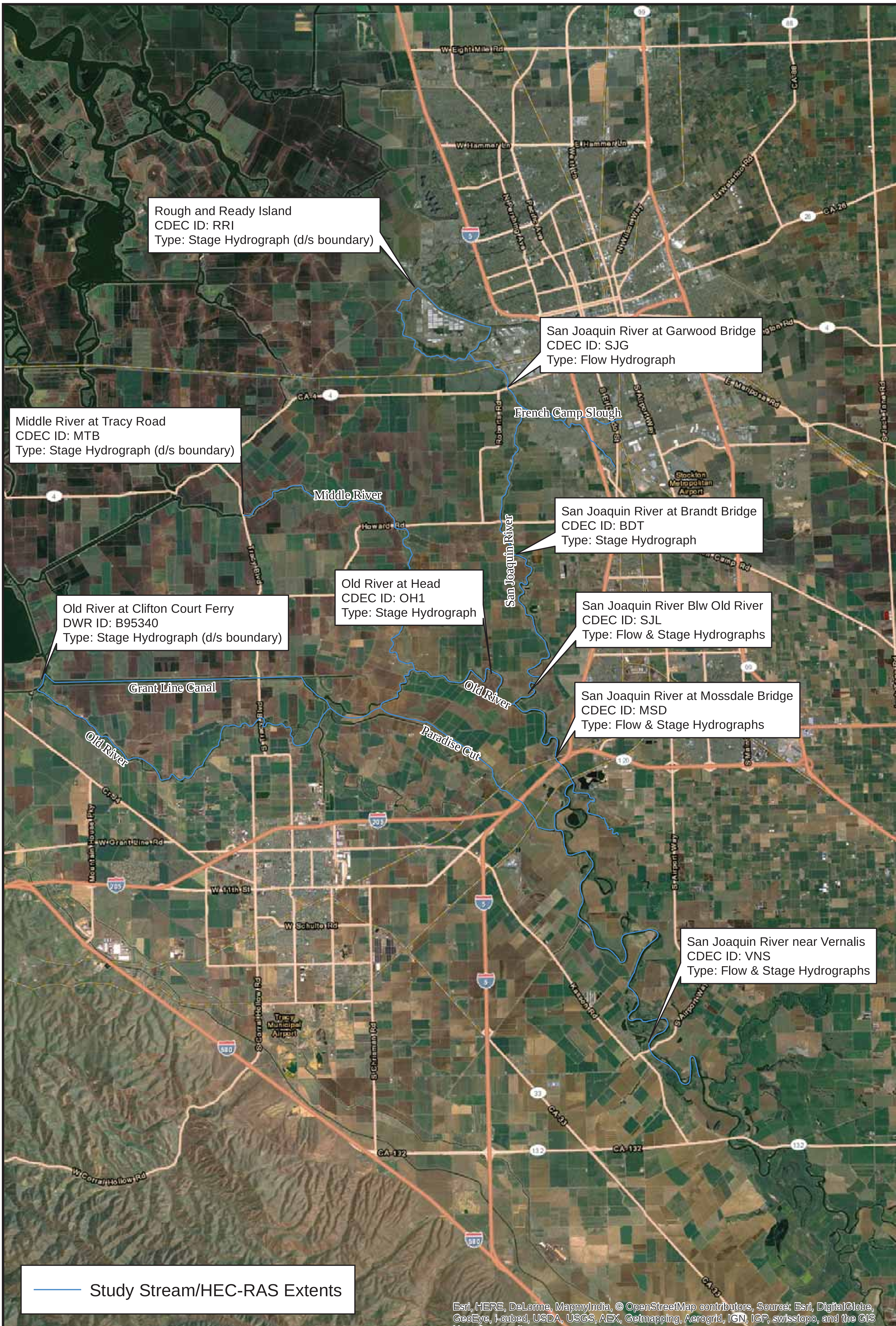
Figure 4. Example of simulated debris loading for the 200-year event at Mossdale railroad crossing.

In general, the addition of debris loading raised WSEs by about 0.1-feet at the upstream side of bridges.

3.8. Calibration of Revised HEC-RAS Model

The TO25 HEC-RAS model was calibrated by the CVFED team as documented in the HDR TM, “Lower San Joaquin River HEC-RAS Model Calibration”, dated November 26, 2012. However, following PBI’s revisions to the model, it was necessary to recalibrate. The revised HEC-RAS model was calibrated to the April 2006 storm event using the same data that the CVFED team used. PBI received the calibration data from the CVFED team on May 1, 2014. The data includes flow and stage hydrographs from various gage stations as well as high water marks.

For the purposes of PBI’s study on the RD17 levee, it was most important to calibrate flows and stages in the San Joaquin River. PBI calibrated the San Joaquin River and the portions of Paradise Cut and Old River that are immediately downstream of the San Joaquin River. The figure on the following page shows the locations of the gages used for the calibration.



PETERSON . BRUSTAD . INC
ENGINEERING . CONSULTING

1180 Iron Point Rd., Suite 260
Folsom, CA 95630

Phone: (916) 608-2212
Fax: (916) 608-2232

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LOCATION OF GAGE STATIONS USED FOR 2006 CALIBRATION

FIGURE 5

The calibration procedure followed 3 main steps:

(1) Calibrate to observed flow hydrographs
(2) Calibrate to observed HWMs
(3) Verify to observed stage hydrographs

Calibration to Observed Flow Hydrographs

PBI coded the observed 2006 flow hydrograph at Vernalis as well as observed stage hydrographs at the downstream boundaries of the model. The calibration simulation was run from 3/1/2006 to 5/30/2006 and modeled flow hydrographs were compared to observed flow hydrographs at several gage locations. Adjustments were necessary to regulate flow splits at Paradise Cut and Old River.

For the Paradise Cut flow spit, the coefficient for Paradise Weir was adjusted until the simulated 2006 hydrograph matched the observed hydrograph at Mossdale bridge (just downstream of Paradise Cut). The weir coefficient was originally set at 2.0 and was changed to 2.6 during calibration. The figure below shows observed and modeled flow hydrographs for the San Joaquin River at Mossdale bridge following model calibration.

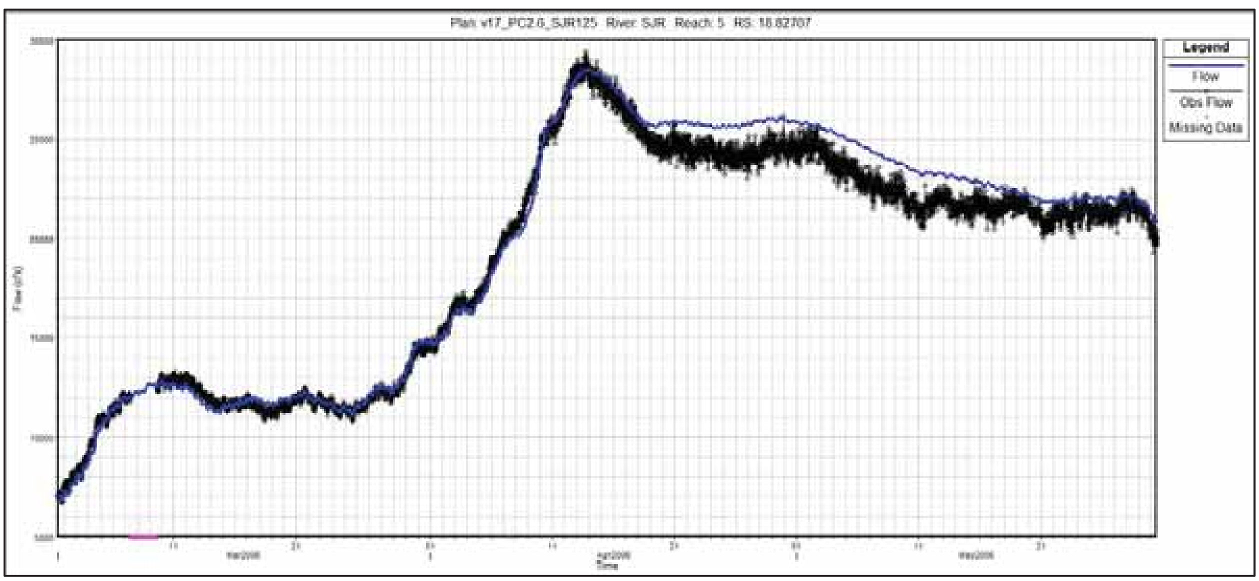

Figure 6. Observed versus simulated flow hydrographs for San Joaquin River at Mossdale bridge.

As verification for the diverted flow at Paradise Cut, the simulated rating curve for Paradise weir was compared to the design rating curve from the USACE 1955 Design Memorandum[2]. Simulated results align with the design rating curve as shown in Figure 7.

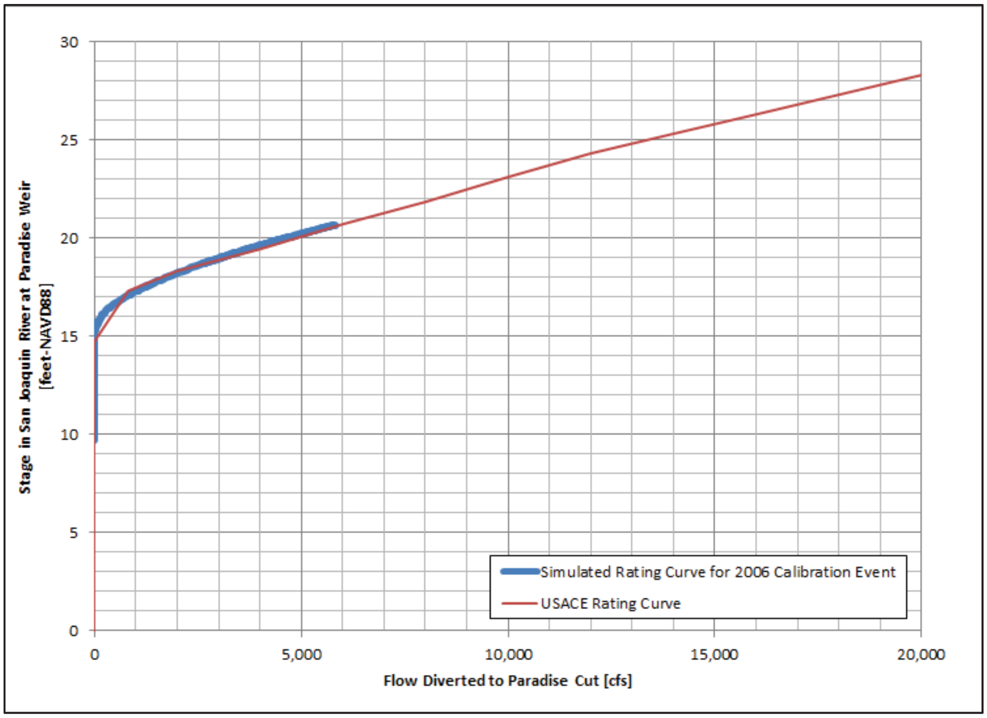

Figure 7. Design versus simulated rating curve for Paradise weir.

To control flow at the Old River split, n values were adjusted in the Old River reach immediately downstream of the San Joaquin River (Old River-Reach 4 in the HEC-RAS model). Increased n values in Old River sends more water down the San Joaquin River; decreased n values on Old River sends more water down Old River.

In-channel n values for Old River were increased by a factor of 1.4 (from 0.03 to 0.042) during the calibration procedure. The figures below show observed and modeled flow hydrographs for the San Joaquin River just below Old River and at Hwy 4/Garwood Bridge following calibration adjustments. The n value adjustments also created a close fit to observed HWMs and stage hydrographs on Old River as discussed later in this section.

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[2] USACE. “Lower San Joaquin River and Tributaries Project Design Memorandum No. 1”. 23DEC1955.

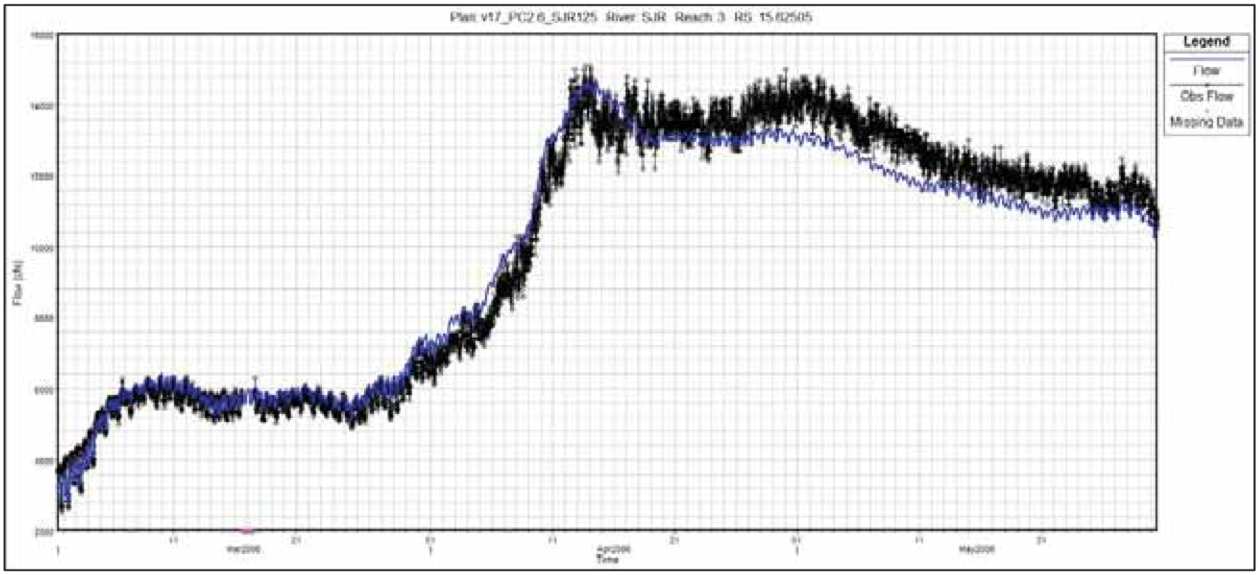


Figure 8. Observed versus simulated flow hydrographs for San Joaquin River below Old River.

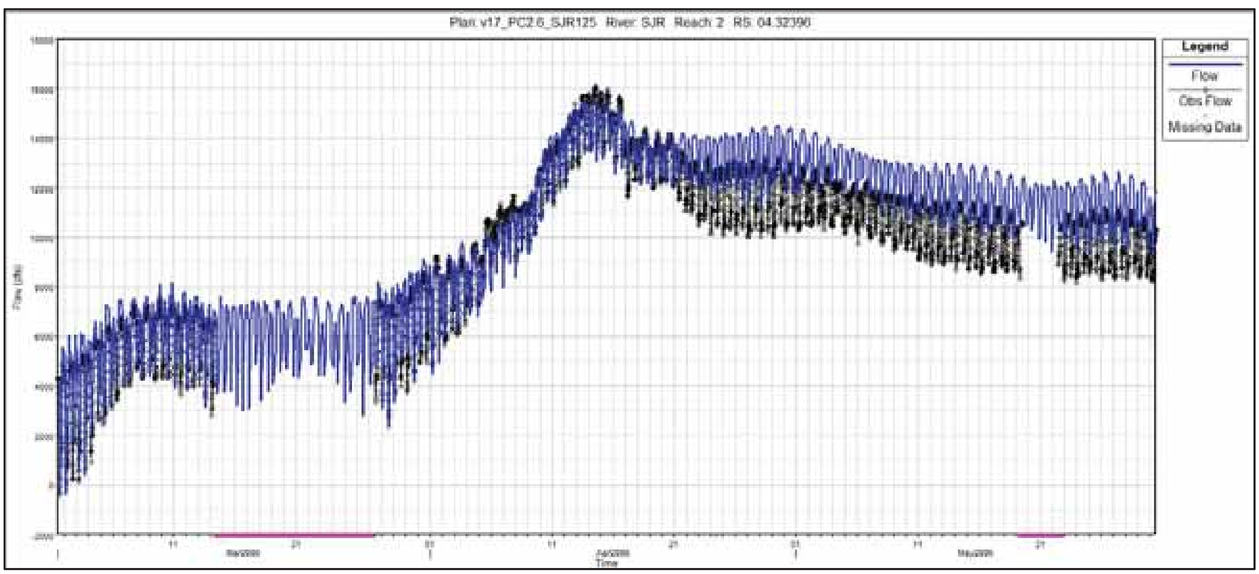


Figure 9. Observed versus simulated flow hydrographs for San Joaquin River at Hwy 4/Garwood Bridge.

Calibration to Observed High Water Marks

The 2006 calibration data includes numerous HWMs along the San Joaquin River, Paradise Cut, and Old River. Once modeled flows were matching observed flows, cross section n values were adjusted so that the simulated water surface profile would create a “best fit” line through the HWMs.

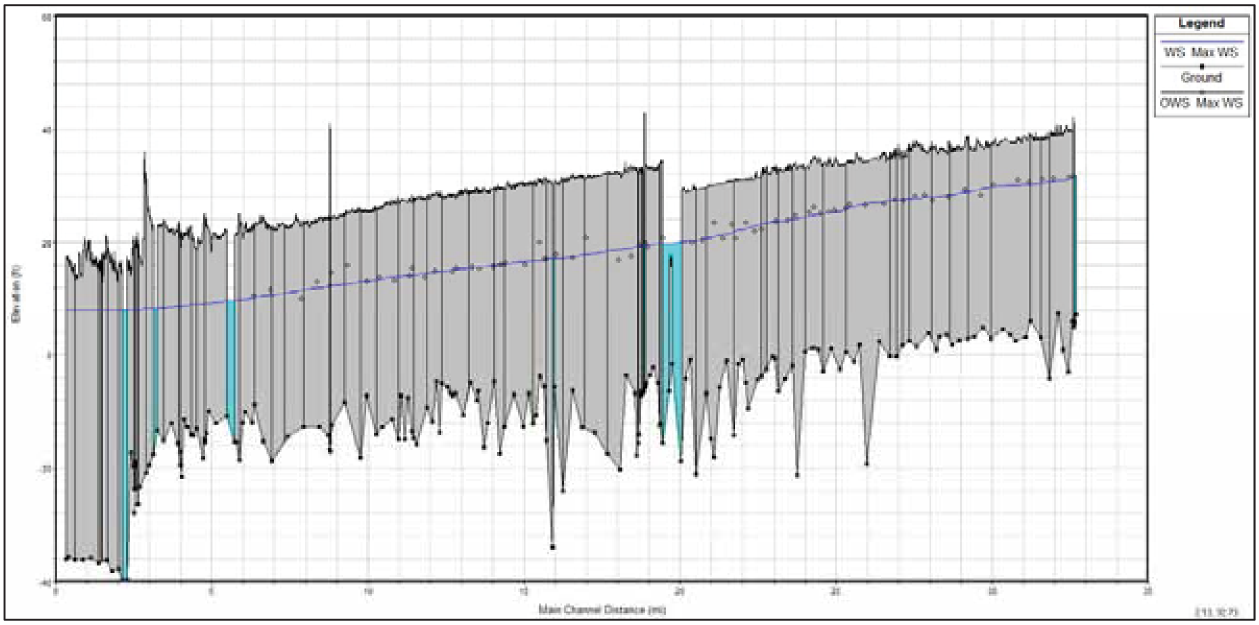


Figure 10. Simulated 2006 water surface profile for the San Joaquin River compared to observed high water marks.

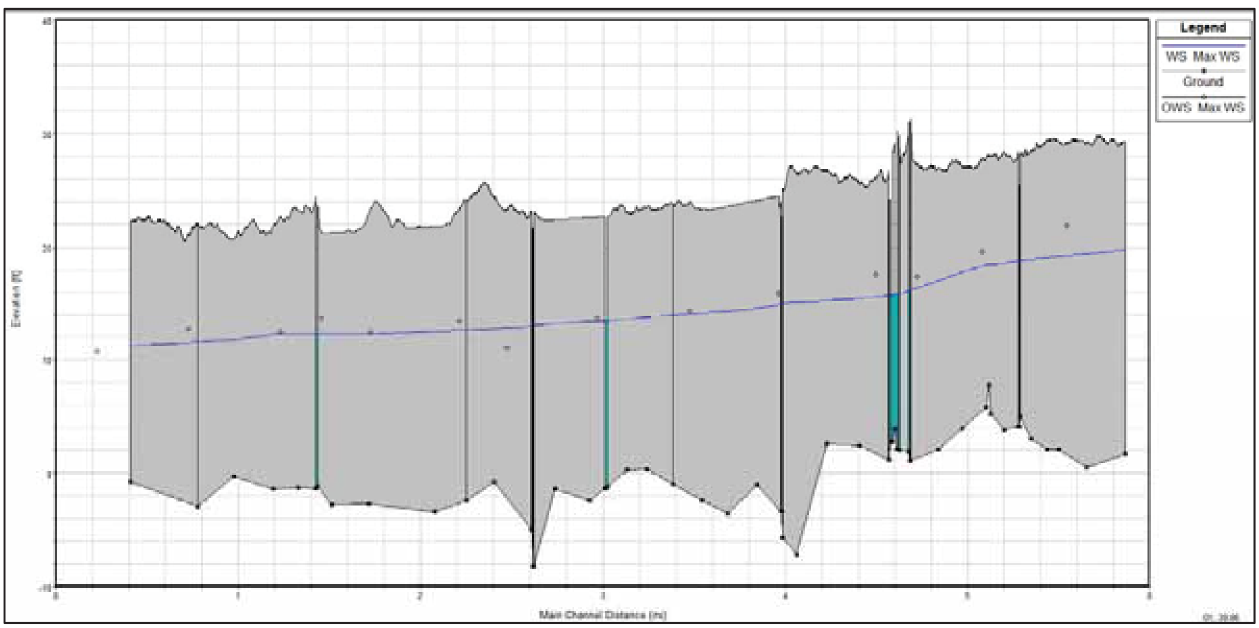


Figure 11. Simulated 2006 water surface profile for Paradise Cut compared to observed high water marks.

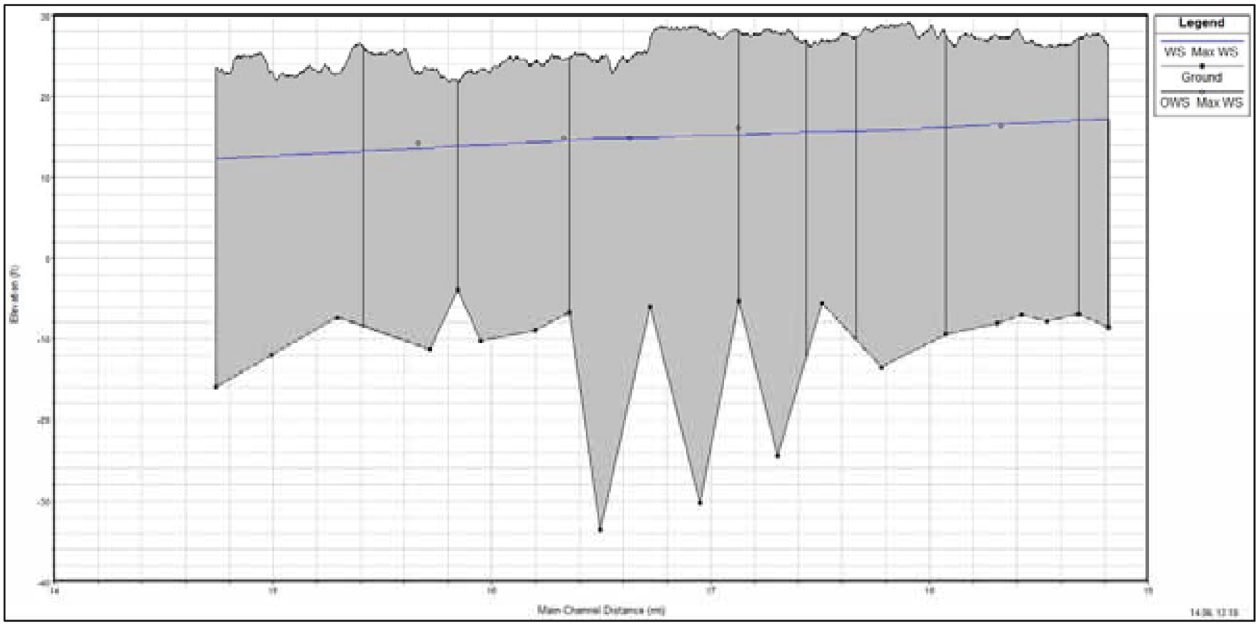


Figure 12. Simulated 2006 water surface profile for Old River compared to observed high water marks.

Verification to Observed Stage Hydrographs

Once n values were adjusted to fit HWMs, observed stage hydrographs were used to verify these adjustments. In general, simulated stage hydrographs overestimate stages during low flows, but closely match observed stage hydrographs during high flows. No additional model adjustments were made during this step.

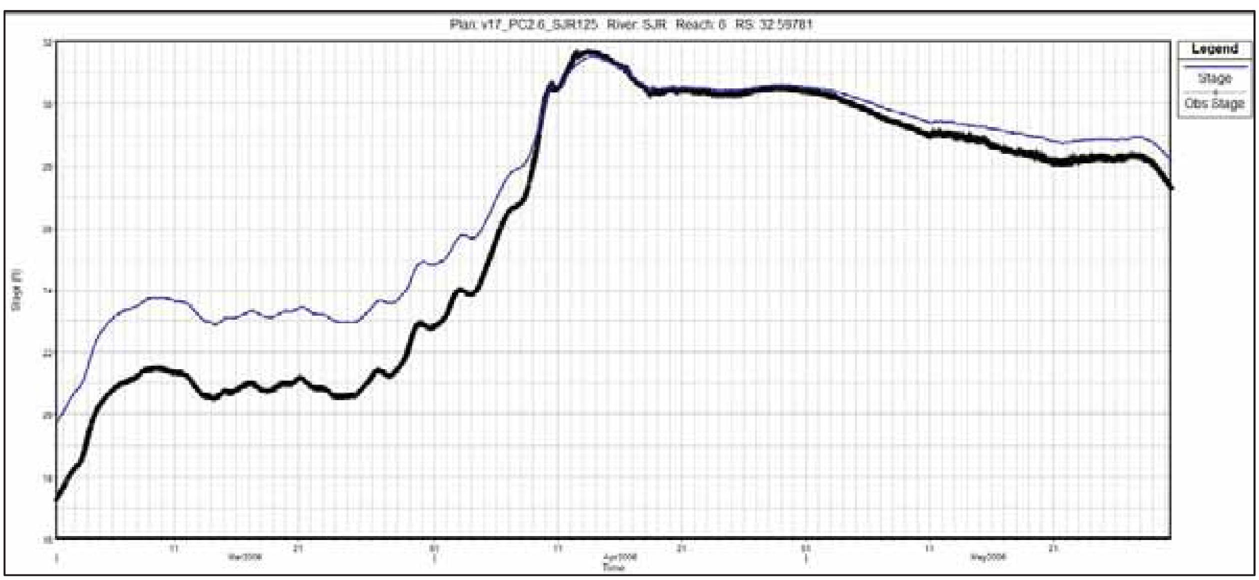


Figure 13. Observed versus simulated stage hydrographs for the San Joaquin River at Vernalis.

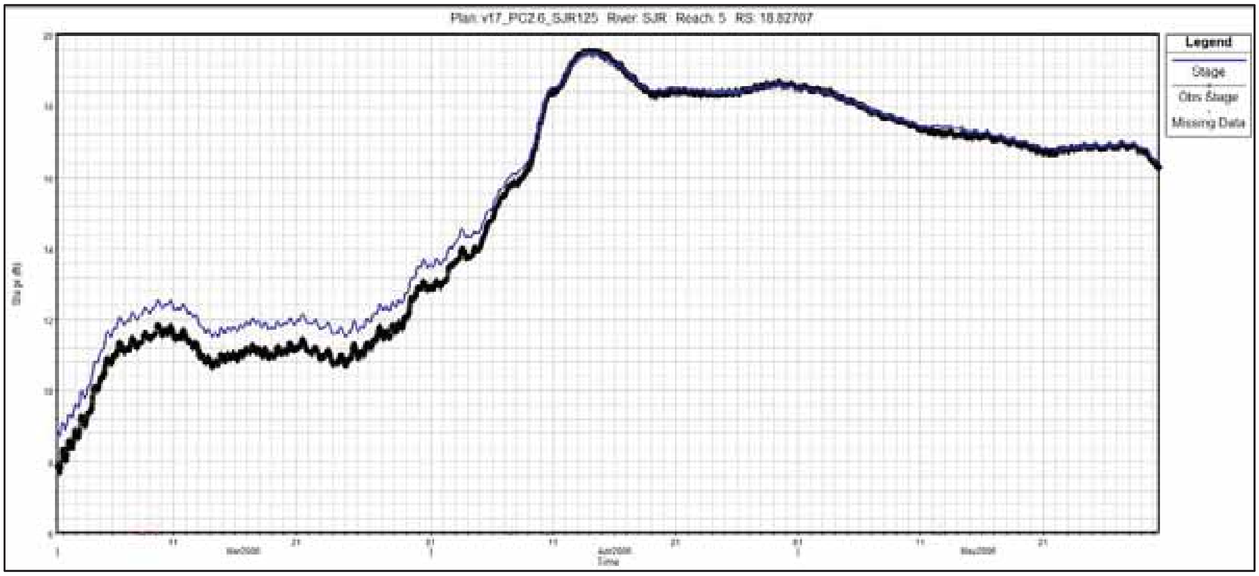


Figure 14. Observed versus simulated stage hydrographs for the San Joaquin River at Mossdale bridge.

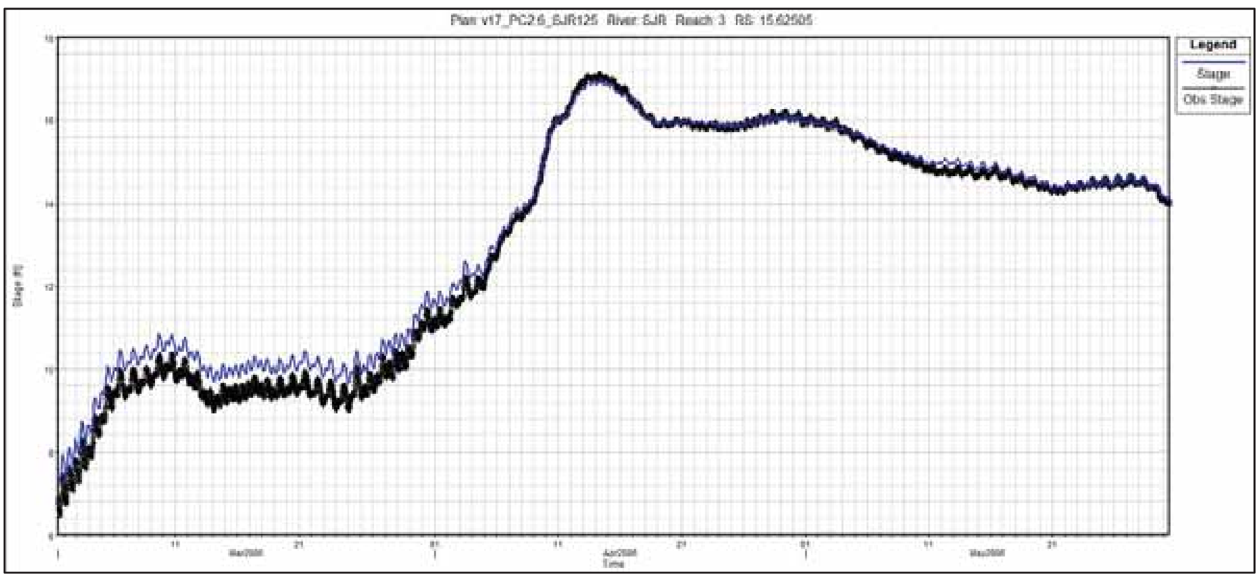


Figure 15. Observed versus simulated stage hydrographs for the San Joaquin River below Old River.

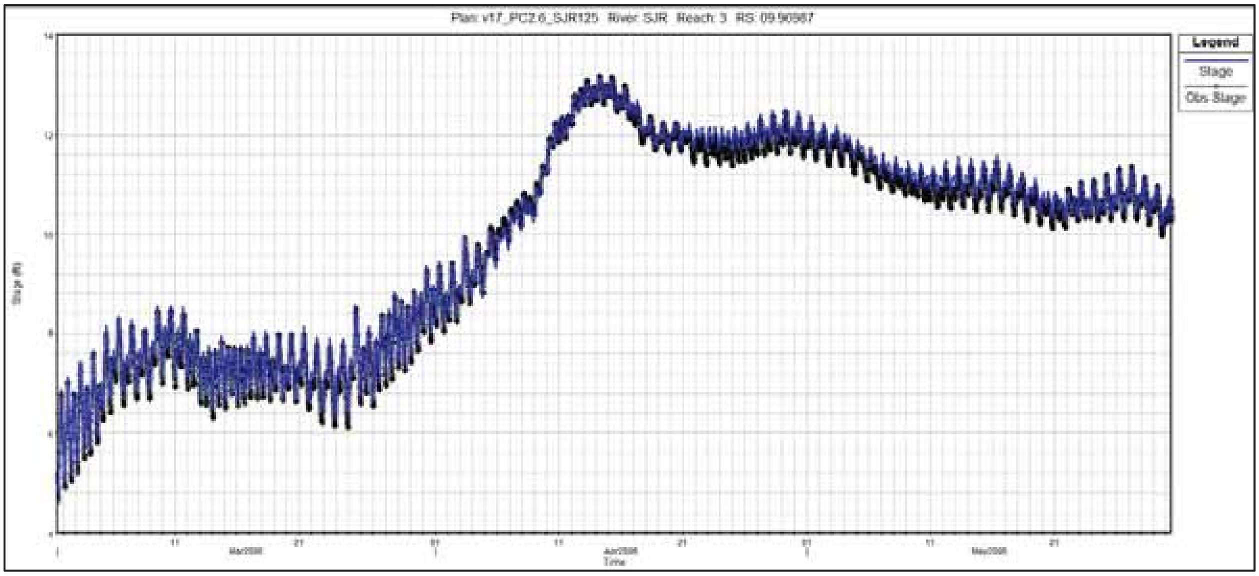


Figure 16. Observed versus simulated stage hydrographs for the San Joaquin River at Brandt bridge.

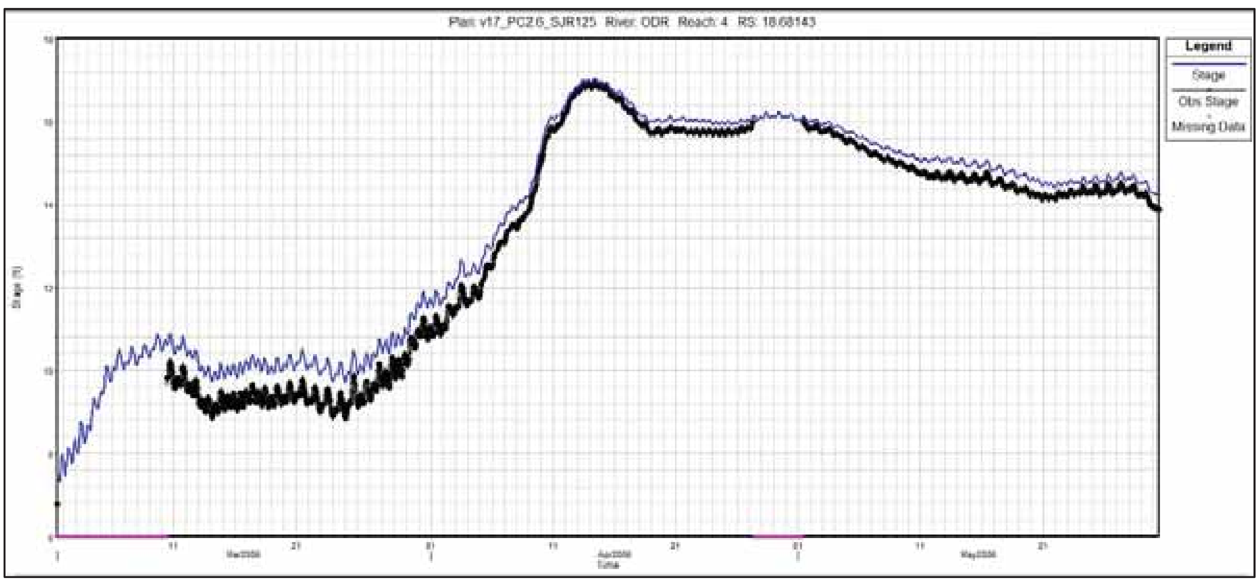


Figure 17. Observed versus simulated stage hydrographs for Old River at head.

3.9. Independent Review of HEC-RAS Model by MBK Engineers

MBK Engineers conducted a review of PBI's revised HEC-RAS model and provided comments which are included in Attachment 4. PBI responded to comments and MBK provided a backcheck which is also included in Attachment 4.

4.0 QUALITY CONTROL (QC) OF CVFED FLO-2D MODEL

The base model used for the RD 17 floodplain modeling was the CVFED TO25 FLO-2D model for the Lower San Joaquin River. Details on the TO25 model setup can be found in the CVFED report titled "Task Orders 23 and 25, Technical Memorandum: Lower San Joaquin River and Tributaries Two-Dimensional (FLO-2D) Hydraulic Model" dated November 20, 2013. Before the model was used for the RD 17 hydraulics study, it was checked for general reasonableness. PBI's review methodologies along with any changes made to the CVFED model are presented in this section.

The CVFED model covers the entire Lower San Joaquin system up to Newman. The PBI Quality Control (QC) effort focused on the area along the right bank of the San Joaquin River between the Stanislaus River and French Camp Slough (Figure 18).

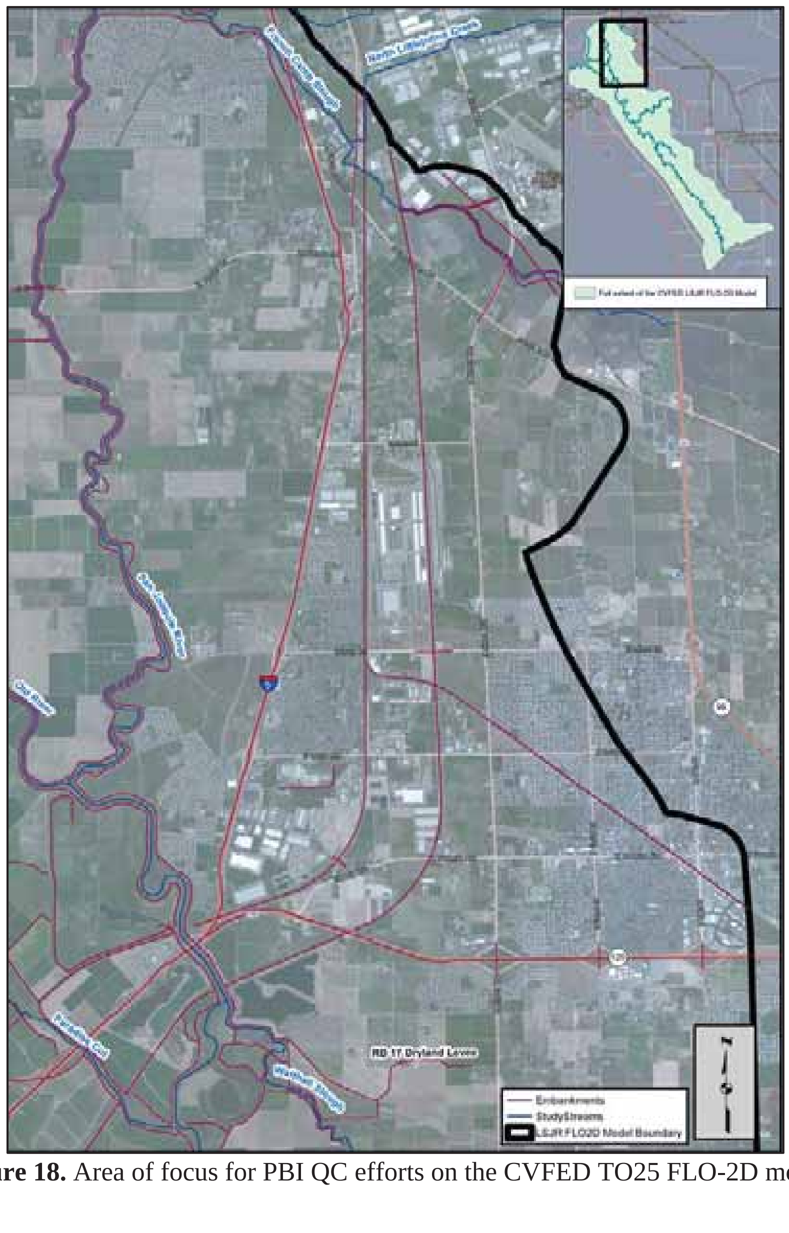


Figure 18. Area of focus for PBI QC efforts on the CVFED TO25 FLO-2D model.

4.1. Embankments

Detailed LiDAR topographic data was used to verify that major levees and embankments were captured in the CVFED model. Consistent with CVFED methodology, embankments greater than 3 feet were considered major embankments that could alter the flowpaths of breach waters.

Two major embankments (in green) were added to the LSJR model following the review:

(1) Railroad embankment parallel to McKinley Avenue (Figure 19)

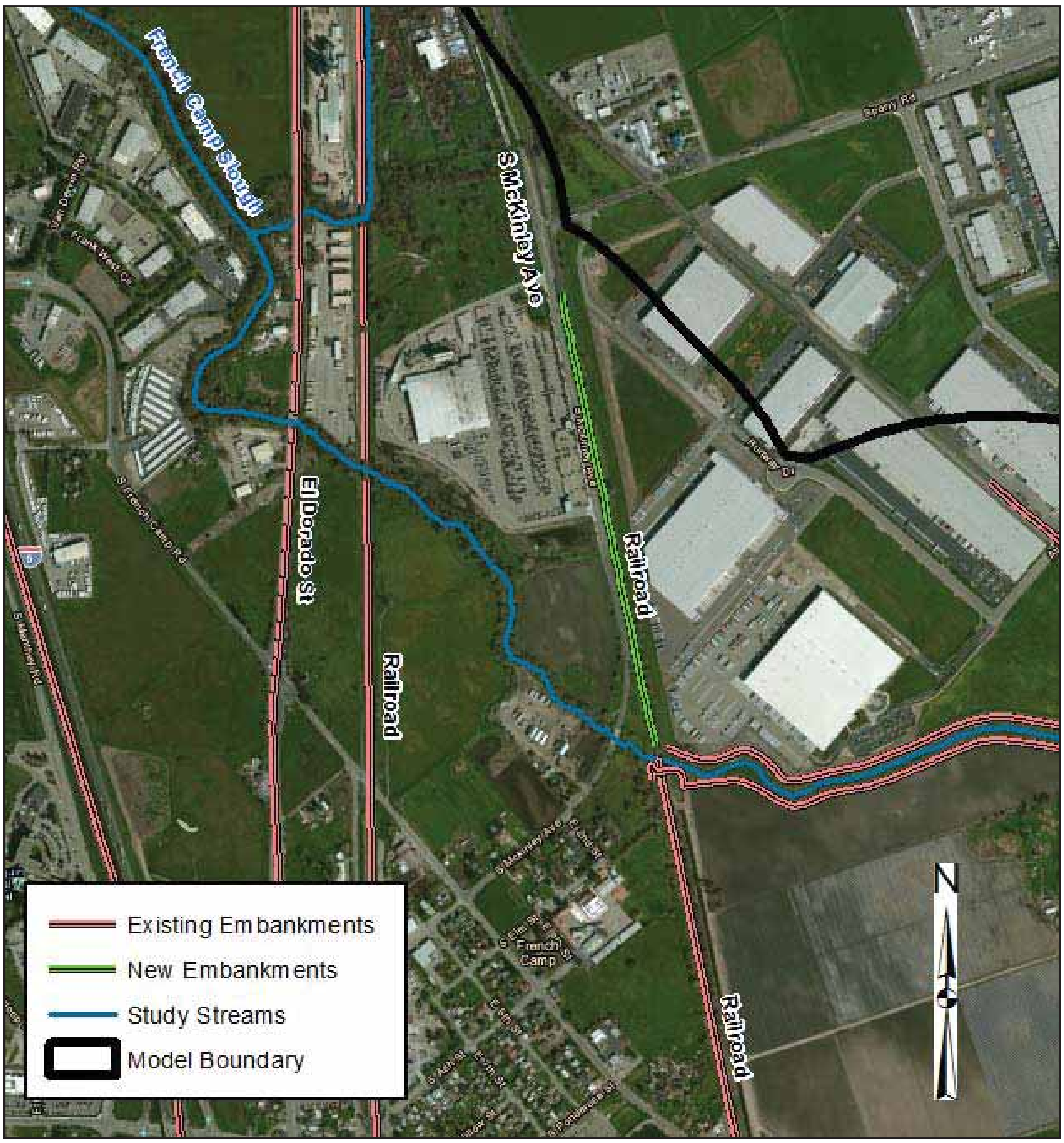


Figure 19. Aerial photo of added FLO-2D railroad embankment.

(2) Airport Way embankment south of French Camp Slough (Figure 20).

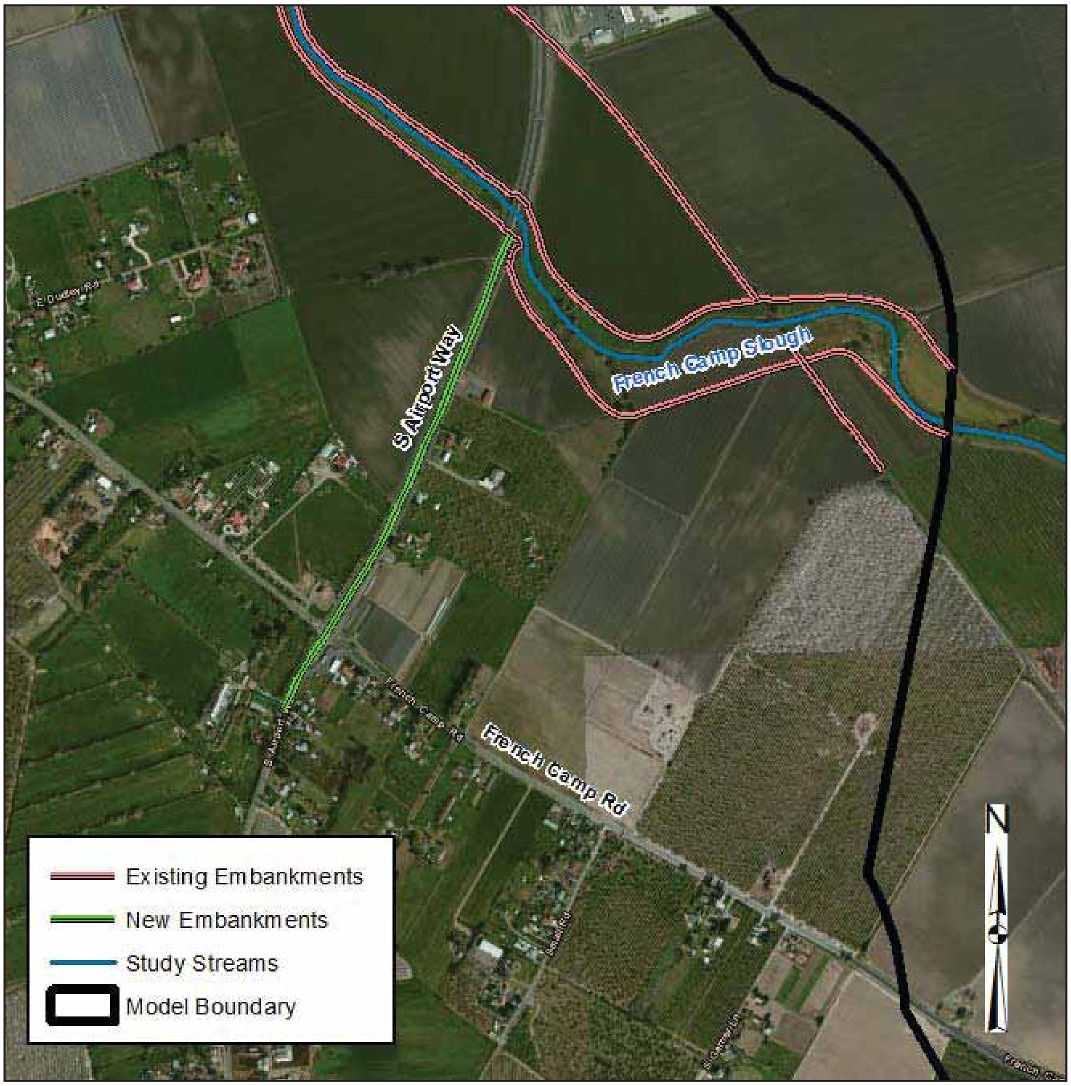


Figure 20. Aerial photo of added FLO-2D embankment along Airport Way.

4.2. Flow through Embankments

Culverts, overpasses, and depressed roadways all allow floodwaters to pass through an embankment. LiDAR data and Google Earth images were used to verify that major conveyance routes were captured in the CVFED model. Consistent with CVFED methodology, the following modeling approach was used to review and add locations where flow passes through embankments:

- Levee Gap
  The "levee gap" method was used in conjunction with Width Reduction Factors (WRF) for selected roadway underpass locations where a small segment of the embankment was removed to let water pass through.

- <u>Channel Segments</u>
  Most road underpasses, along with a select number of culverts, were modeled as levee gaps with short, shallow rectangular channels. A WRF of 1.0 was used to eliminate any floodplain flow through levee gaps.

Five (5) types of modifications related to flow through embankments were made to the CVFED model:

(1) Roadway underpasses that were originally modeled as "levee gaps" were converted to channel segments to allow for more controlled conveyance through the underpass.

(2) All n-values for channel segments representing roadway underpasses were changed to 0.015, which is more typical of a street or concrete channel.

(3) The original CVFED model included 1 culvert that was represented by a rating curve (model grid cells 1381 and 1382). This rating curve was causing significantly longer model simulation times and was not properly letting flow through the embankment. It was therefore removed and replaced with a channel segment which is consistent with the general CVFED modeling approach. The original rating curve was used to back-calculate a reasonable channel width.

(4) Two levee gaps that were in the original CVFED model were removed where there were no visible conveyances.

(5) Two culvert crossings (shown in Figure 21 and Figure 22) were added to the model as channel segments.

A detailed list of changes made to the FLO-2D model regarding flow through embankments is provided in Attachment 5.

Figure 21. Aerial photo of the added culvert near S. Janet Rd.

Figure 22. Aerial photo of the added culvert near E. Krell Lane

4.3. Floodplain N-Values

Manning's n-values assigned to the floodplain were checked for reasonableness. Aerial photography along with San Joaquin County General Plan data were used in the review. Representative Manning's n selection criteria from the CVFED model are shown in the table below. These criteria were also used for PBI's review.

Table 3. CVFED Manning's n-value selection criteria.

Basin Land Use	Representative Manning's n Values
Open Space, Ag	0.12, 0.15
Recreation, Ag Res.	0.1
Residential, Industrial	0.04

The original CVFED model had n-values based on 1996 DWR land use surveys. The floodplain n-values were adjusted in certain areas to reflect urbanization that has occurred over the past 18 years. Changes were primarily for newly urbanized areas within the spheres of influence of Stockton, Lathrop, and Manteca. Figure 23 shows an example of land use changes in Weston Ranch that required an update to Manning's n values in the FLO-2D model.

Google Earth Imagery Date: 8/16/98 Google Earth Imagery Date: 4/11/13

Figure 23. Example of land use changes that warranted changes to FLO-2D Manning's n values.

Manning's n values for grid cells in these newly developed areas were decreased to represent a more urban setting. The composite n-value for each changed grid cell was re-calculated as area-weighted values of the land use types within each grid cell which is consistent with CVFED methodology. Figure 24 provides of summary of changes made to FLO-2D n-values. A more detailed list of n-value changes for each grid cell is provided in Attachment 6.

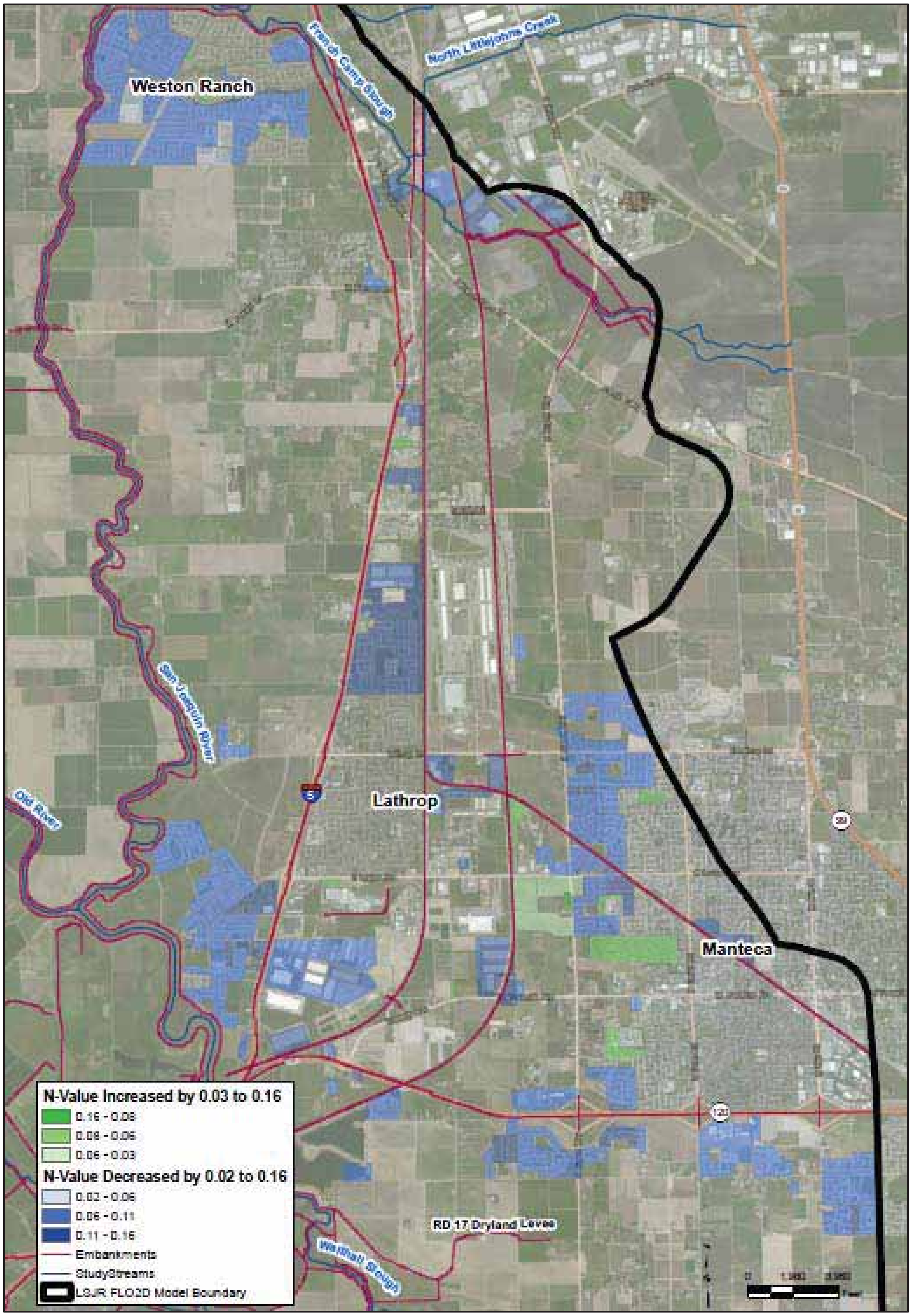


Figure 24. Changes to FLO-2D Manning's n-values.

5.0 200-YEAR WATER SURFACE PROFILE

Once the CVFED TO25 HEC-RAS model was QC'ed and updated (see Section 3.0) it was used to route 200-year CVHS hydrographs (see Section 2.0) and to estimate the 200-year WSP.

5.1. Modeled Scenarios

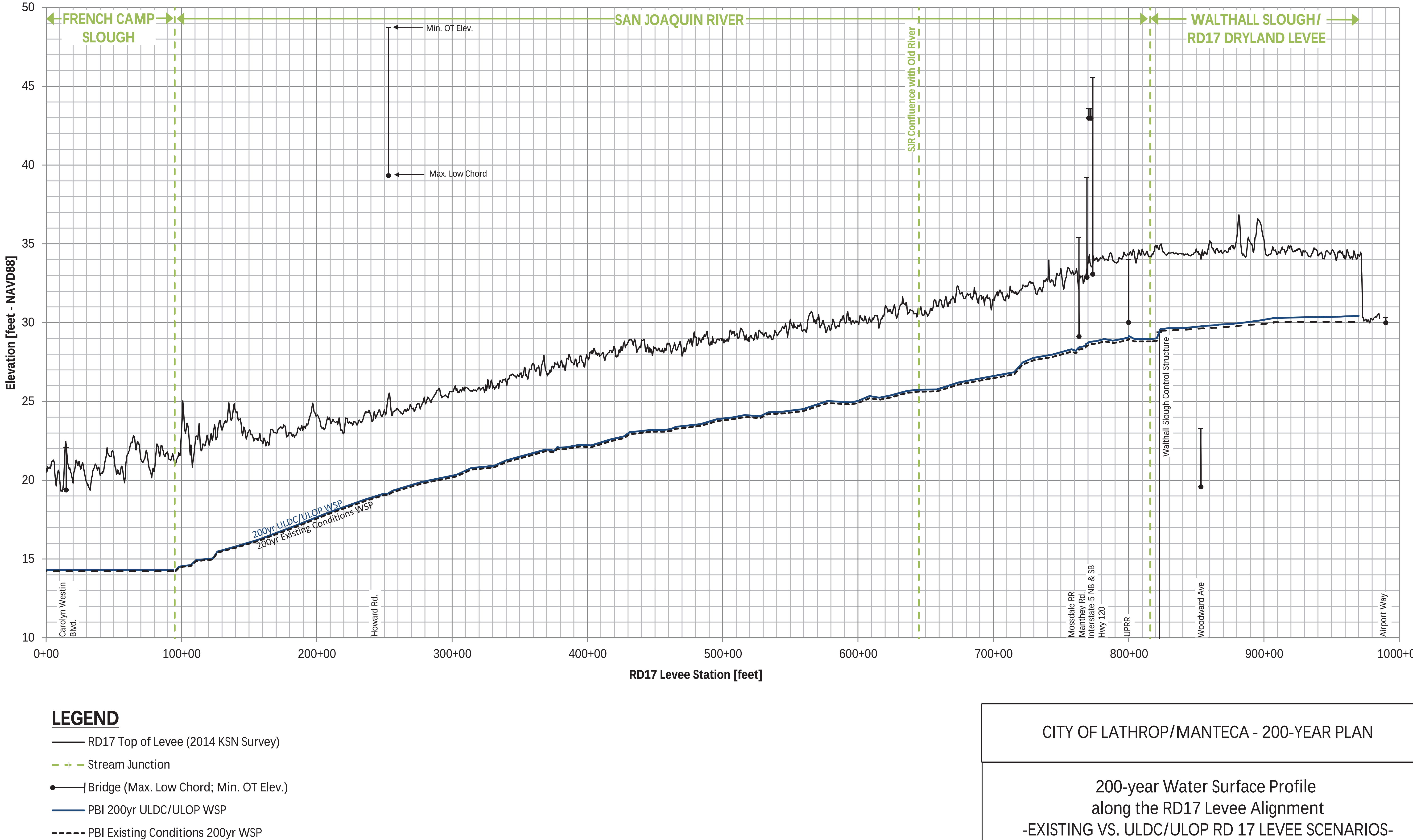
The 200-year WSP assumes that levees can overtop, but do not fail. Two scenarios were modeled:

1. **RD 17 Levee Existing Conditions:** All RD 17 levee tops are set at existing elevations in the HEC-RAS model. This particularly applies to the RD 17 dryland levee which, as it stands today, is expected to have floodwaters flank around it during a 200-year event. All other non-RD 17 levees are set at ULDC/ULOP levees heights (see Section 3.4) in this scenario.

2. **RD 17 Levee ULDC/ULOP Conditions:** All levee tops in the model, including RD 17 levees, are set at minimum ULDC/ULOP elevations. For RD 17 levees this particularly applies to the dryland levee which, in this scenario, is improved so that no floodwaters are able to flank around it. Consequently, this pushes more overbank flow back towards the San Joaquin River.

The existing conditions scenario was used for all levee breach simulations which are described in Section 6.0. The ULDC/ULOP scenario was used for the RD 17 freeboard analysis. The differences between the two WSPs are minimal and are presented in Figure 25. Differences up to 0.15-foot in the WSPs are seen along the San Joaquin River levees. Differences of up to 0.4-foot in the WSP occur along the RD 17 dryland levee.

The water surface profile for the ponded water along the RD 17 dryland levee was generated through FLO-2D floodplain modeling of the 200-year overbank flows that come from the Stanislaus River and San Joaquin River near Vernalis (discussed further in Section 7.0).



CITY OF LATHROP/MANTECA - 200-YEAR PLAN

200-year Water Surface Profile
along the RD17 Levee Alignment
-EXISTING VS. ULDC/ULOP RD 17 LEVEE SCENARIOS-

PETERSON . BRUSTAD . INC
ENGINEERING . CONSULTING

MAY 16, 2014

FIGURE 25

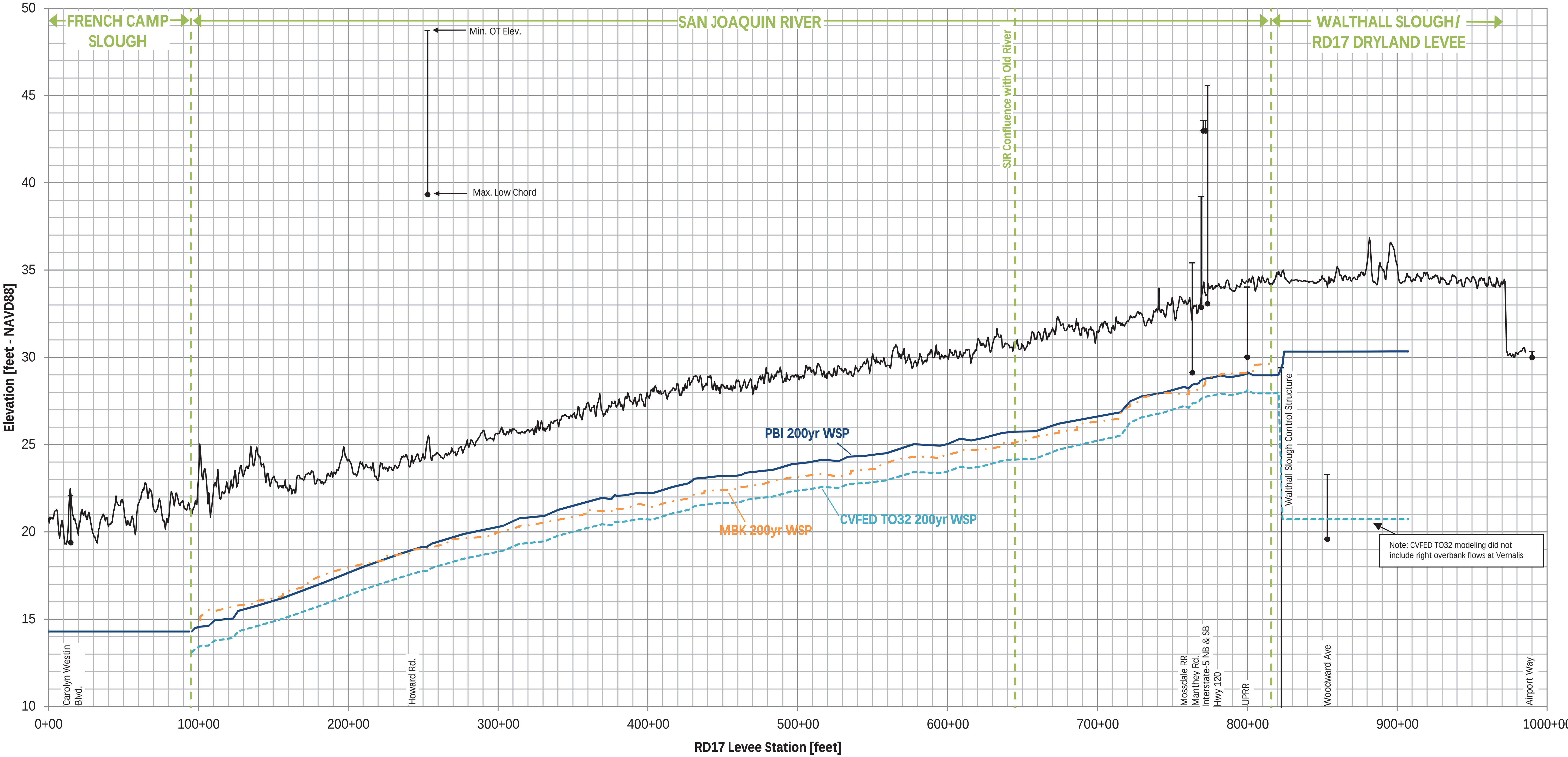
5.2. Comparison to Other Regional Studies

The 200-year ULDC/ULOP WSP calculated for this study was compared to other recent studies that have been done in the Lower San Joaquin region: (a) the CVFED TO32 study and (b) the MBK Engineers/River Islands study. The comparison is presented in Figure 26. The MBK study is ongoing and the WSP included in this figure is current as of May 2014.

5.3. Freeboard Analysis for RD 17 Levees

The ULDC/ULOP 200-year WSP was used to analyze freeboard along the RD 17 levees. Figure 27 plots the 200-year plus 3-feet line against the RD 17 top of levee profile. No freeboard issues were found for RD 17 levees along French Camp Slough or the San Joaquin River. Freeboard evaluation along the RD 17 dryland levee will take further analysis.

ULDC specifies freeboard requirements as the 200-year WSP plus 3-feet *or* 200-year WSP plus wind-wave runup calculations, whichever is greater. In the case of the dryland levee, wind-wave runup calculations are likely to control. The overbank flooding that occurs for the 200-year event creates a large area of ponding between the dryland levee and the Stanislaus River. Fetch lengths for this ponded area are in terms of miles and are expected to drive wind-wave runup calculations beyond 3-feet. A full wind-wave analysis will need to be completed to evaluate freeboard for this levee.



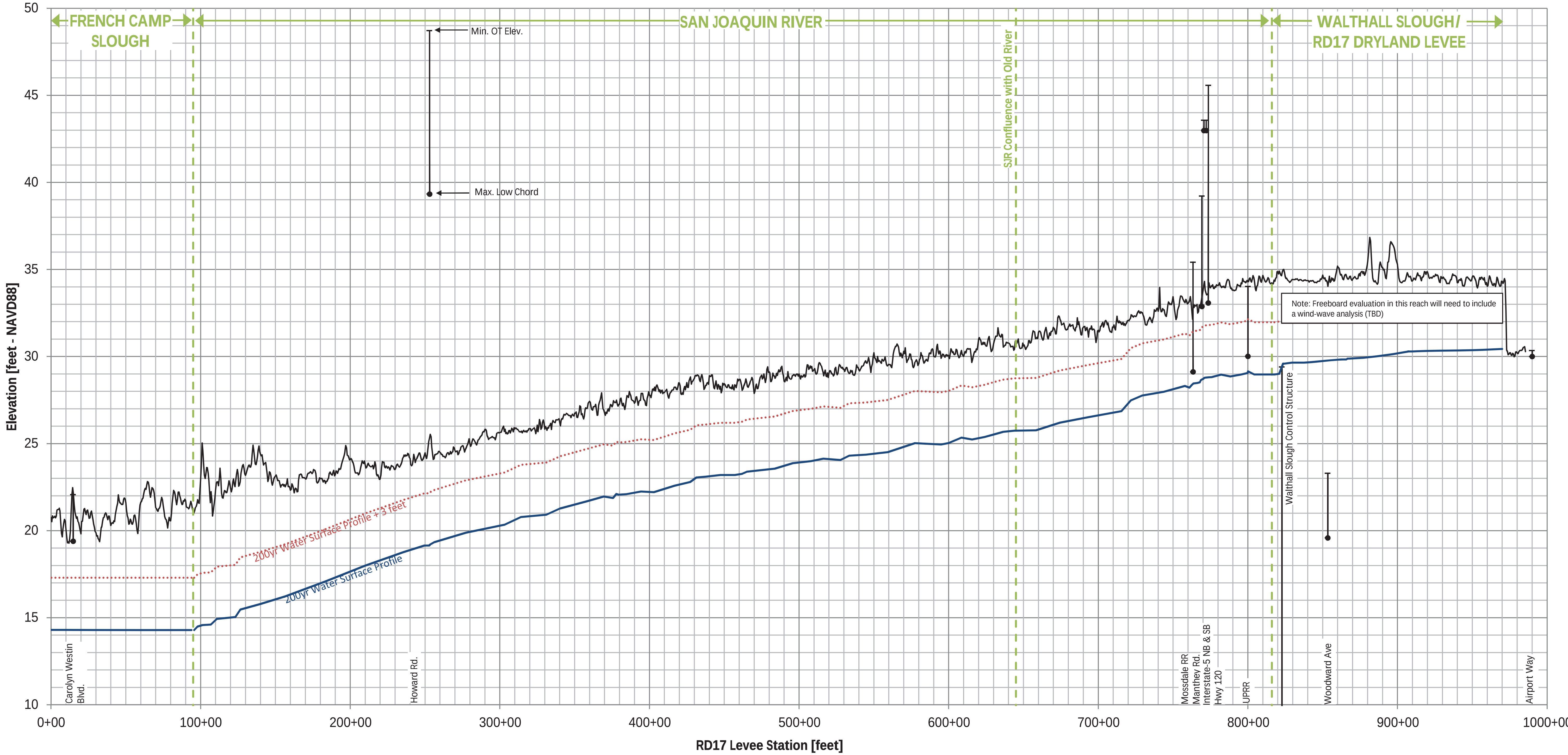
LEGEND

- RD17 Top of Levee (2014 KSN Survey)
- Stream Junction
- Bridge (Max. Low Chord; Min. OT Elev.)
- PBI 200yr WSP
- MBK 200yr WSP
- CVFED TO32 200yr WSP

MAY 16, 2014

CITY OF LATHROP/MANTECA - 200-YEAR PLAN
200-year Water Surface Profile along the RD17 Levee Alignment -COMPARISON OF CURRENT REGIONAL STUDIES-
PETERSON . BRUSTAD . INC ENGINEERING . CONSULTING

FIGURE 26



LEGEND

- RD17 Top of Levee (2014 KSN Survey)
- Stream Junction
- Bridge (Max. Low Chord; Min. OT Elev.)
- PBI 200yr WSP
- PBI 200yr WSP + 3 feet

MAY 16, 2014

CITY OF LATHROP/MANTECA - 200-YEAR PLAN

200-year Water Surface Profile
along the RD17 Levee Alignment
-EVALUATION OF FREEBOARD-

PETERSON . BRUSTAD . INC
ENGINEERING . CONSULTING

FIGURE 27

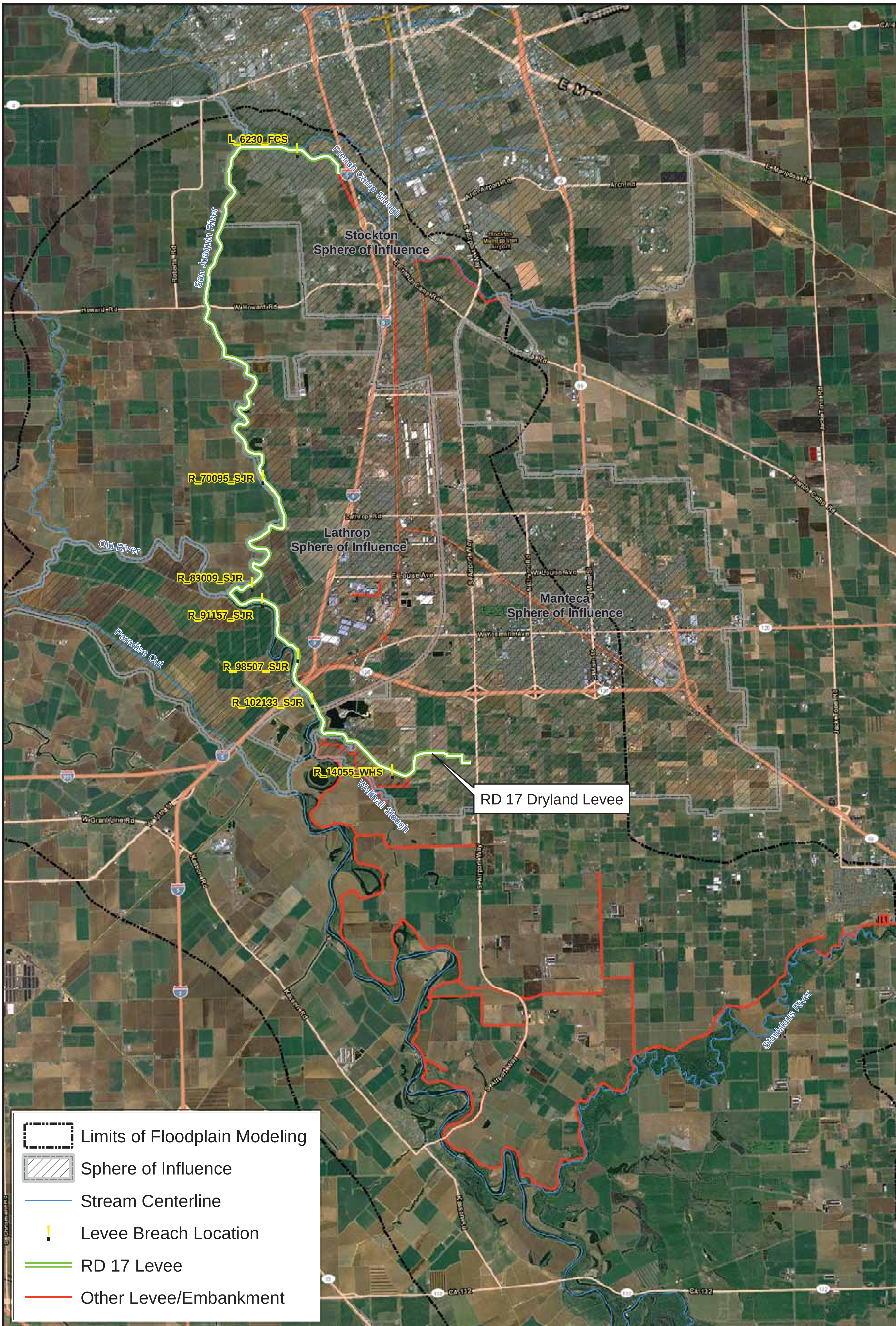
6.0 Developing Levee Breach Hydrographs

Levee breaches were analyzed at several locations along the RD 17 levee in order to develop without-project floodplain maps (see Section 7.0). Breach hydrographs were developed within HEC-RAS using the *RD 17 Levee Existing Conditions* scenario model run (see Section 5.1). Levee breach locations, breach parameters, and resultant breach hydrographs are described in this section.

6.1. Levee Breach Locations

Levee breaches were analyzed at each of the breach locations shown in Figure 28. The 5 breach locations along the San Joaquin River are the same locations used in the CVFED TO32 study and were determined by the CVFED team to be weak spots in the levee where the 200-year WSE exceeded geotechnical reliability elevations. CVFED selection of levee breach locations is further documented in their report, “Task Order 32, Senate Bill 1278/Assembly Bill 1965 Urban Level of Flood Protection Informational Maps, City of Lathrop – Technical Memorandum”, dated August 2013.

In addition to the 5 CVFED breach locations along the San Joaquin River, PBI added 1 breach location on French Camp Slough (L_6230_FCS) and 1 breach location on the RD 17 dryland levee (R_14055_WHS).



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Folsom, CA 95630
Phone: (916) 608-2212
Fax: (916) 608-2232

0 1.5 Miles
1 inch = 1.5 miles
APRIL 21, 2014

CITIES OF LATHROP & MANTECA - 200-YEAR PLAN

LEVEE BREACH LOCATIONS ANALYZED FOR THE RD 17 FLOODPLAIN MAPPING ANALYSIS

FIGURE 28

6.2. Levee Breach Parameters

Levee breach widths and breach progression were calculated according to procedures used by the USACE in the Lower San Joaquin River Feasibility Study (LSJRFS) and are based on equations from peer-reviewed literature[3]. The breach width equations are primarily dependent on the height of the levee, where a taller levee results in a wider breach. Levee failures were set to initiate when the adjacent WSEs reached the elevation of the landside levee toe. Breach progressions were relatively uniform for each location and it took approximately a half hour from the initiation until the breach was fully formed. All breaches were assumed to have vertical side slopes, used a weir coefficient (C_D) of 2.0 and were set to fail to a bottom elevation equal to the adjacent floodplain elevation. Breach widths are presented in Table 4. All HEC-RAS breach parameters are detailed in Attachment 7.

Table 4. Calculated levee breach widths for each breach location.

Breach Location	Breach Width [ft]
R_70095_SJR	177
R_83009_SJR	212
R_91157_SJR	199
R_98507_SJR	172
R_102133_SJR	182
R_14055_WHS	182

Note that the breach on French Camp Slough is not included in Table 4. This breach location was not analyzed in HEC-RAS and was instead evaluated as a "level pool" flooding scenario where the WSE in French Camp Slough was mapped to high ground in RD 17 (see Figure 36 in Section 7.3).

6.3. Levee Breach Hydrographs

Each breach scenario was run individually in the HEC-RAS model for the 200-year event. The full simulation window spanned 1 month (19DEC1996 to 19JAN1997) which includes 2 weeks beyond the passing of the peak flood wave. The following figures show resulting breach hydrographs for each modeled scenario.

[3] Coleman, Stephen E., Andrews, Darryl P., and Webby, M. Grant. *Overtopping Breaching of Noncohesive Homogeneous Embankments*. Journal of Hydraulic Engineering, Issue 829. September 2002.

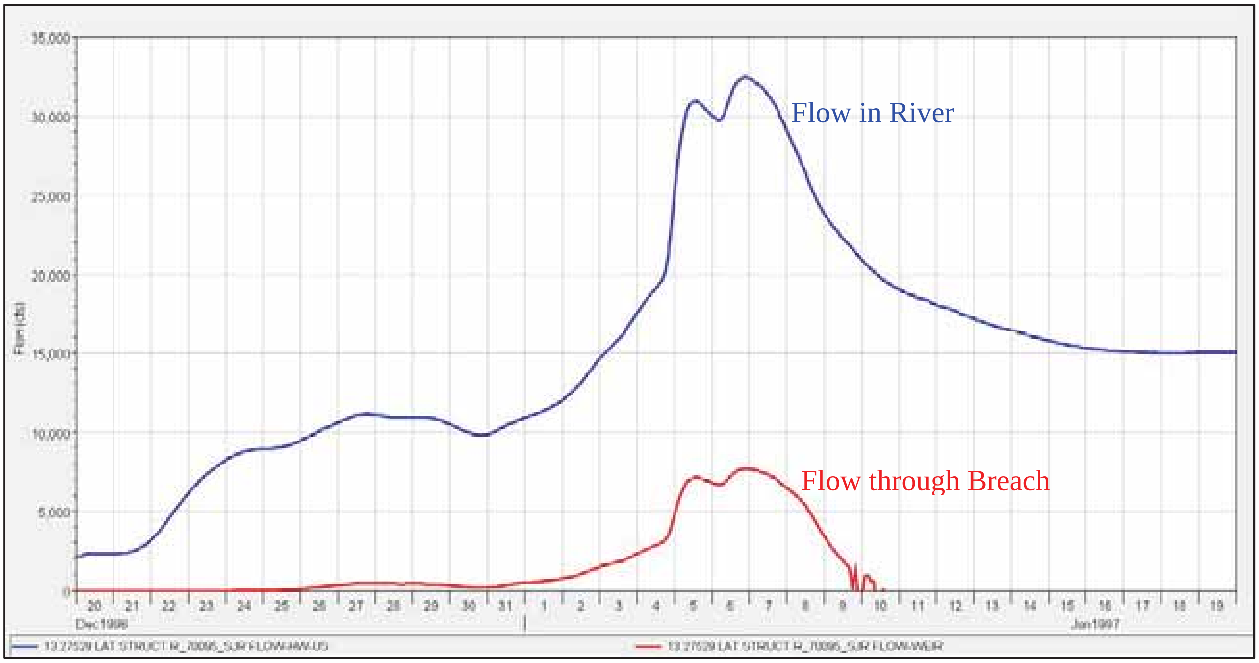


Figure 29. Breach hydrograph at R_70095_SJR.

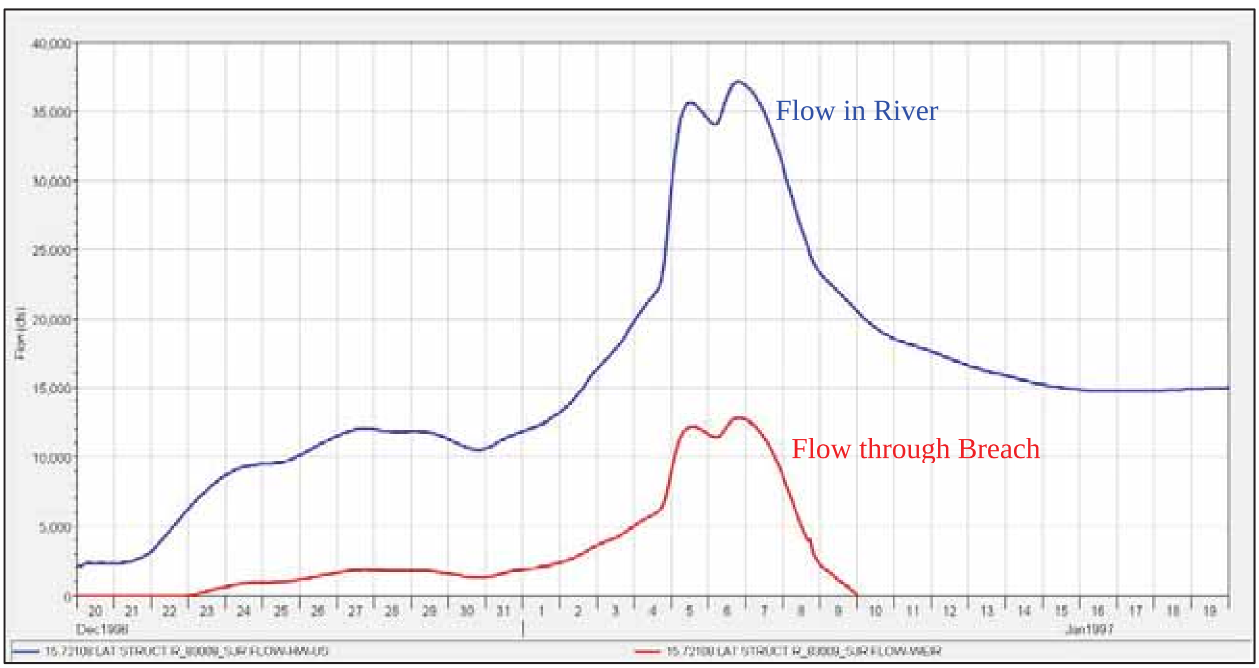


Figure 30. Breach hydrograph at R_83009_SJR.

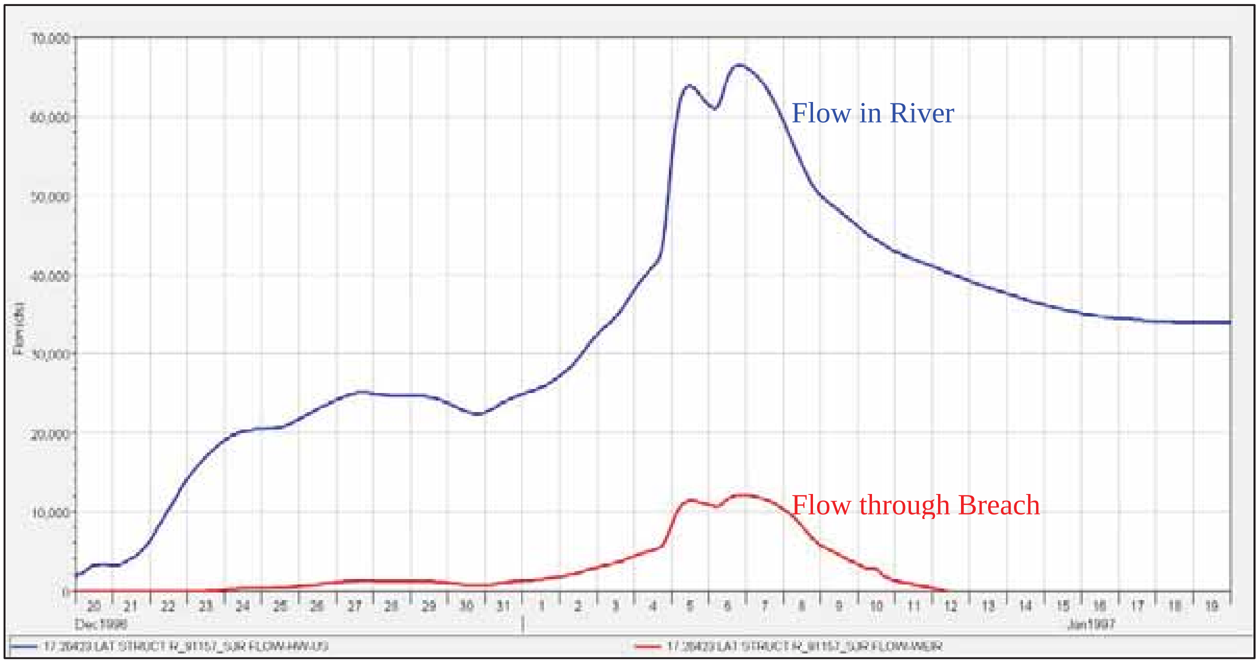


Figure 31. Breach hydrograph at R_91157_SJR.

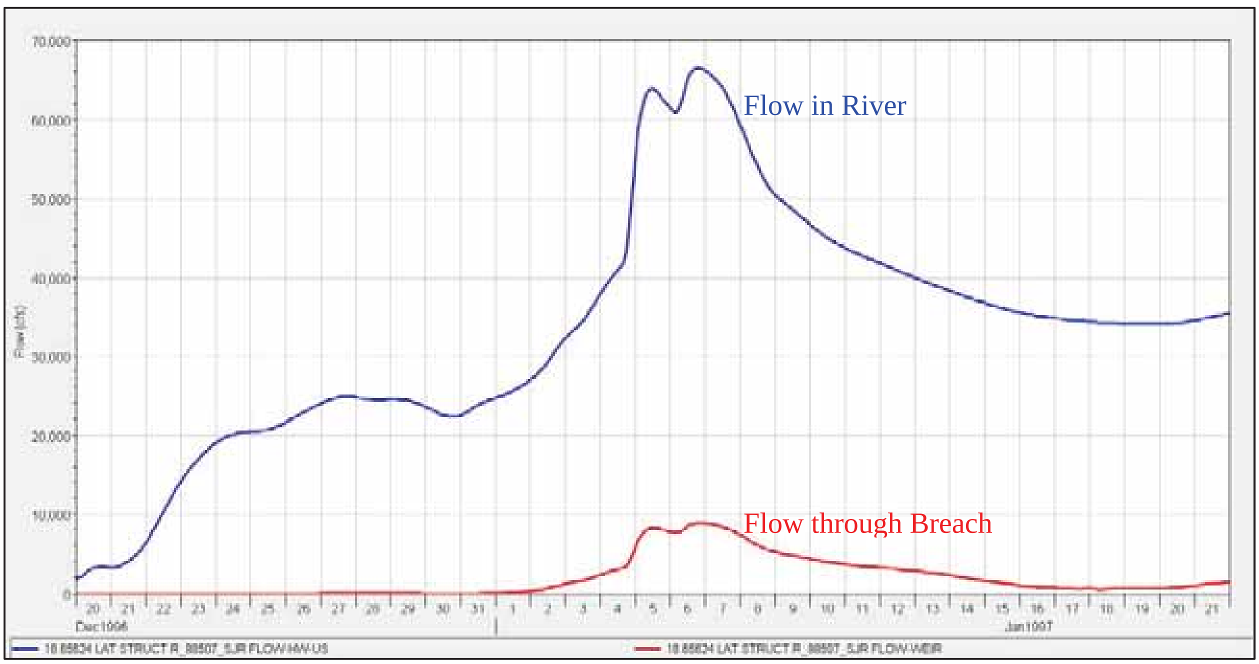


Figure 32. Breach hydrograph at R_98507_SJR.

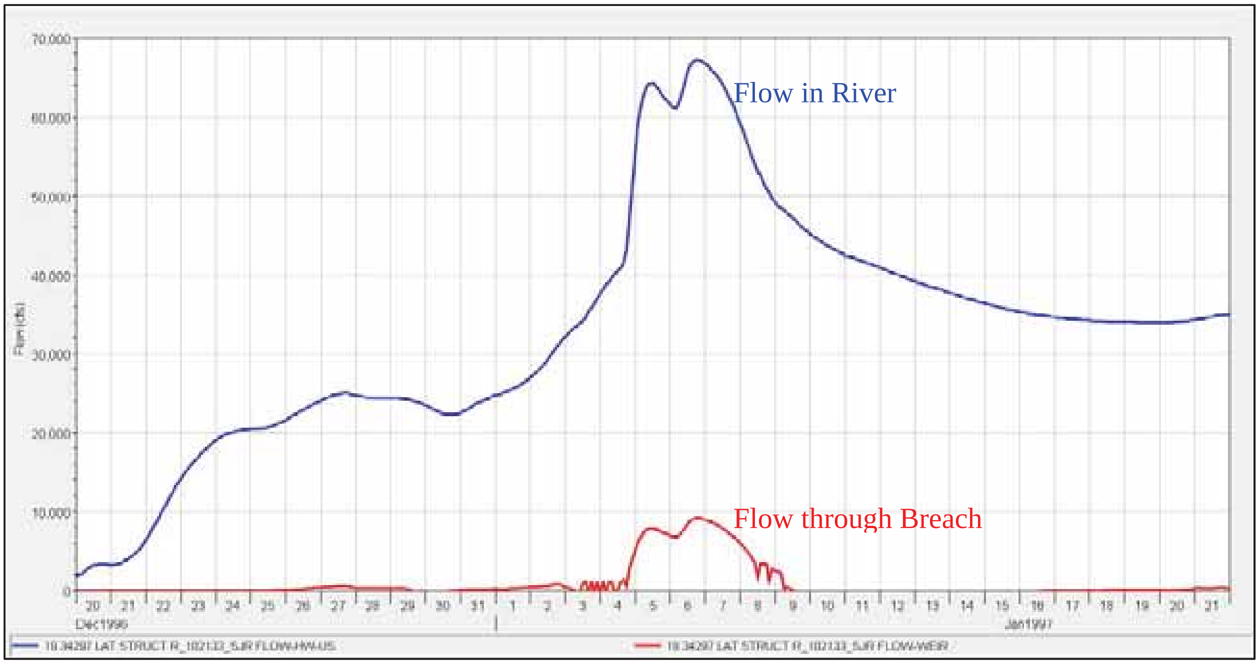


Figure 33. Breach hydrograph at R_102133_SJR.

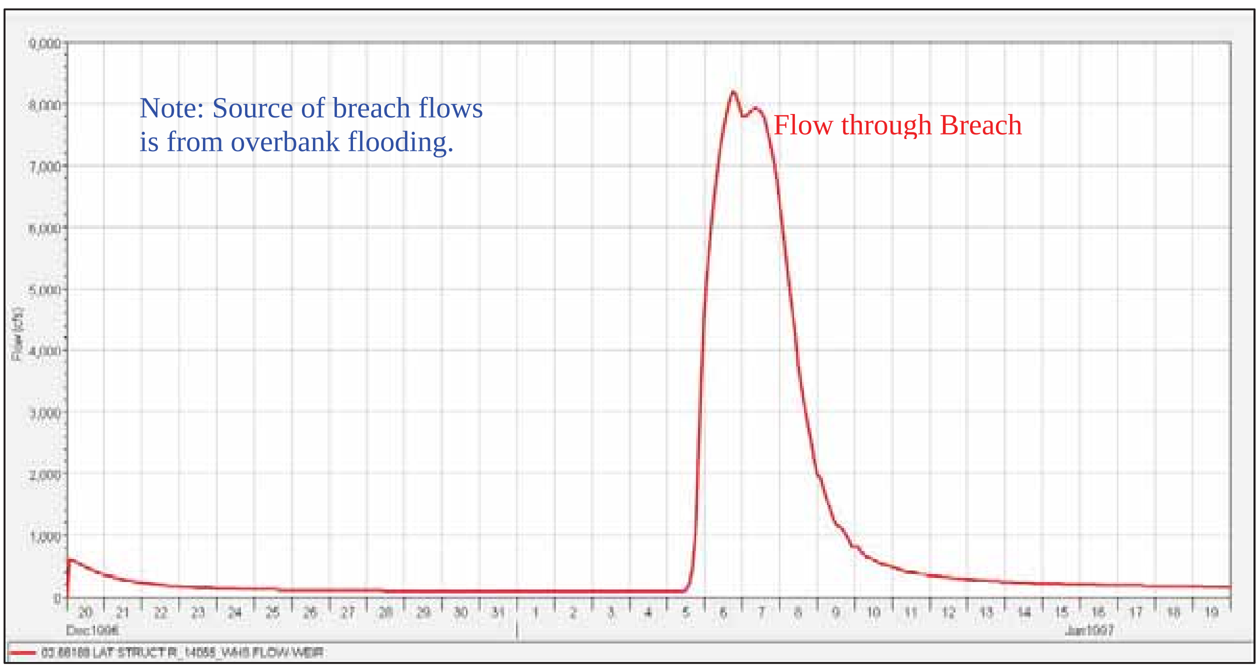


Figure 34. Breach hydrograph at R_14055_WHS.

7.0 200-YEAR FLOODPLAIN MAPPING

Once the CVFED TO25 FLO-2D model was QC'ed and updated (see Section 4.0) it was used for the two-dimensional floodplain modeling of each breach hydrograph described in Section 6.0. A description of FLO-2D model setup along with resultant floodplain maps are included in this section.

7.1. FLO-2D Model Setup

Each of the breach hydrographs described in Section 6.0 were coded into FLO-2D and individually simulated. Table 5 lists the FLO-2D grid cells that were used as inflow nodes for each breach hydrograph.

Table 5. FLO-2D grid numbers used as inflow nodes for each breach hydrograph.

Breach Hydrograph	FLO-2D Inflow Node
L_6230_FCS	n/a (not modeled in FLO-2D)
R_70095_SJR	6998
R_83009_SJR	9580
R_91157_SJR	9836
R_98507_SJR	11927
R_102133_SJR	13617
R_14055_WHS	16016

In addition to the breach hydrograph, most of the FLO-2D runs included a hydrograph coded at grid cell 28420 for the right overbank flows at Vernalis which are present during a 200-year event (see Section 2.0). A portion of these overbank flows flank around the RD 17 dryland levee and into RD 17 where they meet up with flows from the breaches.

The only breach scenarios that did not include the overbank flows were R_14055_WHS (no flow flanks around the dryland levee when the dryland levee is breached) and L_6230_FCS (was not modeled in FLO-2D).

FLO-2D simulations were set to run for a duration of 1,000-hours (41.6 days) which is approximately 30 days beyond the peak of the breach hydrographs. The output interval for all model runs was set at 1-hour.

7.2. Post-Processing of FLO-2D Model Runs

Raw FLO-2D results were inspected for reasonableness. Two main post-processing activities were included during the development of final floodplain maps:

(a) **Investigation of breach flows that cross over river channels:** In some cases, raw FLO-2D results showed breach waters crossing over river channels and inundating areas on the other side. In these cases the magnitude of the flow crossing the channel was evaluated and, if it was less than the channel's available capacity, floodplains on the other side of the river channel were not shown on final maps.

(b) **Accounting for a relief cut scenario:** For RD 17, a relief cut in the levee along French Camp Slough is a planned scenario during flood events where RD17 is inundated. The relief cut would likely be made to the floodplain elevation, but for the purposes of floodplain mapping, FEMA and ULDC only allow the floodplain elevations to be reduced to the lowest top of levee elevation. In the case of the north levee along RD 17, the lowest top of levee elevation is approximately 19.3-feet NAVD88 (Figure 35).

Figure 35. Low points along RD17's north levee.

For breach scenarios R_83009_SJR, R_91157_SJR, and R_98507_SJR, floodwaters that accumulated behind the RD 17 north levee reached elevations greater than 19.3-feet NAVD88. To reduce floodwater elevations to 19.3-feet NAVD88, a "relief cut" was modeled in FLO-2D by removing a piece of the levee embankment in grid cell 248. The width reduction factor (WRF) for the same grid cell was then adjusted and the breach scenario was re-run. The adjustment of the WRF was an iterative process aimed to result in approximately a 19.3-feet NAVD88 ponding elevation behind the RD 17 north levee.

Table 6 summarizes the initial and final ponding elevation for each of the stated breach scenarios.

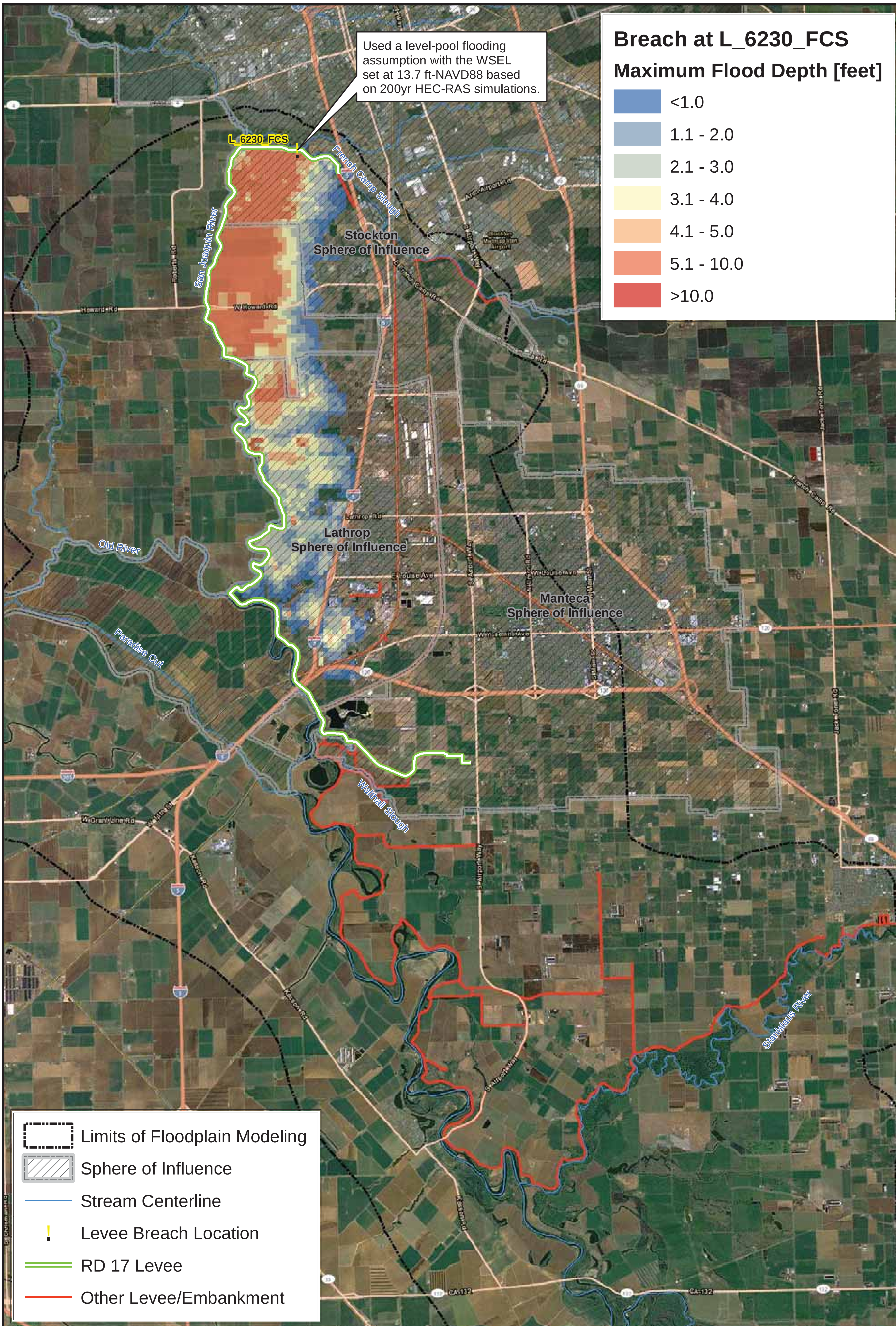
Table 6. Summary of "Relief Cut" modeling.

Breach Scenario	Floodplain Elevation Behind the RD 17 North Levee without Relief Cut	Floodplain Elevation Behind the RD 17 North Levee with Relief Cut
	[ft-NAVD88]	[ft-NAVD88]
R_83009_SJR	20.8	19.3
R_91157_SJR	20.7	19.4
R_98507_SJR	19.9	19.4

All other breach scenarios had ponding behind the RD 17 north levee that was less than 19.3-feet NAVD88 and therefore did not need to be adjusted.

7.3. Floodplain Mapping Results for Individual Breach Scenarios

Each breach scenario was modeled individually. The following figures illustrate the final, post-processed floodplains for each scenario. Overbank flooding from French Camp Slough was not composited into these scenarios.



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Fax: (916) 608-2232

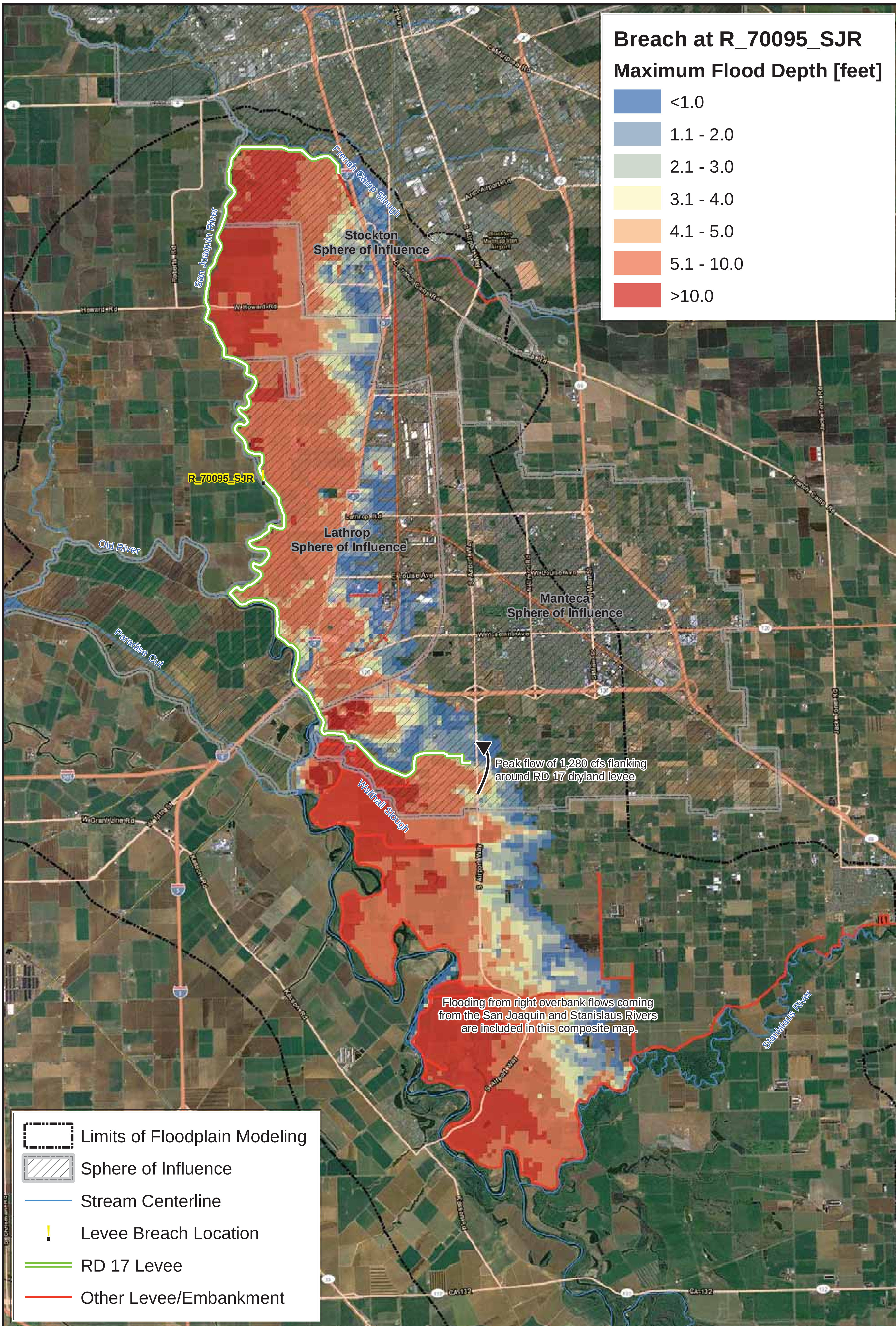
0 1.5 Miles
1 inch = 1.5 miles

APRIL 21, 2014

CITIES OF LATHROP & MANTECA - 200-YEAR PLAN

200-YEAR FLOODPLAIN MAP FOR A BREACH SCENARIO AT L_6230_FCS

FIGURE 36



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0 1.5 Miles
1 inch = 1.5 miles

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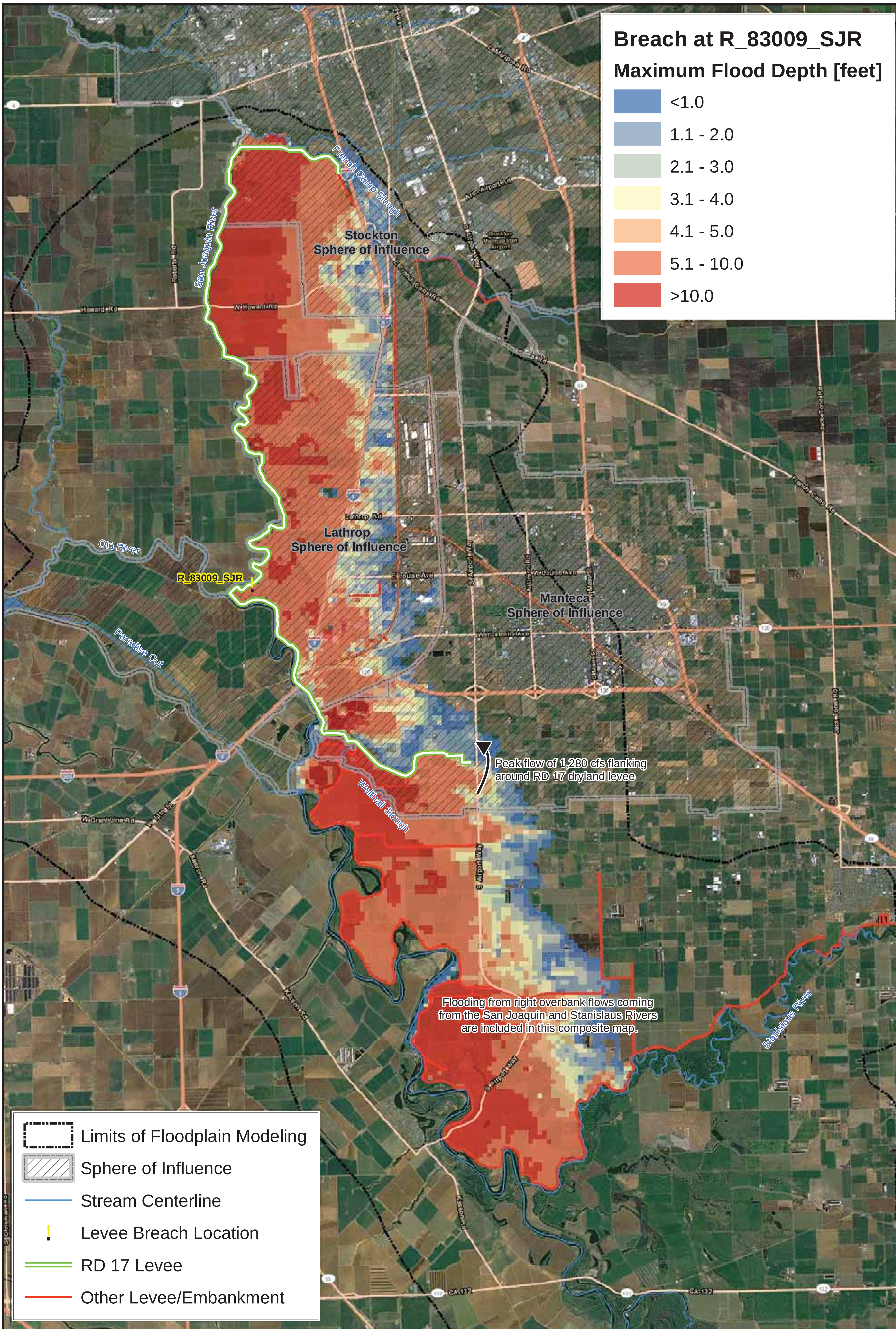
CITIES OF LATHROP & MANTECA - 200-YEAR PLAN

200-YEAR FLOODPLAIN MAP FOR A BREACH SCENARIO AT R_70095_SJR

FIGURE 37



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0 1.5 Miles

1 inch = 1.5 miles

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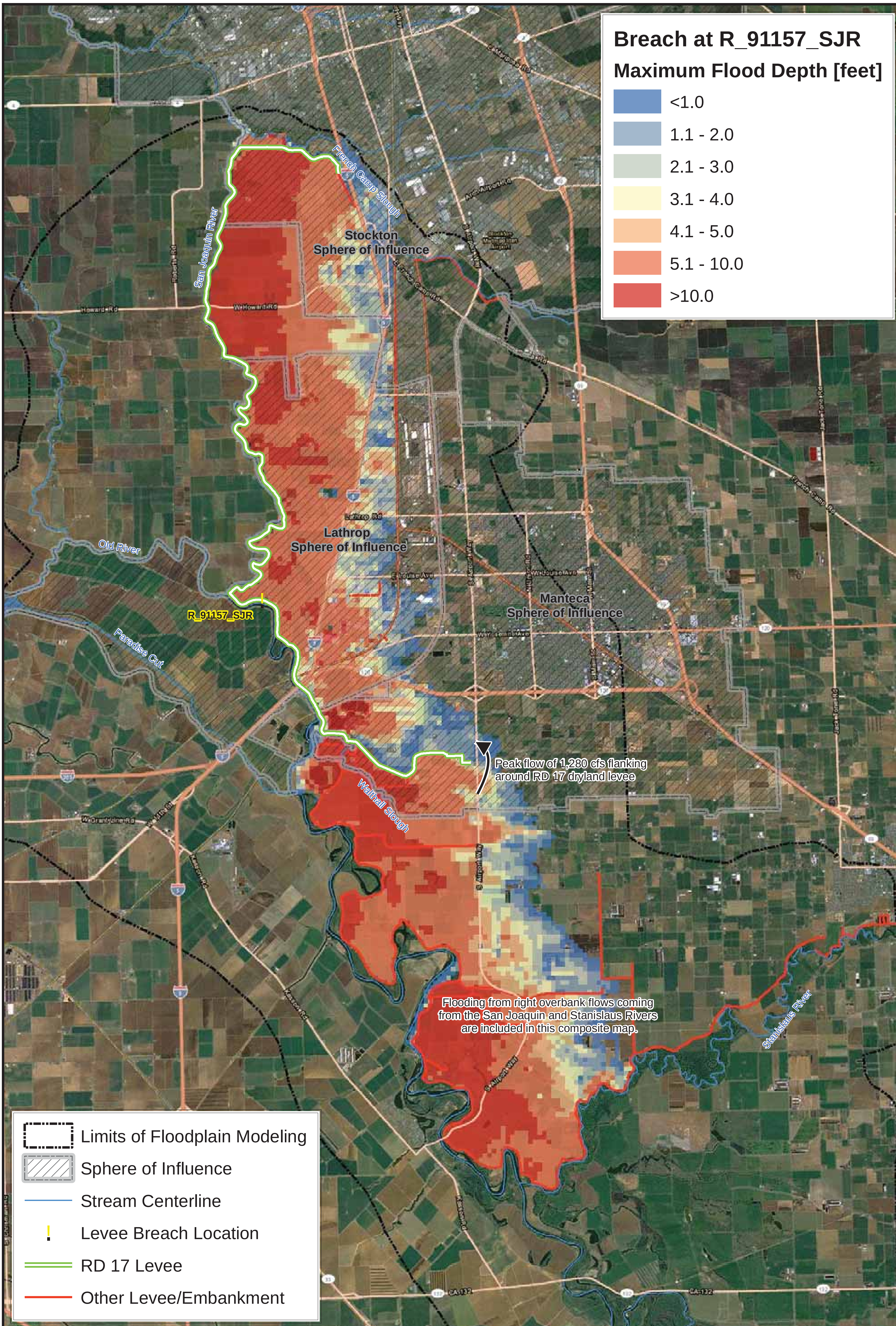
CITIES OF LATHROP & MANTECA - 200-YEAR PLAN

200-YEAR FLOODPLAIN MAP FOR A BREACH SCENARIO AT R_83009_SJR

FIGURE 38



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0 1.5 Miles
1 inch = 1.5 miles

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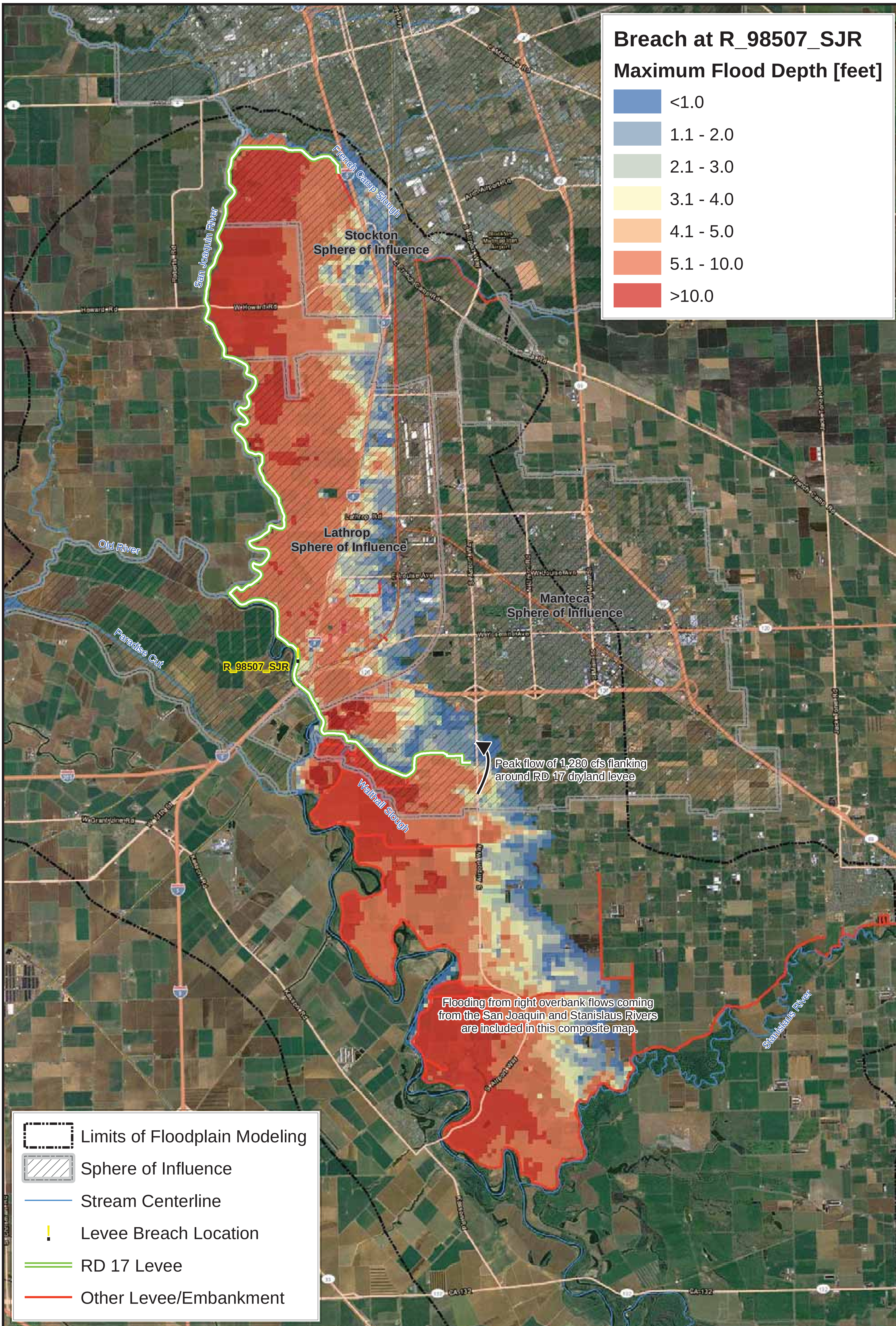
CITIES OF LATHROP & MANTECA - 200-YEAR PLAN

200-YEAR FLOODPLAIN MAP FOR A BREACH SCENARIO AT R_91157_SJR

FIGURE 39



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0 1.5 Miles
1 inch = 1.5 miles

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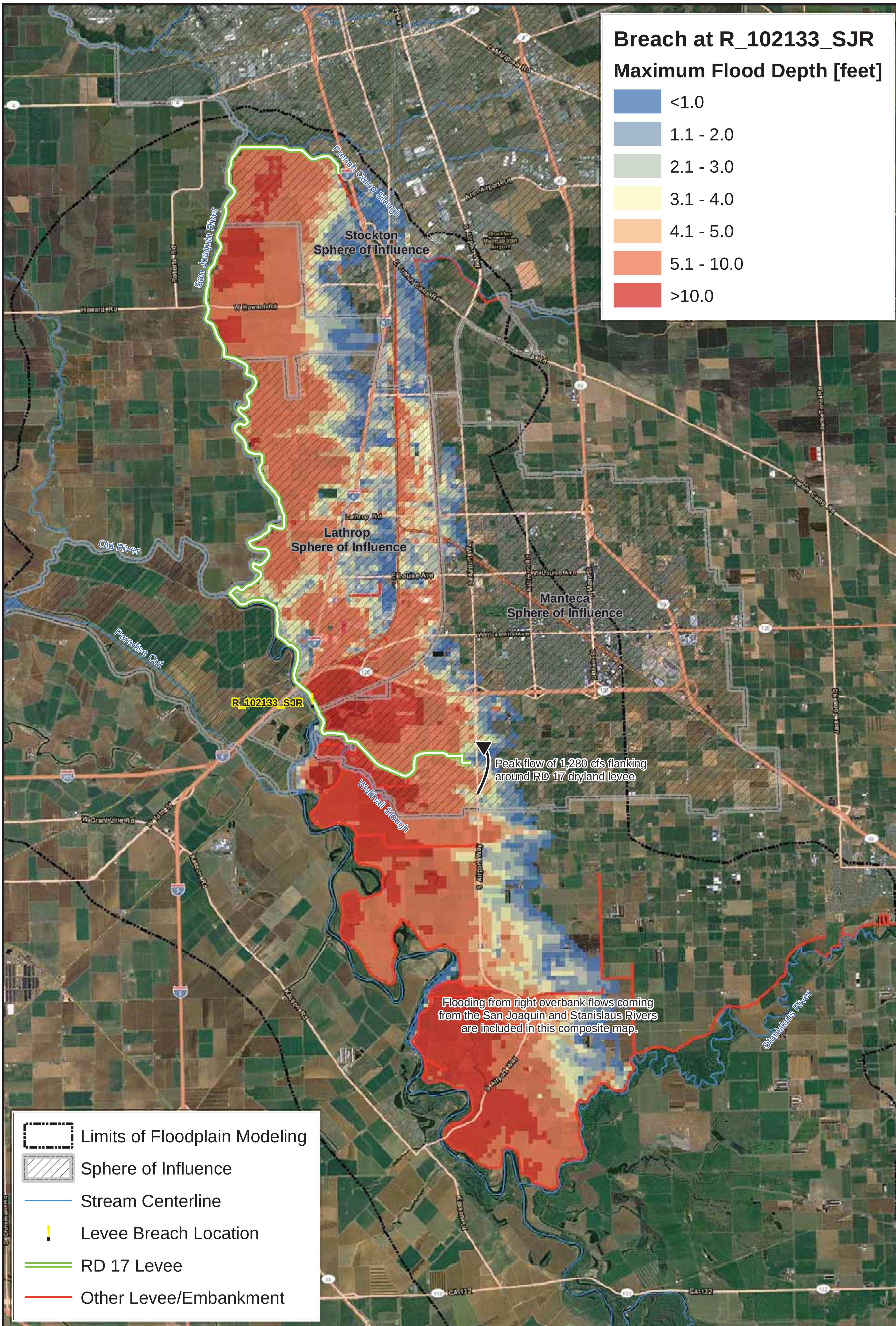
CITIES OF LATHROP & MANTECA - 200-YEAR PLAN

200-YEAR FLOODPLAIN MAP FOR A BREACH SCENARIO AT R_98507_SJR

FIGURE 40



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0 1.5 Miles
1 inch = 1.5 miles

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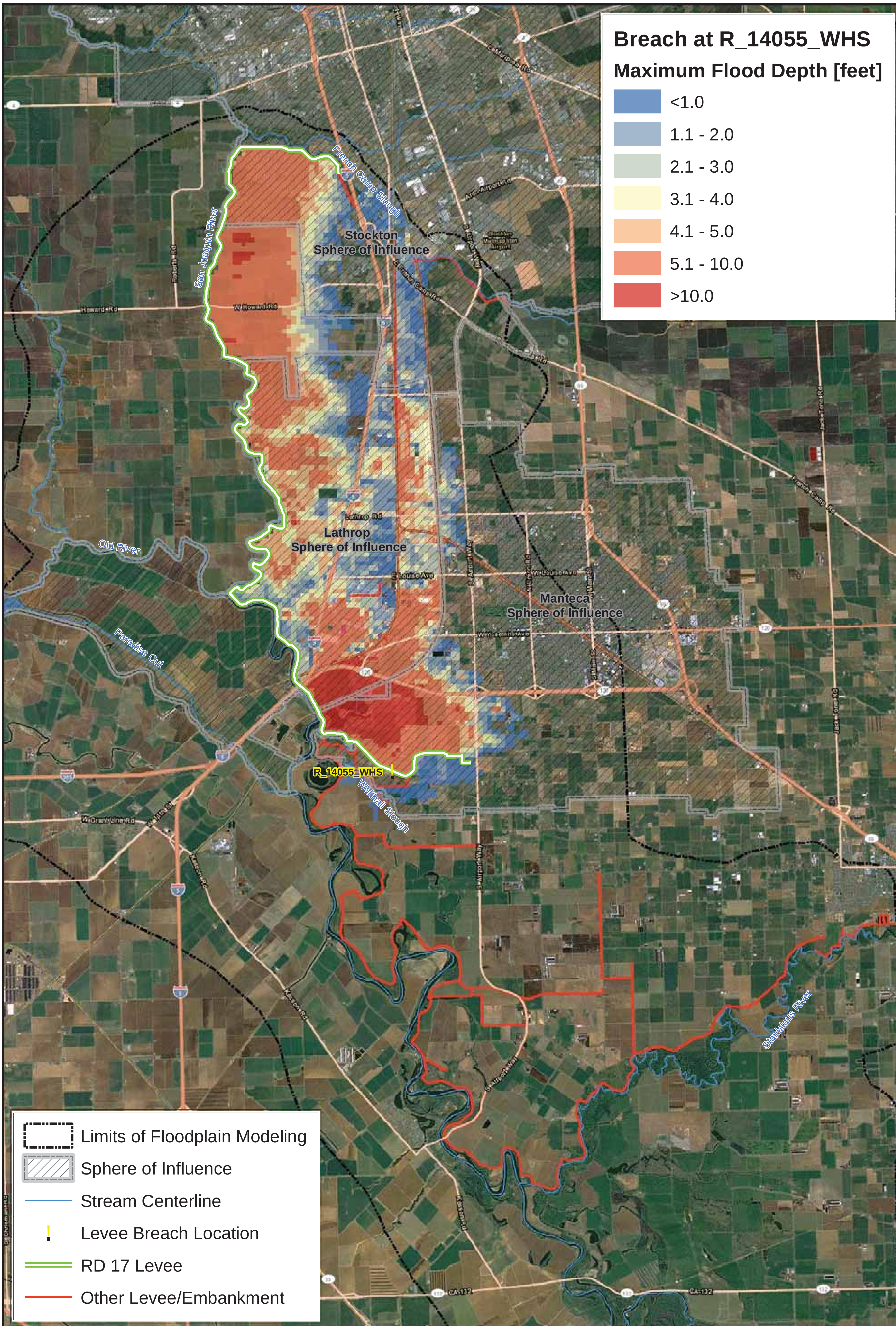
CITIES OF LATHROP & MANTECA - 200-YEAR PLAN

200-YEAR FLOODPLAIN MAP FOR A BREACH SCENARIO AT R_102133_SJR

FIGURE 41



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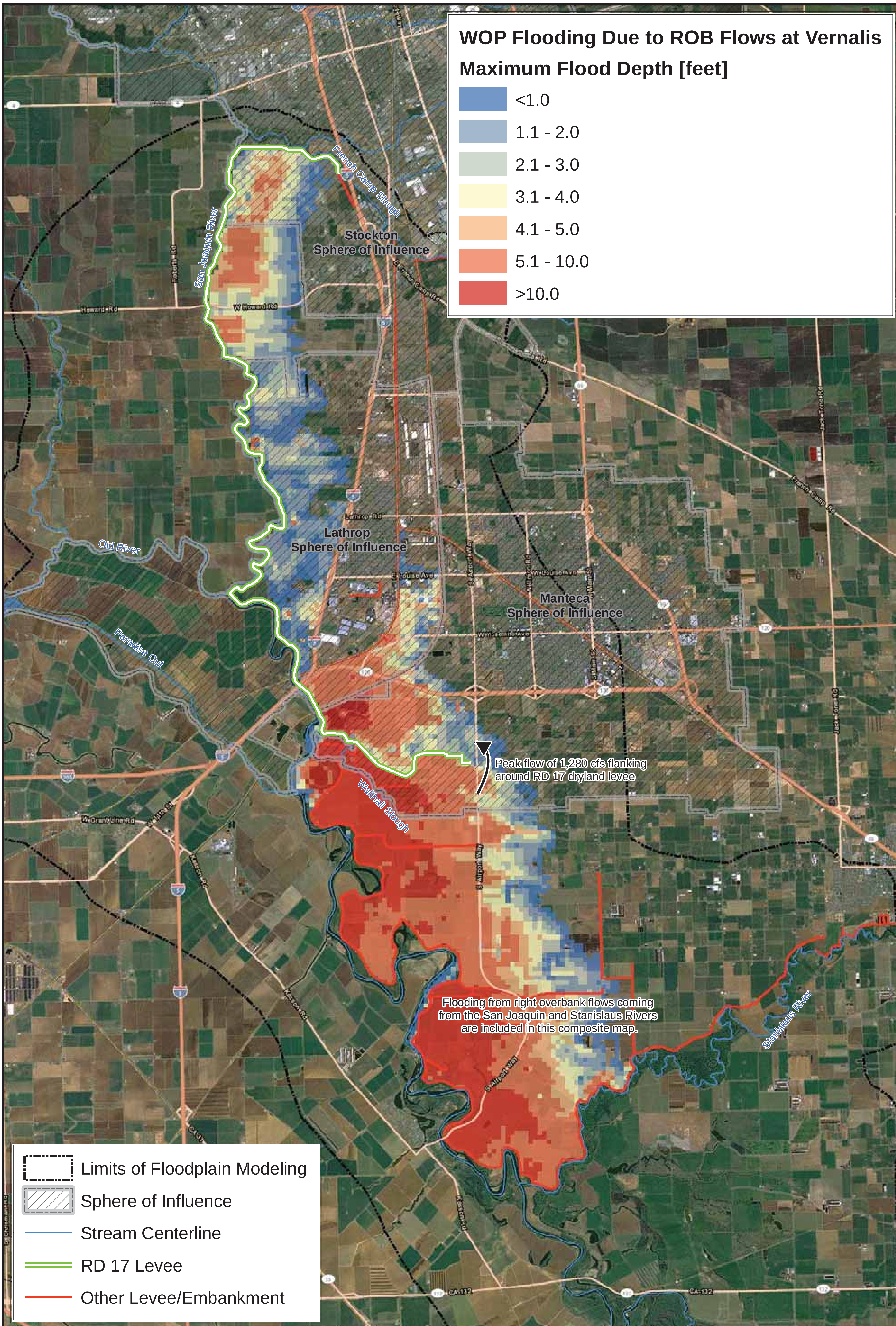
CITIES OF LATHROP & MANTECA - 200-YEAR PLAN

200-YEAR FLOODPLAIN MAP FOR A BREACH SCENARIO AT R_14055_WHS

FIGURE 42



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0 1.5 Miles
1 inch = 1.5 miles

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CITIES OF LATHROP & MANTECA - 200-YEAR PLAN

FLOODPLAIN MAP FOR RIGHT OVERBANK FLOWS COMING FROM THE SAN JOAQUIN & STANISLAUS RIVERS

FIGURE 43

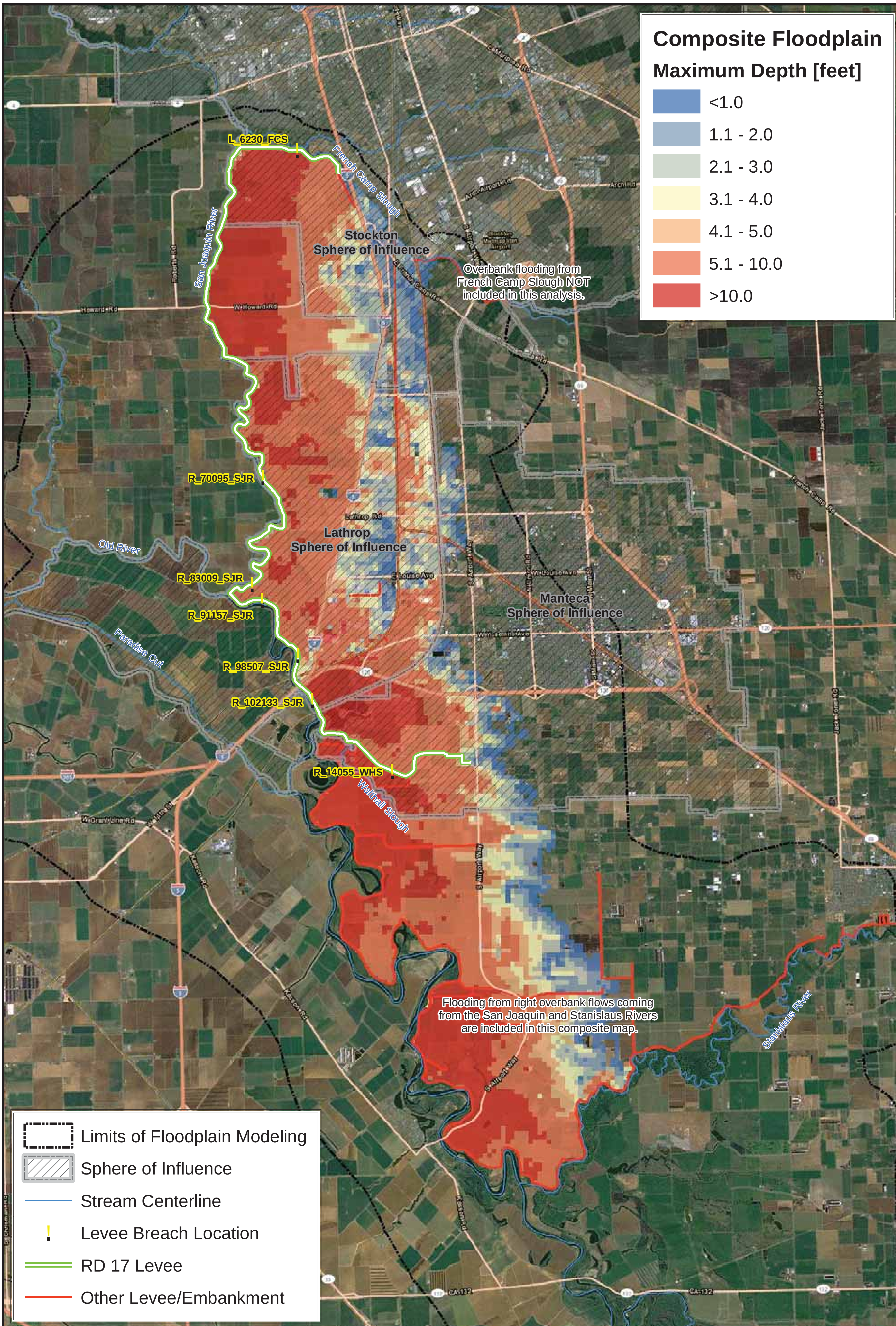
7.4. Composite Floodplain Mapping Results

The seven (7) breach scenarios and one (1) overbank flooding scenario were "combined" to form a composite floodplain. With each FLO-2D grid cell representing a 400-foot by 400-foot area, the worst case flood depth from the scenarios was selected for each grid cell to come up with a composite floodplain map. Results are shown in figures on the following pages.

Figure 44 shows the composite floodplain in terms of flood depths. Figure 45 shows the composite floodplain in terms of water surface elevation (NAVD88-feet). Figure 46 splits the composite floodplain into areas that are inundated to either greater than or less than 3-feet. This distinction is important as, per ULOP, it is the threshold flood depth requiring a ULOP finding.

Note that this composite floodplain does not include a scenario of 200-year flooding in French Camp Slough. The reason for this being that French Camp Slough flooding would not impact Lathrop and Manteca, the sponsors of this study. Stockton and San Joaquin County are cautioned that the additional analysis for French Camp Slough would be needed to refine these maps for their purposes.

The composite floodplain GIS shapefile was provided to KSN, Inc. who developed more detailed floodplain maps on a parcel-by-parcel level (Attachment 8).



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0 1.5 Miles

1 inch = 1.5 miles

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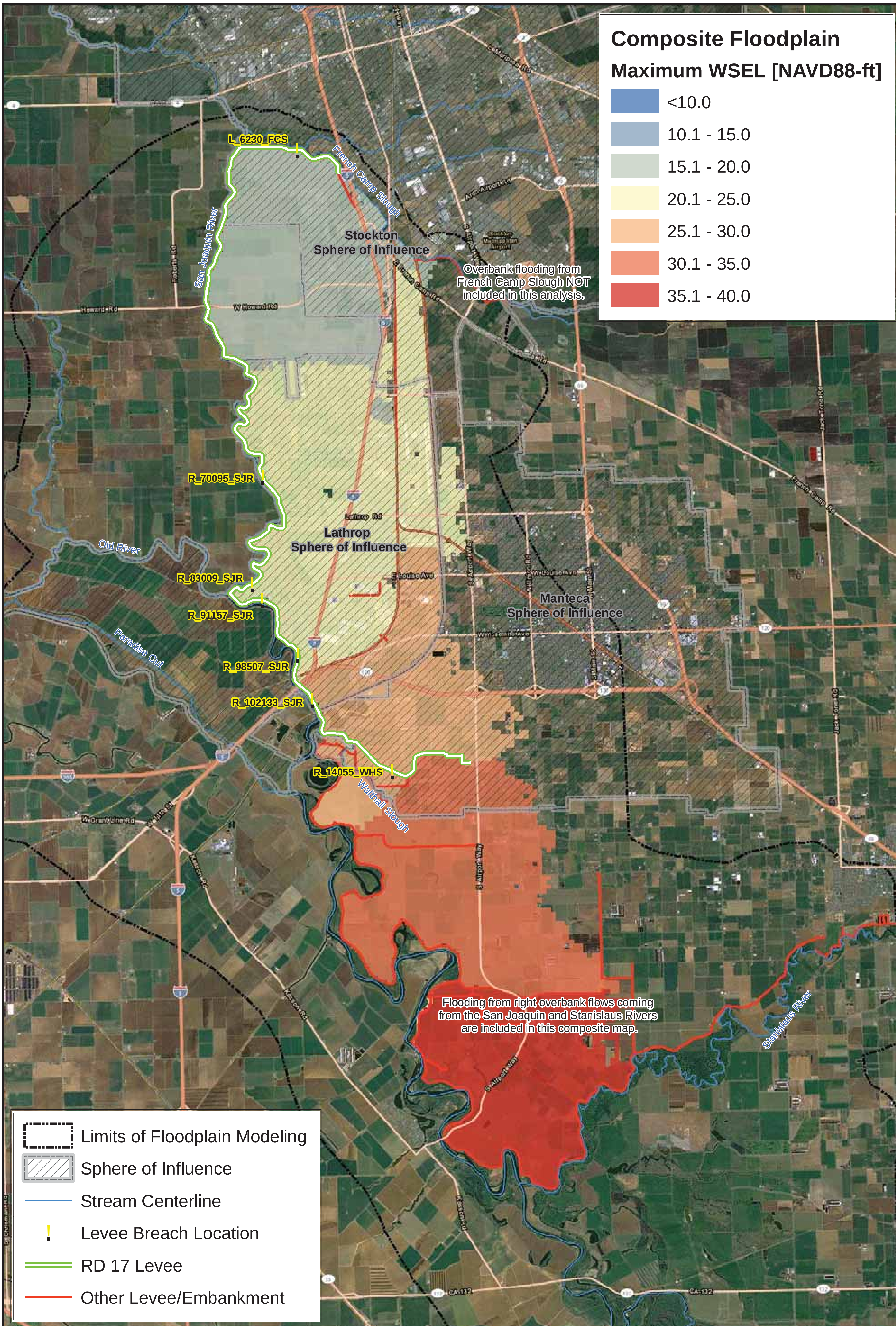
CITIES OF LATHROP & MANTECA - 200-YEAR PLAN

200-YEAR COMPOSITE FLOODPLAIN MAP
-FLOOD DEPTHS-

FIGURE
44



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0 1.5 Miles

1 inch = 1.5 miles

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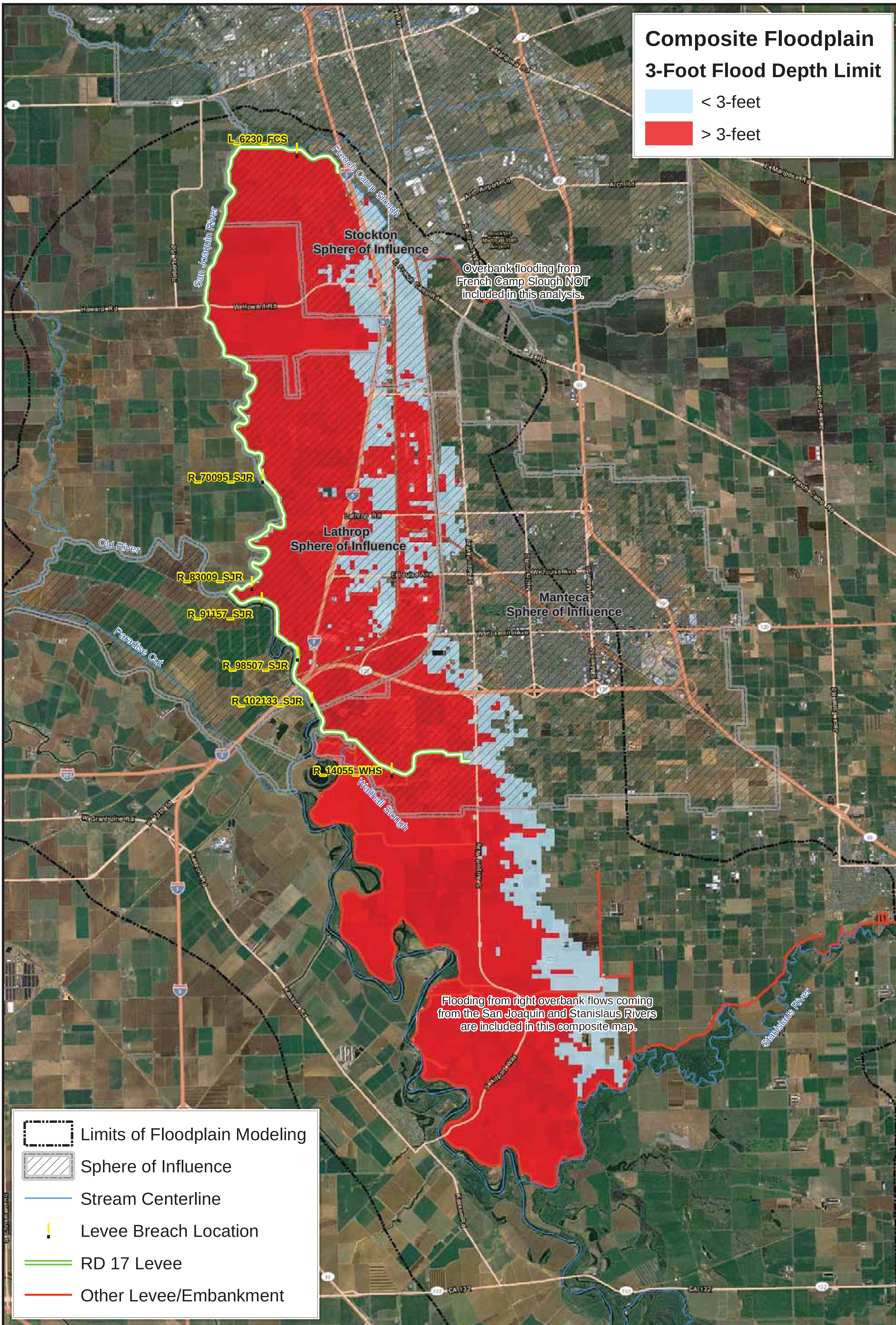
CITIES OF LATHROP & MANTECA - 200-YEAR PLAN

200-YEAR COMPOSITE FLOODPLAIN MAP
-WATER SURFACE ELEVATIONS-

FIGURE

45



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0 1.5 Miles

1 inch = 1.5 miles

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CITIES OF LATHROP & MANTECA - 200-YEAR PLAN

200-YEAR COMPOSITE FLOODPLAIN MAP
-BOUNDARY OF 3-FOOT FLOOD DEPTHS-

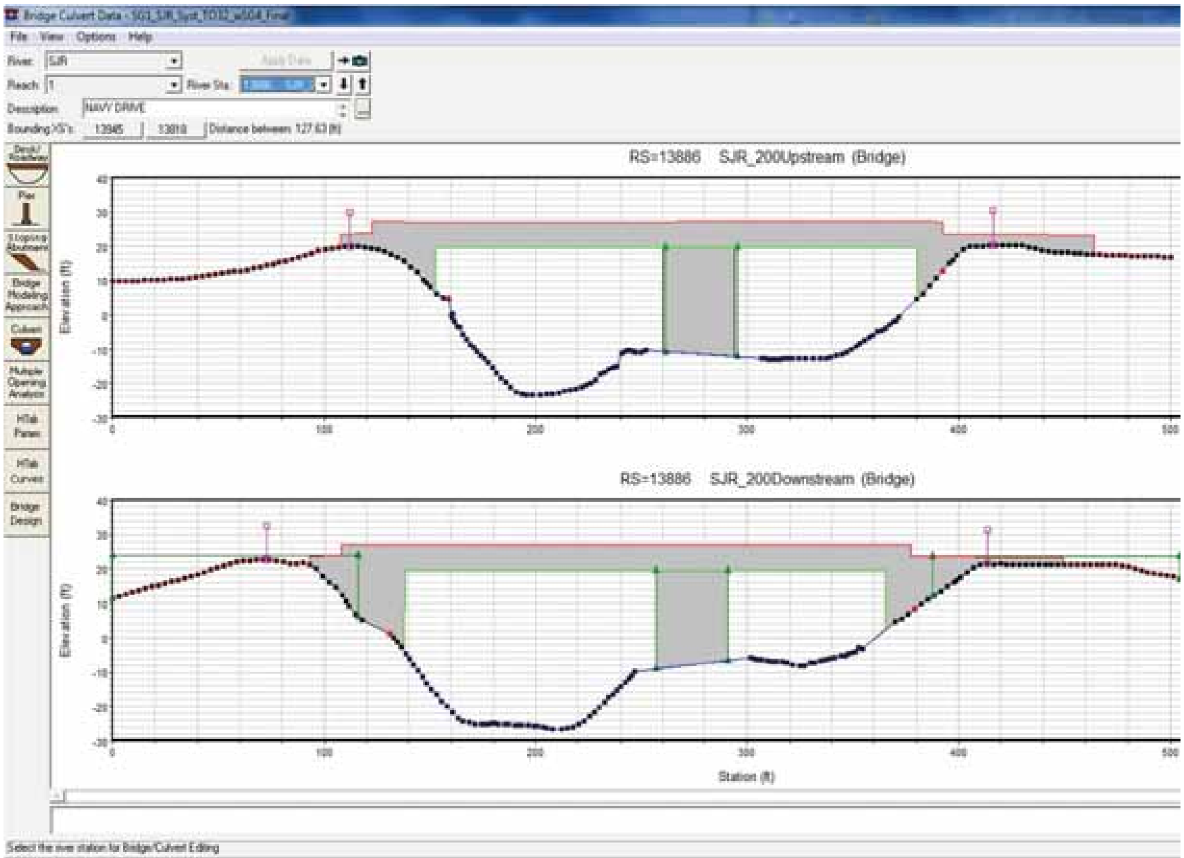
FIGURE
46

Attachment 1

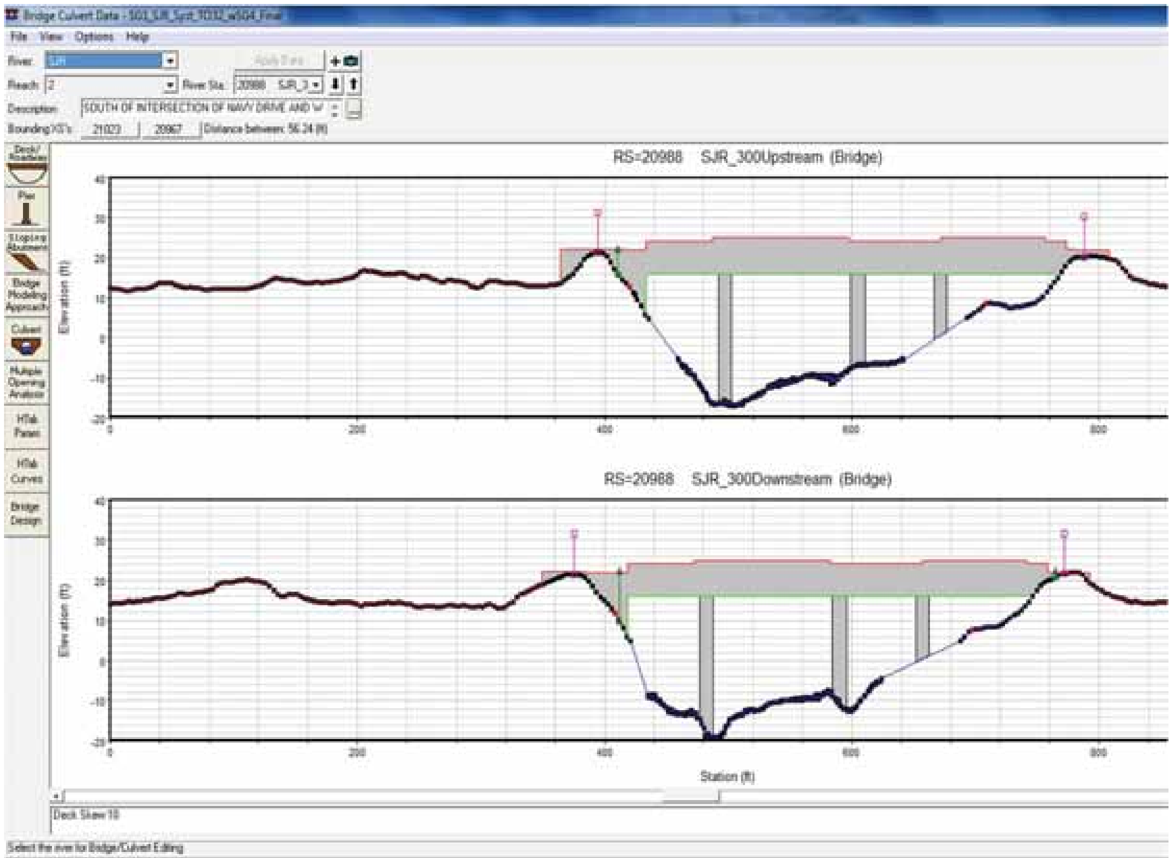
QC OF HEC-RAS BRIDGE GEOMETRY

Crossing:	Spur Line RR
STA:	SJR-1-13289
Notes:	Consistent with bridge photo and Comp Study coding.

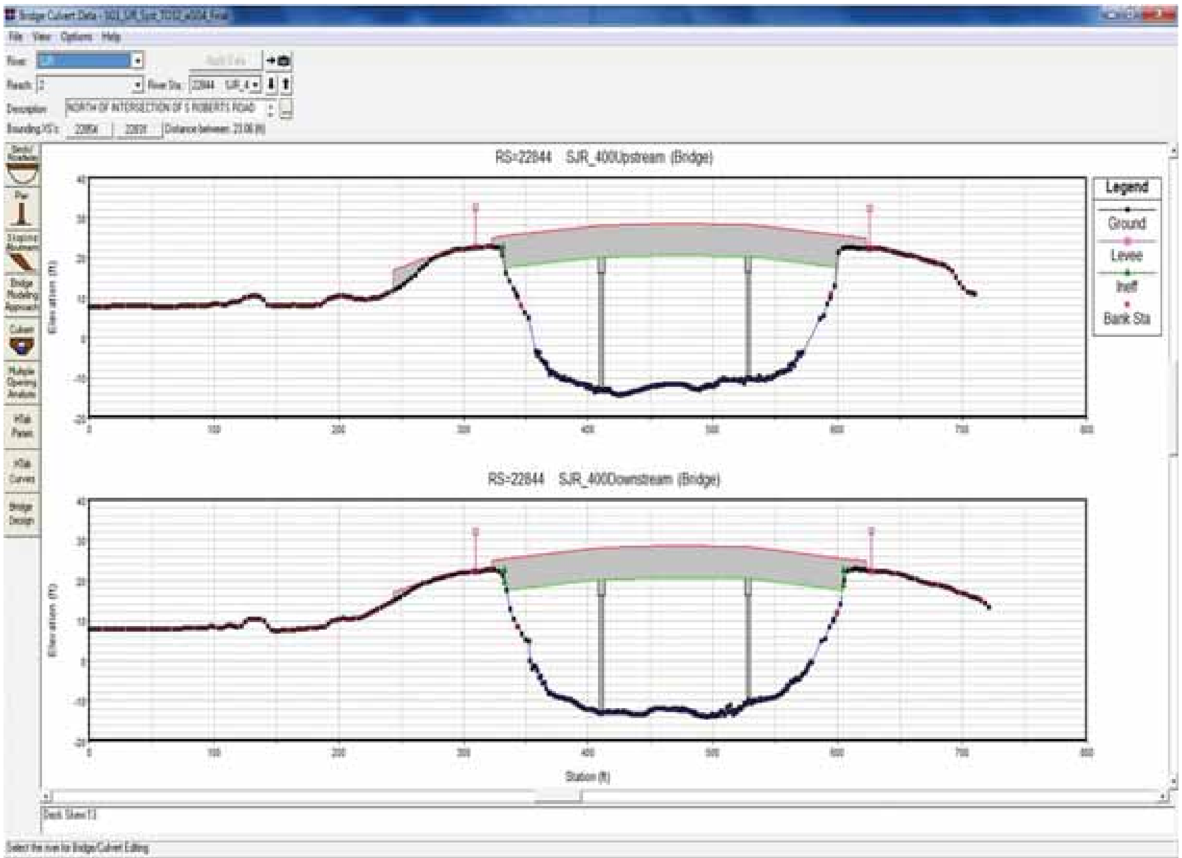
Crossing:	Navy Dr.
STA:	SJR-1-13886
Notes:	Consistent with bridge photo and Comp Study coding.



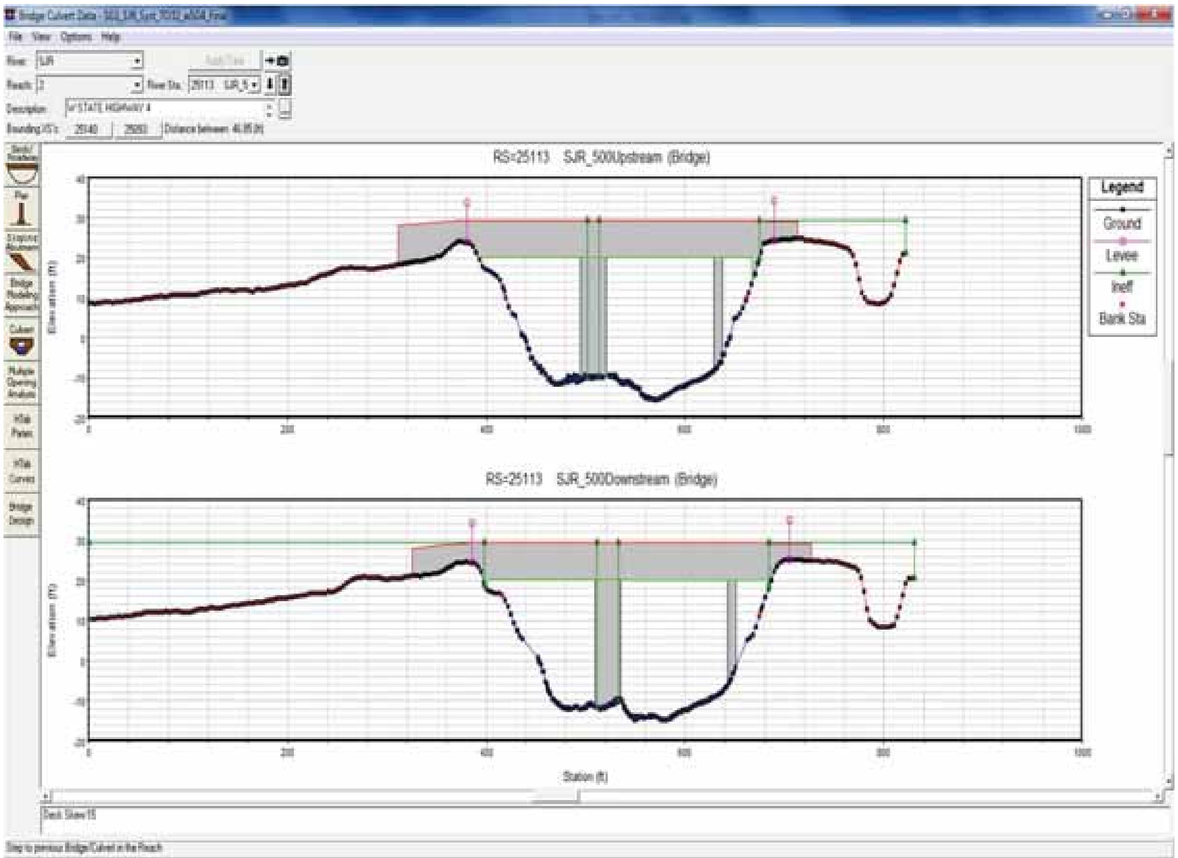
Crossing:	BN&SFRR
STA:	SJR-2-20988
Notes:	Consistent with bridge photo and Comp Study coding.



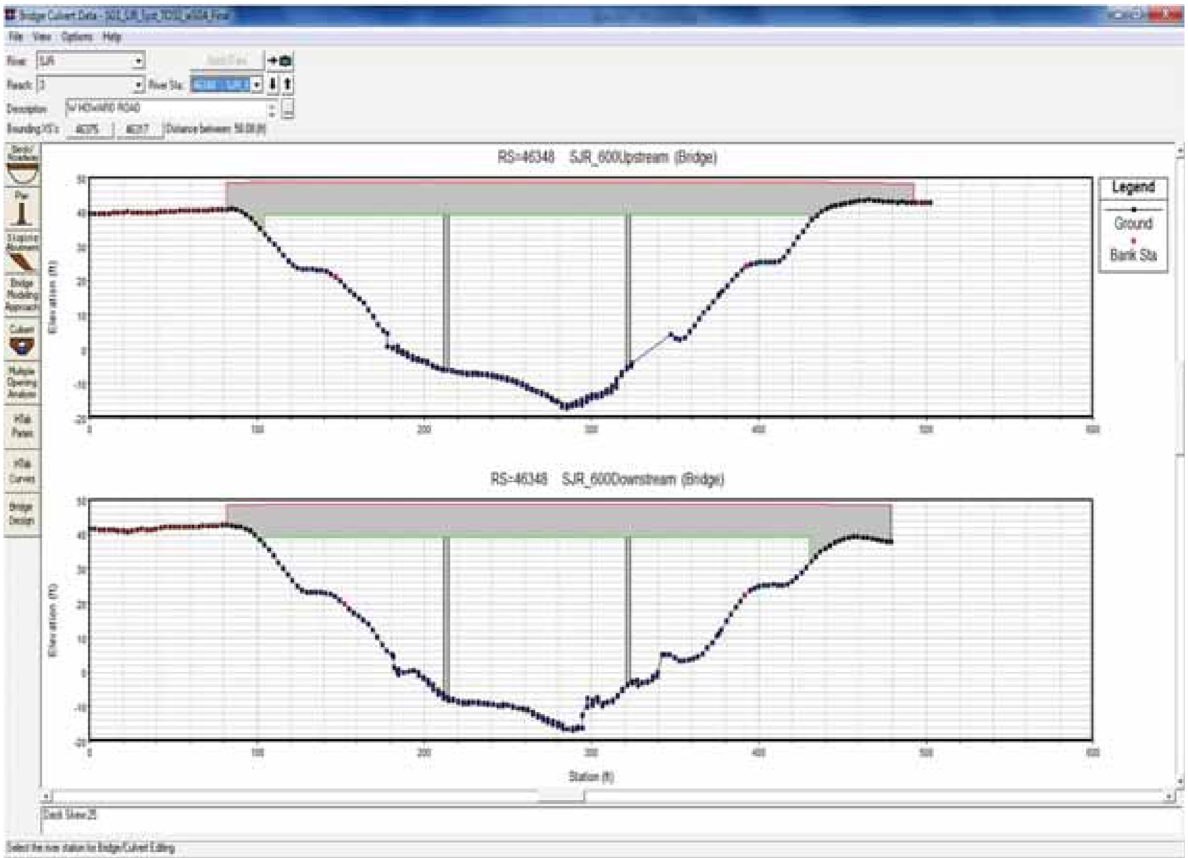
Crossing:	Bridge to WWTP
STA:	SJR-2-22844
Notes:	Consistent with bridge photo.



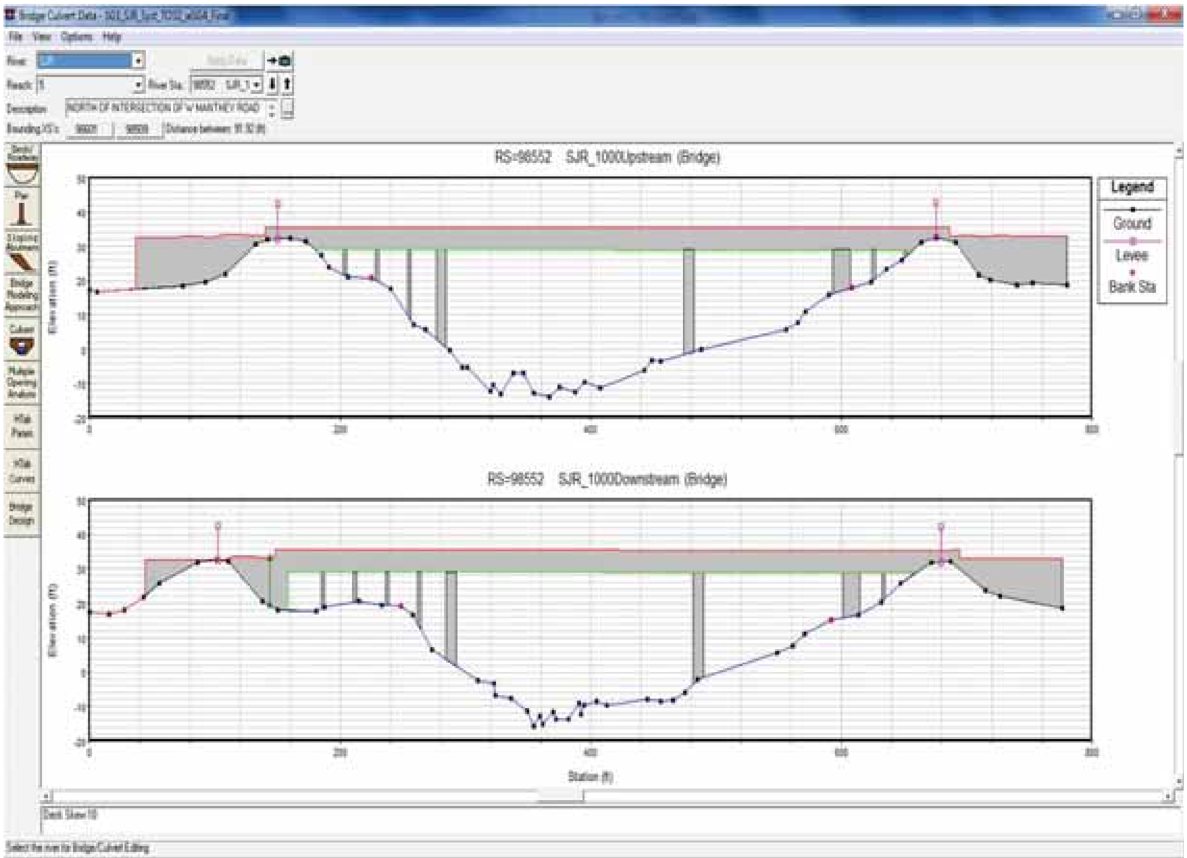
Crossing:	Highway 4
STA:	SJR-2-25113
Notes:	Consistent with bridge photo and Comp Study coding.



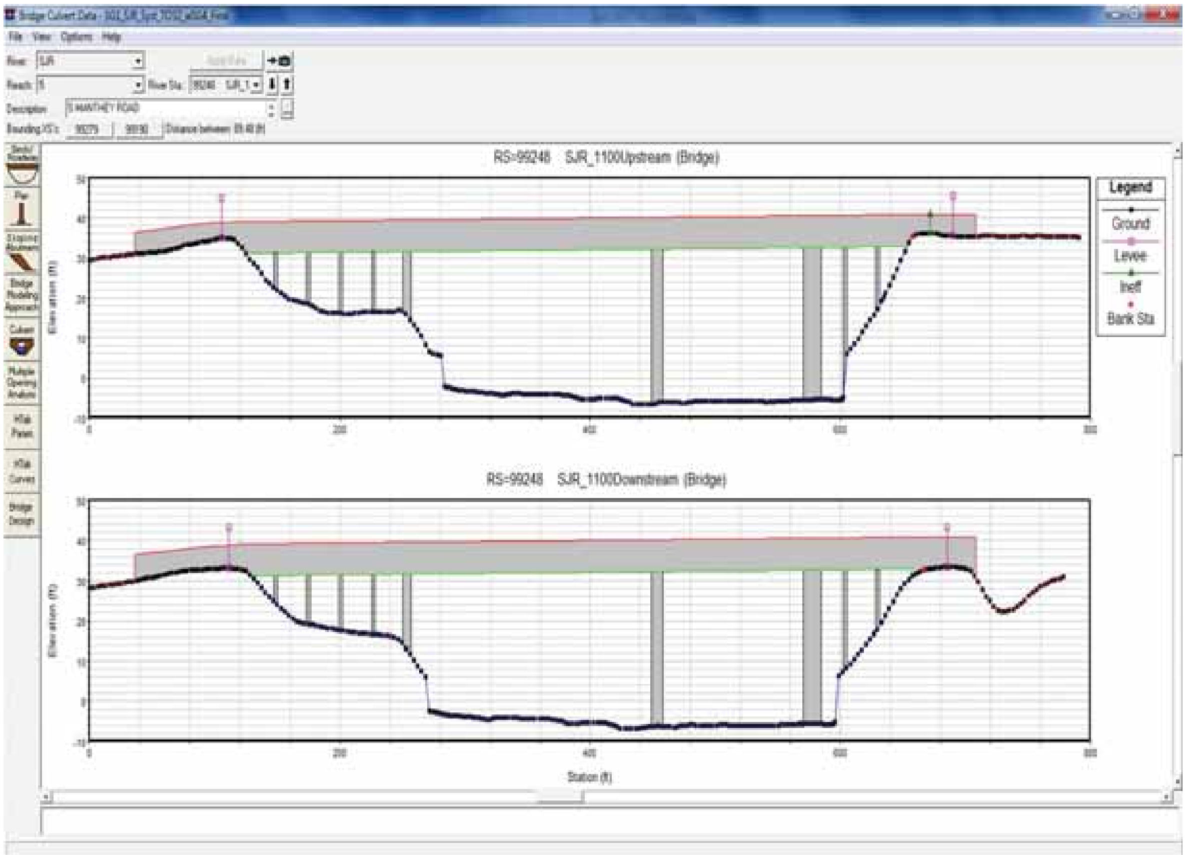
Crossing:	Howard Rd.
STA:	SJR-3-46348
Notes:	Consistent with bridge photo and Comp Study coding.



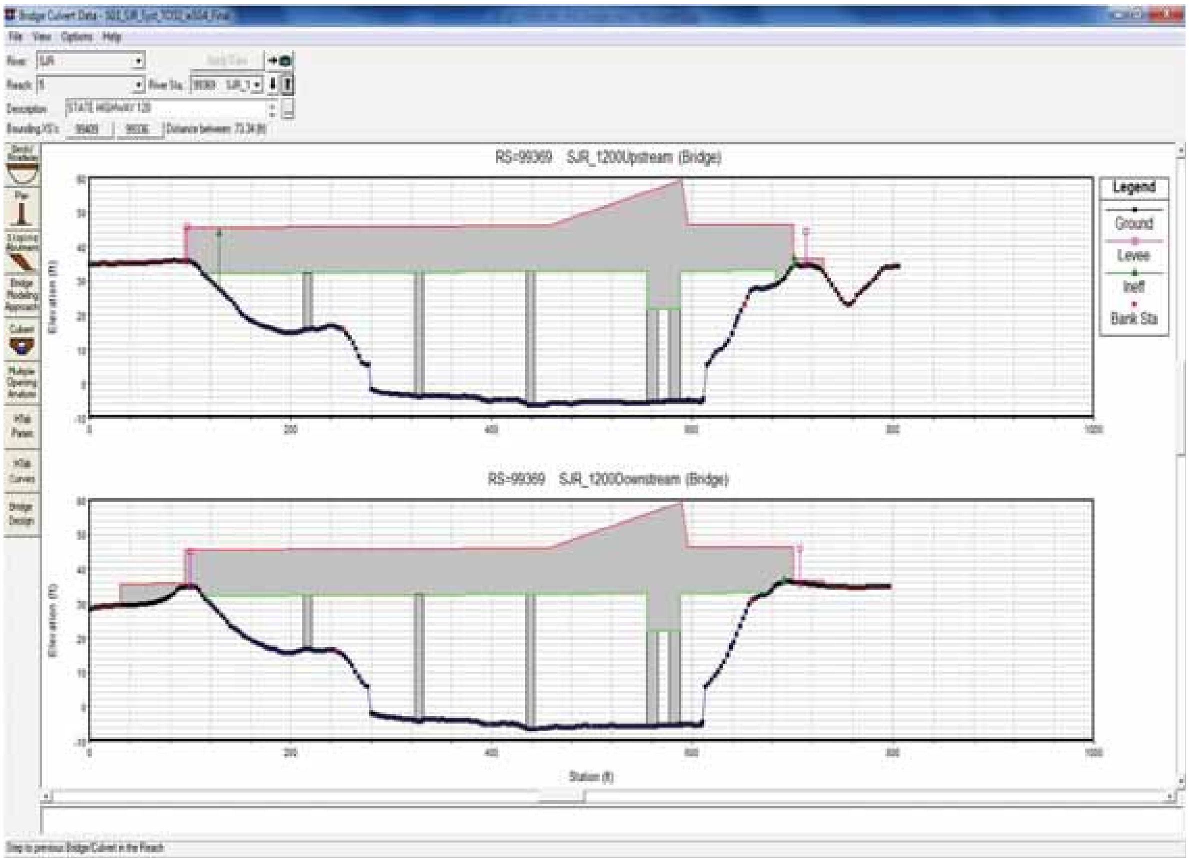
Crossing:	Mossdale RR Crossing
STA:	SJR-5-98552
Notes:	Consistent with bridge photo and Comp Study coding.



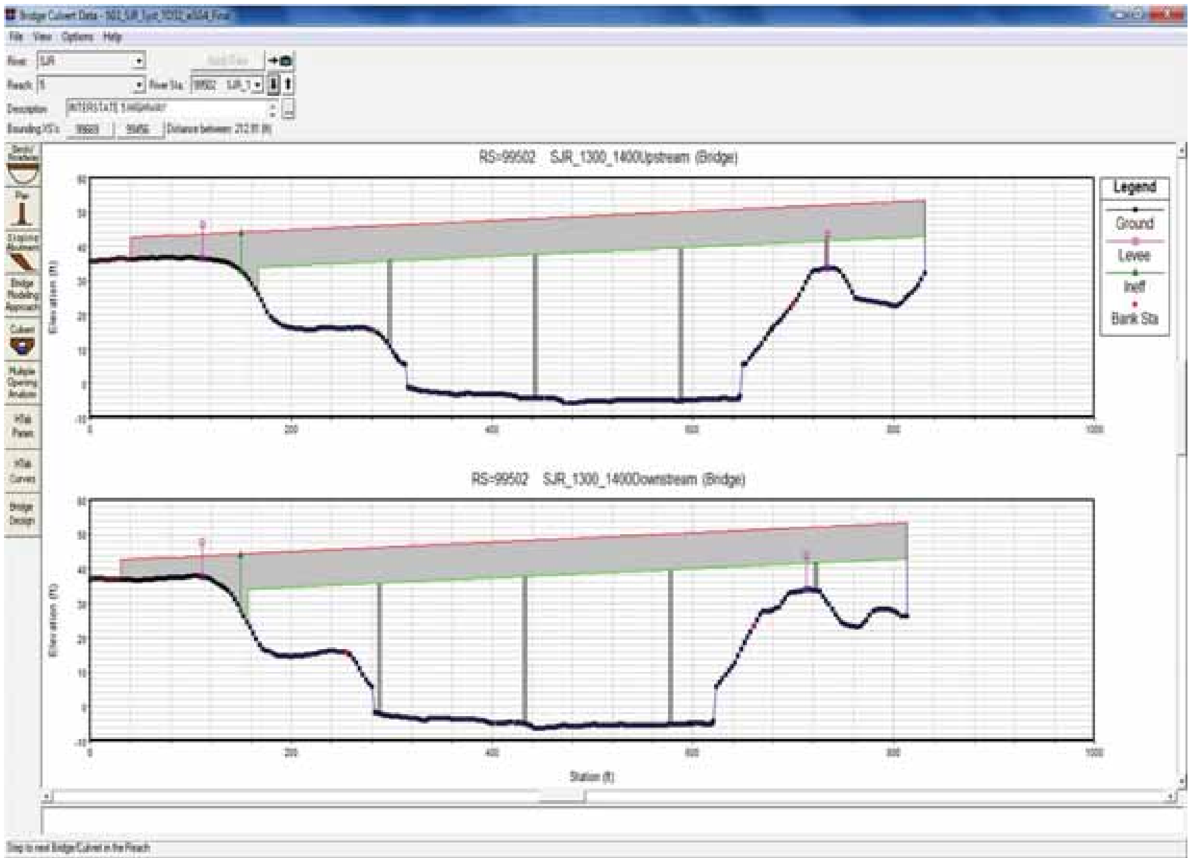
Crossing:	Manthey Rd.
STA:	SJR-5-99248
Notes:	Consistent with bridge photo and Comp Study coding.



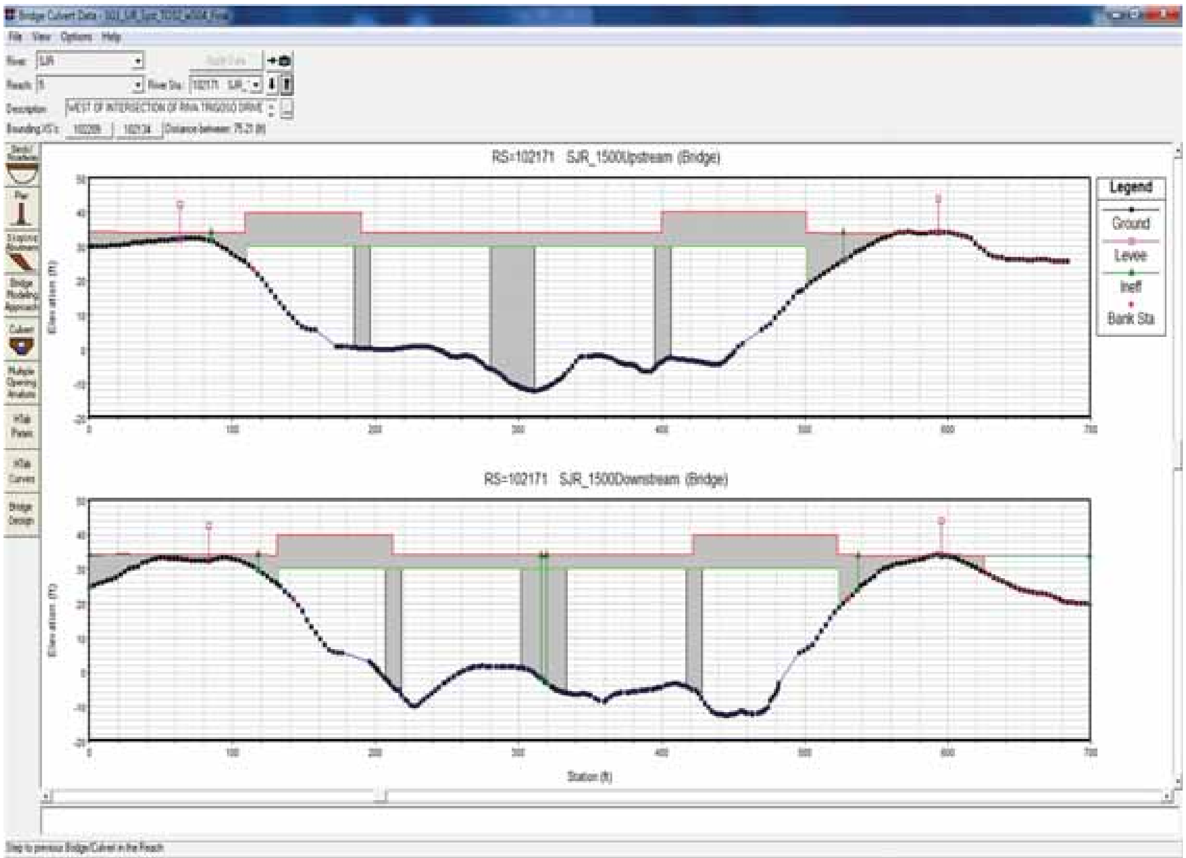
Crossing:	Hwy 120
STA:	SJR-5-99369
Notes:	CVFED piers are more substantial than Comp Study piers, but are consistent with bridge photos.



Crossing:	Interstate 5
STA:	SJR-5-99502
Notes:	Two parallel bridge decks modeled as one. Pier widths inconsistent with Comp Study model. CVFED pier widths set at 3-feet, Comp Study pier widths set at 8-feet. 3-foot pier widths are more reasonable based on Google Earth photo looking from Hwy 120 bridge.



Crossing:	UPRR
STA:	SJR-5-102171
Notes:	Consistent with bridge photo and Comp Study coding.



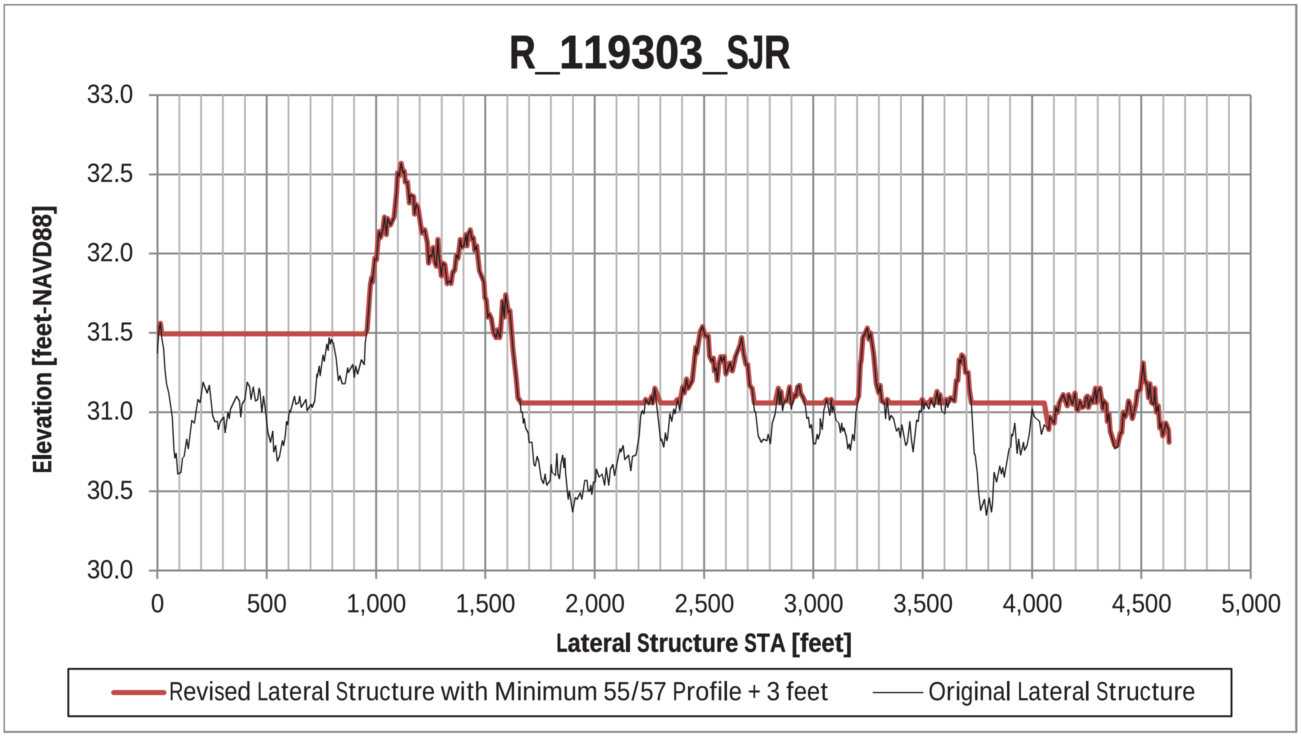
Attachment 2

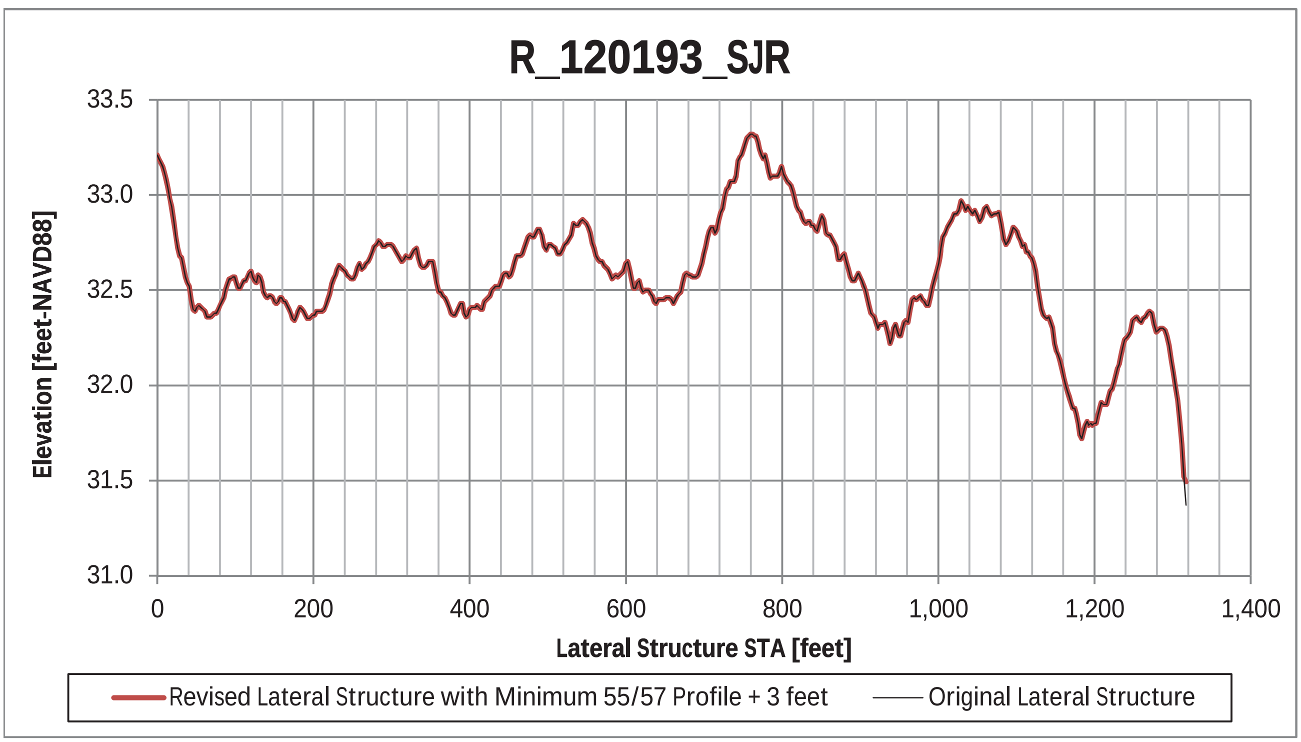
HEC-RAS Lateral Structures Updated
to Meet ULDC Top of Levee Criteria

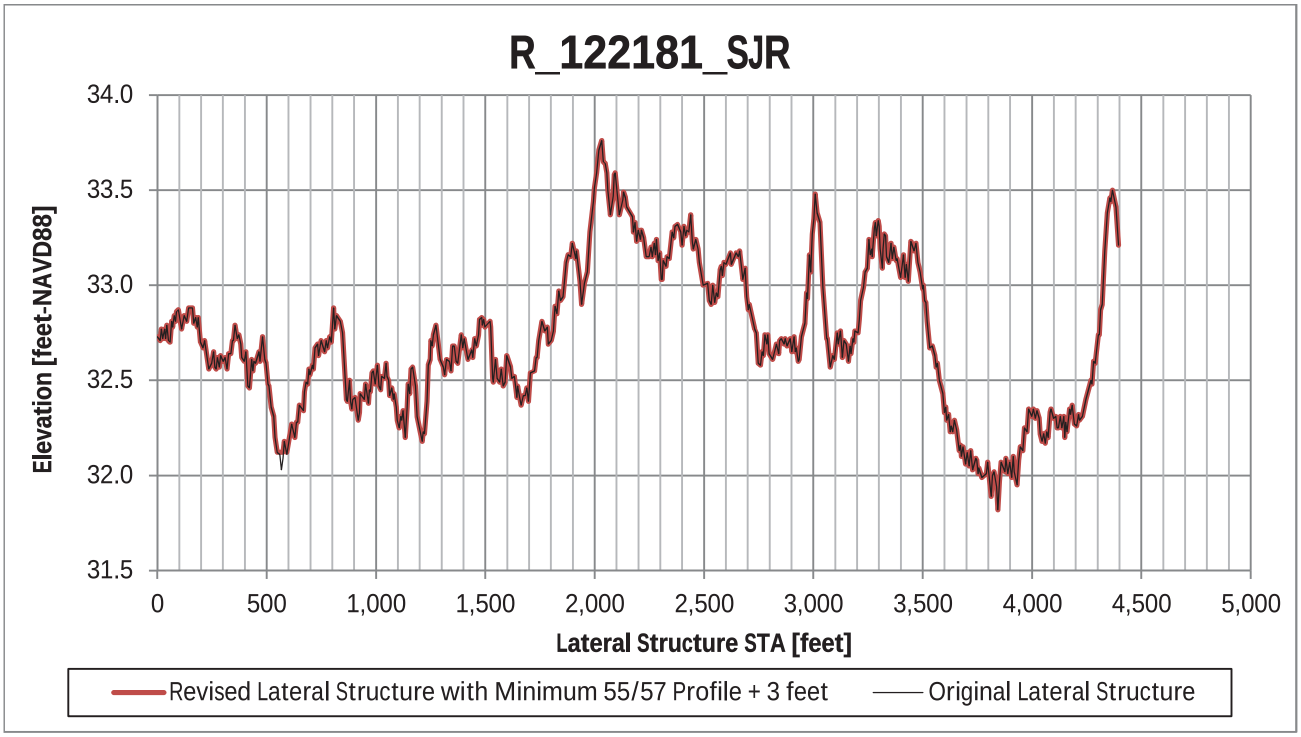
Updated Lateral Structures

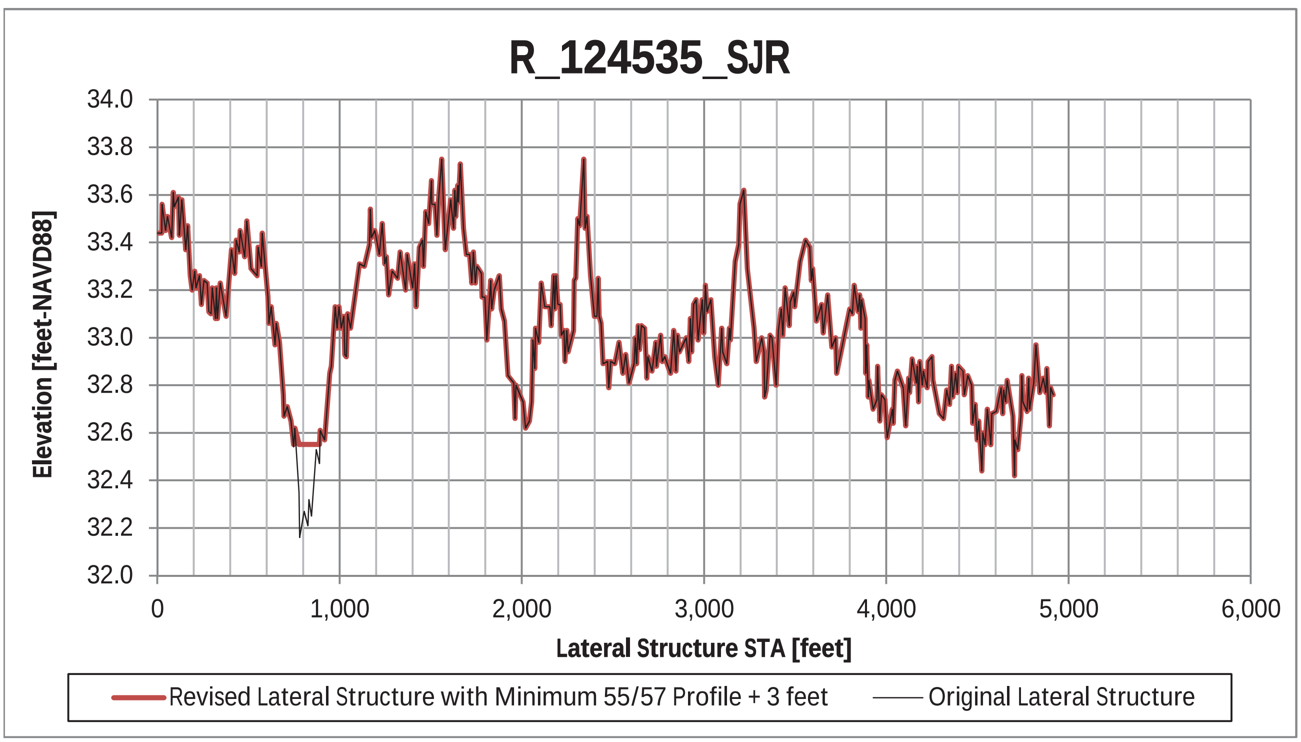
Model	River Code	Node Name	Type LS	Update
SG1_SJR_System	PSC	L_20984_PSC	Non-Urban, Project	55/57 Design WSEL +3
SG1_SJR_System	PSC	L_24112_PSC	Non-Urban, Project	55/57 Design WSEL +3
SG1_SJR_System	PSC	L_27874_PSC	Non-Urban, Project	55/57 Design WSEL +3
SG1_SJR_System	PSC	R_11875_PSC	Non-Urban, Project	55/57 Design WSEL +3
SG1_SJR_System	PSC	R_15895_PSC	Non-Urban, Project	55/57 Design WSEL +3
SG1_SJR_System	PSC	R_17867_PSC	Non-Urban, Project	55/57 Design WSEL +3
SG1_SJR_System	PSC	R_20985_PSC	Non-Urban, Project	55/57 Design WSEL +3
SG1_SJR_System	PSC	R_7525_PSC	Non-Urban, Project	55/57 Design WSEL +3
SG1_SJR_System	SJR	L_110756_SJR	Non-Urban, Project	55/57 Design WSEL +3
SG1_SJR_System	SJR	R_108291_SJR	Non-Urban, Project	55/57 Design WSEL +3
SG1_SJR_System	SJR	R_109933_SJR	Non-Urban, Project	55/57 Design WSEL +3
SG1_SJR_System	SJR	R_114725_SJR	Non-Urban, Project	55/57 Design WSEL +3

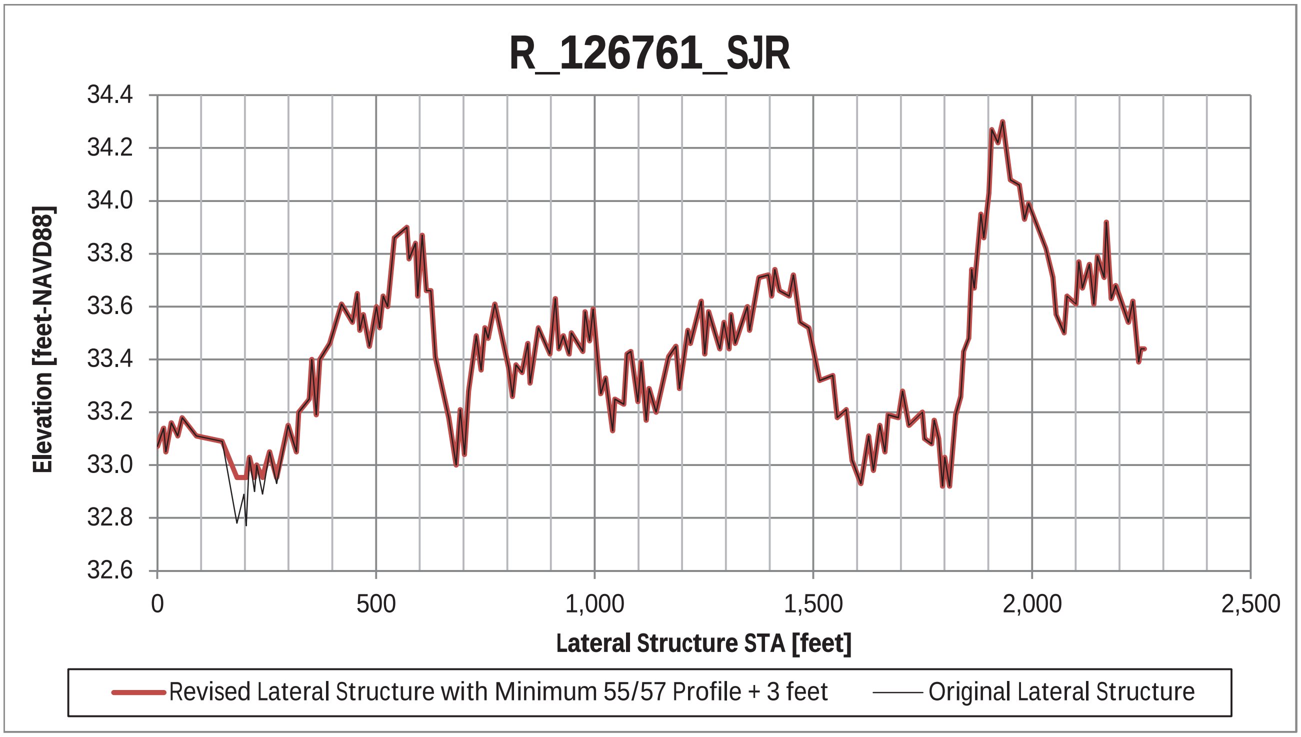
Source: CVFED TM: TO32 HEC-RAS Modeling for the Lower San Joaquin System

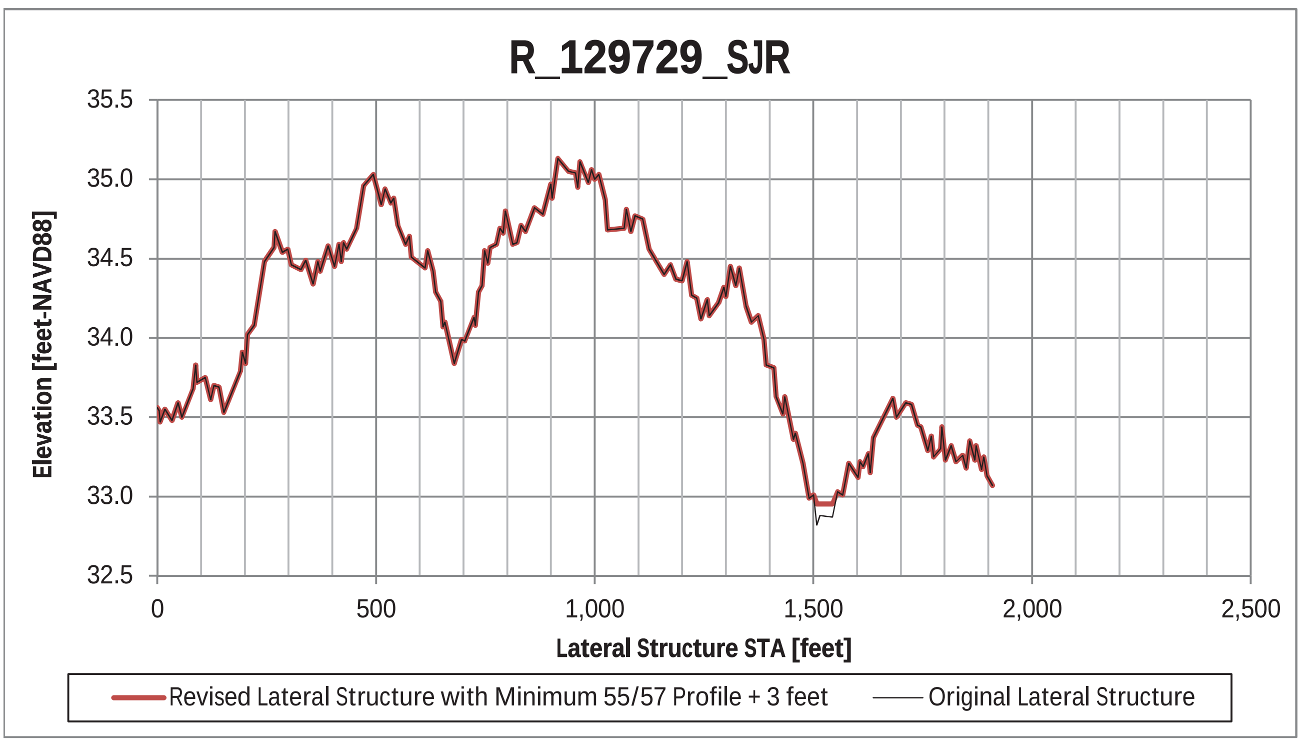

R_119303_SJR
Elevation [feet-NAVD88]
33.0
32.5
32.0
31.5
31.0
30.5
30.0
0
500
1,000
1,500
2,000
2,500
3,000
3,500
4,000
4,500
5,000
Lateral Structure STA [feet]
Revised Lateral Structure with Minimum 55/57 Profile + 3 feet
Original Lateral Structure

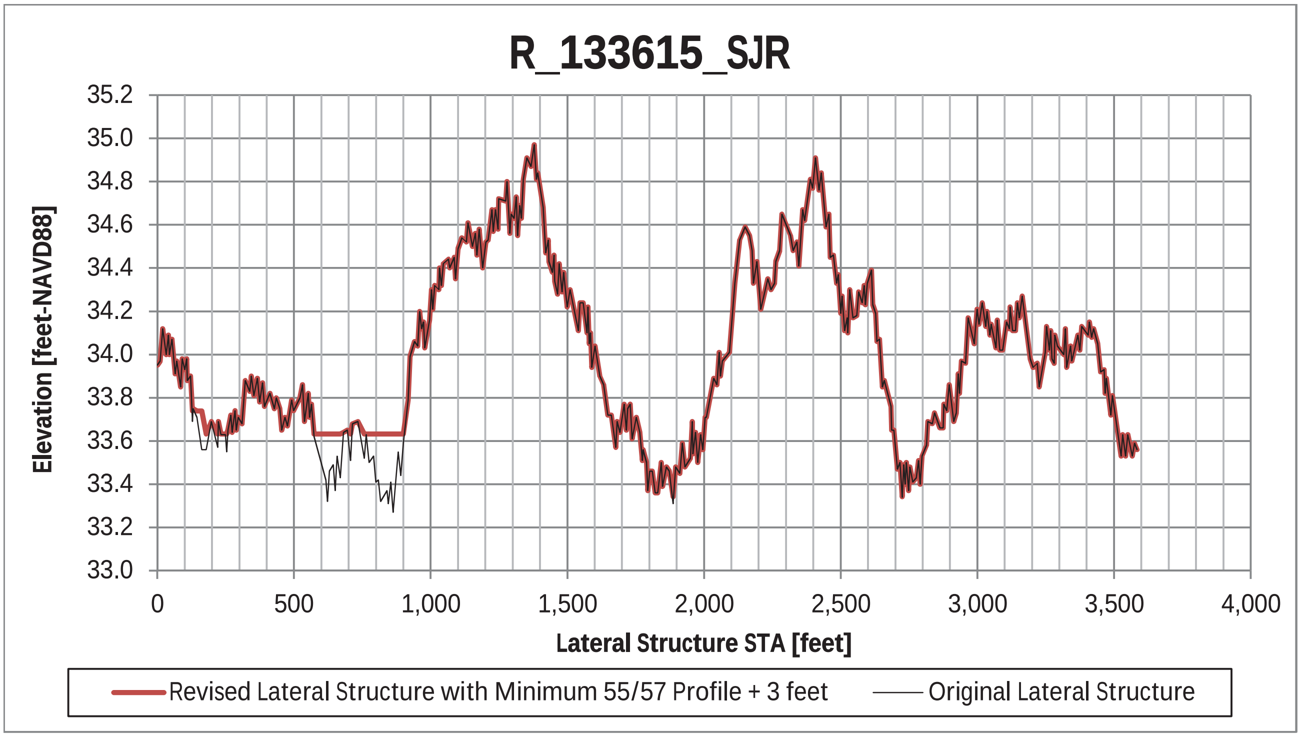

R_120193_SJR
Elevation [feet-NAVD88]
33.5
33.0
32.5
32.0
31.5
31.0
0
200
400
600
800
1,000
1,200
1,400
Lateral Structure STA [feet]
Revised Lateral Structure with Minimum 55/57 Profile + 3 feet
Original Lateral Structure

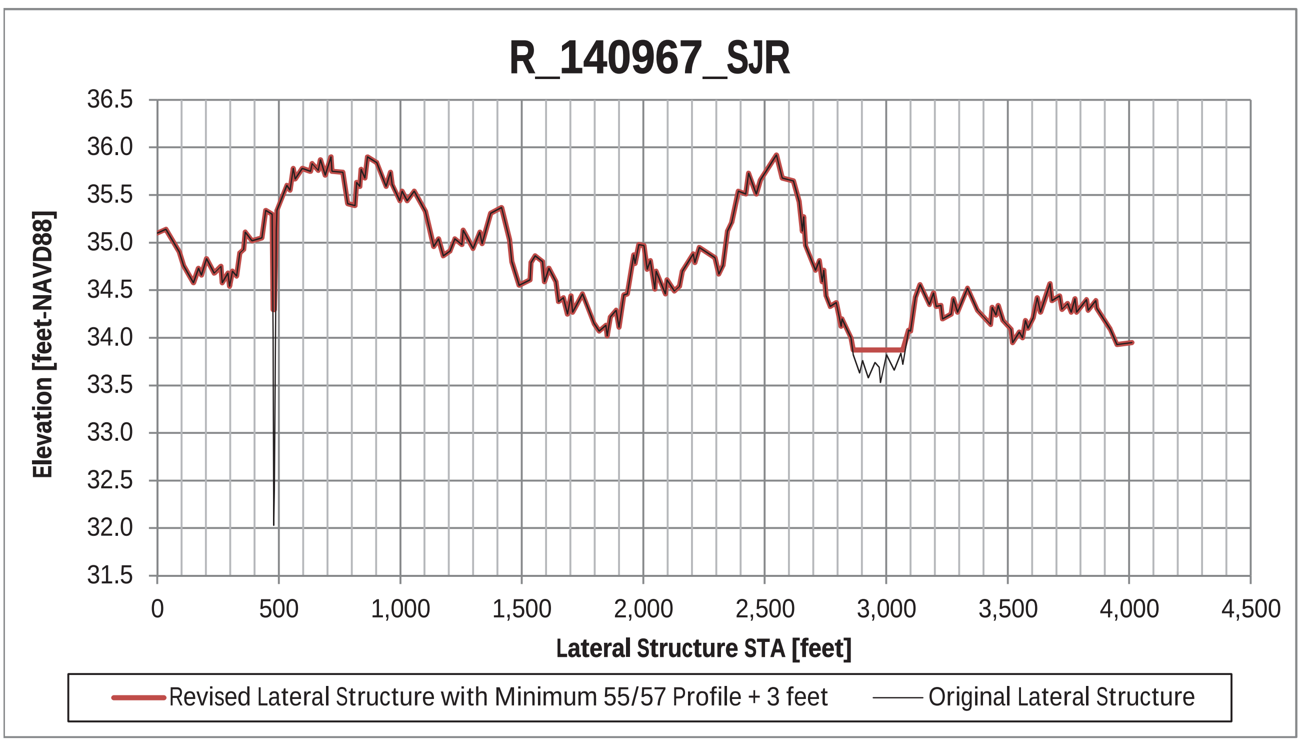

R_122181_SJR
Elevation [feet-NAVD88]
34.0
33.5
33.0
32.5
32.0
31.5
0
500
1,000
1,500
2,000
2,500
3,000
3,500
4,000
4,500
5,000
Lateral Structure STA [feet]
Revised Lateral Structure with Minimum 55/57 Profile + 3 feet
Original Lateral Structure

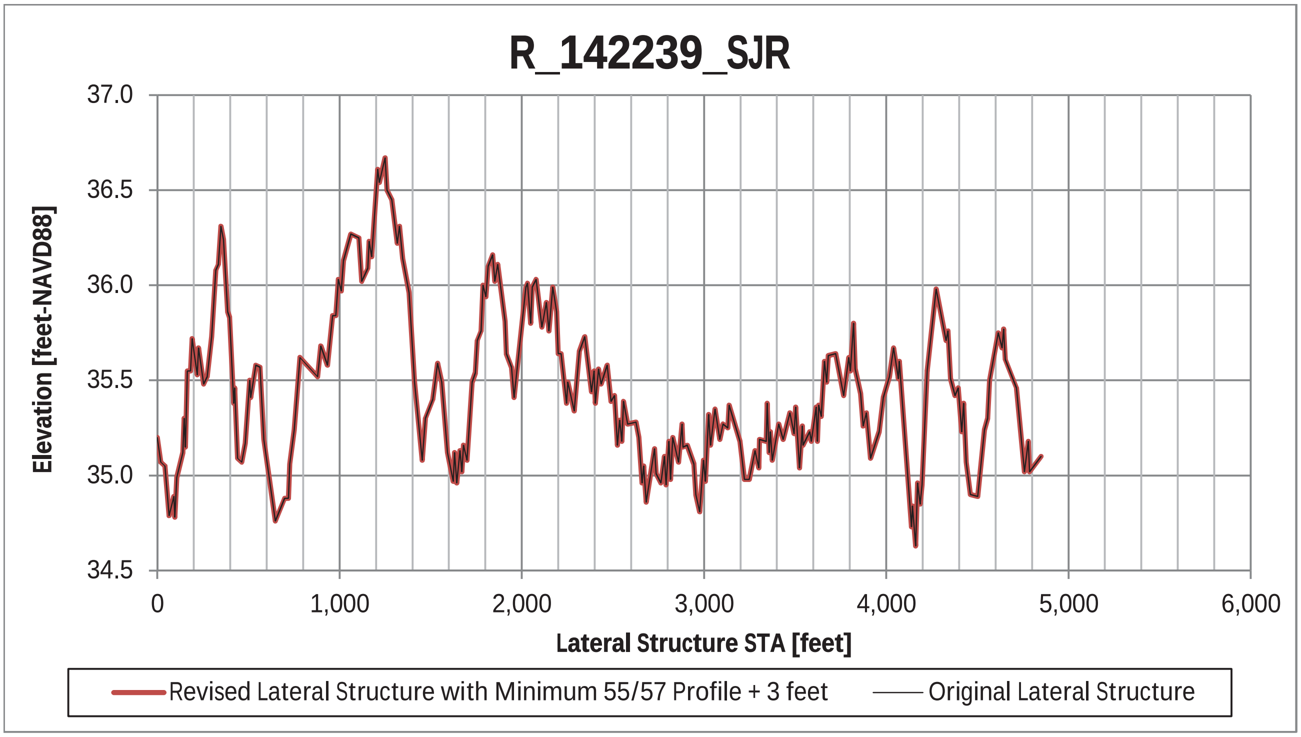

R_124535_SJR
Elevation [feet-NAVD88]
34.0
33.8
33.6
33.4
33.2
33.0
32.8
32.6
32.4
32.2
32.0
0
1,000
2,000
3,000
4,000
5,000
6,000
Lateral Structure STA [feet]
Revised Lateral Structure with Minimum 55/57 Profile + 3 feet
Original Lateral Structure

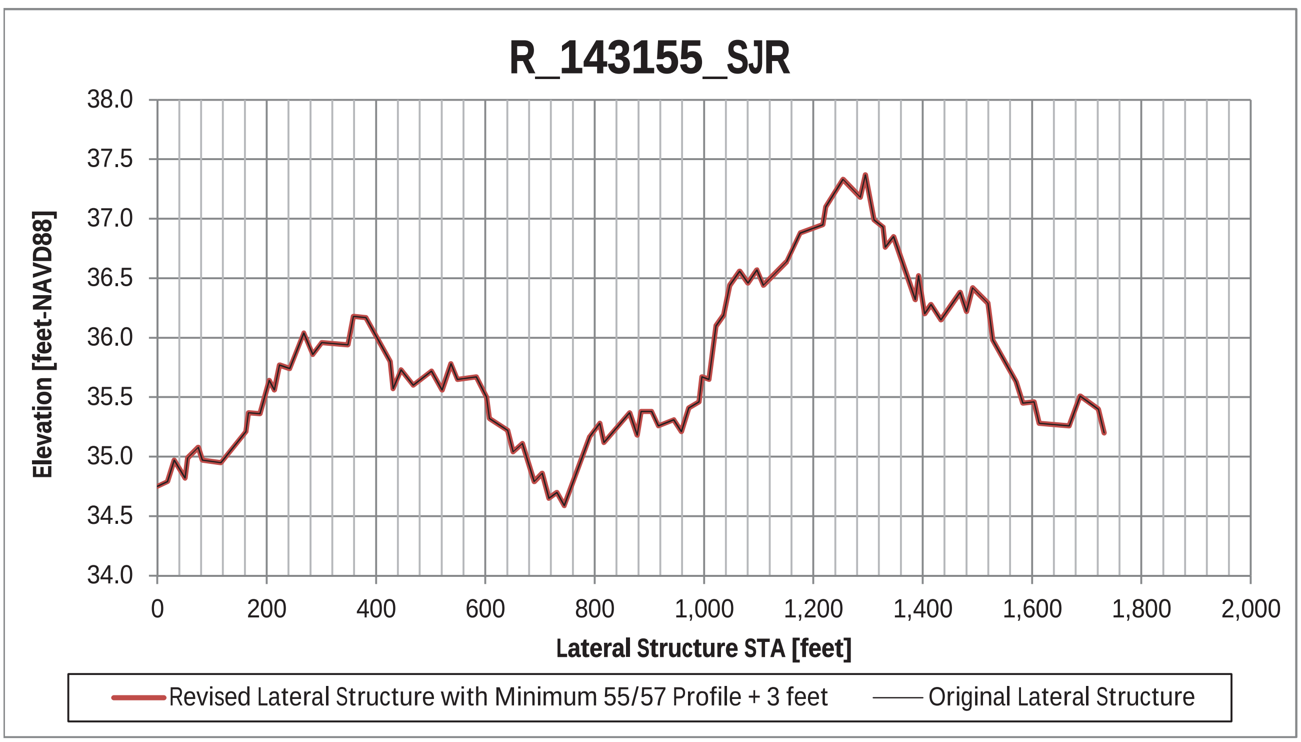

R_126761_SJR
Elevation [feet-NAVD88]
34.4
34.2
34.0
33.8
33.6
33.4
33.2
33.0
32.8
32.6
0
500
1,000
1,500
2,000
2,500
Lateral Structure STA [feet]
Revised Lateral Structure with Minimum 55/57 Profile + 3 feet
Original Lateral Structure

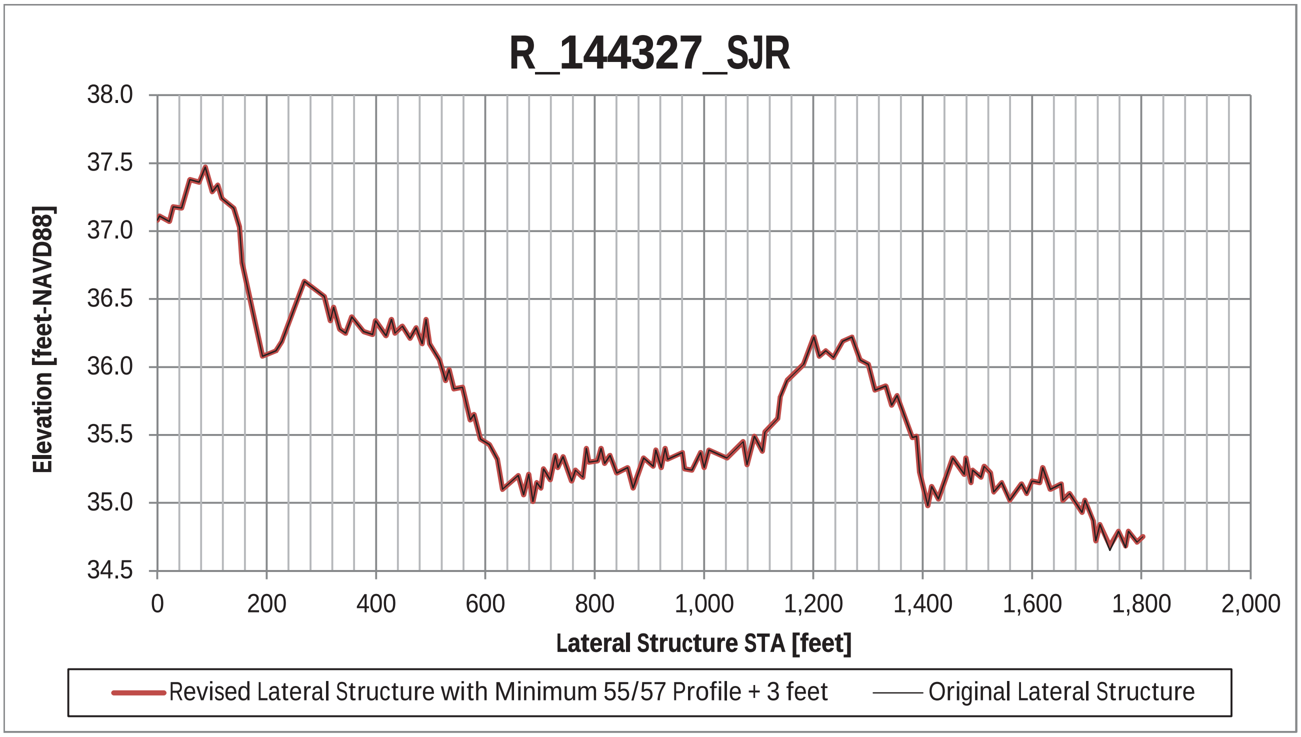

R_129729_SJR
Elevation [feet-NAVD88]
35.5
35.0
34.5
34.0
33.5
33.0
32.5
0
500
1,000
1,500
2,000
2,500
Lateral Structure STA [feet]
Revised Lateral Structure with Minimum 55/57 Profile + 3 feet
Original Lateral Structure

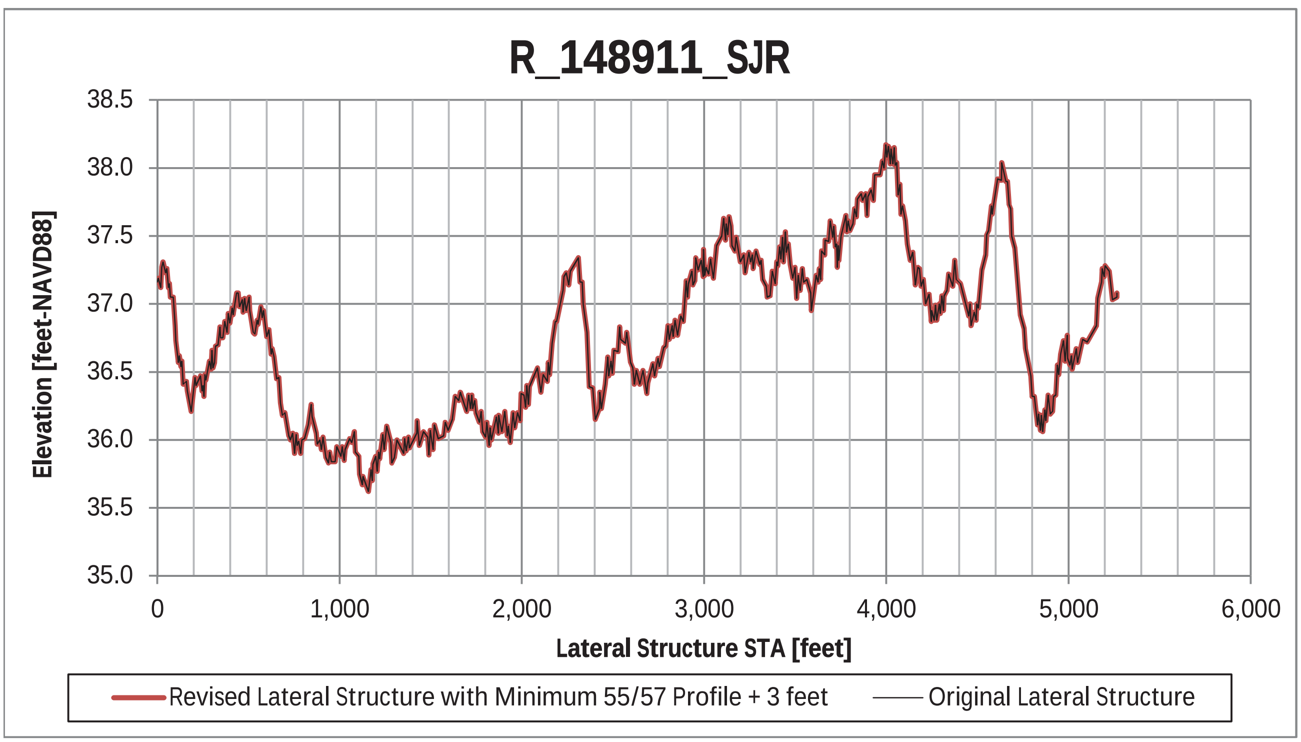

R_133615_SJR
Elevation [feet-NAVD88]
35.2
35.0
34.8
34.6
34.4
34.2
34.0
33.8
33.6
33.4
33.2
33.0
0
500
1,000
1,500
2,000
2,500
3,000
3,500
4,000
Lateral Structure STA [feet]
Revised Lateral Structure with Minimum 55/57 Profile + 3 feet
Original Lateral Structure

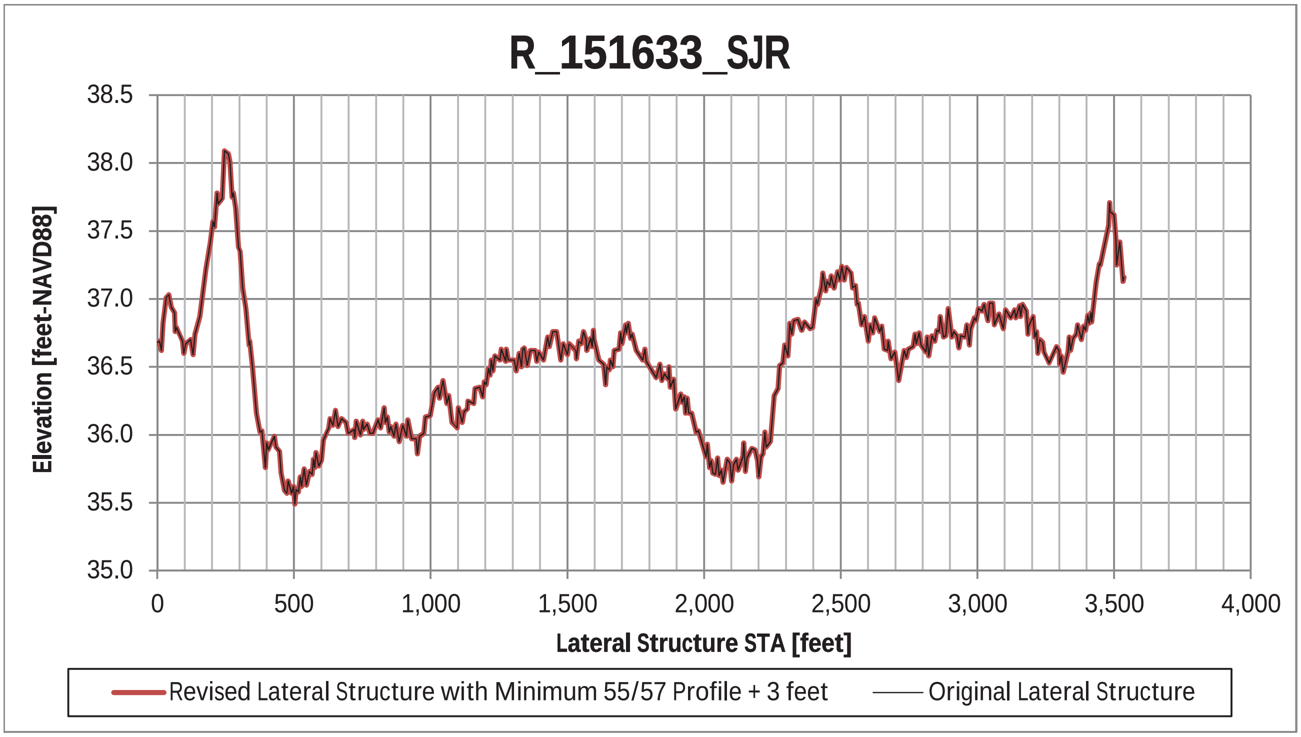

R_140967_SJR
Elevation [feet-NAVD88]
36.5
36.0
35.5
35.0
34.5
34.0
33.5
33.0
32.5
32.0
31.5
0
500
1,000
1,500
2,000
2,500
3,000
3,500
4,000
4,500
Lateral Structure STA [feet]
Revised Lateral Structure with Minimum 55/57 Profile + 3 feet
Original Lateral Structure

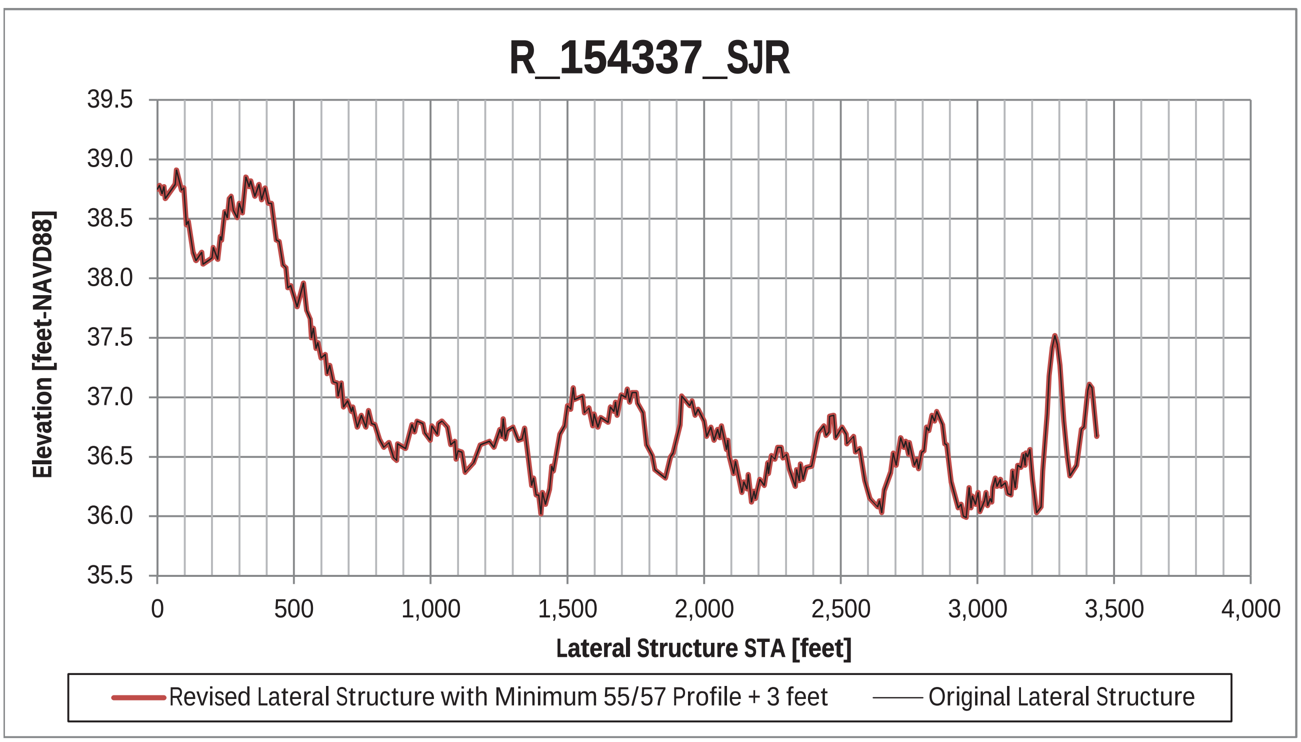

R_142239_SJR
Elevation [feet-NAVD88]
37.0
36.5
36.0
35.5
35.0
34.5
0
1,000
2,000
3,000
4,000
5,000
6,000
Lateral Structure STA [feet]
Revised Lateral Structure with Minimum 55/57 Profile + 3 feet
Original Lateral Structure

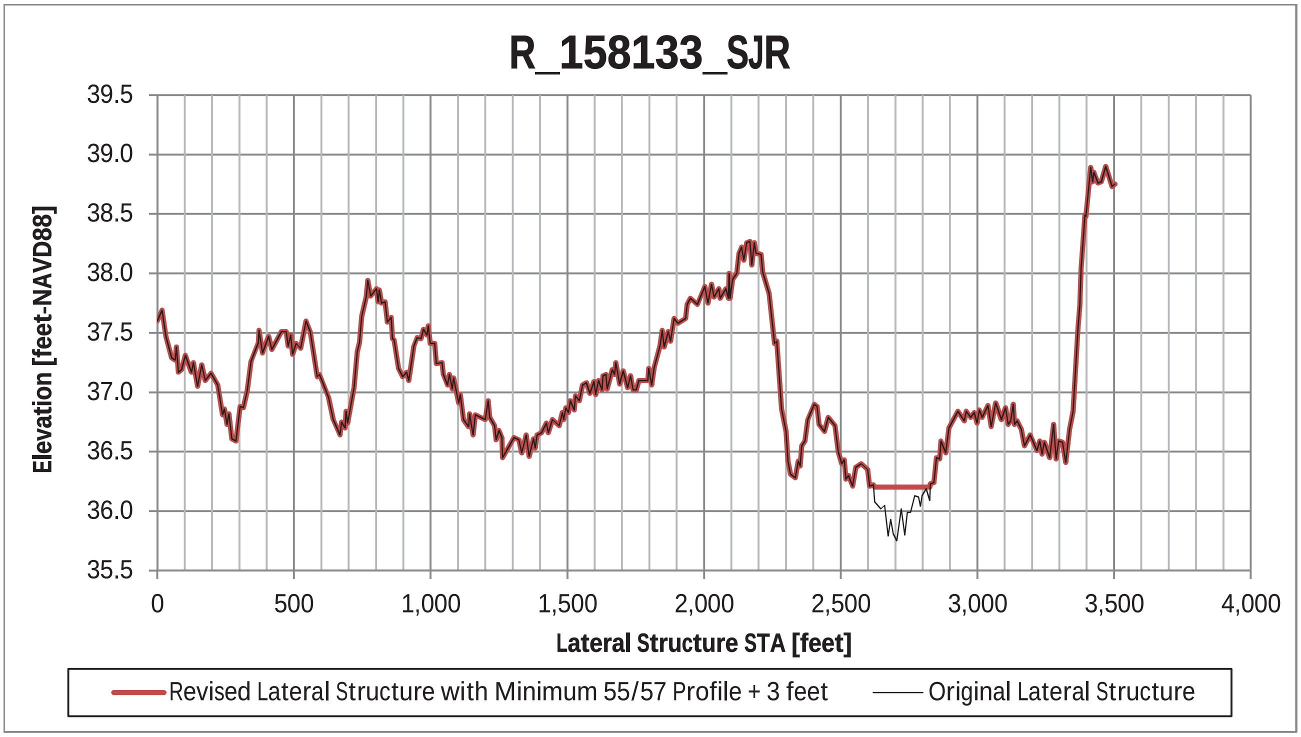

R_143155_SJR
Elevation [feet-NAVD88]
38.0
37.5
37.0
36.5
36.0
35.5
35.0
34.5
34.0
0
200
400
600
800
1,000
1,200
1,400
1,600
1,800
2,000
Lateral Structure STA [feet]
Revised Lateral Structure with Minimum 55/57 Profile + 3 feet
Original Lateral Structure

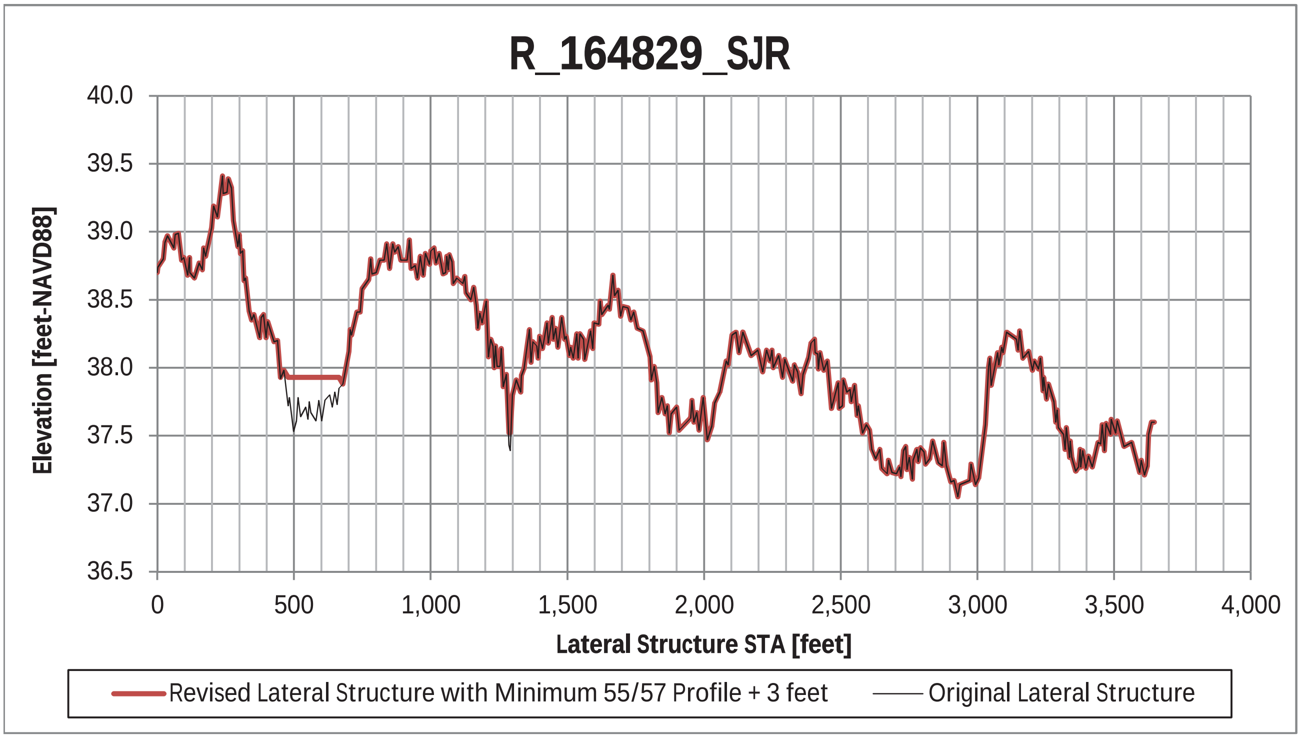

R_144327_SJR
Elevation [feet-NAVD88]
38.0
37.5
37.0
36.5
36.0
35.5
35.0
34.5
0
200
400
600
800
1,000
1,200
1,400
1,600
1,800
2,000
Lateral Structure STA [feet]
Revised Lateral Structure with Minimum 55/57 Profile + 3 feet
Original Lateral Structure

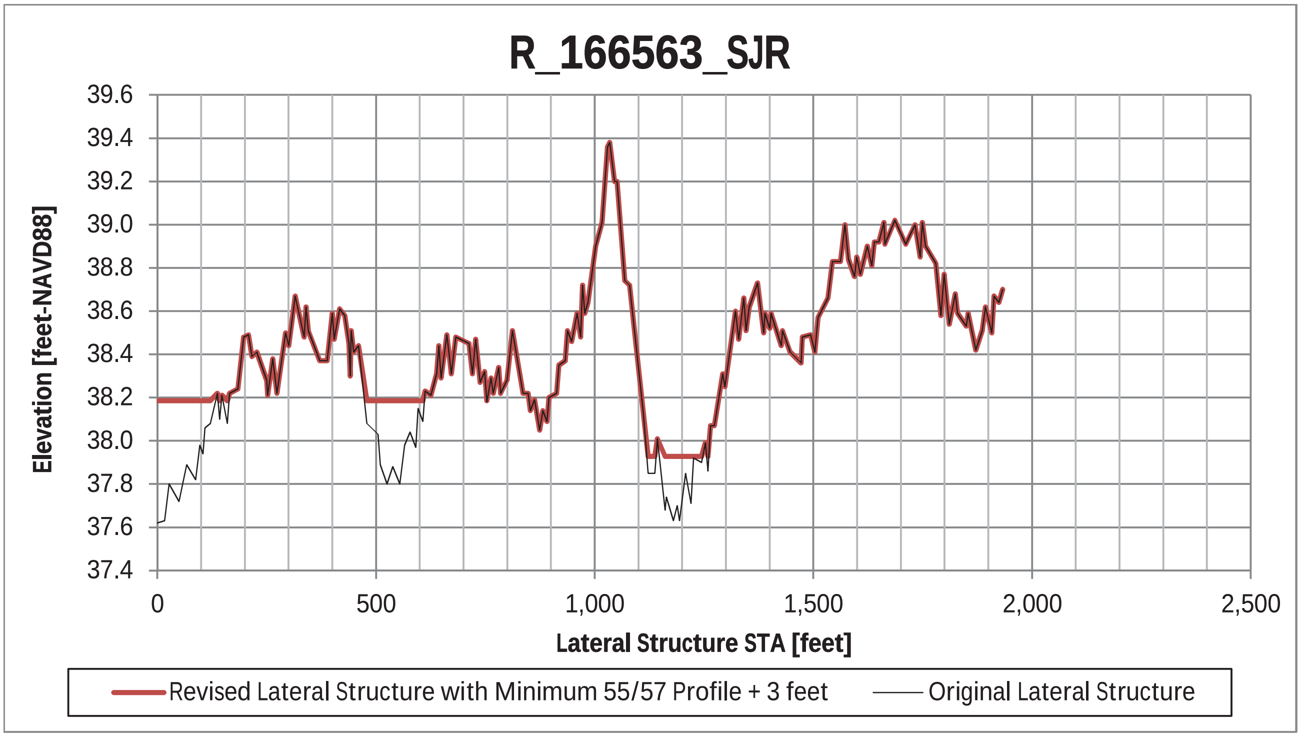

R_148911_SJR
Elevation [feet-NAVD88]
38.5
38.0
37.5
37.0
36.5
36.0
35.5
35.0
0
1,000
2,000
3,000
4,000
5,000
6,000
Lateral Structure STA [feet]
Revised Lateral Structure with Minimum 55/57 Profile + 3 feet
Original Lateral Structure

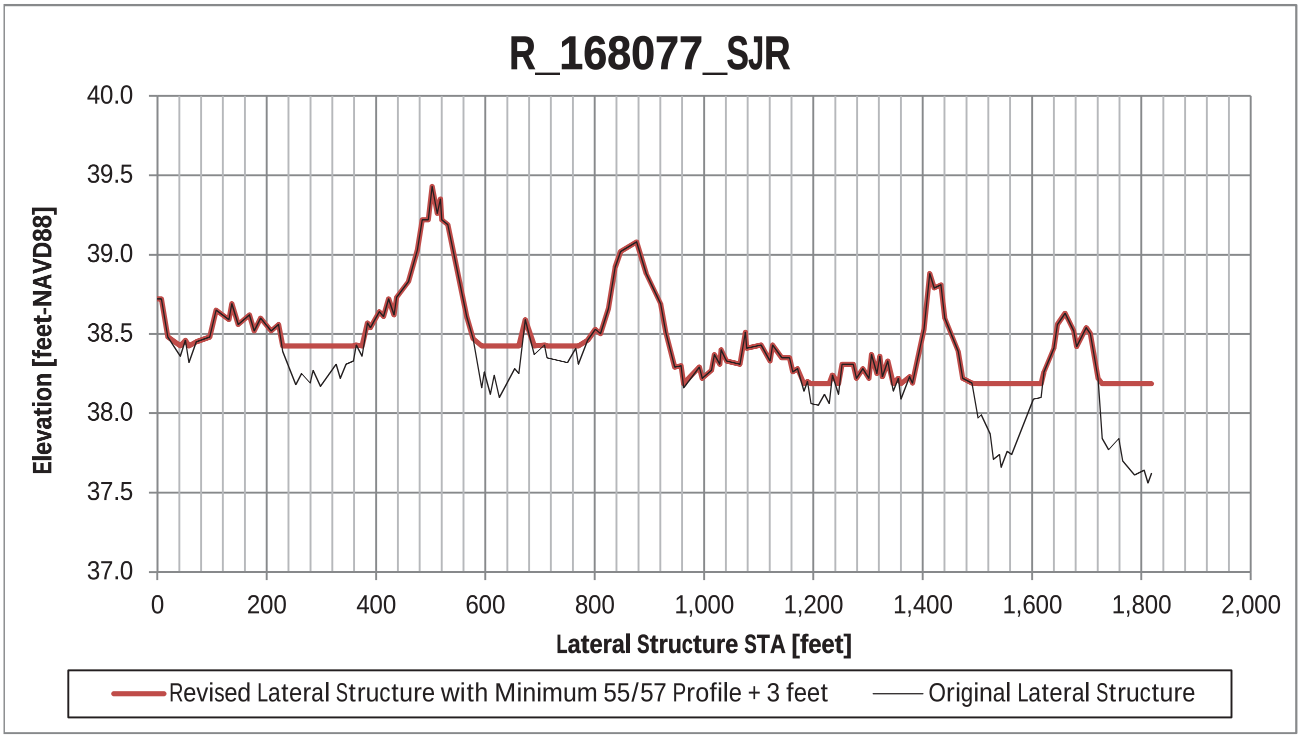

R_151633_SJR
38.5
38.0
37.5
37.0
36.5
36.0
35.5
35.0
Elevation [feet-NAVD88]
0
500
1,000
1,500
2,000
2,500
3,000
3,500
4,000
Lateral Structure STA [feet]
Revised Lateral Structure with Minimum 55/57 Profile + 3 feet
Original Lateral Structure

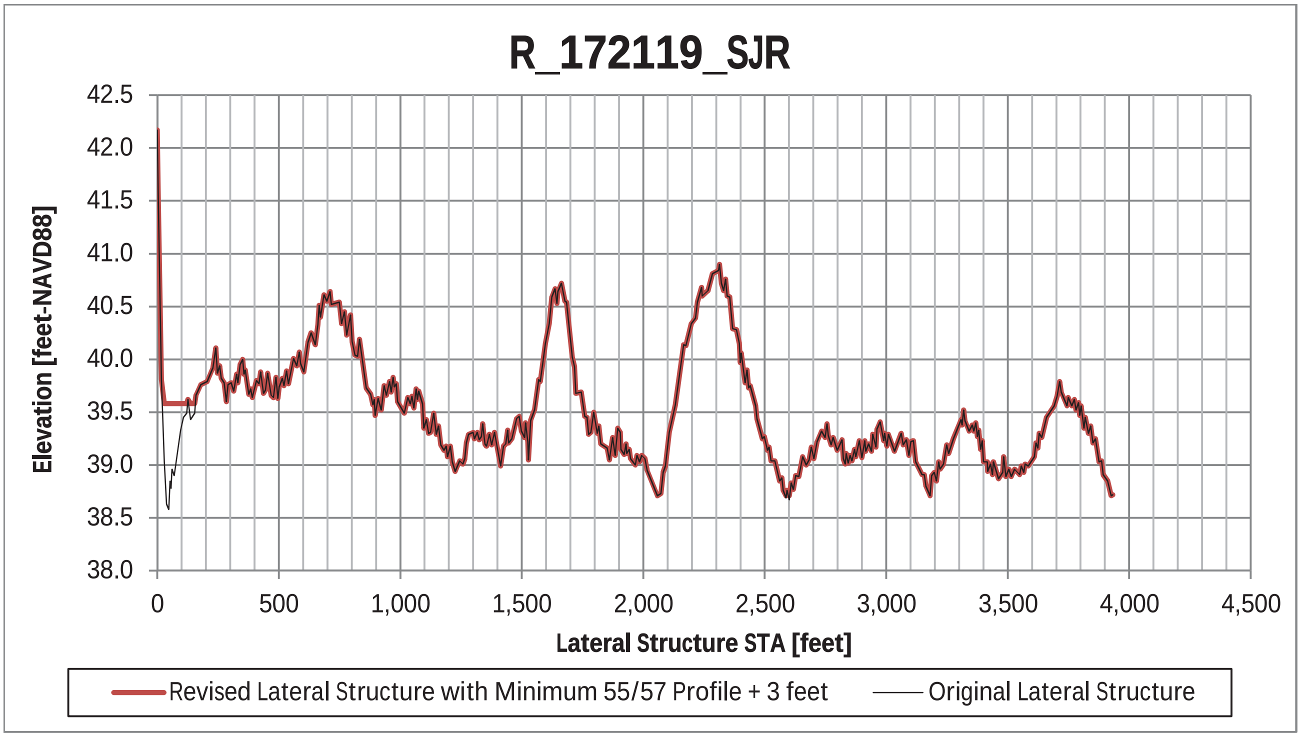

R_154337_SJR
39.5
39.0
38.5
38.0
37.5
37.0
36.5
36.0
35.5
Elevation [feet-NAVD88]
0
500
1,000
1,500
2,000
2,500
3,000
3,500
4,000
Lateral Structure STA [feet]
Revised Lateral Structure with Minimum 55/57 Profile + 3 feet
Original Lateral Structure

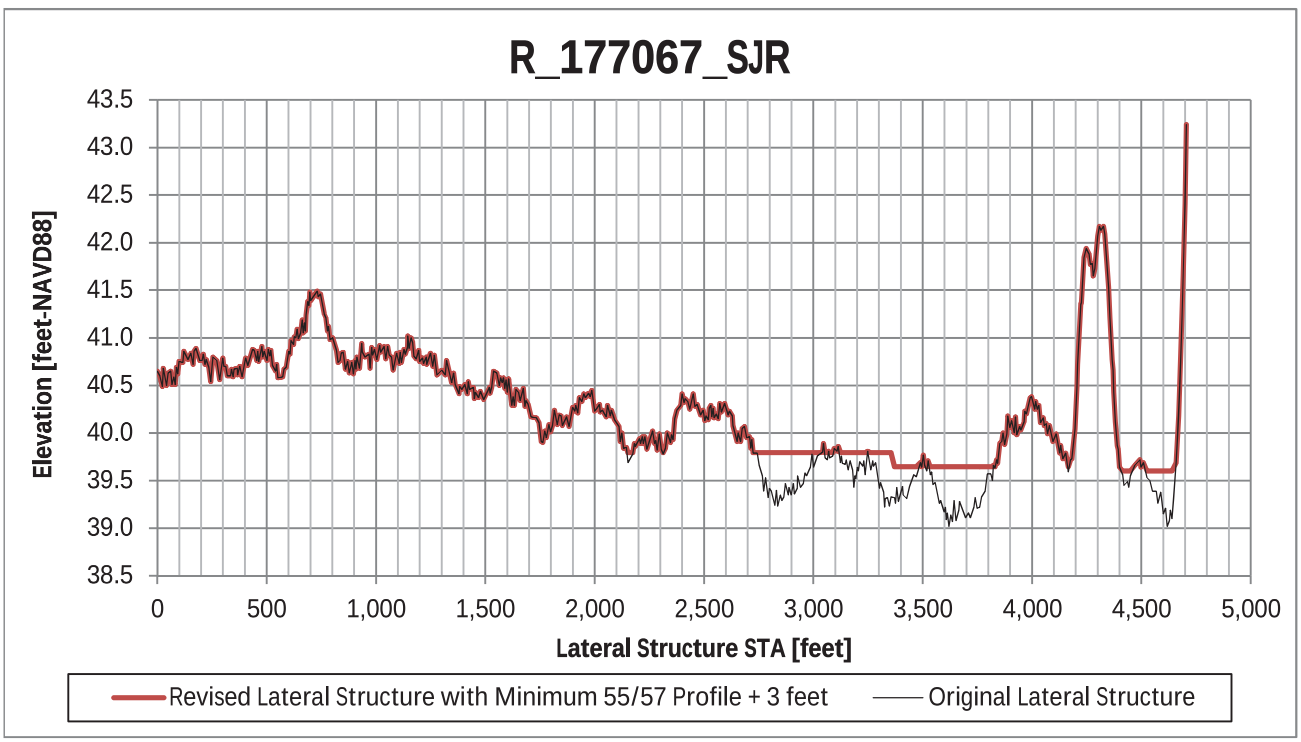

R_158133_SJR
Elevation [feet-NAVD88]
39.5
39.0
38.5
38.0
37.5
37.0
36.5
36.0
35.5
0
500
1,000
1,500
2,000
2,500
3,000
3,500
4,000
Lateral Structure STA [feet]
Revised Lateral Structure with Minimum 55/57 Profile + 3 feet
Original Lateral Structure

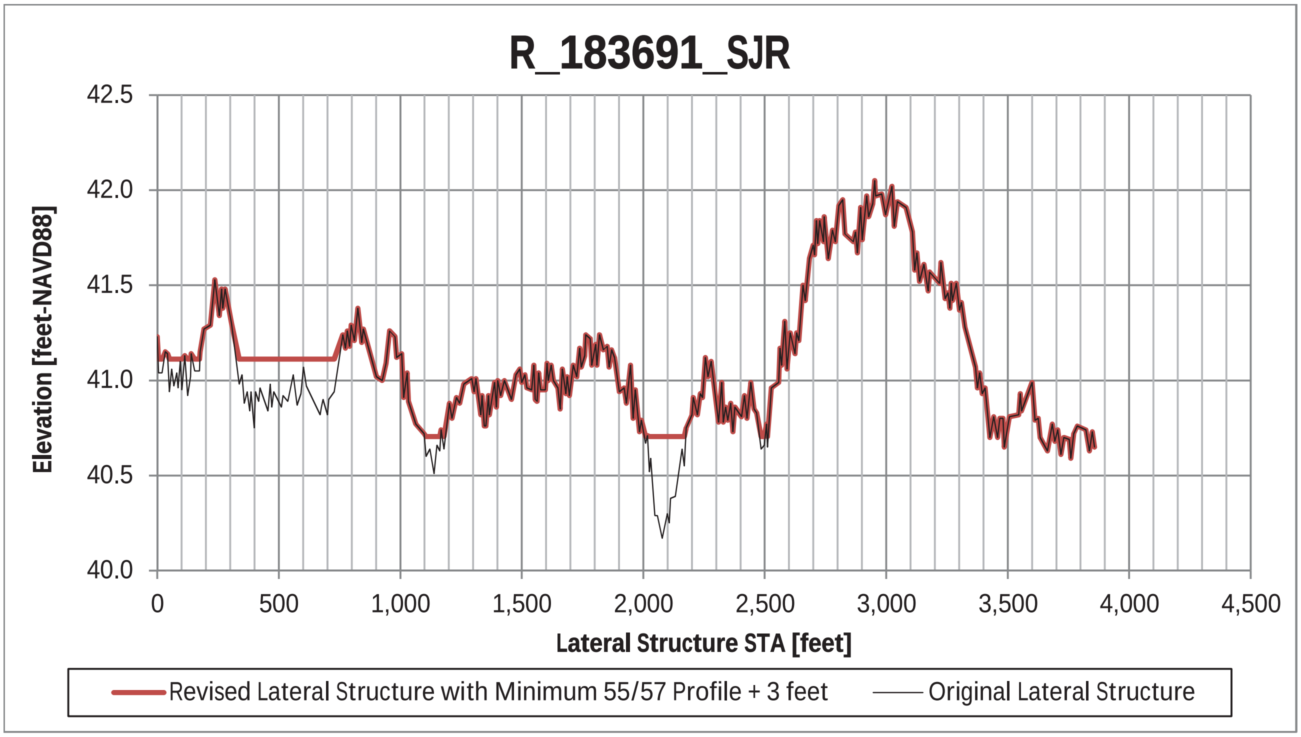

R_164829_SJR
Elevation [feet-NAVD88]
40.0
39.5
39.0
38.5
38.0
37.5
37.0
36.5
0
500
1,000
1,500
2,000
2,500
3,000
3,500
4,000
Lateral Structure STA [feet]
Revised Lateral Structure with Minimum 55/57 Profile + 3 feet
Original Lateral Structure

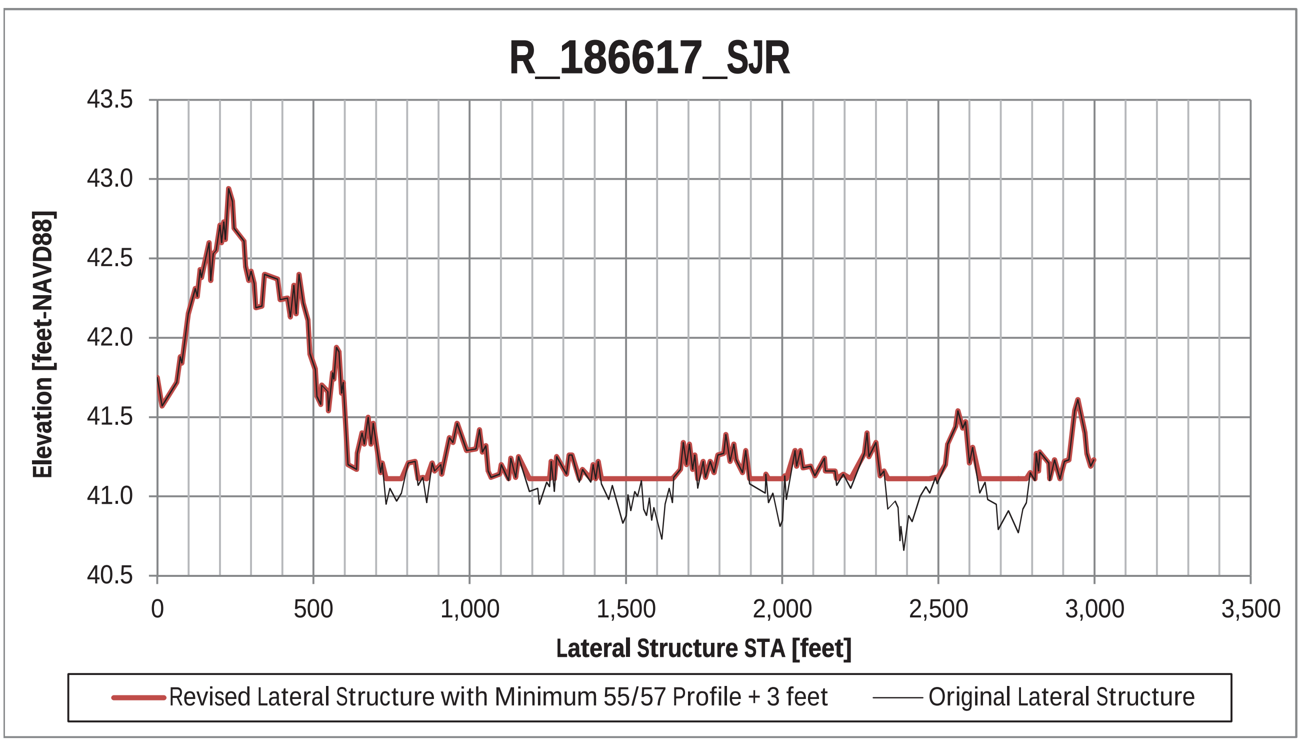

R_166563_SJR
Elevation [feet-NAVD88]
39.6
39.4
39.2
39.0
38.8
38.6
38.4
38.2
38.0
37.8
37.6
37.4
0
500
1,000
1,500
2,000
2,500
Lateral Structure STA [feet]
Revised Lateral Structure with Minimum 55/57 Profile + 3 feet
Original Lateral Structure

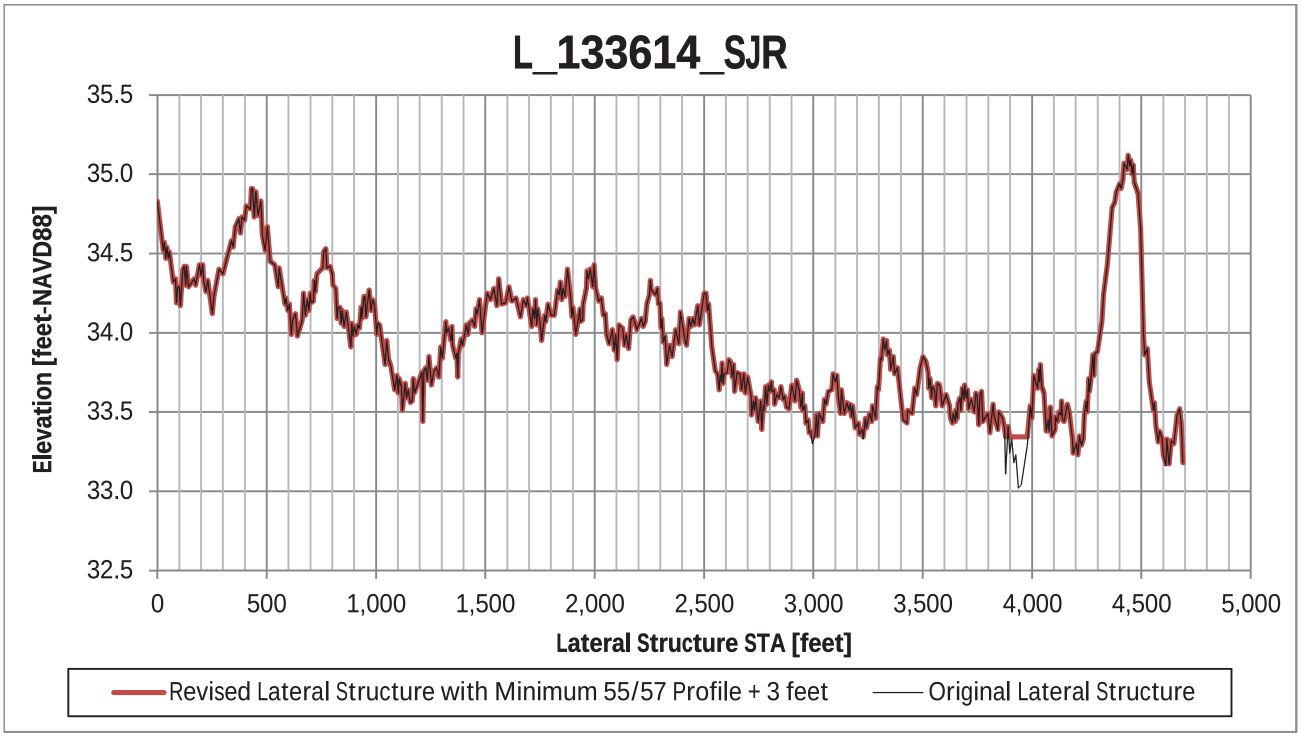

R_168077_SJR
Elevation [feet-NAVD88]
40.0
39.5
39.0
38.5
38.0
37.5
37.0
0
200
400
600
800
1,000
1,200
1,400
1,600
1,800
2,000
Lateral Structure STA [feet]
Revised Lateral Structure with Minimum 55/57 Profile + 3 feet
Original Lateral Structure

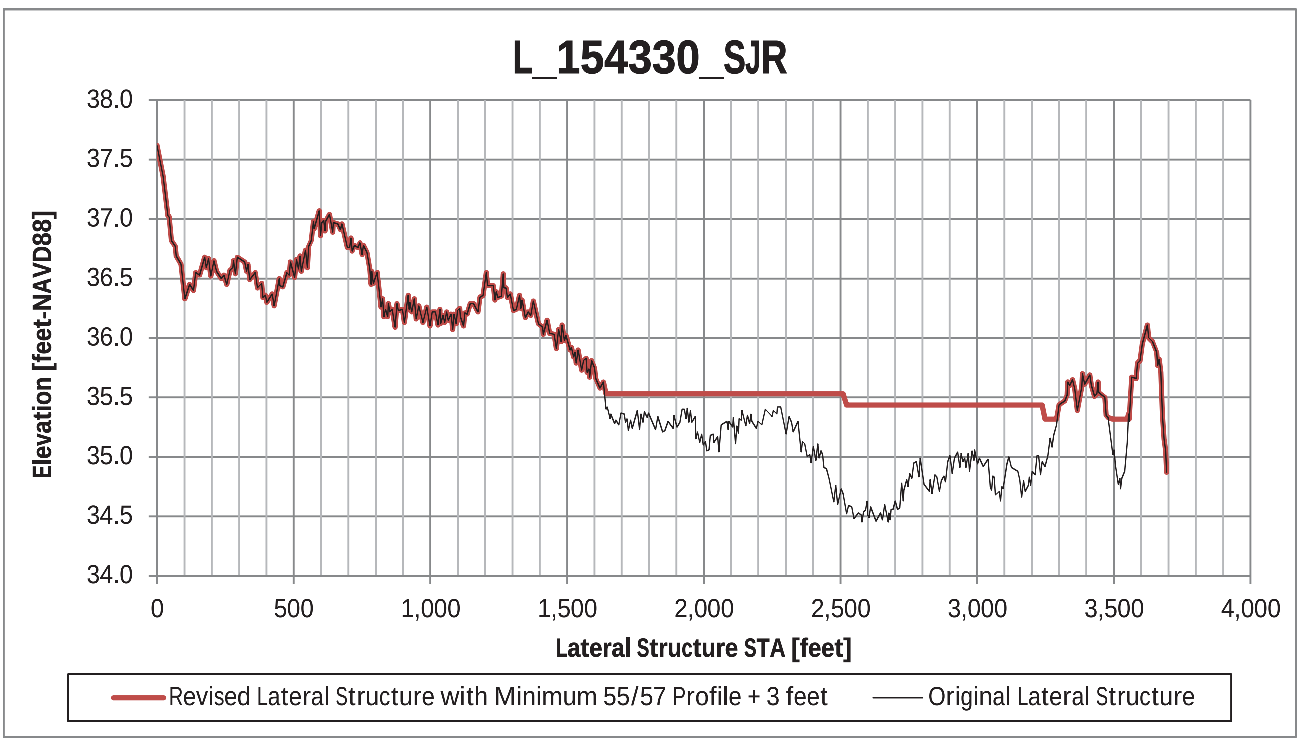

R_172119_SJR
Elevation [feet-NAVD88]
42.5
42.0
41.5
41.0
40.5
40.0
39.5
39.0
38.5
38.0
0
500
1,000
1,500
2,000
2,500
3,000
3,500
4,000
4,500
Lateral Structure STA [feet]
Revised Lateral Structure with Minimum 55/57 Profile + 3 feet
Original Lateral Structure

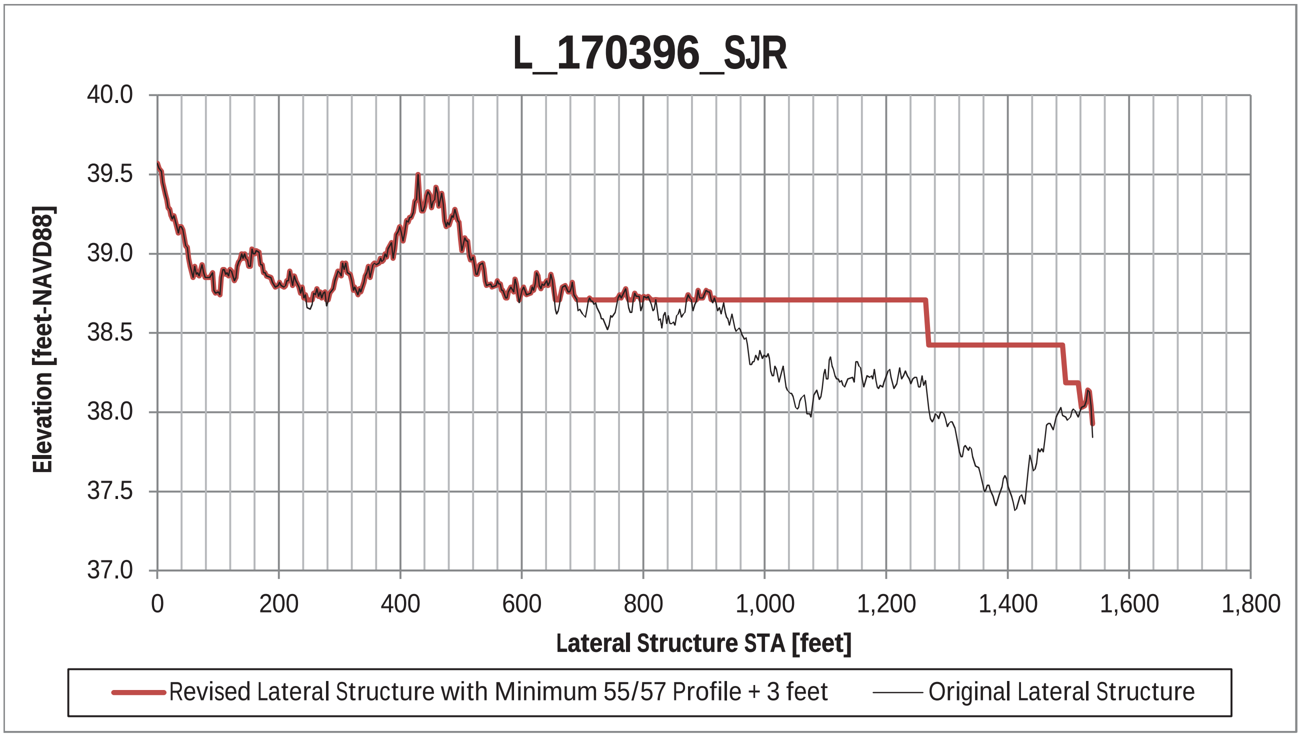

R_177067_SJR
Elevation [feet-NAVD88]
43.5
43.0
42.5
42.0
41.5
41.0
40.5
40.0
39.5
39.0
38.5
0
500
1,000
1,500
2,000
2,500
3,000
3,500
4,000
4,500
5,000
Lateral Structure STA [feet]
Revised Lateral Structure with Minimum 55/57 Profile + 3 feet
Original Lateral Structure

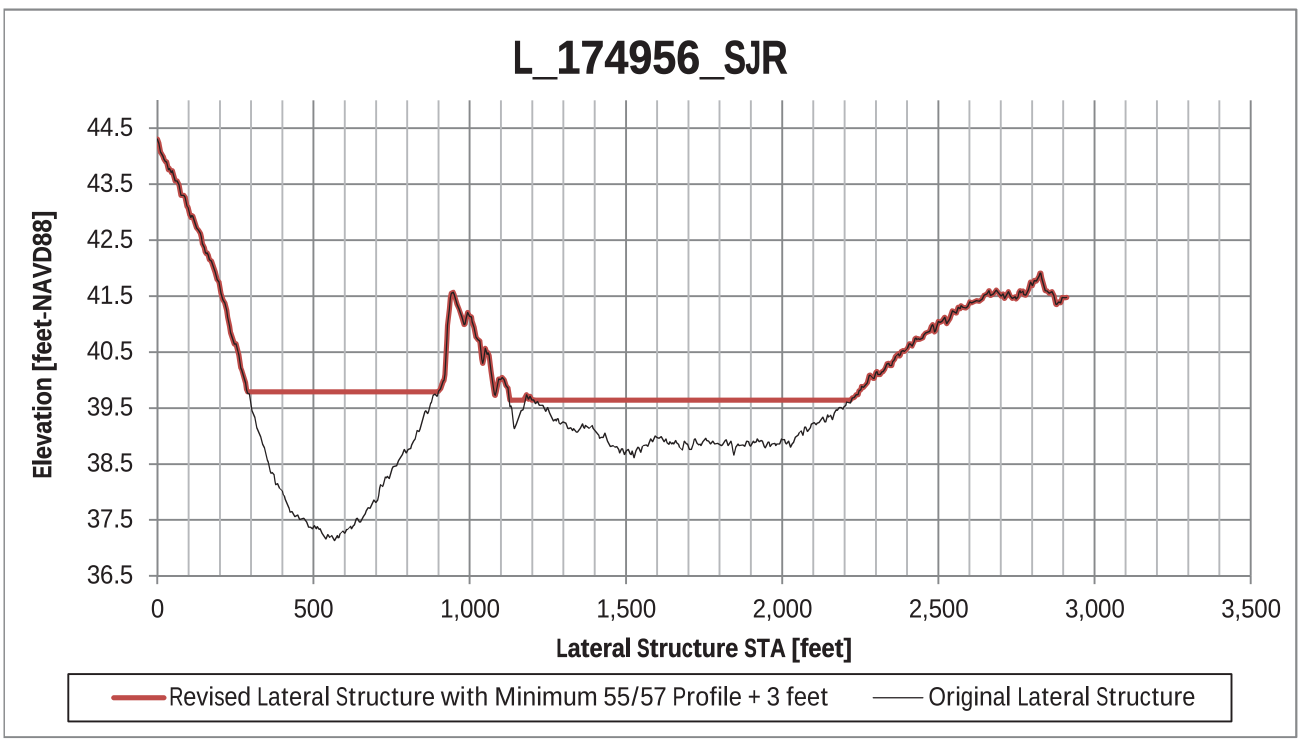

R_183691_SJR
Elevation [feet-NAVD88]
42.5
42.0
41.5
41.0
40.5
40.0
0
500
1,000
1,500
2,000
2,500
3,000
3,500
4,000
4,500
Lateral Structure STA [feet]
Revised Lateral Structure with Minimum 55/57 Profile + 3 feet
Original Lateral Structure

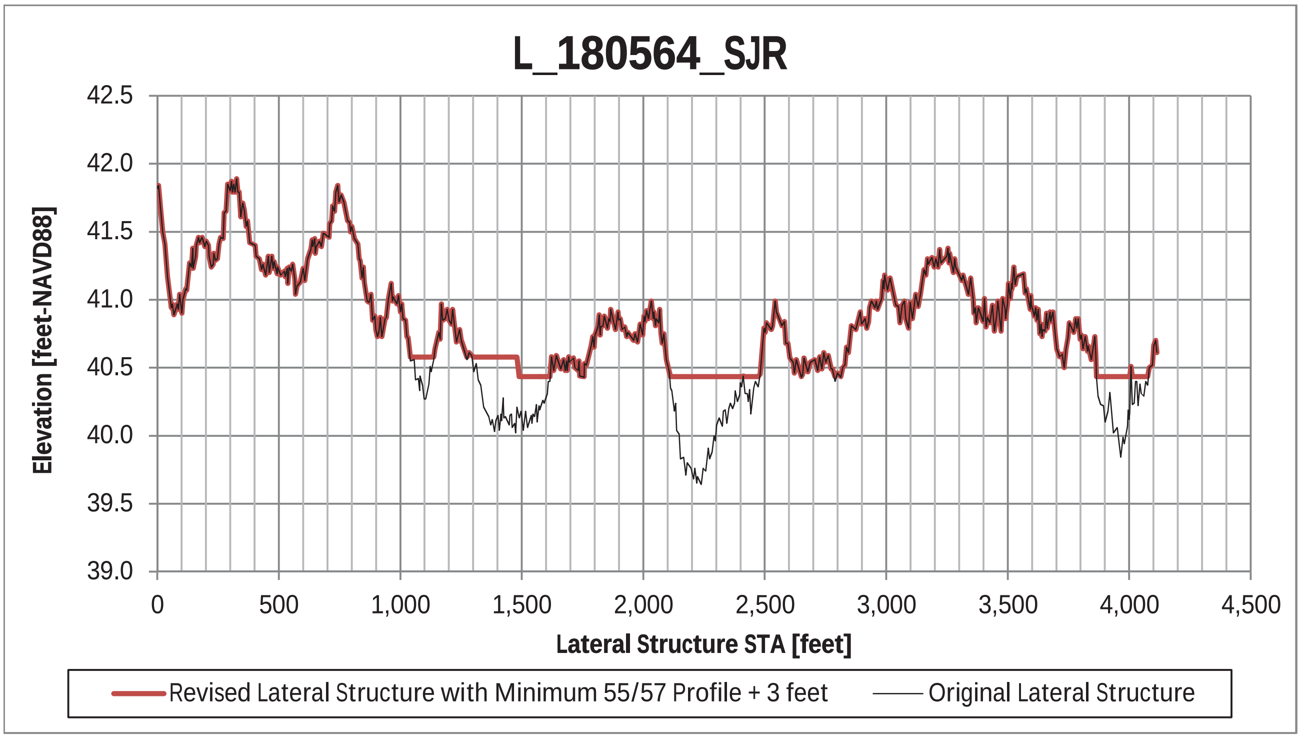

R_186617_SJR
Elevation [feet-NAVD88]
43.5
43.0
42.5
42.0
41.5
41.0
40.5
0
500
1,000
1,500
2,000
2,500
3,000
3,500
Lateral Structure STA [feet]
Revised Lateral Structure with Minimum 55/57 Profile + 3 feet
Original Lateral Structure


L_133614_SJR
Elevation [feet-NAVD88]
35.5
35.0
34.5
34.0
33.5
33.0
32.5
0
500
1,000
1,500
2,000
2,500
3,000
3,500
4,000
4,500
5,000
Lateral Structure STA [feet]
Revised Lateral Structure with Minimum 55/57 Profile + 3 feet
Original Lateral Structure


L_154330_SJR
Elevation [feet-NAVD88]
38.0
37.5
37.0
36.5
36.0
35.5
35.0
34.5
34.0
0
500
1,000
1,500
2,000
2,500
3,000
3,500
4,000
Lateral Structure STA [feet]
Revised Lateral Structure with Minimum 55/57 Profile + 3 feet
Original Lateral Structure


L_170396_SJR
Elevation [feet-NAVD88]
40.0
39.5
39.0
38.5
38.0
37.5
37.0
0
200
400
600
800
1,000
1,200
1,400
1,600
1,800
Lateral Structure STA [feet]
Revised Lateral Structure with Minimum 55/57 Profile + 3 feet
Original Lateral Structure


L_174956_SJR
Elevation [feet-NAVD88]
44.5
43.5
42.5
41.5
40.5
39.5
38.5
37.5
36.5
0
500
1,000
1,500
2,000
2,500
3,000
3,500
Lateral Structure STA [feet]
Revised Lateral Structure with Minimum 55/57 Profile + 3 feet
Original Lateral Structure


L_180564_SJR
42.5
42.0
41.5
41.0
40.5
40.0
39.5
39.0
Elevation [feet-NAVD88]
0
500
1,000
1,500
2,000
2,500
3,000
3,500
4,000
4,500
Lateral Structure STA [feet]
Revised Lateral Structure with Minimum 55/57 Profile + 3 feet
Original Lateral Structure

Attachment 3

Changes Made to Weir Coefficients for
HEC-RAS Storage Area Connections

SA Connection Name:	1SSR3_1SSR11
Underlying Feature:	Road, 1'-3' elevated
CVFED Weir Coefficient:	1.0
Revised Weir Coefficient:	2.0

SA Connection Name:	1SSR11_6SJR65
Underlying Feature:	Road, 1'-3' elevated
CVFED Weir Coefficient:	1.0
Revised Weir Coefficient:	2.0

SA Connection Name:	1SSR11_1SSR30
Underlying Feature:	Road, 1'-3' elevated
CVFED Weir Coefficient:	1.0
Revised Weir Coefficient:	2.0

SA Connection Name:	1SSR13_1SSR30
Underlying Feature:	Road, 1'-3' elevated
CVFED Weir Coefficient:	1.0
Revised Weir Coefficient:	2.0

SA Connection Name:	1SSR30_6SJR65
Underlying Feature:	Road, 1'-3' elevated
CVFED Weir Coefficient:	1.0
Revised Weir Coefficient:	2.0

SA Connection Name:	1SSR30_6SJR60
Underlying Feature:	Road, 1'-3' elevated
CVFED Weir Coefficient:	1.0
Revised Weir Coefficient:	2.0

SA Connection Name:	6SJR65_6SJR60
Underlying Feature:	Levee*/Farm Road, 1'-3' elevated
CVFED Weir Coefficient:	0.5
Revised Weir Coefficient:	2.0

*Identified in the California DWR Levee Database

SA Connection Name:	6SJR65_6SJR59
Underlying Feature:	Levee*, 1'-3' elevated
CVFED Weir Coefficient:	0.5
Revised Weir Coefficient:	2.0

*Identified in the California DWR Levee Database

SA Connection Name:	6SJR59_6SJR60
Underlying Feature:	Levee*/Farm Road, 1'-3' elevated
CVFED Weir Coefficient:	0.5
Revised Weir Coefficient:	2.0

*Identified in the California DWR Levee Database

SA Connection Name:	**6SJR59_6SJR35**
Underlying Feature:	Levee*/Road, 1'-3' elevated
CVFED Weir Coefficient:	1.0
Revised Weir Coefficient:	2.0

*Identified in the California DWR Levee Database

SA Connection Name:	**6SJR60_6SJR35**
Underlying Feature:	Levee*/Road, 1'-3' elevated
CVFED Weir Coefficient:	1.0
Revised Weir Coefficient:	2.0

*Identified in the California DWR Levee Database

SA Connection Name:	**6SJR60_6SJR40**
Underlying Feature:	Levee*/Road, 1'-3' elevated
CVFED Weir Coefficient:	1.0
Revised Weir Coefficient:	2.0

*Identified in the California DWR Levee Database

SA Connection Name:	**1SSR30_6SJR40**
Underlying Feature:	Levee*/Road, 1'-3' elevated
CVFED Weir Coefficient:	1.0
Revised Weir Coefficient:	2.0

*Identified in the California DWR Levee Database

SA Connection Name:	1SSR30_1SSR40
Underlying Feature:	Levee*/Farm Road, 1'-3' elevated
CVFED Weir Coefficient:	1.0
Revised Weir Coefficient:	2.0

*Identified in the California DWR Levee Database

SA Connection Name:	6SJR35_6SJR40
Underlying Feature:	Road, 1'-3' elevated
CVFED Weir Coefficient:	1.0
Revised Weir Coefficient:	2.0

SA Connection Name:	6SJR40_1WHS15
Underlying Feature:	Road, 1'-3' elevated
CVFED Weir Coefficient:	1.0
Revised Weir Coefficient:	2.0

SA Connection Name:	6SJR35_1WHS15
Underlying Feature:	Levee*/Farm Road, 1'-3' elevated
CVFED Weir Coefficient:	1.0
Revised Weir Coefficient:	2.0

*Identified in the California DWR Levee Database

SA Connection Name:	**6SJR35_6SJR30**
Underlying Feature:	Levee*/Farm Road, 1'-3' elevated
CVFED Weir Coefficient:	1.0
Revised Weir Coefficient:	2.0

*Identified in the California DWR Levee Database

SA Connection Name:	**1WHS15_6SJR30**
Underlying Feature:	Natural High Ground Barrier, 1'-3' elevated
CVFED Weir Coefficient:	0.5
Revised Weir Coefficient:	1.0

SA Connection Name:	1WHS15_1WHS5
Underlying Feature:	Levee*, 3' or higher
CVFED Weir Coefficient:	1.0
Revised Weir Coefficient:	2.0

*RD17 Tieback levee. Identified in the California DWR Levee Database

SA Connection Name:	1WHS15_1WHS10
Underlying Feature:	Primarily Road, 1'-3' elevated
CVFED Weir Coefficient:	0.5
Revised Weir Coefficient:	2.0

Attachment 4

MBK Engineers' Review of PBI's Revised HEC-RAS Model

Review of Initial ULDC Water Surface Elevation and Development for Reclamation District No. 17 (RD 17)

Review by: Mike Archer, P.E., MBK Engineers
April 17, 2014

Background

Peterson Brustad Inc. (PBI) has performed a hydraulic analysis to develop 200-year water surface elevations conforming to the State of California Urban Levee Design Criteria (ULDC) for the RD 17 levees. PBI used a modified version of the lower San Joaquin River HEC-RAS model developed for Task Order 25 (TO25) of the Central Valley Floodplain Evaluation and Delineation (CVFED) project. The CVFED TO25 model covers the San Joaquin River, tributaries, and distributaries from below the Merced River to the Stockton Deep Water Ship Channel. PBI truncated the CVFED model moving the upstream boundary to Airport Way just below the Stanislaus River.

For this review, PBI provided a copy of the HEC-RAS model and a brief summary of the changes made to the CVFED TO25 model (see Attachment 1) along with some graphics of study results. PBI also provided a copy of a Technical Memorandum (TM) dated November 26, 2012 documenting the calibration of the CVFED model.

Comments

Calibration

PBI did not make a calibration simulation, relying on the calibration of the original CVFED model. PBI noted in verbal communication in lieu of recalibration they compared results from the modified model with those of the CVFED model and saw little difference. Future review should include a review of this comparison (it was not included in this initial review due to lack of documentation and limited time).

This may be acceptable for this initial water surface elevation determination for the main stem of the San Joaquin River, but for future uses, especially if this model is to be used for other reaches in the model domain, it is strongly recommended that the modified model be re-calibrated. Truncating the model has essentially produced a "new" model, and at the very least the calibration event (April 2006) should be simulated to verify calibration.

Relying on the CVFED calibration implies that the CVFED calibration is acceptable. It may have been acceptable for CVFED purposes, but for this more detailed analysis there appears to be significant room for improvement. Review of the CVFED calibration TM shows a significant underestimation of peak stage in Paradise Cut, with computed peak stage about 5 ft. below surveyed high water mark (HWM) near its upstream end, about 3 ft. below a HWM just downstream of the east branch of the UPRR, and about 2 ft. to 2.5 ft. below HWM's near I-5. Review of peak flows shows a potential significant underestimation of flow diversion to Paradise Cut, overestimation of flow to Old River at the San Joaquin River-Old River split, and corresponding underestimation of flow to San Joaquin River below Old River.

Hydrology
Boundary conditions are correctly applied.

Model Modification
The summary of changes includes the following changes:

- Changed junction modeling approach from "Energy Balance Method" to "Force Equal WS Elevations".
- Changed bridge modeling approach to use only the energy equation for low flow calculation.

PBI notes that sensitivity analysis performed for these changes very small effects, "less than 0.1'," in the San Joaquin River peak water surface elevations. It is agreed that these changes are unlikely to have significant effects on the computed maximum water surface elevations, but reasoning and justification for these changes needs to be documented.

The summary of changes notes that weir coefficients for storage area connections in right floodplain between Vernalis and RD 17 were changed (review of model indicated the coefficients were changed from 1 to 2). It is agreed that this is likely to produce a more conservative condition for the RD 17 levees, but the reasoning and justification for these changes needs to be documented.

From: Michael Rossiter
Sent: Thursday, May 15, 2014 4:38 PM
To: 'Mike Archer'
Cc: dpeterson
Subject: RE: Output from MBK River Islands lower SJR HEC-RAS model

Mike-

In response to your comments, PBI obtained calibration data for the 2006 storm event and completed a full recalibration of our revised TO25 HEC-RAS model. I have attached a section of our draft TM documenting this recalibration.

Please provide backcheck that we have appropriately addressed your comments. We are looking to finalize and send out our report by early next week.

Thank you again for your input. Please let me know if you have any questions.

Mike Rossiter, PE, CFM

Peterson Brustad, Inc.
1180 Iron Point Rd., Suite 260
Folsom, CA 95630
Office: (916) 608-2212 ext. 127
Cell: (916) 416-6599
Fax: (916) 608-2232

From: Mike Archer [mailto:archer@mbkengineers.com]
Sent: Wednesday, May 21, 2014 5:01 PM
To: Michael Rossiter
Cc: dpeterson; Susan Dellosso; Ramon Batista
Subject: Re: Output from MBK River Islands lower SJR HEC-RAS model

Mike,
I've had a chance to review the results of the revised and recalibrated TO25 HEC-RAS model. The revised model looks good for the most part and adequately addresses my earlier comments regarding calibration. The computed flows in the San Joaquin River, Paradise Cut, and Old River all look good. The maximum water surface elevation calibration looks good for the RD17 levee reach (downstream of UPRR), but a few areas, which are described below, still have room for improvement. However, since the flows and water surface elevation in the San Joaquin River along the RD17 levee are well calibrated, further refinement of the areas described below should not have significant effects on the computed water surface elevations along the RD17 levee.

Paradise Cut: Computed water surface elevation are improved but still appear to be 1 to 2 feet low.
San Joaquin River in vicinity of Paradise Weir (approx. 1 mile upstream and downstream of weir): Computed water surface elevation appears to be low. The computed WSE in the SJR at the weir is lower than some surveyed high water marks near the upstream end of Paradise Cut. The underestimation may be on the order of 1 to 1.5 feet at Paradise Weir.
Old River in vicinity of Middle River, and Middle River: Based on the streamgage in Middle River at Mowry Bridge (Undine Rd), the computed water surface at this location is underestimated by just over 1 foot. Due to the close proximity of this gage to Old River, about 1.4 miles, this underestimation translates to Old River and appears to affect Old River for a distance of about a mile upstream and downstream of Middle River.

As mentioned earlier, the areas of improvement described above are localized and should have little effect on the San Joaquin River downstream of the UPRR, but are noted here for documentation purposes in the event the model is used in the future for these areas.

It is my opinion that the model is well calibrated for the purposes of computing water surface elevations along the RD17 levees. If at this time you feel a need to address the areas described above where improvement is needed, please let me know and I can provide more details and support for my conclusions along with specific comments and suggestions related to technical modeling details.

Mike

From: Michael Rossiter
Sent: Thursday, May 22, 2014 2:20 PM
To: 'Mike Archer'
Cc: dpeterson; Susan Dellosso; Ramon Batista
Subject: RE: Output from MBK River Islands lower SJR HEC-RAS model

Mike-

Thank you for providing a backcheck to our calibration refinement. We plan on moving forward and finalizing our report given your concurrence that the WSP is well calibrated in the RD17 study area. We will include all comments as an attachment to our report.

Thank you again for your review. We feel this will strengthen our analysis as we move towards making ULDC findings.

Mike Rossiter, PE, CFM

Peterson Brustad, Inc.
1180 Iron Point Rd., Suite 260
Folsom, CA 95630
Office: (916) 608-2212 ext. 127
Cell: (916) 416-6599
Fax: (916) 608-2232

Attachment 5

Changes Made to CVFED FLO-2D Model
Regarding Flow Through Embankments

PETERSON . BRUSTAD . INC
ENGINEERING . CONSULTING

REVIEW OF CVFED TO25 FLO-2D MODEL
CHANGES MADE REGARDING FLOW THROUGH EMBANKMENTS

FLO-2D Grid Element	Model Changes
171	Added channel segment
172	Added levee segment and channel segment
246	Added levee segment
1228	Added channel segment
1229	Added channel segment
1381	Added channel segment
1382	Added channel segment
1384	Added levee segments
1463	Added levee segments
1464	Added levee segments
1539	Added channel segment
1540	Added channel segment
1541	Added channel segment
1542	Added channel segment
1545	Added levee segments
1627	Added levee segments
1718	Added levee segments
1810	Added levee segments
1903	Added levee segments
1904	Added levee segments
2205	Added channel segment
2810	Added levee segments
2913	Added levee segments
2914	Added levee segments
3017	Added levee segments
3120	Added levee segments
3121	Added levee segments
3223	Added levee segments
3308	Added channel segment
3325	Added levee segments
3326	Added levee segments
3428	Added levee segments
4339	Added channel segment
4340	Added channel segment
4346	Added channel segment
4347	Added channel segment
7855	Added channel segment
7959	Added channel segment
8379	Changed WRF to 1.0
12601	Added gap
12786	Added channel segment
12954	Added channel segment

Attachment 6

Changes Made to the CVFED FLO-2D Model
Regarding Manning's n Values

Grid Element	Original N Value	Revised N Value
246	0.157	0.145
247	0.174	0.147
248	0.171	0.149
249	0.115	0.065
250	0.114	0.062
251	0.112	0.060
252	0.097	0.057
297	0.130	0.060
298	0.120	0.040
299	0.144	0.093
300	0.100	0.041
301	0.100	0.040
302	0.100	0.040
303	0.085	0.040
348	0.105	0.104
349	0.147	0.095
350	0.121	0.042
351	0.120	0.040
352	0.178	0.155
353	0.130	0.088
354	0.100	0.040
355	0.100	0.040
356	0.094	0.040
357	0.064	0.040
358	0.042	0.040
370	0.142	0.136
371	0.100	0.097
403	0.128	0.122
404	0.120	0.040
405	0.120	0.040
406	0.120	0.040
407	0.154	0.108
408	0.131	0.086
409	0.100	0.040
410	0.100	0.040
411	0.100	0.040
412	0.100	0.040
413	0.095	0.040
414	0.052	0.051
423	0.099	0.084
424	0.100	0.054
425	0.100	0.040
426	0.084	0.041
460	0.119	0.089
461	0.120	0.040
462	0.120	0.040
463	0.120	0.040
464	0.117	0.040
465	0.100	0.040
466	0.100	0.040
467	0.100	0.040
468	0.100	0.040
469	0.100	0.040
470	0.093	0.047
471	0.042	0.060
479	0.060	0.040
480	0.100	0.040
481	0.100	0.040
482	0.100	0.040
483	0.100	0.040
484	0.113	0.107
518	0.139	0.085
519	0.120	0.040
520	0.120	0.040
521	0.120	0.040
522	0.111	0.040
523	0.100	0.040
524	0.100	0.040
525	0.100	0.040
526	0.100	0.040
527	0.100	0.040
528	0.083	0.076
529	0.041	0.062
533	0.040	0.044
534	0.040	0.049
535	0.040	0.052
536	0.040	0.052
537	0.047	0.052
538	0.090	0.040
539	0.085	0.040
540	0.079	0.040
541	0.075	0.040
542	0.142	0.131
578	0.133	0.088
579	0.120	0.040
580	0.120	0.040
581	0.120	0.040
582	0.148	0.112
583	0.115	0.064
584	0.100	0.040
585	0.100	0.040
586	0.100	0.040
587	0.100	0.048

Grid Element	Original N Value	Revised N Value
588	0.100	0.099
589	0.084	0.099
590	0.073	0.090
591	0.076	0.091
592	0.080	0.071
593	0.040	0.049
594	0.040	0.043
640	0.130	0.080
641	0.120	0.040
642	0.120	0.040
643	0.120	0.040
644	0.130	0.060
645	0.132	0.064
646	0.133	0.077
647	0.122	0.072
648	0.100	0.040
649	0.099	0.077
654	0.100	0.073
655	0.077	0.040
656	0.072	0.040
657	0.051	0.040
703	0.114	0.089
704	0.121	0.042
705	0.120	0.040
706	0.120	0.044
707	0.120	0.055
708	0.120	0.040
709	0.120	0.040
710	0.124	0.048
711	0.139	0.092
712	0.084	0.082
714	0.047	0.049
715	0.077	0.100
716	0.070	0.075
717	0.063	0.056
718	0.095	0.040
719	0.099	0.040
720	0.058	0.040
721	0.053	0.040
722	0.070	0.040
723	0.090	0.040
724	0.058	0.040
725	0.074	0.040
726	0.085	0.040
769	0.164	0.152
770	0.141	0.083
771	0.120	0.057
772	0.120	0.086
773	0.120	0.070
774	0.120	0.040
775	0.120	0.040
776	0.120	0.075
777	0.110	0.042
778	0.062	0.040
779	0.042	0.048
780	0.040	0.100
781	0.040	0.060
783	0.076	0.040
784	0.096	0.040
785	0.144	0.040
786	0.152	0.040
787	0.146	0.040
788	0.145	0.040
789	0.145	0.040
790	0.138	0.040
791	0.121	0.040
792	0.119	0.118
836	0.139	0.106
837	0.135	0.070
838	0.120	0.072
839	0.120	0.100
840	0.120	0.090
841	0.120	0.040
842	0.120	0.053
843	0.120	0.065
844	0.120	0.040
845	0.120	0.040
846	0.130	0.040
847	0.102	0.044
848	0.114	0.043
849	0.141	0.040
850	0.141	0.040
851	0.127	0.040
852	0.120	0.040
853	0.120	0.040
854	0.120	0.040
855	0.120	0.040
856	0.120	0.040
857	0.120	0.040
858	0.120	0.040
904	0.118	0.084
905	0.120	0.040
906	0.120	0.040

Grid Element	Original N Value	Revised N Value
907	0.120	0.080
908	0.120	0.100
909	0.120	0.090
910	0.120	0.040
911	0.120	0.077
912	0.120	0.042
913	0.120	0.040
914	0.120	0.040
915	0.120	0.040
916	0.120	0.040
917	0.120	0.040
918	0.120	0.040
919	0.120	0.040
920	0.120	0.040
921	0.120	0.040
922	0.120	0.040
923	0.120	0.040
924	0.120	0.040
925	0.120	0.040
926	0.120	0.040
927	0.120	0.042
973	0.095	0.086
974	0.118	0.062
975	0.120	0.062
976	0.120	0.063
977	0.120	0.093
978	0.120	0.106
979	0.120	0.100
980	0.120	0.078
981	0.120	0.063
982	0.120	0.045
983	0.120	0.045
984	0.120	0.045
985	0.120	0.045
986	0.120	0.045
987	0.120	0.045
988	0.120	0.079
989	0.120	0.071
990	0.120	0.040
991	0.120	0.040
992	0.100	0.043
993	0.077	0.041
994	0.075	0.040
995	0.087	0.040
996	0.120	0.040
997	0.120	0.043
1051	0.120	0.121
1053	0.120	0.042
1054	0.120	0.040
1055	0.120	0.040
1056	0.120	0.040
1057	0.120	0.040
1058	0.120	0.040
1059	0.120	0.040
1060	0.120	0.094
1061	0.120	0.082
1062	0.120	0.040
1063	0.120	0.040
1064	0.084	0.050
1065	0.040	0.079
1066	0.040	0.095
1067	0.043	0.042
1068	0.117	0.041
1069	0.117	0.044
1119	0.127	0.107
1120	0.120	0.087
1121	0.120	0.086
1122	0.120	0.085
1123	0.120	0.084
1124	0.120	0.102
1125	0.120	0.067
1126	0.120	0.040
1127	0.120	0.040
1128	0.120	0.040
1129	0.120	0.040
1130	0.120	0.040
1131	0.120	0.040
1132	0.120	0.040
1133	0.120	0.093
1134	0.120	0.081
1135	0.120	0.040
1136	0.110	0.040
1137	0.054	0.040
1192	0.128	0.092
1193	0.123	0.046
1194	0.120	0.040
1195	0.120	0.040
1196	0.120	0.040
1197	0.120	0.040
1198	0.120	0.081
1199	0.120	0.043
1200	0.120	0.040
1201	0.120	0.040

Grid Element	Original N Value	Revised N Value
1202	0.120	0.040
1203	0.120	0.040
1204	0.120	0.051
1205	0.120	0.091
1206	0.120	0.094
1207	0.120	0.111
1208	0.120	0.075
1209	0.120	0.045
1210	0.068	0.040
1267	0.133	0.067
1268	0.120	0.040
1269	0.120	0.040
1270	0.120	0.040
1271	0.120	0.040
1272	0.120	0.053
1273	0.120	0.069
1274	0.120	0.040
1275	0.120	0.040
1276	0.120	0.040
1277	0.120	0.040
1278	0.120	0.040
1279	0.120	0.053
1280	0.120	0.100
1281	0.120	0.099
1282	0.120	0.097
1283	0.120	0.072
1284	0.120	0.039
1285	0.068	0.040
1343	0.112	0.118
1344	0.120	0.098
1345	0.120	0.099
1346	0.120	0.099
1347	0.120	0.100
1348	0.120	0.099
1349	0.120	0.101
1350	0.120	0.102
1351	0.120	0.103
1352	0.120	0.106
1353	0.120	0.109
1354	0.120	0.111
1355	0.120	0.113
1356	0.120	0.114
1357	0.120	0.115
1358	0.120	0.116
1359	0.120	0.118
1360	0.120	0.119
1378	0.102	0.040
1379	0.069	0.040
1381	0.084	0.072
1382	0.165	0.131
1383	0.164	0.128
1384	0.138	0.114
1422	0.134	0.142
1428	0.120	0.115
1455	0.186	0.185
1456	0.131	0.064
1457	0.156	0.040
1460	0.070	0.040
1461	0.120	0.040
1462	0.120	0.040
1463	0.116	0.053
1502	0.109	0.115
1503	0.120	0.121
1510	0.120	0.125
1511	0.120	0.125
1512	0.120	0.125
1513	0.120	0.125
1514	0.120	0.121
1535	0.105	0.087
1536	0.148	0.045
1537	0.132	0.052
1538	0.197	0.040
1539	0.177	0.040
1540	0.126	0.064
1541	0.071	0.044
1542	0.119	0.040
1543	0.120	0.040
1544	0.119	0.043
1546	0.150	0.112
1547	0.150	0.041
1584	0.117	0.119
1585	0.125	0.126
1596	0.120	0.115
1618	0.163	0.055
1619	0.125	0.108
1620	0.191	0.049
1621	0.174	0.066
1622	0.141	0.131
1624	0.084	0.073
1625	0.100	0.040
1626	0.120	0.040
1627	0.128	0.092
1628	0.150	0.043

Grid Element	Original N Value	Revised N Value
1629	0.150	0.040
1630	0.150	0.063
1631	0.150	0.110
1632	0.150	0.044
1633	0.150	0.040
1634	0.150	0.040
1635	0.150	0.040
1636	0.150	0.040
1637	0.150	0.040
1676	0.124	0.128
1687	0.120	0.115
1709	0.159	0.066
1710	0.135	0.105
1711	0.127	0.113
1716	0.082	0.074
1717	0.119	0.093
1718	0.127	0.098
1719	0.150	0.040
1720	0.150	0.040
1721	0.150	0.047
1722	0.150	0.124
1723	0.150	0.126
1724	0.150	0.054
1725	0.150	0.122
1726	0.150	0.078
1727	0.150	0.040
1728	0.150	0.040
1729	0.150	0.040
1768	0.120	0.127
1779	0.120	0.115
1810	0.132	0.131
1811	0.147	0.043
1812	0.150	0.040
1813	0.150	0.040
1814	0.150	0.044
1815	0.150	0.134
1816	0.150	0.148
1818	0.150	0.149
1819	0.150	0.090
1820	0.150	0.040
1821	0.150	0.040
1822	0.151	0.042
1860	0.095	0.100
1861	0.123	0.126
1872	0.134	0.128
1904	0.137	0.056
1905	0.150	0.040
1906	0.150	0.040
1907	0.150	0.084
1913	0.167	0.127
1914	0.158	0.098
1915	0.123	0.109
1955	0.120	0.115
1956	0.120	0.115
1957	0.120	0.115
1958	0.120	0.115
1959	0.120	0.115
1960	0.120	0.115
1961	0.120	0.115
1962	0.120	0.115
1963	0.120	0.115
1964	0.120	0.115
1965	0.120	0.115
1966	0.135	0.132
1998	0.088	0.070
1999	0.102	0.071
2000	0.101	0.049
2001	0.107	0.106
2278	0.047	0.040
2279	0.053	0.052
2377	0.080	0.048
2378	0.072	0.056
2478	0.100	0.058
2479	0.100	0.050
2480	0.140	0.114
2580	0.104	0.088
2581	0.090	0.067
2582	0.138	0.124
3820	0.099	0.085
3821	0.108	0.095
3822	0.135	0.125
3922	0.140	0.048
3923	0.130	0.040
3924	0.132	0.054
4025	0.067	0.040
4026	0.138	0.040
4027	0.133	0.052
4129	0.068	0.040
4130	0.075	0.051
4231	0.069	0.087
4232	0.040	0.070
4233	0.040	0.057
4336	0.057	0.099

Grid Element	Original N Value	Revised N Value
4337	0.040	0.100
4338	0.040	0.076
4552	0.084	0.080
4553	0.066	0.040
4554	0.073	0.040
4555	0.069	0.040
4556	0.077	0.051
4663	0.115	0.066
4664	0.200	0.040
4665	0.200	0.040
4666	0.159	0.040
4667	0.141	0.051
4774	0.110	0.066
4775	0.133	0.040
4776	0.129	0.040
4777	0.130	0.040
4778	0.142	0.050
4888	0.082	0.052
4889	0.127	0.068
5444	0.145	0.117
5554	0.175	0.131
5663	0.180	0.138
5766	0.112	0.103
5767	0.138	0.040
5768	0.140	0.040
5769	0.141	0.040
5770	0.147	0.044
5771	0.153	0.050
5772	0.152	0.046
5773	0.043	0.040
5874	0.104	0.082
5875	0.150	0.040
5876	0.150	0.040
5877	0.150	0.040
5878	0.150	0.040
5879	0.150	0.040
5880	0.150	0.040
5881	0.046	0.040
5983	0.115	0.077
5984	0.150	0.040
5985	0.146	0.040
5986	0.141	0.040
5987	0.141	0.040
5988	0.149	0.040
5989	0.150	0.040
5990	0.049	0.040
6091	0.126	0.069
6092	0.150	0.040
6093	0.103	0.040
6096	0.140	0.040
6097	0.150	0.040
6098	0.053	0.040
6198	0.091	0.059
6199	0.124	0.040
6200	0.130	0.040
6201	0.102	0.040
6202	0.105	0.040
6203	0.146	0.040
6204	0.150	0.040
6205	0.056	0.040
6304	0.112	0.048
6305	0.150	0.040
6306	0.150	0.040
6307	0.150	0.040
6308	0.150	0.040
6309	0.150	0.040
6310	0.150	0.040
6311	0.059	0.040
6409	0.042	0.041
6410	0.081	0.040
6411	0.150	0.040
6412	0.150	0.040
6413	0.150	0.040
6414	0.150	0.040
6415	0.150	0.040
6416	0.063	0.040
6512	0.101	0.095
6513	0.065	0.040
6514	0.183	0.040
6515	0.194	0.040
6516	0.196	0.040
6517	0.197	0.040
6518	0.198	0.040
6519	0.199	0.040
6520	0.076	0.040
6529	0.049	0.047
6530	0.140	0.119
6614	0.138	0.077
6615	0.200	0.040
6616	0.200	0.040
6617	0.200	0.040
6618	0.200	0.040
6619	0.200	0.040

Grid Element	Original N Value	Revised N Value
6620	0.200	0.040
6621	0.200	0.040
6622	0.076	0.040
6631	0.043	0.040
6632	0.120	0.047
6633	0.120	0.114
6715	0.153	0.068
6716	0.200	0.040
6717	0.200	0.040
6718	0.200	0.040
6719	0.200	0.040
6720	0.200	0.040
6721	0.200	0.040
6722	0.200	0.040
6723	0.077	0.040
6733	0.119	0.040
6734	0.120	0.099
6816	0.168	0.059
6817	0.200	0.040
6818	0.200	0.040
6819	0.200	0.040
6820	0.200	0.040
6821	0.200	0.040
6822	0.200	0.040
6823	0.200	0.040
6824	0.077	0.040
6834	0.115	0.074
6835	0.120	0.106
6917	0.183	0.050
6918	0.200	0.040
6919	0.200	0.040
6920	0.200	0.040
6921	0.200	0.040
6922	0.200	0.040
6923	0.200	0.040
6924	0.200	0.040
6925	0.078	0.040
6946	0.100	0.109
7018	0.107	0.106
7019	0.197	0.042
7020	0.200	0.040
7021	0.200	0.040
7022	0.200	0.040
7023	0.200	0.040
7024	0.200	0.040
7025	0.200	0.040
7026	0.200	0.040
7027	0.079	0.040
7048	0.100	0.112
7049	0.100	0.088
7120	0.117	0.098
7121	0.200	0.040
7122	0.200	0.040
7123	0.200	0.040
7124	0.200	0.040
7125	0.200	0.040
7126	0.200	0.040
7127	0.200	0.040
7128	0.200	0.040
7129	0.082	0.040
7148	0.100	0.099
7149	0.101	0.098
7150	0.101	0.103
7151	0.100	0.076
7222	0.105	0.083
7223	0.132	0.040
7224	0.129	0.040
7225	0.126	0.040
7226	0.123	0.040
7227	0.120	0.040
7228	0.117	0.040
7229	0.114	0.040
7230	0.135	0.065
7231	0.086	0.071
7246	0.074	0.044
7247	0.100	0.044
7248	0.100	0.051
7249	0.100	0.042
7250	0.114	0.040
7251	0.120	0.040
7252	0.112	0.054
7253	0.100	0.036
7348	0.082	0.048
7349	0.100	0.040
7350	0.100	0.049
7351	0.100	0.059
7352	0.109	0.044
7353	0.113	0.040
7354	0.109	0.046
7355	0.100	0.035
7356	0.100	0.032
7450	0.106	0.071
7451	0.098	0.040

Grid Element	Original N Value	Revised N Value
7452	0.100	0.050
7454	0.100	0.052
7455	0.100	0.040
7456	0.100	0.040
7457	0.100	0.040
7458	0.100	0.040
7515	0.062	0.061
7551	0.120	0.119
7552	0.111	0.107
7553	0.125	0.109
7554	0.132	0.114
7556	0.133	0.116
7557	0.133	0.113
7558	0.125	0.096
7559	0.100	0.040
7560	0.100	0.040
7561	0.100	0.040
7617	0.086	0.065
7618	0.120	0.046
7654	0.120	0.087
7655	0.124	0.053
7656	0.137	0.102
7657	0.141	0.117
7662	0.100	0.078
7663	0.100	0.050
7664	0.100	0.040
7720	0.128	0.108
7721	0.120	0.051
7758	0.120	0.076
7759	0.120	0.040
7760	0.121	0.045
7761	0.125	0.059
7762	0.128	0.070
7763	0.127	0.065
7764	0.123	0.060
7765	0.105	0.086
7767	0.100	0.094
7823	0.143	0.124
7824	0.120	0.042
7825	0.120	0.054
7826	0.120	0.054
7827	0.140	0.119
7849	0.042	0.041
7853	0.060	0.043
7854	0.064	0.041
7861	0.105	0.068
7862	0.120	0.040
7863	0.120	0.040
7864	0.119	0.040
7865	0.114	0.040
7866	0.113	0.040
7867	0.112	0.040
7868	0.105	0.059
7869	0.100	0.072
7870	0.100	0.070
7871	0.082	0.076
7927	0.134	0.123
7928	0.120	0.072
7929	0.120	0.074
7930	0.120	0.076
7931	0.130	0.116
7950	0.157	0.066
7951	0.193	0.040
7952	0.198	0.040
7953	0.200	0.097
7957	0.200	0.069
7958	0.195	0.043
7965	0.070	0.040
7966	0.120	0.040
7967	0.126	0.040
7968	0.122	0.040
7969	0.100	0.040
7970	0.100	0.046
7971	0.100	0.050
7972	0.100	0.040
7973	0.100	0.040
7974	0.100	0.040
7975	0.056	0.040
8055	0.142	0.075
8056	0.200	0.040
8057	0.200	0.040
8058	0.200	0.098
8062	0.200	0.073
8063	0.200	0.040
8064	0.156	0.154
8070	0.047	0.040
8071	0.079	0.040
8072	0.146	0.040
8073	0.136	0.040
8074	0.100	0.040
8075	0.100	0.073
8076	0.100	0.095
8077	0.100	0.040

Grid Element	Original N Value	Revised N Value
8078	0.100	0.040
8079	0.100	0.040
8080	0.061	0.040
8160	0.103	0.098
8161	0.172	0.057
8162	0.200	0.040
8163	0.200	0.109
8167	0.200	0.078
8168	0.200	0.040
8169	0.155	0.144
8175	0.052	0.042
8176	0.092	0.040
8177	0.100	0.040
8178	0.100	0.040
8179	0.100	0.040
8180	0.100	0.049
8181	0.100	0.054
8182	0.100	0.040
8183	0.100	0.040
8184	0.100	0.040
8185	0.065	0.040
8266	0.101	0.099
8267	0.140	0.071
8268	0.172	0.070
8269	0.174	0.085
8270	0.171	0.091
8271	0.171	0.100
8272	0.162	0.075
8273	0.170	0.057
8274	0.132	0.114
8280	0.067	0.052
8281	0.137	0.040
8282	0.139	0.040
8283	0.135	0.040
8284	0.116	0.040
8285	0.117	0.040
8286	0.086	0.040
8287	0.060	0.040
8288	0.058	0.044
8289	0.055	0.062
8290	0.046	0.040
8371	0.103	0.097
8372	0.139	0.053
8373	0.149	0.040
8374	0.142	0.040
8375	0.137	0.040
8376	0.133	0.040
8377	0.129	0.040
8378	0.110	0.040
8380	0.077	0.088
8381	0.119	0.133
8386	0.167	0.158
8387	0.108	0.040
8388	0.104	0.040
8389	0.105	0.040
8390	0.120	0.040
8391	0.120	0.040
8392	0.079	0.040
8394	0.040	0.056
8395	0.040	0.099
8396	0.040	0.099
8397	0.040	0.074
8478	0.115	0.082
8479	0.150	0.040
8480	0.117	0.040
8487	0.058	0.080
8488	0.040	0.100
8489	0.078	0.110
8490	0.167	0.169
8493	0.188	0.185
8494	0.100	0.040
8495	0.100	0.040
8496	0.101	0.040
8497	0.120	0.040
8498	0.120	0.040
8499	0.084	0.040
8501	0.040	0.043
8502	0.040	0.046
8503	0.040	0.044
8504	0.040	0.042
8586	0.119	0.102
8587	0.150	0.105
8588	0.121	0.090
8595	0.077	0.094
8596	0.042	0.100
8597	0.083	0.100
8598	0.099	0.100
8602	0.072	0.040
8603	0.100	0.040
8604	0.100	0.040
8605	0.104	0.040
8606	0.105	0.040
8607	0.097	0.040

Grid Element	Original N Value	Revised N Value
8608	0.054	0.040
8667	0.150	0.130
8668	0.120	0.073
8669	0.120	0.070
8670	0.120	0.066
8671	0.120	0.116
8704	0.096	0.109
8705	0.063	0.100
8711	0.093	0.040
8712	0.100	0.040
8713	0.100	0.040
8714	0.100	0.040
8715	0.100	0.040
8716	0.100	0.040
8717	0.059	0.040
8776	0.133	0.066
8777	0.120	0.040
8778	0.120	0.040
8779	0.120	0.040
8780	0.120	0.088
8813	0.101	0.110
8814	0.064	0.100
8820	0.098	0.064
8821	0.100	0.041
8822	0.100	0.040
8823	0.100	0.040
8824	0.100	0.040
8825	0.100	0.040
8826	0.060	0.040
8886	0.107	0.091
8887	0.122	0.043
8888	0.120	0.040
8889	0.120	0.040
8890	0.120	0.040
8891	0.120	0.057
8924	0.109	0.112
8925	0.044	0.074
8928	0.089	0.086
8929	0.101	0.100
8931	0.084	0.056
8932	0.090	0.070
8933	0.100	0.068
8934	0.100	0.077
8935	0.100	0.045
8936	0.100	0.040
8937	0.061	0.040
8996	0.133	0.132
8997	0.120	0.099
8998	0.127	0.054
8999	0.120	0.040
9000	0.120	0.040
9001	0.120	0.040
9002	0.120	0.040
9003	0.120	0.040
9004	0.120	0.091
9005	0.122	0.072
9006	0.147	0.139
9039	0.077	0.040
9040	0.120	0.040
9041	0.120	0.093
9043	0.104	0.057
9044	0.100	0.040
9045	0.100	0.064
9046	0.100	0.097
9047	0.100	0.051
9048	0.100	0.040
9049	0.063	0.040
9110	0.120	0.091
9111	0.120	0.040
9112	0.120	0.040
9113	0.120	0.040
9114	0.120	0.043
9115	0.120	0.068
9116	0.120	0.090
9117	0.120	0.041
9118	0.120	0.040
9119	0.127	0.066
9120	0.149	0.147
9144	0.138	0.040
9145	0.088	0.040
9152	0.069	0.040
9153	0.107	0.040
9154	0.120	0.062
9155	0.120	0.083
9156	0.105	0.051
9157	0.100	0.040
9158	0.100	0.040
9159	0.100	0.050
9160	0.100	0.069
9161	0.100	0.044
9162	0.064	0.040
9226	0.132	0.131
9227	0.120	0.045

Grid Element	Original N Value	Revised N Value
9228	0.120	0.043
9229	0.120	0.066
9230	0.120	0.104
9233	0.120	0.048
9234	0.120	0.040
9235	0.120	0.040
9236	0.131	0.080
9260	0.093	0.040
9261	0.069	0.040
9269	0.044	0.040
9270	0.111	0.040
9271	0.120	0.040
9272	0.106	0.041
9273	0.076	0.042
9274	0.067	0.040
9275	0.068	0.040
9276	0.105	0.042
9277	0.107	0.066
9278	0.060	0.045
9344	0.120	0.099
9345	0.120	0.116
9348	0.120	0.102
9349	0.120	0.067
9350	0.120	0.040
9351	0.120	0.040
9352	0.120	0.040
9353	0.120	0.040
9354	0.135	0.097
9356	0.140	0.117
9357	0.083	0.075
9362	0.040	0.067
9363	0.040	0.075
9364	0.040	0.056
9383	0.109	0.131
9384	0.112	0.140
9385	0.115	0.142
9386	0.118	0.147
9387	0.120	0.149
9388	0.120	0.149
9389	0.120	0.151
9390	0.120	0.124
9391	0.119	0.040
9392	0.111	0.040
9393	0.143	0.040
9394	0.150	0.040
9395	0.120	0.040
9396	0.048	0.040
9466	0.120	0.076
9467	0.120	0.040
9468	0.120	0.040
9469	0.120	0.040
9470	0.120	0.040
9471	0.120	0.040
9472	0.122	0.041
9473	0.147	0.064
9474	0.150	0.040
9475	0.117	0.080
9480	0.054	0.087
9481	0.040	0.074
9482	0.040	0.056
9501	0.117	0.141
9502	0.120	0.150
9503	0.120	0.148
9504	0.120	0.150
9505	0.120	0.150
9506	0.116	0.150
9507	0.113	0.150
9508	0.120	0.126
9509	0.120	0.040
9510	0.120	0.040
9511	0.144	0.040
9512	0.150	0.040
9513	0.150	0.040
9514	0.068	0.040
9586	0.120	0.104
9587	0.120	0.040
9588	0.120	0.040
9589	0.120	0.040
9590	0.120	0.040
9591	0.124	0.040
9592	0.144	0.040
9593	0.150	0.040
9594	0.150	0.040
9595	0.118	0.079
9621	0.117	0.138
9622	0.120	0.150
9623	0.124	0.150
9624	0.140	0.150
9625	0.141	0.150
9626	0.120	0.150
9627	0.084	0.105
9628	0.120	0.058
9629	0.120	0.040

Grid Element	Original N Value	Revised N Value
9630	0.074	0.086
9631	0.045	0.092
9632	0.044	0.088
9633	0.150	0.040
9634	0.069	0.040
9707	0.120	0.119
9708	0.120	0.042
9709	0.120	0.040
9710	0.120	0.040
9711	0.120	0.040
9712	0.128	0.040
9713	0.148	0.040
9714	0.150	0.040
9715	0.150	0.040
9716	0.150	0.040
9717	0.119	0.078
9743	0.115	0.137
9744	0.120	0.150
9745	0.125	0.150
9748	0.134	0.150
9749	0.079	0.099
9750	0.119	0.051
9751	0.120	0.108
9752	0.075	0.117
9753	0.040	0.047
9755	0.147	0.040
9756	0.071	0.040
9839	0.120	0.117
9840	0.120	0.108
9841	0.120	0.040
9842	0.120	0.040
9843	0.120	0.040
9844	0.124	0.040
9845	0.137	0.040
9846	0.137	0.040
9847	0.137	0.040
9848	0.137	0.061
9849	0.137	0.075
9850	0.107	0.089
9876	0.117	0.139
9877	0.120	0.150
9878	0.120	0.150
9879	0.121	0.150
9880	0.121	0.150
9881	0.133	0.151
9882	0.124	0.115
9883	0.115	0.045
9884	0.120	0.075
9885	0.105	0.070
9886	0.093	0.043
9887	0.077	0.040
9888	0.067	0.040
9889	0.046	0.040
9895	0.066	0.040
9896	0.103	0.040
9897	0.117	0.040
9898	0.080	0.040
9982	0.120	0.113
9983	0.120	0.040
9984	0.120	0.040
9985	0.120	0.040
9986	0.120	0.040
9987	0.120	0.040
9988	0.120	0.040
9989	0.120	0.040
9990	0.120	0.040
9991	0.120	0.093
10019	0.123	0.143
10020	0.120	0.150
10021	0.120	0.150
10022	0.120	0.150
10023	0.120	0.150
10024	0.120	0.150
10025	0.120	0.123
10026	0.120	0.040
10027	0.120	0.040
10028	0.120	0.040
10029	0.120	0.040
10030	0.098	0.040
10038	0.062	0.040
10039	0.157	0.040
10040	0.200	0.040
10041	0.151	0.040
10130	0.079	0.040
10131	0.094	0.040
10132	0.119	0.040
10133	0.120	0.040
10134	0.120	0.040
10135	0.120	0.040
10136	0.120	0.040
10137	0.120	0.040
10138	0.120	0.106
10162	0.058	0.046

Grid Element	Original N Value	Revised N Value
10163	0.067	0.040
10164	0.149	0.120
10165	0.200	0.155
10166	0.128	0.116
10168	0.120	0.121
10169	0.120	0.127
10170	0.120	0.132
10171	0.120	0.138
10172	0.112	0.114
10173	0.099	0.053
10174	0.100	0.070
10175	0.083	0.067
10176	0.082	0.069
10177	0.071	0.070
10178	0.040	0.071
10179	0.040	0.072
10180	0.040	0.073
10181	0.040	0.075
10182	0.040	0.076
10183	0.040	0.077
10184	0.040	0.041
10187	0.085	0.048
10188	0.153	0.050
10189	0.110	0.040
10190	0.164	0.040
10191	0.165	0.040
10192	0.051	0.040
10280	0.060	0.058
10281	0.111	0.040
10282	0.120	0.040
10283	0.120	0.040
10284	0.123	0.040
10285	0.135	0.040
10286	0.136	0.040
10287	0.136	0.040
10288	0.137	0.075
10289	0.116	0.091
10290	0.099	0.053
10291	0.097	0.040
10292	0.098	0.040
10293	0.100	0.040
10294	0.111	0.050
10295	0.116	0.052
10296	0.116	0.051
10297	0.117	0.049
10298	0.117	0.048
10299	0.118	0.046
10300	0.119	0.044
10301	0.105	0.085
10312	0.164	0.092
10313	0.200	0.040
10314	0.200	0.040
10315	0.200	0.029
10316	0.127	0.098
10324	0.078	0.109
10325	0.040	0.100
10326	0.040	0.100
10327	0.040	0.100
10328	0.040	0.100
10329	0.040	0.100
10330	0.040	0.100
10331	0.040	0.100
10332	0.040	0.100
10333	0.040	0.100
10334	0.040	0.045
10338	0.050	0.040
10339	0.097	0.040
10340	0.200	0.040
10341	0.200	0.040
10342	0.065	0.040
10434	0.153	0.136
10435	0.120	0.080
10436	0.120	0.073
10437	0.120	0.045
10438	0.125	0.040
10439	0.139	0.040
10440	0.111	0.040
10441	0.146	0.040
10442	0.150	0.040
10443	0.111	0.085
10444	0.120	0.041
10445	0.120	0.040
10446	0.120	0.040
10447	0.120	0.040
10448	0.120	0.040
10449	0.120	0.040
10450	0.120	0.040
10451	0.120	0.040
10452	0.120	0.040
10453	0.120	0.040
10454	0.120	0.040
10455	0.106	0.081
10466	0.160	0.096

Grid Element	Original N Value	Revised N Value
10467	0.200	0.040
10468	0.200	0.040
10469	0.199	0.025
10470	0.122	0.108
10478	0.081	0.110
10479	0.040	0.100
10480	0.040	0.100
10481	0.040	0.100
10482	0.040	0.100
10483	0.040	0.100
10484	0.040	0.100
10485	0.040	0.100
10486	0.040	0.100
10487	0.040	0.100
10488	0.040	0.048
10493	0.041	0.040
10494	0.128	0.040
10495	0.198	0.040
10496	0.077	0.040
10596	0.120	0.058
10597	0.124	0.040
10598	0.135	0.040
10599	0.100	0.040
10600	0.145	0.124
10601	0.148	0.101
10602	0.107	0.082
10603	0.120	0.040
10604	0.120	0.040
10605	0.120	0.040
10606	0.110	0.040
10607	0.073	0.040
10608	0.094	0.040
10609	0.117	0.040
10610	0.120	0.040
10611	0.120	0.040
10612	0.120	0.040
10613	0.120	0.040
10614	0.114	0.083
10625	0.156	0.100
10626	0.200	0.040
10627	0.200	0.040
10628	0.187	0.031
10629	0.142	0.095
10637	0.113	0.118
10638	0.095	0.114
10639	0.090	0.112
10640	0.088	0.112
10641	0.083	0.111
10642	0.080	0.110
10643	0.062	0.093
10644	0.040	0.071
10645	0.040	0.071
10646	0.040	0.071
10647	0.040	0.046
10654	0.077	0.040
10655	0.069	0.040
10756	0.132	0.075
10757	0.120	0.064
10758	0.120	0.077
10759	0.120	0.053
10760	0.121	0.040
10761	0.126	0.040
10762	0.109	0.040
10763	0.137	0.074
10764	0.132	0.087
10765	0.111	0.066
10766	0.120	0.040
10767	0.120	0.040
10768	0.120	0.040
10769	0.091	0.040
10772	0.167	0.040
10773	0.184	0.040
10774	0.163	0.040
10775	0.141	0.042
10776	0.163	0.126
10777	0.198	0.197
10788	0.152	0.104
10789	0.200	0.040
10790	0.200	0.040
10791	0.178	0.037
10792	0.155	0.085
10921	0.118	0.117
10922	0.093	0.081
10923	0.088	0.064
10924	0.120	0.054
10925	0.120	0.040
10926	0.120	0.048
10927	0.120	0.045
10928	0.120	0.110
10930	0.117	0.049
10931	0.120	0.040
10932	0.120	0.040
10933	0.120	0.040

Grid Element	Original N Value	Revised N Value
10934	0.082	0.040
10935	0.041	0.040
10936	0.046	0.040
10937	0.163	0.040
10938	0.185	0.040
10939	0.199	0.040
10940	0.176	0.040
10941	0.132	0.065
10942	0.195	0.189
10950	0.127	0.165
10951	0.159	0.160
10953	0.179	0.091
10954	0.200	0.040
10955	0.200	0.037
10956	0.175	0.042
10957	0.157	0.062
10958	0.073	0.064
11087	0.127	0.105
11088	0.117	0.091
11089	0.111	0.082
11090	0.120	0.057
11091	0.120	0.040
11092	0.120	0.117
11095	0.101	0.100
11096	0.068	0.040
11097	0.091	0.040
11098	0.113	0.040
11099	0.120	0.040
11100	0.120	0.040
11101	0.115	0.040
11102	0.102	0.040
11103	0.120	0.040
11104	0.120	0.040
11105	0.126	0.040
11106	0.132	0.040
11107	0.128	0.055
11108	0.184	0.167
11116	0.133	0.216
11119	0.200	0.092
11120	0.200	0.040
11121	0.194	0.029
11122	0.181	0.050
11123	0.159	0.040
11124	0.060	0.040
11254	0.165	0.130
11255	0.120	0.040
11256	0.120	0.040
11257	0.120	0.040
11258	0.120	0.040
11259	0.112	0.104
11266	0.055	0.040
11267	0.091	0.054
11268	0.145	0.091
11269	0.128	0.057
11270	0.120	0.040
11271	0.120	0.040
11272	0.121	0.043
11273	0.156	0.111
11274	0.196	0.191
11283	0.108	0.145
11284	0.107	0.109
11285	0.104	0.106
11286	0.101	0.065
11287	0.098	0.040
11288	0.122	0.051
11289	0.200	0.040
11290	0.162	0.042
11291	0.102	0.093
11303	0.102	0.046
11304	0.048	0.040
11422	0.175	0.159
11423	0.123	0.105
11424	0.120	0.077
11425	0.120	0.040
11426	0.119	0.114
11437	0.179	0.157
11438	0.155	0.110
11439	0.187	0.173
11455	0.106	0.103
11456	0.127	0.113
11457	0.125	0.113
11470	0.091	0.048
11471	0.049	0.040
11591	0.135	0.089
11592	0.120	0.044
11593	0.120	0.079
11594	0.120	0.103
11759	0.132	0.079
11760	0.120	0.040
11761	0.119	0.097
11767	0.200	0.186
11768	0.200	0.169
11801	0.040	0.062

Grid Element	Original N Value	Revised N Value
11802	0.050	0.075
11926	0.116	0.115
11927	0.100	0.099
11928	0.091	0.084
11929	0.051	0.041
11931	0.200	0.186
11932	0.200	0.130
11933	0.200	0.079
11934	0.200	0.042
11935	0.200	0.061
11936	0.200	0.199
11968	0.040	0.078
11969	0.040	0.088
12096	0.100	0.073
12097	0.067	0.041
12099	0.200	0.168
12100	0.200	0.040
12101	0.200	0.040
12102	0.200	0.040
12103	0.196	0.043
12104	0.163	0.133
12105	0.121	0.102
12106	0.092	0.063
12136	0.040	0.076
12137	0.040	0.095
12138	0.040	0.063
12139	0.040	0.061
12140	0.040	0.055
12264	0.100	0.061
12265	0.060	0.047
12268	0.199	0.070
12269	0.175	0.055
12270	0.138	0.077
12271	0.105	0.097
12273	0.101	0.098
12274	0.114	0.043
12304	0.040	0.064
12305	0.040	0.081
12306	0.040	0.081
12307	0.040	0.080
12308	0.040	0.068
12432	0.089	0.074
12436	0.109	0.106
12442	0.118	0.107
12470	0.046	0.041
12471	0.046	0.040
12472	0.046	0.040
12473	0.046	0.040
12474	0.046	0.040
12475	0.043	0.040
12611	0.100	0.183
12612	0.149	0.134
12613	0.119	0.081
12638	0.100	0.057
12639	0.100	0.040
12640	0.100	0.040
12641	0.100	0.040
12642	0.100	0.040
12643	0.077	0.040
12777	0.110	0.098
12778	0.146	0.091
12779	0.136	0.129
12780	0.118	0.106
12781	0.103	0.057
12807	0.100	0.088
12808	0.100	0.057
12809	0.100	0.040
12810	0.100	0.040
12811	0.080	0.040
12946	0.091	0.089
12947	0.097	0.040
12948	0.120	0.102
12953	0.128	0.110
12954	0.111	0.069
12955	0.150	0.144
12967	0.120	0.066
12968	0.120	0.056
12969	0.120	0.053
12970	0.120	0.051
12971	0.120	0.049
12972	0.120	0.047
12973	0.120	0.045
12974	0.136	0.101
12977	0.100	0.068
12978	0.100	0.040
12979	0.100	0.040
12980	0.083	0.040
13116	0.075	0.068
13117	0.079	0.077
13120	0.119	0.102
13121	0.103	0.054
13122	0.100	0.040
13123	0.100	0.040

Grid Element	Original N Value	Revised N Value
13124	0.116	0.105
13136	0.120	0.052
13137	0.120	0.040
13138	0.120	0.040
13139	0.120	0.040
13140	0.120	0.040
13141	0.120	0.040
13142	0.114	0.059
13143	0.110	0.101
13146	0.135	0.097
13147	0.120	0.040
13148	0.108	0.040
13149	0.086	0.040
13289	0.076	0.040
13290	0.100	0.040
13291	0.100	0.040
13292	0.100	0.040
13293	0.105	0.092
13305	0.117	0.086
13306	0.117	0.048
13307	0.117	0.050
13308	0.116	0.052
13309	0.114	0.058
13310	0.105	0.084
13315	0.134	0.123
13316	0.138	0.054
13317	0.136	0.057
13318	0.117	0.061
13331	0.074	0.065
13332	0.078	0.075
13459	0.068	0.041
13460	0.104	0.057
13461	0.105	0.059
13462	0.106	0.061
13463	0.082	0.072
13474	0.114	0.102
13475	0.113	0.070
13486	0.138	0.129
13496	0.103	0.091
13497	0.113	0.062
13498	0.088	0.043
13499	0.061	0.040
13500	0.064	0.040
13501	0.102	0.040
13502	0.104	0.089
13644	0.120	0.094
13645	0.120	0.045
13646	0.120	0.070
13647	0.120	0.069
13648	0.120	0.069
13649	0.120	0.102
13655	0.150	0.088
13656	0.150	0.043
13657	0.150	0.053
13658	0.150	0.055
13659	0.120	0.055
13665	0.115	0.095
13666	0.119	0.042
13667	0.120	0.040
13668	0.120	0.040
13669	0.120	0.040
13670	0.120	0.040
13671	0.120	0.040
13672	0.104	0.089
13813	0.138	0.073
13814	0.143	0.051
13815	0.140	0.040
13816	0.120	0.040
13817	0.120	0.059
13818	0.120	0.099
13819	0.120	0.055
13820	0.120	0.106
13824	0.127	0.109
13825	0.150	0.040
13826	0.150	0.068
13827	0.150	0.074
13828	0.150	0.040
13829	0.121	0.048
13835	0.114	0.093
13836	0.102	0.040
13837	0.101	0.040
13838	0.101	0.040
13839	0.117	0.040
13840	0.120	0.040
13841	0.102	0.040
13842	0.101	0.092
13982	0.120	0.107
13983	0.143	0.045
13984	0.150	0.040
13985	0.145	0.040
13986	0.120	0.040
13987	0.120	0.044
13988	0.120	0.066

Grid Element	Original N Value	Revised N Value
13989	0.120	0.064
13990	0.120	0.058
13991	0.120	0.103
13992	0.120	0.105
13993	0.120	0.083
13994	0.123	0.072
13995	0.135	0.055
13996	0.135	0.129
13998	0.135	0.083
13999	0.121	0.052
14005	0.117	0.094
14006	0.112	0.047
14007	0.113	0.090
14008	0.113	0.040
14009	0.115	0.040
14010	0.120	0.040
14011	0.111	0.040
14012	0.114	0.050
14013	0.122	0.063
14014	0.117	0.112
14022	0.117	0.108
14023	0.116	0.104
14024	0.116	0.103
14152	0.120	0.052
14153	0.143	0.040
14154	0.150	0.040
14155	0.146	0.040
14156	0.120	0.040
14157	0.120	0.040
14158	0.120	0.040
14159	0.120	0.040
14160	0.120	0.040
14161	0.120	0.040
14162	0.120	0.040
14163	0.120	0.040
14164	0.110	0.040
14165	0.106	0.064
14169	0.054	0.051
14175	0.120	0.095
14176	0.120	0.049
14177	0.120	0.117
14178	0.120	0.040
14179	0.120	0.040
14180	0.120	0.040
14181	0.120	0.040
14182	0.120	0.040
14183	0.120	0.040
14184	0.120	0.058
14185	0.118	0.102
14188	0.088	0.086
14189	0.110	0.078
14190	0.109	0.077
14191	0.109	0.075
14192	0.101	0.046
14193	0.100	0.040
14194	0.100	0.040
14306	0.041	0.040
14307	0.098	0.081
14308	0.145	0.126
14309	0.086	0.072
14310	0.118	0.117
14322	0.120	0.081
14323	0.143	0.096
14324	0.150	0.115
14325	0.099	0.062
14326	0.120	0.040
14327	0.120	0.040
14328	0.120	0.040
14329	0.120	0.040
14330	0.120	0.040
14331	0.120	0.040
14332	0.120	0.045
14333	0.120	0.088
14334	0.120	0.098
14335	0.120	0.103
14345	0.109	0.085
14346	0.120	0.041
14347	0.120	0.045
14348	0.120	0.040
14349	0.112	0.064
14350	0.108	0.083
14351	0.113	0.061
14352	0.120	0.040
14353	0.120	0.040
14354	0.120	0.040
14355	0.111	0.067
14358	0.044	0.040
14359	0.100	0.040
14360	0.100	0.040
14361	0.100	0.040
14362	0.100	0.040
14363	0.100	0.040
14364	0.100	0.040

Grid Element	Original N Value	Revised N Value
14476	0.052	0.040
14477	0.100	0.040
14478	0.100	0.040
14479	0.100	0.040
14480	0.119	0.116
14492	0.120	0.090
14493	0.143	0.124
14495	0.095	0.094
14496	0.060	0.040
14497	0.058	0.040
14498	0.108	0.043
14499	0.122	0.046
14500	0.123	0.049
14501	0.123	0.052
14502	0.123	0.075
14515	0.086	0.071
14516	0.093	0.041
14517	0.120	0.072
14518	0.120	0.078
14521	0.063	0.040
14522	0.086	0.040
14523	0.083	0.040
14524	0.080	0.040
14525	0.073	0.052
14528	0.076	0.074
14529	0.100	0.040
14530	0.100	0.040
14531	0.100	0.040
14532	0.100	0.040
14533	0.100	0.040
14534	0.100	0.040
14646	0.064	0.060
14647	0.100	0.063
14648	0.100	0.066
14649	0.100	0.069
14650	0.109	0.107
14662	0.120	0.115
14663	0.123	0.120
14695	0.109	0.064
14696	0.106	0.079
14698	0.100	0.098
14699	0.100	0.040
14700	0.100	0.040
14701	0.100	0.040
14702	0.100	0.040
14703	0.100	0.040
14704	0.100	0.040
14865	0.102	0.094
14866	0.103	0.092
14868	0.100	0.098
14869	0.100	0.040
14870	0.100	0.040
14871	0.100	0.040
14872	0.100	0.040
14873	0.100	0.040
14874	0.100	0.040
15039	0.077	0.040
15040	0.102	0.040
15041	0.109	0.040
15042	0.118	0.040
15043	0.100	0.040
15044	0.100	0.040
15209	0.107	0.042
15210	0.118	0.040
15211	0.120	0.040
15212	0.140	0.040
15213	0.100	0.040
15214	0.100	0.040
15215	0.108	0.072
15380	0.119	0.044
15381	0.120	0.040
15382	0.120	0.040
15383	0.139	0.040
15384	0.100	0.040
15385	0.100	0.040
15386	0.108	0.070
15551	0.102	0.046
15552	0.117	0.047
15553	0.117	0.048
15554	0.133	0.049
15555	0.100	0.050
15556	0.100	0.052
15557	0.106	0.075

Attachment 7

HEC-RAS Levee Breach Parameters at RD 17 Breach Locations

HEC-RAS LEVEE BREACH PARAMETERS AT RD17 BREACH LOCATIONS

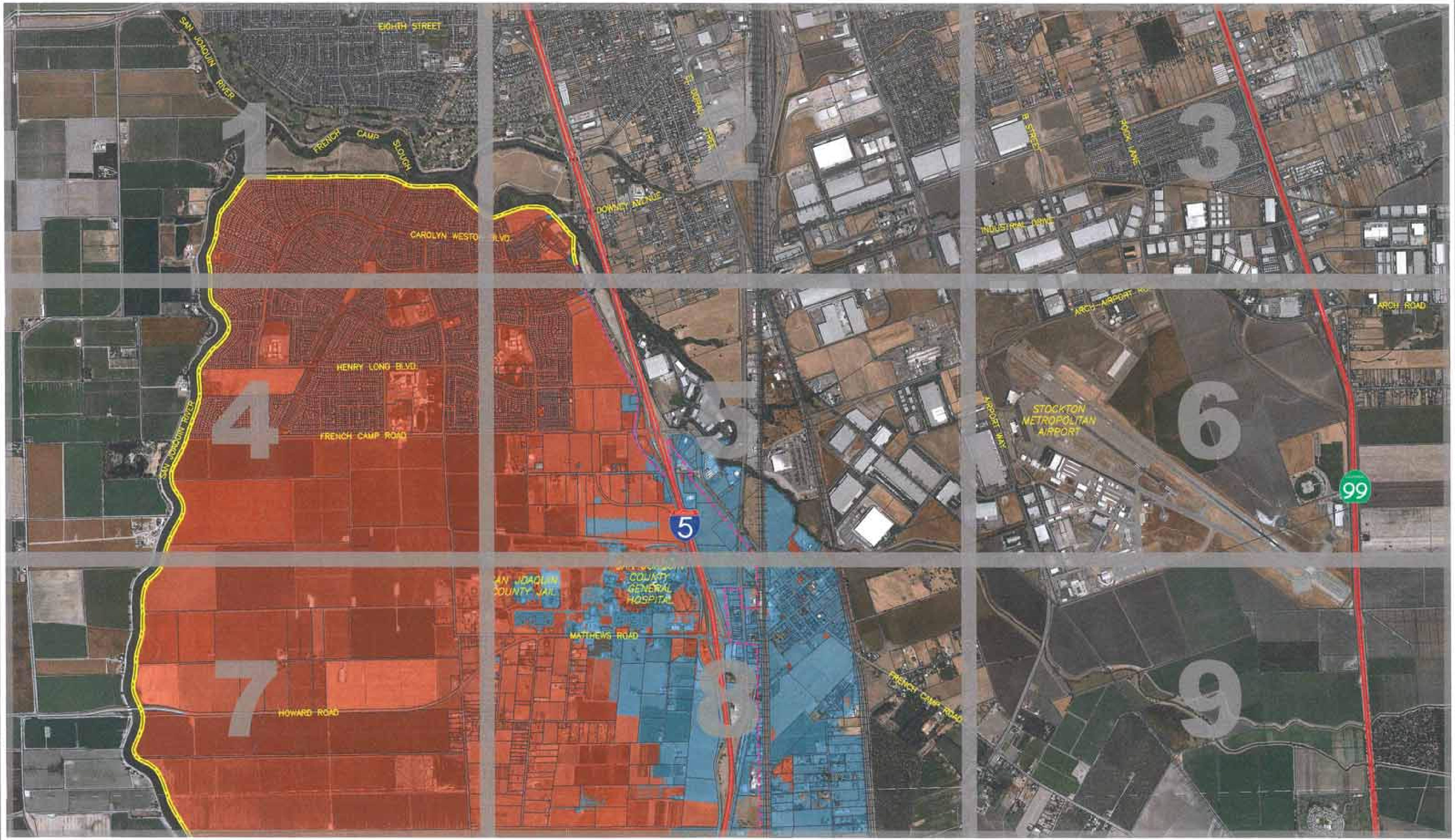
Breach Index Point:	R_70095_SJR	R_83009_SJR	R_91157_SJR	R_98507_SJR	R_102133_SJR	R_14055_WHS
RAS River	SJR	SJR	SJR	SJR	SJR	WHS
RAS River Station [feet]	67010	81524	87781	96380	101130	11692
RAS River Station [miles]	12.69129	15.44015	16.62519	18.25379	19.15341	2.21439
RAS Lateral Structure [feet]	R_70095_SJR	R_83009_SJR	R_91157_SJR	R_98507_SJR	R_102133_SJR	R_14055_WHS
RAS Lateral Structure [miles]	R_13.27529_SJR	R_15.72108_SJR	R_17.26423_SJR	R_18.65624_SJR	R_19.34297_SJR	R_2.66188_WHS
Center Station of Breach [ft]	2770	1619	1582	2038	999	1172
Final Bottom Width of Breach [ft]	176.54	211.91	198.51	172.12	182.09	182.09
Top of Levee Elevation [ft-NAVD88]	28.5	31.2	31.5	32.5	33.0	36.5
Adjacent Floodplain Elevation [ft-NAVD88]	12.5	12.0	13.5	16.9	16.5	20.0
Height of Levee [ft]	16.0	19.2	18.0	15.6	16.5	16.5
Final Bottom Elevation of Breach [ft-NAVD88]	12.5	12.0	13.5	16.9	16.5	20.0
Left Side Slope of Breach [H:V]	0	0	0	0	0	0
Right Side Slope of Breach [H:V]	0	0	0	0	0	0
Breach Weir Coefficient	2.0	2.0	2.0	2.0	2.0	2.0
Full Formation Time [seconds]	1,585	1,737	1,680	1,565	1,610	1,610
Full Formation Time [hrs]	0.440	0.483	0.467	0.435	0.447	0.447
Failure Mode	Piping	Piping	Piping	Piping	Piping	Piping
Piping Coefficient	0.5	0.5	0.5	0.5	0.5	0.5
Initial Piping Elev [ft-NAVD88]	12.5	12.0	13.5	16.9	16.5	20.0
Trigger Failure at	WS Elev	WS Elev	WS Elev	WS Elev	WS Elev	WS Elev
Threshold WS [ft-NAVD88]	12.5	12.0	13.5	16.9	16.5	20.0

Breach Progression	%Time	%Breach	%Time	%Breach	%Time	%Breach	%Time	%Breach	%Time	%Breach	%Time	%Breach
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.114	0.011	0.118	0.022	0.119	0.024	0.118	0.022	0.118	0.022	0.118	0.022
	0.202	0.203	0.206	0.211	0.207	0.213	0.206	0.211	0.206	0.211	0.206	0.211
	0.291	0.355	0.294	0.361	0.295	0.362	0.295	0.361	0.294	0.361	0.294	0.361
	0.379	0.479	0.383	0.483	0.383	0.483	0.383	0.483	0.383	0.483	0.383	0.483
	0.468	0.582	0.471	0.585	0.471	0.586	0.471	0.585	0.471	0.585	0.471	0.585
	0.557	0.672	0.559	0.674	0.560	0.675	0.559	0.674	0.559	0.674	0.559	0.674
	0.645	0.751	0.647	0.753	0.648	0.753	0.647	0.753	0.647	0.753	0.647	0.753
	0.734	0.822	0.735	0.823	0.736	0.823	0.735	0.823	0.735	0.823	0.735	0.823
	0.823	0.887	0.824	0.887	0.824	0.887	0.824	0.887	0.824	0.887	0.824	0.887
	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

PETERSON . BRUSTAD . INC
ENGINEERING . CONSULTING

Attachment 8

Parcel-Level Floodplain Maps Produced by KSN, Inc.



LEGEND:

- 0' TO 3' FLOOD DEPTH
- >3' FLOOD DEPTH
- RD 17 LEVEE
- RD 17 BOUNDARY

NOTES:

1. OVERBANK FLOODING FROM FRENCH CAMP SLOUGH IS <u>NOT</u> INCLUDED IN THIS ANALYSIS.

KSN INC. KJELDSEN SINNOCK NEUDECK
Civil Engineers and Land Surveyors
711 N. Pershing Avenue, Stockton, CA 95203, (209) 946-0268
1355 Halyard Drive, Suite 180, West Sacramento, CA 95691, (916) 403-5900
www.kswinc.com

Scale 1" = 1200'

Original Drawing Scale 0 ½" 1"

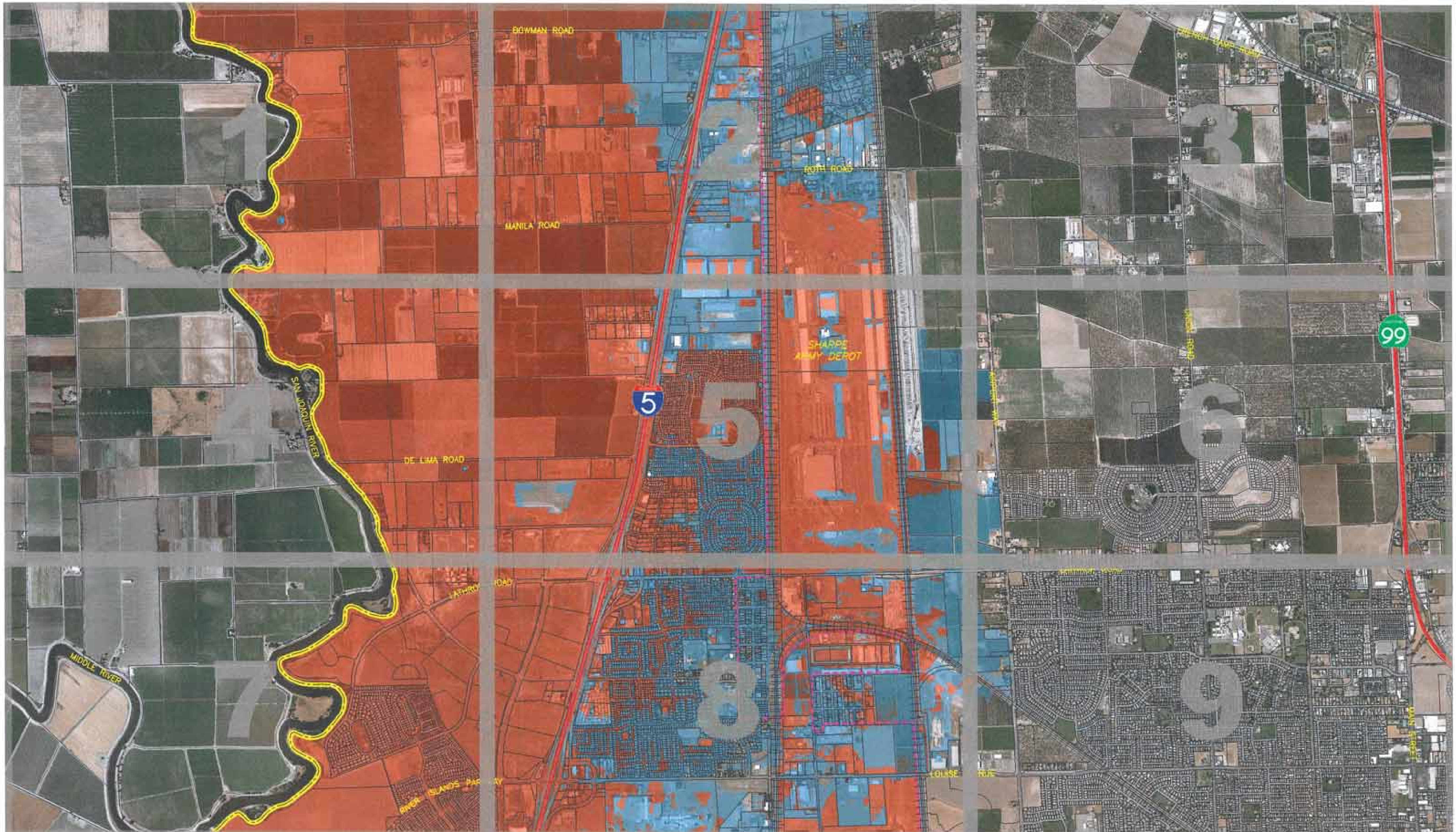
N

CITIES OF LATHROP AND MANTECA
200-YEAR PLAN
200-YEAR COMPOSITE FLOODPLAIN MAP
EXHIBIT A REGIONAL MAP

EXHIBIT A

PAGE 0

FILE SPEC: P:\0856-Mossdale\0610_SB5_Levee_Evaluation\05_Civil\CAD\Sheets\SH_Plan A.dwg
PLOT DATE: May 23, 2014 - 3:50pm



LEGEND:

- 0' TO 3' FLOOD DEPTH
- >3' FLOOD DEPTH
- RD 17 LEVEE
- RD 17 BOUNDARY

NOTES:

1. OVERBANK FLOODING FROM FRENCH CAMP SLOUGH IS NOT INCLUDED IN THIS ANALYSIS.

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Civil Engineers and Land Surveyors
711 N. Pershing Avenue
Stockton, CA 95203
(209) 946-0268
1355 Holyard Drive, Suite 180
West Sacramento, CA 95691
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www.ksninc.com

Scale 1" = 1200'
Original Drawing Scale 0 ½" 1"

N

CITIES OF LATHROP AND MANTECA
200-YEAR PLAN
200-YEAR COMPOSITE FLOODPLAIN MAP
EXHIBIT B REGIONAL MAP

EXHIBIT B

PAGE 0

FILE SPEC: P:\0856-Mossdale\0610_SB5_Levee_Evaluation\05_Civil\CAD\Sheets\Sht_Plan B.dwg
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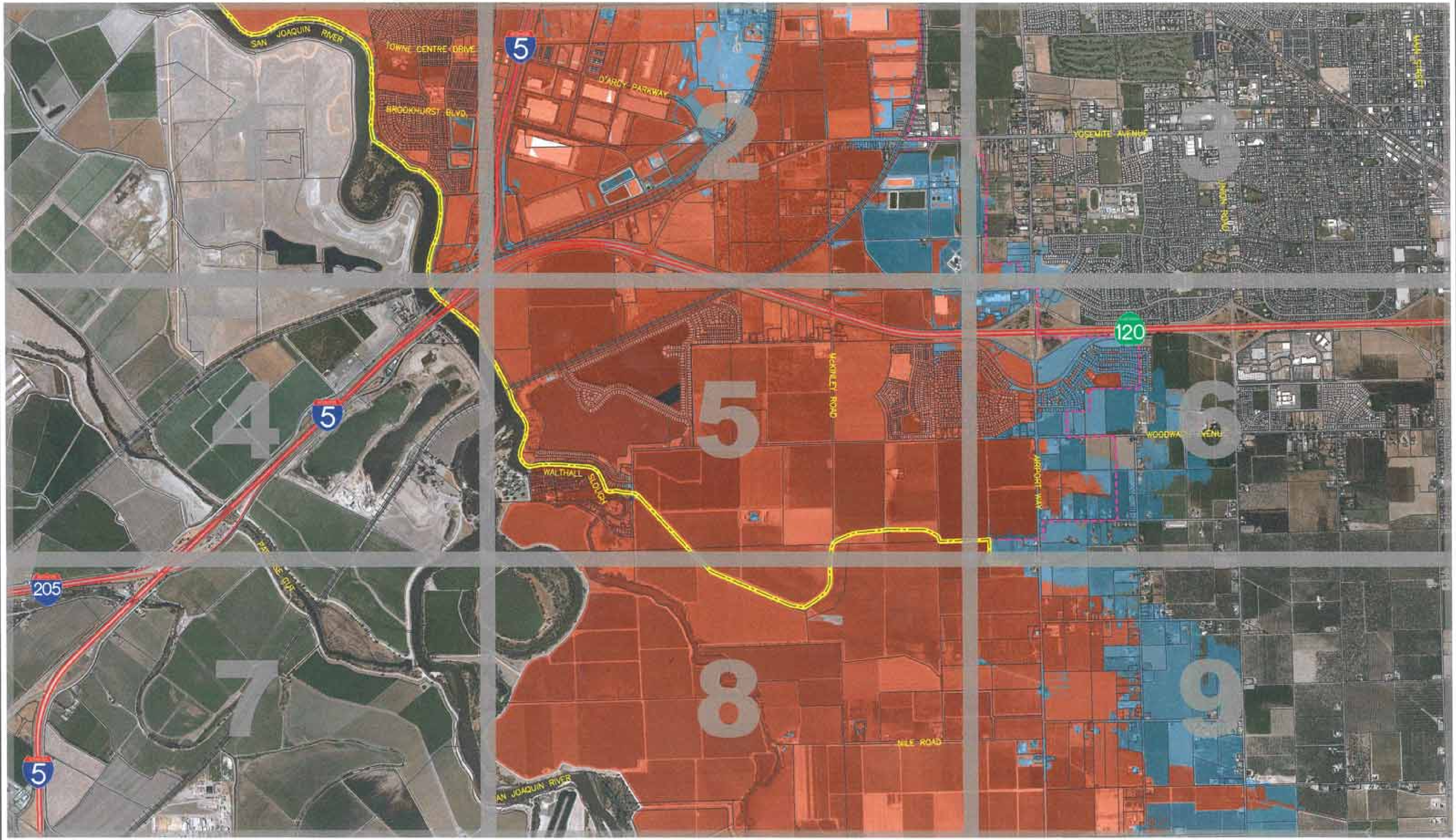

LEGEND:

- 0' TO 3' FLOOD DEPTH
- >3' FLOOD DEPTH
- RD 17 LEVEE
- RD 17 BOUNDARY

NOTES:

1. OVERBANK FLOODING FROM FRENCH CAMP SLOUGH IS NOT INCLUDED IN THIS ANALYSIS.

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KJELDSEN SINNOCK NEUDECK
Civil Engineers and Land Surveyors
711 N. Pershing Avenue
Stockton, CA 95203
(209) 946-0268
1355 Halyard Drive, Suite 180
West Sacramento, CA 95691
(916) 403-5900
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Scale 1" = 1200'

Original Drawing Scale 0 ½" 1"

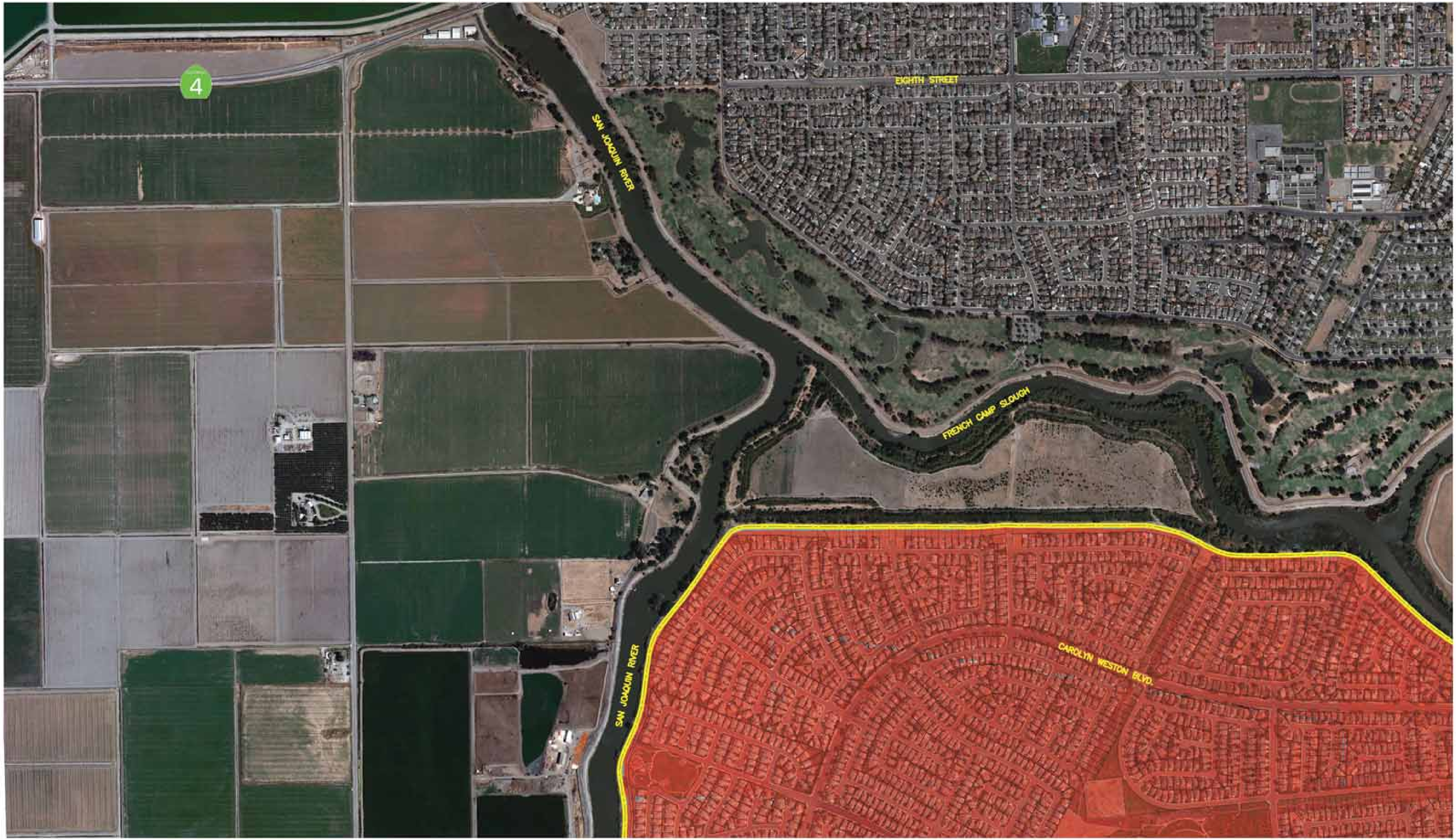
N

CITIES OF LATHROP AND MANTECA
200-YEAR PLAN
200-YEAR COMPOSITE FLOODPLAIN MAP
EXHIBIT C REGION MAP

EXHIBIT C

PAGE 0

FILE SPEC: P:\0856-Mossdale\0610_SB5_Levee_Evaluation\05_Civil\CAD\Sheets\Sht_Plan C.dwg
PLOT DATE: May 23, 2014 - 5:16pm



LEGEND:

- 0' TO 3' FLOOD DEPTH
- >3' FLOOD DEPTH
- RD 17 LEVEE
- RD 17 BOUNDARY

NOTES:

1. OVERBANK FLOODING FROM FRENCH CAMP SLOUGH IS NOT INCLUDED IN THIS ANALYSIS.

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Civil Engineers and Land Surveyors
711 N. Pershing Avenue
Stockton, CA 95203
(209) 946-0268
1365 Halyard Drive, Suite 180
West Sacramento, CA 95691
(916) 403-5900
www.ksninc.com

Scale 1" = 400'

Original Drawing Scale 0 ½" 1"

N

CITIES OF LATHROP AND MANTECA
200-YEAR PLAN
200-YEAR COMPOSITE FLOODPLAIN MAP
EXHIBIT A-1 AREA MAP

EXHIBIT A

PAGE 1

FILE SPEC: P:\0856-Mossdale\0610_SB5_Levee_Evaluation\05_Civil\CAD\Sheets\Sht_Plan A.dwg
PLOT DATE: May 23, 2014 – 12:50pm

LEGEND:

- 0' TO 3' FLOOD DEPTH
- >3' FLOOD DEPTH
- RD 17 LEVEE
- RD 17 BOUNDARY

NOTES:

1. OVERBANK FLOODING FROM FRENCH CAMP SLOUGH IS NOT INCLUDED IN THIS ANALYSIS.

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Civil Engineers and Land Surveyors
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1355 Halyard Drive, Suite 180, West Sacramento, CA 95691, (916) 403-5900
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Scale 1" = 400'
Original Drawing Scale 0 ½" 1"

N

CITIES OF LATHROP AND MANTECA 200-YEAR PLAN
200-YEAR COMPOSITE FLOODPLAIN MAP
EXHIBIT A-2 AREA MAP

EXHIBIT A

PAGE 2

FILE SPEC: P:\0856-Mossdale\0610_SB5_Levee_Evaluation\05_Civil\CAD\Sheets\Sht_Plan A.dwg
PLOT DATE: May 23, 2014 – 12:53pm

LEGEND:

- 0' TO 3' FLOOD DEPTH
- >3' FLOOD DEPTH
- RD 17 LEVEE
- RD 17 BOUNDARY

NOTES:

1. OVERBANK FLOODING FROM FRENCH CAMP SLOUGH IS NOT INCLUDED IN THIS ANALYSIS.

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KJELDSEN SINNOCK NEUDECK
Civil Engineers and Land Surveyors
711 N. Pershing Avenue
Stockton, CA 95203
(209) 946-0268
1355 Halyard Drive, Suite 180
West Sacramento, CA 95691
(916) 403-5900
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Scale 1" = 400'

Original Drawing Scale 0 ½" 1"

N

CITIES OF LATHROP AND MANTECA
200-YEAR PLAN
200-YEAR COMPOSITE FLOODPLAIN MAP
EXHIBIT A-3 AREA MAP

EXHIBIT A

FILE SPEC: P:\0856-Mossdale\0610_SB5_Levee_Evaluation\05_Civil\CAD\Sheets\Sht_Plan A.dwg
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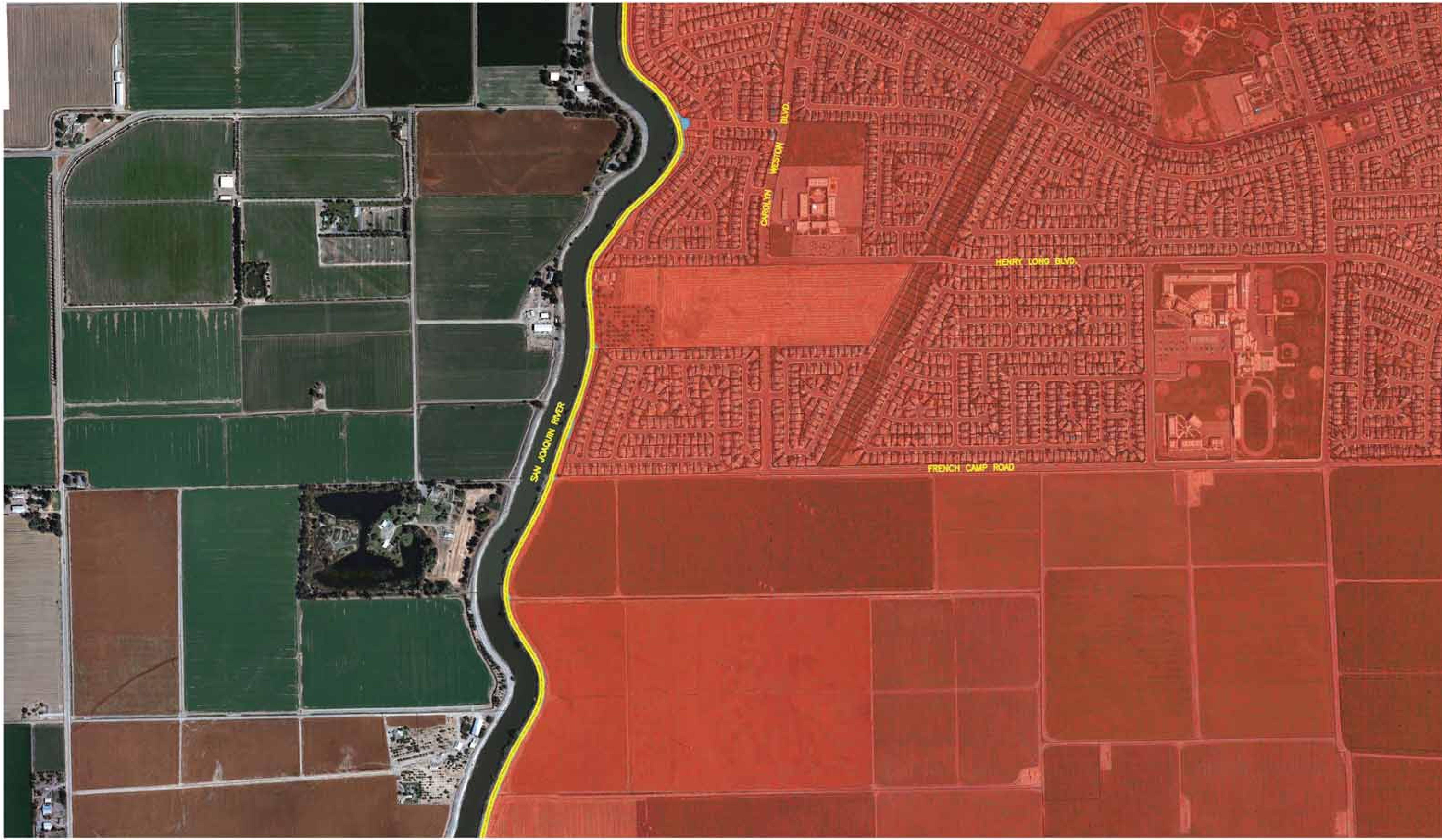

LEGEND:

- 0' TO 3' FLOOD DEPTH
- >3' FLOOD DEPTH
- RD 17 LEVEE
- RD 17 BOUNDARY

NOTES:

1. OVERBANK FLOODING FROM FRENCH CAMP SLOUGH IS NOT INCLUDED IN THIS ANALYSIS.

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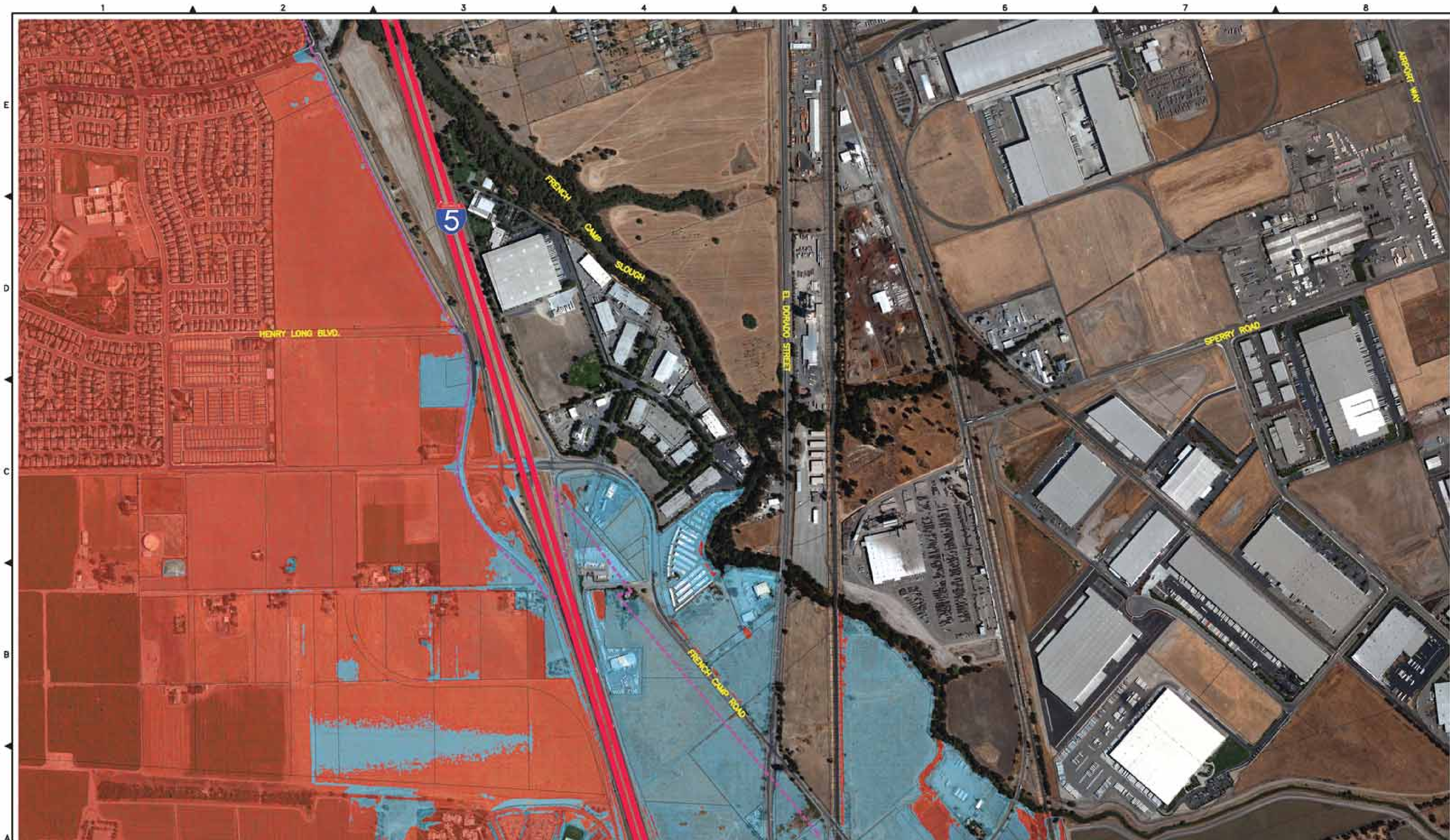
Scale 1" = 400'
Original Drawing Scale 0 ½" 1"

CITIES OF LATHROP AND MANTECA
200-YEAR PLAN
200-YEAR COMPOSITE FLOODPLAIN MAP
EXHIBIT A-4 AREA MAP

EXHIBIT A

PAGE 4



LEGEND:

- 0' TO 3' FLOOD DEPTH
- >3' FLOOD DEPTH
- RD 17 LEVEE
- RD 17 BOUNDARY

NOTES:

1. OVERBANK FLOODING FROM FRENCH CAMP SLOUGH IS NOT INCLUDED IN THIS ANALYSIS.

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KJELDSEN SINNOCK NEUDECK
Civil Engineers and Land Surveyors

711 N. Pershing Avenue
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(209) 946-0268

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Scale
1" = 400'

Original Drawing Scale
0 ½" 1"

N

CITIES OF LATHROP AND MANTECA
200-YEAR PLAN
200-YEAR COMPOSITE FLOODPLAIN MAP
EXHIBIT A-5 AREA MAP

EXHIBIT A

PAGE 5

FILE SPEC: P:\0856-Mossdale\0610_SB5_Levee_Evaluation\05_Civil\CAD\Sheets\SH_Plan A.dwg
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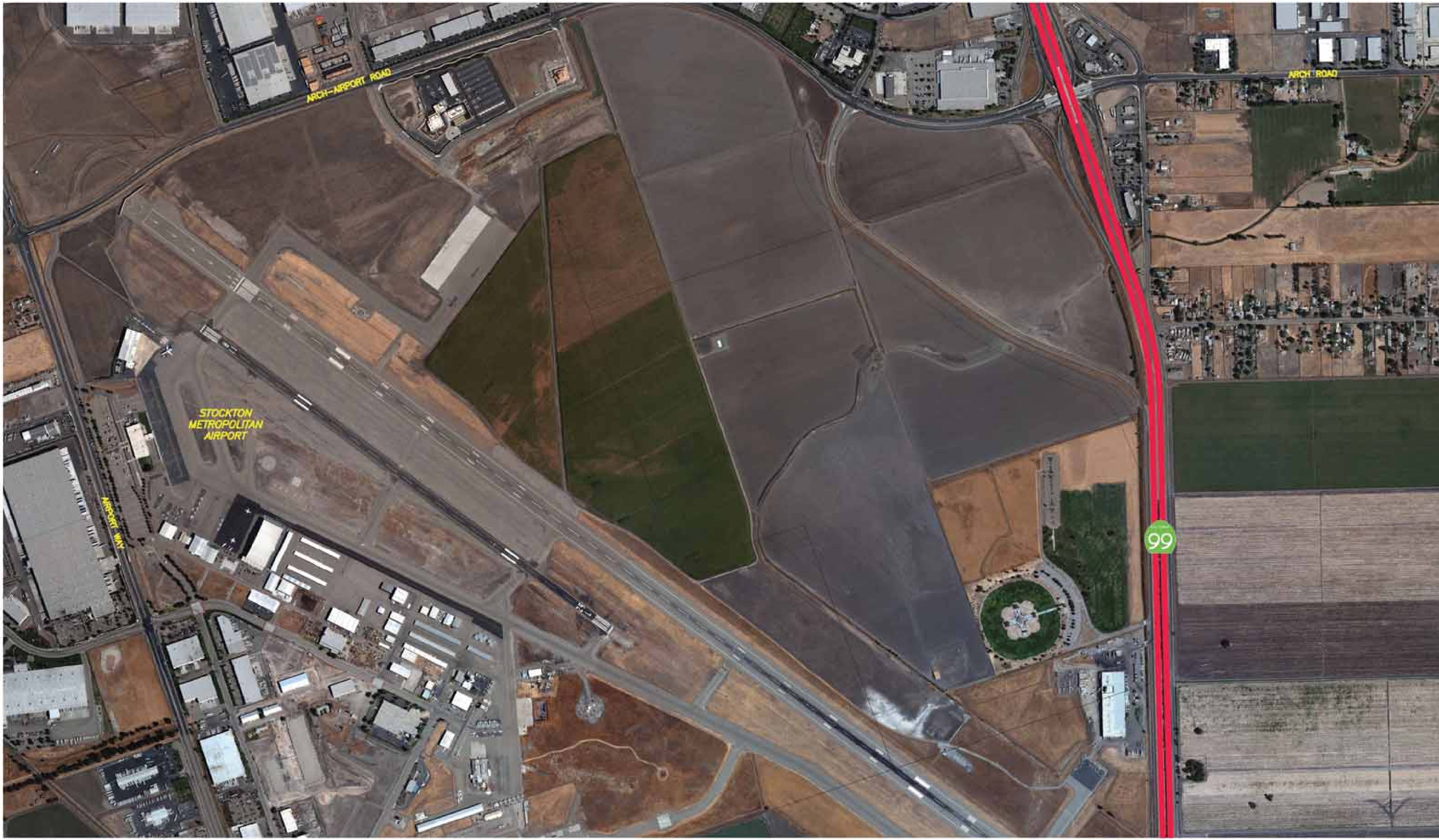

LEGEND:

- 0' TO 3' FLOOD DEPTH
- >3' FLOOD DEPTH
- RD 17 LEVEE
- RD 17 BOUNDARY

NOTES:

1. OVERBANK FLOODING FROM FRENCH CAMP SLOUGH IS <u>NOT</u> INCLUDED IN THIS ANALYSIS.

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Civil Engineers and Land Surveyors
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Scale 1" = 400'

Original Drawing Scale 0 ½" 1"

N

CITIES OF LATHROP AND MANTECA 200-YEAR PLAN
200-YEAR COMPOSITE FLOODPLAIN MAP
EXHIBIT A-6 AREA MAP

EXHIBIT A

FILE SPEC: P:\0856-Mossdale\0610_SB5_Levee_Evaluation\05_Civil\CAD\Sheets\SH_Plan A.dwg
PLOT DATE: May 23, 2014 - 1:12pm

LEGEND:

- 0' TO 3' FLOOD DEPTH
- >3' FLOOD DEPTH
- RD 17 LEVEE
- RD 17 BOUNDARY

NOTES:

1. OVERBANK FLOODING FROM FRENCH CAMP SLOUGH IS NOT INCLUDED IN THIS ANALYSIS.

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West Sacramento, CA 95691
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Scale
1" = 400'

Original Drawing Scale
0 ½" 1"

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CITIES OF LATHROP AND MANTECA
200-YEAR PLAN
200-YEAR COMPOSITE FLOODPLAIN MAP
EXHIBIT A-7 AREA MAP

EXHIBIT A

PAGE 7

FILE SPEC: P:\0856-Mossdale\0610_SB5_Levee_Evaluation\05_Civil\CAD\Sheets\Sht_Plan A.dwg
PLOT DATE: May 23, 2014 - 1:16pm

LEGEND:

- 0' TO 3' FLOOD DEPTH
- >3' FLOOD DEPTH
- RD 17 LEVEE
- RD 17 BOUNDARY

NOTES:

1. OVERBANK FLOODING FROM FRENCH CAMP SLOUGH IS NOT INCLUDED IN THIS ANALYSIS.

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Scale 1" = 400'

Original Drawing Scale 0 ½" 1"

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CITIES OF LATHROP AND MANTECA
200-YEAR PLAN
200-YEAR COMPOSITE FLOODPLAIN MAP
EXHIBIT A-8 AREA MAP

EXHIBIT A

PAGE 8

FILE SPEC: P:\0856-Mossdale\0610_SB5_Levee_Evaluation\05_Civil\CAD\Sheets\SHt_Plan A.dwg
PLOT DATE: May 23, 2014 - 1:19pm

LEGEND:

- 0' TO 3' FLOOD DEPTH
- >3' FLOOD DEPTH
- RD 17 LEVEE
- RD 17 BOUNDARY

NOTES:

1. OVERBANK FLOODING FROM FRENCH CAMP SLOUGH IS NOT INCLUDED IN THIS ANALYSIS.

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Scale 1" = 400'
Original Drawing Scale 0 ½" 1"

N

CITIES OF LATHROP AND MANTECA 200-YEAR PLAN
200-YEAR COMPOSITE FLOODPLAIN MAP
EXHIBIT A-9 AREA MAP

EXHIBIT A

PAGE 9

FILE SPEC: P:\0856-Mossdale\0610_SB5_Levee_Evaluation\05_Civil\CAD\Sheets\SHL_Plan A.dwg
PLOT DATE: May 23, 2014 - 1:21pm

LEGEND:

- 0' TO 3' FLOOD DEPTH
- >3' FLOOD DEPTH
- RD 17 LEVEE
- RD 17 BOUNDARY

NOTES:

1. OVERBANK FLOODING FROM FRENCH CAMP SLOUGH IS NOT INCLUDED IN THIS ANALYSIS.

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Civil Engineers and Land Surveyors
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Scale 1" = 400'

Original Drawing Scale 0 ½" 1"

N

CITIES OF LATHROP AND MANTECA
200-YEAR PLAN
200-YEAR COMPOSITE FLOODPLAIN MAP
EXHIBIT B-1 AREA MAP

EXHIBIT B

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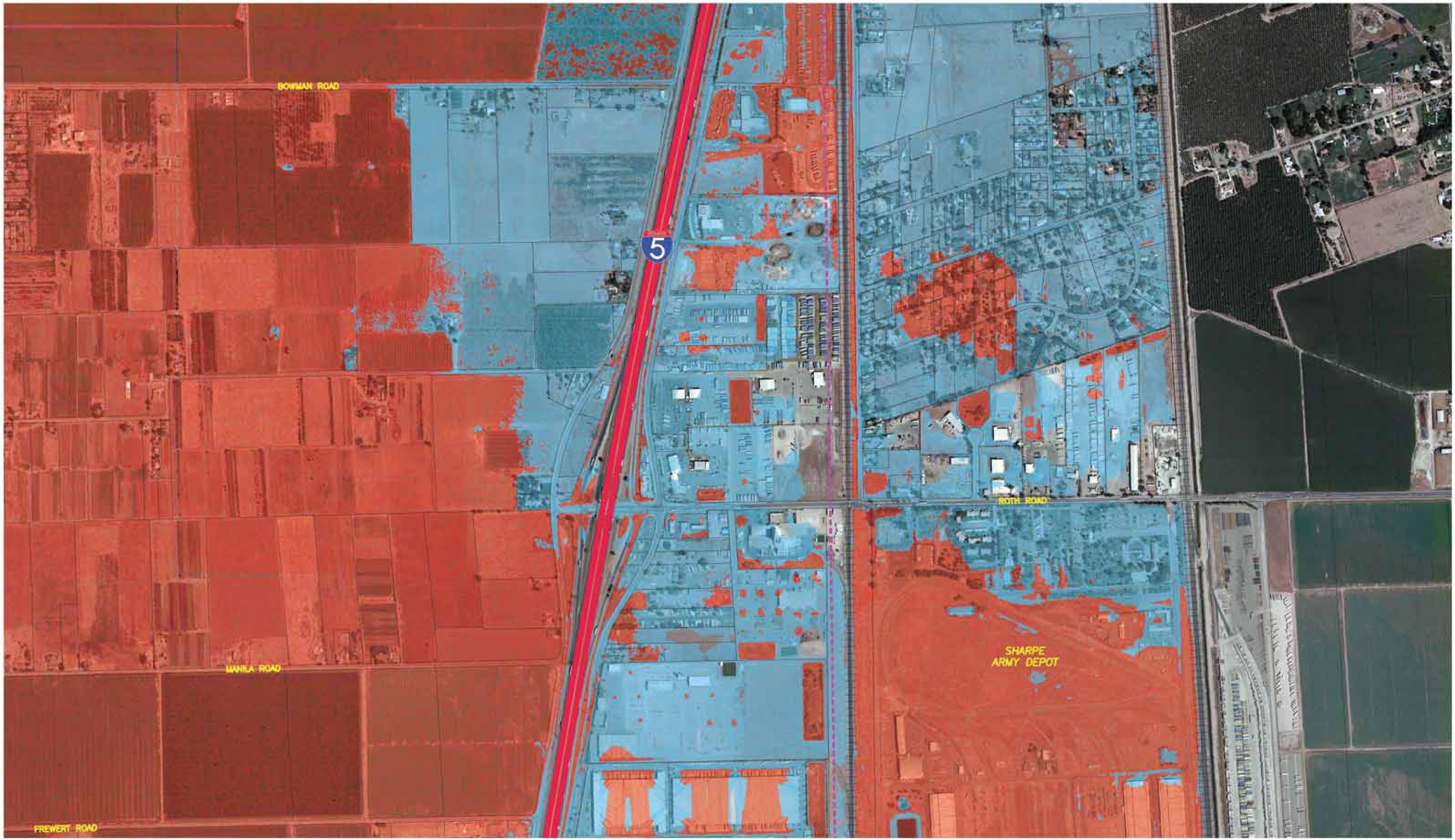

LEGEND:

- 0' TO 3' FLOOD DEPTH
- >3' FLOOD DEPTH
- RD 17 LEVEE
- RD 17 BOUNDARY

NOTES:

1. OVERBANK FLOODING FROM FRENCH CAMP SLOUGH IS NOT INCLUDED IN THIS ANALYSIS.

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SINNOCK
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Scale
1" = 400'
Original Drawing Scale
0 ½" 1"

N

CITIES OF LATHROP AND MANTECA
200-YEAR PLAN
200-YEAR COMPOSITE FLOODPLAIN MAP
EXHIBIT B-2 AREA MAP

EXHIBIT
B

FILE SPEC: P:\0856-Mossdale\0610_SB5_Levee_Evaluation\05_Civil\CAD\Sheets\Sht_Plan B.dwg
PLOT DATE: May 23, 2014 - 10:47pm

LEGEND:

- 0' TO 3' FLOOD DEPTH
- >3' FLOOD DEPTH
- RD 17 LEVEE
- RD 17 BOUNDARY

NOTES:

1. OVERBANK FLOODING FROM FRENCH CAMP SLOUGH IS <u>NOT</u> INCLUDED IN THIS ANALYSIS.

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Scale
1" = 400'

Original Drawing Scale
0 ½" 1"

N

CITIES OF LATHROP AND MANTECA
200-YEAR PLAN
200-YEAR COMPOSITE FLOODPLAIN MAP
EXHIBIT B-3 AREA MAP

EXHIBIT B

FILE SPEC: P:\0856-Mossdale\0610_SB5_Levee_Evaluation\05_Civil\CAD\Sheets\SH_Plan B.dwg
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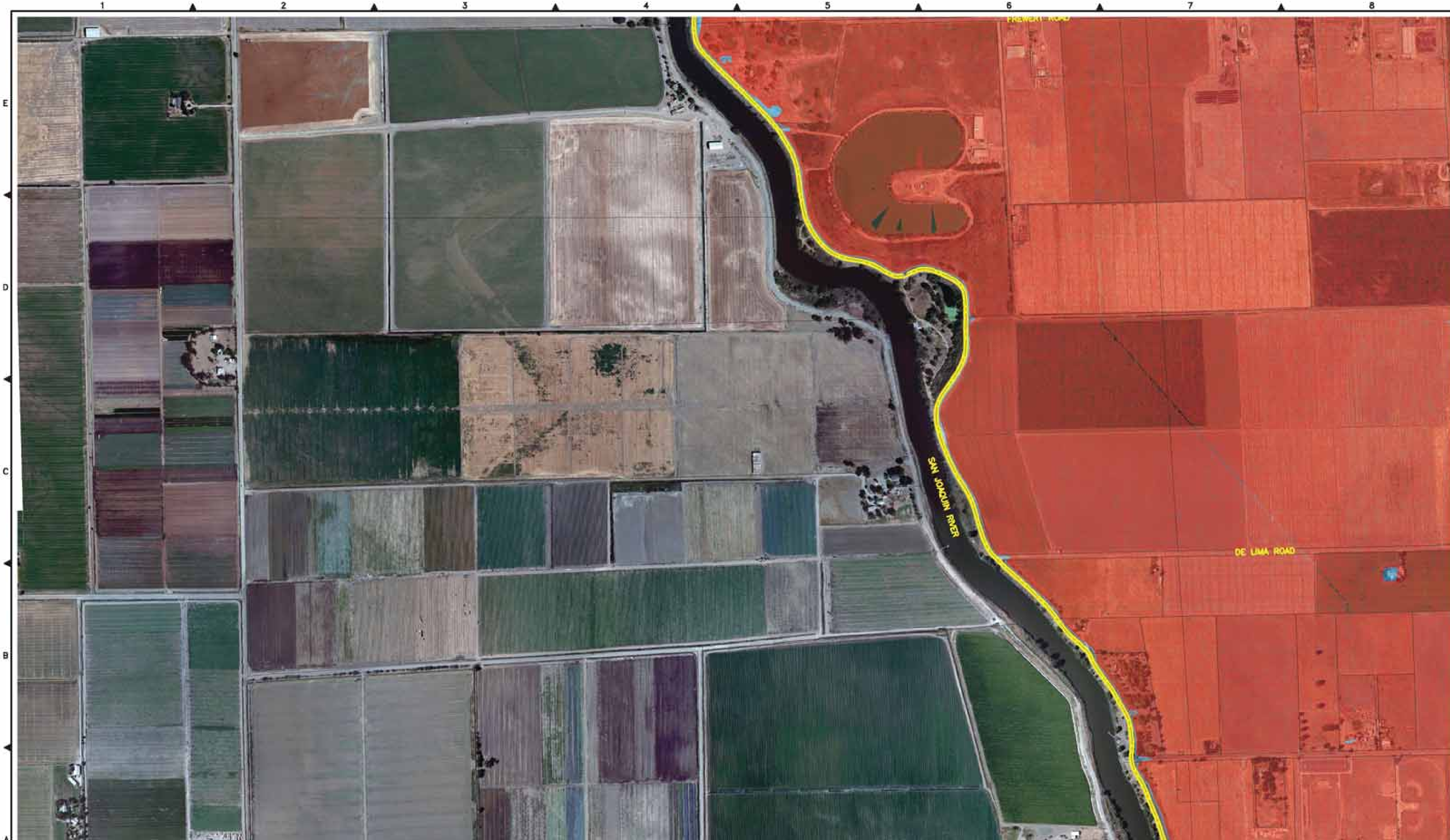

LEGEND:

- 0' TO 3' FLOOD DEPTH
- >3' FLOOD DEPTH
- RD 17 LEVEE
- RD 17 BOUNDARY

NOTES:

1. OVERBANK FLOODING FROM FRENCH CAMP SLOUGH IS <u>NOT</u> INCLUDED IN THIS ANALYSIS.

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Scale
1" = 400'

Original Drawing Scale
0 ½" 1"

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CITIES OF LATHROP AND MANTECA
200-YEAR PLAN
200-YEAR COMPOSITE FLOODPLAIN MAP
EXHIBIT B-4 AREA MAP

EXHIBIT B

FILE SPEC: P:\0856-Mossdale\0610_SB5_Levee_Evaluation\05_Civil\CAD\Sheets\SH_Plan B.dwg
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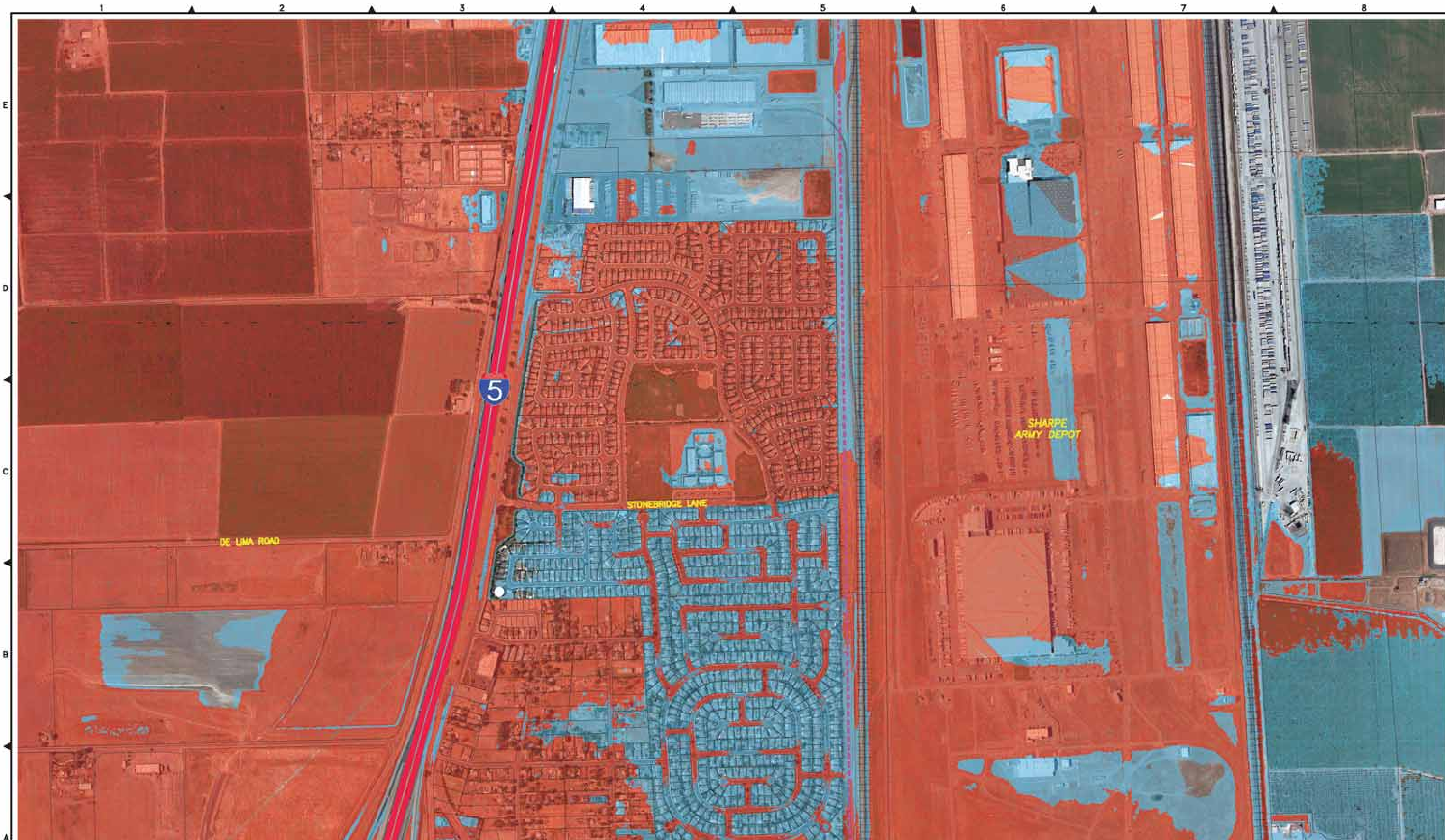

LEGEND:

- 0' TO 3' FLOOD DEPTH
- >3' FLOOD DEPTH
- RD 17 LEVEE
- RD 17 BOUNDARY

NOTES:

1. OVERBANK FLOODING FROM FRENCH CAMP SLOUGH IS NOT INCLUDED IN THIS ANALYSIS.

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Civil Engineers and Land Surveyors

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Scale
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Original Drawing Scale
0 ½" 1"

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CITIES OF LATHROP AND MANTECA 200-YEAR PLAN
200-YEAR COMPOSITE FLOODPLAIN MAP
EXHIBIT B-5 AREA MAP

EXHIBIT B

FILE SPEC: P:\0856-Mossdale\0610_SBS_Levee_Evaluation\05_Civil\CAD\Sheets\SKI_Plan B.dwg
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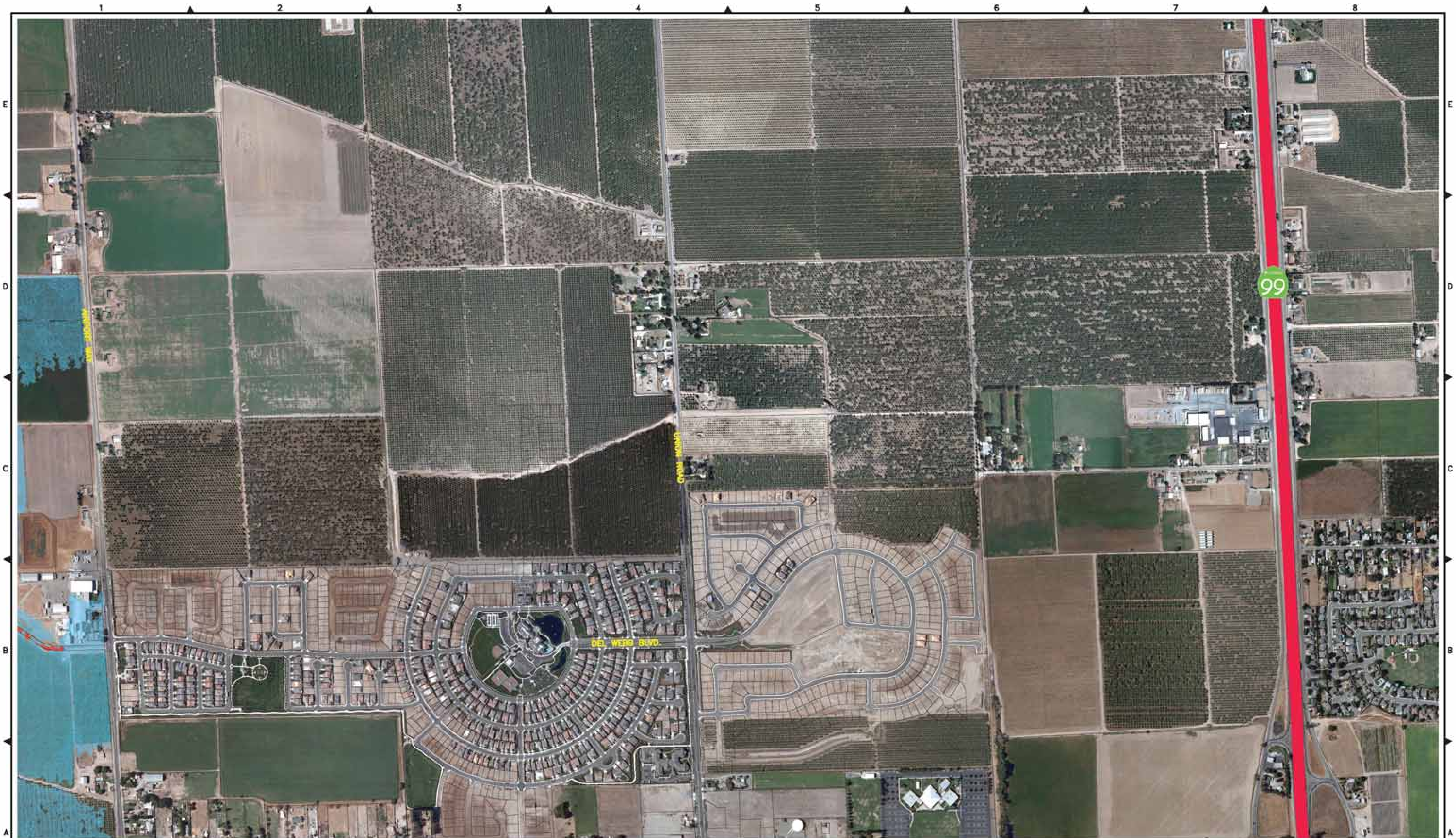

LEGEND:

- 0' TO 3' FLOOD DEPTH
- >3' FLOOD DEPTH
- RD 17 LEVEE
- RD 17 BOUNDARY

NOTES:

1. OVERBANK FLOODING FROM FRENCH CAMP SLOUGH IS NOT INCLUDED IN THIS ANALYSIS.

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Scale 1" = 400'

Original Drawing Scale 0 ½" 1"

N

CITIES OF LATHROP AND MANTECA
200-YEAR PLAN
200-YEAR COMPOSITE FLOODPLAIN MAP
EXHIBIT B-6 AREA MAP

EXHIBIT B

FILE SPEC: P:\0856-Mossdale\0610_SB5_Levee_Evaluation\05_Civil\CAD\Sheets\SH_Plan B.dwg
PLOT DATE: May 23, 2014 – 11:06am

LEGEND:

- 0' TO 3' FLOOD DEPTH
- >3' FLOOD DEPTH
- RD 17 LEVEE
- RD 17 BOUNDARY

NOTES:

1. OVERBANK FLOODING FROM FRENCH CAMP SLOUGH IS NOT INCLUDED IN THIS ANALYSIS.

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Scale 1" = 400'

Original Drawing Scale 0 ½" 1"

N

CITIES OF LATHROP AND MANTECA
200-YEAR PLAN
200-YEAR COMPOSITE FLOODPLAIN MAP
EXHIBIT B-7 AREA MAP

EXHIBIT B

PAGE 7

FILE SPEC: P:\0856-Mossdale\0610_SB5_Levee_Evaluation\05_Civil\CAD\Sheets\SKL_Plan B.dwg
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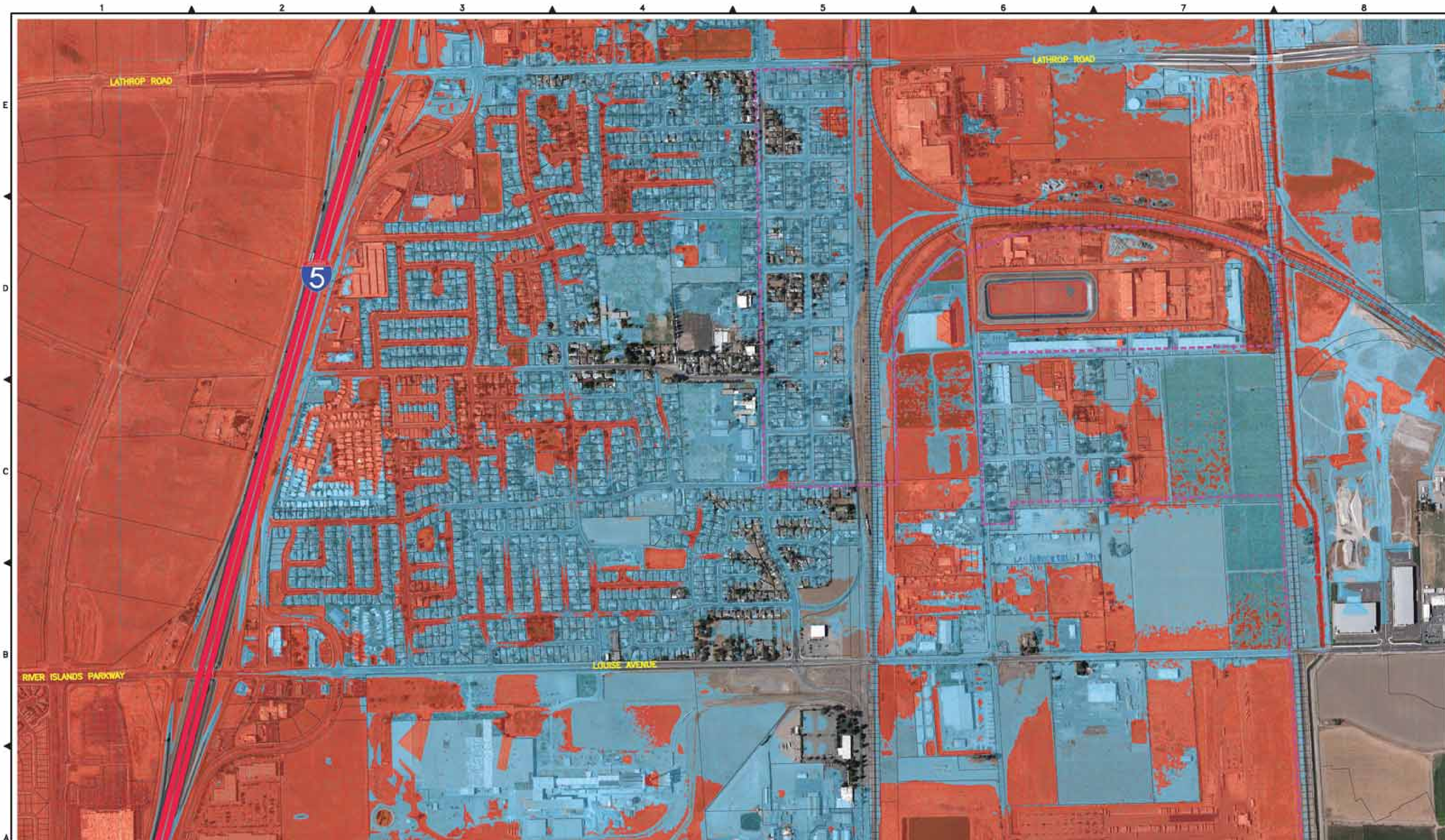

LEGEND:

- 0' TO 3' FLOOD DEPTH
- >3' FLOOD DEPTH
- RD 17 LEVEE
- RD 17 BOUNDARY

NOTES:

1. OVERBANK FLOODING FROM FRENCH CAMP SLOUGH IS NOT INCLUDED IN THIS ANALYSIS.

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Civil Engineers and Land Surveyors
711 N. Pershing Avenue
Stockton, CA 95203
(209) 946-0268
1365 Halyard Drive, Suite 180
West Sacramento, CA 95691
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www.ksninc.com

Scale
1" = 400'
Original Drawing Scale
0 ½" 1"

N

CITIES OF LATHROP AND MANTECA
200-YEAR PLAN
200-YEAR COMPOSITE FLOODPLAIN MAP
EXHIBIT B-8 AREA MAP

EXHIBIT
B

PAGE 8

FILE SPEC: P:\0856-Mossdale\0610_SB5_Levee_Evaluation\05_Civil\CAD\Sheets\Sht_Plan B.dwg
PLOT DATE: May 23, 2014 - 11:20am

LEGEND:

- 0' TO 3' FLOOD DEPTH
- >3' FLOOD DEPTH
- RD 17 LEVEE
- RD 17 BOUNDARY

NOTES:

1. OVERBANK FLOODING FROM FRENCH CAMP SLOUGH IS NOT INCLUDED IN THIS ANALYSIS.

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Civil Engineers and Land Surveyors
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1365 Halyard Drive, Suite 180, West Sacramento, CA 95691, (916) 403-5900
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Scale 1" = 400'

Original Drawing Scale 0 ½" 1"

N

CITIES OF LATHROP AND MANTECA 200-YEAR PLAN
200-YEAR COMPOSITE FLOODPLAIN MAP
EXHIBIT B-9 AREA MAP

EXHIBIT B

FILE SPEC: P:\0856-Mossdale\0610_585_Levee_Evaluation\05_Civil\CAD\Sheets\Sht_Plan B.dwg
PLOT DATE: May 23, 2014 - 11:26am

LEGEND:

- 0' TO 3' FLOOD DEPTH
- >3' FLOOD DEPTH
- RD 17 LEVEE
- RD 17 BOUNDARY

NOTES:

1. OVERBANK FLOODING FROM FRENCH CAMP SLOUGH IS NOT INCLUDED IN THIS ANALYSIS.

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KJELDSEN SINNOCK NEUDECK
Civil Engineers and Land Surveyors
711 N. Pershing Avenue
Stockton, CA 95203
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1365 Halyard Drive, Suite 180
West Sacramento, CA 95691
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Scale
1" = 400'
Original Drawing Scale
0 ½" 1"

N

CITIES OF LATHROP AND MANTECA
200-YEAR PLAN
200-YEAR COMPOSITE FLOODPLAIN MAP
EXHIBIT C-1 AREA MAP

EXHIBIT C

PAGE 1

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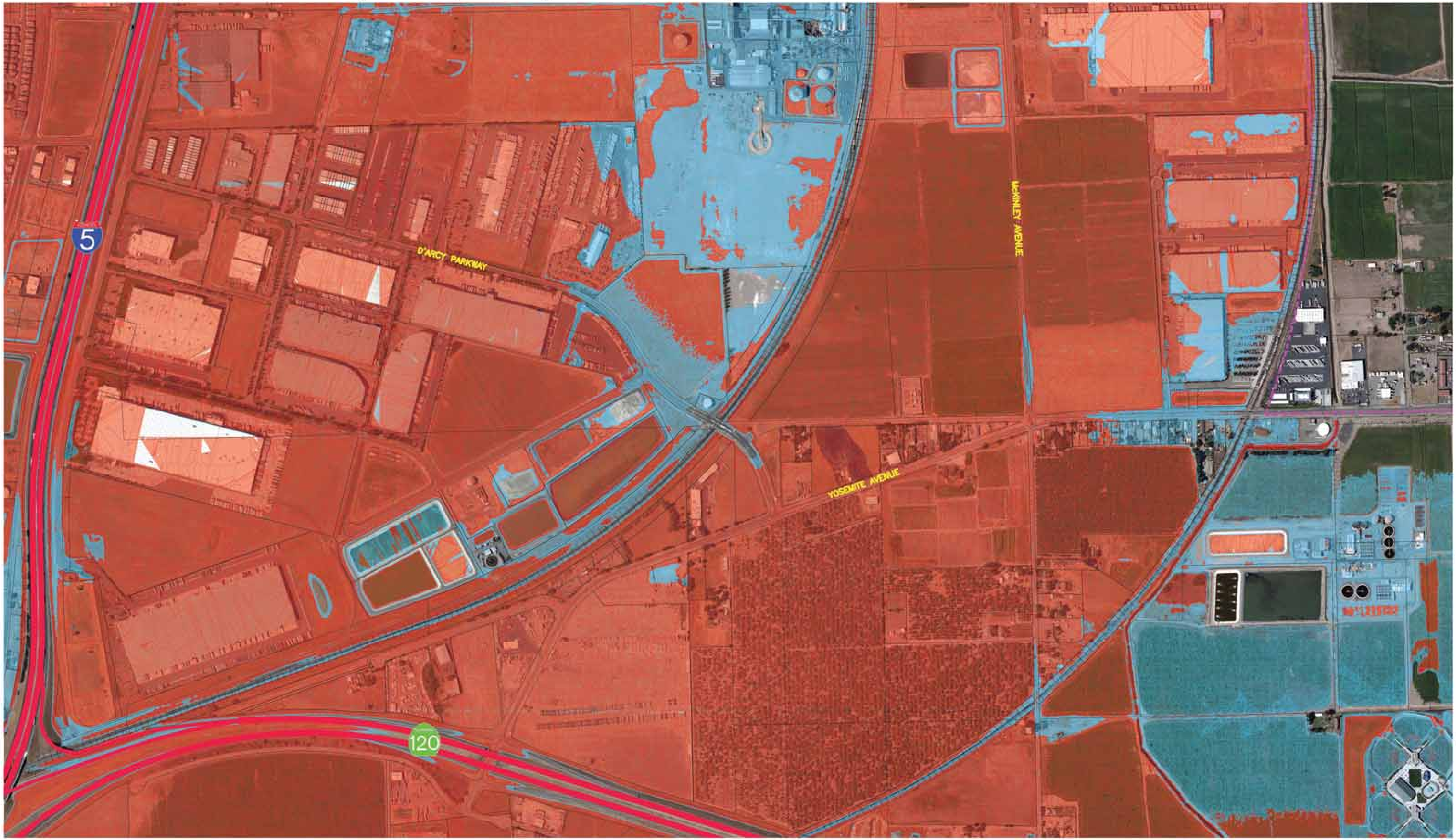

LEGEND:

- 0' TO 3' FLOOD DEPTH
- >3' FLOOD DEPTH
- RD 17 LEVEE
- RD 17 BOUNDARY

NOTES:

1. OVERBANK FLOODING FROM FRENCH CAMP SLOUGH IS NOT INCLUDED IN THIS ANALYSIS.

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West Sacramento, CA 95691
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Scale 1" = 400'

Original Drawing Scale 0 ½" 1"

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CITIES OF LATHROP AND MANTECA
200-YEAR PLAN
200-YEAR COMPOSITE FLOODPLAIN MAP
EXHIBIT C-2 AREA MAP

EXHIBIT C

PAGE 2

FILE SPEC: P:\0856-Mossdale\0610_SBS_Levee_Evaluation\05_Civil\CAD\Sheets\SKL_Plan C.dwg
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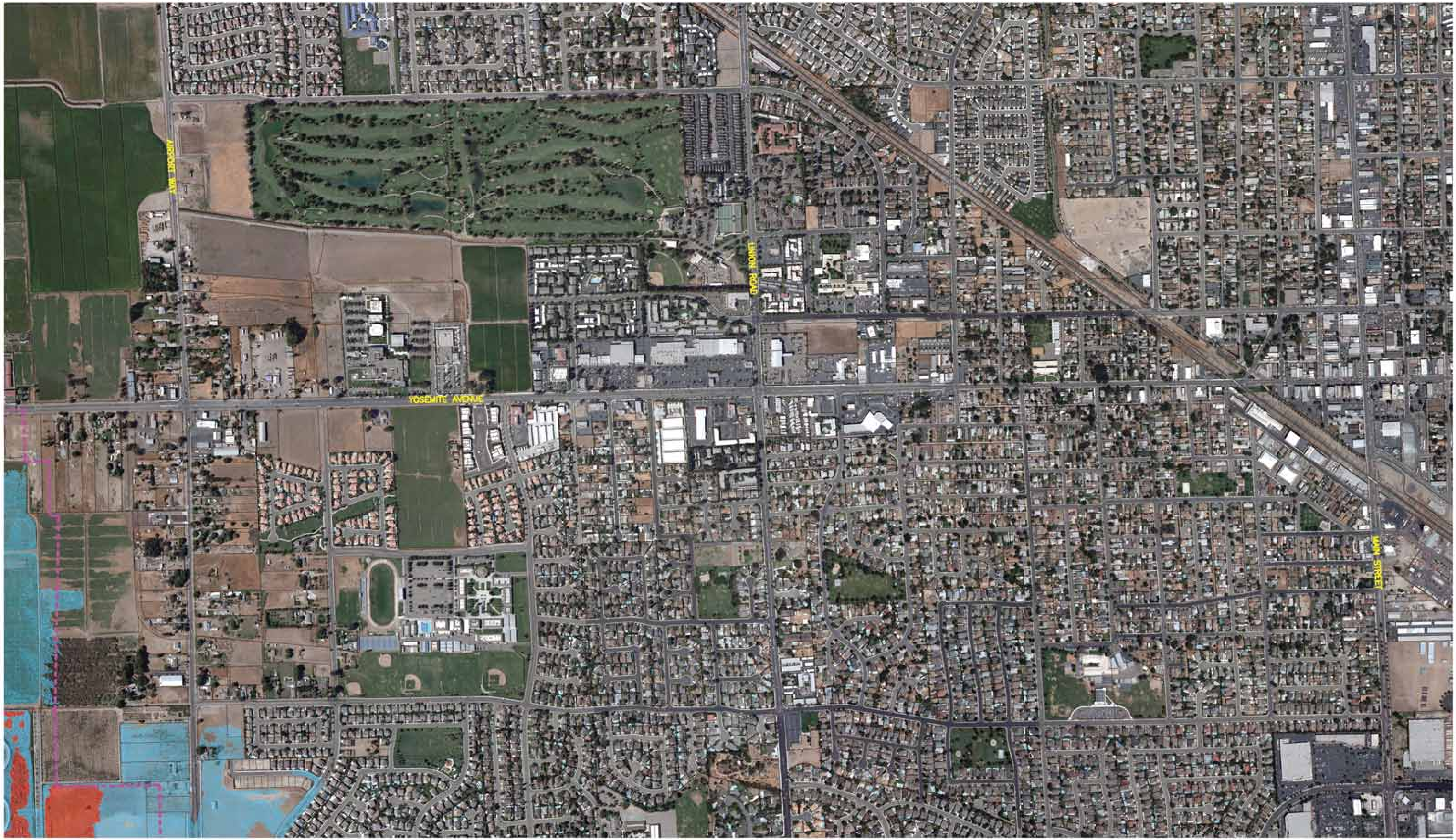

LEGEND:

- 0' TO 3' FLOOD DEPTH
- >3' FLOOD DEPTH
- RD 17 LEVEE
- RD 17 BOUNDARY

NOTES:

1. OVERBANK FLOODING FROM FRENCH CAMP SLOUGH IS NOT INCLUDED IN THIS ANALYSIS.

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(209) 946-0268
1355 Halyard Drive, Suite 180
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Scale
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Original Drawing Scale
0 ½" 1"

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CITIES OF LATHROP AND MANTECA
200-YEAR PLAN
200-YEAR COMPOSITE FLOODPLAIN MAP
EXHIBIT C-3 AREA MAP

EXHIBIT C

PAGE 3

FILE SPEC: P:\0856-Mossdale\0610_SBS_Levee_Evaluation\05_Civil\CAD\Sheets\SH_Plan C.dwg
PLOT DATE: May 23, 2014 - 11:47am

LEGEND:

- 0' TO 3' FLOOD DEPTH
- >3' FLOOD DEPTH
- RD 17 LEVEE
- RD 17 BOUNDARY

NOTES:

1. OVERBANK FLOODING FROM FRENCH CAMP SLOUGH IS NOT INCLUDED IN THIS ANALYSIS.

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Civil Engineers and Land Surveyors
711 N. Pershing Avenue
Stockton, CA 95203
(209) 946-0268
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Scale
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Original Drawing Scale
0 ½" 1"

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CITIES OF LATHROP AND MANTECA
200-YEAR PLAN
200-YEAR COMPOSITE FLOODPLAIN MAP
EXHIBIT C-4 AREA MAP

EXHIBIT C

FILE SPEC: P:\0856-Mossdale\0610_SB5_Levee_Evaluation\05_Civil\CAD\Sheets\SH_Plan_C.dwg
PLOT DATE: May 23, 2014 – 11:53am

LEGEND:

- 0' TO 3' FLOOD DEPTH
- >3' FLOOD DEPTH
- RD 17 LEVEE
- RD 17 BOUNDARY

NOTES:

1. OVERBANK FLOODING FROM FRENCH CAMP SLOUGH IS NOT INCLUDED IN THIS ANALYSIS.

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Stockton, CA 95203
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Scale
1" = 400'

Original Drawing Scale
0 ½" 1"

CITIES OF LATHROP AND MANTECA
200-YEAR PLAN
200-YEAR COMPOSITE FLOODPLAIN MAP
EXHIBIT C-5 AREA MAP

EXHIBIT C

PAGE 5

FILE SPEC: P:\0856-Mossdale\0610_SB5_Levee_Evaluation\05_Civil\CAD\Sheets\SH_Plan C.dwg
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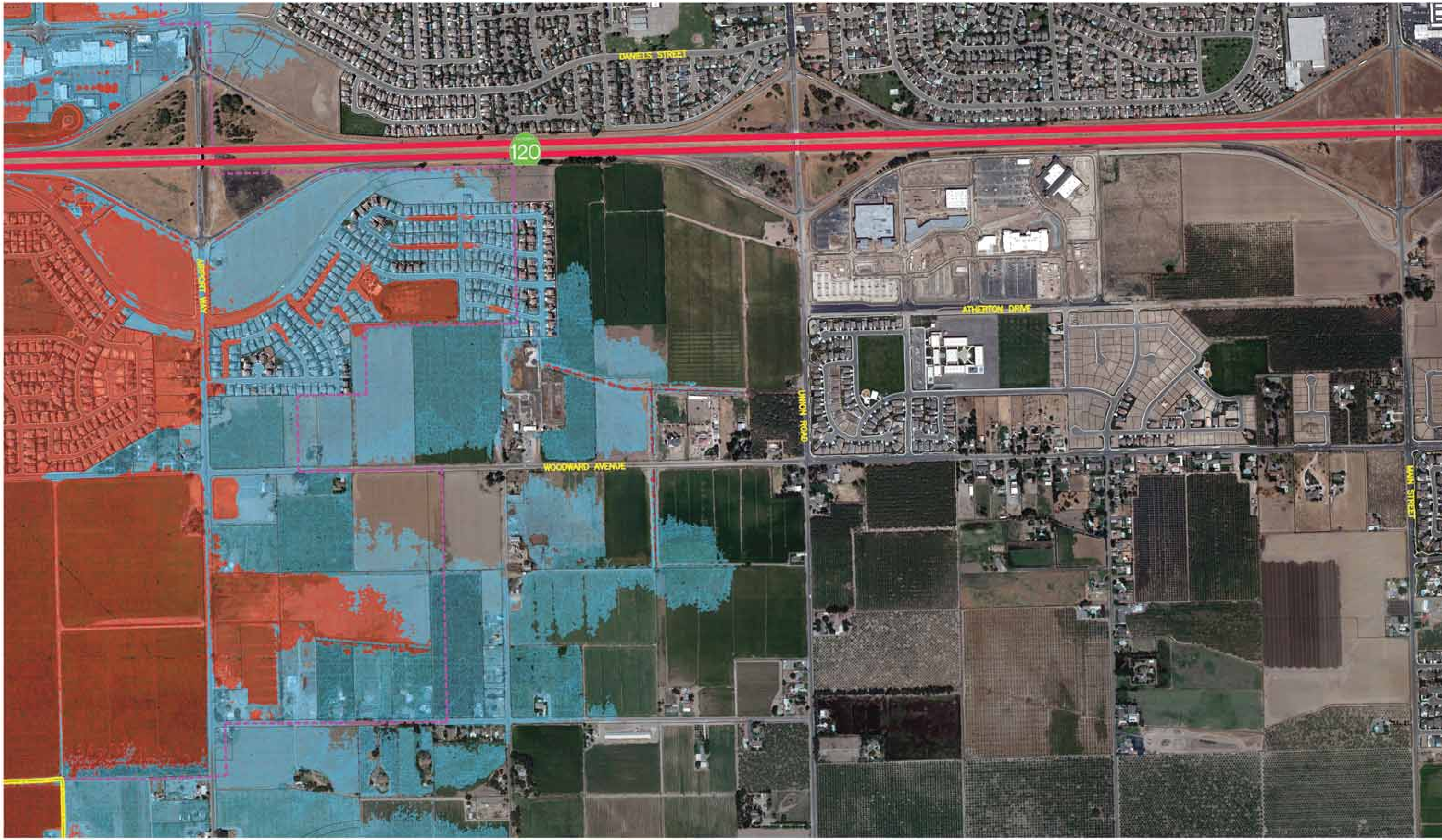

LEGEND:

- 0' TO 3' FLOOD DEPTH
- >3' FLOOD DEPTH
- RD 17 LEVEE
- RD 17 BOUNDARY

NOTES:

1. OVERBANK FLOODING FROM FRENCH CAMP SLOUGH IS NOT INCLUDED IN THIS ANALYSIS.

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Civil Engineers and Land Surveyors
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Stockton, CA 95203
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Scale 1" = 400'
Original Drawing Scale 0 ½" 1"

CITIES OF LATHROP AND MANTECA
200-YEAR PLAN
200-YEAR COMPOSITE FLOODPLAIN MAP
EXHIBIT C-6 AREA MAP

EXHIBIT C

PAGE 6

FILE SPEC: P:\0856-Mossdale\0610_S85_Levee_Evaluation\05_Civil\CAD\Sheets\Sht_Plan C.dwg
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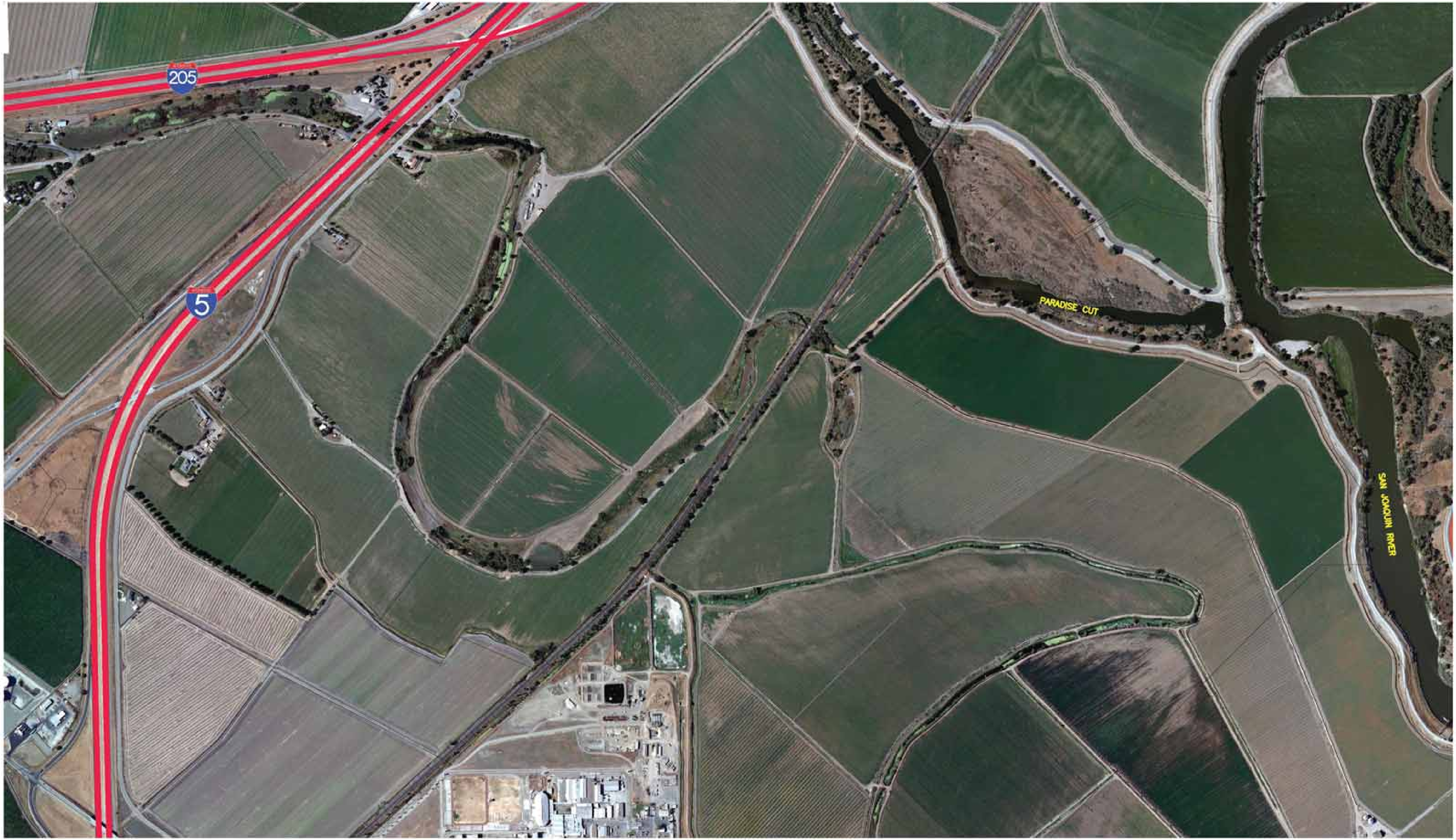

LEGEND:

- 0' TO 3' FLOOD DEPTH
- >3' FLOOD DEPTH
- RD 17 LEVEE
- RD 17 BOUNDARY

NOTES:

1. OVERBANK FLOODING FROM FRENCH CAMP SLOUGH IS NOT INCLUDED IN THIS ANALYSIS.

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711 N. Pershing Avenue
Stockton, CA 95203
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Scale 1" = 400'
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CITIES OF LATHROP AND MANTECA
200-YEAR PLAN
200-YEAR COMPOSITE FLOODPLAIN MAP
EXHIBIT C-7 AREA MAP

EXHIBIT C

PAGE 7

FILE SPEC: P:\0856-Mossdale\0610_SB5_Levee_Evaluation\05_Civil\CAD\Sheets\SH_Plan C.dwg
PLOT DATE: May 23, 2014 – 12:04pm

LEGEND:

- 0' TO 3' FLOOD DEPTH
- >3' FLOOD DEPTH
- RD 17 LEVEE
- RD 17 BOUNDARY

NOTES:

1. OVERBANK FLOODING FROM FRENCH CAMP SLOUGH IS NOT INCLUDED IN THIS ANALYSIS.

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Scale
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Original Drawing Scale
0 ½" 1"

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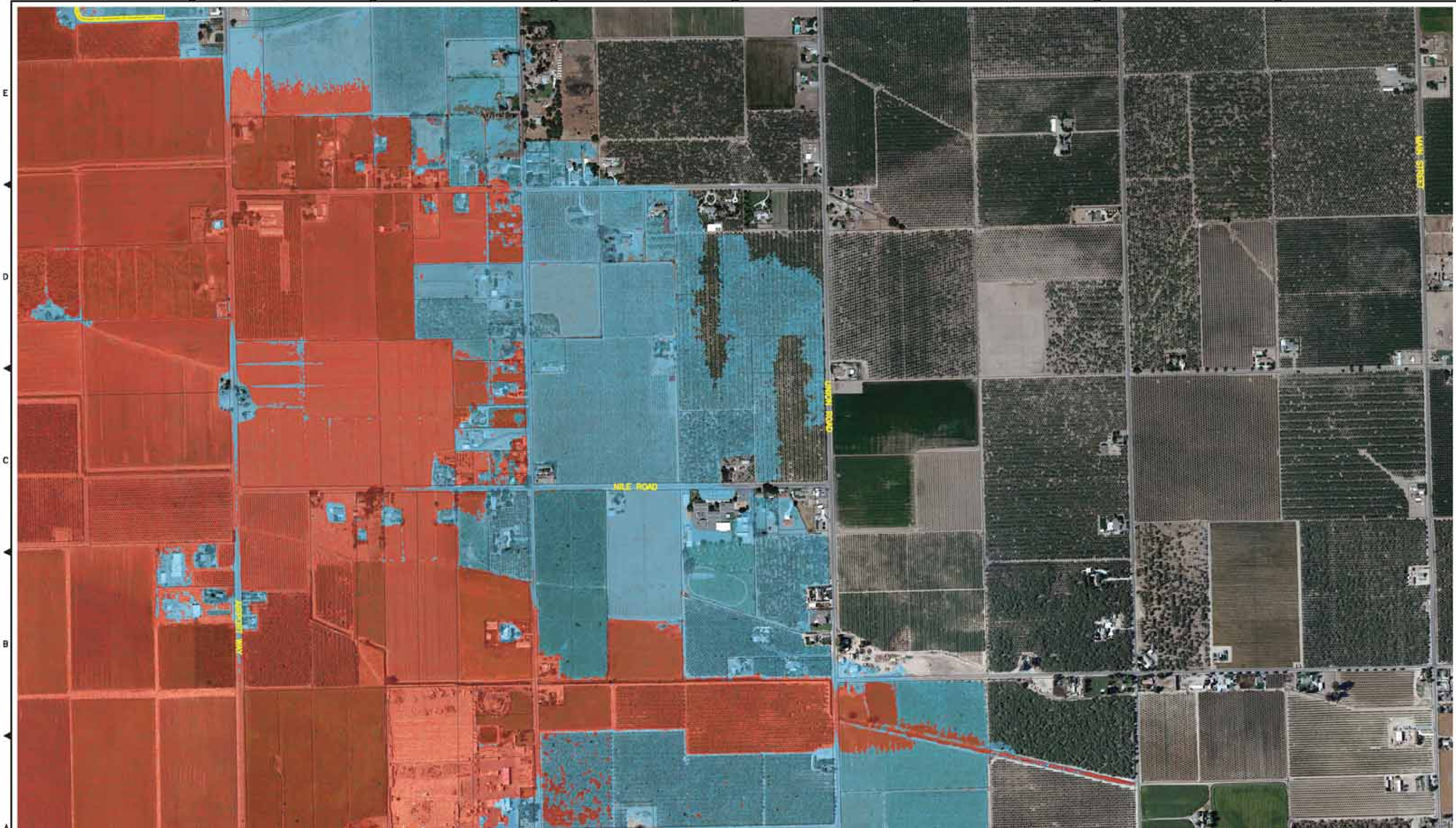
CITIES OF LATHROP AND MANTECA
200-YEAR PLAN
200-YEAR COMPOSITE FLOODPLAIN MAP
EXHIBIT C-8 AREA MAP

EXHIBIT C

PAGE 8

FILE SPEC: P:\0856-Mossdale\0610_SB5_Levee_Evaluation\05_Civil\CAD\Sheets\SH_Plan_C.dwg
PLOT DATE: May 23, 2014 - 12:07pm



LEGEND:

- 0' TO 3' FLOOD DEPTH
- >3' FLOOD DEPTH
- RD 17 LEVEE
- RD 17 BOUNDARY

NOTES:

1. OVERBANK FLOODING FROM FRENCH CAMP SLOUGH IS NOT INCLUDED IN THIS ANALYSIS.

KSN INC.
KJELDSEN SINNOCK NEUDECK
Civil Engineers and Land Surveyors

711 N. Pershing Avenue
Stockton, CA 95203
(209) 946-0268

1365 Halyard Drive, Suite 180
West Sacramento, CA 95691
(916) 403-5900

www.ksninc.com

Scale 1" = 400'

Original Drawing Scale 0 ½" 1"

N

CITIES OF LATHROP AND MANTECA
200-YEAR PLAN
200-YEAR COMPOSITE FLOODPLAIN MAP
EXHIBIT C-9 AREA MAP

EXHIBIT C

PAGE 9

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PLOT DATE: May 23, 2014 – 12:15pm

ATTACHMENT B

HYDRAULICS ANALYSIS SPREADSHEET

Table 1: RD 17 Levee Water Surface Profiles (all elevations ft - NAVD-88)

Stream	Approx. RD17 Levee Station	10yr WSEL**	200yr WSEL* (DWSE)	500yr WSEL**	DWSE with adjustment
French Camp Slough	-1+18	11.6	14.5	15.7	14.5
French Camp Slough	8+40	11.5	14.5	15.7	14.5
French Camp Slough	9+40	11.5	14.5	15.7	14.5
French Camp Slough	14+25	11.5	14.5	15.7	14.5
French Camp Slough	15+40	11.5	14.5	15.7	14.5
French Camp Slough	17+45	11.5	14.5	15.7	14.5
French Camp Slough	25+10	11.4	14.5	15.7	14.5
French Camp Slough	38+90	11.3	14.5	15.7	14.5
French Camp Slough	46+00	11.3	14.5	15.7	14.5
French Camp Slough	45+99	11.3	14.5	15.7	14.5
French Camp Slough	54+95	11.3	14.5	15.7	14.5
French Camp Slough	64+50	11.3	14.5	15.6	14.5
French Camp Slough	73+60	11.3	14.5	15.6	14.5
French Camp Slough	85+55	11.2	14.5	15.6	14.5
French Camp Slough	93+95	11.1	14.5	15.6	14.5
French Camp Slough	93+94	11.1	14.5	15.6	14.5
San Joaquin River	95+70	11.1	14.5	15.6	14.5
San Joaquin River	95+71	11.1	14.5	15.6	14.5
San Joaquin River	97+90	11.2	14.7	15.8	14.7
San Joaquin River	101+25	11.3	14.7	15.8	14.7
San Joaquin River	106+85	11.3	14.8	15.8	14.8
San Joaquin River	110+85	11.4	15.1	16.2	15.1
San Joaquin River	123+20	11.5	15.2	16.2	16.2
San Joaquin River	126+60	11.6	15.6	16.7	16.6
San Joaquin River	139+85	11.8	15.9	17.0	16.9
San Joaquin River	156+50	12.0	16.3	17.4	17.3
San Joaquin River	183+50	12.4	17.2	18.3	18.2
San Joaquin River	209+55	12.8	18.1	19.2	19.1
San Joaquin River	235+75	13.2	18.9	20.0	19.9
San Joaquin River	249+60	13.4	19.2	20.3	20.2
San Joaquin River	252+80	13.4	19.2	20.3	19.2
San Joaquin River	253+40	13.4	19.3	20.4	19.3
San Joaquin River	256+20	13.5	19.4	20.5	20.4
San Joaquin River	277+30	13.8	20.0	21.1	21.0
San Joaquin River	303+25	14.1	20.4	21.5	20.4
San Joaquin River	314+10	14.3	20.8	22.0	20.8
San Joaquin River	331+20	14.5	21.0	22.1	21.0
San Joaquin River	340+20	14.7	21.3	22.5	21.3
San Joaquin River	358+50	14.9	21.7	22.9	21.7
San Joaquin River	369+50	15.1	21.9	23.1	22.9
San Joaquin River	375+60	15.1	22.0	23.1	23.0
San Joaquin River	377+90	15.2	22.1	23.2	23.1
San Joaquin River	379+35	15.2	22.1	23.3	23.1
San Joaquin River	384+60	15.2	22.1	23.3	23.1
San Joaquin River	394+30	15.3	22.3	23.4	23.3
San Joaquin River	402+90	15.3	22.3	23.4	23.3
San Joaquin River	416+90	15.6	22.6	23.8	23.6
San Joaquin River	427+20	15.7	22.8	24.0	23.8
San Joaquin River	431+40	15.8	23.1	24.3	24.1
San Joaquin River	437+65	15.9	23.1	24.4	24.1
San Joaquin River	447+40	16.0	23.2	24.5	24.2
San Joaquin River	457+15	16.1	23.2	24.5	24.2
San Joaquin River	462+00	16.1	23.3	24.6	24.3
San Joaquin River	465+30	16.1	23.4	24.7	24.4
San Joaquin River	470+40	16.2	23.5	24.8	24.5
San Joaquin River	483+70	16.3	23.6	24.9	24.6
San Joaquin River	495+90	16.5	23.9	25.2	24.9
San Joaquin River	507+90	16.6	24.0	25.3	25.0
San Joaquin River	516+30	16.7	24.1	25.4	24.1
San Joaquin River	527+60	16.7	24.2	25.5	24.2
San Joaquin River	533+50	16.9	24.3	25.7	24.3
San Joaquin River	544+70	16.9	24.4	25.8	24.4
San Joaquin River	553+30	17.0	24.5	25.9	24.5
San Joaquin River	559+30	17.1	24.5	26.0	24.5
San Joaquin River	577+50	17.4	25.0	26.6	25.0
San Joaquin River	595+00	17.5	25.0	26.7	25.0
San Joaquin River	600+15	17.5	25.1	26.7	25.1
San Joaquin River	608+60	17.7	25.3	26.9	25.3
San Joaquin River	615+70	17.7	25.4	27.1	25.4
San Joaquin River	624+00	17.8	25.4	27.1	25.4
San Joaquin River	630+90	17.9	25.6	27.4	25.6
San Joaquin River	636+50	18.0	25.7	27.5	25.7
San Joaquin River	644+09	18.1	25.8	27.6	25.8
San Joaquin River	644+10	18.1	25.8	27.6	25.8
San Joaquin River	645+19	18.1	25.8	27.6	25.8
San Joaquin River	645+20	18.1	25.8	27.6	25.8
San Joaquin River	658+40	18.2	25.8	27.6	25.8
San Joaquin River	674+40	18.4	26.2	28.2	26.2
San Joaquin River	693+50	18.7	26.5	28.6	26.5
San Joaquin River	715+50	18.9	26.9	29.1	26.9
San Joaquin River	721+80	19.3	27.5	30.0	27.5
San Joaquin River	729+60	19.6	27.8	30.3	27.8
San Joaquin River	743+70	19.8	28.0	30.5	28.0
San Joaquin River	757+85	20.0	28.2	30.8	28.2
San Joaquin River	761+00	20.1	28.3	31.0	28.3
San Joaquin River	762+70	20.1	28.4	31.0	28.4
San Joaquin River	763+65	20.2	28.5	31.2	28.5
San Joaquin River	766+25	20.2	28.5	31.2	28.5
San Joaquin River	767+90	20.2	28.5	31.3	28.5
San Joaquin River	768+60	20.3	28.7	31.4	28.7
San Joaquin River	769+50	20.3	28.7	31.5	28.7
San Joaquin River	769+50	20.3	28.7	31.5	28.7
San Joaquin River	771+00	20.4	28.8	31.6	28.8
San Joaquin River	771+60	20.4	28.8	31.7	28.8
San Joaquin River	773+80	20.4	28.8	31.7	28.8
San Joaquin River	775+80	20.4	28.8	31.7	28.8
San Joaquin River	782+15	20.4	28.9	31.7	28.9
San Joaquin River	788+30	20.5	29.0	31.9	29.0
San Joaquin River	795+65	20.5	29.0	31.9	29.0
San Joaquin River	799+90	20.5	29.0	31.9	29.0
San Joaquin River	800+10	20.5	29.0	31.9	29.0
San Joaquin River	804+19	20.5	29.0	31.9	29.0
San Joaquin River	804+20	20.5	29.0	31.9	29.0
Walthall Slough_1	817+69	20.6	29.1	31.9	29.1
Walthall Slough_1	817+70	20.5	29.0	31.9	29.0
Walthall Slough_1	819+55	20.5	29.0	31.9	29.0
Walthall Slough_1	820+90	20.5	29.0	31.9	29.0
Walthall Slough_2	823+50	25.0	29.6	32.2	29.6
Walthall Slough_2	824+55	25.0	29.6	32.8	29.6
Walthall Slough_2	824+55	25.0	29.6	32.8	29.6
Walthall Slough_2	837+35	25.0	29.7	32.8	29.7
Walthall Slough_2	840+75	25.0	29.7	32.8	29.7
Walthall Slough_2	851+75	25.0	29.8	32.8	29.8
Walthall Slough_2	862+50	25.0	29.8	32.8	29.8
Walthall Slough_2	863+20	25.0	29.8	32.8	29.8
Walthall Slough_2	865+10	25.0	29.8	32.8	29.8
Walthall Slough_2	865+70	25.0	29.8	32.8	29.8
Walthall Slough_2	866+60	25.0	29.9	32.8	29.9
Walthall Slough_2	867+70	25.0	29.9	32.8	30.9
Walthall Slough_2	877+25	25.0	29.9	32.9	30.9
Walthall Slough_2	886+35	25.0	30.0	32.9	31.0
Walthall Slough_2	897+10	25.0	30.1	32.9	31.1
Walthall Slough_2	907+40	25.0	30.3	32.9	31.3
Walthall Slough_2	907+01	25.0	30.3	32.9	31.3
RD17 Tieback Levee	910+00	--	30.3	32.9	31.3
RD17 Tieback Levee	920+00	--	30.3	32.9	31.3
RD17 Tieback Levee	930+00	--	30.3	32.9	31.3
RD17 Tieback Levee	940+00	--	30.4	32.9	31.4
RD17 Tieback Levee	950+00	--	30.4	32.9	31.4
RD17 Tieback Levee	960+00	--	30.4	32.9	31.4
RD17 Tieback Levee	970+00	--	30.4	32.9	31.4

* An additioanl 1' should be added as a factor of safety in work reaches. Includes sea level rise through 2050.

** Used for geotechnical analyses.