

**State of California
Department of Water Resources**

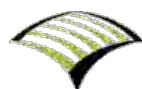
**Contract Number 4600007989
Lower Sacramento River Basin**

**CENTRAL VALLEY
FLOODPLAIN EVALUATION AND DELINEATION**

**Floodplain Management Branch
Floodplain Mapping Section**



**SUBTASK 5
COMBINED SACRAMENTO RIVER
SYSTEM MODEL
TECHNICAL MEMORANDUM
February 5, 2014
Approved February 6, 2014**



WOOD RODGERS

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INTRODUCTION

The California Department of Water Resources (DWR) began a Central Valley-wide hydrologic and hydraulic evaluation for the Sacramento River System and the San Joaquin River System as part of the Central Valley Floodplain Evaluation and Delineation (CVFED) Program in 2008. The DWR tasked CH2M HILL with development of the one-dimensional hydraulic model for the Upper Sacramento River (USR) System; and Wood Rodgers, Inc. (Wood Rodgers) with development of both a one-dimensional hydraulic model for the Lower Sacramento River (LSR) System as well as a single Sacramento River System model combining the USR and LSR models. The intent of these baseline models is to provide:

- Flexibility for use in a variety of flood related applications;
- Robust models that have been tested, stabilized and calibrated where possible;
- Models that are defensible and usable by DWR, the United States Army Corps of Engineers (USACE), and other flood agencies and local jurisdictions;
- Comprehensive coverage of flooded areas impacted by and including the State Plan of Flood Control (SPFC).

This Technical Memorandum describes the process of the development of the Combined Sacramento River (CSR) System Model which represents 902 miles of streams comprising 6,294 cross-sections; riverine levees comprised of 3,471 lateral structures; and a floodplain area containing 499 storage areas totaling 3,053 square miles. For use in flood-related applications, the CSR model provides the advantages of system connectivity that the USR and LSR models do not provide. Detailed flood routing that accurately represents detailed riverine conveyance, overbank spilling and floodplain storage along the Sacramento River system will be a useful tool for performing future flood impacts analyses and planning/alternatives assessments.

While Wood Rodgers carried out the development of the CSR Model, the product was enhanced by the active involvement of the Independent Quality Assurance Review (IQAR) Team comprising Atkins and USACE, Sacramento District. The product development and the quality assurance of the IQAR Team ensured that geometric representation of the model was accurate and that the model produced results that were hydraulically sound. Because of the large number of elements in the CSR Model, the Model Development Team has faced technological limits with the Hydrologic Engineering Center's River Analysis System Model

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HEC-RAS 4.1.0 (version 2008), which was the software used in the USR and LSR Models. The USACE Hydrologic Engineering Center’s (HEC) Senior Technical Hydraulic Engineer, Mr. Gary W. Brunner, P.E., D.WRE, M.ASCE, helped with the decision to consider the use of HEC-RAS Version 4.2.0 (Beta, June 2013) for the CSR Model.

BACKGROUND

The objective of Task Order (TO) 25 Subtask 5 (Upper and Lower Sacramento River Basins HEC-RAS Model Connection) is to connect the approved USR and LSR HEC-RAS system models developed in TO 25 by CH2M HILL and Wood Rodgers, respectively. The extents of the respective USR and LSR HEC-RAS system model layouts are shown on **Figure 1**. The model development and subsequent calibration and validation efforts for the USR and LSR systems models have been documented separately from this Technical Memorandum.

Each team developed a stand-alone “connected” model for the respective Study Areas representing the full geometry of the State Plan of Flood Control within the USR watershed and the LSR watershed. The process of building the connected USR and LSR system models consisted of developing model geometry on a reach-by-reach basis using topographic and bathymetric survey data approved for use by DWR for the CVFED Program. The process involved using test flow hydrology, reviewing geometry and parameters, and integrating the individual streams into a network of connected rivers and tributaries. The largest testing effort included calibrating and validating the data, which involved routing historical storm event flows through the model geometry and adjusting roughness parameters, ineffective flow parameters, and contraction and expansion parameters to match the calculated water surface elevations from the model with measured historical water surface elevations from gages and high water mark surveys. Once the riverine networks were calibrated, storage areas representing the adjacent floodplains were added to the respective system models. The routing characteristics of the model storage areas were then validated using two-dimensional floodplain models (where available) which were developed separately as part of the CVFED Program.

More definitive statistical system hydrology is anticipated to be defined by others in the future as part of the Central Valley Hydrology Study (CVHS) and/or other programs. Currently, the large flow testing utilized for model development combined large flow estimates from different areas without regard to defining the overall statistical hydrologic recurrence interval for the entire Sacramento River system hydrology. While the large test flow is referred to as an approximate 500-year hydrology, no supporting analysis was performed to characterize the test flows as truly

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representing a 500-year storm condition. The test flow hydrology utilized by Wood Rodgers for assessing high flow conditions in the model cannot be considered definitive analyses of the 500-year storm event. The purpose of developing the CVFED modeling was to prepare hydraulic models that would be usable once official hydrology becomes available. The model as a whole is a mixture of high-flow representations which are loosely based on 500-year conditions occurring simultaneously throughout the whole stream system. As such, timing and coincidence should not be given any specific weight and, ultimately, peak flow and stage should not be considered as true “500-year” conditions. Given the size of the overall Sacramento River watershed, it is not reasonable to assume that 500-year conditions occur throughout the system simultaneously.

SUBTASK 5 – UPPER AND LOWER SACRAMENTO RIVER BASINS HEC-RAS MODELS CONNECTION

Description – Goals and Objectives

The Subtask 5 portion of the TO 25 work effort consisted of combining the LSR HEC-RAS model with the USR HEC-RAS model to create a combined model geometry for all streams. In order to achieve this, it required close coordination between Wood Rodgers, CH2M HILL, Atkins and DWR, with additional review by the USACE.

The Subtask 5 effort was defined as producing two coupled model geometries and simulations representing the current (2013) system geometric conditions with approximate 500-year flows, and the 2006 system geometric conditions with the January 1, 2006 flow conditions. These geometries are slightly different because improvements and changes to the channel and levee geometry have occurred since 2006. These geometric differences between 2006 conditions and current conditions are documented in separate technical memorandums for each separate study area. The LSR Technical Memorandum is approved and dated January 18, 2014, and the USR Technical Memorandum is approved and dated January 31, 2014.

The technical aspects of the LSR and USR HEC-RAS models were reviewed and approved separately for adherence to CVFED modeling standards. Each HEC-RAS model was documented with respect to geometry, calibration, flow input parameters, and other factors, to operate as stand-alone modeling efforts. The respective documentation efforts by Wood Rodgers and CH2M HILL (LSR and USR Technical Memorandums) have been approved and are referenced as the basis of the effort supporting this document. The LSR and USR technical

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memorandums are based on supporting documentation developed as part of the separate modeling Study Areas and serve as the basis of each stand-alone model.

The combination of these two previously-approved geometries required examination and modification in the areas where flows must translate downstream from one study area to the other. Prior to combining the models into a single geometry dataset, a number of modifications to the respective geometries were required. This effort is described in more detail below.

Additional/Modified Geometry

The process of linking the LSR and USR models into one combined model first required editing the base geometry datasets in order to remove overlap elements, to re-delineate storage areas for better alignment with model elements from adjacent models, and to assign appropriate connections between storage areas and streams through lateral structures along the edges of each model domain.

In order to tie the USR and LSR system models together, Wood Rodgers identified four (4) floodplain connection zones where the geometries would be linked together:

- Connection Zone 1 represents the vicinity of Cherokee Canal and Thermalito Afterbay north of the Sutter Buttes (**Figure 2**).
- Connection Zone 2 represents the linkage between the Sutter Bypass upstream of the confluence with the Feather River and the Levee District No. 1 floodplain (**Figure 3**).
- Connection Zone 3 represents the linkage between the Sutter Bypass downstream of the confluence with the Feather River and the Reclamation District 1500 floodplain (**Figure 4**).
- Connection Zone 4 represents the linkage between the Colusa Basin Drain and the adjacent floodplain to the south (**Figure 5**).

These zones will be discussed moving from upstream to downstream.

Connection Zone 1: The first connection zone between the two models occurs between the left bank of the Cherokee Canal and the storage areas to the southeast of the Cherokee Canal, in the area north of the Sutter Buttes. The two model geometries overlapped in this area due to having different storage area boundary layouts. Wood Rodgers determined that the LSR watershed

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model storage area boundaries provided more detail and a better hydraulic representation of the overlap area in the combined model than those included in the USR model, and therefore deleted several of the overlap storage areas. The storage areas from the USR system model that were deleted in this connection zone were 048, 047, 050, 051, and 053. Storage areas FEA-19 and FEA-20 from the LSR model were modified to better align at the connection with the USR model. New storage area connections were developed to form the following connections in order to link the USR and LSR model geometries:

- Storage area FEA-15 to storage area 054
- Storage area FEA-17 to storage area 055
- Storage area FEA-17 to storage area 118

The lateral structures along the left bank of the Butte Sink did require modification to eliminate overlap of any lateral structure being physically adjacent to more than one storage area. The lateral structures that were modified are:

- Butte_Sink_Subreach3_26.384
- Butte_Sink_Subreach3_27.134.

Connection Zone 2: The second connection zone is between the left bank of the Sutter Bypass and the storage areas representing the Yuba City area and land to the south between the Sutter Bypass and the Feather River, and includes the Wadsworth Canal. The Wadsworth Canal was developed as a stand-alone model by Wood Rodgers as part of a previous task order and incorporated as part of the USR system model developed by CH2M HILL in TO 25. With respect to the storage area geometry in this area, no additional modifications were necessary as the layouts were already consistent between the USR and LSR system models. The lateral structures along the left bank of the Sutter Bypass did require modification to eliminate overlap of any lateral structure being adjacent to more than one storage area. The lateral structures that were modified are:

- Sutter Bypass_Reach 1_70.450
- Sutter Bypass_Reach 1_71.058
- Sutter Bypass_Reach 1_75.050

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- Sutter Bypass_Reach 1_75.446.

Connection Zone 3: The third connection zone is along the right bank of the Sutter Bypass between the Sacramento River confluence and cross-section 65.647 of the Sutter Bypass. The storage areas to the west of the Sutter Bypass from the USR model were utilized with no modification. The lateral structures along the right bank of the Sutter Bypass did require modification to eliminate overlap of any lateral structure being physically adjacent to more than one storage area. The lateral structures that were modified are:

- Sutter Bypass_Reach 1_58.137
- Sutter Bypass_Reach 1_58.325
- Sutter Bypass_Reach 1_61.655
- Sutter Bypass_Reach 1_62.033.

Connection Zone 4: The fourth connection zone is best described as the areas feeding into the Fremont Weir complex, including portions of the Sacramento River, the Colusa Basin Drain, and the Knights Landing Ridge Cut canal, as well as the storage areas between them interfacing with the Fremont Weir and the upper Yolo Bypass reach. There is significant overlap between the two modeling Study Areas in this area when compared to other areas. The Fremont Weir and the streams flowing in and out of this area are highly inter-dependent, requiring the same level of detail to be in both separated models to make them work properly. In order to provide a clean interface with the Colusa Basin Drain cross-section geometry defined in the USR system model, storage areas CAC-11, CAC-10, CAC-13, and CAC-17 from the LSR model were removed. Likewise, storage areas 001 and 003 from the USR system model were removed to eliminate overlaps with the LSR storage area layout. Two newly defined storage areas (CAC-10A and CAC-11A) were created to replace the deleted storage area portions in this vicinity and to provide a clean interface with the Colusa Basin Drain cross-sections. Storage area connections associated with the deleted storage areas and new storage areas were also created, deleted or modified accordingly. The upstream-most right bank lateral structure for the Knights Landing Ridge Cut Canal was connected differently than the USR model, making it into a connection between the Colusa Basin Drain cross-sections immediately upstream of the junction. The lateral structures along the right bank of the Sacramento River did require modification to eliminate the overlap of any lateral structure that was physically adjacent to more than one storage area. The lateral structures that were modified were:

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- Sacramento River_Reach 1_85.256
- Sacramento River_Reach 1_85.257

Riverine Connections: There are three locations where the riverine components of the USR and LSR models were connected:

- The Sutter Bypass upstream of the confluence with the Feather River (RM 66.665)
- The Sacramento River west of the Fremont Weir (RM 85.010)
- The Knights Landing Ridge Cut upstream of County Road 16 (RM 3.199)

At each of these locations, Wood Rodgers merged the respective stream reach geometries between the USR and LSR systems models using the HEC-RAS geometry editor.

Connection Descriptions

The primary type of connection necessary to join the two modeling Study Areas involved taking lateral structures (along riverine embankments) and storage areas that are defined in separate models, bringing them together in a single geometry file, and identifying them as connected in the HEC-RAS geometry definition. Lateral structures can define the connection between two reaches or the connection between a reach and a storage area. Storage areas can be connected to one another using storage area connections. All types of connection definition modifications were utilized to join the two models.

In order to facilitate review and approval of all of the detailed connection definitions required to integrate the upper and lower models together, Wood Rodgers developed a table identifying the lateral structures in the model that have new connection designations and their respective new tailwater settings. The lateral structure connections that were added to the combined model geometry are summarized in **Table 1**.

Hydrology

Each of the two modeling teams applied several different flow conditions to test the operation of each model Study Area. The USR model was simulated using two (2) historical storm events (1997 and 2006), and a simulation representing a very large event, loosely defined as equivalent to a 500-year flow condition. The LSR model was simulated using the same two historical storm

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events and two other simulations representing a very large event (approximate 500-year flow) and a smaller event (approximate 10-year flow).

While both teams ended up simulating both the January 1997 and January 2006 events, since there was more calibration data readily available for the 2006 event, it was selected for use in combining the two models. Flow inputs for the USR model were investigated and found to line up well as far as timing and peak flow, and did not require adjustment during the combination process. Thus, aside from the LSR inflows at the channel connection points between the two models for the Sacramento River and Sutter Bypass (which were removed), all inflows from both the USR and LSR models were used in the combined model without modification.

The effort to couple the models for the approximate 500-year flow representation required some modification to the timing of inflow in the USR model domain to better align flow combinations temporally downstream and to maintain stressing the system with coincident peak flows downstream of major confluences. The hydrology of the approximate 500-year flow for the USR model was based upon 1997 time window hydrology. Previous system hydrology available for the LSR model from USACE did not extend far enough upstream to be used for the entire USR model layout. The LSR model utilized the “Common Features” flows for test hydrology purposes, which simulated an arbitrary storm window (for modeling purposes) that started in January 1900. The simulation time window for the LSR model was utilized for the combined model simulation, and the USR model inflows were adjusted to align with LSR model inflows. The USR model input hydrographs were lengthened by adding approximately 7.4 days of base flow, prior to the start of the hydrographs as they were originally provided, to better coincide with downstream hydrology and timing. This adjustment was based upon an assessment of the original inflow timing in the LSR model relative to the start of the simulation window, and the USR peak flow timing relative to its original beginning of simulation. Though the approximate 500-year flows were derived separately for the USR and LSR models, the peak flow hydrograph shapes and magnitudes matched closely, with some minor differences in peak flow and volume. This comparison was performed at the Sutter Bypass and Sacramento River, where the LSR model utilized a placeholder flow prior to being combined with the USR model to determine if the realigned combined hydrology was consistent with the magnitude and volume of flow that tested the LSR model. Ensuring continuity between the combined system model and the LSR model hydrology inputs was critical for evaluating potential errors or impacts resulting from the system model connection. Once temporal alignment of peak flow was performed, the representation of the approximate 500-year hydrology was considered acceptable.

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After modifying and combining the geometry of the system, Wood Rodgers made adjustments to initial flows and base flow settings to allow the combined geometry to run with stability. A detailed description of these flow changes is not classified as hydrology in this report, but is discussed in detail below as revised model parameters.

Final/Revised Model Parameters

Model parameters documented in this Technical Memorandum include:

- Storage Area Initial Conditions Settings
- Initial Flow Settings
- Minimum (Base) Flow Settings
- Mixed Flow Settings
- Junction Computation Settings (Energy Balance or Force Equal Water Surface methods)
- Calculations, Options and Tolerance Settings
- Time Step and Simulation Window Settings

The initial flow conditions settings for the combined system model were based on the settings established for the USR and LSR systems models. The initial flow settings can introduce significant instability and computational error if they are not set correctly. A comparison between the final accepted initial storage area water surface elevations in the combined model with the original settings in the respective USR and LSR systems models is presented in **Table 2**. A comparison between the final accepted initial flow settings in the combined model with the original settings in the respective USR and LSR systems models is presented in **Table 3**.

The minimum flow settings are typically utilized in sensitive reaches where very low flows can be computationally unstable. In these locations, a minimum flow setting was added to ensure that stable flow computations are maintained throughout the simulation. A summary of the minimum flow settings for the combined models (approximate 500-year and 2006) is provided in **Table 4**.

Typically, the mixed flow setting is required to perform unsteady flow computations in creeks and streams with higher slopes and flow conditions that exceed sub-critical flow conditions. The

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USR watershed model was finalized and approved with mixed flow turned on in order to overcome geometric issues with the model that have not been properly addressed at this time. Because the USR watershed model was finalized and approved with mixed flow turned on, the combined model also needs to be run in mixed flow. The two global parameters used to adjust the mixed flow equations are documented in the HEC-RAS Users Manual. The exponent value “m” and the Froude Number threshold (F_T) adjust the Local Partial Inertia (LPI) factor, allowing the momentum equation transition to critical and supercritical flow to be “dampened”. The default settings are $m=10$ and $F_T=1.0$. The final settings for both the approximate 500-year event and the 2006 event are $m=2$ and $F_T=1.5$. Introduction of the mixed flow option in HEC-RAS allows the user to specify two key parameters which define the LPI factor and its use in the modified momentum equation, allowing the computations through critical depth and supercritical depth to transition more smoothly. The shape of the curve generated by the “m” and “ F_T ” input parameters defines how the LPI factor reduces to zero through the variation of Froude Number in the equation. The parameters utilized in the USR model are $m=10$ and $F_T=1.0$. The final parameters utilized in the combined model are $m=2$ and $F_T=1.5$; therefore, a detailed comparison was requested by DWR to better understand and identify the impacts of using different mixed flow parameters. Considering that the combined model would not run successfully using the mixed flow parameters set in the USR portion of the model, adjustment in the LSR model of mixed flow parameters was necessary to obtain a functional combined model.

The correct equation for the mixed flow curve was provided by Mr. Gary Brunner from the USACE HEC via personal correspondence where:

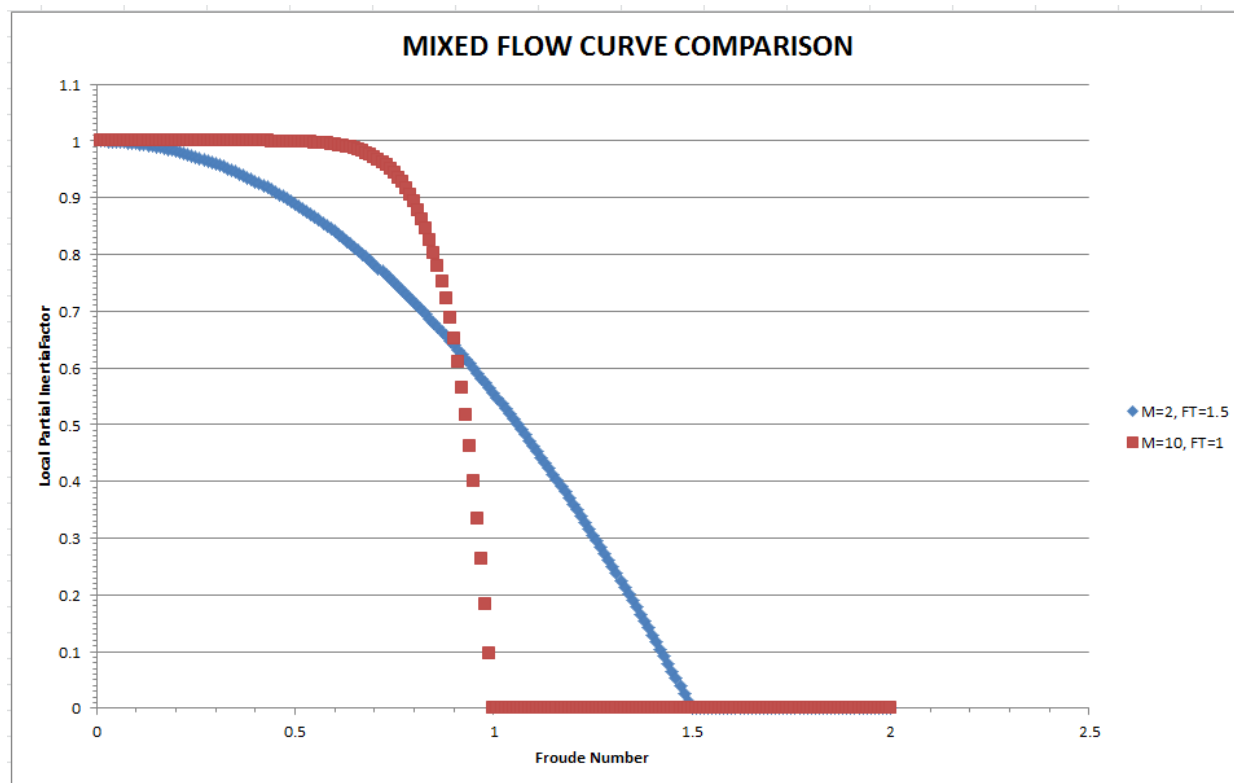
$$\text{LPI factor} = 1.0 - (F_r/F_T)^m \quad (F_r \leq F_T; m \geq 1)$$

The LPI factor is set to 0 for $F_r > F_T$

The following graph displays both mixed flow curves relative to the Froude Number.

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Use of the curve dampens the acceleration term in the equation and affects the values most when the Froude Number is close to a value of 1.0 or exceeding 1.0; a majority of locations where these conditions exist are in the USR portion of the model. CH2M HILL performed a detailed comparison of the effects of utilizing both sets of mixed flow parameters on the steepest streams within their Study Area, and documentation describing these differences can be found in **Appendix A**.

The junction computations can be performed using either the Energy Balance method or the Force Equal Water Surface method, which can be specified at each stream junction independently. Both the USR and LSR separate models utilized a combination of these computational methods, using whichever method provided more stable computations. While there was guidance specifying the use of the Energy Balance method whenever possible, not all junctions perform well using this method. The final junction methods for each junction in the combined model are provided in **Table 5**.

The operation of each HEC-RAS unsteady flow model allows for the adjustment of some parameters which affect the solution convergence of mathematical computations. The settings of

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these parameters in the combined model for the approximate 500-year event are shown in the following screen shot:

HEC-RAS Unsteady Computation Options and Tolerances

General (1D Options) | 2D Flow Options

Unsteady Flow Options

Theta [implicit weighting factor] (0.6-1.0):	1
Theta for warm up [implicit weighting factor] (0.6-1.0):	1
Water surface calculation tolerance (ft):	0.02
Storage Area elevation tolerance (ft):	0.05
Flow calculation tolerance [optional] (cfs):	
Maximum number of iterations (0-40):	20
Number of warm up time steps (0 - 100,000):	60
Time step during warm up period (hrs):	0
Minimum time step for time slicing (hrs):	0
Maximum number of time slices:	100
Lateral Structure flow stability factor (1.0-3.0):	1
Inline Structure flow stability factor (1.0-3.0):	1
Weir flow submergence decay exponent (1.0-3.0):	1
Gate flow submergence decay exponent (1.0-3.0):	1
DSS Messaging Level (1 to 10, Default = 4)	4
Maximum error in water surface solution (Abort Tolerance):	100

☒ Compute energy losses over junctions

Geometry Preprocessor Options

☐ Convert Energy Method Bridges to Cross Sections with Lids

Family of Rating Curves for Internal Boundaries

☒ Use existing internal boundary tables when possible.

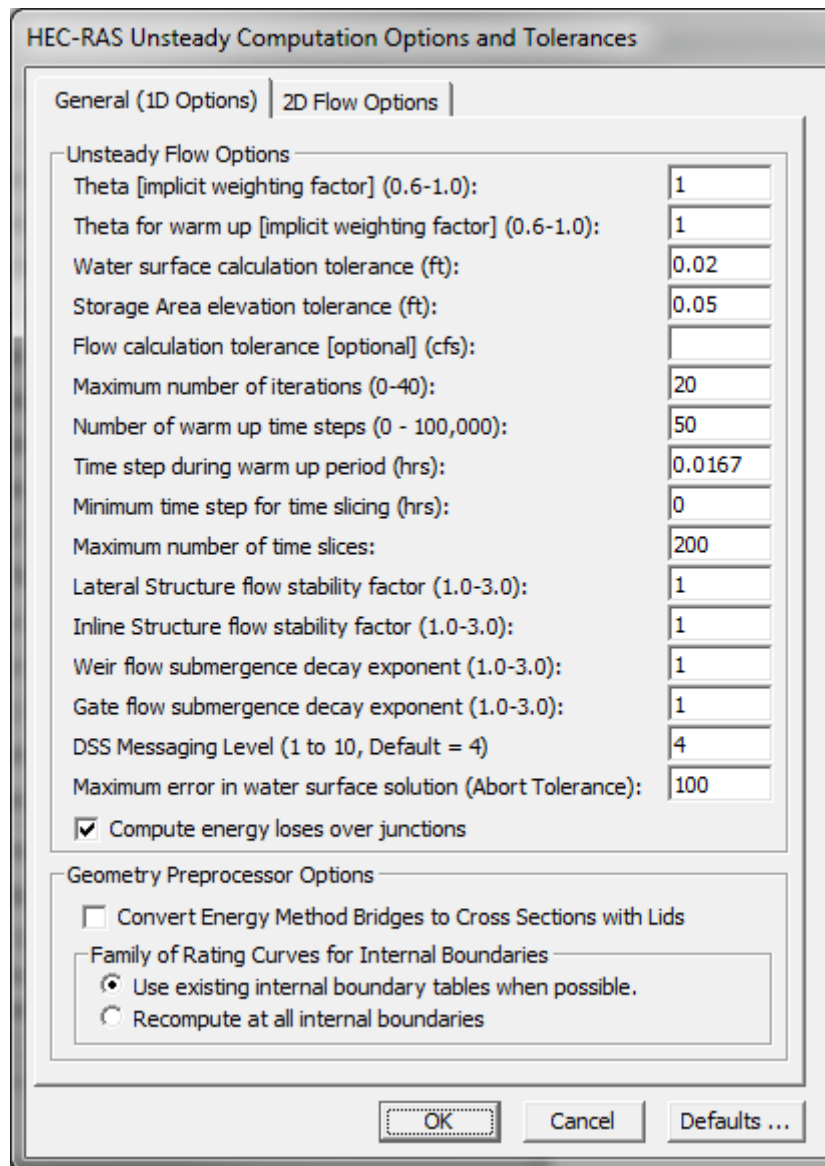
☐ Recompute at all internal boundaries

OK Cancel Defaults ...

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The settings of these parameters for the 2006 model are shown in the following screen shot:



HEC-RAS Unsteady Computation Options and Tolerances	
General (1D Options) 2D Flow Options	
Unsteady Flow Options	
Theta [implicit weighting factor] (0.6-1.0):	1
Theta for warm up [implicit weighting factor] (0.6-1.0):	1
Water surface calculation tolerance (ft):	0.02
Storage Area elevation tolerance (ft):	0.05
Flow calculation tolerance [optional] (cfs):	
Maximum number of iterations (0-40):	20
Number of warm up time steps (0 - 100,000):	50
Time step during warm up period (hrs):	0.0167
Minimum time step for time slicing (hrs):	0
Maximum number of time slices:	200
Lateral Structure flow stability factor (1.0-3.0):	1
Inline Structure flow stability factor (1.0-3.0):	1
Weir flow submergence decay exponent (1.0-3.0):	1
Gate flow submergence decay exponent (1.0-3.0):	1
DSS Messaging Level (1 to 10, Default = 4)	4
Maximum error in water surface solution (Abort Tolerance):	100
<input checked="" type="checkbox"/> Compute energy losses over junctions	
Geometry Preprocessor Options	
<input type="checkbox"/> Convert Energy Method Bridges to Cross Sections with Lids	
Family of Rating Curves for Internal Boundaries	
<input checked="" type="radio"/> Use existing internal boundary tables when possible.	
<input type="radio"/> Recompute at all internal boundaries	
OK Cancel Defaults ...	

The time step and simulation time window settings stipulate the frequency and overall duration of the simulation computations. For the 500-year combined model, the computational time step was set at one minute and the simulation duration was 542 hours beginning on January 6, 1900 at 9:00 a.m., and ending on January 28, 1900 at 11:00 p.m. For the 2006 combined model, the computational time step was set at one minute and the simulation duration was 262 hours, beginning on December 25, 2005, at 1:00 a.m., and ending on January 4, 2006, at 11:00 p.m. These parameters are modified uniquely for each storm simulation hydrology.

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Geometric Model Modifications

The combined system model geometry is intended, to the extent possible, to maintain the original model geometry of the USR and LSR models. Although some changes were required to link the two models together at their boundaries, in general, DWR preferred to maintain the original geometry as closely as possible to obtain stable model computations/operation. One geometric change was made to adjust for instabilities encountered in the combined model development that were not encountered in the USR and LSR model development: at the junction of Wadsworth Canal and the Sutter Bypass, the computation made for the 2006 event was changed from energy to forced mode. Contraction and expansion coefficients in the upper American River were added ($C=0.6$, $E=0.8$) between River Mile (RM) 19.654 and RM 20.093, and between RM 13.45 and RM 14.2735, to reduce model instability and error during high flow conditions. For consistency, the coefficients were utilized in both combined model simulations.

Software/Hardware Constraints:

Both the USR and LSR models have been executed using the HEC-RAS Version 4.1 Release, available online to the public at the USACE HEC website: (www.hec.usace.army.mil)

HEC-RAS Version 4.1 was originally intended to be the software for all HEC-RAS system modeling for the CVFED program; however, HEC-RAS Version 4.1 is not adequate for modeling the combined Upper and Lower model(s) for the Sacramento River System watershed because the number of features in the combined geometry model exceeds the virtual memory limitations of the 32-bit software, and the program cannot perform computations. Faced with this limitation, Wood Rodgers discussed alternatives with DWR, Atkins, and HEC which included utilizing the HEC-RAS Version 4.2 Beta Release software which operates as a 64-bit program and has significantly more virtual memory capability. If HEC-RAS Version 4.1 were to be utilized, the combined model geometry size would need to be reduced by removing geometric features in order to operate within the software limitations. This would require significant time and effort to determine what portions of the system geometry could be simplified and/or eliminated.

To enable the DWR to make a decision regarding the acceptability of using the HEC-RAS Version 4.2 Beta Version software, Wood Rodgers performed comparisons of HEC-RAS Version 4.1 and HEC-RAS Version 4.2 Beta. To perform such a comparison requires running the exact same model geometry and flows through both versions and reviewing the results. As the combined model geometry does not run in both, the Lower Sacramento River HEC-RAS

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model was selected and run in both versions of software for both the approximate 500-year and the 2006 storm event simulations. The DWR requested that all significant differences be documented by Wood Rodgers. The differences were calculated by taking the maximum water surface elevation value in the HEC-RAS Version 4.2 Beta simulation and subtracting the maximum water surface elevation value of the HEC-RAS Version 4.1 simulation. Thus, positive values show higher conditions in the HEC-RAS Version 4.2 Beta relative to HEC-RAS Version 4.1, and negative values indicate higher conditions in HEC-RAS Version 4.1.

HEC-RAS Software Comparison for 500-Year:

The approximate 500-year simulation spills into many of the floodplain storage areas and inundates the riverine system more comprehensively. The comparisons representing the differences for the approximate 500-year test are shown on **Figure 6** through **Figure 10**.

Upstream of the Sutter Bypass, small differences occurred in the approximate 500-year simulation. With some minor increases in water surface elevations in the Feather River, small increases in spill volume occurred in storage areas adjacent to the river, such as Storage Area FEA-28 (shown on **Figure 6**).

In the approximate 500-year simulation, the junction of Dry Creek and Bear River was behaving differently in the respective software versions (as shown in the profile on **Figure 11** and in plan view on **Figure 7**). The water surface increase of between 0.2 to 0.3 feet was primarily due to a difference in junction loss computation in the junction of Dry Creek and Bear River. In the HEC-RAS Version 4.2 Beta on simulation, the adjacent storage areas to the north of Dry Creek received more water from a higher Dry Creek profile and have an expected increase in peak water surface elevation, accordingly due to what occurred in Dry Creek. The profile of Dry Creek for the HEC-RAS Version 4.2 Beta software at this stream junction is considered hydraulically acceptable. However, this issue was reviewed with HEC staff, and it was determined that this water surface difference was created by a bug in HEC-RAS Version 4.1, in which the junction length input was overridden by the program, and in this particular case underestimated, resulting in an underestimation of the head loss across the junction. This error has been corrected in HEC-RAS Version 4.2 Beta, which provides more reasonable losses across the junction.

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The most significant difference between the models occurred within the Sacramento River just upstream of the Fremont Weir. The water surface elevations were significantly higher in the HEC-RAS Version 4.1 by approximately 2.5 feet, as shown on **Figure 12** and in plan view on **Figure 8**. This increase in water surface represented significant head loss through the junction where water entered the Sutter Bypass from the upstream Sacramento River. In the HEC-RAS Version 4.1 model, this water surface increase forced approximately 8,000 cfs to spill out into adjacent storage areas during peak conditions, thus reducing peak flow in the downstream system. In HEC-RAS Version 4.2, this spill was eliminated, thus more flow was retained in the riverine system to be carried downstream. The consequential effects of this flow increase were felt both upstream and downstream of this location in the HEC-RAS Version 4.2 Beta simulation. This issue was reviewed with HEC staff and it was determined that this water surface difference was created by the aforementioned bug in HEC-RAS Version 4.1, in which the junction length input was overridden by the program, and in this particular case over-estimated, resulting in an overestimation of the head loss across the junction. As noted previously, this error has been corrected in HEC-RAS Version 4.2 Beta, and provides more reasonable losses across the junction.

The water surface increases in the Sutter Bypass upstream of the Fremont Weir were a direct result of the additional 8,000 cfs that remain in the riverine system in the HEC-RAS Version 4.2 Beta simulation. The storage areas adjacent to the Sutter Bypass received slightly more river overflow water and showed an increase in maximum storage area elevations. The increased water in the system also forced more water to flow down the Sacramento River and the Yolo Bypass. These increases forced a higher tailwater condition for the Natomas Cross Canal, which increased backup of water in the entire Natomas Cross Canal system. The defined overflow at Sankey Road was also affected, increasing the volume of spill into the upstream end of the Natomas East Main Drain Canal (NEMDC). This increment of volume increases peak conditions on the upper NEMDC channel and backs up at the inline pump station near the confluence of the NEMDC (Sacramento County), as the pumping facility is at capacity and cannot evacuate the flood volume fast enough to keep up with the additional volume.

The additional water in the Sacramento River and Yolo Bypass increases the volume of water spilling into the adjacent storage areas from West Sacramento northward.

Downstream of the Sacramento/West Sacramento area, the increase in flow is creating very minor increases in peak water surface elevation in the reaches of the Sacramento River and Yolo Bypass upstream of their confluence, as shown on **Figure 9**. Near Rio Vista, the

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convergence of flow combines the increases and creates water surface increases in the river and adjacent storage area spills, as shown on **Figure 10**.

The only storage area to show an increase in stage that was not caused by the riverine differences due to the Sacramento River/Sutter Bypass junction results was storage area AMES-38. Wood Rodgers performed an examination of the flow patterns through the storage areas south of the American River and east of the Sacramento River. It was found that the flow across storage area connections which combine weir flow with culvert flow can produce slightly different results when using HEC-RAS Version 4.2 Beta. As shown on **Figure 13**, the connection between storage areas AMES-37 and AMES-32 exhibits some differences depending on which version of HEC-RAS the model is run in. Wood Rodgers performed an additional comparison in which the culvert across this storage area connection was removed and found that, once the culvert was removed, both versions of the software produce identical results. Wood Rodgers has brought these observations to the attention of HEC and plans to explore this topic in greater detail as part of a subsequent Task Order.

HEC-RAS Software Comparison for 2006 Storm:

Flows in the 2006 storm simulation are of lower magnitude than those in the approximate 500-year simulation, and consequently less water spills into the adjacent floodplain storage areas in the 2006 storm simulation. Thus, the comparison of HEC-RAS Version 4.1 and HEC-RAS Version 4.2 Beta for the 2006 storm simulation emphasizes review of the riverine components more than the storage area interaction. **Figure 14** and **Figure 15** depict a comparison of the maximum water surface elevations at each cross-section in the LSR model. This comparison shows a much closer alignment between the two versions when the water is restricted to the channels. Similar to what was observed in the 500-year analysis, there are differences between the model results at the junction where the Sacramento River enters the Fremont Weir Complex, as well as at the junction representing the confluence of Dry Creek and Bear River. The differences are similar to the approximate 500-year comparison. As the differences between HEC-RAS Version 4.1 and HEC-RAS Version 4.2 Beta are generally small, the impact to the previously completed calibration efforts of the USR and LSR models is considered negligible.

Based on this comparison of both HEC-RAS versions, DWR approved the use of HEC-RAS Version 4.2 Beta for completion of Subtask 5.

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Combined Model Output Review

The finalization of the combined model required incremental adjustments of model parameters and comparisons of results between the USR model (HEC-RAS Version 4.1), the LSR model (HEC-RAS Version 4.1), and the Combined System model (HEC-RAS Version 4.2 Beta) to understand whether the combined model output replicated the modeled conditions of the regional USR and LSR Study Areas.

While the intent was to take the geometry and flow conditions of each regional model and simply join them to obtain the combined model, the joining effort required unforeseen adjustments to the combined model that were not required in either the USR or LSR separate models.

The most significant difference between the combined model operation and the USR and LSR models is the use of mixed flow and the settings associated with mixed flow. The LSR model did not require the use of mixed flow, with all computations performed using sub-critical flow assumptions (Froude Numbers less than 1.0). The USR model has select locations that exhibit steeper slopes as well as representation of drop structures and other minor hydraulic controls through the use of cross-sections only, which were solved using mixed flow options with default input parameters ($m=10$, $F_T=1.0$); it also has reaches where outstanding IQAR review comments were not completely addressed per DWR direction that could also be hindering the ability to run the model in the subcritical flow regime. The combination of both geometries also utilizes mixed flow, but would not run through an entire simulation using the default mixed flow settings. The mixed flow options were modified to be $m=2$ and $F_T=1.5$, and the final model produced stable results. The model development process was iterative, requiring a total of 52 versions of the model setup as part of the finalization process for both the 2006 and approximate 500-year simulations, as shown on **Table 6**.

Model No. 38 was selected as the best simulation available for the 2006 event combined model. This model is provided in digital format as part of this submittal.

Model No. 51 was selected as the final accepted simulation, producing the best obtained results for the approximate 500-year condition. This model is provided in digital format as part of this submittal.

With such a large, complex system model, achieving optimum results at every cross-section location under two drastically different flow conditions was not realistic. The following

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discussion is an overview of the major issues that were discovered and resolved, and the level of resolution accepted.

To assess the performance of the combined models, Wood Rodgers compared the maximum water surface elevations of the approximate 500-year and 2006 model simulations between the separate and combined models output using the HEC-RAS Version 4.2 Beta for the combined model and the LSR model, and HEC-RAS Version 4.1 output for the USR model. Wood Rodgers was able to run the approved LSR models using the HEC-RAS Version 4.2 Beta software and mixed flow settings in order to perform more direct comparisons with the combined model output. An in-depth discussion on the assessment of the LSR models using HEC-RAS Version 4.2 Beta is provided in **Appendix B**.

Figures 16 and 17 show a colorized comparison of the 2006 event output. The differences are fairly insignificant in the majority of the model domain. The combined model representing the 2006 event was unable to prevent high initial conditions from forming in the Colusa Basin Drain portion of the model. Recent modifications to this area were provided by CH2M HILL, but these adjustments prevented the model from running entirely. While these high conditions dissipated in the simulation before the 2006 event flows reached this portion of the model, DWR directed CH2M HILL to determine a solution for the USR model that did not produce such initial conditions in the Colusa Basin Drain. CH2M HILL proceeded to make adjustments to the USR model that included changes to initial conditions water surface elevation settings at specific cross-sections and storage areas. These adjustments were successfully implemented in the USR model and are documented by CH2M HILL as part of the USR documentation. These same changes were placed in the 2006 combined model and the model failed without producing output. At the time, DWR and Atkins requested that the 2006 simulation be put on hold until the issue could be rectified in the approximate 500-year model. No further adjustments for the Colusa Basin Drain were made for the 2006 event after model No. 38 was completed.

Wood Rodgers maintained the original settings for the Colusa Basin Drain. It is important to note that the lack of adjustment does not affect the operation of the Colusa Basin Drain during the peak portion of the storm event. The initial conditions, while higher than the main event, dissipate before the main event enters the system. Future users should be aware of this condition and manually extract maximum water surface elevations from the event generated peak, disregarding initial output. Future users may consider further modifications to lower initial conditions to more acceptable levels. A similar condition also exists in the UNT (unnamed tributary of Honcut Creek) reach, where initial conditions were increased above 2006 event flow

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conditions in order to get the model to run. The initial conditions also dissipate before the main event portion of the simulation and will require manual effort to extract the maximum water surface elevations for this stream reach.

In the detailed comparison shown on **Figure 16**, the storage areas both north and south of the Sutter Buttes indicate differences in output. For the storage areas to the north, this comparison is being made between LSR storage areas, which see no water from the Feather River in the stand-alone model, to the combined model output which receives overflow from the Cherokee Canal. The storage area layout for the combined model does not match the USR model in this area, so a direct comparison was not possible. To the south of the Sutter Buttes, the Wadsworth Canal was not included in the LSR model, but was added to the USR model with the definition of storage areas between Sutter Bypass and Feather River matching the LSR model. For the 2006 comparison in this location, the water surfaces in storage areas FEA-01, FEA-04, FEA-01, FEA-34 and FEA-30 were compared to the USR model.

The lower Sutter Bypass, Yolo Bypass and Sacramento River are approximately 0.2 to 0.3 feet lower in the combined model due to a flow difference of approximately 3,000 cfs. The combined model routes the 2006 event through the USR geometry and computes a slightly different flow in the Sutter Bypass when compared to the hydrograph obtained from the USACE 2006 hydrology from 2012.

At American River RM 14.4245, there are water surface elevation differences between the regional and combined models. Upon closer examination, it appears that the 2006 peak flow conditions are at a point in the conveyance where ineffective flow areas become effective, generating minor oscillations in the computations. These flows are contained in the main channel and the differences are less than 0.4 feet, dissipating shortly upstream and downstream. As the combined model geometry is much larger, the solution matrix is greatly expanded for the entire model, and can converge on a slightly different solution, even with exactly the same local geometry and flow.

At American River RM 20.284 there are increased water surface elevations in the combined model due to adjustments made to the contraction and expansion coefficients in the vicinity of the Sunrise Boulevard Bridge. The increases are less than 0.4 feet and dissipate to zero a short distance upstream. During the development of the combined model geometry, significant error and instability were witnessed in this portion of the American River, and contraction and expansion coefficients were adjusted to reduce model error. Further discussion on this issue is

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found below for the approximate 500-year event, as differences were more pronounced under higher flow conditions.

Boundary conditions for the USR and LSR stand-alone models were estimated at the time of model development. These conditions are understood to be overridden by the combined model results, once both models are allowed to transfer flow freely, according to hydraulic principles. The locations where differences in boundary conditions are affecting the model are east of Cherokee Canal, along Wadsworth Canal and adjoining storage areas, west of Sutter Bypass, and within the Knights Landing Ridge Cut Canal. These differences do not affect the model and can be disregarded.

A few initial storage area elevation differences exist between the two models, but most of the storage areas do not get wet during the 2006 simulation because most of the water is contained within the river corridors.

Upon closer evaluation, the 500-year event hydrology is not the same in the combined model as it is in the separate LSR model due to differences in routed flow reaching the Sutter Bypass. The USR model utilizes different hydrology when compared to the injected flow hydrograph from the USACE Common Features model that was utilized in the LSR model. Because the hydrology and geometry are changed, it is impossible to evaluate the performance of the model using the comparison, as the differences may be flow-based or due to geometry combination. Wood Rodgers did perform a comparison of the approximate 500-year results between the LSR model and the combined model, and have provided the supporting GIS comparison files as digital files attached to this document.

The simulation of the approximate 500-year conditions (high flow) yielded more differences, considering more areas of the model are inundated, with spilling conditions into floodplain (storage) areas. Comparison of the USR and LSR models to the combined model output must be taken with consideration of hydrologic differences between the models. The hydrology for the USR model was derived separately, and does not match the flow originally utilized as a boundary condition for the LSR model.

The major issues concerning comparisons of the approximate 500-year models are related to the Colusa Basin Drain maximum conditions and the routing of flow from the USR model to the LSR model domain around the Sutter Buttes.

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The Colusa Basin Drain in the combined model for the approximate 500-year conditions is significantly different than the approved USR stand-alone model, and is provided in **Appendix A** of the main report. In the presentation by CH2M HILL on January 24, 2014, and discussed in the **Appendix A** documentation effort, the Colusa Basin profile has an erroneously low water surface elevation at the junction with Knights Landing Ridge Cut which affects water surfaces for a long distance upstream in the Colusa Basin Drain. The combined model does not see this anomaly, and produces maximum water surface elevation that is consistent with the inflow and surrounding hydraulic connectivity with the Sacramento River and the Knights Landing Ridge Cut.

The combined model connects the entire Sacramento River system together, including the overflow of water around the east side of the Sutter Buttes. Review of the combined model output shows that approximately 100 cfs leaves the Cherokee Canal and Butte Sink area, and flows around the east side of the Sutter Buttes. This has a minor influence on conditions just west of Yuba City. The storage areas between the Feather River and Sutter Bypass are higher in the combined model than in either the LSR model or the USR model, as flow is spilling out of both the Feather River and Sutter Bypass system and only the combined model accounts for both. The maximum stages in the Sutter Bypass upstream of the Feather River are primarily due to the difference between the boundary condition utilized in the USR and the computed backwater in the combined model from the confluence with the Feather River. The same flow leaves the USR model under much lower elevations than the combined model computes. While the water surface differences decrease moving upstream past Wadsworth Canal, these differences force more water to spill west of the Sutter Bypass in the combined model. In the combined system model, approximately 50,000 cfs less flows from the upper Sutter Bypass (USR model) to the lower Sutter Bypass (LSR model), and stage comparisons downstream show the combined model with consistently lower stages than the LSR model. This is partly due to the change in spills and partly due to the fundamental differences in the sources of hydrology.

While not a major issue, the upper American River does experience higher water surface elevations upstream of Sunrise Boulevard in the combined model due to the presence of contraction and expansion coefficients. The model development process was iterative and is outlined in **Table 6**. As shown in **Table 6**, maximum error messages were present in the upper American River that were reduced or eliminated with the use of contraction and expansion. The contraction and expansion effects are more pronounced in the high flow conditions and produce conservative estimates of water elevation. This portion of the model is at the upstream end of urban areas and upstream of levees, just downstream of Nimbus Dam. As these coefficient

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adjustments were made early in the iteration process, Wood Rodgers re-tested the model without these coefficients under Model No. 52, but the model crashed. Future users may consider refinement in this area that may include additional cross-sections and/or adjustments to effective flow area designations.

Overall, the model geometry and operation during lower flow and higher flow events was tested under Subtask 5 and found to be substantially acceptable. All future users of the model will need to consider adjustments to model parameters with different hydrology and/or project considerations.

Model Sensitivity:

As part of the model iteration process, Wood Rodgers did encounter sensitivity at certain locations more frequently than at others. These sensitive areas are described below.

- Big Chico Creek and Butte Creek: This portion of the model is from the USR geometry and was very sensitive to initial flow settings.
- Colusa Basin Drain: This portion of the model upstream of the junction of Knights Landing Ridge Cut was very sensitive and required initial elevations set at river stations to force the model to start computations below peak storm levels.
- Coon Creek and the Upper Natomas Cross Canal System: This portion of the model is very flat and is subject to considerable backwater, negative flow and flow reversal when the local inflow drains and the Sacramento River rises to flood stage. Maintaining significant minimum flow in these channels appears to maintain stability, with different settings required for the 2006 and approximate 500-year conditions.
- Upper American River: This portion of the model contains numerous cross-sections, with permanent ineffective and temporary ineffective flow settings where tiered overbank areas are located. As flow increases in the hydrology, some ineffective flow areas can become effective and can cause minor instability.
- Upper Feather River: In the reach upstream of the Oroville Wildlife Area, there are complex overbank areas represented with permanent and temporary ineffective flow areas that have repeatedly introduced error during model iterations.

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- Upper WPIC: The upstream end of the WPIC channel is connected to a storage area as a narrow channel connecting immediately downstream to lateral overflow and storage. For higher flow conditions, the model transitions all upstream stored water from zero velocity to constrained (narrow) channel flow, with higher velocities to significantly lower velocity once flow laterally leaves the channel, creating significant head loss and instability in this one-dimensional configuration.
- WPIC Upstream of Pump Station: The portion of the WPIC just upstream of the Highway 70 crossing diverts water to overflow detention while also gravity draining and pumping. Under past iterations, the model has indicated some instability with water surface elevation anomalies in the profile.
- Yankee Slough: There are instabilities occurring at the confluence upstream of Bear River as the flow transitions from narrow channel to wide river conditions.

Instability and computational sensitivity to changed conditions are indicative of model geometry and/or flow conditions that create abrupt changes in cross-sectional flow area from time step to time step. These abrupt changes can be triggered by abrupt flow increases as well, which can inundate cross-sectional area differently. Unsteady flow models, such as HEC-RAS, become overwhelmed in the computational phase when there are any abrupt changes between cross-sections that may force flow to significantly drop, contract or expand in short distances, or very short time frames. Many general modifications are recommended to avert these instabilities, including adding more intermediate cross-sections, decreasing the computational time step, adding minimum flow, and smoothing ineffective and effective flow area transitions. Any geometry may present different instabilities depending upon hydrologic differences. Future users should be properly trained in the use of HEC-RAS before running or making modifications to these models.

Model Errors and Warnings:

As part of the model review process, all warning messages and error identifications were reviewed to identify computational variance and potential problem spots for future model users applying different hydrology. It is noted that, in any HEC-RAS model with dynamic hydrology, the model solution process will involve iterations. In general, the computational matrix can become unstable under very low flow conditions and under conditions where flow and/or conveyance changes abruptly. With a fixed time interval, large changes in flow cannot be processed effectively, which helps to explain the very small time steps utilized for the combined

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model. To prevent the model from crashing under low flow conditions, minimum flows can be maintained in the channels to give enough for the matrix to continue processing smoothly until higher flows enter the system.

The HEC-RAS Version 4.2 Beta software stores error log information in an “hdf” file format, which is binary. The error summary is accessible through the HEC-RAS interface only; however, Wood Rodgers copied the log data from HEC-RAS to a spreadsheet to review and sort the information for each successful model run. These spreadsheet files are provided in the digital deliverables with the HEC-RAS model files for the runs performed by Wood Rodgers. If the model output settings are properly set, additional error log information can be ascertained from the HEC-RAS “bco” file format, which can be readily opened in a text editor program.

In general, the successful model runs completed all computational intervals without exceeding an error of 0.3 feet at any cross-section, and without exceeding an error of 0.5 feet at any storage area. These reported error messages do not necessarily indicate error at the peak of the floodwave, but often report error encountered during other parts of the simulation. For cross-sections and storage areas, very small flows are harder to iterate, as small changes in volume/flow can often generate large changes in elevation due to geometric constraints. Small amounts of error can be tolerated, particularly when they occur early in the simulation or at points where the system is initially filling, such as storage areas that first receive overtopping flows.

Warnings are different than error reporting, and can be interpreted more as cautions to the user rather than actual measurable error in final result reporting. The developers of HEC-RAS found that reporting conditions encountered during the iterative process can help identify model geometry that has difficulty iterating under certain conditions, and that may benefit from adding detail. Modifications to the model as a response to each warning is left to the discretion of the user, as many warnings occur during the iterative process that never get translated into the final solution.

For example, one warning encountered in the development of the combined model is shown below:

*!WARNING, AT TIME T =347.82 USED COMPUTED CHANGES IN FLOW
AND STAGE AT MINIMUM ERROR. MINIMUM ERROR OCCURRED
DURING ITERATION 2.*

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Solution Solver Failed. Unstable for initial iteration.

Solution failure was associated with

Cross Section WPIC WPIC 6.281

There was some concern that this represented an overall model instability at this location, so Wood Rodgers consulted with Mr. Gary Brunner regarding the meaning of the warning and any possible changes to the model that might eradicate the warning. Mr. Brunner responded verbally via telephone and with email correspondence. The following is a copy of Mr. Brunner’s emailed description of the solver iteration process and selection of results:

Here is how the solution scheme works:

- 1. The solver makes an initial trial at the water surface, flows derivatives etc. The Unsteady flow equations are solved in the implicit finite difference matrix solver (we use a solver called the Skyline Matrix solver)*
- 2. All computational nodes (Cross sections, storage areas, and now 2D cells) are checked to see if the computed water surface minus the guess is less than the numerical solution tolerance.*
- 3. If the error is less than the numerical solution tolerance, then it is finished for that time step, it uses those answers as the correct solution for the time step, and moves on to the next time step.*
- 4. If the numerical error is greater than the tolerance at any node, it iterates. Meaning it makes a new estimate of all the derivatives and solves the equations again.*
- 5. During the iteration process, if it comes up with a solution in which the numerical error is less than the tolerance at all locations, it is done and it uses that iteration as the correct answers, and goes on to the next time step.*
- 6. During the iteration (and even first trial) process, the program saves the trial with the least amount of numerical error as being the best solution so far. All water surfaces and flows are saved at all locations.*

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7. *Any iteration that produces a better answer, but does not meet the tolerance, is saved as the current best solution.*
8. *If it goes to the maximum number of iterations (20 by default), then it prints out a warning. However it uses the trial that had the best answer. It also prints out the location that had the greatest amount of numerical error and the magnitude of that error.*
9. *This happens even if one of the trials/iterations causes the matrix to go completely unstable. It still does this process and often can find a trial that is not unstable, but does not produce an error less than the numerical tolerance, so it goes with that iteration and moves on.*

Wood Rodgers discussed this process further with Mr. Brunner via telephone, specific to the warning message shown above. He indicated that the program documents whenever any time step produces an unstable iteration, as described under his items 8 and 9 above. He described further that this location successfully found a solution that was not unstable, and proceeded to the next time step using the best solution from the iterative process, not the unstable iteration. He suggested that model stability at this location could be demonstrated and/or verified by looking at the stage and flow hydrograph for this cross-section. If instability were present in the final solution, it should show up as a discontinuity at the same time step.

Wood Rodgers examined the final reported output for the locations where this warning message appeared in the final models and found no further indication of model instability. The warning only appeared for one reported time step, and did not get used in the computation for that time step. If any iterative instability propagated from this point in the model, it would be reported; therefore, the model can be considered functional. Review of these warning messages is still considered a crucial part of assessing the overall performance of any model and is recommended for future users of the model.

A computational error was noted at the cross-section immediately upstream of the Southern Pacific Railroad crossing at Jack Slough (RM 1.294) in which the water surface was extrapolated beyond the bridge rating curve. This location is characterized by a significant tailwater influence from the Feather River. In order to eliminate this error during model development of the LSR system model, Wood Rodgers attempted to adjust the ineffective flow area settings near the bridge and made adjustments to the bridge HTab settings. Neither of these actions was successful; however, the resultant water surface profiles and output tables appear to

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be reasonable. Although no further action was considered necessary at this time, future users of the model may want to consider investigating this issue further.

Runtime Messages:

The overall model reporting of runtime messages identifies each time step and individual geometric location where an error is reported. An error is only reported where the model iterated for the maximum number of iterations and could not reach a solution that was less than the tolerance set in the Calculations, Options and Tolerances.

For the approximate 500-year model, there were 2,075 total reported instances of error (272 related to storage areas and 1,803 related to cross-sections). The overall model has 32,520 time steps. There were 124 instances reported convergence errors of greater than 0.2 feet but less than 0.3 feet at cross-section locations along the Cherokee Canal, Butte Creek, Dry Creek and the American River.

For the 2006 event model, there were 899 total reported instances of error (226 related to storage areas and 673 related to cross-sections). The overall model has 15,720 time steps. No instances were reported at cross-sections with convergence errors of greater than 0.2 feet. There were 38 instances where the storage area convergence error exceeded 0.2 feet at the storage area labeled “YUB-20”.

Model Future Refinements and Limitations:

A number of future model refinements were recommended in the stand-alone technical memorandums for the USR and LSR model efforts. As noted previously, the combined system model geometry is intended, to the extent possible, to maintain the original model geometry of the USR and LSR models. Model stabilization was accomplished to the extent possible through the modification of mixed flow parameters and initial conditions settings rather than geometric edits. Geometric updates, with many already detailed in the Upper and Lower Sacramento Technical Memorandums, were not considered when trying to stabilize and refine the Combined Sacramento River model at the direction of DWR due to schedule constraints and consistency with existing approved work products. It is strongly recommended that future users evaluate these geometric updates and model instabilities prior to using the model for their purposes.

An area of the combined model that should be considered for model refinement and that was not previously identified under the stand-alone technical memorandum is the use of contraction and expansion coefficients in the Upper American River. The LSR model does not utilize these

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coefficients and produces lower water surfaces under both sub-critical and mixed flow settings. The combined model stability may be improved without contraction and expansion being added if more detailed cross-sections and ineffective/effective flow area settings are added to these areas, along with shorter time steps being utilized. This will compromise the already long run times, so careful consideration should be given to any changes which result in longer run times.

With respect to the operation of the combined model, the run times are very large, with the full computation (input processing, computation and output) taking approximately 18 hours to complete for the 500-year simulation and approximately 11 hours to complete for the 2006 simulation. There are a number of potential slowing factors related to the settings of the model that can be assessed as future refinements. For instance, the use of the mixed flow parameter setting, instead of performing computations using sub-critical flow, can slow the operation of the model. The LSR computations were performed using sub-critical flow; however, the USR model was finalized using mixed flow, which forced the entire combined system to be simulated using mixed flow. Review of the upper streams of the Upper Sacramento River model should be performed to determine if reconfiguration of the model geometry and/or adjustment of the roughness coefficients would allow the combined model to potentially be run under sub-critical flow conditions. The simulation window (input time length) can also be modified to minimize unnecessary warm-up of the simulation prior to the storm hydrograph passing through the model.

As noted previously, Wood Rodgers maintained the original initial conditions settings for the Colusa Basin Drain despite the fact that this creates an erroneous volume of water at the beginning of the simulation. Although this distorts the results at the beginning of the simulation, it does not impact the operation of the Colusa Basin Drain during the peak portion of the storm event. These initial conditions settings create an artificial stage at the beginning of the simulation that is higher than the actual peak of event. However, this distortion dissipates prior to the arrival of the peak floodwave and does not impact the performance of the model during peak flow conditions. Future users should be aware of this condition and manually extract maximum water surfaces from the event-generated peak, disregarding the distortion in the initial output. Future users may also wish to consider further modifications to lower initial conditions to more acceptable levels. A similar condition also exists in the UNT reach, where initial conditions were increased above 2006 event flow conditions in order to get the model to run. The initial conditions also dissipate before the main event portion of the simulation and will require manual effort to extract the maximum water surface for this stream reach.

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During model development of the 2006 combined system model, Wood Rodgers encountered an issue using HEC-RAS Version 4.2 Beta where the model output was only partially being written out, which created an issue with inspecting the model results in profile. Upon removal of the observed dataset, the model ran to completion and successfully completed writing the full output dataset. It is not clear at this time whether there is an issue with HEC-RAS Version 4.2 Beta or there was simply an error in the observed data input. Wood Rodgers brought these observations to the attention of HEC and plans to explore this topic in greater detail as part of a subsequent Task Order.

In order to operate the model for the 2006 event and see the entire output, Wood Rodgers identified a simple work-around solution:

1. The model is first run with a copy of the boundary conditions file containing all inflow and boundary conditions, without the observed data. The model will run and write output fully.
2. After the model is run, an identical copy of the unsteady flow file with the observed data added can be substituted into the working model directory with the same file name, and then referenced in the plan file input. The model output can then be accessed and compared with the observed data.

It should be noted that HEC has not yet performed its final debugging and approval testing of the Beta-version software. Therefore, the use of HEC-RAS Version 4.2 may need to be re-assessed when the final approved software version is released to the general public.

SUMMARY

The combined system model using HEC-RAS Version 4.2 Beta for the Sacramento River System Watershed has performed within acceptable limits. The comparison of the combined model 2006 event results with the results from the USR and LSR models indicates close correlation, which continues to validate the current calibration settings for use in the current conditions geometry tested with the approximate 500-year conditions. The computational error did not exceed 0.30 feet at any cross-section, with many of the computational errors occurring at the earliest portions of the simulation and disappearing during the peak flow time window. Utilization of the HEC-RAS Version 4.2 Beta allowed the combined model to retain all of the riverine and floodplain geometry and complexity contained in the separate USR and LSR models.

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Concurrent with the combined system model development, CH2M HILL performed a quality control review of the combined model and coordinated with Wood Rodgers as needed to ensure that all technical issues were addressed prior to submittal to DWR’s IQAR team. IQAR reviews were conducted with Atkins and USACE staff members to ensure that the models and documentation are of high quality and will be useful for future users going forward. Due to schedule constraints imposed by Wood Rodgers’ contractual agreement, the following portions of this Technical Memorandum did not receive complete USACE review:

- All Figures
- **Appendix A**
- **Appendix B**
- Although the Combined Model Output discussion section was reviewed, portions of it were not completely reviewed, edited or commented on.

The overall combined system model domain is quite extensive and covers over 900 miles of stream and several thousand square miles of floodplain protected by the SPFC. The size of the model may be unwieldy for some local and regional project applications. Therefore, future users may need to consider additional modifications to the model in order to meet specific project needs. The model is also sensitive to changes in geometry, hydrology, and initial conditions settings. It is recommended that special attention be paid to ensuring that thorough quality control reviews be performed during the course of any major edits to assess changes to the baseline model performance. Special consideration should also be made for the application of basin-wide hydrology given the geographic extent of the model.

The riverine components of the model were previously calibrated and validated separately for the USR and LSR systems. Following the connection of both systems, Wood Rodgers reviewed the 2006 calibration water surface results between the combined system model and the USR and LSR systems models. Although some differences were noted, they were considered minor and it was determined that recalibration of the overall system model would not be necessary. It should be noted, however, that the calibration analyses for the USR and LSR systems were performed for relatively large flood events and, therefore, some caution should be exercised when applying the assumptions and parameters used for these events to lower flow events. Many elements of the model are schematized specifically for high-flow events and may not perform well for low-flow events. The Fremont Weir Complex is one location where the model has been optimized for evaluating high flow conditions, but might be better reconfigured and refined for low flow applications.

TABLES

TABLE 1

**CENTRAL VALLEY FLOODPLAIN EVALUATION AND DELINEATION PROGRAM
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**CHANGES TO UPPER AND LOWER SACRAMENTO RIVER LATERAL STRUCTURES INCLUDED
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Lateral Structure (LSR)	Action Taken (LSR)
CAC_R1_10.262	Connected to modified storage area CAC-10A
CAC_R1_10.602	Connected to modified storage area CAC-10A
CAC_R1_10.762	Connected to modified storage area CAC-10A
CAC_R1_11.082	Connected to modified storage area CAC-10A
CAC_R1_11.342	Connected to modified storage area CAC-10A
CAC_R1_11.662	Connected to modified storage area CAC-10A
CAC_R1_11.802	Connected to modified storage area CAC-11A
CAC_R1_12.102	Connected to modified storage area CAC-11A
CAC_R1_12.130	Connected to modified storage area CAC-11A
CAC_R1_8.302	Connected to modified storage area CAC-10A
CAC_R1_8.562	Connected to modified storage area CAC-10A
CAC_R1_8.882	Connected to modified storage area CAC-10A
CAC_R1_9.06	Connected to modified storage area CAC-10A
CAC_R1_9.342	Connected to modified storage area CAC-10A
CAC_R1_9.662	Connected to modified storage area CAC-10A
CAC_R1_9.962	Connected to modified storage area CAC-10A
KNI_18020109_R1_1.154	Renamed to KNI_Subreach1_1.154
KNI_18020109_R1_1.155	Renamed to KNI_Subreach1_1.155
KNI_18020109_R1_1.449	Renamed to KNI_Subreach1_1.449
KNI_18020109_R1_1.450	Renamed to KNI_Subreach1_1.450
KNI_18020109_R1_1.684	Renamed to KNI_Subreach1_1.684
KNI_18020109_R1_1.885	Renamed to KNI_Subreach1_1.885
KNI_18020109_R1_1.886	Renamed to KNI_Subreach1_1.886
KNI_18020109_R1_2.082	Renamed to KNI_Subreach1_2.082
KNI_18020109_R1_2.259	Renamed to KNI_Subreach1_2.259
KNI_18020109_R1_2.452	Renamed to KNI_Subreach1_2.452
KNI_18020109_R1_2.641	Renamed to KNI_Subreach1_2.641
KNI_18020109_R1_2.812	Renamed to KNI_Subreach1_2.812
KNI_18020109_R1_3.017	Renamed to KNI_Subreach1_3.017
KNI_18020109_R1_3.184	Renamed to KNI_Subreach1_3.184
KNI_18020109_R1_3.185	Renamed to KNI_Subreach1_3.185
KNI_18020109_R1_3.196	Renamed to KNI_Subreach1_3.196
KNI_18020109_R1_3.197	Renamed to KNI_Subreach1_3.197
Sacramento River_Reach 1_84.889	Renamed to SAC_Subreach2_84.889
Sacramento River_Reach 1_85.007	Deleted
Sacramento River_Reach 1_85.008	Deleted
Sutter Bypass_Reach 1_57.439	Connected to USR storage area 004
Sutter Bypass_Reach 1_57.775	Merged with US LS (58.137) - Merged ID is 58.137
Sutter Bypass_Reach 1_58.137	Merged with US LS (57.775) - Merged ID is 58.137
Sutter Bypass_Reach 1_58.325	Connected to USR storage area 005
Sutter Bypass_Reach 1_58.865	Connected to USR storage area 005
Sutter Bypass_Reach 1_59.793	Connected to USR storage area 005
Sutter Bypass_Reach 1_60.335	Connected to USR storage area 005

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Lateral Structure (LSR)	Action Taken (LSR)
Sutter Bypass_Reach 1_60.709	Connected to USR storage area 005
Sutter Bypass_Reach 1_61.093	Connected to USR storage area 005
Sutter Bypass_Reach 1_61.467	Renamed to Sutter Bypass_Reach 1_61.655 and extended the length by 560-ft upstream of XS 61.469 due to Storage Area Boundary for SA "005"
Sutter Bypass_Reach 1_62.033	Connected to USR storage area 010 and trimmed the length by 560-ft due to the storage area boundary. The trimmed length is added to LS 61.655
Sutter Bypass_Reach 1_62.401	Connected to USR storage area 010
Sutter Bypass_Reach 1_62.773	Connected to USR storage area 010
Sutter Bypass_Reach 1_63.145	Connected to USR storage area 010
Sutter Bypass_Reach 1_63.513	Connected to USR storage area 010
Sutter Bypass_Reach 1_63.893	Connected to USR storage area 010
Sutter Bypass_Reach 1_64.273	Connected to USR storage area 010
Sutter Bypass_Reach 1_64.631	Connected to USR storage area 010
Sutter Bypass_Reach 1_65.007	Connected to USR storage area 010
Sutter Bypass_Reach 1_65.645	Connected to USR storage area 010
Butte_Sink_Subreach3_27.134	Connected to LSR storage area FEA-19
CHC_LC_Subreach1_0.930	Connected to LSR storage area FEA-18
CHC_LC_Subreach1_1.462	Connected to LSR storage area FEA-16
CHC_Subreach1_0.522	Connected to LSR storage area FEA-19
CHC_Subreach1_1.150	Connected to LSR storage area FEA-19
CHC_Subreach1_1.764	Connected to LSR storage area FEA-18
CHC_Subreach1_2.340	Connected to LSR storage area FEA-18
CHC_Subreach1_2.876	Connected to LSR storage area FEA-18
CHC_Subreach1_3.606	Connected to LSR storage area FEA-18
CHC_Subreach1_3.704	Connected to LSR storage area FEA-18
CHC_Subreach1_4.030	Connected to LSR storage area FEA-18
CHC_Subreach1_4.768	Connected to LSR storage area FEA-18
CHC_Subreach1_5.334	Connected to LSR storage area FEA-18
CHC_Subreach1_5.906	Connected to LSR storage area FEA-18
CHC_Subreach1_6.384	Connected to LSR storage area FEA-18
CHC_Subreach2_10.314	Connected to LSR storage area FEA-15
CHC_Subreach2_10.688	Connected to LSR storage area FEA-15
CHC_Subreach2_11.134	Connected to LSR storage area FEA-15
CHC_Subreach2_8.418	Connected to LSR storage area FEA-15
CHC_Subreach2_8.606	Connected to LSR storage area FEA-15
CHC_Subreach2_9.364	Connected to LSR storage area FEA-15
COD_Subreach2_0.279	Connected to LSR storage area CAC-01
COD_Subreach2_0.521	Connected to LSR storage area CAC-01
COD_Subreach3A_0.999	Deleted
COD_Subreach3A_1.451	Deleted
KNI_Subreach1_3.47	Connected to LSR storage area CAC-01

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Lateral Structure (LSR)	Action Taken (LSR)
KNI_Subreach1_3.561	Connected to LSR storage area CAC-04
KNI_Subreach1_3.956	Connected to LSR storage area CAC-01
KNI_Subreach1_4.355	Connected to LSR storage area CAC-04
KNI_Subreach1_4.522	Connected to LSR storage area CAC-01
KNI_Subreach1_4.881	Connected to LSR storage area CAC-04
KNI_Subreach1_5.17	Connected to LSR storage area CAC-01
KNI_Subreach1_5.564	Connected to LSR storage area CAC-01
KNI_Subreach1_5.667	Connected to LSR storage area CAC-04
KNI_Subreach1_6.379	Connected to LSR storage area CAC-04
KNI_Subreach1_6.448	Connected to LSR storage area CAC-01
KNI_Subreach1_6.675	Connected to LSR storage area CAC-04
KNI_Subreach1_6.915	Connected to LSR storage area CAC-04
KNI_Subreach1_6.916	Connected to LSR storage area CAC-01
KNI_Subreach1_7.126	Connected to LSR storage area CAC-01
KNI_Subreach1_7.127	Connected to LSR storage area CAC-10A
SAC_Subreach2_85.601	Connected to LSR storage area CAC-01
SAC_Subreach2_86.101	Connected to LSR storage area CAC-01
SAC_Subreach2_86.401	Connected to LSR storage area CAC-01
SAC_Subreach2_87.101	Connected to LSR storage area CAC-01
SAC_Subreach2_87.401	Connected to LSR storage area CAC-01
SAC_Subreach2_87.791	Connected to LSR storage area CAC-01
SAC_Subreach2_88.411	Connected to LSR storage area CAC-01
SAC_Subreach2_89.301	Connected to LSR storage area CAC-01
SAC_Subreach2_89.801	Connected to LSR storage area CAC-01
SAC_Subreach2_90.001	Connected to LSR storage area CAC-01
SAC_Subreach2_90.221	Connected to LSR storage area CAC-01
SAC_Subreach2_90.273	Connected to LSR storage area CAC-01
SUB_Subreach1_66.457	Renamed to Sutter Bypass_Reach 1
SUB_Subreach1_66.458	Renamed to Sutter Bypass_Reach 1 and connected to LSR storage area FEA-30
SUB_Subreach1_67.057	Renamed to Sutter Bypass_Reach 1
SUB_Subreach1_67.058	Renamed to Sutter Bypass_Reach 1 and connected to LSR storage area FEA-30
SUB_Subreach1_67.858	Renamed to Sutter Bypass_Reach 1 and connected to LSR storage area FEA-30
SUB_Subreach1_67.859	Renamed to Sutter Bypass_Reach 1
SUB_Subreach1_68.248	Renamed to Sutter Bypass_Reach 1 and connected to LSR storage area FEA-30
SUB_Subreach1_68.649	Renamed to Sutter Bypass_Reach 1
SUB_Subreach1_68.65	Renamed to Sutter Bypass_Reach 1 and connected to LSR storage area FEA-30
SUB_Subreach1_69.448	Renamed to Sutter Bypass_Reach 1 and connected to LSR storage area FEA-30

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Lateral Structure (LSR)	Action Taken (LSR)
SUB_Subreach1_69.449	Renamed to Sutter Bypass_Reach 1
SUB_Subreach1_70.247	Renamed to Sutter Bypass_Reach 1
SUB_Subreach1_70.248	Renamed to Sutter Bypass_Reach 1 and connected to LSR storage area. Also split and merged with US LS and renamed to Sutter Bypass_Reach 1_70.450 and connected to LSR storage area FEA-30
SUB_Subreach1_71.058	Renamed to Sutter Bypass_Reach 1 and connected to LSR storage area FEA-34
SUB_Subreach1_71.059	Renamed to Sutter Bypass_Reach 1
SUB_Subreach1_71.44	Renamed to Sutter Bypass_Reach 1 and connected to LSR storage area FEA-34
SUB_Subreach1_71.441	Renamed to Sutter Bypass_Reach 1
SUB_Subreach1_72.047	Renamed to Sutter Bypass_Reach 1
SUB_Subreach1_72.048	Renamed to Sutter Bypass_Reach 1 and connected to LSR storage area FEA-34
SUB_Subreach1_72.637	Renamed to Sutter Bypass_Reach 1
SUB_Subreach1_72.638	Renamed to Sutter Bypass_Reach 1 and connected to LSR storage area FEA-34
SUB_Subreach1_73.437	Renamed to Sutter Bypass_Reach 1
SUB_Subreach1_73.44	Renamed to Sutter Bypass_Reach 1 and connected to LSR storage area FEA-34
SUB_Subreach1_74.036	Renamed to Sutter Bypass_Reach 1 and connected to LSR storage area FEA-34
SUB_Subreach1_74.037	Renamed to Sutter Bypass_Reach 1
SUB_Subreach1_74.437	Renamed to Sutter Bypass_Reach 1
SUB_Subreach1_74.438	Renamed to Sutter Bypass_Reach 1 and connected to LSR storage area FEA-34
SUB_Subreach1_75.047	Renamed to Sutter Bypass_Reach 1
SUB_Subreach1_75.446	Renamed to Sutter Bypass_Reach 1 and connected to LSR storage area FEA-01
SUB_Subreach1_75.447	Renamed to Sutter Bypass_Reach 1
SUB_Subreach1_75.857	Renamed to Sutter Bypass_Reach 1
SUB_Subreach1_76.456	Renamed to Sutter Bypass_Reach 1 and connected to LSR storage area FEA-01
SUB_Subreach1_76.457	Renamed to Sutter Bypass_Reach 1
SUB_Subreach1_77.223	Renamed to Sutter Bypass_Reach 1
SUB_Subreach1_77.248	Renamed to SUB_WAD_to_TIS and connected to LSR storage area FEA-01
SUB_Subreach2_78.06	Renamed to SUB_WAD_to_TIS and connected to LSR storage area FEA-01
SUB_Subreach2_78.261	Renamed to SUB_WAD_to_TIS 015
SUB_Subreach2_78.86	Renamed to SUB_WAD_to_TIS and connected to LSR storage area FEA-01

TABLE 1

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IN THE COMBINED MODEL CURRENT CONDITIONS AND 2006 VALIDATION MODELS**

Lateral Structure (LSR)	Action Taken (LSR)
SUB_Subreach2_79.061	Renamed to SUB_WAD_to_TIS and connected to LSR storage area 015
SUB_Subreach2_79.66	Renamed to SUB_WAD_to_TIS and connected to LSR storage area FEA-01
SUB_Subreach2_79.861	Renamed to SUB_WAD_to_TIS and connected to LSR storage area 015
SUB_Subreach2_80.45	Renamed to SUB_WAD_to_TIS and connected to LSR storage area FEA-01
SUB_Subreach2_80.651	Renamed to SUB_WAD_to_TIS and connected to LSR storage area 015
SUB_Subreach2_81.25	Renamed to SUB_WAD_to_TIS and connected to LSR storage area FEA-01
SUB_Subreach2_81.451	Renamed to SUB_WAD_to_TIS and connected to LSR storage area 015
SUB_Subreach2_82.05	Renamed to SUB_WAD_to_TIS and connected to LSR storage area FEA-01
SUB_Subreach2_82.251	Renamed to SUB_WAD_to_TIS and connected to LSR storage area 015
SUB_Subreach2_82.86	Renamed to SUB_WAD_to_TIS and connected to LSR storage area FEA-01
SUB_Subreach2_83.251	Renamed to SUB_WAD_to_TIS and connected to LSR storage area 015
SUB_Subreach2_83.64	Deleted due to the inclusion of Wadsworth Canal
SUB_Subreach2_84.44	Connected to LSR storage area FEA-31
SUB_Subreach2_85.25	Connected to LSR storage area FEA-31
SUB_Subreach2_86.04	Connected to LSR storage area FEA-31
SUB_Subreach2_86.84	Connected to LSR storage area FEA-31
SUB_Subreach2_87.64	Connected to LSR storage area FEA-31
SUB_Subreach2_87.91	Connected to LSR storage area FEA-06
SUB_Subreach2_88.08	Trimmed and renamed to SUB_Subreach2_87.98 and connected to LSR storage area FEA-06

TABLE 2
CENTRAL VALLEY FLOODPLAIN EVALUATION AND DELINEATION PROGRAM
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INITIAL STORAGE ELEVATIONS SUMMARY (ft, NAVD 88)

Storage Area ID	2006 Storm Simulation			500-Year Test Flow Simulation			Notes
	Upper Sacramento River	Lower Sacramento River	Combined System Model	Upper Sacramento River	Lower Sacramento River	Combined System Model	
001	24	N/A	N/A	24	N/A	N/A	This Storage Area is removed from the Combined System Model. See Figure 5 for more details.
002	22.01	N/A	N/A	22.01	N/A	N/A	This Storage Area is removed from the Combined System Model. See Figure 5 for more details.
003	24	N/A	N/A	24	N/A	N/A	This Storage Area is removed from the Combined System Model. See Figure 5 for more details.
004	11	N/A	11	11	N/A	11	
005	11	N/A	11	11	N/A	11	
006	18	N/A	40.13	18	N/A	18	
008	20.2	N/A	20.2	20.2	N/A	20.2	
009	12	N/A	12	12	N/A	12	
010	11	N/A	11	11	N/A	11	
012	20.2	N/A	20.2	20.2	N/A	20.2	
014	23.2	N/A	23.2	23.2	N/A	23.2	
015	25	N/A	25	25	N/A	25	
016	25	N/A	25	25	N/A	25	
018	27	N/A	27	27	N/A	27	
019	41.28	N/A	41.28	41.28	N/A	41.28	
020	30	N/A	30	30	N/A	30	
021	34	N/A	34	34	N/A	34	
022	41.165	N/A	41.165	41.165	N/A	41.165	
023	43.21	N/A	43.21	43.21	N/A	41.91	
024	35	N/A	35	35	N/A	35	
025	43.19	N/A	43.19	43.19	N/A	42	
026	43.19	N/A	43.19	43.19	N/A	42.23	
027	39	N/A	39	39	N/A	39	
028	43.37	N/A	43.37	43.37	N/A	42.1	
029	52.04	N/A	52.04	52.04	N/A	50.07	
030	44.1	N/A	44.1	44.1	N/A	44.1	
031	43.1	N/A	43.1	43.1	N/A	44	
032	50	N/A	50	50	N/A	50	
033	48	N/A	48	48	N/A	48	
034	59	N/A	59	59	N/A	59	
035	59	N/A	59	59	N/A	59	
036	62	N/A	62	62	N/A	62	
037	68	N/A	68	68	N/A	68	
038	72	N/A	72	72	N/A	72	
039	79	N/A	79	79	N/A	79	
040	92	N/A	92	92	N/A	92	
041	91	N/A	91	91	N/A	91	

TABLE 2
CENTRAL VALLEY FLOODPLAIN EVALUATION AND DELINEATION PROGRAM
LOWER SACRAMENTO RIVER BASIN
TASK ORDER NO. 25

INITIAL STORAGE ELEVATIONS SUMMARY (ft, NAVD 88)

Storage Area ID	2006 Storm Simulation			500-Year Test Flow Simulation			Notes
	Upper Sacramento River	Lower Sacramento River	Combined System Model	Upper Sacramento River	Lower Sacramento River	Combined System Model	
042	109	N/A	109	109	N/A	109	
043	114	N/A	114	114	N/A	114.66	
044	143	N/A	143	143	N/A	143	
045	129	N/A	129	129	N/A	129	
046	146	N/A	146	146	N/A	146	
047	67	N/A	N/A	67	N/A	N/A	This Storage Area is removed from the Combined System Model. See Figure 2 for more details.
048	58	N/A	N/A	58	N/A	N/A	This Storage Area is removed from the Combined System Model. See Figure 2 for more details.
049	74	N/A	74	74	N/A	74	
050	88	N/A	N/A	88	N/A	N/A	This Storage Area is removed from the Combined System Model. See Figure 2 for more details.
051	78	N/A	N/A	78	N/A	N/A	This Storage Area is removed from the Combined System Model. See Figure 2 for more details.
052	76	N/A	76	76	N/A	76	
053	98	N/A	N/A	98	N/A	N/A	This Storage Area is removed from the Combined System Model. See Figure 2 for more details.
054	94	N/A	94	94	N/A	94	
055	96	N/A	96	96	N/A	96	
056	103	N/A	103	103	N/A	103	
057	102	N/A	102	102	N/A	102	
058	90.05	N/A	90.05	90.05	N/A	90.02	
059	89	N/A	89	89	N/A	89	
060	115	N/A	115	115	N/A	115	
061	157	N/A	157	157	N/A	157	
062	119	N/A	119	119	N/A	119	
063	133	N/A	133	133	N/A	133	
064	102	N/A	102	102	N/A	102	
065	170	N/A	170	170	N/A	170	
066	120	N/A	120	120	N/A	120	
067	142	N/A	142	142	N/A	142	
068	129	N/A	129	129	N/A	129	
069	163	N/A	163	163	N/A	163	
070	153	N/A	153	153	N/A	153	
071	155	N/A	155	155	N/A	155	
072	144	N/A	144	144	N/A	144	
073	173	N/A	173	173	N/A	173	
074	172	N/A	172	172	N/A	172	
075	124.84	N/A	124.84	124.84	N/A	126.04	
076	190	N/A	190	190	N/A	190	
077	124.84	N/A	124.84	124.84	N/A	125.97	

TABLE 2
CENTRAL VALLEY FLOODPLAIN EVALUATION AND DELINEATION PROGRAM
LOWER SACRAMENTO RIVER BASIN
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INITIAL STORAGE ELEVATIONS SUMMARY (ft, NAVD 88)

Storage Area ID	2006 Storm Simulation			500-Year Test Flow Simulation			Notes
	Upper Sacramento River	Lower Sacramento River	Combined System Model	Upper Sacramento River	Lower Sacramento River	Combined System Model	
078	192.02	N/A	192.02	192.02	N/A	191.84	
079	139	N/A	139	139	N/A	139	
080	213	N/A	213	213	N/A	213	
082A_Upper	128	N/A	128	128	N/A	128	
082B	143	N/A	143	143	N/A	143	
082C	121	N/A	121	121	N/A	121	
083	176	N/A	176	176	N/A	176	
084	233	N/A	233	233	N/A	233	
085A	150	N/A	150	150	N/A	149	
085B	158	N/A	158	158	N/A	158	
085C	146	N/A	146	146	N/A	146	
085D	170	N/A	170	170	N/A	170	
086	132.56	N/A	132.56	132.56	N/A	133.31	
087	212.1	N/A	212.1	212.1	N/A	212.1	
088A	174	N/A	174	174	N/A	174	
088B	189	N/A	189	189	N/A	189	
088C	174	N/A	174	174	N/A	174	
088D	195	N/A	195	195	N/A	195	
088E	187	N/A	187	187	N/A	187	
088F	197	N/A	197	197	N/A	197	
089A	132	N/A	132	132	N/A	132	
089B	146.92	N/A	149.92	146.92	N/A	146	
089C	158	N/A	158	158	N/A	157	
089D	169.3	N/A	169.3	169.3	N/A	169	
090A	125	N/A	125	133.66	N/A	135.27	
090B	132	N/A	132	132	N/A	133.36	
090C	131	N/A	131	131	N/A	131	
091A	196	N/A	196	196	N/A	196	
091B	221	N/A	221	221	N/A	220	
091C	239	N/A	239	239	N/A	237	
091D	212	N/A	212	212	N/A	211	
091E	236	N/A	236	236	N/A	235	
091F	264	N/A	264	264	N/A	263	
091G	266	N/A	266	266	N/A	266	
091H	254	N/A	254	254	N/A	254	
091I	218	N/A	218	218	N/A	218	
091J	234.15	N/A	234.15	234.15	N/A	234	
092	147.26	N/A	147.26	148.43	N/A	148.39	
093A	135	N/A	135	135	N/A	134	

TABLE 2
CENTRAL VALLEY FLOODPLAIN EVALUATION AND DELINEATION PROGRAM
LOWER SACRAMENTO RIVER BASIN
TASK ORDER NO. 25

INITIAL STORAGE ELEVATIONS SUMMARY (ft, NAVD 88)

Storage Area ID	2006 Storm Simulation			500-Year Test Flow Simulation			Notes
	Upper Sacramento River	Lower Sacramento River	Combined System Model	Upper Sacramento River	Lower Sacramento River	Combined System Model	
093B	144	N/A	144	144	N/A	144	
094A	136	N/A	136	136	N/A	136	
094B	146	N/A	146	146	N/A	146	
095A	190	N/A	190	190	N/A	190	
095B	212.42	N/A	212.42	212.42	N/A	212	
096A	125	N/A	125	132.16	N/A	134.75	
096B	135	N/A	135	135	N/A	135	
096C	137	N/A	137	137	N/A	137	
097A	173	N/A	173	173	N/A	173	
098A	185	N/A	185	185	N/A	185	
098B	189.06	N/A	189.06	189.06	N/A	188	
099A	189.23	N/A	189.23	189.23	N/A	189.23	
099B	199.07	N/A	199.07	199.07	N/A	198	
100A	144	N/A	144	144	N/A	143.66	
100B	147	N/A	147	147	N/A	146	
100C	146	N/A	146	146	N/A	146	
101A	189	N/A	189	189	N/A	189	
101B	175	N/A	175	175	N/A	176.03	
102	175	N/A	175	175	N/A	175	
103	169	N/A	169	169	N/A	169	
104A	246	N/A	246	246	N/A	246	
104B	261	N/A	261	261	N/A	261	
105A	150	N/A	150	150	N/A	150	
105B	146	N/A	146	146	N/A	146	
106	56.25	N/A	56.25	56.25	N/A	54.39	
107	65	N/A	65	65	N/A	65	
108	62.61	N/A	62.61	62.61	N/A	62.59	
109	120	N/A	120	120	N/A	120	
110	150	N/A	150	150	N/A	150	
111	165	N/A	165	165	N/A	165	
112	97	N/A	97	97	N/A	97	
113	84	N/A	84	84	N/A	84	
114	106	N/A	106	106	N/A	106	
115	99	N/A	99	99	N/A	99	
116	95	N/A	95	95	N/A	95	
117	85	N/A	85	85	N/A	85	
118	96	N/A	96	96	N/A	96	
1536	224.41	N/A	224.41	224.41	N/A	224.43	
204B	183.86	N/A	183.86	183.86	N/A	183	

TABLE 2
CENTRAL VALLEY FLOODPLAIN EVALUATION AND DELINEATION PROGRAM
LOWER SACRAMENTO RIVER BASIN
TASK ORDER NO. 25

INITIAL STORAGE ELEVATIONS SUMMARY (ft, NAVD 88)

Storage Area ID	2006 Storm Simulation			500-Year Test Flow Simulation			Notes
	Upper Sacramento River	Lower Sacramento River	Combined System Model	Upper Sacramento River	Lower Sacramento River	Combined System Model	
205B	217	N/A	217	217	N/A	217	
82A_Lower	124.68	N/A	114.68	124.68	N/A	126.44	
97B	187	N/A	187	187	N/A	187	
AMEN-01	N/A	29.8	29.8	N/A	29.8	29.8	
AMEN-02	N/A	30.8	30.8	N/A	30.8	30.8	
AMEN-03	N/A	22.5	22.5	N/A	22.5	22.5	
AMEN-04	N/A	13.8	13.75	N/A	13.75	13.75	
AMEN-05	N/A	11	11	N/A	11	11	
AMEN-06	N/A	13	13	N/A	13	20	
AMEN-07	N/A	37.3	37.25	N/A	37.25	37.25	
AMEN-08	N/A	10.8	10.75	N/A	10.75	10.75	
AMEN-09	N/A	14.28	10	N/A	12.91	15.63	
AMEN-10	N/A	47.3	47.3	N/A	47.3	47.3	
AMEN-11	N/A	21.5	22.25	N/A	22.25	21.5	
AMES-01	N/A	2.3	2.25	N/A	2.25	2.25	
AMES-02	N/A	7.5	7.5	N/A	7.5	7.5	
AMES-03	N/A	0	0	N/A	0	0	
AMES-04	N/A	28.5	28.5	N/A	28.5	28.5	
AMES-05	N/A	-1	0.1	N/A	-1	-1	
AMES-06	N/A	3	3	N/A	3	3	
AMES-07	N/A	0.5	0.5	N/A	0.5	0.5	
AMES-08	N/A	8.5	8.5	N/A	8.5	8.5	
AMES-09	N/A	0	0	N/A	0	0	
AMES-10	N/A	-6.5	-6.5	N/A	-6.5	-6.5	
AMES-11	N/A	-11.3	-11.25	N/A	-11.25	-11.25	
AMES-12	N/A	88.5	88.5	N/A	88.5	88.5	
AMES-13	N/A	61	58.93	N/A	61	61	
AMES-14	N/A	3	3	N/A	3	3	
AMES-15	N/A	0	0	N/A	0	0	
AMES-16	N/A	1.8	1.75	N/A	1.75	1.75	
AMES-17	N/A	10	10	N/A	10	10	
AMES-18	N/A	20	22	N/A	20	20	
AMES-19	N/A	26.8	26.75	N/A	26.75	26.75	
AMES-20	N/A	0.8	0.75	N/A	0.75	0.75	
AMES-21	N/A	4.5	4.5	N/A	4.5	4.5	
AMES-22	N/A	8	8	N/A	8	8	
AMES-23	N/A	8	10.5	N/A	8	8	
AMES-24	N/A	8	8	N/A	20	20	
AMES-25	N/A	40	38	N/A	40	40	

TABLE 2
CENTRAL VALLEY FLOODPLAIN EVALUATION AND DELINEATION PROGRAM
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INITIAL STORAGE ELEVATIONS SUMMARY (ft, NAVD 88)

Storage Area ID	2006 Storm Simulation			500-Year Test Flow Simulation			Notes
	Upper Sacramento River	Lower Sacramento River	Combined System Model	Upper Sacramento River	Lower Sacramento River	Combined System Model	
AMES-26	N/A	30.5	30.5	N/A	30.5	30.5	
AMES-27	N/A	65	62.98	N/A	67	67	
AMES-28	N/A	49	49	N/A	49	49	
AMES-29	N/A	88.4	88.4	N/A	88.4	88.4	
AMES-30	N/A	42.5	42.5	N/A	42.5	42.5	
AMES-31	N/A	46	46	N/A	46	46	
AMES-32	N/A	18	18	N/A	18	18	
AMES-33	N/A	28.8	28.75	N/A	28.75	28.75	
AMES-34	N/A	7.5	7.5	N/A	7.5	7.5	
AMES-35	N/A	17	17	N/A	17	17	
AMES-36	N/A	18	18	N/A	18	18	
AMES-37	N/A	9.5	9.5	N/A	9.5	9.5	
AMES-38	N/A	-4	-4	N/A	-4	-4	
AMES-39	N/A	1.5	1.5	N/A	1.5	1.5	
AMES-40	N/A	6.16	8	N/A	6.13	6.13	
AMES-41	N/A	2.8	2.75	N/A	2.75	2.75	
AMES-42	N/A	3.8	3.75	N/A	3.75	3.75	
AMES-43	N/A	3.5	3.5	N/A	3.5	3.5	
AMES-44	N/A	-3.8	-3.75	N/A	-3.75	-3.75	
AMES-45	N/A	3.8	3.75	N/A	3.75	3.75	
AMES-46	N/A	6.5	6.5	N/A	6.5	6.5	
AMES-47	N/A	9.8	9.75	N/A	9.75	9.75	
AMES-48	N/A	5	5	N/A	5	5	
AMES-49	N/A	0.5	0.5	N/A	0.5	0.5	
AMES-50	N/A	7	7	N/A	7	7	
AMES-51	N/A	18.8	18.75	N/A	18.75	18.75	
AMES-52	N/A	18.3	18.3	N/A	18.3	18.3	
AMES-53	N/A	10	10	N/A	10	10	
AMES-54	N/A	8.5	8.5	N/A	8.5	8.5	
AMES-55	N/A	13	13	N/A	13	13	
AMES-56	N/A	4	4	N/A	4	4	
AMES-57	N/A	3.3	3.25	N/A	3.25	3.25	
AMES-58	N/A	-11.3	-11.25	N/A	-11.25	-11.25	
AMES-59	N/A	8	8	N/A	8	8	
AMES-60	N/A	15.8	15.75	N/A	15.75	15.75	
AMES-61	N/A	19.8	19.75	N/A	19.75	19.75	
AMES-62	N/A	19.5	19.5	N/A	19.5	19.5	
AMES-63	N/A	21	21	N/A	21	21	
AMES-64	N/A	8.8	8.75	N/A	8.75	8.75	

TABLE 2
CENTRAL VALLEY FLOODPLAIN EVALUATION AND DELINEATION PROGRAM
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INITIAL STORAGE ELEVATIONS SUMMARY (ft, NAVD 88)

Storage Area ID	2006 Storm Simulation			500-Year Test Flow Simulation			Notes
	Upper Sacramento River	Lower Sacramento River	Combined System Model	Upper Sacramento River	Lower Sacramento River	Combined System Model	
AMES-65	N/A	7.5	9.5	N/A	7.5	7.32	
AMES-66	N/A	5.8	5.75	N/A	5.75	5.75	
AMES-67	N/A	3.5	3.5	N/A	3.5	3.5	
AMES-68	N/A	2.5	2.5	N/A	2.5	2.5	
AMES-69	N/A	6	4	N/A	7.25	7.25	
AMES-70	N/A	4.5	4.5	N/A	4.5	4.5	
AMES-71	N/A	-0.8	-0.75	N/A	-0.75	-0.75	
AMES-72	N/A	-4.3	-4.25	N/A	-4.25	-4.25	
AMES-73	N/A	5.8	5.75	N/A	5.75	5.75	
AMES-74	N/A	-3	-3	N/A	-3	-3	
AMES-75	N/A	5	5	N/A	5	5	
AMES-78	N/A	4.5	4.5	N/A	4.5	4.5	
AMES-79	N/A	2	2	N/A	2	2	
AMES-80	N/A	-3	-3	N/A	-3	-3	
AMES-81	N/A	1.5	1.5	N/A	1.5	1.5	
AMES-83	N/A	21	21	N/A	21	21	
AMES-84	N/A	-7.5	-7.5	N/A	-7.5	-7.5	
AMES-85	N/A	-7.5	-7.5	N/A	-7.5	-7.5	
AMES-86	N/A	8.3	8.25	N/A	8.25	8.25	
AMES-87	N/A	14	14	N/A	14	14	
AMES-88	N/A	29	29	N/A	29	29	
AMES-89	N/A	16.5	16.5	N/A	16.5	16.5	
AMES-90	N/A	3.8	3.75	N/A	3.75	3.75	
AMES-91	N/A	0.8	0.75	N/A	0.75	0.75	
Auburn_Upstream	N/A	38	39	N/A	39	39	
BEAC-01	N/A	28	28	N/A	28	28	
BEAC-02	N/A	22	21.71	N/A	22	22	
BEAC-03	N/A	56	55.92	N/A	56	56	
BEAC-04	N/A	50	49.04	N/A	50	50	
BEAC-05	N/A	39	38.77	N/A	39	39	
BEAC-06	N/A	32	32	N/A	32	32	
BEAC-07	N/A	44	43	N/A	44	44	
BEAC-16	N/A	12	12	N/A	12	12	
BEAC-17	N/A	24	24	N/A	24	24	
BEAC-18	N/A	47.09	43	N/A	46.96	46.95	
BEAC-20	N/A	62	62	N/A	62	62	
BEAC-21	N/A	65	65	N/A	65	65	
BEAC-22	N/A	89.09	91	N/A	89.07	89.07	
BEAC-24	N/A	71	71	N/A	71	71	

TABLE 2
CENTRAL VALLEY FLOODPLAIN EVALUATION AND DELINEATION PROGRAM
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INITIAL STORAGE ELEVATIONS SUMMARY (ft, NAVD 88)

Storage Area ID	2006 Storm Simulation			500-Year Test Flow Simulation			Notes
	Upper Sacramento River	Lower Sacramento River	Combined System Model	Upper Sacramento River	Lower Sacramento River	Combined System Model	
BEAD-01	N/A	49	49	N/A	49	49	
BEAD-02	N/A	72.25	79.2	N/A	72.25	72.25	
BEAD-03	N/A	51	45.5	N/A	45.5	45.5	
BEAD-04	N/A	66	65.57	N/A	70	69	
BEAD-05	N/A	62.07	64	N/A	62.04	62.04	
BEAD-06	N/A	70	63	N/A	63	63	
BEAD-07	N/A	71.1	66.5	N/A	71.02	71.01	
BEAD-08	N/A	78.1	78.1	N/A	78.1	78.1	
BEAD-09	N/A	73.1	73.1	N/A	73.1	73.1	
BEAD-10	N/A	100	99.75	N/A	99.75	99.75	
BEAD-11	N/A	88	87.32	N/A	88	89.03	
BEAD-13	N/A	59.89	61.67	N/A	60	59.9	
BEAD-16	N/A	89.9	89.88	N/A	89.88	89.88	
BEAD-169	N/A	151	151	N/A	151	151	
BEAD-17	N/A	82	82	N/A	82	82	
BEAD-172	N/A	150.59	154	N/A	150.92	150.72	
BEAD-173	N/A	150.3	150.25	N/A	150.25	150.25	
BEAD-18	N/A	83	83	N/A	83	83	
BEAD-19	N/A	84.32	91	N/A	84.54	83.98	
BEAD-20	N/A	84	84	N/A	84	84	
BEAD-22	N/A	76.34	75	N/A	76.48	77.61	
CAC-01	N/A	19	19	N/A	19	20.8	
CAC-02	N/A	22	22	N/A	22	25.62	
CAC-03	N/A	21	21	N/A	21	21	
CAC-04	N/A	24	24	N/A	24	24.79	
CAC-05	N/A	17	17	N/A	17	17	
CAC-06	N/A	20	20	N/A	20	20	
CAC-07	N/A	18	18	N/A	18	18	
CAC-08	N/A	44.8	44.75	N/A	44.75	44.75	
CAC-09	N/A	32	32	N/A	32	32	
CAC-10A	N/A	N/A	25	N/A	N/A	25	
CAC-10	N/A	30	N/A	N/A	27	N/A	This Storage Area is removed from the Combined System Model. See Figure 5 for more details.
CAC-11	N/A	27.36	N/A	N/A	24	N/A	This Storage Area is removed from the Combined System Model. See Figure 5 for more details.
CAC-11A	N/A	N/A	47	N/A	N/A	47.06	
CAC-12	N/A	26	26	N/A	26	26	
CAC-13	N/A	27.75	N/A	N/A	24.5	N/A	This Storage Area is removed from the Combined System Model. See Figure 5 for more details.
CAC-14	N/A	38.01	39	N/A	37.87	41.64	

TABLE 2
CENTRAL VALLEY FLOODPLAIN EVALUATION AND DELINEATION PROGRAM
LOWER SACRAMENTO RIVER BASIN
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INITIAL STORAGE ELEVATIONS SUMMARY (ft, NAVD 88)

Storage Area ID	2006 Storm Simulation			500-Year Test Flow Simulation			Notes
	Upper Sacramento River	Lower Sacramento River	Combined System Model	Upper Sacramento River	Lower Sacramento River	Combined System Model	
CAC-15	N/A	39	39.5	N/A	39.5	39.5	
CAC-16	N/A	29.22	30.5	N/A	29.18	29.18	
CAC-17	N/A	31.62	N/A	N/A	26	N/A	This Storage Area is removed from the Combined System Model. See Figure 5 for more details.
CAC-18	N/A	N/A	N/A	N/A	216.62	216.62	
CAS-SAC Junction	N/A	5	5	N/A	6	6	
Coon_Upstream	N/A	39	38	N/A	39.44	41.07	
Curry_Upstream	N/A	35.63	32	N/A	34.4	34.4	
DEL-01	N/A	-24	-24	N/A	-24	-24	
DEL-02	N/A	-19	-19	N/A	-19	-19	
DEL-03	N/A	-16	-16	N/A	-16	-16	
DEL-04	N/A	-8	-8	N/A	-9.7	-8.77	
DEL-05	N/A	5.09	5	N/A	6.14	6.15	
DEL-06	N/A	-6	-6	N/A	-6	-6	
DEL-07	N/A	-6	-6	N/A	-6	-6	
DEL-08	N/A	4	4	N/A	4	4	
DEL-09	N/A	3	3	N/A	3	3	
DEL-10	N/A	4	4	N/A	4	4	
DEL-11	N/A	8	8	N/A	8	8	
DEL-12	N/A	4	4	N/A	4	4	
DEL-13	N/A	-2	-2	N/A	-2	-2	
DEL-14	N/A	4	4	N/A	4	4	
DEL-15	N/A	12	11.23	N/A	12	12	
DEL-16	N/A	12	12	N/A	12	12	
DEL-17	N/A	4.5	2.62	N/A	6.22	6.2	
DEL-18	N/A	3	3	N/A	3	3	
DEL-19	N/A	4	4	N/A	4	4	
DEL-20	N/A	3	3	N/A	3	3	
DEL-21	N/A	12	12	N/A	12	12	
DEL-22	N/A	27	27	N/A	27	27	
DEL-23	N/A	12	12	N/A	12	12	
DEL-24	N/A	26	26	N/A	26	26	
DEL-25	N/A	4	4	N/A	4	4	
DEL-26	N/A	6	6	N/A	6	6.14	
DEL-27	N/A	6	6	N/A	6	6	
DEL-28	N/A	5	5	N/A	5	5	
DEL-29	N/A	5	5	N/A	5	5	
DEL-30	N/A	4	4	N/A	4	4	
DEL-31	N/A	6	6	N/A	6	6	

TABLE 2
CENTRAL VALLEY FLOODPLAIN EVALUATION AND DELINEATION PROGRAM
LOWER SACRAMENTO RIVER BASIN
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INITIAL STORAGE ELEVATIONS SUMMARY (ft, NAVD 88)

Storage Area ID	2006 Storm Simulation			500-Year Test Flow Simulation			Notes
	Upper Sacramento River	Lower Sacramento River	Combined System Model	Upper Sacramento River	Lower Sacramento River	Combined System Model	
DEL-32	N/A	12	12	N/A	12	12	
DEL-33	N/A	3	3	N/A	3	3	
DEL-34	N/A	2.4	3	N/A	3	3	
DEL-35	N/A	3	2.86	N/A	3	3	
DEL-36	N/A	6	6	N/A	6	6.27	
DEL-37	N/A	5.37	3	N/A	6.08	6.09	
DEL-38	N/A	-21	-21	N/A	-21	-21	
DEL-39	N/A	-20	-20	N/A	-19	-19	
DEL-40	N/A	12.3	12.25	N/A	12.25	12.25	
DEL-41	N/A	12.3	12.3	N/A	12.3	12.3	
DEL-42	N/A	3.8	3.83	N/A	3.83	3.83	
DEL-43	N/A	4.03	1.91	N/A	4.75	4.76	
East Side 01	N/A	38.02	35.68	N/A	40	40	
East Side 02	N/A	31.7	31.69	N/A	34	34	
East Side 03	N/A	26.1	26.06	N/A	32.39	32.39	
East Side 04	N/A	29.1	29.06	N/A	34	34	
East Side 07	N/A	35.3	35.26	N/A	39.1	39.1	
East Side 08	N/A	33.9	33.88	N/A	35.22	35.22	
EGB1	N/A	-5.81	-9	N/A	-7	-7	
FEA-01	26	26	26	26	26	26	
FEA-02	N/A	64	64	N/A	64	64	
FEA-03	N/A	46	46	N/A	46	46	
FEA-04	52.94	50	50	53.86	50	51.55	
FEA-05	54.13	44	44	54.13	44	53.73	
FEA-06	41	41	41	41	41	41	
FEA-07	N/A	100	100	N/A	100	100	
FEA-08	N/A	88	88	N/A	88	88	
FEA-09	N/A	103	103	N/A	103	103	
FEA-10	N/A	64.5	64.5	N/A	64.5	64.5	
FEA-14	N/A	47	47	N/A	47	47	
FEA-15	N/A	79.6	79.6	N/A	79.6	79.6	
FEA-16	N/A	68	68	N/A	69.1	69.1	
FEA-17	N/A	88	88	N/A	88	88	
FEA-18	N/A	61	61	N/A	63.1	65.06	
FEA-19	N/A	67	67	N/A	67	67	
FEA-20	N/A	59	67	N/A	59	67	
FEA-21	N/A	68	68	N/A	68	68	
FEA-22	N/A	75	75	N/A	75	75	
FEA-23	N/A	67	67	N/A	67	67	

TABLE 2
CENTRAL VALLEY FLOODPLAIN EVALUATION AND DELINEATION PROGRAM
LOWER SACRAMENTO RIVER BASIN
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INITIAL STORAGE ELEVATIONS SUMMARY (ft, NAVD 88)

Storage Area ID	2006 Storm Simulation			500-Year Test Flow Simulation			Notes
	Upper Sacramento River	Lower Sacramento River	Combined System Model	Upper Sacramento River	Lower Sacramento River	Combined System Model	
FEA-24	N/A	70	70	N/A	70	70	
FEA-25	N/A	74	74	N/A	74	74	
FEA-26	N/A	78	78	N/A	78	78	
FEA-27	N/A	96	96	N/A	96	96	
FEA-28	N/A	81	81	N/A	81	81	
FEA-29	N/A	69	69	N/A	69	69	
FEA-30	25	25	25	25	25	25	
FEA-31	38	38	38	38	38	38	
FEA-32	41	41	41	41	41	41	
FEA-33	N/A	38	38	N/A	38	38	
FEA-34	26	26	26	26	26	26	
FEA-35	N/A	102	103	N/A	103	103	
FEA-36	N/A	84.71	88	N/A	85.7	85.7	
FEA-37	N/A	87.04	88	N/A	88	88	
FEA-38	N/A	100	100	N/A	100	100	
FEA-39	N/A	92	92	N/A	92	92	
FEA-40	N/A	107	107	N/A	107	107	
HON-01	N/A	44	44	N/A	44	44	
HON-02	N/A	71	71	N/A	71	71	
HON-03	N/A	59	59	N/A	59	59	
HON-04	N/A	69	69	N/A	69	69	
HON-05	N/A	71	71	N/A	71	71	
HON-06	N/A	75	75	N/A	75	75	
HON-07	N/A	81	81	N/A	81	81	
HON-08	N/A	84	83	N/A	84.35	85.52	
HON-10	N/A	86	86	N/A	88	88.92	
HON-11	N/A	87.35	86.1	N/A	87	87.88	
HON-12	N/A	85.1	85.09	N/A	87	87	
HON-13	N/A	85.4	85.41	N/A	87	87	
HON-14	N/A	72.24	70	N/A	72.22	70.98	
HON-15	N/A	101	101	N/A	101	101	
HON-16	N/A	83	83	N/A	83	83	
HON-17	N/A	93	93	N/A	93	93	
HON-18	N/A	99	99	N/A	99	99	
HON-19	N/A	125.5	125.5	N/A	125.5	125.5	
Markham Ravine	N/A	36.24	35.26	N/A	37.26	37.26	
Markham_Upstream	N/A	38	35.53	N/A	38.5	39.49	
NAT-01	N/A	0.4	0.4	N/A	0.4	0.4	
NAT-02	N/A	1.5	1.54	N/A	1.54	1.54	

TABLE 2
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INITIAL STORAGE ELEVATIONS SUMMARY (ft, NAVD 88)

Storage Area ID	2006 Storm Simulation			500-Year Test Flow Simulation			Notes
	Upper Sacramento River	Lower Sacramento River	Combined System Model	Upper Sacramento River	Lower Sacramento River	Combined System Model	
NAT-03	N/A	9	9	N/A	9	9	
NAT-04	N/A	5.4	5.44	N/A	5.44	5.44	
NAT-05	N/A	14.3	14.34	N/A	14.34	14.34	
NAT-06	N/A	10.7	10.73	N/A	10.73	10.73	
NAT-07	N/A	10	10	N/A	10	10	
NAT-08	N/A	11	11	N/A	11	11	
NAT-09	N/A	9.4	9.39	N/A	9.39	9.39	
NAT-10	N/A	4	7	N/A	4	4	
NAT-11	N/A	8.3	8.31	N/A	8.31	8.31	
NAT-12	N/A	12.7	13.68	N/A	13.68	13.68	
NAT-13	N/A	12.3	12.33	N/A	12.33	12.33	
NAT-14	N/A	31.4	31.38	N/A	32.38	32.38	
NAT-16	N/A	31	31	N/A	31	31	
NAT-17	N/A	12	12	N/A	12	12	
NAT-18	N/A	13	13	N/A	13	13	
NAT-19	N/A	1.93	1	N/A	2.05	2.05	
NAT-20	N/A	38.5	38.16	N/A	39.66	38.66	
NEMDC_East 01B	N/A	26.4	26.44	N/A	26.44	26.44	
NEMDC_East_01	N/A	29.54	25.25	N/A	25.64	30.97	
NEMDC_East_02	N/A	29.05	25.11	N/A	27.41	31.12	
NEMDC_East_03	N/A	30.04	26.41	N/A	29	31.03	
NEMDC_East_04	N/A	29.78	25.35	N/A	28.08	31.75	
NEMDC_East_05	N/A	34.39	32.06	N/A	33	35.63	
PGC_Upstream	N/A	35.75	30.87	N/A	34.87	34.87	
PUT-01	N/A	13.6	13.62	N/A	13.62	13.62	
PUT-02	N/A	8.4	8.41	N/A	8.41	8.41	
PUT-03	N/A	33	33	N/A	33	33	
PUT-04	N/A	44.9	44.94	N/A	44.94	44.94	
PUT-05	N/A	30.8	30.78	N/A	30.78	30.78	
PUT-06	N/A	47.4	47.42	N/A	47.42	47.42	
PUT-07	N/A	50.8	50.76	N/A	50.76	50.76	
PUT-08	N/A	26.2	26.18	N/A	26.18	26.18	
SHO-NHO	N/A	77.5	78	N/A	78.47	78.47	
STM-CAS Junction	N/A	5	5	N/A	6	6	
Trilia	N/A	30	24	N/A	N/A	N/A	This Storage Area was refined for current conditions geometry to reflect the TRLIA setback levee along the Feather River.
WIL-01	N/A	18	18	N/A	18	18	
WIL-02	N/A	22	22	N/A	22	22	
WIL-03	N/A	11	11	N/A	11	11	

TABLE 2
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INITIAL STORAGE ELEVATIONS SUMMARY (ft, NAVD 88)

Storage Area ID	2006 Storm Simulation			500-Year Test Flow Simulation			Notes
	Upper Sacramento River	Lower Sacramento River	Combined System Model	Upper Sacramento River	Lower Sacramento River	Combined System Model	
WIL-04	N/A	43.3	45	N/A	43.83	43.83	
WSAC-01	N/A	-5	-5	N/A	-5	-5	
WSAC-02	N/A	4	4	N/A	4	4	
WSAC-03	N/A	4	4	N/A	4	4	
WSAC-04	N/A	3	3	N/A	3	3	
WSAC-05	N/A	-1	-1	N/A	-1	-1	
WSAC-06	N/A	-5	-5	N/A	-5	-5	
WSAC-07	N/A	-7	-7	N/A	-7	-7	
WSAC-08	N/A	4	4	N/A	4	4	
WSAC-09	N/A	14.8	14.8	N/A	13.81	13.81	
WSAC-10	N/A	9	9	N/A	9	9	
WSAC-11	N/A	10	10	N/A	10	10	
WSAC-12	N/A	0	0	N/A	0	0	
WSAC-13	N/A	3.4	3.38	N/A	4	4	
WSAC-14	N/A	-14	-14	N/A	-14	-14	
WSAC-15	N/A	-1.1	-1	N/A	-1	-1	
WSAC-16	N/A	11.09	8	N/A	10.88	10.88	
WSAC-17	N/A	9	9	N/A	9	9	
WSAC-18	N/A	10	10	N/A	10	10	
WSAC-19	N/A	6	6.02	N/A	6.02	6.02	
WSAC-22	N/A	5.7	6	N/A	6	6	
WSAC-23	N/A	13	13	N/A	13	13	
WSAC-24	N/A	2	2	N/A	2	2	
WSAC-25	N/A	3	3	N/A	3	3	
WSAC-26	N/A	12	9	N/A	10.28	10.28	
WSAC-27	N/A	14	14	N/A	14	14	
WSAC-28	N/A	13	13	N/A	13	13	
YUB-01	N/A	62	40.99	N/A	59.84	60.29	
YUB-02	N/A	N/A	N/A	N/A	48	48	This Storage Area was formally a part of the "Trilia" storage area defined in the 2006 Model geometry. The storage area was subdivided in the current conditions model to reflect the TRLIA setback levee along the Feather River.
YUB-03	N/A	N/A	N/A	N/A	29	29	This Storage Area was formally a part of the "Trilia" storage area defined in the 2006 Model geometry. The storage area was subdivided in the current conditions model to reflect the TRLIA setback levee along the Feather River.
YUB-04	N/A	N/A	N/A	N/A	41.22	43.73	This Storage Area was formally a part of the "Trilia" storage area defined in the 2006 Model geometry. The storage area was subdivided in the current conditions model to reflect the TRLIA setback levee along the Feather River.
YUB-05	N/A	40	39.25	N/A	40	40	

TABLE 2
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INITIAL STORAGE ELEVATIONS SUMMARY (ft, NAVD 88)

Storage Area ID	2006 Storm Simulation			500-Year Test Flow Simulation			Notes
	Upper Sacramento River	Lower Sacramento River	Combined System Model	Upper Sacramento River	Lower Sacramento River	Combined System Model	
YUB-06	N/A	N/A	N/A	N/A	48	48	This Storage Area was formally a part of the "Trilia" storage area defined in the 2006 Model geometry. The storage area was subdivided in the current conditions model to reflect the TRLIA setback levee along the Feather River.
YUB-07	N/A	47	46.6	N/A	47	47	
YUB-09	N/A	60	59.31	N/A	60	60.76	
YUB-10	N/A	N/A	N/A	N/A	59.83	61.18	This Storage Area was formally a part of the "Trilia" storage area defined in the 2006 Model geometry. The storage area was subdivided in the current conditions model to reflect the TRLIA setback levee along the Feather River.
YUB-11	N/A	67	47.82	N/A	63.18	64.18	
YUB-12	N/A	40	39.38	N/A	40	40	
YUB-13	N/A	48.67	38.96	N/A	48.31	51.85	
YUB-14	N/A	56.86	49.31	N/A	56.25	58.2	
YUB-19	N/A	N/A	N/A	N/A	48	48	This Storage Area was formally a part of the "Trilia" storage area defined in the 2006 Model geometry. The storage area was subdivided in the current conditions model to reflect the TRLIA setback levee along the Feather River.
YUB-20	N/A	63.1	64	N/A	64	63.1	
YUB-21	N/A	57	57	N/A	57	57	
YUB-22	N/A	58.39	52	N/A	52	52	
YUB-23	N/A	67	67	N/A	67	67	
YUB-24	N/A	31	31	N/A	31	31	
YUB-25	N/A	58.39	44.41	N/A	45	47.09	
YUB-26	N/A	N/A	N/A	N/A	30.65	31.2	This Storage Area was formally a part of the "Trilia" storage area defined in the 2006 Model geometry. The storage area was subdivided in the current conditions model to reflect the TRLIA setback levee along the Feather River.
YUB-27	N/A	55	50.66	N/A	55.25	54.02	
YUB-28	N/A	65	65	N/A	65	65	
YUB-29	N/A	63.06	57.36	N/A	64.57	62.68	
YUB-30	N/A	60.49	54.26	N/A	58.12	59.56	
YUB-31	N/A	61	59.79	N/A	62	62	

TABLE 3
CENTRAL VALLEY FLOODPLAIN EVALUATION AND DELINEATION PROGRAM
LOWER SACRAMENTO RIVER BASIN
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INITIAL FLOW SUMMARY (CFS)

River	Reach	River Mile	2006 Storm Simulation			500-Year Test Flow Simulation			Note
			Upper Sacramento River	Lower Sacramento River	Combined System Model	Upper Sacramento River	Lower Sacramento River	Combined System Model	
AME	R1	22.357	N/A	2,000	2,000	N/A	2,000	5,000	
Auburn_Ravine	Main_Branch	0.695	N/A	100	100	N/A	50	50	
Bear River	Bear US	17.005	N/A	5,000	5,000	N/A	5,000	5,000	
Bear River	Dry to WPIC	5.728	N/A	5,000	5,000	N/A	5,000	5,000	
Bear River	WPIC to Yankee	4.132	N/A	5,000	5,000	N/A	5,000	5,000	
Bear River	Yanke to Feather	4.074	N/A	5,000	5,000	N/A	5,000	5,000	
Best Slough	Best Slough	18.301	N/A	800	800	N/A	800	800	
Big Chico Creek	Main	8.743	300	N/A	400	300	N/A	400	
Big Chico Creek	Main	1.678	350	N/A	350	350	N/A	350	
Big Chico Creek	Lower	2.012	600	N/A	800	600	N/A	600	
BUC	Subreach1	45.399	400	N/A	400	400	N/A	400	
BUC	Subreach1	42.691	600	N/A	600	600	N/A	600	
BUC1	Subreach1	2.897	200	N/A	200	200	N/A	200	
Butte_Sink	Subreach1	50.282	6,000	N/A	6,000	6,000	N/A	6,000	
Butte_Sink	Subreach1	38.614	7,000	N/A	7,000	7,000	N/A	7,000	
Butte_Sink	Subreach2	38.385	7,000	N/A	7,000	7,000	N/A	7,000	
Butte_Sink	Subreach2	37.633	7,500	N/A	7,500	7,500	N/A	7,500	
Butte_Sink	Subreach3	27.14	8,000	N/A	8,000	8,000	N/A	8,000	
Butte_Sink	Subreach3	27.136	8,000	N/A	8,000	8,000	N/A	8,000	
CAC	R1	31.258	N/A	N/A	N/A	N/A	1,000	1,000	Cache Creek was trimmed at RM 12.19 for 2006 Model.
CAC	R1	12.19	N/A	2,000	2,000	N/A	N/A	N/A	The inflow was placed at the upstream end for 500 year model.
Cache Sl (CAS)	R1 abv HAS	25.739	N/A	10	10	N/A	10	10	
Cache Sl (CAS)	R2 HAS-YOL	24.299	N/A	20	20	N/A	20	20	
Cache Sl (CAS)	R3 MIN-STM	18.559	N/A	28,000	28,000	N/A	28,000	28,000	
Cache Sl (CAS)	R3 MIN-STM	18.557	N/A	28,000	28,000	N/A	28,000	28,000	
Cache Sl (CAS)	R4 STM-SAC	14.847	N/A	49,000	49,000	N/A	49,000	49,000	
CHC	Subreach3	21.337	469	N/A	469	469	N/A	469	
CHC	Subreach2	15.68	469	N/A	469	469	N/A	469	
CHC	Subreach2	15.556	469	N/A	469	469	N/A	469	

TABLE 3
CENTRAL VALLEY FLOODPLAIN EVALUATION AND DELINEATION PROGRAM
LOWER SACRAMENTO RIVER BASIN
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INITIAL FLOW SUMMARY (CFS)

River	Reach	River Mile	2006 Storm Simulation			500-Year Test Flow Simulation			Note
			Upper Sacramento River	Lower Sacramento River	Combined System Model	Upper Sacramento River	Lower Sacramento River	Combined System Model	
CHC	Subreach1	6.387	469	N/A	469	469	N/A	469	
CHC_CTW	Subreach1	1.224	200	N/A	200	200	N/A	200	
CHC_LC	Subreach1	1.464	200	N/A	200	200	N/A	200	
COD	Subreach3	34.228	100	N/A	100	100	N/A	500	
COD	Subreach3A	1.677	500	N/A	100	500	N/A	500	
COD	Subreach2	0.524	100	N/A	100	100	N/A	100	
COD_OB	SubReach1	32.27	100	N/A	100	100	N/A	100	
Coon_Creek	Upper_Reach	5.255	N/A	40	100	N/A	60	60	
Coon_Creek	Right_Branch	5.218	N/A	30	100	N/A	50	100	
Coon_Creek	Left_Branch	0.324	N/A	30	100	N/A	30	30	
Curry_Creek	Main_Branch	0.405	N/A	70	500	N/A	70	70	
DRY	Reach1	0.4802	25	N/A	25	25	N/A	25	
Dry Creek	Dry CreekLower	14.248	N/A	1,475	1,475	N/A	1,475	1,475	
Dry Creek	Dry Creek	15.348	N/A	3,000	3,000	N/A	3,000	3,000	
DryCr_NEMDC	Lower_Reach	1.695	N/A	30	30	N/A	N/A	N/A	Initial Flow was not placed for 500-year Model.
East_Side_Canal	Upper_Reach	4.954	N/A	60	100	N/A	100	200	
East_Side_Canal	Lower_Reach	1.905	N/A	60	60	N/A	100	100	
Elk SI (ELK)	R1 SAC-SUT	9.416	N/A	200	100	N/A	100	100	
Feather	1	147.396	N/A	25,000	25,000	N/A	25,000	10,000	
Feather	1	136.85	N/A	25,000	25,000	N/A	25,000	10,000	
Feather	Honcut to Jack	127.247	N/A	25,000	25,000	N/A	25,000	10,000	
Feather	Honcut to Jack	127.247*	N/A	25,000	25,000	N/A	25,000	10,000	
Feather	Jack to Bear	109.616	N/A	25,000	25,000	N/A	25,000	10,000	
Feather	Jack to Bear	109.616*	N/A	25,000	25,000	N/A	25,000	10,000	
Feather	Bear to SacRiver	92.336	N/A	25,000	25,000	N/A	25,000	10,000	
Feather	Bear to SacRiver	87.767	N/A	65,000	65,000	N/A	65,000	65,000	
Feather_Trib_A	1	2.014	N/A	100	100	N/A	100	100	
Georgiana (GEO)	R1 SAC-MOK	12.317	N/A	10,000	10,000	N/A	10,000	10,000	
Hass SI (HAS)	R1 abv CAS	2.658	N/A	10	10	N/A	10	100	
Honcut Creek	Reach 1	2.192	N/A	1,450	1,450	N/A	1,450	1,450	

TABLE 3
CENTRAL VALLEY FLOODPLAIN EVALUATION AND DELINEATION PROGRAM
LOWER SACRAMENTO RIVER BASIN
TASK ORDER NO. 25

INITIAL FLOW SUMMARY (CFS)

River	Reach	River Mile	2006 Storm Simulation			500-Year Test Flow Simulation			Note
			Upper Sacramento River	Lower Sacramento River	Combined System Model	Upper Sacramento River	Lower Sacramento River	Combined System Model	
Horseshoe (HOR)	R1 HOR	3.076	N/A	3,000	3,000	N/A	3,000	3,000	
JackSlough	JackSlough	7.569	N/A	500	500	N/A	200	200	
KNI	Subreach1	7.13	400	N/A	100	400	N/A	400	
KNI_18020109	R1	3.199	N/A	10	N/A	N/A	10	N/A	This reach was merged with KNI in the combined model.
Lindo Channel	Upper	8.055	400	N/A	400	400	N/A	400	
Lindsey Sl (LIN)	R1 abv YOL	6.18	N/A	10	10	N/A	10	10	
Lwr Egbert (EGB)	R1	3.761	N/A	50	10	N/A	20	20	
MCT	Reach 1	0.263	25	N/A	25	25	N/A	25	
Miner Sl (MIN)	R1 SUT-CAS	7.534	N/A	7,000	7,000	N/A	7,000	7,000	
Moulton_Channel	Subreach1	1.162	300	N/A	300	300	N/A	300	
MUC	Subreach1	10.34	200	N/A	200	200	N/A	200	
MUC	Subreach2	7.862	675	N/A	675	675	N/A	675	
MUC	Subreach3	4.995	725	N/A	725	725	N/A	725	
Natomas Cross	Main_Branch	5.163	N/A	100	100	N/A	1,100	1,100	
NEMDC	Upper_Reach	14.316	N/A	1,000	1,000	N/A	100	N/A	
NEMDC	Robla_to_Dry	6.186	N/A	1,000	1,000	N/A	1,000	1,000	
NEMDC	Arcade_to_Robla	5.894	N/A	1,000	1,000	N/A	1,000	1,000	
NEMDC	Mouth_to_Arcade	3.599	N/A	1,000	1,000	N/A	1,000	1,000	
North Honcut	Reach 3	2.933	N/A	450	500	N/A	450	450	
North Honcut	Reach 2	0.808	N/A	1,000	1,000	N/A	1,000	1,000	
North Honcut	Reach 1	0.477	N/A	1,500	1,500	N/A	1,500	1,500	
Pleas_Grove_Cr	Main_Branch	0.85	N/A	100	200	N/A	10	10	
PleasGroveCanal	Upper_Reach	3.834	N/A	100	100	N/A	100	100	
PleasGroveCanal	Middle_Reach	3.113	N/A	100	100	N/A	100	100	
PleasGroveCanal	Lower_Reach	2.548	N/A	100	100	N/A	100	100	
Robla Creek	Lower_Reach	2.16	N/A	500	500	N/A	N/A	N/A	
SAB_18020109	R1	2.99	N/A	100	100	N/A	200	200	
SAC	NCC to NEMDC	78.935	N/A	70,000	70,000	N/A	20,000	20,000	
SAC	Steel to Amer	60.616	N/A	70,000	70,000	N/A	20,000	20,000	
SAC	DS American	60.412	N/A	70,000	70,000	N/A	20,000	20,000	

TABLE 3
CENTRAL VALLEY FLOODPLAIN EVALUATION AND DELINEATION PROGRAM
LOWER SACRAMENTO RIVER BASIN
TASK ORDER NO. 25

INITIAL FLOW SUMMARY (CFS)

River	Reach	River Mile	2006 Storm Simulation			500-Year Test Flow Simulation			Note
			Upper Sacramento River	Lower Sacramento River	Combined System Model	Upper Sacramento River	Lower Sacramento River	Combined System Model	
SAC	Subreach1	200.782	7,000	N/A	7,000	7,000	N/A	7,000	
SAC	Subreach2	90.276	5,740	N/A	5,740	5,740	N/A	5,740	
Sac R (SAC)	R5 CAS-THR	14.242	N/A	75,000	75,000	N/A	20,000	20,000	
Sac R (SAC)	R6 THR-HOR	9.141	N/A	75,000	75,000	N/A	20,000	20,000	
Sac R (SAC)	R2 SUT-STM	34.164	N/A	50,000	50,000	N/A	20,000	20,000	
Sac R (SAC)	R3 STM-GEO	32.563	N/A	36,000	36,000	N/A	20,000	20,000	
Sac R (SAC)	R7 HOR-HOR	8.742	N/A	72,000	72,000	N/A	20,000	20,000	
Sac R (SAC)	R8 blw HOR	6.74	N/A	75,000	75,000	N/A	20,000	20,000	
Sac R (SAC)	R4 GEO-CAS	26.606	N/A	26,000	26,000	N/A	20,000	20,000	
Sacramento River	Reach 1	85.01	N/A	10,000	N/A	N/A	20,000	N/A	This reach was merged with SAC_Subreach2 in the combined model.
SCS	SCS_Subreach1	0.888	25	N/A	100	25	N/A	25	
Ship Chan (SAD)	R1	44.391	N/A	10	10	N/A	100	10	
SHO	Reach 1	0.956	N/A	1,000	1,000	N/A	1,000	1,000	
Steamboat (STM)	R1 SAC-SUT	11.5	N/A	14,000	14,000	N/A	14,000	14,000	
Steamboat (STM)	R2 SUT-CAS	7.109	N/A	21,000	21,000	N/A	21,000	21,000	
SUB	Subreach2	99.282	100	N/A	100	100	N/A	100	
SUB	Subreach2	95.612	1,000	N/A	1,000	1,000	N/A	1,000	
SUB	WAD_to_TIS	83.453	2,000	N/A	10,000	2,000	N/A	5,000	
SUB	Subreach1	77.252	2,000	N/A	N/A	2,000	N/A	N/A	This reach was merged with Sutter Bypass_Reach 1 in the combined model.
Sutter Bypass	Reach 1	77.252	N/A	N/A	10,000	N/A	N/A	10,000	
Sutter Bypass	Reach 1	66.665	N/A	10,000	10,000	N/A	10,000	10,000	
Sutter Bypass	Reach 1	65.646	N/A	10,000	10,000	N/A	10,000	10,000	
Sutter SI (SUT)	R1 SAC-ELK	6.639	N/A	14,000	14,000	N/A	14,000	14,000	
Sutter SI (SUT)	R2 ELK-MIN	6.088	N/A	14,000	14,000	N/A	14,000	14,000	
Sutter SI (SUT)	R3 MIN-STM	2.338	N/A	7,000	7,000	N/A	7,000	7,000	
SYC	Reach1	6.113	400	N/A	500	400	N/A	400	
SYC	Reach1B	1.9	450	N/A	500	450	N/A	450	
SYC	Reach2	1.597	475	N/A	500	475	N/A	475	
Threemile (THR)	R1 SAC-SJR	3.282	N/A	60,000	60,000	N/A	60,000	60,000	

TABLE 3

**CENTRAL VALLEY FLOODPLAIN EVALUATION AND DELINEATION PROGRAM
LOWER SACRAMENTO RIVER BASIN
TASK ORDER NO. 25**

INITIAL FLOW SUMMARY (CFS)

River	Reach	River Mile	2006 Storm Simulation			500-Year Test Flow Simulation			Note
			Upper Sacramento River	Lower Sacramento River	Combined System Model	Upper Sacramento River	Lower Sacramento River	Combined System Model	
TIS	Subreach1	4.701	N/A	N/A	N/A	500	N/A	500	500-year Model ends at RM 4.701
TIS	Subreach1	4.721	500	N/A	500	N/A	N/A	N/A	2006 Model extends up to RM 4.721
UNT	Reach 1	2.431	N/A	50	500	N/A	50	50	
Wadsworth Canal	Reach 1	4.6291	1,500	N/A	1,500	1,500	N/A	1,500	
WPIC	WPIC	9.187	N/A	800	1,000	N/A	800	800	
WPIC	WPIC blw Best SI	2.249	N/A	500	500	N/A	275	8,275	
WSB	R1	9.785	N/A	50	50	N/A	50	50	
Wyandotte Creek	Reach 2	0.917	N/A	1,000	1,000	N/A	1,000	500	
Wyandotte Creek	Reach 1	0.484	N/A	1,000	1,000	N/A	1,000	500	
YOL	R1	56.708	N/A	35,000	35,000	N/A	35,000	35,000	
YOL	KNL-Sac Bypass	53.9249	N/A	35,000	35,000	N/A	35,000	35,000	
YOL	KNL-Sac Bypass	53.9249*	N/A	35,000	35,000	N/A	35,000	35,000	
YOL	Sac Bypass-WSB	43.954	N/A	35,000	35,000	N/A	35,000	35,000	
YOL	WSB-PUT	42.968	N/A	35,000	35,000	N/A	35,000	35,000	
YOL	Putah-Cache SI	37.289	N/A	35,000	35,000	N/A	35,000	35,000	
YOL	Putah-Cache SI	38.633	N/A	35,000	35,000	N/A	35,000	35,000	
YOL	Cache-Lindsey SI	20.708	N/A	N/A	35,000	N/A	35,000	35,000	
YOL	Linsey-LwrEdgber	19.598	N/A	N/A	35,000	N/A	35,000	35,000	

TABLE 4
CENTRAL VALLEY FLOODPLAIN EVALUATION AND DELINEATION PROGRAM
LOWER SACRAMENTO RIVER BASIN
TASK ORDER NO. 25

MINIMUM FLOW SUMMARY (CFS)

Boundary Location			2006 Storm Simulation			500-Year Test Flow Simulation		
River/Storage Area	Reach	River Mile	Upper Sacramento River	Lower Sacramento River	Combined System Model	Upper Sacramento River	Lower Sacramento River	Combined System Model
AME	R1	22.357	N/A	N/A	N/A	N/A	2,000	5,000
Arcade_Creek	Main_Reach	6.605	N/A	10	10	N/A	100	100
DryCr_NEMDC	Lower_Reach	1.695	N/A	N/A	N/A	N/A	10	10
Robla_Creek	Lower_Reach	2.16	N/A	N/A	N/A	N/A	118	118
NEMDC	Upper_Reach	13.485	N/A	25	25	N/A	N/A	N/A
NEMDC	Upper_Reach	11.987	N/A	10	10	N/A	N/A	N/A
NEMDC	Upper_Reach	11.585	N/A	10	10	N/A	N/A	N/A
NEMDC	Upper_Reach	10.991	N/A	10	10	N/A	N/A	N/A
NEMDC	Upper_Reach	10.266	N/A	10	10	N/A	N/A	N/A
NEMDC	Upper_Reach	10.131	N/A	10	10	N/A	N/A	N/A
NEMDC	Upper_Reach	9.591	N/A	10	10	N/A	N/A	N/A
NEMDC	Arcade_to_Robla	4.590	N/A	10	10	N/A	N/A	N/A
Auburn_Upstream	N/A	N/A	N/A	50	50	N/A	50	50
Coon_Upstream	N/A	N/A	N/A	200	200	N/A	100	400
Markham_Upstream	N/A	N/A	N/A	10	10	N/A	10	10
PGC_Upstream	N/A	N/A	N/A	100	200	N/A	100	100
Curry_Upstream	N/A	N/A	N/A	200	500	N/A	10	10
Feather_Trib_A	1	2.014	N/A	100	100	N/A	100	100
Bear River	Bear US	17.005	N/A	1,000	1,000	N/A	N/A	N/A
Dry Creek	Dry Creek	15.348	N/A	3,000	3,000	N/A	3,000	3,000
Yankee_Slough	1	14.262	N/A	300	300	N/A	N/A	N/A
Feather	1	147.396	N/A	25,000	25,000	N/A	25,000	10,000
North Honcut	Reach 4	4.605	N/A	500	500	N/A	800	500
SHO	Reach 2	7.65	N/A	500	500	N/A	500	500
Wilson Creek	Reach 1	4.248	N/A	500	500	N/A	500	500
Wyman Ravine	Reach 1	1.49	N/A	500	500	N/A	500	50
PUT	R1	21.874	N/A	500	500	N/A	200	200
WSB	R1	9.785	N/A	50	50	N/A	50	50
HON-10	N/A	N/A	N/A	N/A	N/A	N/A	N/A	500
FEA-17	N/A	N/A	N/A	N/A	N/A	N/A	1	1
FEA-37	N/A	N/A	N/A	N/A	N/A	N/A	50	50
NAT-20	N/A	N/A	N/A	25	25	N/A	100	10
HON-14	N/A	N/A	N/A	N/A	N/A	N/A	500	200
BUC1	Subreach1	2.897	200	N/A	200	200	N/A	200
CHC	Subreach3	21.337	469	N/A	469	469	N/A	469
CHC_CTW	Subreach1	1.224	186	N/A	186	186	N/A	186
BUC	Subreach1	45.399	400	N/A	400	400	N/A	400
SAC	Subreach1	190.745	200	N/A	200	200	N/A	200
COD	Subreach3	28.190	100	N/A	100	100	N/A	100
Butte_Sink	Subreach2	38.384	100	N/A	100	100	N/A	100

TABLE 4
CENTRAL VALLEY FLOODPLAIN EVALUATION AND DELINEATION PROGRAM
LOWER SACRAMENTO RIVER BASIN
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MINIMUM FLOW SUMMARY (CFS)

Boundary Location			2006 Storm Simulation			500-Year Test Flow Simulation		
River/Storage Area	Reach	River Mile	Upper Sacramento River	Lower Sacramento River	Combined System Model	Upper Sacramento River	Lower Sacramento River	Combined System Model
DRY	Reach1	0.4802	25	N/A	25	N/A	N/A	N/A
MUC	Subreach1	10.34	200	N/A	200	N/A	N/A	N/A
SYC	Reach1	6.113	400	N/A	500	N/A	N/A	N/A
092	N/A	N/A	25	N/A	50	N/A	N/A	N/A
023	N/A	N/A	100	N/A	100	100	N/A	100
025	N/A	N/A	100	N/A	100	100	N/A	100
YUB-11	N/A	N/A	N/A	800	800	N/A	800	800
099A	N/A	N/A	25	N/A	25	N/A	N/A	N/A
HON-11	N/A	N/A	N/A	500	800	N/A	500	N/A
FEA-05	N/A	N/A	1,500	N/A	1,500	1,500	N/A	N/A

TABLE 5
CENTRAL VALLEY FLOODPLAIN EVALUATION AND DELINEATION PROGRAM
LOWER SACRAMENTO RIVER BASIN
TASK ORDER NO. 25

JUNCTION CALCULATION METHOD SUMMARY

Junction	2006 Storm Simulation			500-Year Test Flow Simulation		
	Upper Sacramento River	Lower Sacramento River	Combined System Model	Upper Sacramento River	Lower Sacramento River	Combined System Model
SacAmer	N/A	Force Equal WS Elevations	Force Equal WS Elevations	N/A	Force Equal WS Elevations	Force Equal WS Elevations
Arcade-NEMDC	N/A	Force Equal WS Elevations	Force Equal WS Elevations	N/A	Force Equal WS Elevations	Force Equal WS Elevations
Auburn-ESC	N/A	Force Equal WS Elevations	Force Equal WS Elevations	N/A	Force Equal WS Elevations	Force Equal WS Elevations
BR@Dry Ck	N/A	Energy Balance Method	Energy Balance Method	N/A	Energy Balance Method	Energy Balance Method
BR@WPIC	N/A	Force Equal WS Elevations	Force Equal WS Elevations	N/A	Force Equal WS Elevations	Force Equal WS Elevations
BR@Yankee	N/A	Force Equal WS Elevations	Force Equal WS Elevations	N/A	Force Equal WS Elevations	Force Equal WS Elevations
Bear@Feather	N/A	Force Equal WS Elevations	Force Equal WS Elevations	N/A	Force Equal WS Elevations	Force Equal WS Elevations
Best@WPIC	N/A	Energy Balance Method	Energy Balance Method	N/A	Energy Balance Method	Energy Balance Method
HAS-CAS	N/A	Energy Balance Method	Energy Balance Method	N/A	Energy Balance Method	Energy Balance Method
Yolo-CacheSl	N/A	Force Equal WS Elevations	Force Equal WS Elevations	N/A	Force Equal WS Elevations	Force Equal WS Elevations
Yolo-Edgbert	N/A	Force Equal WS Elevations	Force Equal WS Elevations	N/A	Force Equal WS Elevations	Force Equal WS Elevations
Coon-US	N/A	Force Equal WS Elevations	Force Equal WS Elevations	N/A	Force Equal WS Elevations	Force Equal WS Elevations
Coon-DS	N/A	Force Equal WS Elevations	Force Equal WS Elevations	N/A	Force Equal WS Elevations	Energy Balance Method
Curry-PGCC	N/A	Force Equal WS Elevations	Force Equal WS Elevations	N/A	Force Equal WS Elevations	Force Equal WS Elevations
Dry-NEMDC	N/A	Force Equal WS Elevations	Force Equal WS Elevations	N/A	Force Equal WS Elevations	Force Equal WS Elevations
ESC-PGCC-NCC	N/A	Force Equal WS Elevations	Force Equal WS Elevations	N/A	Force Equal WS Elevations	Force Equal WS Elevations
ELK-SUT	N/A	Force Equal WS Elevations	Force Equal WS Elevations	N/A	Force Equal WS Elevations	Force Equal WS Elevations
Honcut@FEA	N/A	Force Equal WS Elevations	Force Equal WS Elevations	N/A	Force Equal WS Elevations	Force Equal WS Elevations
Jack@Feather	N/A	Force Equal WS Elevations	Force Equal WS Elevations	N/A	Force Equal WS Elevations	Force Equal WS Elevations
NCC@SAC	N/A	Force Equal WS Elevations	Force Equal WS Elevations	N/A	Force Equal WS Elevations	Force Equal WS Elevations
SAC-GEO	N/A	Energy Balance Method	Energy Balance Method	N/A	Energy Balance Method	Energy Balance Method
NHO/SHO	N/A	Force Equal WS Elevations	Force Equal WS Elevations	N/A	Force Equal WS Elevations	Force Equal WS Elevations
SAC-HOR(US)	N/A	Energy Balance Method	Energy Balance Method	N/A	Energy Balance Method	Energy Balance Method
SAC-HOR(DS)	N/A	Energy Balance Method	Energy Balance Method	N/A	Energy Balance Method	Energy Balance Method
Yolo-KNL	N/A	Force Equal WS Elevations	Force Equal WS Elevations	N/A	Force Equal WS Elevations	Force Equal WS Elevations
Yolo-LinseyS	N/A	Force Equal WS Elevations	Force Equal WS Elevations	N/A	Force Equal WS Elevations	Force Equal WS Elevations
SUT-MIN	N/A	Energy Balance Method	Energy Balance Method	N/A	Energy Balance Method	Energy Balance Method
Robla-NEMDC	N/A	Force Equal WS Elevations	Force Equal WS Elevations	N/A	Force Equal WS Elevations	Force Equal WS Elevations
Steel@SAC	N/A	Force Equal WS Elevations	Force Equal WS Elevations	N/A	Force Equal WS Elevations	Force Equal WS Elevations
NHO/UNT	N/A	Force Equal WS Elevations	Force Equal WS Elevations	N/A	Force Equal WS Elevations	Force Equal WS Elevations
WYN/NHO	N/A	Force Equal WS Elevations	Force Equal WS Elevations	N/A	Force Equal WS Elevations	Force Equal WS Elevations
WYM/NHO	N/A	Force Equal WS Elevations	Force Equal WS Elevations	N/A	Force Equal WS Elevations	Force Equal WS Elevations
PGC-PGCC	N/A	Force Equal WS Elevations	Force Equal WS Elevations	N/A	Force Equal WS Elevations	Force Equal WS Elevations
Yolo-PUT	N/A	Energy Balance Method	Energy Balance Method	N/A	Force Equal WS Elevations	Force Equal WS Elevations
Yolo-Sac BP	N/A	Force Equal WS Elevations	Force Equal WS Elevations	N/A	Force Equal WS Elevations	Force Equal WS Elevations
SAC-SUT	N/A	Force Equal WS Elevations	Energy Balance Method	N/A	Force Equal WS Elevations	Energy Balance Method
SAC-THR	N/A	Energy Balance Method	Energy Balance Method	N/A	Energy Balance Method	Energy Balance Method
SAC-STM	N/A	Energy Balance Method	Energy Balance Method	N/A	Energy Balance Method	Energy Balance Method
Fremont Weir	N/A	Energy Balance Method	Energy Balance Method	N/A	Energy Balance Method	Energy Balance Method
WLS/SHO	N/A	Force Equal WS Elevations	Force Equal WS Elevations	N/A	Force Equal WS Elevations	Force Equal WS Elevations
SUT-STM	N/A	Force Equal WS Elevations	Force Equal WS Elevations	N/A	Force Equal WS Elevations	Force Equal WS Elevations

TABLE 5
CENTRAL VALLEY FLOODPLAIN EVALUATION AND DELINEATION PROGRAM
LOWER SACRAMENTO RIVER BASIN
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JUNCTION CALCULATION METHOD SUMMARY

Junction	2006 Storm Simulation			500-Year Test Flow Simulation		
	Upper Sacramento River	Lower Sacramento River	Combined System Model	Upper Sacramento River	Lower Sacramento River	Combined System Model
WYN/UNT	N/A	Force Equal WS Elevations	Force Equal WS Elevations	N/A	Force Equal WS Elevations	Force Equal WS Elevations
Yolo- WSB	N/A	Force Equal WS Elevations	Force Equal WS Elevations	N/A	Force Equal WS Elevations	Force Equal WS Elevations
LC_BCC	Energy Balance Method	N/A	Energy Balance Method	Energy Balance Method	N/A	Energy Balance Method
BS_BUC	Force Equal WS Elevations	N/A	Force Equal WS Elevations	Force Equal WS Elevations	N/A	Force Equal WS Elevations
BS_CHK	Force Equal WS Elevations	N/A	Force Equal WS Elevations	Force Equal WS Elevations	N/A	Force Equal WS Elevations
CHC-CTW	Energy Balance Method	N/A	Energy Balance Method	Energy Balance Method	N/A	Energy Balance Method
CHC-LC	Energy Balance Method	N/A	Energy Balance Method	Energy Balance Method	N/A	Energy Balance Method
COD_OB	Force Equal WS Elevations	N/A	Force Equal WS Elevations	Force Equal WS Elevations	N/A	Force Equal WS Elevations
COD_KNI	Energy Balance Method	N/A	Energy Balance Method	Energy Balance Method	N/A	Energy Balance Method
COD_SAC	Energy Balance Method	N/A	Energy Balance Method	Energy Balance Method	N/A	Energy Balance Method
SYC_DRY	Energy Balance Method	N/A	Energy Balance Method	Energy Balance Method	N/A	Energy Balance Method
MUC_MCT	Energy Balance Method	N/A	Energy Balance Method	Energy Balance Method	N/A	Energy Balance Method
MUC_SYC	Energy Balance Method	N/A	Energy Balance Method	Energy Balance Method	N/A	Energy Balance Method
Junction2	Energy Balance Method	N/A	Energy Balance Method	Energy Balance Method	N/A	Energy Balance Method
TIS_SUB	Force Equal WS Elevations	N/A	Force Equal WS Elevations	Force Equal WS Elevations	N/A	Force Equal WS Elevations
WAD@SUB	Force Equal WS Elevations	N/A	Force Equal WS Elevations	Energy Balance Method	N/A	Energy Balance Method

TABLE 6
CENTRAL VALLEY FLOODPLAIN EVALUATION AND DELINEATION PROGRAM
LOWER SACRAMENTO RIVER BASIN
TASK ORDER NO. 25

COMBINED SACRAMENTO RIVER MODEL DEVELOPMENT SUMMARY

Simulation Model Run	Model Simulation Results	Mixed Flow	Mixed Flow Options	Model Start Date Machine	Approx. Total Runtime including Curves Computing, if applicable (hrs)	Approx. Time to Recompute Curves (hrs)	Geometry Date	Number of Iterations	Max. Convergence Error at a Cross Section	Max. Convergence Error at a Storage Area	Note: The default values of M=10, F=1 are not listed in the spreadsheet because these parameters did not work in the combined model.
1	500-year Failed at 26 Jan	Yes	M = 7; F = 0.5	Jan 8, 6 pm	74	x	1/6/2014 6:22:00PM	40	-----	-----	-----
2	500-year Failed at 24 Jan	Yes	M = 7; F = 0.5	Jan 10, 3 pm	72	x	1/8/2014 5:50:00PM	40	-----	-----	-----
3	500-year Complete	Yes	M = 7; F = 0.5	Jan 10, 6 pm	59	x	1/8/2014 9:13am	40	0.3 WAD@XS 1.022	0.5 AMEN-02/06	Completed Run from Selena; Completed run from Wood Rodgers approx. 64.hrs
4	500-year Failed at 24 Jan	Yes	M = 7; F = 0.5	Jan 11, 3 pm	48	x	1/11/14 2:45pm	40	-----	-----	-----
5	500-year Failed at Jan21	Yes	M = 7; F = 0.5	Restarted Jan 12, 820 am	26	x	1/12/14 2:45pm	40	-----	-----	-----
6	500-year Failed at Jan21	Yes	M = 7; F = 0.5	Restarted Jan 11 8:30 pm	38	x	1/11/14 2:45pm	40	-----	-----	Adj. Coon Creek Initial Conditions; Added C&E @ AME/WAD Bridges; Adj WPIC Htabs; Coon Creek Junction changed to Forced
7	500-year Completed	No	N/A	Jan 12, 12pm	23	4	1/12/2014 11:36am	40	0.3' @ WAD	2.206' @ SA-059 @ one timestep	Subcritical Run Required Initial Flows to be adjusted at Sutter Bypass and Wadswork Canal.
8	500-year Failed on Jan18	Yes	M = 7; F = 0.2	Jan 13, 10 am	12	x	1/12/14 2:45pm	40	-----	-----	C&E coefficients added to AME; XS 19.747 & 14.188
9	500-year Completed	Yes	M = 7; F = 0.5	Jan 15, 4:00 PM WR-Sacmodel-4	67	Curves from Model 14 due to no geometry change	1/14/2014 1:16pm	40	0.346 @ CHC	0.570 @ SA-064	Includes updated Arcade Creek hydrograph and Wadsworth Canal reach Length of 550'
10	500-year Completed	Yes	M = 2 & F = 1.5	Jan 13, 4 pm	23	x	1/13/2014 9:37am	40	0.244 @ BUC	0.3 AMES-24	First run with adj. Mixed Flow Options. Will rerun with 1/14/14 geometry.
11	500-year Failed @ Coon Creek	Yes	M = 8; F = 1.0	Jan 14, 7:18 PM	----	x	1/14/2014 1:16pm	40	-----	-----	Includes updated Arcade Creek hydrograph and Wadsworth Canal reach Length of 550'
12	500-year Failed @ Coon Creek	Yes	M = 8; F = 1.0	Jan 14, 7:25 PM	----	x	1/14/2014 1:16pm	20	-----	-----	Includes updated Arcade Creek hydrograph and Wadsworth Canal reach Length of 550'
13	500-year Completed	No	N/A	Jan 14, 5:14 PM	12	4	1/14/2014 1:16pm	20	0.377 @ one time step AMR; 0.277' @ CAC	2.206' @ SA-059 @ one timestep	Subcritical Run Required Initial Flows to be adjusted at Sutter Bypass and Wadswork Canal; Includes updated Arcade Creek hydrograph and Wadsworth Canal reach Length of 550'
14	500-year Completed	Yes	M = 2; F = 1.5	Jan 14, 7:37 PM	25	5	1/14/2014 1:16pm	Failed halfway through simulation at 20 iterations. Restarted and completed with 30	0.24 @ BUC	0.487 @ AB 24	Note: The curves were recomputed initially for 20 iterations. After the model failed at 20 iterations, the model was restarted with 30 iterations. Includes updated Arcade Creek hydrograph and Wadsworth Canal reach Length of 550' (Note: Approx. run time added 4 hrs. for recomputing the curves.)
15	500-year Failed @ Coon Creek	Yes	M = 3; F = 1.5	Jan 14, 8:02 PM	----	x	1/14/2014 1:16pm	40	-----	-----	Includes updated Arcade Creek hydrograph and Wadsworth Canal reach Length of 550'
16	500-year Completed	Yes	M = 2; F = 2.0	Jan 14, 8:00 PM	18	Curves from Model 14 due to no geometry change	1/14/2014 1:16pm	40	0.567 @ BUC	0.390 @ 061	Convergence errors outside acceptable range. Includes updated Arcade Creek hydrograph and Wadsworth Canal reach Length of 550'
17	500-year Completed	Yes	M = 2; F = 1.5	Jan 15, 4:00 PM	23	Curves from Model 14 due to no geometry change	1/14/2014 1:16pm	40	0.248 @ BUC	0.487 @ AMES-24	Includes updated Arcade Creek hydrograph and Wadsworth Canal reach Length of 550'
18	500-year Unstable at Feather River (Atkins' Model)	Yes	M = 7; F = 0.5	Jan 15, 4:00 PM	16	Recompute Curves	1/14/2014 1:16pm	20	-----	-----	This is #9 except the no. of iterations are 20 in this. Geometry updated with CH2M Hill's storage areas.
19	500-year Model Crashed at 16 Jan	Yes	M=10, F=1	Jan 17,9:45 AM	30	4	1/16/2014 4:00pm	20			Includes updated initial flow at Coon Creek Upper Reach to 100 cfs and updated Storage Area Minimum Elevations for Upper Sac Areas. And FEA-01, -05 Coon Creek Initial Flow changed to 60, 40, 30 cfs. FEA-04 to 51.55' & FEA-05 to 53.73'

TABLE 6
CENTRAL VALLEY FLOODPLAIN EVALUATION AND DELINEATION PROGRAM
LOWER SACRAMENTO RIVER BASIN
TASK ORDER NO. 25

COMBINED SACRAMENTO RIVER MODEL DEVELOPMENT SUMMARY

Simulation Model Run	Model Simulation Results	Mixed Flow	Mixed Flow Options	Model Start Date Machine	Approx. Total Runtime including Curves Computing, if applicable (hrs)	Approx. Time to Recompute Curves (hrs)	Geometry Date	Number of Iterations	Max. Convergence Error at a Cross Section	Max. Convergence Error at a Storage Area	Note: The default values of M=10, F=1 are not listed in the spreadsheet because these parameters did not work in the combined model.
20	500-year Model Crashed at 14 Jan	Yes	M = 2; F = 1.5	Jan 17, 11:18 AM	20	4 (Curve used from 1/16 before Junction Length update)	1/16/2014 4:00pm	30 (Does not run with 20)			This is a copy of Model #14 with updated geometry, updated initial flow at Coon Creek, Storage area FEA-04, -05.
21	500-year Crashed at 17 Jan at Yankee Slough	Yes	M=10, F=1	Jan 17, 5:55 PM WR-Sacmodel-5	7	5	1/17/2014 17:00	20	---	---	Update Coon Creek by adding two interpolated XS and move XS 5.254 in the plan view. Change Feather River XS ineffective flow area to permanent.
22	500-year Crashed at warmup on Coon Creek	Yes	M=10, F=1	Jan 17, 5:52 PM WR-Sacmodel-5	---	5	1/17/2014 17:00	30	---	---	Update Coon Creek by adding two interpolated XS and move XS 5.254 in the plan view. Change Feather River XS ineffective flow area to permanent.
23	500-year Completed	Yes	M=10, F=1	Jan 17, 6:09 PM WR-Cmilligan	74	5.5	1/17/2014 17:00	40	0.4' @ Dry Creek		Update Coon Creek by adding two interpolated XS and move XS 5.254 in the plan view. Change Feather River XS ineffective flow area to permanent.
24	500-year Crashed at 26 Jan 18:11 Coon Creek Left Branch, Right Branch & East Side Canal	Yes	M = 2; F = 1.5	Jan 17, 5:55 PM WR-Sacmodel-4	21	5	1/17/2014 17:00	20	---	---	Update Coon Creek by adding two interpolated XS and move XS 5.254 in the plan view. Change Feather River XS ineffective flow area to permanent.
25	500-year Completed Uploaded to Atkins FTP	Yes	M = 2; F = 1.5	Jan 17, 6:05 PM WR-Sacmodel-2	19.5	4	1/17/2014 17:00	30	0.248 @ BUC	0.396 @ AMEN-02	Update Coon Creek by adding two interpolated XS and move XS 5.254 in the plan view. Change Feather River XS ineffective flow area to permanent. ftp://ftp.na.atkinsglobal.com/Temp/CVFED/For_WR/Combined_Model_20140118_2_1-5/
26	500-year Model Crashed at warmup at Coon Creek	Yes	M = 2; F = 1.5	Jan 17, 6:05 PM WR-Sacmodel-2	---	4	1/17/2014 17:00	40	---	---	Update Coon Creek by adding two interpolated XS and move XS 5.254 in the plan view. Change Feather River XS ineffective flow area to permanent.
27	500-Year Completed	Yes	M = 2; F = 1.5	Jan 18, 11:26 AM WR-Sacmodel-3	17	4	Jan 18, 8:00 am	20	0.248 @ BUC	0.485 @ AMES-24	This geometry reverts back to original Feather River IE settings with only Coon Creek XS updated. ftp://ftp.na.atkinsglobal.com/Temp/CVFED/For_WR/Combined_Model_500yr_20140119/
28	500-year Crashed at 16 Jan 6:27 Coon Creek Left Branch	Yes	M = 2; F = 1.5	Jan 18, 11:27 AM WR-Sacmodel-3	---	4	Jan 18, 8:00 am	30	---	---	This geometry reverts back to original Feather River IE settings with only Coon Creek XS updated.
29	500-year Completed	Yes	M = 2; F = 1.5	Jan 18, 2:04 PM WR-Sacmodel-2 (RS)	22	4	Jan 18, 8:00 am	40	0.244 @ BUC	0.484 @ AMES-24	This geometry reverts back to original Feather River IE settings with only Coon Creek XS updated. East Side Canal Upper reach initial flow changed from 100 to 200 cfs. ftp://ftp.na.atkinsglobal.com/Temp/CVFED/For_WR/Combined_Model_500yr_20140119/
30	500-year WR-Crashed 19 Jan 15:29 @ Feather River	Yes	M=10, F=1	Jan 18, 1:49 PM WR-Sacmodel-4 (RS)	---	5	Jan 18, 8:00 am	20			This geometry reverts back to original Feather River IE settings with only Coon Creek XS updated.
31	500-year Completed	Yes	M=10, F=1	Jan 18, 2:10 pm WR-Sacmodel-2 (RS)	44	4	Jan 18, 8:00 am	30	2.3' @ FEA 143.598 on 19 Jan 9:25	0.377' @ AMES-34	This geometry reverts back to original Feather River IE settings with only Coon Creek XS updated. This model uses Initial Flow at Coon Creek 100, 100, 100 (from 60, 40, 30)
32	500-year Model Crashed at Feather River on 19 Jan 13:36	Yes	M=10, F=1	Jan 18, 2:49 PM WR-Sacmodel-4 (RS)	---	5	Jan 18, 8:00 am	40	---	---	This geometry reverts back to original Feather River IE settings with only Coon Creek XS updated.
33	500-year Running but with Errors > 1ft Model killed due to Errors	Yes	M=10, F=1.5	Jan 18, 2:54 PM WR-Sacmodel-5 (AB)	74	5	Jan 18, 8:00 am	30	>1' @ BUC		This is a trial run to get higher value of "m" working with FT = 1.5 This model has convergence error of 0.275' at Best Slough before recomputing curves.
34	500-year Crashed at Coon Creek	Yes	M=8, F=1.5	Jan 18, 2:56 PM WR-Sacmodel-5 (AB)	50	5	Jan 18, 8:00 am	30	0.36' @ BUC		This is a trial run to get higher value of "m" working with FT = 1.5 This model has convergence error of 0.275' at Best Slough before recomputing curves.
35	500-year Crashed at Coon Creek	Yes	M=6, F=1.5	Jan 18, 3:10 PM WR-Abathulla (AB)	50	5.5	Jan 18, 8:00 am	30	0.27' @ Best Slough		This is a trial run to get higher value of "m" working with FT = 1.5 The initial settings were changed at Coon Creek to 60, 50, 30 cfs and at East Side Canal Upper Reach to 200 cfs.
36	2006 Model Complete Uploaded to Atkins FTP site	Yes	M=2; F=1.5	Jan 20, 4:35 PM WR-Sacmodel-4	12.75	5	Jan 20, 12:08 PM	20	0.249' @ CHC	0.273' @ YUB-20	Initial flows were changed at Coon Creek, East Side Canal, Pleasant Grove Creek and Big Chico Creek. Minimum Flow was changed at Storage Area PGC_Upstream. ftp://ftp.na.atkinsglobal.com/Temp/CVFED/For_WR/Combined_Model_2006_20140121/

TABLE 6
CENTRAL VALLEY FLOODPLAIN EVALUATION AND DELINEATION PROGRAM
LOWER SACRAMENTO RIVER BASIN
TASK ORDER NO. 25

COMBINED SACRAMENTO RIVER MODEL DEVELOPMENT SUMMARY

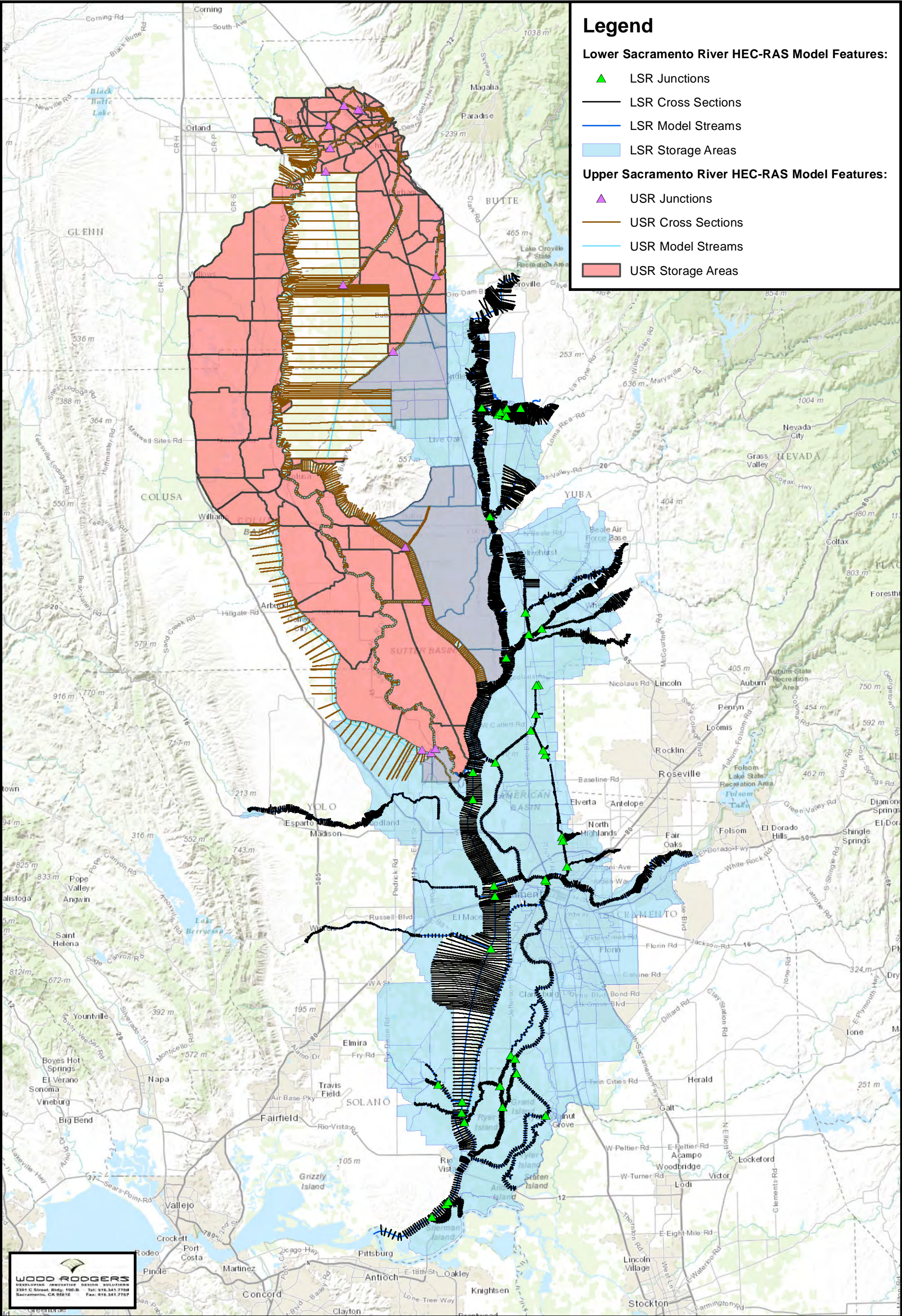
Simulation Model Run	Model Simulation Results	Mixed Flow	Mixed Flow Options	Model Start Date Machine	Approx. Total Runtime including Curves Computing, if applicable (hrs)	Approx. Time to Recompute Curves (hrs)	Geometry Date	Number of Iterations	Max. Convergence Error at a Cross Section	Max. Convergence Error at a Storage Area	Note: The default values of M=10, F=1 are not listed in the spreadsheet because these parameters did not work in the combined model.
37	2006 Model Completed	Yes	M=2; F=1.5	Jan 20, 12:50 PM WR-Sacmodel-3	13.4	4	Jan 20, 12:08 PM	40	0.249' @ CHC	0.273' @ YUB-20	Coon Creek Initial Flow changed to 100 cfs for Upper Reach, Left and Right Branch. ftp://ftp.na.atkinsglobal.com/Temp/CVFED/For_WR/Combined_Model_2006_20140121/
38	2006 Completed	Yes	M=2; F=1.5	Jan 22, 6:07 PM WR-Sacmodel-3	6.5	Curves from Model 36 due to no geometry change	Jan 22, 12:08 PM	20	0.249' @ CHC	0.273' @ YUB-20	Updated Wadsworth Canal Inflow to SA FEA-05 and Upper Sac Initial Conditions. ftp://ftp.na.atkinsglobal.com/Temp/CVFED/For_WR/2006_Combined_Model_20140123/
39	500-year Crashed on 17 Jan 06:52:00 , at Coon Creek Right Branch XS 5.058	Yes	M=2; F=1.5	Jan 22, 10:00 PM WR-Sacmodel-4	---	Curves from Model 27 due to no geometry change	Jan 18, 8:00 am	20			Updated Hydrology from Upper Sac Model. All hydrographs shifted by 7.4 days. Multiplier Factor Removed.
40	500-year Crashed at COD Subreach3 during warmup	Yes	M=2; F=1.5	Jan 22, 10:30 PM WR-Sacmodel-4	---	Curves from Model 27 due to no geometry change	Jan 18, 8:00 am	20			Updated Hydrology from Upper Sac Model. All hydrographs shifted by 7.4 days. Multiplier Factor Removed. Updated to Colusa Basin applied based on Email from Chakri on Jan 22, 9:22 PM.
41	2006 Model Crashed at COD Subreach3 during warmup	Yes	M=2; F=1.5	Jan 22, 10:45 PM WR-Rsubedi	---	Curves from Model 27 due to no geometry change	Jan 20, 12:08 PM	20			Updated Wadsworth Canal Inflow to SA FEA-05 and Upper Sac Initial Conditions. Updated to Colusa Basin applied based on Email from Chakri on Jan 22, 9:22 PM.
42	500-year Completed	Yes	M=2; F=1.5	Jan 23, 12:49 PM WR-Abathulla	19	Curves from Model 27 due to no geometry change	Jan 18, 8:00 am	20	0.256' @ CHC	0.460' @ AMES-24	This is a copy of Model #39 in order to debug at Coon Creek. Option #1 - Change Coon Creek Right Branch to 50 cfs and Left Branch to 10 cfs (from 40 & 30 cfs).
43	500-year Error greater than 0.5' for XS	Yes	M=2; F=1.5	Jan 23, 2:02 PM WR-Sacmodel-5	---	Curves from Model 27 due to no geometry change	Jan 18, 8:00 am	20	0.5' at AME		This is a copy of Model #39 in order to debug at Coon Creek. Option #2 - Change Coon Creek Right Branch to 50 cfs (from 40 cfs). Change Max. no. of time slices to 40 from 100 and LS flow stability factor to 2 (default 1)
44	500-year Completed	Yes	M=2; F=1.5	Jan 23, 2:21 PM WR-Sacmodel-3	13	Curves from Model 27 due to no geometry change	Jan 18, 8:00 am	20	0.256' @ CHC	0.458' @ AMES-24	This is a copy of Model #39 in order to debug at Coon Creek. Option #3 - Change Minimum Flow at Storage Area Coon_Upstream to 400 cfs (default 200 cfs). ftp://ftp.na.atkinsglobal.com/Temp/CVFED/For_WR/500yr_Combined_Model_20140124/20140123_500yr_Model_44_2_1-5_20_Shift_Only.zip
45	500-year Model crashed at warmup.	Yes	M=2; F=1.5	Jan 23, 4:30 PM WR-Rsubedi	---	Curves from Model 27 due to no geometry change	Jan 18, 8:00 am	20			This is a copy of Model #39 in order to debug at Coon Creek. Option #4 - Change initial Flow at Coon Creek, Left & Right Branch to acceptable settings.
46	500-year Completed	Yes	M=2; F=1.5	Jan 23, 11:50 PM WR-Abathulla	20	Curves from Model 27 due to no geometry change	Jan 18, 8:00 am	20	0.256' @ CHC	0.467' @ AMES-24	This is a copy of Model #39 in order to debug at Coon Creek. Option #5 - Select Time Step Adjustment Option for Coon_Upstream SA hydrograph with Max Change in flow of 200 cfs.
47	500-year Model crashed at Warmup	Yes	M=2; F=1.5	Jan 23, 4:30 PM Ashok	---	Curves from Model 27 due to no geometry change	Jan 18, 8:00 am	20			This is a copy of Model #42 in order to debug at Coon Creek and updated Colusa Drain.
48	500-year Model crashed at COD Subreach3 at Warmup	Yes	M=2; F=1.5	Jan 23, 5:05 PM WR-Rsubedi	---	Curves from Model 27 due to no geometry change	Jan 18, 8:00 am	20			This is a copy of Model #44 for a parallel update on Colusa Drain.
49	500-year Model crashed at COD Subreach3 at Warmup	Yes	M=2; F=1.5	Jan 23, 10:05 PM WR-Rsubedi	---	Curves from Model 27 due to no geometry change	Jan 18, 8:00 am	20			This is a copy of Model #46 for a parallel update on Colusa Drain.

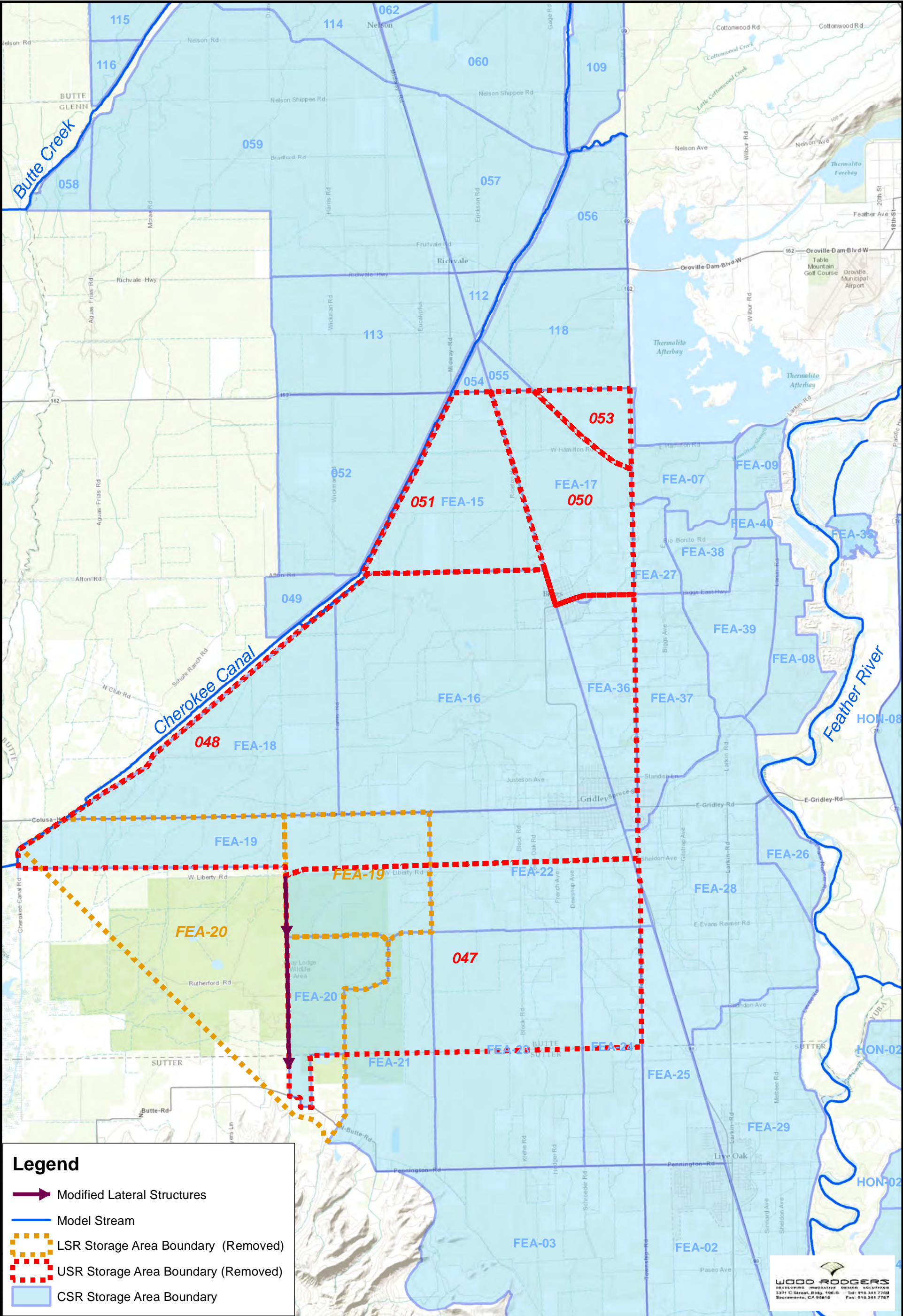
TABLE 6
CENTRAL VALLEY FLOODPLAIN EVALUATION AND DELINEATION PROGRAM
LOWER SACRAMENTO RIVER BASIN
TASK ORDER NO. 25

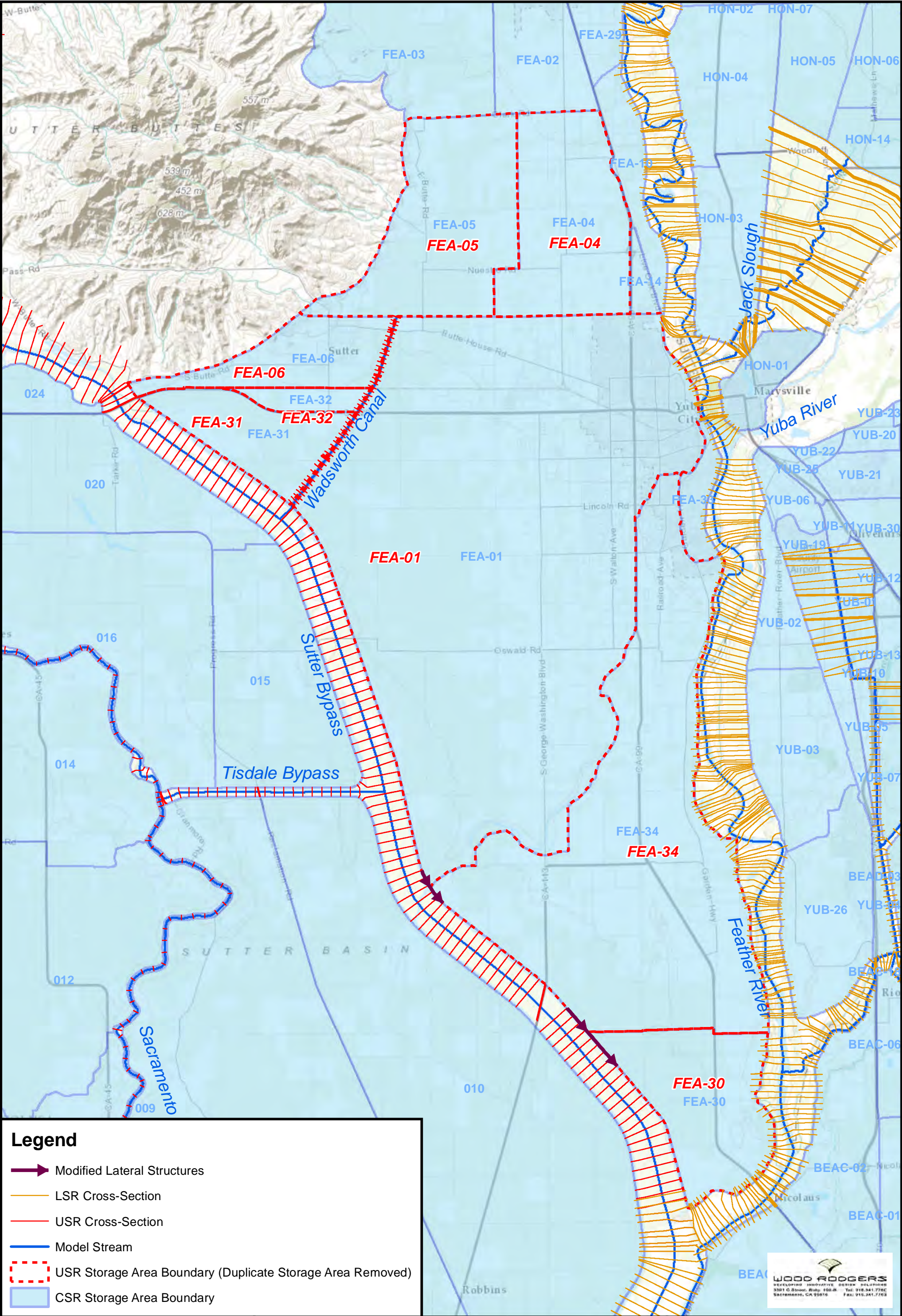
COMBINED SACRAMENTO RIVER MODEL DEVELOPMENT SUMMARY

Simulation Model Run	Model Simulation Results	Mixed Flow	Mixed Flow Options	Model Start Date Machine	Approx. Total Runtime including Curves Computing, if applicable (hrs)	Approx. Time to Recompute Curves (hrs)	Geometry Date	Number of Iterations	Max. Convergence Error at a Cross Section	Max. Convergence Error at a Storage Area	Note: The default values of M=10, F=1 are not listed in the spreadsheet because these parameters did not work in the combined model.
50	500-year Completed	Yes	M=2; F=1.5	Jan 24, 12:47 AM WR-Ashok	21.5	Curves from Model 27 due to no geometry change	Jan 18, 8:00 am	30	0.256' @ CHC	0.461' @ AMES-24	<p>This run is to fix Colusa Drain Issues by changing minimum SA elev for "006" to 18 ft.</p> <p>-----</p> <p>Change Initial Flows at Big Chico Creek Main XS 8.743 to 400 cfs, COD Subreach3 XS 34.228 to 500 cfs & COD_OB Subreach1 XS 32.27 to 500 cfs.</p> <p>Select Time Step Adjustment Option for Coon_Upstream SA hydrograph with Max Change in flow of 200 cfs.</p> <p>ftp://ftp.na.atkinsglobal.com/Temp/CVFED/For_WR/500yr_Combined_Model_20140124/20140124_500yr_Model_50_Shift_plus_Colusa.zip</p>
51	500-year Completed	Yes	M=2; F=1.5	Jan 26, 7:15 PM WR-Rsubedi	13	Curves from Model 27 due to no geometry change	Jan 18, 8:00 am	20	0.256' @ CHC	0.462' @ AMES-24	<p>This is a copy of Model #44 to fix the Colusa Drain issue with following changes.</p> <p>-----</p> <p>Changes for Colusa Drain Fix: Change minimum SA elev for "006" to 18 ft and Initial RS Stage for COD Subreach 2, 3 and KNI Subreach1 to 24 ft. Initial Storage Area Elevation of CAC-10A to 25 ft.</p> <p>-----</p> <p>Additional Changes for Debugging: Change Initial Flows at Coon Creek Right Branch to 100 cfs, East Side Canal Upper Reach to 200 cfs, Big Chico Creek Main XS 8.743 to 400 cfs, COD Subreach3 & 3A to 500 cfs & KNI Subreach1 to 500 cfs.</p> <p>Initial Storage Area Elevation of CAC-10A to 25 ft.</p> <p>-----</p> <p>ftp://ftp.na.atkinsglobal.com/Temp/CVFED/For_WR/Combined_Model_51_20140127/</p>
52	500-year Model crashed at Coon Creek at Warmup	Yes	M=2; F=1.5	Jan 26, 6:30 PM WR-Rsubedi	---	Curves from Model 27 due to no geometry change	Jan 26, 6:00 pm (The geometry from Jan 18, 8:00 am was taken to remove C&E coefficients)	20	---	---	<p>This is a copy of Model #44 for a trial run to remove Contraction and Expansion coefficients at American River that were added from Model #6 onwards to lower the convergence error at American River cross-sections.</p>

FIGURES







Legend

Modified Lateral Structures

LSR Cross-Section

USR Cross-Section

Model Stream

USR Storage Area Boundary (Duplicate Storage Area Removed)

CSR Storage Area Boundary

1" = 10,000'

0 5,000 10,000

Datum: NAD83

Zone: 10N

Sources:

Projection: UTM

Units: US Feet

Central Valley Floodplain Evaluation and Delineation Program

Sacramento River Basin

TASK ORDER NO. 25

COMBINED HEC-RAS SYSTEM MODEL

CONNECTION ZONE 2

FloodSAFE

CALIFORNIA

DEPARTMENT OF WATER RESOURCES

STATE OF CALIFORNIA

Prepared By: Wood Rodgers

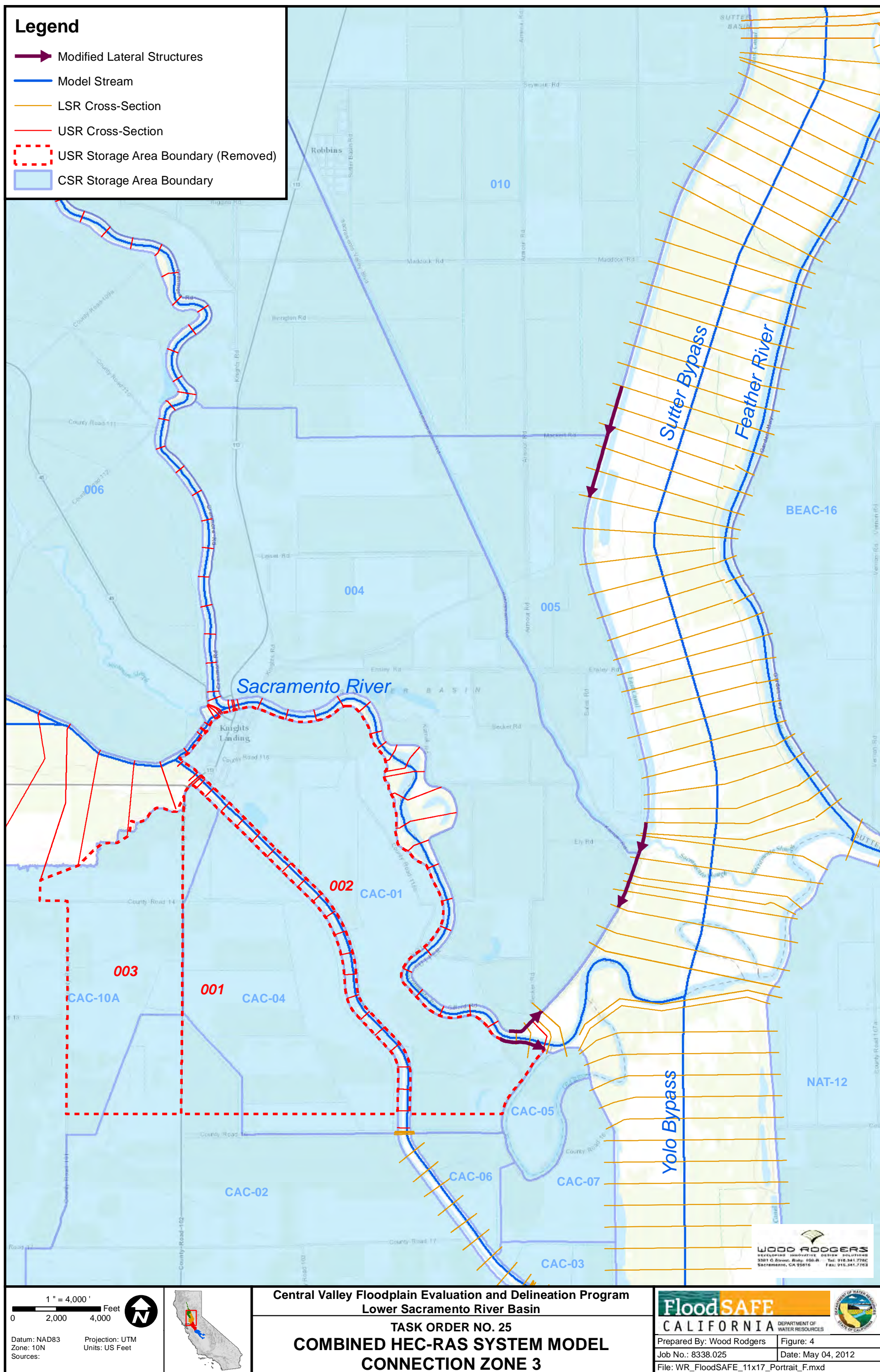
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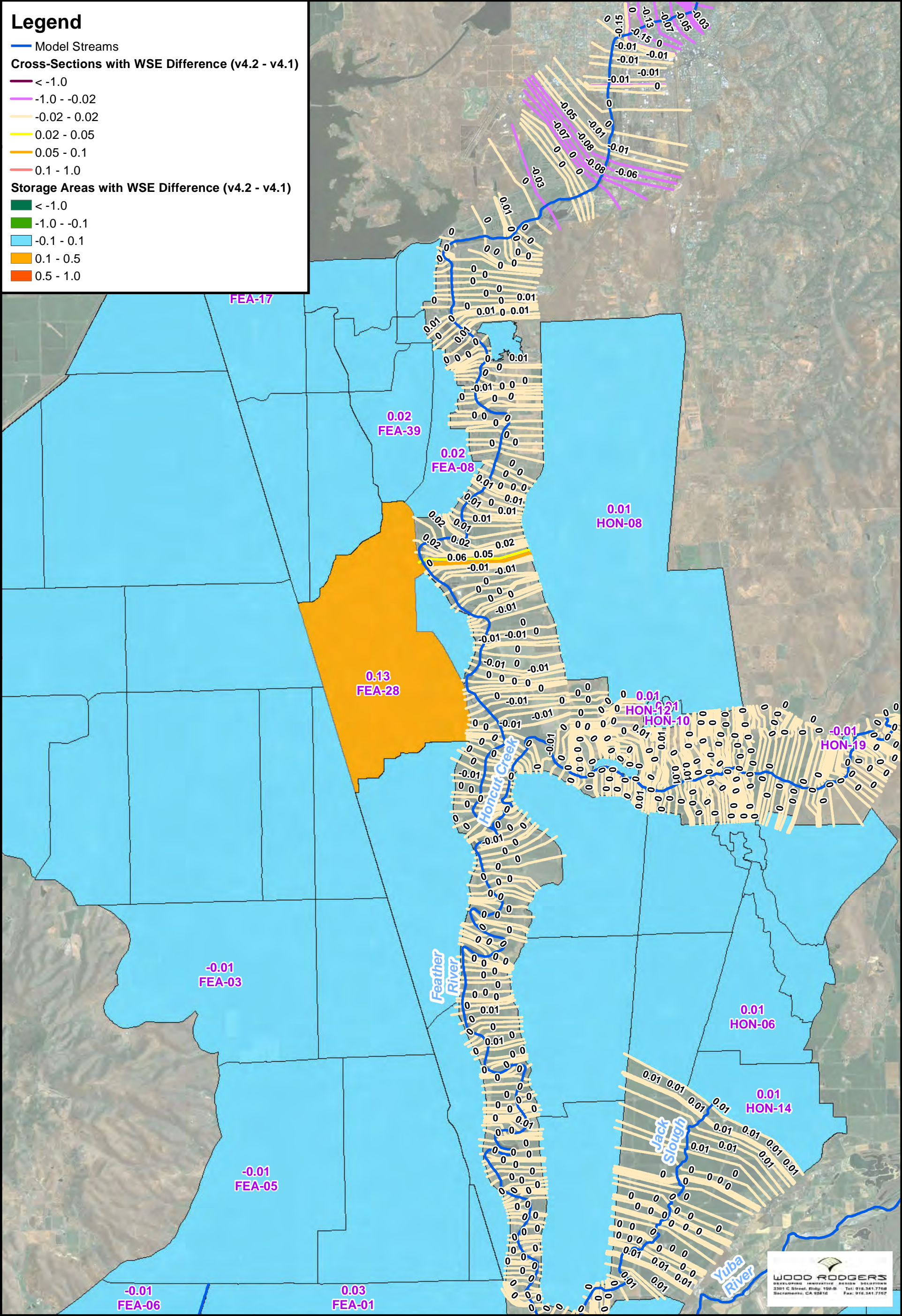
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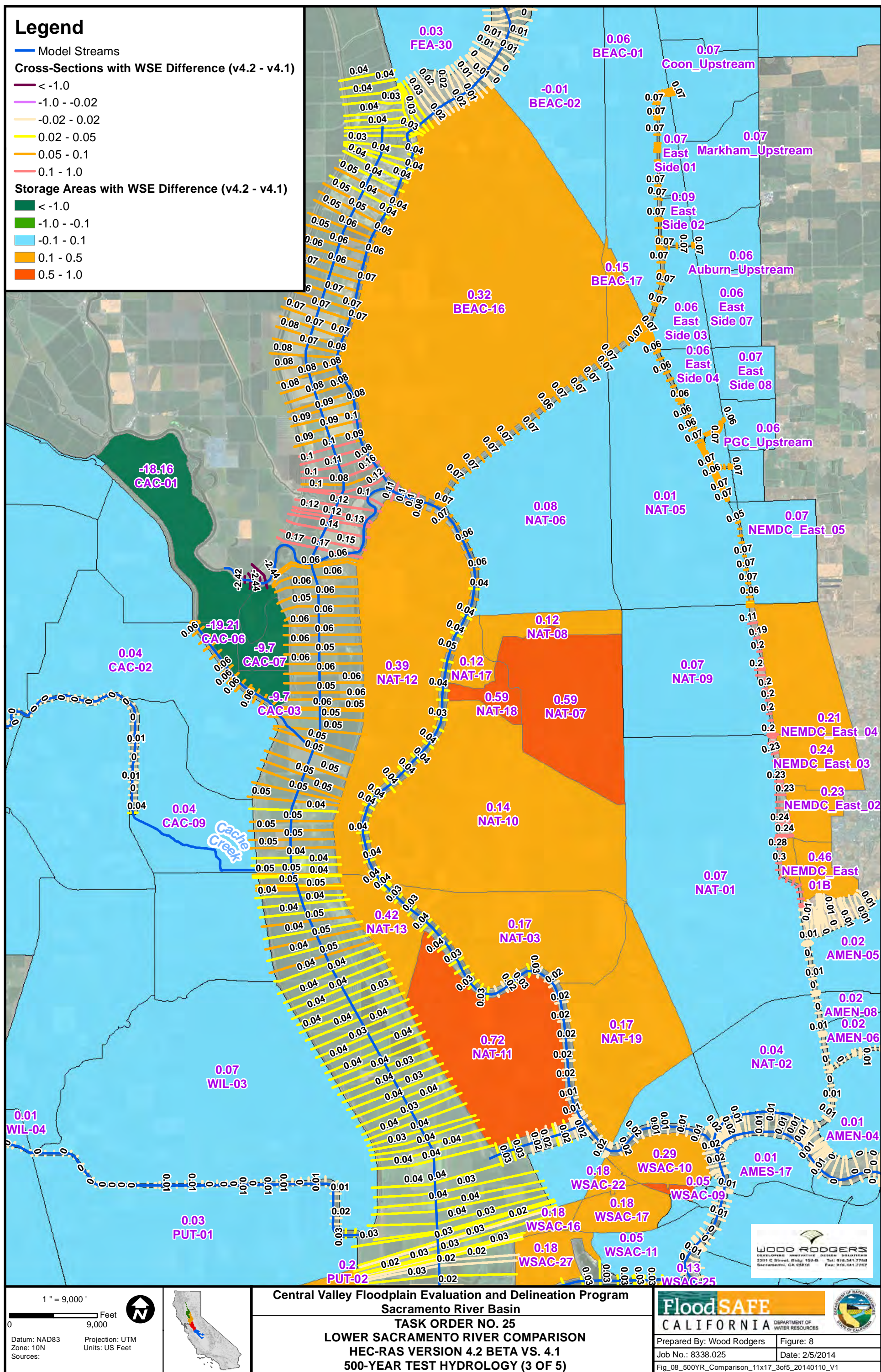
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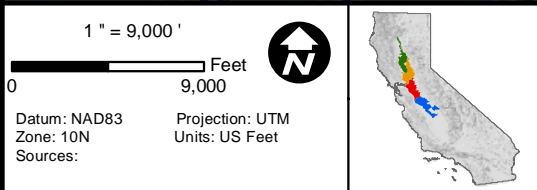
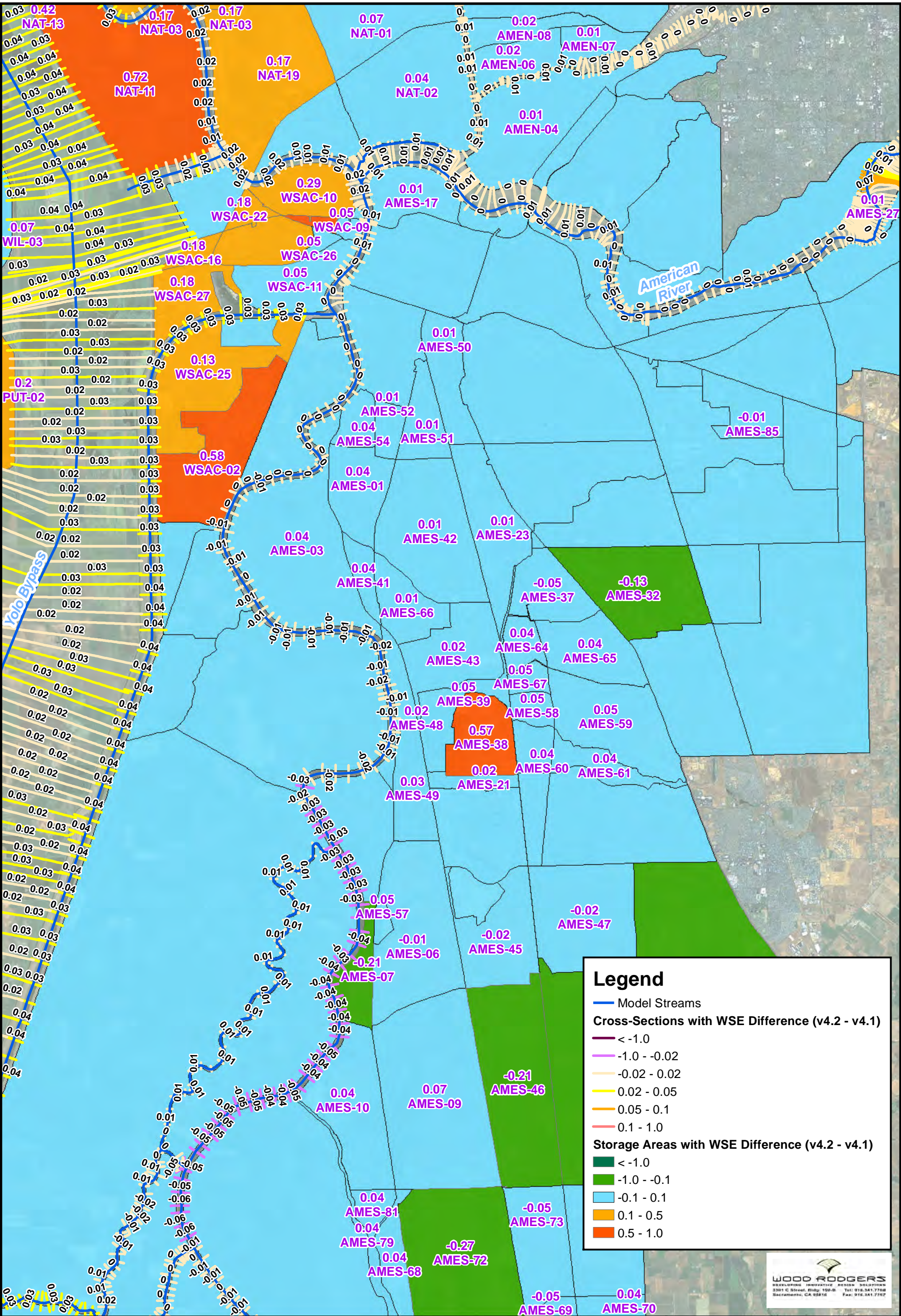
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Central Valley Floodplain Evaluation and Delineation Program
Sacramento River Basin

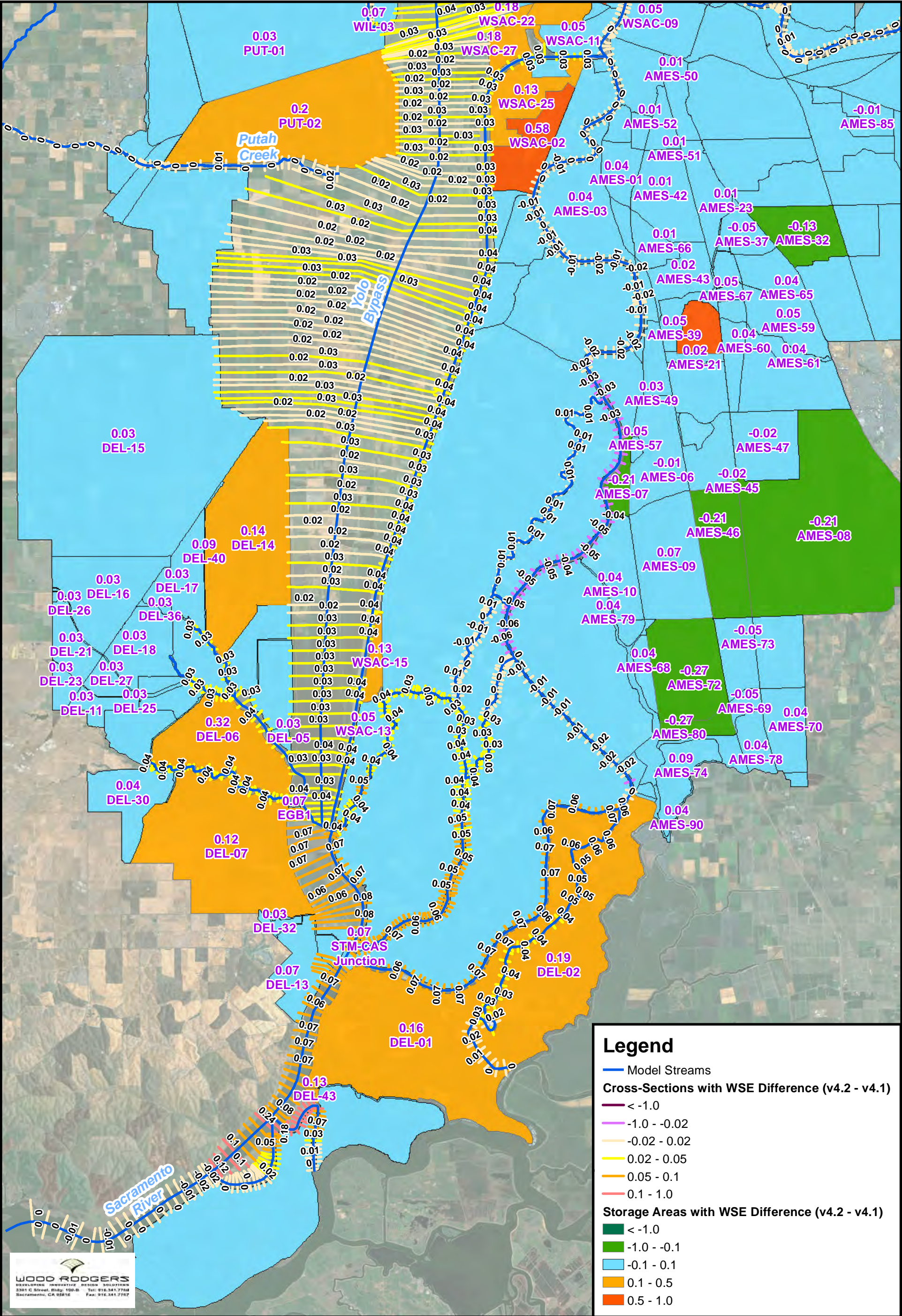
TASK ORDER NO. 25
LOWER SACRAMENTO RIVER COMPARISON
HEC-RAS VERSION 4.2 BETA VS. 4.1
500-YEAR TEST HYDROLOGY (4 OF 5)

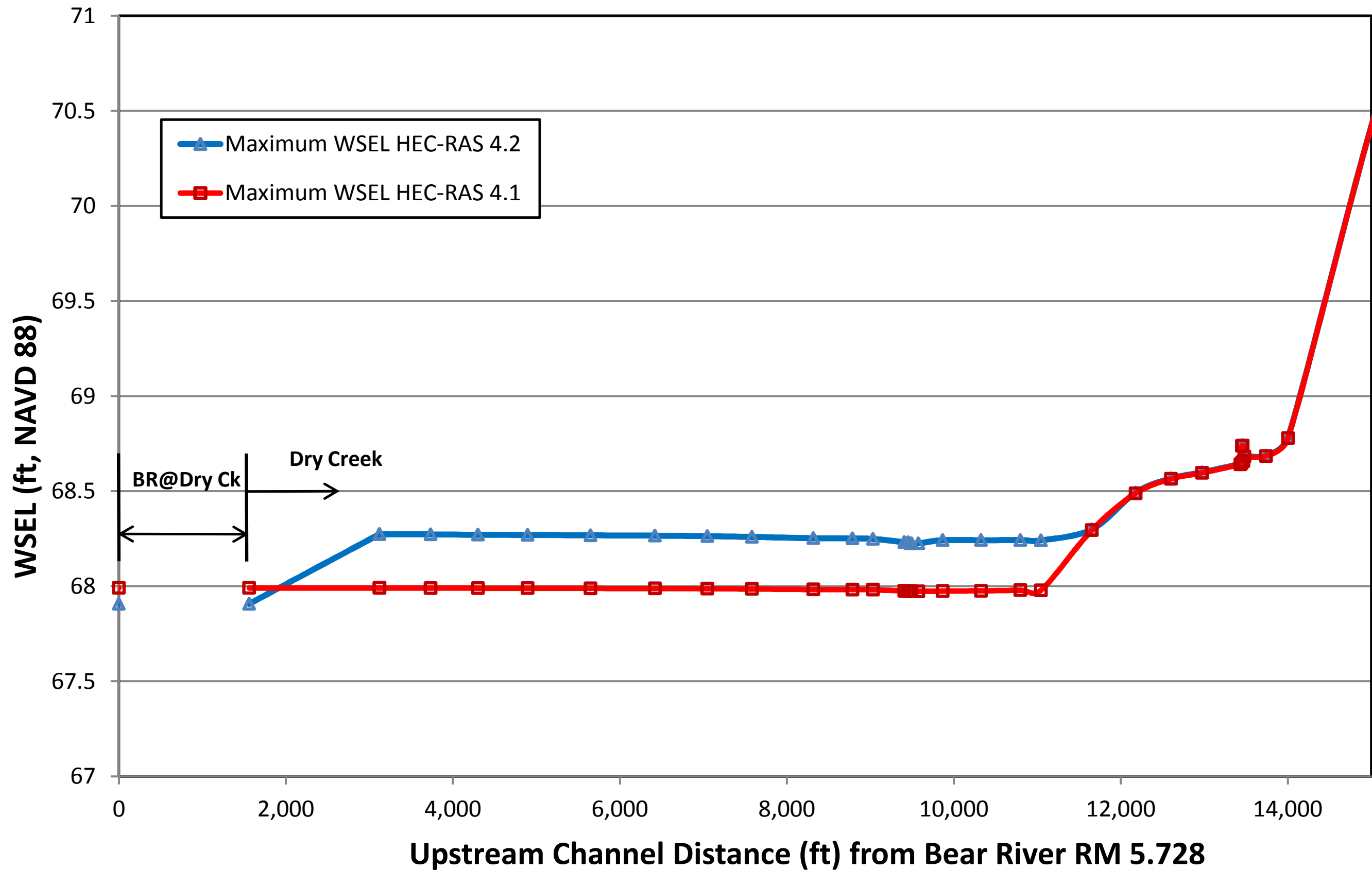
FloodSAFE
CALIFORNIA
DEPARTMENT OF WATER RESOURCES

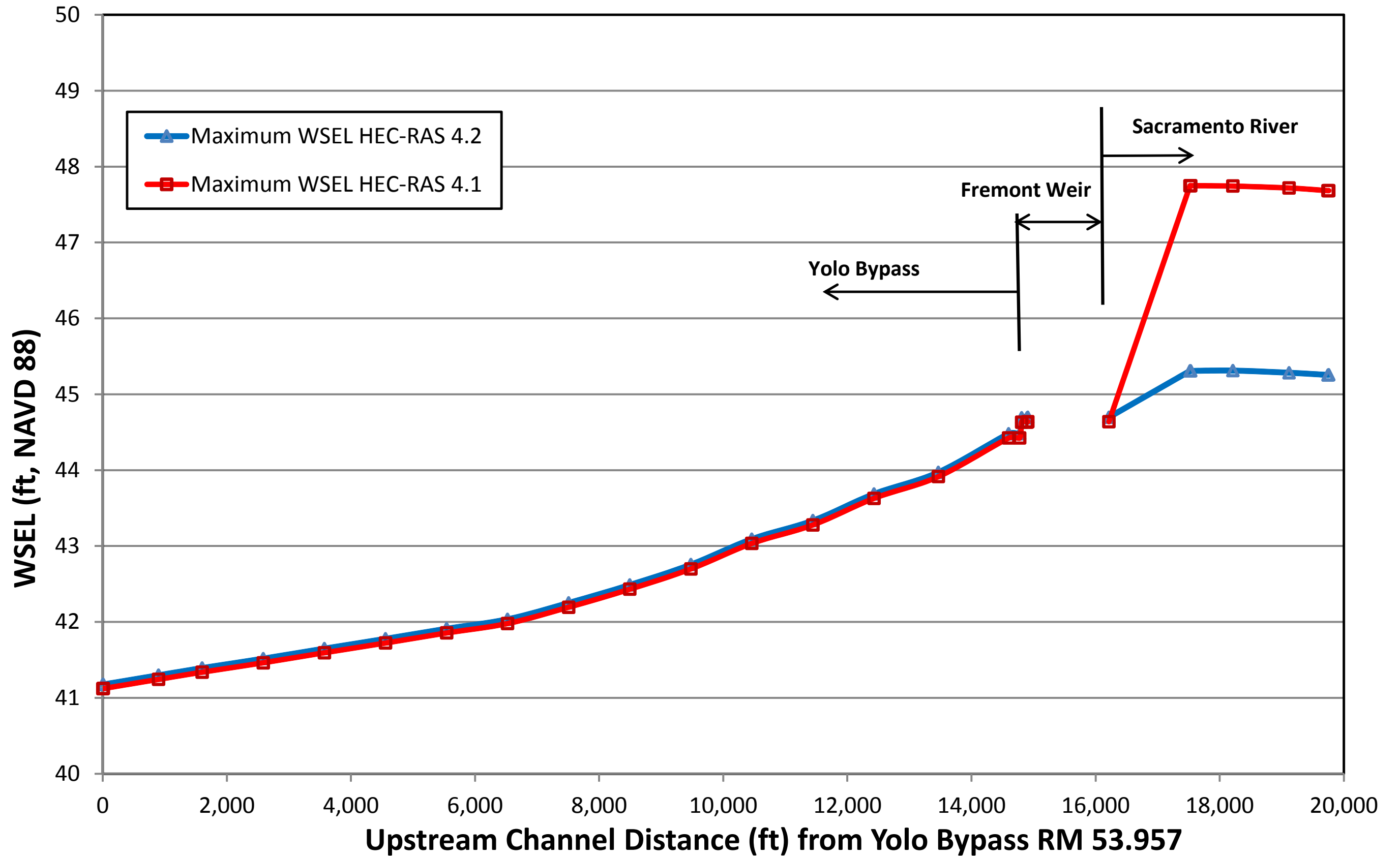
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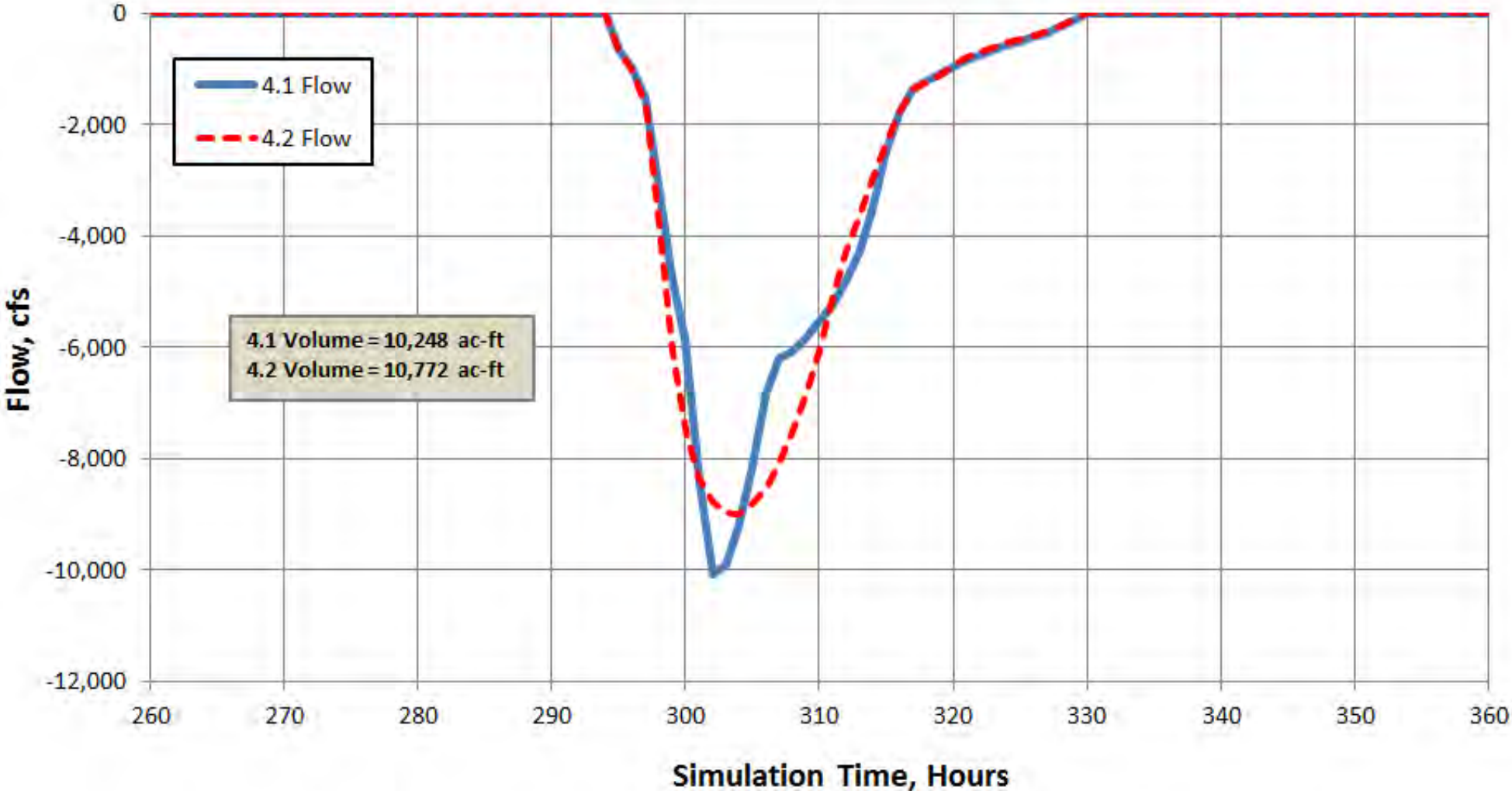
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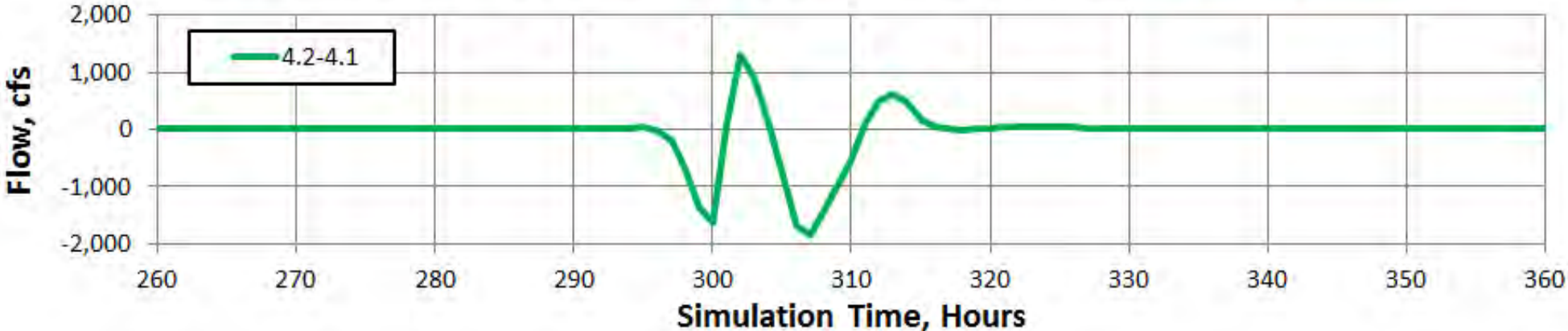


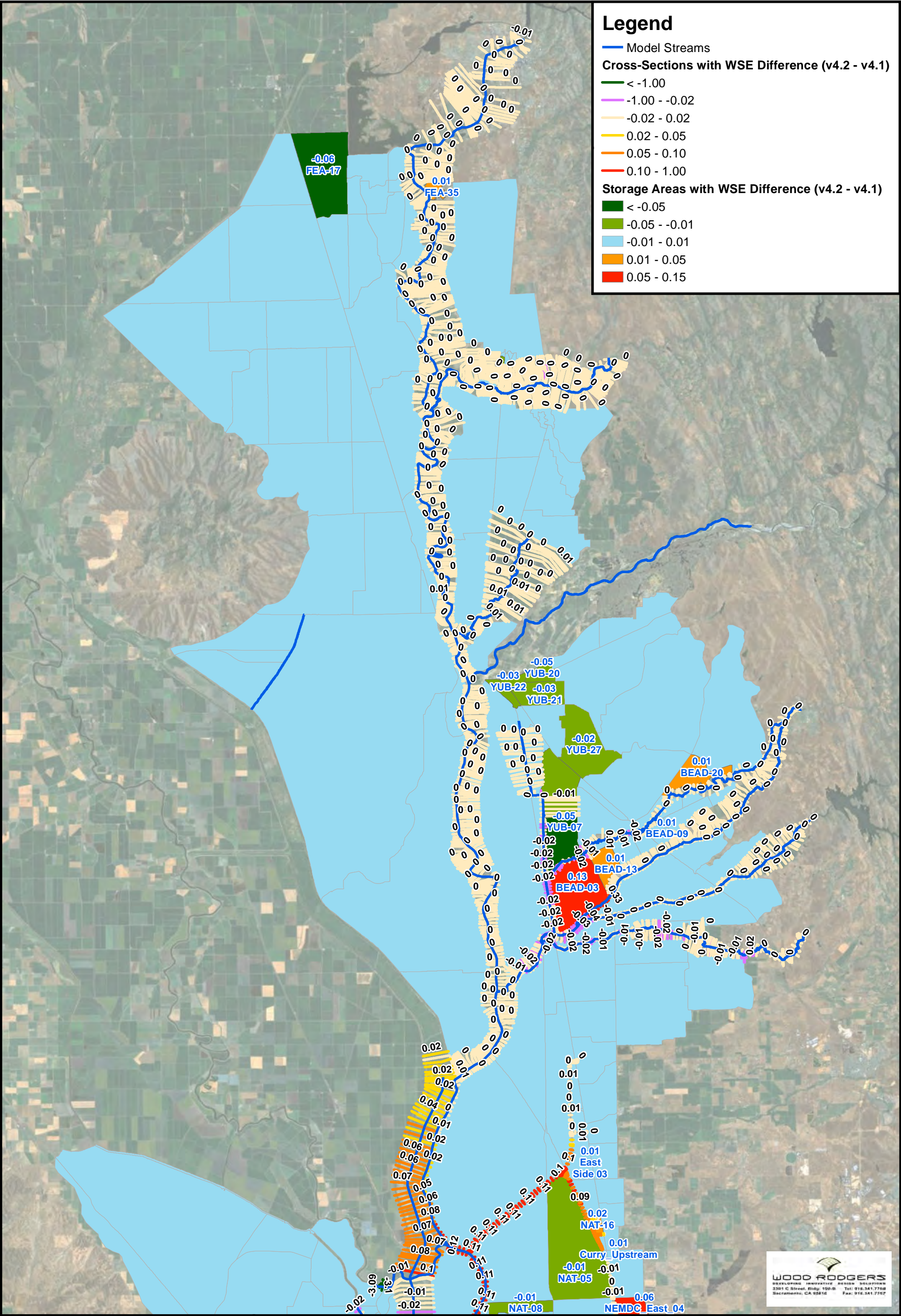


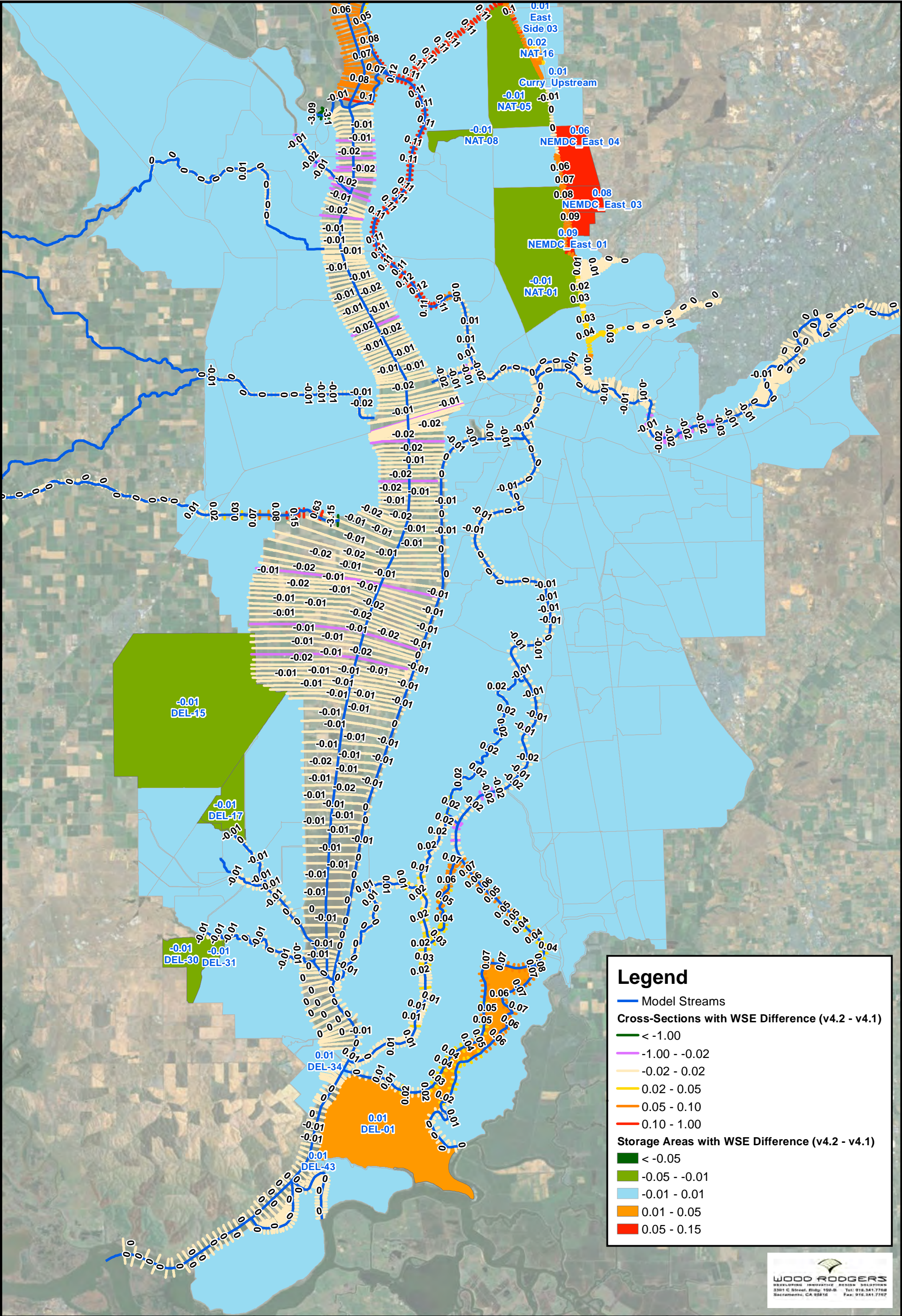
SAC AMES-37 to AMES-32 Flow Hydrograph



SAC AMES-37 to AMES-32 Flow Hydrograph Difference





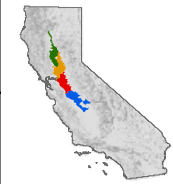


1" = 20,000'

0 20,000 Feet

Datum: NAD83
Zone: 10N
Sources:

Projection: UTM
Units: US Feet



Central Valley Floodplain Evaluation and Delineation Program
Sacramento River Basin

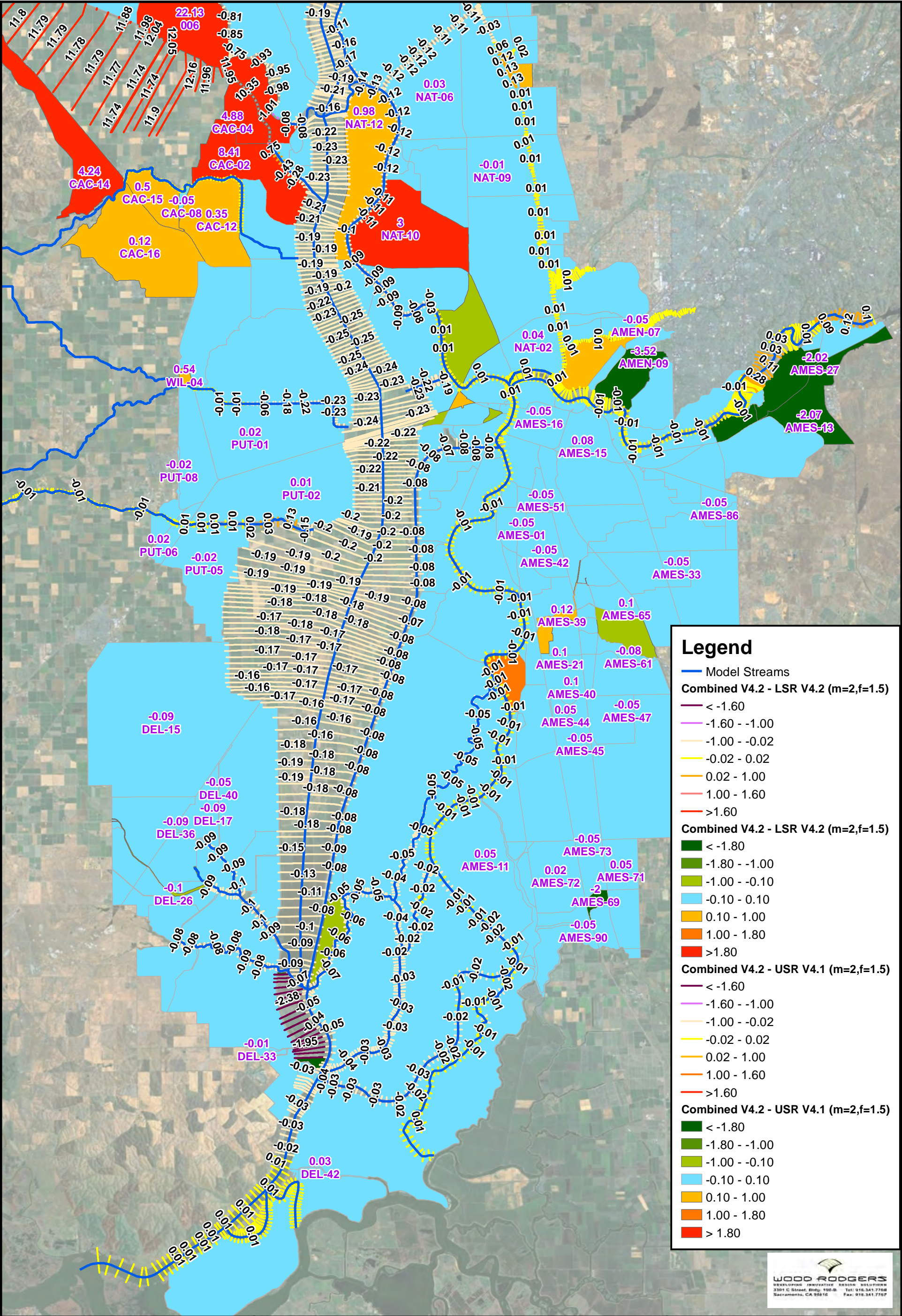
TASK ORDER NO. 25
LOWER SACRAMENTO RIVER COMPARISON
HEC-RAS VERSION 4.2 BETA VS. 4.1
2006 TEST HYDROLOGY (2 OF 2)

FloodSAFE
CALIFORNIA
DEPARTMENT OF WATER RESOURCES

Prepared By: Wood Rodgers
Job No.: 8338.025
Document Name: Fig_15_2006_Comparison_11x17_20140110_V1

Figure: 15
Date: 2/5/2014





1" = 20,000'

0

20,000

Feet

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Datum: NAD83

Zone: 10N

Sources:

Projection: UTM

Units: US Feet

Central Valley Floodplain Evaluation and Delineation Program

Sacramento River Basin

TASK ORDER NO. 25

COMBINED MODEL COMPARISON

2006 HYDROLOGY (2 OF 2)

FloodSAFE

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DEPARTMENT OF WATER RESOURCES

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Figure: 17

Job No.: 8338.025

Date: 1/30/2014

Fig_17_2006_Combined_Comparison_11x17_20140110_V1

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APPENDICES

APPENDIX A

Upper Sacramento River Model Iterations for Combined Model

CVFED Task Order 25, Upper Sacramento River HEC-RAS Model Results Comparison

Prepared for
State of California,
Department of Water Resources

February 2014

CH2MHILL®

2485 Natomas Park Drive, Suite 600
Sacramento, CA 95833

Introduction

CH2M HILL is the Architect/Engineer Contractor for California Department of Water Resources (DWR) Task Order (TO) 25 Hydraulic Engineering Center's River Analysis System (HEC-RAS) Model development activities of the Upper Sacramento River System (USR). The purpose of this Technical Memorandum is to present the comparison of DWR-approved TO 25 USR Model results with other versions of the USR models using different mixed flow parameters, and using different versions of HEC-RAS modeling software. These model comparisons are performed as part of coordination efforts with Wood Rodgers.

Wood Rodgers is tasked under TO 25 to develop a Combined USR Model by incorporating the USR Model developed by CH2M HILL. This Combined Model has been developed using HEC-RAS version 4.2 and different mixed flow parameters than that of the USR Model. Therefore, this comparative analysis is performed to understand the impacts of change in mixed flow parameters and use of different versions of HEC-RAS modeling software on the USR model results.

Models Compared

The TO 25 USR Model (Deliverable Model) was developed using HEC-RAS version 4.1. In addition, the model was run and calibrated in the mixed flow regime utilizing the default mixed flow parameters of $m = 10$ and $f = 1$. The maximum of number of iterations for unsteady flow computation was set to 20. Additional models were run by changing the mixed flow parameters and HEC-RAS versions. Table 1 lists all the models run and compared to the Deliverable model.

TABLE 1
Upper Sacramento River Models compared in the analysis

Event Simulated	Deliverable Models (HEC-RAS version 4.1)	Varied Mixed Flow Parameter Models (HEC-RAS version 4.1)	HEC-RAS version 4.2 Models
1997	M=10, F=1, 20 Iterations	M=2, F=1.5, 20 Iterations	N/A
2006	M=10, F=1, 20 Iterations	M=2, F=1.5, 20 Iterations	M=10, F=1, 40 Iterations
500 Year	M=10, F=1, 20 Iterations	M=2, F=1.5, 20 Iterations	M=10, F=1, 40 Iterations

Comparison Metrics

The metrics used for the comparison are the peak Water Surface Elevations (Peak WSE) and peak flow (Peak Q) for each cross section in the model. Similarly, peak Water Surface Elevation (Peak WSE) is used for comparison for each Storage Area in the model. The default "Max WS" profiles generated by the HEC-RAS software extracts the peak WSE and corresponding peak flow during the entire simulation time period including the initial conditions of the model. This phenomenon sometimes causes high WSE and Q being reported from the initial time step that were set to stabilize the model. To eliminate the effect of the initial conditions, a time window of 8 simulation days (30th Dec to 7th Jan) covering the peak of inflow boundary hydrograph is selected and WSE and Q profiles are extracted for each HEC-RAS river reach. From the extracted profiles, Peak WSE and Peak Q at each cross section are computed using post processing tools. Similarly, Peak WSEs are extracted for each Storage Area.

After computing the Peak WSE and Peak Q at each cross section for all the models listed in Table 1, absolute differences are computed with respect to Deliverable models. E.g. 1. 500 Year Event Deliverable Model (Column 2 in Table 1) minus 500 Year Event Varied Mixed Flow Model (Column 3 in Table 2). E.g. 2. 500 Year Event Deliverable Model (Column 2 in Table 1) minus 500 Year Event HEC-RAS version 4.2 Model (Column 4 in Table 2). Based on the computed absolute differences at each cross section, maximum and minimum of the absolute differences are computed within each sub reach and are reported. Similarly, absolute differences for each storage area are computed and reported.

Results

Tables 2A-2B, 3A-3B and 4A-4B show the summary of differences between the Varied Mixed Flow Parameter Models and Deliverable Models for 1997, 2006 and 500 year events respectively. Similarly, Tables 5A-5B and 6A-6B show the summary of differences between the HEC-RAS version 4.2 Models and Deliverable Models for 2006 and 500 year events respectively.

Tables 2A-2B, 3A-3B and 4A-4B exhibit the differences in model outputs caused by the variation in mixed flow parameters.

Similarly Tables 5A-5B and 6A-6B exhibit the differences in model outputs caused by the use of HEC-RAS version 4.2.

Following are the conclusions based on the observations.

- With the variation of mixed flow parameters, slight Peak WSE differences of less than 1 feet occur at the cross sections between the models.
- The differences in Peak WSEs caused by variation of mixed flow parameters are associated with differences in Peak flows at the cross sections and are concentrated mainly near the junctions.
- With the variation of mixed flow parameters, slight Peak WSE differences of less than 1.5 feet occur in the storage areas between the models.
- With the use of HEC-RAS version 4.2, internal River Station initial stage condition used in the Colusa Drain Channel near Knights Landing Ridge Cut is treated as a fixed WSE for the entire simulation irrespective of the flow conditions. This anomaly is observed in both 2006 event and 500 Year event Models.
- Due to this anomaly, greater Peak WSE and Peak Q differences are observed between the models at the cross sections and in the storage areas near the Colusa-Knights Landing junction.

Table 2A

Summary of Peak WSE and Peak Q differences between USR 1997 Models with different Mixed Flow Parameters

Model 1: HEC-RAS Version 4.1; Mixed Flow Factors M=10 & F=1; Max # of Iterations: 20

Model 2: HEC-RAS Version 4.1; Mixed Flow Factors M=2 & F=1.5; Max # of Iterations: 20

Reach	Sub reach	Peak Q Difference (cfs)		Peak WSE Difference (ft)	
		Minimum	Maximum	Minimum	Maximum
Big Chico Creek	Lower	0.41	103.21	0.00	0.03
Big Chico Creek	Main	-0.39	227.87	-0.44	0.62
BUC	Subreach1	-150.66	18.52	-0.82	0.65
BUC2	Subreach1	-0.47	54.20	-0.53	0.19

Table 2A**Summary of Peak WSE and Peak Q differences between USR 1997 Models with different Mixed Flow Parameters****Model 1: HEC-RAS Version 4.1; Mixed Flow Factors M=10 & F=1; Max # of Iterations: 20****Model 2: HEC-RAS Version 4.1; Mixed Flow Factors M=2 & F=1.5; Max # of Iterations: 20**

Reach	Sub reach	Peak Q Difference (cfs)		Peak WSE Difference (ft)	
		Minimum	Maximum	Minimum	Maximum
Butte_Sink	Subreach1	-111.58	166.25	-0.01	0.01
Butte_Sink	Subreach2	-398.44	1838.90	0.00	0.01
Butte_Sink	Subreach3	-12.40	17.86	0.00	0.00
CHC	Subreach1	-74.19	386.12	-0.09	0.07
CHC	Subreach2	-1.59	-1.07	-0.01	0.00
CHC	Subreach3	-1.40	0.02	-0.04	0.04
CHC_CTW	Subreach1	-2.40	0.14	0.00	0.00
CHC_LC	Subreach1	0.00	0.27	0.00	0.00
COD	Subreach2	-0.08	0.03	0.00	0.00
COD	Subreach3	-5.11	4.23	-0.02	0.00
COD	Subreach3A	0.13	0.17	0.00	0.00
COD_OB	Subreach1	-4.26	3.60	0.00	0.00
DRY	Reach1	0.00	0.41	-0.01	0.00
KNI	Subreach1	0.12	0.16	0.00	0.00
Lindo Channel	Upper	-5.75	4.55	-0.10	0.35
MCT	Reach 1	0.70	0.71	0.00	0.03
Moulton_Channel	Subreach1	-159.70	0.00	-0.07	0.14
MUC	Subreach1	-6.19	0.00	-0.05	0.38
MUC	Subreach2	-5.86	-0.61	-0.05	0.01
MUC	Subreach3	-11.99	-1.30	-0.01	0.02
SAC	Subreach1	-458.60	763.30	-0.09	0.05
SAC	Subreach2	9.91	10.50	0.00	0.00
SCS	SCS_Subreach1	-0.22	0.30	-0.01	0.02
SUB	Subreach1	-17.89	0.39	0.00	0.00
SUB	Subreach2	-33.31	14.89	0.00	0.01
SUB	WAD_to_TIS	-6.61	-4.70	0.00	0.00
SYC	Reach1	-8.86	0.00	-0.20	0.18
SYC	Reach1B	-6.75	-6.72	-0.01	0.00
SYC	Reach2	-8.75	-7.25	-0.01	0.00
TIS	Subreach1	-8.48	-3.86	0.00	0.00
Wadsworth Canal	Reach 1	-3.29	0.17	0.00	0.00

Table 2B

Summary of Storage Area Peak WSE differences between USR 1997 Models with different Mixed Flow Parameters

Model 1: HEC-RAS Version 4.1; Mixed Flow Factors M=10 & F=1; Max # of Iterations: 20

Model 2: HEC-RAS Version 4.1; Mixed Flow Factors M=2 & F=1.5; Max # of Iterations: 20

Storage Area Name	Peak WSE Difference (ft)
001	0.00
002	0.00
003	0.00
004	0.00
005	0.00
006	0.00
008	0.00
009	0.00
010	0.00
012	0.00
014	0.00
015	-0.01
016	0.00
018	0.00
019	0.00
020	0.00
021	0.00
022	0.00
023	0.00
024	0.00
025	0.00
026	0.00
027	0.00
028	0.00
029	0.00
030	0.00
031	0.00
032	0.00
033	0.03
034	0.03
035	0.03
036	0.05
037	0.00
038	0.05
039	0.00

Table 2B

Summary of Storage Area Peak WSE differences between USR 1997 Models with different Mixed Flow Parameters

Model 1: HEC-RAS Version 4.1; Mixed Flow Factors M=10 & F=1; Max # of Iterations: 20

Model 2: HEC-RAS Version 4.1; Mixed Flow Factors M=2 & F=1.5; Max # of Iterations: 20

Storage Area Name	Peak WSE Difference (ft)
040	0.00
041	0.02
042	0.00
043	0.04
044	0.00
045	0.00
046	0.00
047	0.00
048	-0.12
049	0.00
050	0.00
051	0.00
052	0.00
053	0.00
054	0.00
055	0.00
056	0.00
057	0.00
058	-0.01
059	0.00
060	0.01
061	0.01
062	0.00
063	0.00
064	0.01
065	0.00
066	0.00
067	0.00
068	0.00
069	0.00
070	0.00
071	0.00
072	0.00
073	0.00
074	0.00

Table 2B**Summary of Storage Area Peak WSE differences between USR 1997 Models with different Mixed Flow Parameters****Model 1: HEC-RAS Version 4.1; Mixed Flow Factors M=10 & F=1; Max # of Iterations: 20****Model 2: HEC-RAS Version 4.1; Mixed Flow Factors M=2 & F=1.5; Max # of Iterations: 20**

Storage Area Name	Peak WSE Difference (ft)
075	0.00
076	0.00
077	0.01
078	0.00
079	0.00
080	0.00
083	0.00
084	0.04
086	0.00
087	0.00
092	0.00
102	0.00
103	0.00
106	0.00
107	0.07
108	0.00
109	-0.04
110	0.00
111	0.00
112	0.00
113	0.00
114	0.02
115	0.01
116	0.01
117	0.01
118	0.00
1536	0.01
082A_Upper	0.00
082B	0.03
082C	0.05
085A	0.04
085B	-0.02
085C	0.00
085D	0.00
088A	0.00

Table 2B**Summary of Storage Area Peak WSE differences between USR 1997 Models with different Mixed Flow Parameters****Model 1: HEC-RAS Version 4.1; Mixed Flow Factors M=10 & F=1; Max # of Iterations: 20****Model 2: HEC-RAS Version 4.1; Mixed Flow Factors M=2 & F=1.5; Max # of Iterations: 20**

Storage Area Name	Peak WSE Difference (ft)
088B	0.01
088C	0.00
088D	0.01
088E	0.00
088F	0.00
089A	0.01
089B	0.00
089C	0.00
089D	0.00
090A	0.00
090B	0.00
090C	0.00
091A	0.00
091B	0.00
091C	0.07
091D	0.30
091E	0.01
091F	-0.42
091G	0.03
091H	0.05
091I	0.00
091J	0.00
093A	0.00
093B	0.00
094A	0.00
094B	0.00
095A	0.00
095B	0.00
096A	0.00
096B	0.00
096C	0.00
097A	0.00
098A	0.00
098B	-0.06
099A	0.02

Table 2B**Summary of Storage Area Peak WSE differences between USR 1997 Models with different Mixed Flow Parameters****Model 1: HEC-RAS Version 4.1; Mixed Flow Factors M=10 & F=1; Max # of Iterations: 20****Model 2: HEC-RAS Version 4.1; Mixed Flow Factors M=2 & F=1.5; Max # of Iterations: 20**

Storage Area Name	Peak WSE Difference (ft)
099B	0.00
100A	0.00
100B	0.00
100C	0.00
101A	0.02
101B	0.20
104A	0.00
104B	0.00
105A	0.00
105B	-0.01
204B	0.00
205B	0.00
82A_Lower	0.00
97B	0.00
FEA-01	0.00
FEA-04	0.00
FEA-05	0.00
FEA-06	0.00
FEA-30	0.00
FEA-31	0.00
FEA-32	0.00
FEA-34	0.00

Table 3A**Summary of Peak WSE and Peak Q differences between USR 2006 Models with different Mixed Flow Parameters****Model 1: HEC-RAS Version 4.1; Mixed Flow Factors M=10 & F=1; Max # of Iterations: 20****Model 2: HEC-RAS Version 4.1; Mixed Flow Factors M=2 & F=1.5; Max # of Iterations: 20**

Reach	Sub reach	Peak Q Difference (cfs)		Peak WSE Difference (ft)	
		Minimum	Maximum	Minimum	Maximum
Big Chico Creek	Lower	-12.26	1.18	-0.01	0.00
Big Chico Creek	Main	-37.72	4.42	-0.40	0.17
BUC	Subreach1	-20.29	36.83	-0.91	0.28

Table 3A**Summary of Peak WSE and Peak Q differences between USR 2006 Models with different Mixed Flow Parameters****Model 1: HEC-RAS Version 4.1; Mixed Flow Factors M=10 & F=1; Max # of Iterations: 20****Model 2: HEC-RAS Version 4.1; Mixed Flow Factors M=2 & F=1.5; Max # of Iterations: 20**

Reach	Sub reach	Peak Q Difference (cfs)		Peak WSE Difference (ft)	
		Minimum	Maximum	Minimum	Maximum
BUC2	Subreach1	-0.92	2.70	-0.39	0.13
Butte_Sink	Subreach1	-14.13	106.96	0.00	0.01
Butte_Sink	Subreach2	-256.90	466.49	0.00	0.00
Butte_Sink	Subreach3	0.66	11.64	0.00	0.00
CHC	Subreach1	-67.74	260.39	-0.08	0.04
CHC	Subreach2	-0.98	3.58	-0.01	0.01
CHC	Subreach3	-2.81	2.60	-0.04	0.04
CHC_CTW	Subreach1	-2.28	3.78	0.00	0.00
CHC_LC	Subreach1	-0.18	0.13	0.02	0.03
COD	Subreach2	0.00	0.04	0.00	0.00
COD	Subreach3	-4.98	3.69	-0.01	0.00
COD	Subreach3A	0.55	0.55	0.00	0.00
COD_OB	Subreach1	-2.88	4.06	0.00	0.00
DRY	Reach1	-0.01	0.00	0.00	0.00
KNI	Subreach1	0.54	0.55	0.00	0.00
Lindo Channel	Upper	-3.06	4.22	-0.09	0.33
MCT	Reach 1	-0.35	-0.34	0.00	0.00
Moulton_Channel	Subreach1	-87.31	6.29	-0.10	0.10
MUC	Subreach1	-7.32	2.43	-0.05	0.32
MUC	Subreach2	-3.63	0.95	-0.05	0.01
MUC	Subreach3	-3.64	1.72	0.00	0.02
SAC	Subreach1	-383.90	527.30	-0.09	0.04
SAC	Subreach2	4.80	6.89	0.00	0.00
SCS	SCS_Subreach1	-0.18	-0.09	-0.01	0.01
SUB	Subreach1	-7.90	-4.00	0.00	0.00
SUB	Subreach2	-13.94	9.34	0.00	0.01
SUB	WAD_to_TIS	-4.50	-3.90	0.00	0.00
SYC	Reach1	-1.53	0.00	-0.28	0.19
SYC	Reach1B	-1.28	-1.25	0.00	0.00
SYC	Reach2	-1.49	-1.04	0.00	0.01
TIS	Subreach1	-5.11	-3.89	0.00	0.00
Wadsworth Canal	Reach 1	-0.52	0.06	0.00	0.00

Table 3B

Summary of Storage Area Peak WSE differences between USR 2006 Models with different Mixed Flow Parameters

Model 1: HEC-RAS Version 4.1; Mixed Flow Factors M=10 & F=1; Max # of Iterations: 20

Model 2: HEC-RAS Version 4.1; Mixed Flow Factors M=2 & F=1.5; Max # of Iterations: 20

Storage Area Name	Peak WSE Difference (ft)
001	0.00
002	0.00
003	0.00
004	0.00
005	0.00
006	0.00
008	0.00
009	0.00
010	0.00
012	0.00
014	0.00
015	0.00
016	0.00
018	0.00
019	0.00
020	0.00
021	0.00
022	0.00
023	0.00
024	0.00
025	0.00
026	0.00
027	0.00
028	0.00
029	0.01
030	0.00
031	0.00
032	0.00
033	0.00
034	0.00
035	0.00
036	0.00
037	0.00
038	0.00
039	0.00

Table 3B**Summary of Storage Area Peak WSE differences between USR 2006 Models with different Mixed Flow Parameters****Model 1: HEC-RAS Version 4.1; Mixed Flow Factors M=10 & F=1; Max # of Iterations: 20****Model 2: HEC-RAS Version 4.1; Mixed Flow Factors M=2 & F=1.5; Max # of Iterations: 20**

Storage Area Name	Peak WSE Difference (ft)
040	0.00
041	0.02
042	0.00
043	0.03
044	0.00
045	0.00
046	0.00
047	0.00
048	0.00
049	0.00
050	0.00
051	0.00
052	0.00
053	0.00
054	0.00
055	0.00
056	0.00
057	0.00
058	-0.01
059	-0.01
060	-0.08
061	0.01
062	0.00
063	0.00
064	0.00
065	0.00
066	0.00
067	0.00
068	0.00
069	0.00
070	0.00
071	0.00
072	0.00
073	0.00
074	0.00

Table 3B**Summary of Storage Area Peak WSE differences between USR 2006 Models with different Mixed Flow Parameters****Model 1: HEC-RAS Version 4.1; Mixed Flow Factors M=10 & F=1; Max # of Iterations: 20****Model 2: HEC-RAS Version 4.1; Mixed Flow Factors M=2 & F=1.5; Max # of Iterations: 20**

Storage Area Name	Peak WSE Difference (ft)
075	0.00
076	0.00
077	0.01
078	0.00
079	0.00
080	0.00
083	-0.02
084	0.00
086	0.00
087	-0.01
092	0.00
102	0.00
103	0.00
106	0.00
107	0.06
108	0.00
109	-0.22
110	0.00
111	0.00
112	0.00
113	0.00
114	0.00
115	0.00
116	0.01
117	0.00
118	0.00
1536	0.01
082A_Upper	0.00
082B	0.00
082C	-0.01
085A	-0.01
085B	0.00
085C	0.00
085D	0.00
088A	0.00

Table 3B**Summary of Storage Area Peak WSE differences between USR 2006 Models with different Mixed Flow Parameters****Model 1: HEC-RAS Version 4.1; Mixed Flow Factors M=10 & F=1; Max # of Iterations: 20****Model 2: HEC-RAS Version 4.1; Mixed Flow Factors M=2 & F=1.5; Max # of Iterations: 20**

Storage Area Name	Peak WSE Difference (ft)
088B	0.00
088C	-0.01
088D	0.00
088E	0.00
088F	0.00
089A	0.00
089B	-0.01
089C	0.00
089D	0.00
090A	0.00
090B	0.00
090C	0.00
091A	0.00
091B	0.00
091C	0.02
091D	0.05
091E	0.03
091F	-0.45
091G	0.01
091H	0.01
091I	0.00
091J	0.00
093A	0.00
093B	0.00
094A	0.00
094B	0.00
095A	0.00
095B	0.00
096A	0.00
096B	0.00
096C	0.00
097A	0.00
098A	0.00
098B	0.00
099A	0.02

Table 3B**Summary of Storage Area Peak WSE differences between USR 2006 Models with different Mixed Flow Parameters****Model 1: HEC-RAS Version 4.1; Mixed Flow Factors M=10 & F=1; Max # of Iterations: 20****Model 2: HEC-RAS Version 4.1; Mixed Flow Factors M=2 & F=1.5; Max # of Iterations: 20**

Storage Area Name	Peak WSE Difference (ft)
099B	0.00
100A	0.00
100B	0.00
100C	0.00
101A	0.02
101B	0.00
104A	0.00
104B	0.00
105A	0.00
105B	-0.13
204B	0.00
205B	0.00
82A_Lower	0.00
97B	0.00
FEA-01	0.00
FEA-04	0.00
FEA-05	0.00
FEA-06	0.00
FEA-30	0.00
FEA-31	0.00
FEA-32	0.00
FEA-34	0.00

Table 4A**Summary of Peak WSE and Peak Q differences between USR 500Yr Models with different Mixed Flow Parameters****Model 1: HEC-RAS Version 4.1; Mixed Flow Factors M=10 & F=1; Max # of Iterations: 20****Model 2: HEC-RAS Version 4.1; Mixed Flow Factors M=2 & F=1.5; Max # of Iterations: 20**

Reach	Sub reach	Peak Q Difference (cfs)		Peak WSE Difference (ft)	
		Minimum	Maximum	Minimum	Maximum
Big Chico Creek	Lower	-0.51	95.41	0.00	0.02
Big Chico Creek	Main	-8.97	146.72	-0.43	0.51
BUC	Subreach1	-304.03	64.69	-0.79	0.48

Table 4A

Summary of Peak WSE and Peak Q differences between USR 500Yr Models with different Mixed Flow Parameters

Model 1: HEC-RAS Version 4.1; Mixed Flow Factors M=10 & F=1; Max # of Iterations: 20

Model 2: HEC-RAS Version 4.1; Mixed Flow Factors M=2 & F=1.5; Max # of Iterations: 20

Reach	Sub reach	Peak Q Difference (cfs)		Peak WSE Difference (ft)	
		Minimum	Maximum	Minimum	Maximum
BUC2	Subreach1	-148.42	34.78	-0.45	0.21
Butte_Sink	Subreach1	-89.59	427.80	0.00	0.01
Butte_Sink	Subreach2	-155.41	5770.31	0.00	0.01
Butte_Sink	Subreach3	-568.41	-20.09	0.00	0.00
CHC	Subreach1	-1166.80	258.19	-0.05	0.13
CHC	Subreach2	3.10	3.80	-0.01	0.01
CHC	Subreach3	-84.31	112.14	-0.11	0.13
CHC_CTW	Subreach1	-13.51	1.63	-0.02	0.00
CHC_LC	Subreach1	0.00	1.39	0.00	0.00
COD	Subreach2	-2.42	3.23	-0.02	0.00
COD	Subreach3	-54.60	139.76	-0.04	0.01
COD	Subreach3A	-54.60	-53.82	-0.02	-0.02
COD_OB	Subreach1	-46.80	15.35	-0.02	0.00
DRY	Reach1	0.00	10.31	-0.03	0.04
KNI	Subreach1	-56.81	-19.17	-0.02	-0.02
Lindo Channel	Upper	-5.46	4.55	-0.10	0.35
MCT	Reach 1	0.84	1.15	0.00	0.00
Moulton_Channel	Subreach1	-59.85	265.35	-0.05	0.11
MUC	Subreach1	-10.62	44.56	-0.06	0.25
MUC	Subreach2	-1.56	4.59	-0.07	0.01
MUC	Subreach3	0.77	26.59	-0.01	0.00
SAC	Subreach1	-1005.30	3368.31	-0.26	0.07
SAC	Subreach2	0.63	12.01	0.00	0.00
SCS	SCS_Subreach1	-7.90	-2.49	-0.02	0.02
SUB	Subreach1	-25.00	-16.69	0.00	0.00
SUB	Subreach2	-93.41	10.63	-0.01	0.00
SUB	WAD_to_TIS	-5.00	10.50	0.00	0.00
SYC	Reach1	-7.06	0.00	-0.20	0.18
SYC	Reach1B	-6.32	-6.16	-0.01	0.00
SYC	Reach2	-6.54	-5.02	0.00	0.01
TIS	Subreach1	-27.35	0.00	0.00	0.00
Wadsworth Canal	Reach 1	-6.49	0.26	0.00	0.00

Table 4B**Summary of Storage Area Peak WSE differences between USR 500Yr Models with different Mixed Flow Parameters****Model 1: HEC-RAS Version 4.1; Mixed Flow Factors M=10 & F=1; Max # of Iterations: 20****Model 2: HEC-RAS Version 4.1; Mixed Flow Factors M=2 & F=1.5; Max # of Iterations: 20**

Storage Area Name	Peak WSE Difference (ft)
001	-0.12
002	0.02
003	-0.01
004	0.01
005	0.00
006	0.01
008	0.01
009	0.00
010	0.00
012	0.00
014	0.01
015	-0.01
016	-0.01
018	0.00
019	0.00
020	-0.01
021	-0.01
022	0.00
023	0.00
024	-0.01
025	0.00
026	0.00
027	0.00
028	0.00
029	0.00
030	0.01
031	0.02
032	0.01
033	0.00
034	0.00
035	0.01
036	0.02
037	0.02
038	0.02
039	0.01

Table 4B**Summary of Storage Area Peak WSE differences between USR 500Yr Models with different Mixed Flow Parameters****Model 1: HEC-RAS Version 4.1; Mixed Flow Factors M=10 & F=1; Max # of Iterations: 20****Model 2: HEC-RAS Version 4.1; Mixed Flow Factors M=2 & F=1.5; Max # of Iterations: 20**

Storage Area Name	Peak WSE Difference (ft)
040	0.00
041	0.00
042	0.00
043	0.03
044	0.00
045	0.00
046	0.00
047	0.00
048	0.01
049	0.00
050	0.00
051	0.00
052	0.00
053	0.03
054	0.00
055	0.01
056	0.01
057	0.04
058	0.00
059	0.00
060	0.01
061	-0.01
062	0.02
063	-0.02
064	-0.02
065	0.00
066	0.07
067	0.00
068	0.26
069	0.50
070	0.35
071	0.52
072	0.00
073	0.21
074	1.12

Table 4B**Summary of Storage Area Peak WSE differences between USR 500Yr Models with different Mixed Flow Parameters****Model 1: HEC-RAS Version 4.1; Mixed Flow Factors M=10 & F=1; Max # of Iterations: 20****Model 2: HEC-RAS Version 4.1; Mixed Flow Factors M=2 & F=1.5; Max # of Iterations: 20**

Storage Area Name	Peak WSE Difference (ft)
075	0.01
076	0.00
077	0.01
078	0.16
079	-0.03
080	0.00
083	-0.05
084	0.00
086	0.00
087	-0.05
092	-0.01
102	0.00
103	0.00
106	0.00
107	-0.03
108	0.00
109	0.00
110	0.00
111	0.00
112	0.04
113	0.00
114	0.00
115	-0.01
116	0.00
117	0.00
118	0.03
1536	-0.04
082A_Upper	0.00
082B	0.02
082C	0.00
085A	0.03
085B	-0.02
085C	0.00
085D	0.00
088A	0.00

Table 4B**Summary of Storage Area Peak WSE differences between USR 500Yr Models with different Mixed Flow Parameters****Model 1: HEC-RAS Version 4.1; Mixed Flow Factors M=10 & F=1; Max # of Iterations: 20****Model 2: HEC-RAS Version 4.1; Mixed Flow Factors M=2 & F=1.5; Max # of Iterations: 20**

Storage Area Name	Peak WSE Difference (ft)
088B	0.00
088C	-0.01
088D	0.00
088E	0.00
088F	0.00
089A	0.00
089B	0.00
089C	0.00
089D	0.00
090A	-0.01
090B	-0.01
090C	0.00
091A	0.00
091B	0.00
091C	0.08
091D	0.30
091E	0.01
091F	-0.43
091G	0.03
091H	0.04
091I	0.00
091J	0.00
093A	-0.01
093B	-0.02
094A	-0.01
094B	-0.02
095A	0.00
095B	0.00
096A	-0.04
096B	-0.03
096C	0.00
097A	0.00
098A	0.00
098B	-0.01
099A	0.02

Table 4B**Summary of Storage Area Peak WSE differences between USR 500Yr Models with different Mixed Flow Parameters****Model 1: HEC-RAS Version 4.1; Mixed Flow Factors M=10 & F=1; Max # of Iterations: 20****Model 2: HEC-RAS Version 4.1; Mixed Flow Factors M=2 & F=1.5; Max # of Iterations: 20**

Storage Area Name	Peak WSE Difference (ft)
099B	0.00
100A	-0.04
100B	0.00
100C	0.00
101A	0.02
101B	0.00
104A	0.00
104B	-0.24
105A	0.00
105B	0.00
204B	0.00
205B	0.00
82A_Lower	0.00
97B	-0.06
FEA-01	0.00
FEA-04	-0.01
FEA-05	0.00
FEA-06	-0.01
FEA-30	0.00
FEA-31	0.00
FEA-32	-0.01
FEA-34	0.00

Table 5A**Summary of Peak WSE and Peak Q differences between USR 2006 Models with different HEC-RAS Versions****Model 1: HEC-RAS Version 4.1; Mixed Flow Factors M=10 & F=1; Max # of Iterations: 20****Model 2: HEC-RAS Version 4.2; Mixed Flow Factors M=10 & F=1; Max # of Iterations: 40**

Reach	Sub reach	Peak Q Difference (cfs)		Peak WSE Difference (ft)	
		Minimum	Maximum	Minimum	Maximum
Big Chico Creek	Lower	-0.20	4.64	0.00	0.00
Big Chico Creek	Main	-21.46	0.04	-0.20	0.09
BUC	Subreach1	-338.58	7658.27	-0.01	0.70

Table 5A

Summary of Peak WSE and Peak Q differences between USR 2006 Models with different HEC-RAS Versions

Model 1: HEC-RAS Version 4.1; Mixed Flow Factors M=10 & F=1; Max # of Iterations: 20

Model 2: HEC-RAS Version 4.2; Mixed Flow Factors M=10 & F=1; Max # of Iterations: 40

Reach	Sub reach	Peak Q Difference (cfs)		Peak WSE Difference (ft)	
		Minimum	Maximum	Minimum	Maximum
BUC2	Subreach1	-0.86	0.01	0.00	0.00
Butte_Sink	Subreach1	-13307.67	286.00	-0.58	0.01
Butte_Sink	Subreach2	-340.77	-136.80	-0.01	0.00
Butte_Sink	Subreach3	-157.79	55.79	0.00	0.00
CHC	Subreach1	-17.52	60.78	-0.01	0.00
CHC	Subreach2	6.06	11.74	-0.15	0.01
CHC	Subreach3	-0.02	6.65	-0.37	0.34
CHC_CTW	Subreach1	0.00	7.42	-0.08	-0.07
CHC_LC	Subreach1	-3.41	0.38	-0.02	-0.02
COD	Subreach2	-7.81	-1.41	-1.43	-0.11
COD	Subreach3	-1105.75	0.58	0.00	4.14
COD	Subreach3A	-1079.83	-1079.56	4.14	5.46
COD_OB	Subreach1	-64.50	662.84	0.00	4.14
DRY	Reach1	-0.05	0.04	-0.08	0.00
KNI	Subreach1	-1077.03	-1072.65	-1.43	-1.34
Lindo Channel	Upper	-0.16	37.87	-0.15	0.02
MCT	Reach 1	0.18	0.21	-0.34	-0.28
Moulton_Channel	Subreach1	-41.17	0.00	-0.01	0.00
MUC	Subreach1	-1.91	0.02	-0.02	0.00
MUC	Subreach2	-4.46	2.20	-0.01	0.01
MUC	Subreach3	4.90	25.19	0.00	0.01
SAC	Subreach1	-123.40	12.80	-0.01	0.00
SAC	Subreach2	-12.92	-9.58	0.00	0.00
SCS	SCS_Subreach1	-0.39	0.16	-0.13	0.00
SUB	Subreach1	-23.00	-3.90	0.00	0.00
SUB	Subreach2	-63.21	5.13	-0.01	0.00
SUB	WAD_to_TIS	-7.60	-3.10	0.00	0.00
SYC	Reach1	-0.03	0.15	0.00	0.00
SYC	Reach1B	0.11	0.15	0.00	0.00
SYC	Reach2	-0.24	0.21	-0.08	0.00
TIS	Subreach1	-9.18	-8.66	0.00	0.00
Wadsworth Canal	Reach 1	-0.07	0.14	0.00	0.00

Table 5B

Summary of Storage Area Peak WSE differences between USR 2006 Models with different HEC-RAS Versions

Model 1: HEC-RAS Version 4.1; Mixed Flow Factors M=10 & F=1; Max # of Iterations: 20

Model 2: HEC-RAS Version 4.2; Mixed Flow Factors M=10 & F=1; Max # of Iterations: 40

Storage Area Name	Peak WSE Difference (ft)
001	0.00
002	0.00
003	-4.40
004	0.00
005	0.00
006	0.00
008	0.00
009	0.00
010	0.00
012	0.00
014	0.00
015	0.00
016	0.00
018	0.00
019	0.00
020	0.00
021	0.00
022	0.00
023	0.00
024	0.00
025	0.00
026	0.00
027	0.00
028	0.00
029	0.00
030	0.00
031	0.00
032	0.00
033	0.00
034	0.00
035	0.00
036	0.00
037	0.00
038	0.00
039	0.00

Table 5B

Summary of Storage Area Peak WSE differences between USR 2006 Models with different HEC-RAS Versions

Model 1: HEC-RAS Version 4.1; Mixed Flow Factors M=10 & F=1; Max # of Iterations: 20

Model 2: HEC-RAS Version 4.2; Mixed Flow Factors M=10 & F=1; Max # of Iterations: 40

Storage Area Name	Peak WSE Difference (ft)
040	0.00
041	0.00
042	0.00
043	0.00
044	0.00
045	0.00
046	0.00
047	0.00
048	0.00
049	0.00
050	0.00
051	0.00
052	0.00
053	0.00
054	0.00
055	0.00
056	0.00
057	0.00
058	0.47
059	0.92
060	0.16
061	0.00
062	0.00
063	0.00
064	0.00
065	0.00
066	0.00
067	0.00
068	0.00
069	0.00
070	0.00
071	0.00
072	0.00
073	0.00
074	0.00

Table 5B**Summary of Storage Area Peak WSE differences between USR 2006 Models with different HEC-RAS Versions****Model 1: HEC-RAS Version 4.1; Mixed Flow Factors M=10 & F=1; Max # of Iterations: 20****Model 2: HEC-RAS Version 4.2; Mixed Flow Factors M=10 & F=1; Max # of Iterations: 40**

Storage Area Name	Peak WSE Difference (ft)
075	0.00
076	0.00
077	0.00
078	0.00
079	0.00
080	0.00
083	0.00
084	0.00
086	0.00
087	0.00
092	-0.30
102	0.00
103	0.00
106	0.00
107	-0.01
108	0.00
109	3.33
110	0.00
111	0.00
112	0.00
113	-0.01
114	0.00
115	0.00
116	-0.02
117	-0.01
118	0.00
1536	0.00
082A_Upper	0.00
082B	-0.01
082C	0.00
085A	0.00
085B	0.00
085C	0.00
085D	0.00
088A	0.00

Table 5B

Summary of Storage Area Peak WSE differences between USR 2006 Models with different HEC-RAS Versions

Model 1: HEC-RAS Version 4.1; Mixed Flow Factors M=10 & F=1; Max # of Iterations: 20

Model 2: HEC-RAS Version 4.2; Mixed Flow Factors M=10 & F=1; Max # of Iterations: 40

Storage Area Name	Peak WSE Difference (ft)
088B	0.00
088C	0.00
088D	0.00
088E	0.00
088F	0.00
089A	0.00
089B	-0.02
089C	0.00
089D	0.00
090A	0.00
090B	0.00
090C	0.00
091A	0.00
091B	0.00
091C	0.00
091D	0.00
091E	0.00
091F	0.00
091G	0.00
091H	0.00
091I	0.00
091J	0.00
093A	0.00
093B	0.00
094A	0.00
094B	0.00
095A	0.00
095B	0.00
096A	0.00
096B	0.00
096C	0.00
097A	0.00
098A	0.00
098B	0.00
099A	0.00

Table 5B**Summary of Storage Area Peak WSE differences between USR 2006 Models with different HEC-RAS Versions****Model 1: HEC-RAS Version 4.1; Mixed Flow Factors M=10 & F=1; Max # of Iterations: 20****Model 2: HEC-RAS Version 4.2; Mixed Flow Factors M=10 & F=1; Max # of Iterations: 40**

Storage Area Name	Peak WSE Difference (ft)
099B	0.00
100A	0.00
100B	0.00
100C	0.00
101A	-0.01
101B	0.00
104A	0.00
104B	0.00
105A	0.00
105B	-0.38
204B	0.00
205B	0.00
82A_Lower	0.00
97B	0.00
FEA-01	0.00
FEA-04	0.00
FEA-05	0.00
FEA-06	0.00
FEA-30	0.01
FEA-31	0.00
FEA-32	0.00
FEA-34	0.01

Table 6A**Summary of Peak WSE and Peak Q differences between USR 500Yr Models with different HEC-RAS Versions****Model 1: HEC-RAS Version 4.1; Mixed Flow Factors M=10 & F=1; Max # of Iterations: 20****Model 2: HEC-RAS Version 4.2; Mixed Flow Factors M=10 & F=1; Max # of Iterations: 40**

Reach	Sub reach	Peak Q Difference (cfs)		Peak WSE Difference (ft)	
		Minimum	Maximum	Minimum	Maximum
Big Chico Creek	Lower	-8.23	1.01	0.00	0.00
Big Chico Creek	Main	-92.29	6.80	-0.21	0.11
BUC	Subreach1	-881.91	19928.70	-0.07	0.48

Table 6A

Summary of Peak WSE and Peak Q differences between USR 500Yr Models with different HEC-RAS Versions

Model 1: HEC-RAS Version 4.1; Mixed Flow Factors M=10 & F=1; Max # of Iterations: 20

Model 2: HEC-RAS Version 4.2; Mixed Flow Factors M=10 & F=1; Max # of Iterations: 40

Reach	Sub reach	Peak Q Difference (cfs)		Peak WSE Difference (ft)	
		Minimum	Maximum	Minimum	Maximum
BUC2	Subreach1	-10.27	0.98	0.00	0.00
Butte_Sink	Subreach1	-24371.59	1314.50	-0.19	0.00
Butte_Sink	Subreach2	-3569.89	82.00	-0.07	-0.01
Butte_Sink	Subreach3	-409.38	75.00	-0.01	-0.01
CHC	Subreach1	-19.23	218.52	-0.01	0.07
CHC	Subreach2	218.85	219.94	-0.10	0.10
CHC	Subreach3	-34.44	264.40	-0.21	0.00
CHC_CTW	Subreach1	-78.12	130.93	-0.02	-0.02
CHC_LC	Subreach1	-0.41	1.35	0.04	0.04
COD	Subreach2	-5.04	-1.00	-0.67	-0.15
COD	Subreach3	-4204.03	0.92	0.00	4.44
COD	Subreach3A	-2015.03	-2011.61	4.44	9.44
COD_OB	Subreach1	-1143.36	2457.50	0.00	4.44
DRY	Reach1	0.00	1.81	-0.07	0.00
KNI	Subreach1	-2114.44	-712.56	-0.69	-0.66
Lindo Channel	Upper	-0.36	37.87	-0.16	0.02
MCT	Reach 1	9.70	11.63	-0.03	-0.03
Moulton_Channel	Subreach1	-155.93	0.00	-0.01	0.00
MUC	Subreach1	-0.16	3.96	-0.02	0.02
MUC	Subreach2	-0.84	0.49	-0.01	0.02
MUC	Subreach3	-16.17	2.55	0.00	0.00
SAC	Subreach1	-355.20	76.89	-0.03	0.01
SAC	Subreach2	3.82	107.41	0.01	0.01
SCS	SCS_Subreach1	-3.16	-0.62	-0.11	0.00
SUB	Subreach1	-629.59	-377.81	-0.02	-0.02
SUB	Subreach2	-1365.09	0.00	-0.02	0.01
SUB	WAD_to_TIS	-699.80	-354.30	-0.02	-0.02
SYC	Reach1	-0.04	2.19	0.00	0.00
SYC	Reach1B	2.17	2.19	0.00	0.00
SYC	Reach2	1.52	2.37	-0.08	0.00
TIS	Subreach1	-170.49	0.00	-0.02	0.02
Wadsworth Canal	Reach 1	-477.02	-1.68	-0.01	0.01

Table 6B**Summary of Storage Area Peak WSE differences between USR 500Yr Models with different HEC-RAS Versions****Model 1: HEC-RAS Version 4.1; Mixed Flow Factors M=10 & F=1; Max # of Iterations: 20****Model 2: HEC-RAS Version 4.2; Mixed Flow Factors M=10 & F=1; Max # of Iterations: 40**

Storage Area Name	Peak WSE Difference (ft)
001	-3.46
002	0.17
003	-0.71
004	0.04
005	0.00
006	-1.13
008	0.01
009	0.05
010	0.00
012	0.00
014	0.02
015	0.03
016	0.03
018	-0.01
019	0.00
020	0.03
021	0.03
022	0.00
023	0.00
024	0.03
025	0.00
026	0.00
027	-0.01
028	0.00
029	0.00
030	0.00
031	-0.01
032	0.00
033	0.00
034	0.00
035	0.00
036	0.00
037	0.00
038	0.00
039	0.00

Table 6B**Summary of Storage Area Peak WSE differences between USR 500Yr Models with different HEC-RAS Versions****Model 1: HEC-RAS Version 4.1; Mixed Flow Factors M=10 & F=1; Max # of Iterations: 20****Model 2: HEC-RAS Version 4.2; Mixed Flow Factors M=10 & F=1; Max # of Iterations: 40**

Storage Area Name	Peak WSE Difference (ft)
040	0.00
041	0.00
042	0.00
043	0.00
044	0.00
045	0.00
046	0.00
047	-0.01
048	-0.01
049	0.01
050	0.00
051	-0.01
052	0.20
053	-0.22
054	-0.03
055	-0.31
056	-0.06
057	0.93
058	0.19
059	0.18
060	0.04
061	-0.02
062	-0.01
063	-0.21
064	0.00
065	0.00
066	-0.05
067	0.00
068	0.00
069	-0.01
070	-0.01
071	0.00
072	0.00
073	0.00
074	-0.02

Table 6B**Summary of Storage Area Peak WSE differences between USR 500Yr Models with different HEC-RAS Versions****Model 1: HEC-RAS Version 4.1; Mixed Flow Factors M=10 & F=1; Max # of Iterations: 20****Model 2: HEC-RAS Version 4.2; Mixed Flow Factors M=10 & F=1; Max # of Iterations: 40**

Storage Area Name	Peak WSE Difference (ft)
075	0.00
076	0.00
077	0.00
078	0.00
079	0.00
080	0.00
083	0.00
084	0.00
086	0.00
087	0.00
092	-0.04
102	0.00
103	0.00
106	0.00
107	0.00
108	-0.01
109	-0.03
110	0.00
111	0.00
112	2.85
113	0.23
114	-0.01
115	-0.01
116	-0.02
117	0.00
118	-0.22
1536	0.00
082A_Upper	0.00
082B	-0.01
082C	0.00
085A	-0.01
085B	-0.05
085C	0.00
085D	0.00
088A	0.00

Table 6B**Summary of Storage Area Peak WSE differences between USR 500Yr Models with different HEC-RAS Versions****Model 1: HEC-RAS Version 4.1; Mixed Flow Factors M=10 & F=1; Max # of Iterations: 20****Model 2: HEC-RAS Version 4.2; Mixed Flow Factors M=10 & F=1; Max # of Iterations: 40**

Storage Area Name	Peak WSE Difference (ft)
088B	-0.01
088C	0.00
088D	0.00
088E	0.00
088F	0.00
089A	0.00
089B	0.00
089C	0.00
089D	0.00
090A	0.00
090B	0.00
090C	0.01
091A	0.00
091B	0.00
091C	0.00
091D	0.00
091E	-0.01
091F	0.00
091G	0.00
091H	0.00
091I	0.00
091J	0.00
093A	0.00
093B	-0.02
094A	0.00
094B	-0.01
095A	0.00
095B	0.00
096A	0.00
096B	0.00
096C	0.00
097A	0.01
098A	-0.02
098B	-0.01
099A	0.00

Table 6B**Summary of Storage Area Peak WSE differences between USR 500Yr Models with different HEC-RAS Versions****Model 1: HEC-RAS Version 4.1; Mixed Flow Factors M=10 & F=1; Max # of Iterations: 20****Model 2: HEC-RAS Version 4.2; Mixed Flow Factors M=10 & F=1; Max # of Iterations: 40**

Storage Area Name	Peak WSE Difference (ft)
099B	0.00
100A	0.00
100B	0.00
100C	0.00
101A	0.00
101B	0.00
104A	0.00
104B	0.00
105A	0.00
105B	-0.02
204B	0.00
205B	0.00
82A_Lower	0.00
97B	0.02
FEA-01	-0.08
FEA-04	-0.01
FEA-05	-0.01
FEA-06	-0.01
FEA-30	-0.15
FEA-31	0.00
FEA-32	-0.01
FEA-34	-0.15

APPENDIX B

Lower Sacramento River Model Iterations for Combined Model

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APPENDIX B

The combined model for the Upper and Lower Sacramento River Study Areas were forced to utilize mixed flow options to accommodate super-critical and near super-critical conditions in the upper (steeper) streams. It must be run using HEC-RAS Version 4.2 Beta due to virtual memory limitations of Version 4.1. Due to these issues, Wood Rodgers, Inc. (Wood Rodgers) was asked to perform model comparisons. In order to consider acceptance of the combined model, the California Department of Water Resources (DWR) requested that the Lower Sacramento River (LSR) HEC-RAS model be run using the same software version and mixed flow settings as the combined model. The approved LSR model was originally finalized using HEC-RAS Version 4.1 (32-bit) software, and was run under sub-critical flow conditions, not considering mixed flow. However, because the Upper Sacramento River (USR) model required the use of mixed flow, the combined model was obliged to also utilize mixed flow.

CH2M HILL was directed to perform more in-depth comparisons of variations of mixed flow parameters, recognizing that the USR model was approved using mixed flow. As the LSR model results were derived using sub-critical flow conditions under Version 4.1, DWR requested that Wood Rodgers run the LSR model using Version 4.2 Beta, and using the same mixed flow settings as the combined model ($m=2$, $F_T=1.5$). A detailed comparison was performed for both the approximate 500-year and 2006 event conditions.

As part of a presentation to DWR staff on January 24, 2014, detailed comparisons of maximum water surface elevations were performed using GIS tools. All GIS results and comparison files are provided in digital format under this submittal.

The sub-critical and mixed flow maximum water surfaces were very close to one another in both the approximate 500-year and 2006 event simulations, except at a few locations. The largest difference in maximum water surface elevation occurred in the downstream reach of Cache Creek as it enters the Cache Creek Settling Basin. The transition from channel to storage area was always poorly represented using sub-critical flow computations only, producing significant loss as the flow enters the storage area. As this portion of the model was finalized using a one-dimensional and two-dimensional coupled model (TUFLOW) under Task Order 25, no one-dimensional program sufficiently represents the vertical and horizontal transition. The mixed flow settings in HEC-RAS do make the transition smoother than sub-critical

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computations. It is important to note that even the approximate 500-year flow is contained within the levees of the Cache Creek Settling Basin in this area.

There are many areas where the sub-critical and mixed flow results vary slightly, with no clear indication that one is superior to the other. In some locations, the two methods are both slightly above and below each other, but generally produce the same level of “smooth” profile. Many aspects of the model geometry may contribute to how the different methods iterate through their respective computations to arrive at a converged solution without producing significant error. It is beyond the scope of this study to determine the reasons for each distinct variation.

The model input and output in HEC-RAS format, as well as the results of each sub-critical and mixed flow run, are provided in digital format and attached to this document.