Technical Memorandum

To: San Jacinto River Stage III Technical Advisory Committee

From: Joseph Caldwell, PE, Director of Stormwater Engineering

Date: June 08, 2016

Re: San Jacinto River Stage III Hydraulic Modeling Approach

The purpose of this Technical Memorandum is to outline the hydraulic modeling approach that will be used to evaluate various elements and alternatives for the San Jacinto River Stage III planning. The Stage III planning extends from Ramona Expressway to Railroad Canyon. The limits of the hydraulic modeling will need to extend past the actual Stage III Project limits to evaluate the impacts of the existing and future floodplain conditions and the resulting effects on the downstream San Jacinto River flows.

Under current conditions, the majority of storm water runoff will flow into Mystic Lake through the San Jacinto River levee breach located just downstream of Bridge Street. Mystic Lake must be filled to a minimum surface elevation of 1430 feet before the San Jacinto River will continue to flow within the levees. Mystic Lake must reach an elevation of 1423 feet before the water will flow from the lake in a westerly direction through an existing earthen channel. **Figure 1** shows the vicinity around Mystic Lake. The potential use of Mystic Lake Dead Storage is discussed in a separate Technical Memorandum. It was determined that due to the uncertainly of the Mystic Lake water surface elevations and the relatively minor reduction in downstream water surface elevations that a more robust analysis would provide, that the "dead storage" in Mystic Lake should not be utilized in the modeling of this reach. This is consistent with the current Federal Emergency Management Agency (FEMA) floodplain study which assumes that Mystic Lake is full.

The selection of an appropriate hydraulic model is a very important aspect of the hydraulic analysis process. It is proposed that the hydraulic modeling of San Jacinto River Stage III will be performed using the U.S. Army Corps of Engineers HEC-RAS (ver. 5.0.1) computer program. The unsteady flow component of the HEC-RAS modeling system is capable of simulating one-dimensional (1D), two-dimensional (2D) and combined one/two-dimensional unsteady flow analysis. The HEC-RAS 2D modeling capability uses a Finite-Volume solution scheme. This algorithm was developed to allow for the use of a structured or unstructured computational Mesh (grid). This means that the computational 2D mesh can be a mixture of multi-sided computational cells (max of 8 sides) and can be refined with break line and mesh editing tools. This is beneficial in capturing some of the complex topographic features along the San Jacinto River.

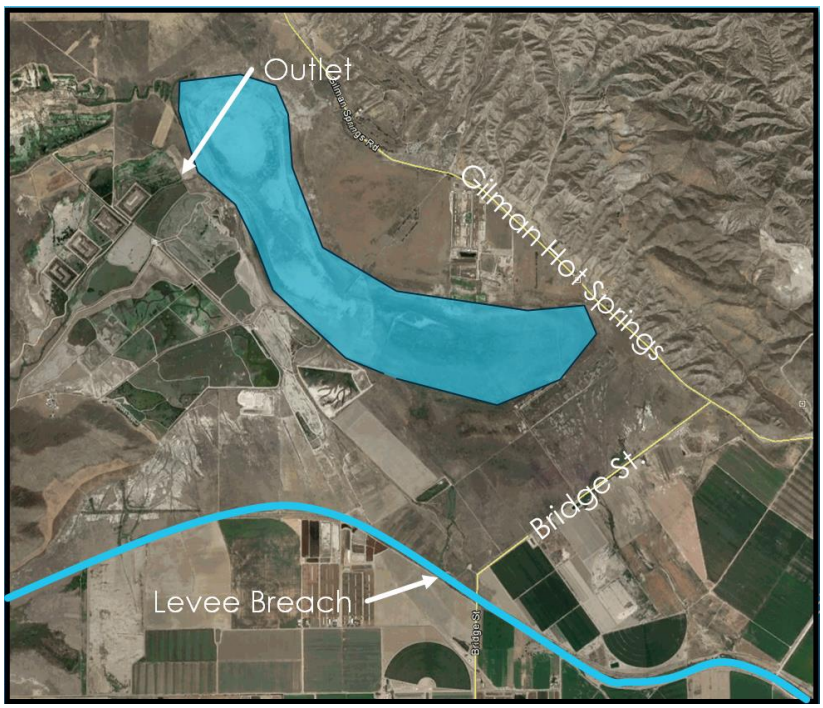

Figure 1 - Mystic Lake Levee Breech and Outlet

As with all unsteady flow hydraulic models, stability problems can occur due to sudden changes in conveyance, such as at bridges and at flow control structures, causing the sudden rush of water into an area of the model. However, the implicit finite volume solution algorithm does provide an increment of improved stability and robustness over traditional finite difference and finite element techniques, but does not solve the problem completely. In order to avoid the instability of unsteady flow hydraulic modeling as described, a three reach modeling approach is proposed as shown in **Figure 2** and described in **Table 1**.

Figure 2 - Modeling Reaches for Current Planning Effort

Reach 1 will be modeled using the 2-D unsteady flow component of the HEC-RAS model. To account for the uncertainty of the Mystic Lake available storage, it will be assumed that Mystic Lake is full and that the "dead storage" will not provide any attenuation of the San Jacinto River flow. The effects of the "flow control structure" at Ramona Expressway will be easier to evaluate by ending the model at Ramona Expressway. This will be done via a stage-discharge curve along the downstream model boundary. This rating curve will be based on the various conditions (i.e. Ramona Expressway Protected or a upstream flow control structure). The outflow hydrograph from Reach 1 will be used as input into the Reach 2 model.

Table 1: Modeling Reach Summary

Reach No.	Start of Reach	End of Reach	Model / State
1	U/S of Bridge Street	Ramona Expressway	2D HEC-RAS / Unsteady
2	Ramona Expressway	I – 215	2D HEC-RAS / Unsteady
3	I – 215	Railroad Canyon	1D HEC-RAS / Steady

Reach 2 will be modeled using the 2-D unsteady flow component. The downstream boundary control for Reach 2 will be based on a stage-discharge relationship developed from the Reach 3 1-D steady flow HEC-RAS hydraulic analysis. As explained earlier, unsteady flow models are sensitive to a rapid change of flow such as a rapidly rising water surface at

the upstream side of an undersized culvert (I-215 Freeway culvert). It is also proposed that the 1-D hydraulic equations used in the HEC-RAS bridge/culvert routines produces better results than the 2-D equations.

Reach 3 alternative will initially be modeled using the 1-D steady flow component. The same cross sections used in the Physical Map Revision model will be used for this reach. The geometry of these sections will be adjusted based on the various alternatives. These models will initially be used to establish a stage-discharge rating curves for the various scenarios of the Reach 2. The peak flow from the downstream end of the Reach 2 model will be input in to the Reach 3 models as a steady state flow. For the alternatives analysis this will provide an accurate enough comparison of the alternatives. Once a preferred alternative is developed, Reach 3 will be modeled with an unsteady analysis.

Breaking up the San Jacinto River Stage III hydraulic model into three separate models will improve the models stability and performance due to the numerous anticipated flow control structures which may cause the unsteady flow models to go unstable. Separate models will provide better flexibility in evaluating the proposed alternatives by isolating the other reaches that are not changing for that particular alternative. Using stage-discharge rating curves for the models boundary conditions will increase the efficiency in the alternative developments.