San Jacinto River Regional Watershed Study
Preliminary Scope of Services
March 27, 2018

INTRODUCTION

BACKGROUND

In August 2017, Hurricane Harvey struck the Texas coast, bringing a historic amount of rainfall to the Houston region. The storm produced never-before-seen precipitation depths in Harris and Montgomery Counties, as well as several surrounding counties. As was the case with most of the watersheds in the region, the San Jacinto River basin experienced widespread flooding, which resulted in significant damage. In the wake of the storm, the Harris County Flood Control District (HCFCD), San Jacinto River Authority (SJRA), Montgomery County (MCO), and City of Houston (COH) recognized that steps needed to improve coordination, communication, and response among the responsible agencies along the San Jacinto River during major flooding events. In addition, a comprehensive plan of improvements aimed at reducing flood risk in the basin was also recognized as a key piece of the overall recovery plan. The scope provided below is intended to be the first step in addressing each of these elements for the San Jacinto River Basin.

GOALS AND OBJECTIVES

The overall goal of the San Jacinto River Regional Watershed Study is to:

Perform a hydrologic and hydraulic analysis of the San Jacinto River Basin's major streams during extreme rainfall events, develop approaches to enhance the flood warning and flood response planning capabilities during a disaster, and evaluate flood mitigation strategies that can be implemented both near-term and over the long-term to reduce the flood risk to people and property.

As such, the study specific objectives include the following:

- Prepare a plan to integrate flood warning information from HCFCD, SJRA, MCO, and COH into a shared system that can be utilized by all parties to make informed decisions. This plan will also include recommendations for adding to the existing Harris County Flood Warning System gage network and recommendations for addition additional gages at recommended locations throughout the San Jacinto River Basin.
- Coordinate with flood responders including Harris County Office of Emergency Management (OEM), Montgomery County OEM, SJRA, City of Houston, and potentially others, such as the Harris County Flood Control District's Hydrologic Operations Department, to develop a consistent communications protocol and action plan. This plan should help facilitate a consistent approach across all agencies to locate and protect critical facilities, deploy emergency services, and communicate evacuation routes and shelters to the public.

- Recommend strategies to reduce flood risk and prepare a plan to implement the recommendations. Flood damage reduction options will likely include large regional detention ponds, channel improvements, vegetation and sedimentation removal, and property buy-outs.
- Develop programs and/or materials that educate the decision makers and the public on the extent of the San Jacinto River Basin, general drainage patterns, maintenance programs for the San Jacinto River and its tributaries, potential flood reduction projects, and where to find information relating major stream flooding in the San Jacinto River.

STUDY LOCATION

The study area will include the entire San Jacinto River (SJR) Basin, including its major tributaries, from the headwaters to the crossing at Interstate 10. **Exhibit 1** shows the extent of the SJR Basin that will be included in this study. While an updated hydrology model for the entire study area will be prepared using HEC-HMS, hydraulic models of the San Jacinto River and twelve (12) of its major tributaries will be included in the study. Existing hydrologic and hydraulic modeling data that has already been developed for the study area will be incorporated into the proposed regional watershed study "as is" when practical, and others will be updated from the existing Base Level Engineering (BLE) models currently being developed through FEMA. The table below provides a list of the streams to be analyzed during the study. In addition to the 13 channels that will be included in the study, water supply reservoirs located at Lake Conroe and Lake Houston will also be included in the study.

Table 1. Streams that will be Included in the San Jacinto Regional Watershed Study

Stream Name	Stream Length (Miles)
West Fork San Jacinto River	61.4
East Fork San Jacinto River	73.2
San Jacinto River	16.3
Lake Creek	58.9
Cypress Creek	60.5
Little Cypress Creek	20.8
Spring Creek	69
Willow Creek	19.8
Caney Creek	49.3
Peach Creek	53.5
Luce Bayou	31.2
Tarkington Bayou	17.1
Jackson Bayou	4.6
Total	**535.6**

STUDY PARTNERS

There are several partners that will contribute to the study in a variety of ways. The primary funding partners are anticipated to be:

- Harris County Flood Control District (Lead Agency)
- Montgomery County
- San Jacinto River Authority
- City of Houston

Other potential partners may provide support during the grant study process. These partners may include:

- Texas Department of Transportation (TXDOT)
- City of Conroe
- Woodlands Township
- The community of Kingwood
- Liberty County (Luce Bayou)
- San Jacinto County (East Fork SJR)
- Walker County (Upper West Fork SJR)
- United States Geological Survey (USGS)
- National Weather Service (NWS) River Forecast Center (RFC)
- Other communities in the study watershed

SCOPE OF SERVICES

I. PROJECT MANAGEMENT AND COORDINATION

A. Project Management and Administration – Based on an estimated schedule of 12 - 18 months, the Project Manager will be responsible for project management and coordination services consisting of internal team management and subconsultant management, as well as regular communication with the Harris County Flood Control District (HCFCD) and the other study partners. Specific tasks include:

1. Internal project management including task leadership, internal communication, and data management as specified in the Project Management Plan (PMP).
2. Subconsultant management and coordination including contracting, invoicing, review of deliverables, and communication.
3. Administration of the contract, including preparation of invoices and progress reports on monthly basis and requests for authorization as needed. Authorizations will be based on the scope of services and justification will be provided as needed.
4. Provide a project schedule indicating tasks, critical dates, and deliverables, and prepare regular updates.

B. Study Kickoff Meeting – Attend the initial study kickoff meeting to discuss study goals and objectives, review the project schedule, discuss deliverables and other relevant items. Meeting will be attended by the Project Manager and a Project Engineer at a minimum.

C. Weekly Conference Calls –Participate in weekly coordination calls with HCFCD.

D. Monthly Project Coordination Meetings – Prepare for and attend a monthly project progress meeting with the project team (18 meetings). This includes preparation of the meeting agenda and any necessary meeting materials (maps, documents, etc.). Minutes documenting the discussion will be provided summarizing the discussion and action items. All meetings will be attended by the Project Manager and one (1) additional team member at a minimum.

E. HCFCD Executive Briefings – Prepare for and attend up to two (2) executive briefings for HCFCD. The appropriate time for these briefings will be determined by the project team.

1. Attend two (2) Executive Briefings to present study findings (to date) as well as the steps moving forward.
2. Prepare a PowerPoint presentation as well as necessary exhibits for the meetings. Draft versions of both the presentations and materials will be provided to HCFCD for review and comments. Make adjustments to the materials based on comments.
3. Participate in up to two (2) pre-meetings for each Executive Briefing. These meetings are intended to discuss the presentation and exhibit content as well as to vet the study findings to be presented.

F. San Jacinto River Authority (SJRA), City of Houston (COH) and Montgomery County (MCO) Briefings – Prepare for and present at up to two additional meetings for SJRA, COH and MCO in addition to the HCFCD executive briefings. These meetings will share the same information as the HCFCD executive briefings and should be conducted after the HCFCD meetings have been held.

G. Coordination Meetings with Supporting Partners – Attend up to five (5) meetings with supporting partners as listed in the **STUDY PARTNERS** section on Page 2 of this scope. Provide general information relating to the study. Materials to be provided will be at the discretion of HCFCD but it is assumed they would not vary significantly from the materials developed for the Executive Briefings or SJRA/MCO/COH meetings.

II. DATA COLLECTION AND REVIEW

A. Data Collection – Collect relevant items to be reviewed and utilized in the study. Data includes, but is not limited to, existing studies, plans, models, GIS data, gage information, etc.

- Terrain Information (Updated LiDAR, available survey data, limited field survey including bridges and culverts)
- Gage Information (HCFWS, USGS, SJRA, MC Gages, etc.) to include rainfall, WSEL, and Discharge (if applicable)
- Historical High-Water Marks (HWM)
- Existing Hydrologic and Hydraulic models for San Jacinto River and tributaries will also be gathered. Models and Sources for this information may include:
    - HCFCD M3 Models for the San Jacinto River, Spring Creek, Willow Creek, Cypress Creek, Little Cypress Creek, Luce Bayou, and Jackson Bayou
    - SJRA Models for the drainage area upstream of Lake Conroe, as well as a HEC-RAS dam breach model of the West Fork San Jacinto River downstream of Lake Conroe.
    - Base Level Engineering (BLE) FEMA Models for East Fork San Jacinto, Peach Creek, and Caney Creek (Bridges may need to be added to these models)
    - Available FEMA Effective models including Lake Creek and others
- Precipitation Data – Multi-sensor Precipitation Estimate (MPE) rainfall from the NWS for Hurricane Harvey, TS Allison, 2016 storm, and historical rainfall information for October 1994 from available gages
- Historical flood complaints that can be provided by the study partners
- Sedimentation data and reports for the SJR Watershed
- Available reports detailing previous model development efforts and mitigation planning.

- Existing flood response communication protocols from Harris County, Montgomery County, City of Houston, CWA, and SJRA.

B. Field Reconnaissance Visits –Conduct site visits along each of the major streams at to familiarize the project team with the conditions. These site visits will focus on viewing the channel at major roadway crossings to view the conditions at the crossing as well as the channel conditions upstream and downstream. Visits to Lake Conroe and Lake Houston will also be included to verify the dam configuration is consistent with the modeling. Site visits will be documented in a field observation report that includes photographs and notes detailing our findings.

C. Model Evaluation and Data Review –Review the collected data and leverage the information provided for model updates, potential flood reduction project recommendations, identifying locations for potential flood gages, updating flood response protocols, and developing educational materials. Specific tasks include the following:

1. Review all reports provided and determine additional data needs.
2. Evaluate gage information for completeness and period of record as well as comparison to the historical HWM and flood complaint information to determine consistency.
3. Evaluate available H&H models to determine additional model construction needs.
4. Evaluate available terrain information for modeling and mapping purposes.
5. Provide a comprehensive summary of the review of available reports and data.

D. Field Survey Data (as needed) –Determine the locations needed for field survey based on the data collected in previous tasks. Survey may include high water marks after storm events, up to (25) stream crossings and up to (15) channel cross sections.

E. Task Deliverables

1. Catalog of Data Collected including name, date, and source of information
2. Field Observation Reports for site visits
3. Comprehensive Summary of reports and data
4. Field survey text files and field notes

III. EXISTING CONDITIONS H&H MODEL DEVELOPMENT

A. Hydrologic Modeling –Update the available hydrologic modeling to provide an improved baseline condition and verify calculated flows for frequency storms. The available HEC-HMS model will be updated to incorporate all the stream watersheds into a single, consistent model. The model will be updated to utilize consistent precipitation, loss parameters, and hydrograph transform parameters. Existing detailed HEC-HMS models provided by HCFCD will not be updated. Specific tasks include:

1. Hydrologic Model for Steady Analysis –Prepare a comprehensive hydrologic model to be utilized in conjunction with unsteady HEC-RAS modeling.
   a. Convert existing HEC-HMS model to the most current version (v. 4.2.1 or later)
   b. Confirm and/or update reservoir information for Lake Conroe and Lake Houston

c. Subdivide or combine drainage areas to ensure adequate computational points and consistency with the existing gage network. Drainage areas for HCFCD models will not be altered. Drainage areas for other areas will be delineated such that major changes in discharges are captured at tributary confluence as well as significant hydrologic features such as bridges, culverts, detention basins, major outfalls, and other features. Future potential gage locations will also be considered as break points for the drainage area delineation.
d. Develop hydrologic loss and transform parameters using a consistent methodology. The new hydrology will utilize the Initial and Constant loss method and the Clark UH transform method. Hydrologic parameters for HCFCD models (Spring, Cypress, Luce, Jackson) will not be altered and will maintain the HCFCD specific parameters.
e. Update or develop hydrologic loss (Initial & Constant) and transform (Clark UH) parameters for the watershed using appropriate hydrologic methodology.
f. If needed, develop storage routing using available hydraulic models (utilize Muskingum-Cunge in areas where no HEC-RAS modeling exists). Unsteady state HEC-RAS will be utilized for the study and it is anticipated that hydrographs generated in HEC-HMS will be routed with the unsteady state HEC-RAS model. However, certain instances may arise when some routing will be required in HEC-HMS. Hydraulic models will be discussed in subsequent sections.
g. Update, if appropriate, the HEC-HMS model to include any regional detention ponds, diversions, or other flood control structure that is not in the current model.
h. Execute model for a range of storms including the 2-, 5-, 10-, 25-, 50-, 100-, and 500-year storm and review/compare the data to the effective modeling (where available)

B. Hydraulic Modeling –Update the available hydraulic (HEC-RAS) models to reflect the desired level of detail. The models are intended to be used for planning purposes and will not meet standards, specifically with respect to survey of cross sections and hydraulic structures, for a FEMA Letter of Map Revision (LOMR) or Physical Map Revision (PMR). However, they will provide sufficient information to identify flood risks along the streams included in the study, and to develop inundation data sufficient for local communities to utilize when updating their Hazard Mitigation Plans, as well as information that can be utilized for communities in the study area to refer to when planning for future capital projects or the location of critical facilities. Models will be developed or updated using multiple sources including: existing effective steady state models, base level engineering (BLE) models, and existing planning level unsteady modeling. Existing modeling will be leveraged as much as is deemed appropriate. **Table 1** shows the streams to be studied.

1. Unsteady State Hydraulic Analysis – Develop unsteady state modeling for the tributaries listed in Table1.
   a. Convert all HEC-RAS models to the most current version (v 5.0.3 or later)
   b. Update HEC-RAS models to reflect most current terrain data and field survey

i. Adjust cross section alignments and update elevations from the terrain data. The hydraulic models will be updated using the most recent terrain with the exception of the effective HCFCD models, which will not be altered

ii. Add bridge and culvert crossings as needed to the HEC-RAS models. These will be based on field survey data where it is available or field observation and measurements if survey data is unavailable.

c. Review and update model parameters, including roughness values, obstructions, and ineffective flow areas, as needed based on site visits and/or aerial imagery.

d. Update flow data and apply inflow hydrographs. Consideration for flow change locations will include (at a minimum) roadway crossings where there are currently gages or future potential gage locations, confluences of tributaries, or other locations where there are significant changes in stormwaterdischarge when inflow hydrographs are applied.

e. Execute the model for an array of storms including the 2-, 5-, 10-, 25-, 50-, 100-, and 500-year storm and review/compare the data to the effective modeling (where available). It is understood that the development of the combined unsteady HEC-RAS model will require multiple run iterations for each of the streams at various stages of completion to construct a stable model.

f. Inundation mapping will be provided once the models are calibrated and the existing conditions finalized (Task IV.C.3). The inundation mapping will be used to illustrate the extent and depth of the floodplain along the studied streams for the analyzed storm events. Additionally, this information will also be used to estimate the number of structures located within the analyzed floodplains, as well as the acres of land and miles of roadway that become inundated by the floodplain generated by the analyzed storm events.

C. Task Deliverables

1. Technical memorandum detailing the methodology, development, and results of the existing conditions modeling effort including related exhibits and results tables
2. Hydrologic Models in HEC-HMS
3. Hydraulic Models for steady state and combined unsteady state model in HEC-RAS
4. GIS data supporting modeling efforts in geodatabase format
5. Supporting parameter calculation spreadsheets or other related files

IV. ANALYSIS OF HISTORICAL STORMS AND MODEL CALIBRATION

A. Analysis of Historical Storms –Conduct an analysis that includes the evaluation of several historical storms. Precipitation data gathered from multiple sources will be entered in the existing conditions models to compare modeled results to observed data.

1. Apply the Multi-sensor Precipitation Estimate (MPE) rainfall data for Hurricane Harvey (2017), T.S. Allison (2001), and the Tax Day Flood (2016) to the updated existing conditions HEC-HMS model.

2. For the October 1994 storm, the rainfall data for each subbasin will be developed using the Isohyetal contours and the available gage data from the San Jacinto River Basin and contributing tributaries. Gages outside the basin will be used to ensure the most accurate rainfall distribution possible. Apply the rainfall to the updated existing HEC-HMS model.
3. Execute HEC-HMS model for each of the historical storm(s) listed and review results compared to available discharge gages. Compare estimated elevations and discharges for Lake Conroe and Lake Houston.
4. Apply historical storm(s) discharges to available HEC-RAS models and evaluate calculated WSELs to available gage data and High-Water Marks (HWM) data.

B. Model Calibration – Utilize the gage data, HWMs, and modeled historical storms to evaluate the validity of the existing conditions models and adjust the models to provide a more consistent result between the modeled and observed results.

1. Document and compare total volume, peak discharges, hydrograph shape, and calculated WSEL for each of the historical storms in the HEC-HMS model vs. the observed gage data at gages and other HWM locations.
2. Adjust R/TC+R and Modified-Puls (MP) subreaches as necessary to reasonably approach observed gage data. If there is a significant volume difference some of the infiltration loss parameters may require adjustment.

C. Final Existing Conditions Model – Execute the calibrated HEC-HMS and HEC-RAS models for the range of flows

1. Execute HEC-HMS model with adjusted parameters; Interpolate discharges from HEC-HMS using HCFCD criteria and enter steady flow data into HEC-RAS models.
2. Execute HEC-RAS model for an array of storms including the 2-, 5-, 10-, 25-, 50-, 100-, and 500-year storm with adjusted parameters and review model results
3. Prepare inundation mapping for the 100- and 500-year events on all modeled streams. Mapping will be based on RAS Mapper; no additional editing or cleanup will be performed on the mapping. Depth grids may also be provided if requested.
4. Prepare water surface profiles for the 2-, 5-, 10-, 25-, 50-, 100-, and 500-year storms
5. Provide comparison tables of the calculated WSEL to the effective modeling (if applicable) to show the changes and provide a discussion of any significant changes.

Task Deliverables

1. Technical memorandum detailing the collection and application of historical rainfall and the calibration effort and results
2. Gage information for historical storms
3. Final Hydrologic Model in HEC-HMS
4. Final Hydraulic Model for steady state and combined unsteady state model in HEC-RAS
5. Inundation Mapping for historical storms and (if requested) depth grids
6. GIS data supporting calibration efforts in geodatabase format
7. Supporting parameter calculation spreadsheets or other related files

V. Future Condition Without Flood Mitigation Measures Hydrologic and Hydraulic Model Development

A. Development of future condition hydrologic and hydraulic models – Update the existing conditions hydrologic and hydraulic models developed in Task III to estimate a future condition within the watershed if no new flood mitigation measures were pursued. Future conditions will be estimated by utilizing available population growth projections, and regional growth/development patterns, drainage criteria that has been adopted by appropriate relevant agencies within the watershed, among other information. Consideration of the future conditions analysis will aid in the evaluation of long-term flood mitigation measures.

B. Task Deliverables

1. Technical memorandum detailing the methodology, development, and results of the future conditions modeling effort including related exhibits and results tables.
2. Hydrologic Models
3. Hydraulic Models
4. GIS data supporting modeling efforts in geodatabase format.
5. Supporting parameter calculation spreadsheets or other related files.

VI. FLOOD WARNING SYSTEM

A. Flood Warning Coordination – Coordinate with responsible agencies within the study area, including HCFCD, MCO, SJRA and TxDOT, to discuss the current Harris County Flood Warning System (FWS) and a potential expansion to be identified as part of this study. Recommended locations for additional ALERT 2 Rain and WSEL gages within the San Jacinto River Basin will be identified. This includes potential gages along major tributaries. It is expected that at least 5 gages will be installed during this effort.

B. Task Deliverables

1. Agenda and meeting minutes detailing the discussion, decisions and action items for the meetings with Harris County Hydrologic Operations Division, HCFCD Planning, Montgomery County, and SJRA
2. Memorandum detailing the specific gage improvements including gages previously identified for installation, additional gages to be considered, and associated budget and schedule for implementation

VII. FLOOD RESPONSE PLANNING

A. Flood Response Coordination –Meet with responsible agencies to discuss existing plans/protocols and strategies to improve flood response. Agencies include but are not limited to the Harris County Hydrologic Operations Division, Harris County Office of Emergency Management (OEM), Montgomery County OEM, SJRA, City of Houston, and TxDOT

B. Communications Plan/Protocol Update – Develop a communications plan/protocol for the responsible agencies (listed above in Task VI.A) that will facilitate information sharing in a timely manner. This includes a review of existing protocols, discussion about the pros/cons of the current protocols, and recommendations for future response coordination.

C. Locate Critical Infrastructure – Provide an exhibit and related GIS shapefile that locates critical facilities along the modeled streams. This could include government buildings, water and wastewater treatment facilities, police and fire stations, major utility crossings, and others. The level of risk for each of the facilities will also be established based on the frequency of inundation as determined by the updated existing conditions modeling and mapping.

D. Identify Evacuation Routes – Determine major roadway (TXDOT) accessibility during flood events and evaluate potential evacuation routes.

1. Identify roadways that overtop for a range of rainfall frequencies
2. Using the modeling and gage information, set target gage elevations where inundation at nearby road crossings is likely
3. Identify evacuation routes along major roads based on frequency of inundation and traffic capacity.
4. Consider potential improvements to major roadways that could reduce the risk of inundation and provide a more reliable evacuation route. Recommendations for this task will be limited to identifying crossings that should be raised. Recommendations for flood reduction projects will be addressed in Task VII.A.

E. Task Deliverables

1. Agenda and meeting minutes detailing the discussion, decisions and action items for the meetings with Harris County Hydrologic Operations Division, HCFCD Planning, Montgomery County, and SJRA, or other organizations that coordination with is necessary to perform the flood response planning.
2. Memorandum detailing the updated communications plan/protocol. This includes specific exhibits, tables, etc. that clarify the communications process to be followed in the event of a flood event. Explicit information about responsible parties and updated contact information will be included in the revised protocol.
3. Exhibit and GIS Shapefile for critical facilities and infrastructure

4. Memorandum detailing the evacuation routes on major highways and potential improvements to reduce inundation frequency. Include related exhibits and tables identifying evacuation routes for multiple rainfall frequencies.

VIII. FLOOD MITIGATION PLANNING

A. Primary Flood Mitigation Alternatives

1. Review previous studies across the SJR watershed and develop a comprehensive list of major projects that were previously proposed as well as any public feedback related to the proposed projects.
2. Develop screening criteria and rank the previously proposed major projects with consideration to metrics such as project cost, design life, maintenance, feasibility, constructability, public benefit, and public safety.
3. Score the projects and identify the top four (4) for detailed H&H evaluation and benefit-cost evaluation.
4. Proposed Alternatives H&H Analysis
   a. Update the relevant hydrologic and hydraulic model based on the proposed improvements.
   b. Evaluate the effectiveness of the proposed improvements by comparing flows, WSELs, and inundation limits. Changes in peak flows and WSEL will be evaluated throughout the entire model to ensure no negative impacts.
   c. Identify project right-of-way needs, environmental constraints, utility challenges, and other potential issues that may hinder implementation

B. Secondary Flood Mitigation Alternatives

1. Develop additional alternative projects that were not previously identified. Projects may include large regional detention facilities, channel modifications, sedimentation removal, and home buyouts.
2. Rank alternatives based on the screening criteria developed in Task VII.A.2
3. Score the projects and identify the top five (5) for detailed H&H evaluation and benefit-cost evaluation
4. Proposed Alternatives H&H Analysis
   a. Update the relevant hydrologic and hydraulic model based on the proposed improvements. If the proposed project is along the West Fork SJR, Spring Creek, or Lake Creek, the unsteady models will be utilized. If the proposed improvement is along one of the other modeled streams, the steady state models will be used.
   b. Evaluate the effectiveness of the proposed improvements by comparing flows, WSELs, and inundation limits. Changes in peak flows and WSEL will be evaluated throughout the entire model to ensure no negative impacts.
   c. Identify project ROW needs, environmental constraints, utility challenges, and other potential issues that may hinder implementation

C. Benefit Cost Analysis

1. Estimate expected annual flood damages using HEC-FDA for the existing conditions as well as the proposed alternative scenarios; the analysis will focus on the studied streams only and depth-damage information will be based on USACE curves.
2. Prepare a conceptual level cost estimate for each of the flood reduction projects modeled.
3. Determine estimated costs associated with buyout areas; utilize available County Appraisal District information.
4. Identify potential benefits by subtracting the alternative flood damages from the existing (without project) damages. The difference between the two will be considered the benefit.

D. Alternative Funding Opportunities – Potential alternative funding opportunities using grant or loan programs (HMGP, CDBG, CWA-SRF, etc.) will be identified, evaluate the funding source requirements and applicability to specific projects, and provide recommendations for funding candidates

E. Project Implementation – Provide HCFCD, SJRA, and MCO with a list of recommended flood reduction projects and/or strategies and specific information related to implementation.

1. Provide project description, costs, Right-of-way needs, potential project constraints (environmental, utility, etc.), and a timeframe for implementation.
2. Develop a plan to implement recommended projects and/or buyout programs within the basin.
3. Identify the highest priority project and develop a preliminary scope of work for a Preliminary Engineering Report; Cite critical tasks such as environmental assessment and permitting, right-of-way acquisition, utility relocation, and additional detailed H&H analysis that will be required to implement the project in a timely fashion.

F. Vegetation and Sediment Control – One of the key strategies that will be evaluated to help reduce flood risk is the development and implementation of a maintenance plan to help control sedimentation and vegetative growth along the major streams included in this study, particularly along the West Fork of the San Jacinto.

1. Coordinate with SJRA and HCFCD Facilities Maintenance Department.
2. Review and update the *Lake Houston Watershed Flood Program* report prepared by Brown & Root Services (June 2000).
3. Review previous sedimentation reports and update as necessary.
4. Leverage the Lake Houston report and others to develop a sediment management strategy for during and after flood events for West Fork San Jacinto River and Spring Creek.
5. Determine the agency or agencies that are responsible for desilting and vegetative debris removal efforts in the West Fork San Jacinto River. Develop a draft memorandum of understanding for the agencies to consider.
6. Develop a document discussing the history of sand mining operations in the basin.

a. Review aerial photography and available topography to observe changes in the stream alignments for the West Fork San Jacinto River and Spring Creek.
b. Identify potential sources of sedimentation in Spring Creek and West Fork San Jacinto River.
c. Review changes in sand mining operations along the West Fork San Jacinto River, including changes in regulations that the sand mining operations are required to follow.
d. Submit technical report detailing the process and findings.

7. Determine the floodplain impacts of desilting and debris removal.

G. Task Deliverables

1. Technical memorandum detailing the alternatives identified for evaluation.
2. Technical memorandum detailing the alternatives evaluated; include project type and configuration, comparison to existing model, expected reduction in damages, expected implementation costs, ROW needs, and constraints.
3. Inundation maps will be prepared to illustrate the extent and depth of the floodplain along the studied streams for the analyzed storm events with the proposed alternatives in place.
4. Additionally, estimates of the number of structures located within the analyzed floodplains, as well as the acres of land and miles of roadway that become inundated by the floodplain generated by the analyzed storm events with the recommended flood mitigation measures in place.
5. Memorandum discussing potential alternative funding sources.
6. Memorandum detailing the proposed implementation plan for recommended projects and identification of the highest priority project with a preliminary scope of work.
7. Document discussing history of mining operations along the West Fork San Jacinto River.
8. Document detailing the proposed sediment management strategy.

IX. COMMUNITY OUTREACH AND EDUCATION

A. Public Education –Assist with the development of educational materials specifically related to the San Jacinto River Basin including, but not limited to, the following:

1. Preparing basic exhibits showing the contributing drainage area and streams, inundation mapping based on the effort completed in Tasks III and IV, roadway crossings, etc.
2. Prepare narratives for educational materials which provide a general description of the watershed characteristics, area, history of flooding, intent of the study, etc.
3. Provide graphics for websites, social media, and video preparation.
4. It is understood that HCFCD, SJRA, and MCO will provide guidance and the ultimate decision about what material is presented in the educational materials.

B. Task Deliverables

1. Exhibits, graphics, narratives and other materials generated as part of the public education effort

X. FINAL DELIVERABLES

A. Draft Report – Three copies (3) of a draft report detailing each of the tasks included in the scope will be provided and will include the following components:

1. Executive Summary providing an overview of the study tasks, findings and recommendations
2. Study narrative detailing each of the tasks listed in the scope including assumptions, procedures, findings, and recommendations. A section including preliminary recommendations for implementation of projects and tasks will be provided
3. Figures and Tables within the narrative providing graphic information relevant to the associated narrative section
4. Exhibits showing necessary information including, but not limited to project location, FEMA mapping, existing and revised drainage areas, land uses, parameter development, existing inundation for frequency and historical storms, potential flood mitigation projects, critical facilities and evacuation routes, and other information
5. Each of the technical memorandums provided will be included as an Appendix and referenced throughout the narrative. These include information about the data collection and review, model development, model calibration, flood warning system enhancements, flood response planning, lake operations, vegetation and sediment control, and public education efforts

B. Final Report – Three (3) copies of the final report will be submitted following a review and comment period by HCFCD, SJRA, and MCO. Comments on the draft report will be addressed and incorporated into the final report before final submittal.

C. Supporting Data – The following data will be provided with the Final Report delivery

1. Provide a complete PDF copy of the final report with bookmarks
2. Provide individual PDF versions of all exhibits and appendices
3. Provide spreadsheets used for parameter calculation, results tables, cost estimates, etc. in Microsoft Excel 2016
4. Provide final versions of the HEC-HMS and HEC-RAS models in the most current versions
5. Provide supporting GIS data in geodatabase format
6. Provide photographs in a digital format converted to JPEG. Images shall have a resolution not lower than 1024 X 768.