SJRA
SAN JACINTO RIVER AUTHORITY

March 18, 2022

Mr. Cody Ransone, CFM, CTCM
Flood Mitigation Grant Coordinator
Texas Water Development Board

Re: Flood Early Warning System for San Jacinto County
Flood Infrastructure Fund – Category 4
Engineering Feasibility Report

Dear Mr. Ransone:

This letter report supplements the Preliminary Engineering Feasibility Report ("PEFR") for the Flood Early Warning System for San Jacinto County, prepared by Halff Associates, Inc. and dated December 21, 2020. This letter report documents progress made on the project since the PEFR was developed, as well as changes/deviations related to the required information per Article II, Item 6 of the grant contract between the Texas Water Development Board (TWDB) and the San Jacinto River Authority (SJRA). **This letter report, and all attachments included herein, shall serve as the Engineering Feasibility Report (EFR) for the project.** During the course of the project, if there are any substantive changes or deviations from this EFR, the EFR will be updated, and TWDB will be notified prior to the project's completion; in the case of a substantive change to equipment to be installed/constructed, TWDB will be notified prior to installation/construction.

Supplemental information attached to this letter report includes:

- **Appendix A** – "Preliminary Engineering Feasibility Report, Flood Early Warning System for San Jacinto County" by Halff Associates, Inc., dated December 21, 2020;
- **Appendix B** – "Determination of No Effect" issued by the Texas Water Development Board, dated May 5, 2021;
- **Appendix C** – Path Analysis Study Report by Distinctive AFWS Designs, Inc., dated January 12, 2022;
- **Appendix D** – Preliminary TxDOT Drawings for installation of flood early warning system equipment, by SJRA, dated March 17, 2022.

Project Description and Purpose

The project description and purpose has not changed from that which is stated in the PEFR, with the exception that it appears, based on the report by Distinctive AFWS Designs, Inc. (Appendix C), infeasible to install rain gaging equipment at one site due to heavy tree coverage which would render the data inaccurate (East Fork San Jacinto River at FM 945). The elimination of rain gaging capabilities at one of the sites does not change the primary purpose of the project, which is to provide flood early warning downstream of the project locations, which will be provided primarily

through the streamgages to be installed at each site. San Jacinto County has indicated that the elimination of rain gaging at the East Fork San Jacinto River site is acceptable to the County.

Entities to be Served and Current and Future Populations

There are no changes from the PEFR with respect to entities and population to be served by the project. As stated in the PEFR, the beneficiary of the proposed project is the entire current population of San Jacinto County, as well as the future population of the County.

Project Cost

The PEFR estimated the total project cost to be approximately $65,000.00, including a cost split between Project Management ($8,338.00) and Equipment Installation ($56,662.00; "Construction" in the grant agreement between SJRA and TWDB). No changes to the total project cost have been determined at this time. SJRA will coordinate with TWDB regarding any future changes to total project cost, or to the split between Project Management and Construction.

The tables below provide additional breakdown of the budget; if SJRA performs more than the anticipated $16,000 in in-kind contribution, the SJRA cash amount may be reduced.

Sources of Funding	Amount	Percent of Total Project Cost
SJRA Cash	$900.00	1.4%
SJRA In-Kind Contribution	$16,000.00	24.6%
TWDB FIF Grant	$48,100.00	74%
TOTAL PROJECT COST	**$65,000.00**	**100%**

The table below shows the estimated project budget broken out by Task.

Task	Description	TWDB Amount	In-Kind Amount	Local Amount	Total Amount
1	Project Management	$0.00	$8,338.00	$0.00	$8,338.00
2	Construction	$48,100.00	$7,662.00	$900.00	$56,662.00
	TOTAL	**$48,100.00**	**$16,000.00**	**$900.00**	**$65,000.00**

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Description of Alternatives Considered and Reasons for the Selection of the Proposed Project

The San Jacinto Regional Watershed Master Drainage Plan (SJMDP), referenced in the PEFR, has now been completed. The final SJMDP recommends installation of 26 flood warning gages across the Upper San Jacinto River Basin, including one of the gages to be installed via this project (Winters Bayou at SH 150). The SJDMP recommends rainfall, stage, and flow be measured at this site. SJRA plans to install rainfall and stage gaging equipment at this site, but flow will not be measured at this time. If flow gaging is determined to be beneficial in the future to San Jacinto County or a downstream stakeholder, a rating curve could potentially be developed to provide flow estimation at the site. However, additional infrastructure (such as a concrete-lined portion of stream channel) could be required to ensure the accuracy of the rating curve and flow measurements.

Evaluation of Engineering Feasibility of the Proposed Project

In evaluation of engineering feasibility of the proposed project, the PEFR indicated the proposed project is feasible from an engineering perspective. The PEFR also included the following phrasing regarding proposed equipment, including type of streamgages:

> *"SJRA intends to use instream gages at each location. However, SJRA may choose to use radar gages at one or more locations depending on site-specific requirements, such as permitting or physical constraints. The equipment vendor will recommend the necessary equipment for each location."*

SJRA recently contracted with Distinctive AFWS Designs, Inc. to conduct a Path Analysis Study (the "Study") to evaluate each of the proposed gage sites, determine site constraints, and recommend equipment for each site. The Study took into consideration site conditions, ability of radio signals to travel from each site to SJRA's existing radio receiver and repeater locations, data accuracy, and overall usefulness of the new data. The most significant result of the Study was the recommendation for radar gages in lieu of instream streamgages for all three sites. The Study is attached as **Appendix C**. A site-by-site summary of the results of the Study is as follows:

<u>Peach Creek at FM 3081</u>

- Recommended gage shelter location is southeast (downstream) corner of bridge; on-site radio test was successful for this location;
- Recommend mounting sensor gage above flood level;
- Due to shifting path of the creek, potential impact of flood debris, and general reliability and durability concerns about instream pressure transducer streamgages, a

radar gage is recommended over an instream pressure transducer streamgage at this site;

- Solar coverage is limited by nearby tree line; recommend trimming nearby trees for improved rain measurements and accurate data collection. ***[NOTE: SJRA intends to hire a contractor to perform tree trimming at this location due to proximity of trees to overhead power lines; SJRA has obtained right of entry from neighboring landowner to obtain access to trim trees]***

Winters Bayou at FM 150

- Recommended gage shelter location is on southwest (downstream) corner of bridge; on-site radio tests found that signals did not reach both of SJRA's receiver/repeater sites at optimal levels; ***[NOTE: SJRA will mitigate by use of a directional antenna at this site]***
- Recommend mounting sensor gage above flood level;
- Due to general reliability and durability concerns about instream pressure transducer streamgages, a radar gage is recommended over an instream pressure transducer streamgage at this site;
- Study recommends clearing trees near the channel for a clear radar path. ***[NOTE: Rather than clear trees, SJRA will TRIM trees/brush along the channel at this site; no full trees, shrubs, etc. will be removed]***

East Fork San Jacinto River @ FM 945

- Recommended gage shelter location is on southwest (downstream) side of bridge; on-site radio tests found a power amplifier was required to reliably receive data from this site; use of a power amplifier and/or use of a directional antenna instead of an omnidirectional antenna (as was used in the path analysis) is anticipated to be required to improve the signal at this site;
- No tree trimming or clearing is required for the site;
- A rain gage is NOT recommended at the site due to overhead vegetation likely blocking precipitation at the site and leading to inaccurate measurements.
- Recommend mounting sensor gage above flood level;
- Due to the tendency for the stream to move and difficulty of access to the bridge for maintenance, as well as general reliability and durability concerns about instream pressure transducer streamgages, a radar gage is recommended over an instream pressure transducer gage at this site;

For installation of equipment at all sites, SJRA intends to follow the recommendations described in the Path Analysis Study, with the exception of trimming vs. clearing trees at the Winters Bayou site. All proposed work in the project will be in accordance with the TWDB environmental requirements described in the Determination of No Effect (**Appendix B**), including tree/brush

trimming at the Peach Creek and Winters Bayou sites. SJRA will coordinate with TxDOT and private landowners for trimming of trees, including obtaining access/right-of entry during this project for initial trimming efforts, as well as for continued maintenance trimming.

The Texas Department of Transportation (TxDOT) has notified SJRA that the bridge at the East Fork San Jacinto River site is scheduled for replacement in May 2024. If the bridge is replaced, SJRA will coordinate with TxDOT to remove streamgage equipment from the existing bridge prior to construction, and SJRA will re-permit with TxDOT and re-install equipment on the new bridge. SJRA will also coordinate with San Jacinto County during this process.

Project Location Maps and Drawings

The PEFR included seven (7) exhibits consisting of maps and figures showing the overall project location, location of each gage site, and details of the proposed gage shelter layout and installation. Additionally, SJRA has prepared preliminary drawings to be submitted for review and approval by TxDOT. Following TxDOT approval, SJRA staff will perform the equipment installation at all sites. The TxDOT drawings supersede the PEFR exhibits. As per the TxDOT drawings, locations of proposed equipment as shown on the drawings are approximate and may vary based on site conditions encountered during installation. The Preliminary TxDOT Drawings are attached as **Appendix D**.

Major exceptions between the PEFR and the TxDOT drawings that supersede it are as follows:

- All sites will utilize radar-type streamgages in lieu of instream streamgages;
- All sites will utilize 10-watt solar panels in lieu of 5-watt panels;
- The East Fork San Jacinto site will NOT include the rain gage shown in Exhibit 7 of the PEFR.

Sincerely,

Gregory R. Lushbaugh, P.E.
Project Manager 2
San Jacinto River Authority

Cc: Matt Barrett, PE, SJRA
Briana Gallagher, PMP, SJRA

STATE OF TEXAS
GREGORY R. LUSHBAUGH
90211
LICENSED
PROFESSIONAL ENGINEER
03/18/2022

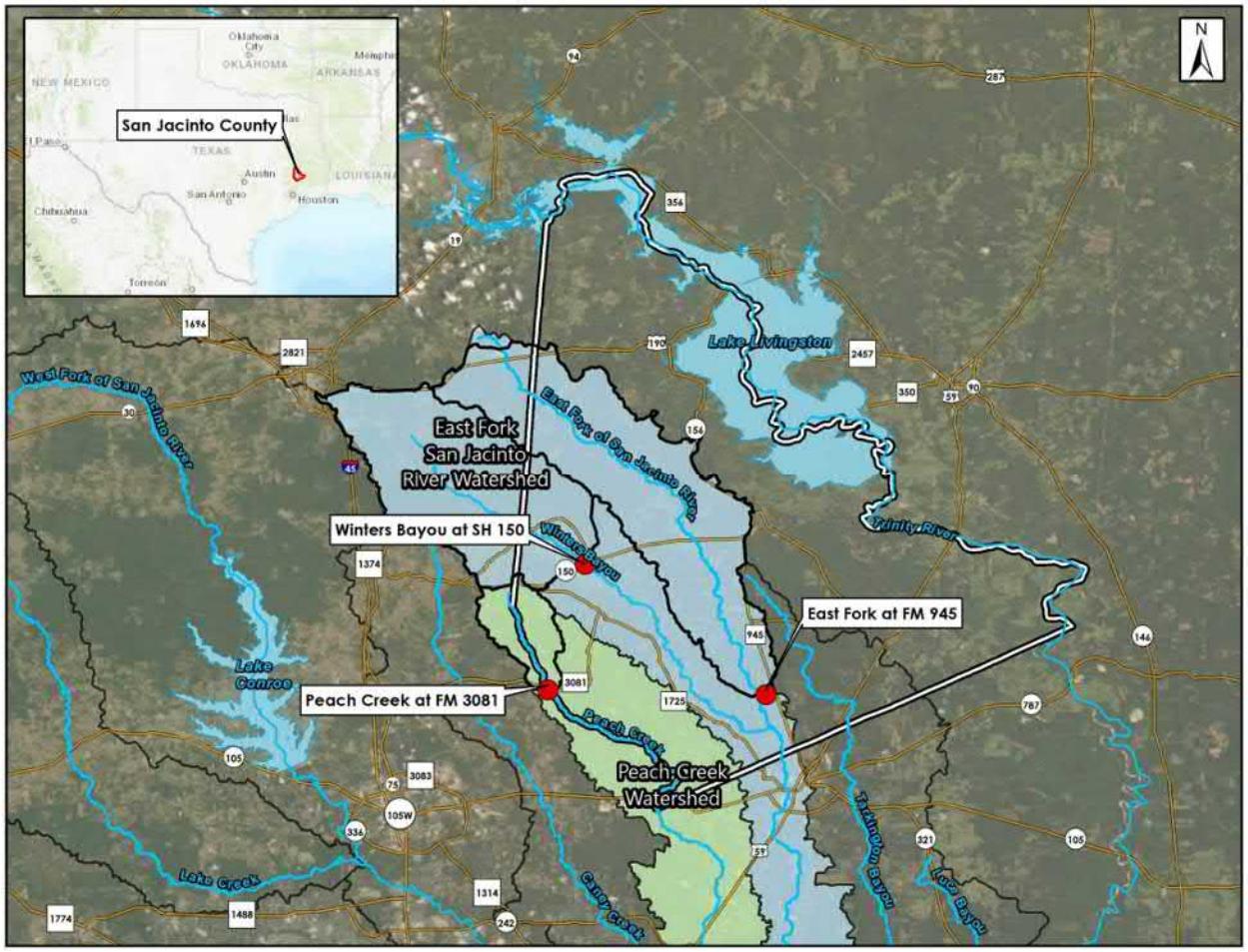
ADMINISTRATIVE OFFICES	LAKE CONROE DIVISION	GRP DIVISION	WOODLANDS DIVISION	HIGHLANDS DIVISION	FLOOD MANAGEMENT DIVISION
P.O. Box 329	P.O. Box 329	P.O. Box 329	2436 Sawdust Road	P.O. Box 861	P.O. Box 329
Conroe, Texas 77305	Conroe, Texas 77305	Conroe, Texas 77305	The Woodlands, Texas 77380	Highlands, Texas 77562	Conroe, Texas 77305
(T) 936.588.3111	(T) 936.588.1111	(T) 936.588.1662	(T) 281.367.9511	(T) 281.843.3300	(T) 936.588.3111
(F) 936.588.3043	(F) 936.588.1114	(F) 936.588.7182	(F) 281.362.4385	(F) 281.426.2877	(F) 936.588.3043

APPENDIX A

Preliminary Engineering Feasibility Report

HALFF

AVO 42346
December 2020



Prepared for the San Jacinto River Authority

PRELIMINARY ENGINEERING FEASIBILITY REPORT

Flood Early Warning System for San Jacinto County

HALFF

Firm Registration No. 312

PRELIMINARY ENGINEERING FEASIBILITY REPORT

FLOOD EARLY WARNING SYSTEM FOR SAN JACINTO COUNTY

SAN JACINTO RIVER AUTHORITY, TEXAS

Prepared by

HALFF ASSOCIATES, INC.

AVO 42346
December 2020

December 21, 2020
AVO 42346

Briana Gallagher
Project Coordinator, Flood Management Division
San Jacinto River Authority
PO Box 329
Conroe, TX 77305

Re: Preliminary Engineering Feasibility Report for Flood Early Warning System for San Jacinto County

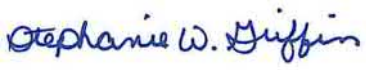
Dear Ms. Gallagher:

Halff Associates, Inc. is pleased to submit the enclosed report to the San Jacinto River Authority (SJRA) documenting the Preliminary Engineering Feasibility of the Flood Early Warning System for San Jacinto County. This report summarizes the results of the feasibility study performed.

Please forward the report to the Texas Water Development Board to accompany the Flood Infrastructure Fund Category 4 grant application that SJRA submitted in October. Halff Associates, Inc. appreciates the opportunity to be of service to you and the San Jacinto River Authority on this important project. Please call if you have any questions or concerns regarding this project.

Sincerely,

HALFF ASSOCIATES, INC.



Stephanie W. Griffin, P.E., CFM
Senior Project Manager

Letter of Transmittal

To Briana Gallagher
San Jacinto River Authority
PO Box 329
Conroe, TX 77305

From Stephanie Griffin **Date** December 21, 2020
Email sgriffin@halff.com **AVO** 42346

We are sending you

☒ Attached ☐ Under separate cover via _____

the following

☐Shop Drawings ☐Prints ☐Plans ☐Drawings ☐Specifications
☐Copy of Letter ☒Report(s) ☐CD/DVD ☐Other: _____

via

☐Hand Delivery ☐USPS ☐Courier ☐Overnight Express

These are transmitted

☐For approval ☐Approval as submitted ☐Resubmit _____ copies for approval
☒For your use ☐Approved as noted ☐Submit _____ copies for approval
☐As requested ☐Returned for corrections ☐Return _____ corrected prints
☐For review/comment ☒Other: Submittal to TDWB

Items sent:

- Preliminary Engineering Feasibility Report for Flood Early Warning System for San Jacinto County

Comments

I have prepared the PEFR according to the instructions provided by the Texas Water Development Board as a requirement for the Flood Infrastructure Fund Category 4 grant application. Please submit this file to the TWDB so that the Board can complete its review and approval of the FIF funding.

Signed: Stephanie W. Griffin

Copies
☐File ☐Owner ☐Contractor ☐Other: _____

Halff Associates, Inc.
4000 Fossil Creek Blvd | Fort Worth, Texas | 76137-2729
Phone: (817) 813-5704

Table of Contents

Executive Summary

San Jacinto River Authority (SJRA) intends to expand its existing rain and stream gage system with the addition of three new gages. The proposed locations do not currently have any gaging instrumentation or information. However, SJRA believes its current network is sufficient to collect the data from the new hardware and publish it on the SJRA Contrail website.

The locations were selected based on previous flood and flood response experiences in these areas. The proposed new rain and stream gages will provide advance warning information to the public and emergency responders such that they can take appropriate actions and provide appropriate instructions based on the conditions at the time. The advanced warning will also allow emergency responders time to prioritize the dispatch of first responders.

1. Project Description and Purpose

San Jacinto County has identified three locations as critical for flood early warning capabilities as shown in Exhibit 1.

- Winters Bayou at SH 150
- Peach Creek at FM 3081
- East Fork San Jacinto River at FM 945

The proposed project includes the purchase and installation of three new rain and stream gages and associated equipment and appurtenances within San Jacinto County. The County selected these locations based on the impacts of previous flood events.

The purpose of the proposed project is to provide early warning notification to residents, businesses, property owners, etc. downstream of the proposed gage locations, as well as county emergency personnel and responders, protecting life and allowing protection of property which can be moved to a safe location with adequate warning. Per San Jacinto County, the areas downstream of the proposed gages have been impacted by several previous storm events, including Hurricanes Harvey, Rita, and Ike, as well as storms in 1994, 1998, 2015, and 2016, causing road closures, high water rescues, etc. These have historically been low population areas but are growing rapidly. The early warning system could reduce the burden on county emergency services by reducing the necessary number of high water rescues during a flooding event, and could give emergency responders more time to close roads before they become flooded, therefore benefitting more than just the residents and businesses directly downstream of the proposed gages.

2. Entities to be Served and Current and Future Populations

The entire population (27,819 according to the 2018 US Census Bureau) of San Jacinto County is the beneficiary of the proposed Flood Early Warning System (FEWS) project. The future population of San Jacinto County will also benefit from the FEWS project as it is intended to be maintained for the long-term. The FEWS project will provide San Jacinto County staff and emergency responders with notice regarding rising waters that will allow them to determine appropriate emergency responses to protect nearby residents and businesses. The warnings will provide the county with information for potential road closures, evacuation needs, etc. The county will know from these gage warnings when areas downstream are in jeopardy of flooding. Real-time water level data is anticipated to reduce the burden on

county-wide emergency services by providing current condition information that allows county staff time to implement preventive actions which can reduce high water rescues, etc.

San Jacinto County potentially could use the information from the flood warning system to send reverse 911 calls to residents and businesses downstream or within the vicinity of these three gages to inform them on appropriate emergency responses, such as evacuation or shelter-in-place.

Another project benefit includes providing real-time data to downstream areas, including Harris County Flood Control District (HCFCD), who can use the information to know about potential flooding conditions heading towards them.

3. Project Cost

The San Jacinto River Authority (SJRA) estimates the project cost to be approximately $65,000.00. The primary project cost line items include project management and equipment as shown in Table 1. Project Management includes the day-to-day management of the project, grant paperwork/reports, invoices, in-kind services tracking, public communication efforts, etc. Equipment Installation includes the purchase, installation, calibration and testing, of the three rain/stream gage equipment and appurtenances. Equipment Installation also includes incorporating the gages into the SJRA's Contrail website where the rain and stream gage data will be visible to the public. Any professional or other outside services required to complete the project is also included in this task. and

Table 1: Estimated Project Costs

Task	Description	Amount
1	Project Management	$8,338.00
2	Equipment Installation	$56,662.00
Total		**$65,000.00**

SJRA qualified for a 74% Flood Infrastructure Fund (FIF) grant with a 26% local match. The Texas Water Development Board (TWDB) offered SJRA the option of applying for a 0% interest loan in lieu of the local match. SJRA will be providing the majority of the 26% local match via in-kind services with the remainder coming from the Flood Management Division budget. The San Jacinto River Authority will not use the 0% interest loan option.

4. Description of Alternatives Considered and Reasons for the Selection of the Proposed Project

San Jacinto County specifically requested SJRA to pursue flood early warning capabilities at these three proposed gage locations based on the impacts of recent storms. SJRA did not consider any other alternative projects.

SJRA has coordinated with HCFCD for many years regarding the two parties' gage networks and potential sites for additional gages. SJRA shares its gage data with HCFCD, which provides data on conditions upstream of HCFCD's service area.

SJRA and HCFCD, along with Montgomery County and the City of Houston, recently coordinated on the San Jacinto Regional Watershed Master Drainage Plan project. This joint study is still in progress but is nearing completion. The

draft report from the study recommends 25 additional gages be installed within the Upper San Jacinto River Basin, including one of the gages proposed as part of SJRA's FIF-funded grant project. The proposed project sites will provide HCFCD with early warning information on rainfall and stream levels upstream of their service area. HCFCD has considered installing gages in San Jacinto County but has not done so to date. The gages proposed in SJRA's grant project may eliminate the need for some of the gages previously considered by HCFCD or could potentially supplement future HCFCD gages.

5. Evaluation of Engineering Feasibility of the Proposed Project

In reviewing the proposed equipment to be installed at the 3 water crossings, adverse impacts to the existing structures are not expected. The existing structures are designed to take AASHTO live loading as well as wind and water loading. The small area and minimal additional weight that would be added through the installation of the proposed devices will not impact the factor of safety of the bridge components. Therefore, the proposed project is considered to be feasible from an engineering perspective.

SJRA intends to use instream gages at each location. However, SJRA may choose to use radar gages at one or more locations depending on site-specific requirements, such as permitting or physical constraints. The equipment vendor will recommend the necessary equipment for each location.

6. Project Location Maps and Drawings

The San Jacinto River Authority (SJRA) intends to add three new rain and stream gages to its existing flood early warning system (FEWS) as shown in Exhibit 1. The locations include Winters Bayou at SH 150, Peach Creek at FM 3081 and East Fork San Jacinto River at FM 945. Two of the gages will be located in the East Fork San Jacinto River Watershed and one gage will be located in the Peach Creek Caney Creek Watershed. The following maps are included in Attachment 1 of this report:

- Exhibit 1: Project Location Map
- Exhibit 2: Aerial View of Winters Bayou at SH 150
- Exhibit 3: Aerial View of Peach Creek at FM 3081
- Exhibit 4: East Fork San Jacinto at FM 945
- Exhibit 5: Topographic Map
- Exhibit 6: FEMA Floodplain Map
- Exhibit 7: Proposed Pelco Breakaway System

Exhibits 2 through 4 provide aerial views of each of the three proposed sites. Exhibit 5 presents the topographic information of the proposed study area while Exhibit 6 overlays the study area on the FEMA floodplain. Exhibit 7 includes diagrams of the proposed rain and stream gage equipment for each of the three locations.

7. Conclusion

The San Jacinto River Authority (SJRA) continues to work with neighboring jurisdictions to better inform and warn the public and first responders of potential flooding conditions. The proposed rain and stream gages will provide flood warning information for San Jacinto County, as well as the downstream Harris County Flood Control. The public and first responders will have real-time gage data to aid in making decisions regarding public and property safety with notice during a flood event.

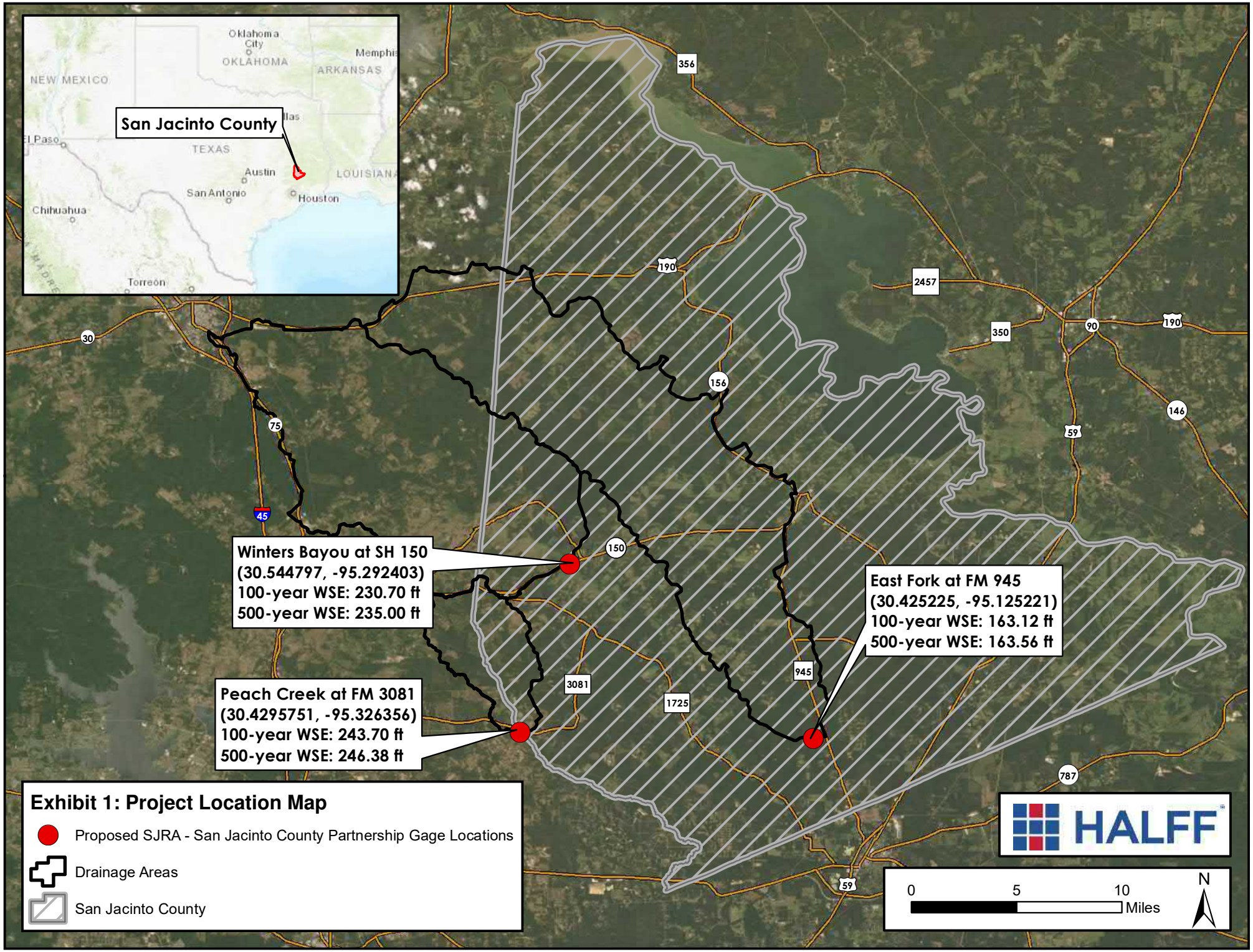
References

Halff Associates, Inc. *San Jacinto Regional Watershed Master Drainage Plan*, Prepared for the San Jacinto River Authority, September 2020.

HALFF

Preliminary Engineering Feasibility Report
Flood Early Warning System for San Jacinto County

ATTACHMENT 1
EXHIBITS


San Jacinto County
Oklahoma City
OKLAHOMA
Memphis
ARKANSAS
NEW MEXICO
El Paso
TEXAS
Austin
LOUISIANA
San Antonio
Houston
Chihuahua
Torreón
Winters Bayou at SH 150
(30.544797, -95.292403)
100-year WSE: 230.70 ft
500-year WSE: 235.00 ft
East Fork at FM 945
(30.425225, -95.125221)
100-year WSE: 163.12 ft
500-year WSE: 163.56 ft
Peach Creek at FM 3081
(30.4295751, -95.326356)
100-year WSE: 243.70 ft
500-year WSE: 246.38 ft
Exhibit 1: Project Location Map
Proposed SJRA - San Jacinto County Partnership Gage Locations
Drainage Areas
San Jacinto County
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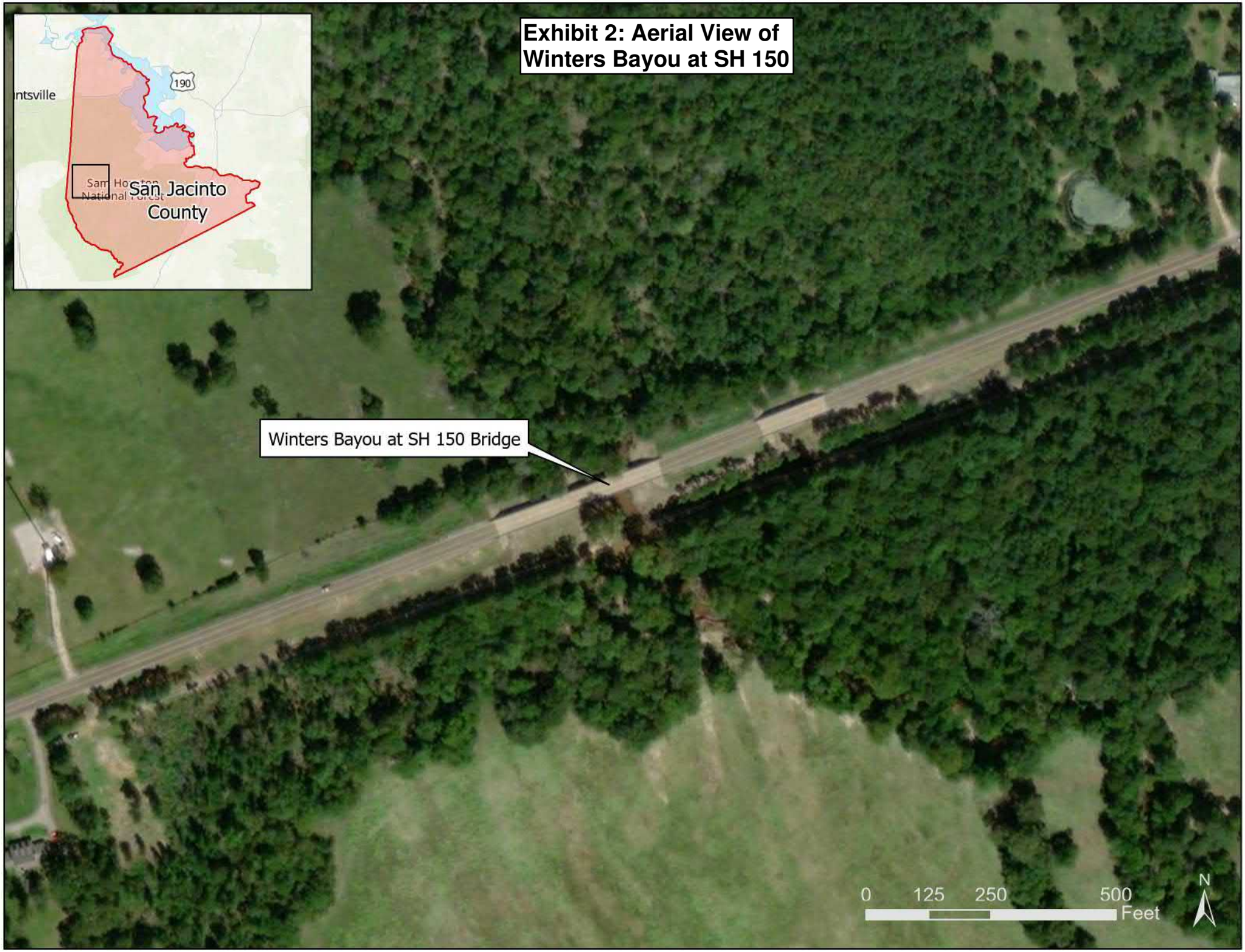
Exhibit 2: Aerial View of Winters Bayou at SH 150
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San Jacinto County
Winters Bayou at SH 150 Bridge
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Exhibit 3: Aerial View of Peach Creek at FM 3081
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San Jacinto County
Peach Creek at FM 3081 Bridge
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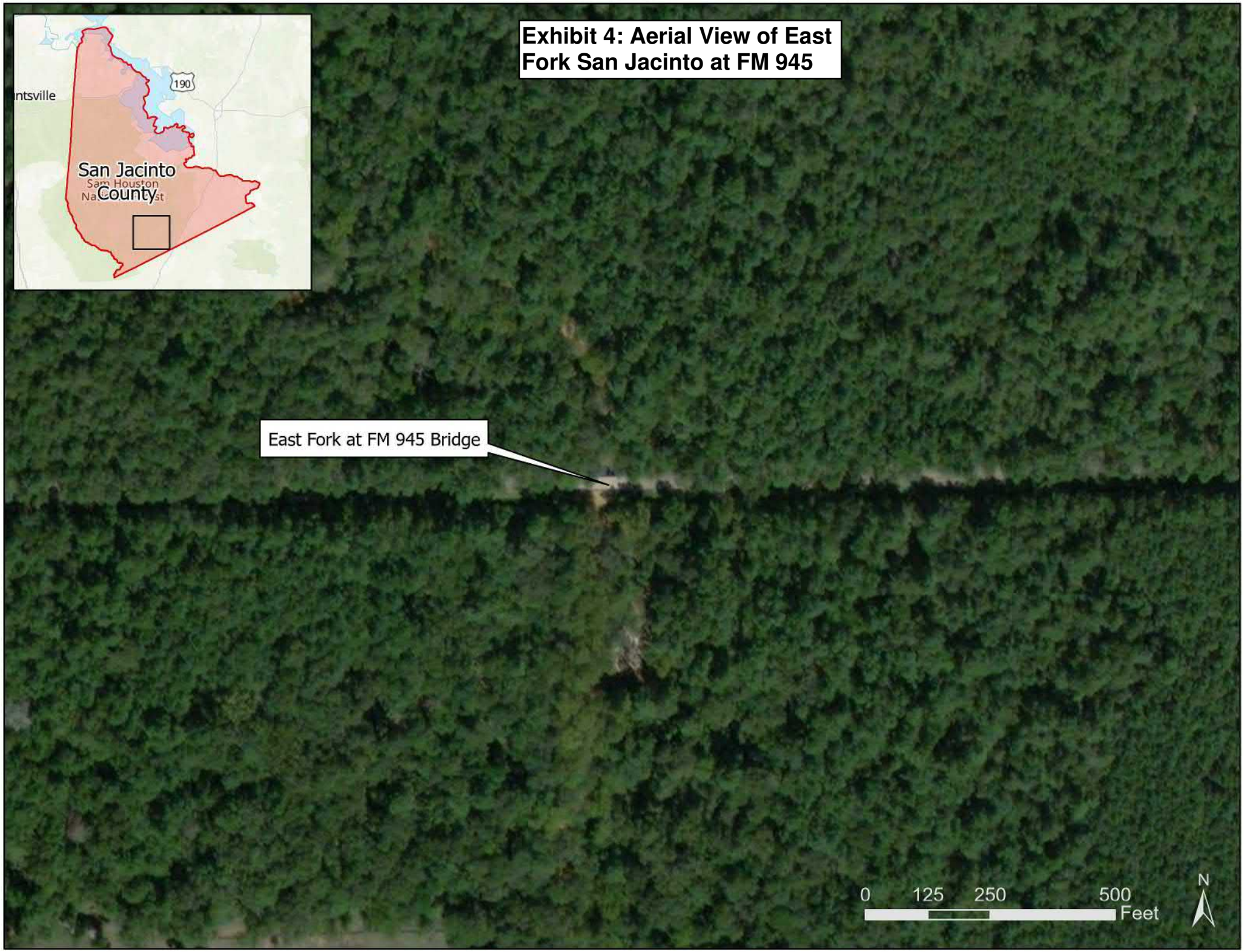
Exhibit 4: Aerial View of East Fork San Jacinto at FM 945
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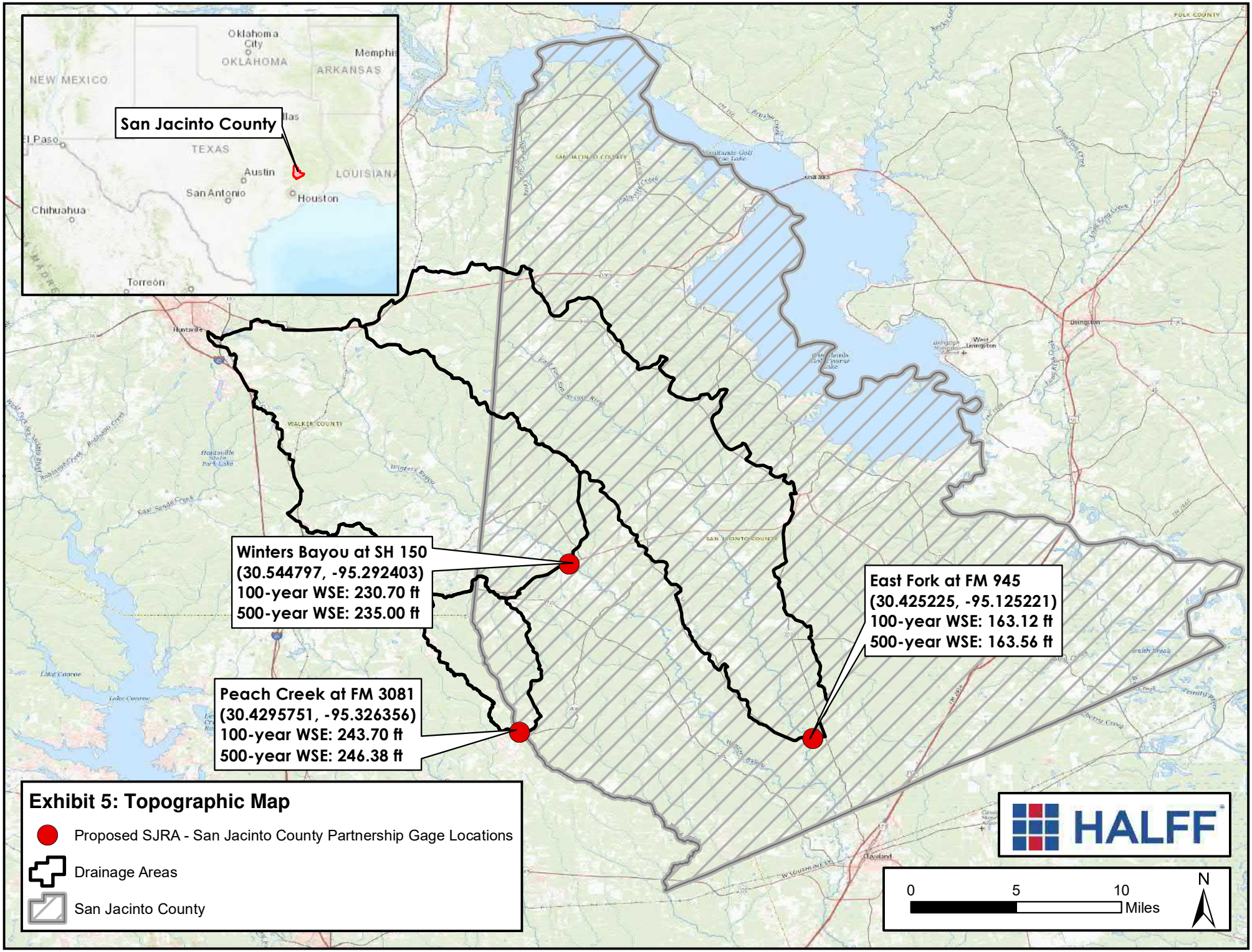
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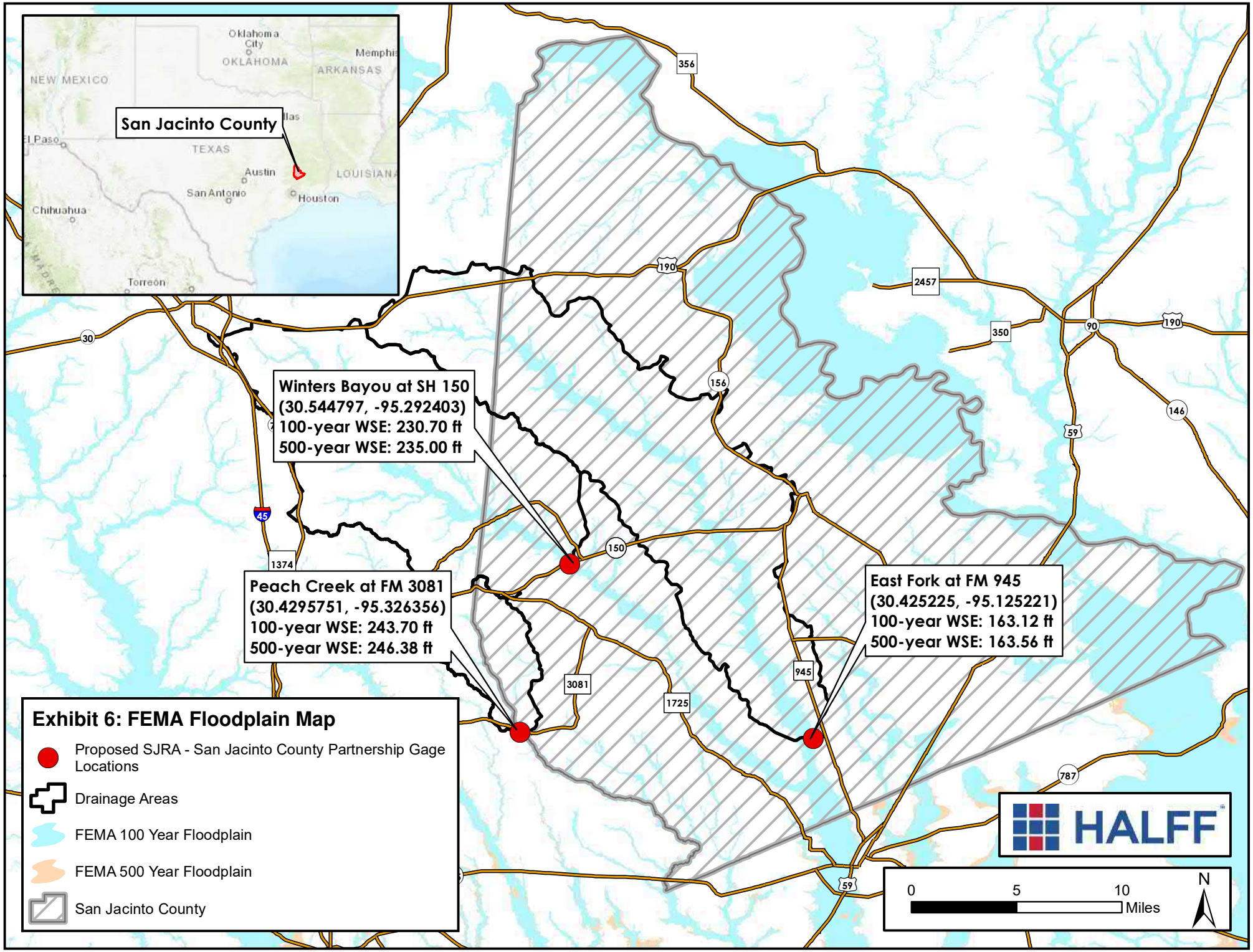
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FEMA 500 Year Floodplain
San Jacinto County
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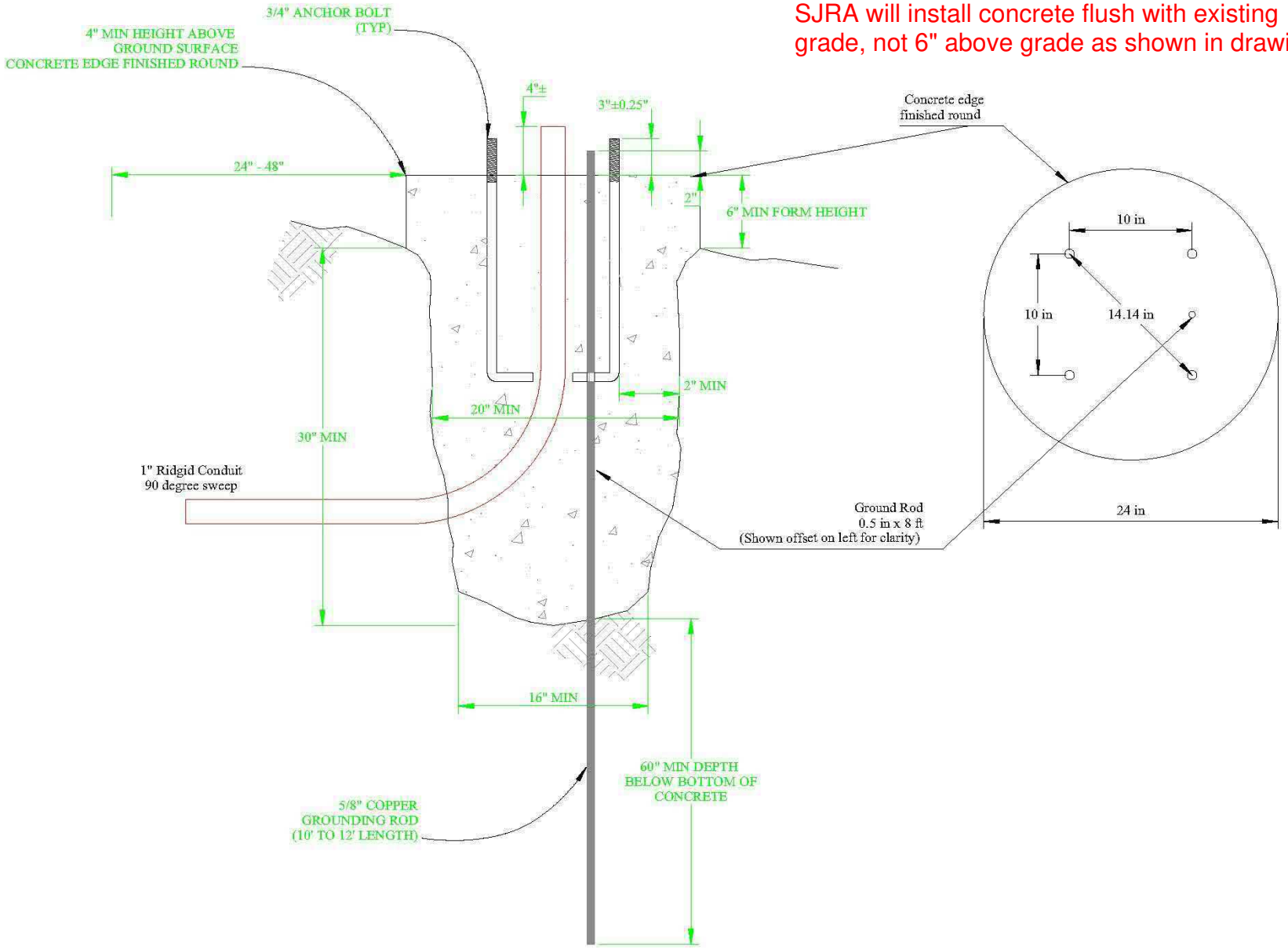
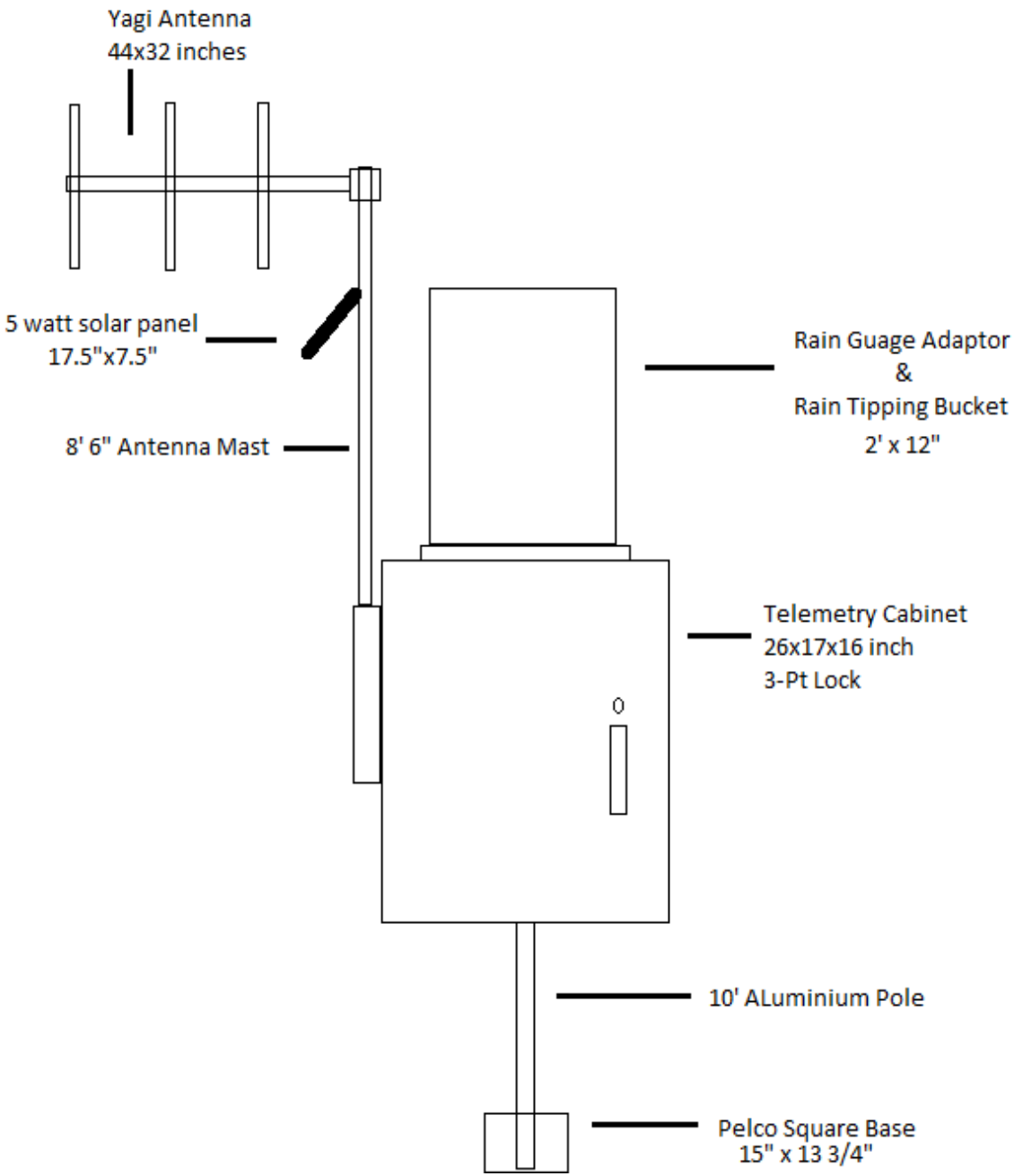
Exhibit 7: Proposed Pelco Breakaway System

SJRA will install concrete flush with existing grade, not 6" above grade as shown in drawing.




Yagi Antenna
44x32 inches
5 watt solar panel
17.5"x7.5"
8' 6" Antenna Mast
Rain Guage Adaptor
&
Rain Tipping Bucket
2' x 12"
Telemetry Cabinet
26x17x16 inch
3-Pt Lock
10' ALuminium Pole
Pelco Square Base
15" x 13 3/4"

APPENDIX B

Determination of No Effect

Texas Water Development Board

P.O. Box 13231, 1700 N. Congress Ave.
Austin, TX 78711-3231, www.twdb.texas.gov
Phone (512) 463-7847, Fax (512) 475-2053

May 5, 2021

TO ALL POTENTIALLY INTERESTED PARTIES

RE: San Jacinto River Authority, San Jacinto County, Texas
TWDB FIF Project No. 40042
Flood Early Warning System for San Jacinto County

The attached document is being provided for your information. This is not a permit application. No action is required from your agency. This project does not involve federal funds.

The attached document is an environmental determination issued by the Texas Water Development Board (TWDB) for a proposed project to be funded through the TWDB. Pursuant to the environmental assessment requirements of 31 Texas Administrative Code § 363.14, the Executive Administrator of the TWDB has determined that the proposed action described in the attached document may be exempted from formal environmental review requirements. A review by TWDB staff included a consideration of potential environmental impacts and permitting requirements. If there were any concerns about particular regulations or permits, the appropriate regulatory agency would have been contacted for clarification, and this would be described in the attached environmental determination.

Comments regarding this determination may be submitted to the Director of Regional Water Project Development, Texas Water Development Board, P.O. Box 13231, Austin, Texas 78711-3231 or via email at RWPD-Environmental@twdb.texas.gov

Texas Water Development Board

P.O. Box 13231, 1700 N. Congress Ave.
Austin, TX 78711-3231, www.twdb.texas.gov
Phone (512) 463-7847, Fax (512) 475-2053

May 5, 2021

DETERMINATION OF NO EFFECT

TO ALL POTENTIALLY INTERESTED AGENCIES:

Pursuant to the environmental assessment requirements of 31 Texas Administrative Code (TAC) § 363.14, the Texas Water Development Board (TWDB) staff has determined that proposed action identified below may be exempted from formal environmental review requirements:

San Jacinto River Authority, San Jacinto County, Texas
TWDB FIF Project No. 40042
Flood Early Warning System for San Jacinto County
Total Financing Amount: $48,100 (G1001228)

The San Jacinto River Authority (Authority) is proposing to use $48,100 in grant funding from the Flood Infrastructure Fund (FIF) Program to install a flood early warning system (FEWS) that includes three new rain and stream gages for the Authority's existing system. The residents and businesses downstream of the proposed gage sites have been impacted by several previous storm events and do not have any formal advance warning system in place to warn of pending floods. The proposed project may reduce the burden on San Jacinto County (County) emergency services by reducing the number of high water rescues and allow emergency responders more time to close roads before they become flooded. The proposed project will provide early warning notification to residents, businesses, and property owners downstream of the proposed gage locations. The Authority selected the locations based on previous flood events that resulted in road closures and high water rescues. The locations include Winters Bayou at State Highway (SH) 150, Peach Creek at Farm-to-Market (FM) 3081, and East Fork of the San Jacinto River at FM 945. Specifically, the following is proposed to be installed at each location: (1) concrete base; (2) Pelco system; (3) NEMA box; (4) antenna; (5) conduit; (6) transmitter; (7) water level sensor; and (8) rain gage.

At the Peach Creek at FM 3081 and East Fork of the San Jacinto River at FM 945 locations, conduit will be underground from the instrumentation box to the bridge and will transition from underground to hanging from the side of the bridge via clamps.

Once over the stream, the conduit will turn downward and run down to the stream, terminating at the water level sensor. The stream gage sensors will be within the river below the ordinary high watermark. The instrumentation boxes will be installed adjacent to the bridges. Rain gage equipment will be installed at the instrumentation boxes. An approximately 24-inch diameter and 30-inch deep hole will be hand dug for the mounting of the instrumentation box, and a ground rod and anchor bolts will be installed in the hole and filled with concrete to the existing ground surface. An approximately 6-inch wide trench will be dug for the conduit installation. Ideally, the sensors will be placed on the downstream side of the bridges; however, field conditions may dictate that the sensors need to be placed on the upstream side of the bridges.

At the Winters Bayou at SH 150 location, the Authority anticipates the same installation with the only exception that instead of the conduit running down the bridge to the river and sensor in the river, there will be a mount arm on the bridge with a radar sensor to measure the stream data.

The Authority will coordinate with the County and the Texas Department of Transportation (TxDOT) to acquire all necessary permissions to install equipment on County/TxDOT bridges and within County/TxDOT rights-of-way. During equipment installation, the Authority will coordinate with all appropriate entities to provide traffic control, as necessary. The disturbed areas will be reseeded after installations are complete.

To comply with Section 10 of the Rivers and Harbors Act of 1899 and Section 404 of the Clean Water Act, the Authority will abide by the United States Army Corp of Engineers (USACE) Nationwide Permit (NWP) 5 for Scientific Measurement Devices. The NWP 5 is for installation of devices, whose purpose is to measure and record scientific data. Upon completion of the use of the device to measure and record scientific data, the measuring device and any other structures or fills associated with that device must be removed to the maximum extent practicable and the site restored to pre-construction elevations. A pre-construction notification to USACE is not anticipated for the proposed project. Compliance with NWP 5 is a condition on this environmental finding.

All of the gages will be flood-hardened above the 100-year floodplain. The proposed project appears to be partially within the 100-year floodplain, as designated by the Federal Emergency Management Agency (FEMA). Projects involving construction in the 100-year floodplain require a floodplain development permit from the local floodplain administrator. This environmental finding is conditioned so that a floodplain development permit must be obtained prior to TWDB design approval.

Reviews by Regulatory Agencies and Resulting Conditions

In order to ensure that there will be no adverse environmental impacts associated with the construction, the Authority coordinated with the Texas Historical Commission (THC) and the Texas Parks and Wildlife Department (TPWD). No adverse comments were received. A summary of the correspondence is provided below.

Texas Parks and Wildlife Department, Wildlife Division, Wildlife Habitat Assessment Program

The TPWD Wildlife Habitat Assessment Program reviewed the proposed project in accordance with the Texas Parks and Wildlife Code, and provided a response dated December 10, 2020 (TPWD Project No. 45531). The TPWD stated that they have reviewed the submitted documentation and agree with the Authority's assessment that, provided there is employee/contractor training regarding the alligator snapping turtle (*Macrochelys temminckii*), no significant impacts to wildlife or habitats would be anticipated with this project. Based on a review of the documentation and description provided, the Wildlife Habitat Assessment Program does not anticipate significant adverse impacts to rare, threatened, or endangered species, or other fish and wildlife resources. However, it is the responsibility of the project proponent to comply with all federal, state, and local laws that protect fish and wildlife. Provided the project plans do not change, the TPWD considers coordination to be complete.

Based on the TPWD response, the TWDB did not require a formal consultation with the United States Fish and Wildlife Service (USFWS). Pursuant to the conditions of this approval, if a threatened or endangered species is encountered during construction, the Authority's Contractor will immediately cease work in the area of the encounter and notify the Authority, who will immediately implement actions in accordance with the Endangered Species Act and applicable State statutes. These actions will include reporting the encounter to the TWDB, USFWS, and TPWD, obtaining any necessary approvals or permits to enable the work to continue, or implement other mitigation actions. The Contractor shall not resume construction in the area of the encounter until authorized to do so by the Authority.

Texas Historical Commission & City's Historic Preservation Officer

The THC reviewed the proposed project under the Antiquities Code of Texas and responded on November 24, 2020 (THC Tracking No. 202102188). The THC stated that no above-ground historic properties or identified historic properties, archeological sites, or other cultural resources are present or affected by the project as proposed.

Pursuant to the conditions of this approval, if archeological sites are discovered during construction, work will cease immediately in that area and the Authority will notify the owner, THC, and TWDB of the discovery. The Authority will then proceed in accordance with the regulations of the Advisory Council on Historic Preservation (36 CFR Part 800) and Antiquities Code of Texas prior to taking any action which would affect the cultural resources. The Authority's Contractor will take reasonable steps to protect and preserve the discoveries until they have been inspected by the Owner's representative. The Owner will promptly coordinate with the State Historic Preservation Officer and any other appropriate agencies to obtain any necessary approvals or permits to enable the work to continue. The Contractor will not resume work in the area of the discovery until authorized to do so by the Owner.

CONDITIONS AND RECOMMENDATIONS

The decision to grant a Determination of No Effect is allowed because the specified project elements should not cause significant adverse impacts to the quality of the environment. Documentation supporting this determination is on file at the TWDB.

This determination shall be revoked if it is found that:

(1) the project no longer meets the requirements for a categorical exclusion from a full environmental review as a result of changes in the project;
(2) the project involves extraordinary circumstances as described in 31 TAC § 363.14; or
(3) the project may violate or has violated federal, state, local, or tribal laws.

The Authority has committed to the mitigation measures and has the ability and authority to do so. The project also must comply with the following conditions:

- Compliance with the terms and conditions of United States Army Corps of Engineers Nationwide Permit 5 for Scientific Measurement Devices;
- As per agreement with Texas Parks and Wildlife Department (TPWD Project No. 45531) and to ensure compliance with Texas Parks and Wildlife Code and the Endangered Species Act, the Authority will ensure that training will be provided for employee and contractors regarding the State-level threatened alligator snapping turtle (*Macrochelys temminckii*);
- In order to comply with requirements of the Federal Emergency Management Agency regarding implementation of the National Flood Insurance Act, Flood Disaster Protection Act, National Flood Insurance Reform Act, Federal Executive Orders 11988 and 11990, and to comply with related state statutes, proponents of construction projects in special flood hazard areas must coordinate in advance with the local floodplain administrator and obtain a floodplain development permit prior to TWDB Notice To Proceed;
- Standard emergency condition for the discovery of cultural resources; and

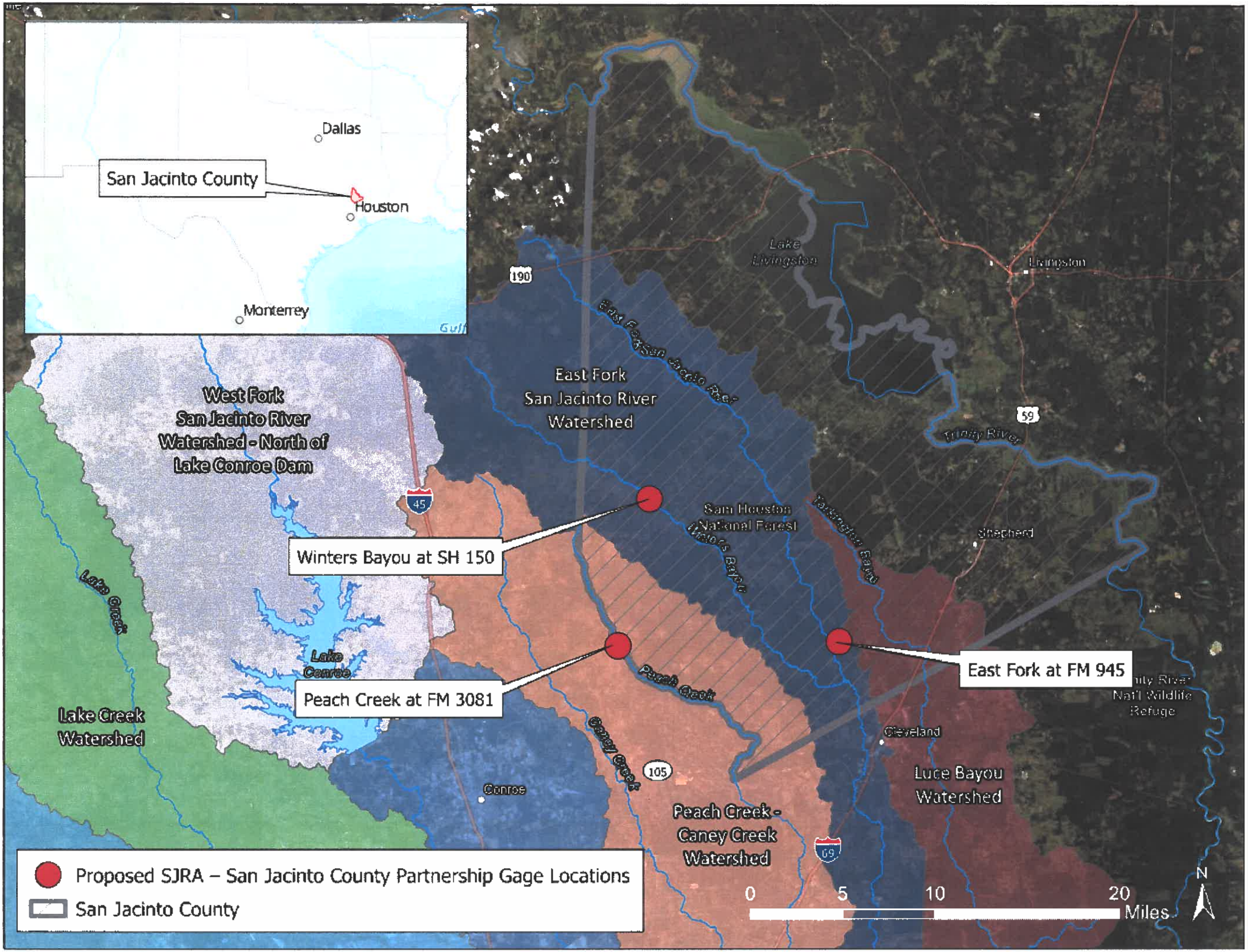
- Standard emergency condition for the discovery of threatened and endangered species.

Comments regarding this determination may be submitted to the Director of Regional Water Project Development, Texas Water Development Board, P.O. Box 13231, Austin, Texas 78711-3231 or via email at RWPD-Environmental@twdb.texas.gov.

Sincerely,

T. Clay Schultz Digitally signed by T. Clay Schultz
Date: 2021.05.04 07:07:16 -05'00'

T. Clay Schultz, Ph.D., Director
Regional Water Project Development


Dallas
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Watershed - North of
Lake Conroe Dam
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San Jacinto River
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Winters Bayou at SH 150
Peach Creek at FM 3081
East Fork at FM 945
Lake Creek
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Proposed SJRA – San Jacinto County Partnership Gage Locations
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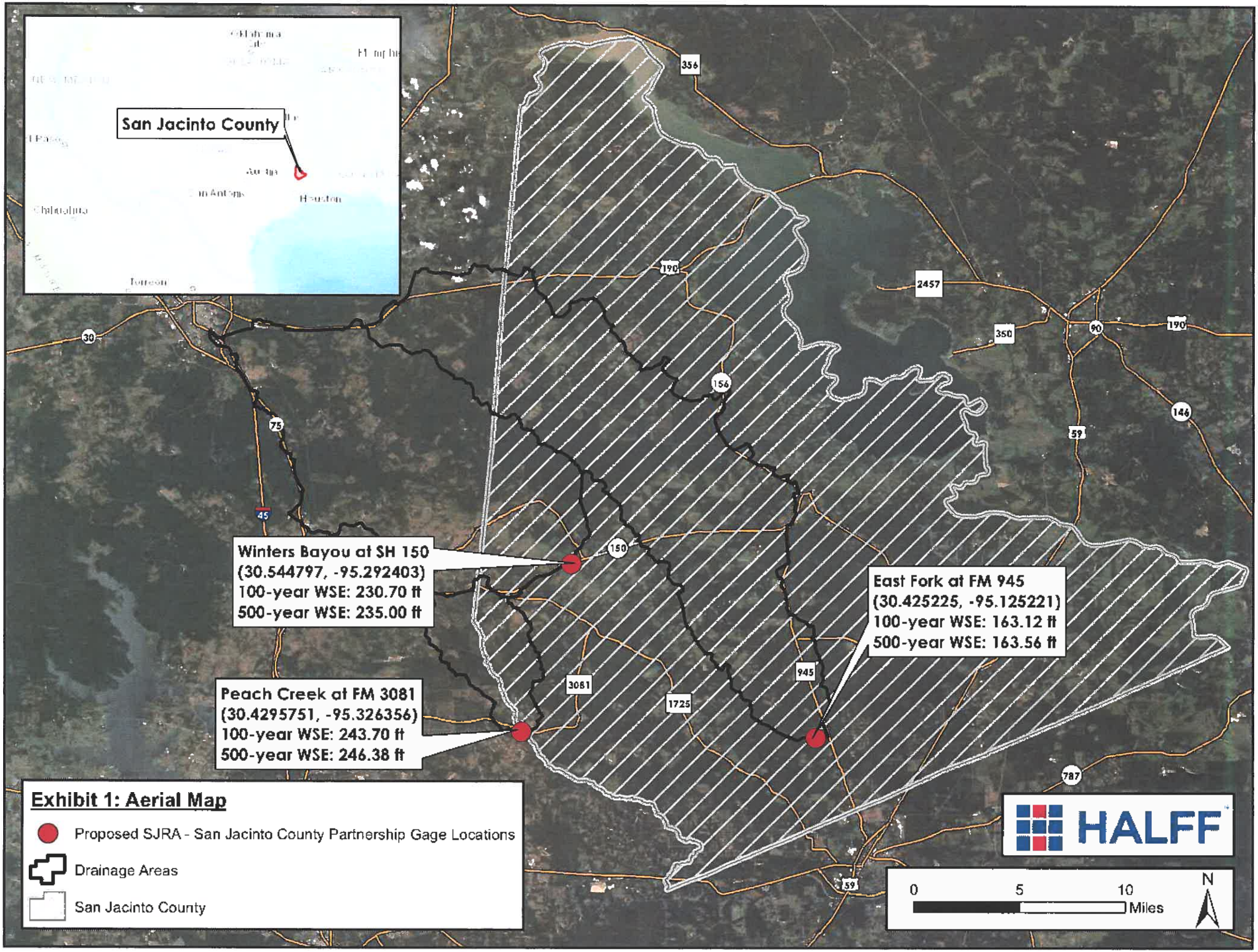
San Jacinto County
Winters Bayou at SH 150
(30.544797, -95.292403)
100-year WSE: 230.70 ft
500-year WSE: 235.00 ft
Peach Creek at FM 3081
(30.4295751, -95.326356)
100-year WSE: 243.70 ft
500-year WSE: 246.38 ft
East Fork at FM 945
(30.425225, -95.125221)
100-year WSE: 163.12 ft
500-year WSE: 163.56 ft
Exhibit 1: Aerial Map
Proposed SJRA - San Jacinto County Partnership Gage Locations
Drainage Areas
San Jacinto County
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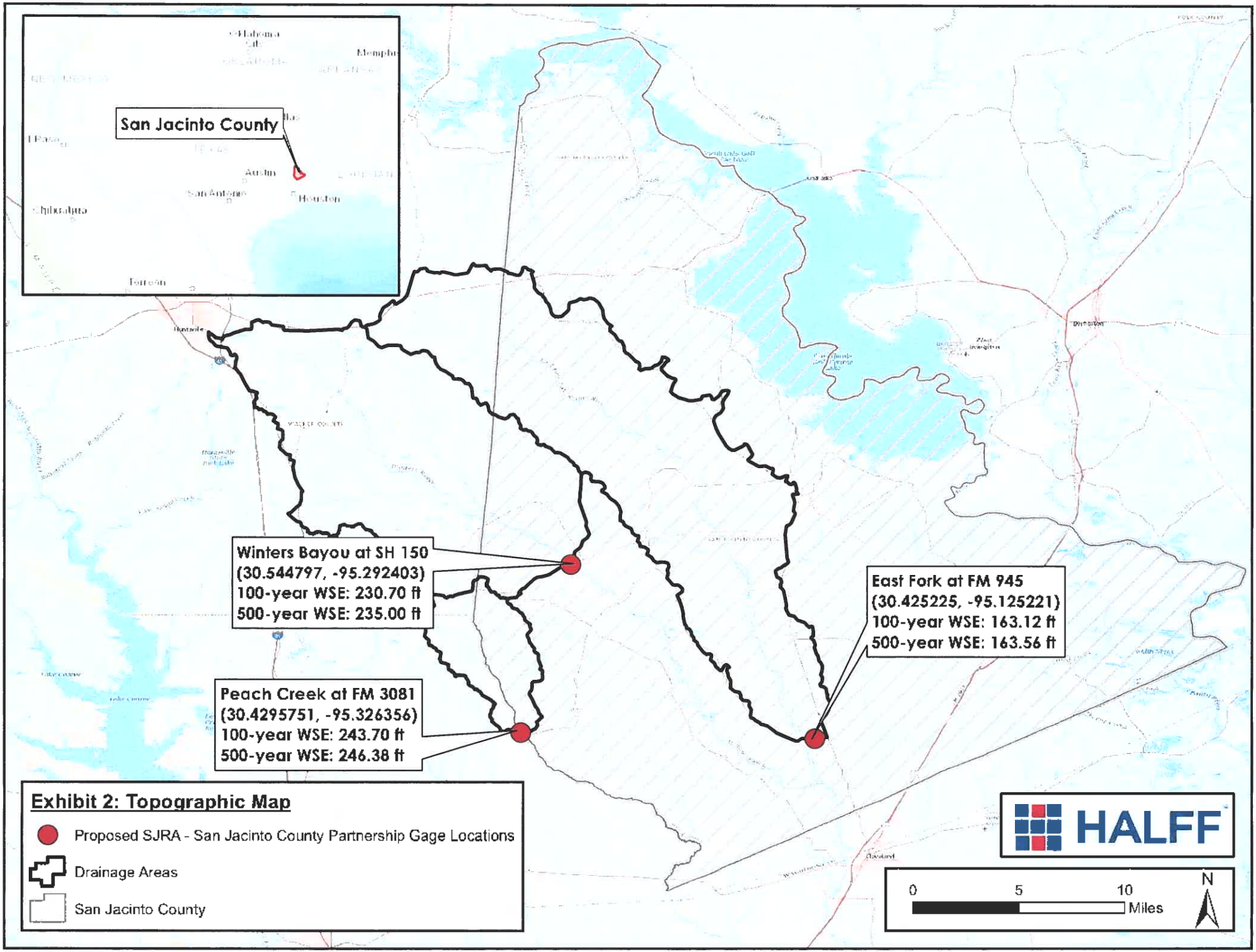
San Jacinto County
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Houston
San Antonio
Winters Bayou at SH 150
(30.544797, -95.292403)
100-year WSE: 230.70 ft
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Peach Creek at FM 3081
(30.4295751, -95.326356)
100-year WSE: 243.70 ft
500-year WSE: 246.38 ft
Exhibit 2: Topographic Map
Proposed SJRA - San Jacinto County Partnership Gage Locations
Drainage Areas
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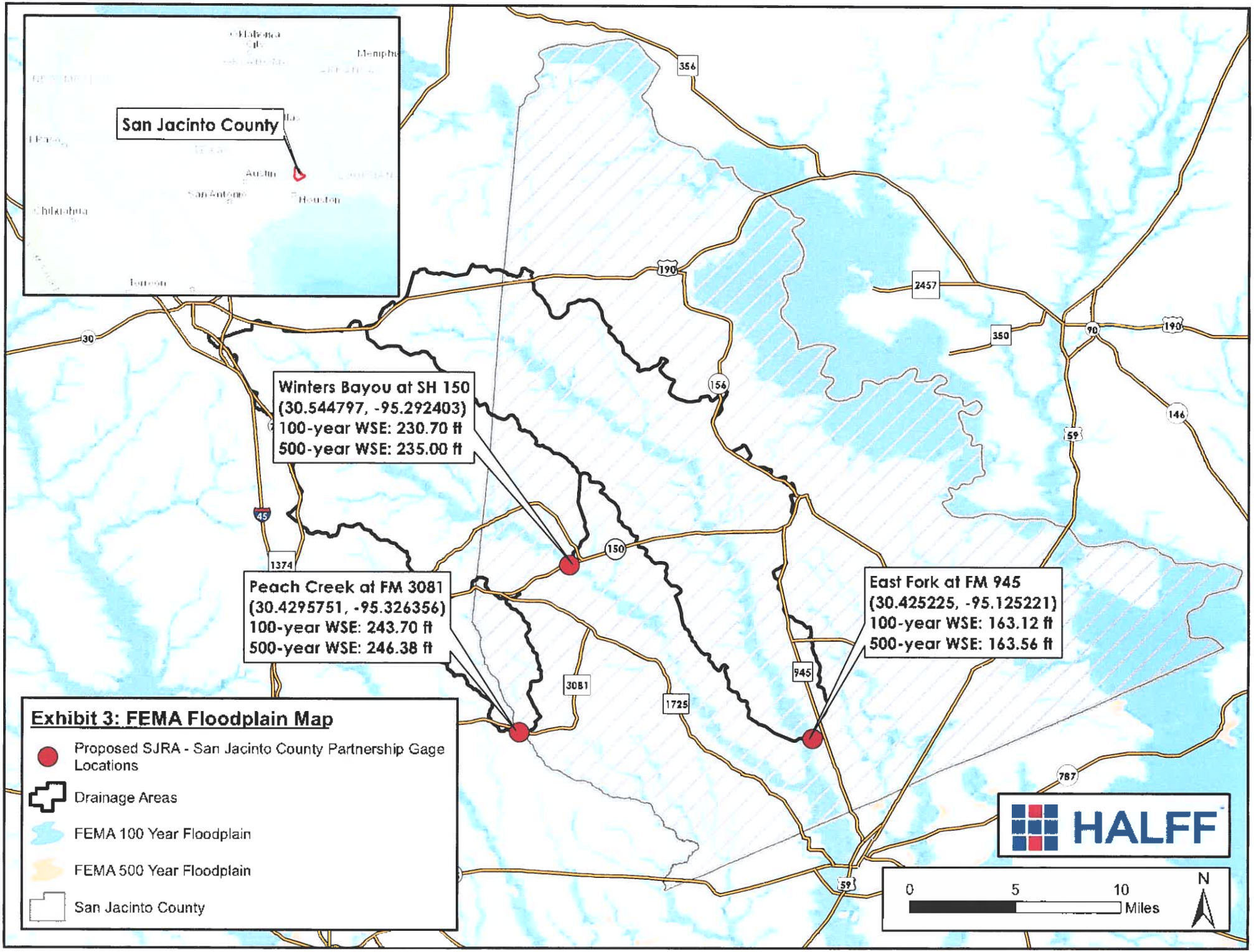
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East Fork at FM 945
(30.425225, -95.125221)
100-year WSE: 163.12 ft
500-year WSE: 163.56 ft
Exhibit 3: FEMA Floodplain Map
Proposed SJRA - San Jacinto County Partnership Gage Locations
Drainage Areas
FEMA 100 Year Floodplain
FEMA 500 Year Floodplain
San Jacinto County
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APPENDIX C

Path Analysis Study Report

DISTINCTIVE AFWS DESIGNS, INC.
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(828) 683-1566
www.distinctiveafwsdesigns.com

Mike Biehle
Maintenance Tech III, Lake Conroe Maintenance
P.O. Box 329, Conroe, TX 77305
1561 Dam Site Rd., Conroe, TX 77304

Below you will find a report detailing the site investigations for three new sites to be installed by the San Jacinto River Authority working with San Jacinto County. Installing and maintaining gauges in rural, forested areas presents unique challenges that must be considered for the long-term sustainability of the gauge.

Our company moto is "No data is better than bad data." By this, we mean that gauge installation must be done in such a way to provide accurate, trustworthy, and reliable data. Poor data leads to a lack of public involvement, funding, and trust in the agency. The report as well as on-site discussions provide suggestions and feedback to help the San Jacinto River Authority install the best gauges given the locations required.

We are grateful for the opportunity to work with the agencies and encouraged to see the upfront work occurring to ensure the sustainability of the flood warning system. Should you have any questions, please feel free to reach out at any time.

Best Regards,
Mark

Mark Moore
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distinctiveafwsdesigns.com

System Overview

The San Jacinto River Authority (SJRA) flood warning system consists of 14 ALERT2 gauges that primarily monitor water level and rainfall on watersheds that drain into Lake Conroe. The data transmitted from the gauges are publicly available on the SJRA website, and historical information can be viewed and downloaded.

Figure 1 The 14 gauges of the SJRA flood warning system.

Any gauge network must be established with proper standards and goals to ensure a properly working system. This includes standards for the installation of new gauge sites. New installations should not be completed without careful consideration of site conditions, radio path success, data accuracy, and overall usefulness of the new data. What may be a perfect spot for a water level monitoring location could potentially have significant vegetation overhead that would impact good rainfall data. Some sites may be better served with a pressure transducer to monitor the water level while other locations require a radar. Including these factors in the site design ensures the long-term usefulness and survivability of the site.

The sites described below will use the ALERT2 protocol to transmit their data. This radio transmission occurs on an FCC registered and protected radio frequency. Gauges have a range of approximately 20 miles. This range can be significantly impacted by local topography, vegetation, or antenna direction. However, the SJRA flood warning system extends further than 20 miles. This is possible due to additional radio receivers and repeaters. There are two locations where gauge data can be received and repeated. The first is at a water standpipe on the east side of Lake Conroe (30.39469, -95.5161 at 42m above ground level). The second location is co-located with the Forest Service and is located at one of their towers in the Sam Houston National Forest (30.53123, -95.53667 at 24m above ground level). On-site tests were conducted to determine which receivers were able to detect data from the proposed locations, and information is included in the report below.

Peach Creek at FM 3081

Gauge Placement

Due to property ownership as discussed on site, the ideal location for the conditions for the placement of the gauge is on the south-east corner of the bridge. Solar coverage will be limited by the nearby tree line. The nearby trees should be cut for improved rain measurements and accurate data collection. Rain gauges require a cone of clearance above the collection funnel 45 degrees in all directions. Gauge must be installed above flood level to prevent damage during flood events.

Figure 2 Facing east, the gauge should be installed near the end of the guardrail within the appropriate right of ways.

Figure 3 Approximate location of the recommended installation location, facing the bridge.

Radio Test

On-site test confirms the tree coverage will not be an issue for radio signals. 100% of test messages arrived at both the main standpipe receiver location and the forest service repeater.

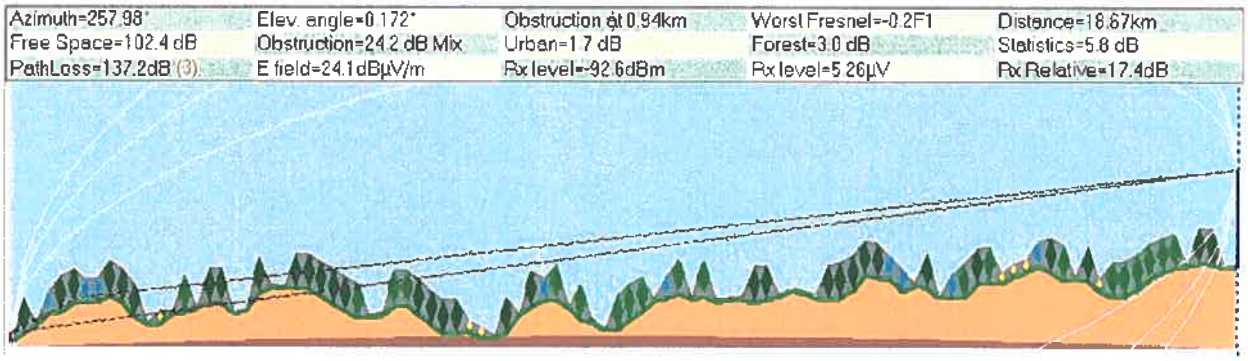

Figure 4 Radio Mobile screenshot of the path analysis. The Fade Margin was calculated to 17.4 dB, and anything over 12dB should have good radio success.

Water Level Sensor

Standard water level appears to be 12 feet below the bridge Site is unsuited for a Pressure Transducer (PT), as the creek is known to shift over the course of the year and would require moving the PT after significant rainfall. In addition, the only feasible location would be down the bridge columns, which does not offer suitable protection from flood debris. Access to this location would not be safe for maintenance due to the lack of shoulder on the bridge. If a radar is installed, the device must be mounted sufficiently high enough to prevent damage during flood events. Most radars only work when the water level is no higher than 1 ft below the sensor.

While a radar sensor does have higher upfront costs, for gauges like this the long-term maintenance may end up far cheaper than a pressure transducer. PTs require calibration and cleaning, additional conduit, and may require reinstallation should the stream channel move following a flood event. Radars may also require reinstallation, however as everything is mounted above the bridge deck this requires significantly less hardware and labor costs. Last, PTs typically require replacement every 3 to 6 years, while a radar will often last the lifespan of the gauge as the device is not constantly in the water and impacted by environmental changes. Thus, when conditions allow, or in this case nearly require, a radar sensor provides a longer lasting and more reliable sensor for gauge installation.

Figure 5 Current location of streambed, subject to change during next flood event.

Winters Bayou at FM 150

Gauge Placement

We recommend installation of the gauge on the southwest corner of the bridge for best solar and rain collection capabilities. While not ideal for parking, this spot represents the best location for gauge installation.

Figure 6 An ideal gauge location would be near or behind the Bayou sign. Note the shadows indicating nearby trees, which would be far enough away to avoid solar impacts.

Radio Test

On-site test confirms the tree coverage will not be an issue for radio signals. While only 35% of messages arrived at the main standpipe collection point, 100% arrived at the forest service repeater.

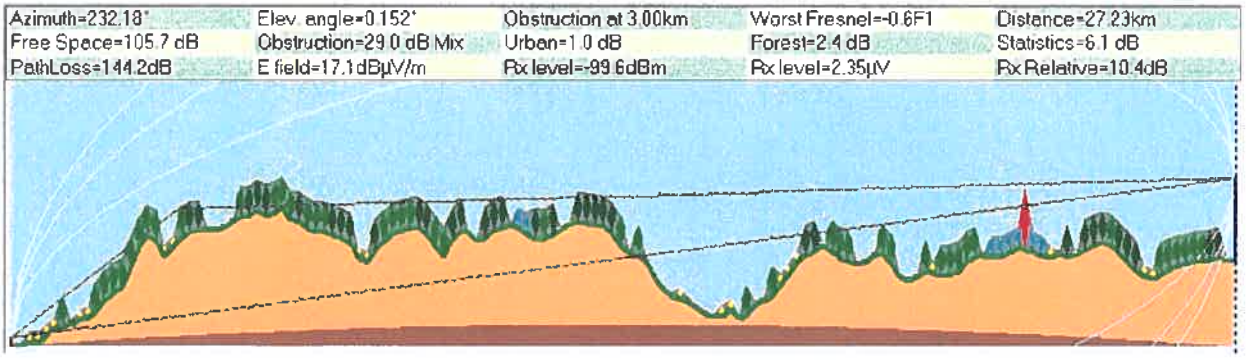

Figure 7 Radio Mobile screenshot of analysis, calculating a fade margin of 10.4 dB. This is below the standard acceptable 12 dB and explains why not all of the data made it to the main standpipe receiver location.

Water Level Sensor

Site is not ideal for a pressure transducer, though it is possible to run a transducer through conduit along the side of the bridge; a radar sensor seems ideal for this site. Should a radar be installed, it must be high enough to be out of the floodplain and trees near the channel should be cleared to ensure a clear radar path.

Figure 8 View from under the bridge. The trees growing over the creek may impact radar performance and should be cleared.

East Fork San Jacinto @ FM 945

Gauge Placement

The location selected for this gauge is in a non-ideal location. Trees on both the upstream and downstream side of the bridge will have significant impacts to rain and solar power collection. This site may benefit from a 10- or 20-Watt solar panel and larger batteries to overcome the poor solar collection. Rain measurements will not be accurate, and care should be taken to ensure that the data is collected in a useful way. There is no rain sensor that can account for lost rainfall due to blockage by vegetation. To someone unfamiliar with the site, this location will likely report lower rainfall than nearby sites and bias models or forecasting low. For these reasons a rain gauge will not be installed at the site.

The southwest side of the bridge has the best location for gauge placement, just after a driveway entrance.

The nearby hill helps demonstrate the topography of the area and could even be considered for a flashing beacon to warn drivers of flooded roadways.

Figure 9 Note the sunny spot in the picture above, where there is slightly less impact from nearby trees. We recommend installation of the gauge here.

Radio Test

On-site tests found a power amplifier was required to reliably receive data from this site. Installation may work with a directional antenna instead of an omni antenna that was used for testing. 66% of messages were received at the primary standpipe receiver and 100% at the forest service site after testing with a power amplifier.

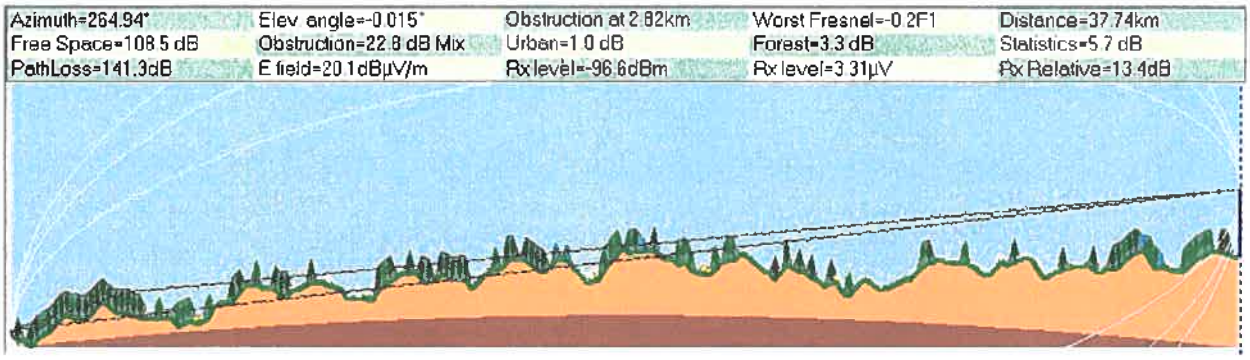

Figure 10 Radio mobile output of the gauge, with a fade margin of 13.4 dB. Anything greater than 12 dB should work with good success, but on-site test found otherwise. This is likely due to the program's difficulty measuring the impact of trees.

Water Level Sensor

Due to the tendency for the main streamway to move and difficulty of access to the bridge, we again recommend a radar sensor so long as the sensor itself is well out of the floodplain.

Figure 11 Downstream side of the bridge where radar installation is recommended.