2024 ANNUAL PROGRESS REPORT, OF THE UPPER SABINAL RIVER WATERSHED - WESTERN BANDERA COUNTY, TEXAS FLOOD EARLY WARNING SYSTEM

Texas Water Development Board / Contract Number 1800012307 - Annual Progress Report A.P.R.-2024-002

USGS Stream Gage (No. 08197970) Sabinal River at FM-1050, Utopia, Tx.

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Contents

Abbreviations / Acronyms

(AHPS) Advanced Hydrologic Prediction Service
(A.P.R.) Annual Progress Report
(BCRAGD) Bandera County River Authority and Groundwater District
(CFM) Certified Floodplain Manager
(DCP) USGS Satellite Telemetry, Data-Collection Platform
(DEM) Digital Elevation Model
(DOI) Department of the Interior
(FEMA) Federal Emergency Management Agency
(FEWS) Flood Early Warning Systems
(FIM) Flood Inundation Map
(FIMP) USGS Flood Inundation Mapping Program
(FIMS) Flood Inundation Maps
(FIS) Flood Insurance Study
(GAM) Generalized Additive Regression Model
(GIS) Geographic Information System
(GOES) Geostationary Operational Environmental Satellite
(GWL-BLS) Groundwater Level – Below Land Surface
(HEC-RAS) Hydrologic Engineering Center-River Analysis System
(HWM) High Water Marks
(Lidar) Light Detection and Ranging
(NAD 83) North American Datum of 1983
(NAVD 88) North American Vertical Datum of 1988
(NRS) Natural Resource Specialist
(NWIS) USGS National Water Information Center
(NWS) National Weather Service
(PT) Non-real-time pressure transducer
(RMSE) Root Mean Square Error
(ROW) Highway Easement - Right of Way
(SIR) USGS-Scientific Investigations Report
(TWDB) Texas Water Development Board
(USACE) U.S. Army Corps of Engineers
(USGS) U.S. Geological Survey

Datum

Vertical coordinate information is referenced to stage, the height above an arbitrary datum established at a streamflow-gaging station, and elevation, the height above the North American Vertical Datum of 1988 (NAVD 88).

Horizontal coordinate information is referenced to the North American Datum of 1983 (NAD 83).

Conversion Factors

Table 1 *- U.S. customary units to International System of Units*

Multiply	By	To obtain
	Length	
foot (ft)	0.3048	meter (m)
mile (mi)	1.609	kilometer (km)
	Area	
square mile (mi^2)	2.590	square kilometer (km^2)
	Flow rate	
cubic foot per second (ft^3/s)	0.02832	cubic meter per second (m^3/s)
	Slope	
Foot per foot (ft/ft)	5,280	Foot per mile (ft/mi)

1. Preamble

1.1. Abstract

Floods are the leading cause of natural disaster losses in the United States. Although loss of life to floods during the past half century have declined, in part because of improved warning systems, economic losses have continued to rise with increased urbanization in flood hazard areas throughout the nation (U.S. Geological Survey, 2006).

On November 12, 2018, the Bandera County River Authority and Groundwater District, (BCRAGD) was approved for and received a 50/50 cost shared cooperative agreement funding grant from the Texas Water Development Board, (TWDB) totaling $230,000.00 each side. A contract was entered into agreement by TWDB and BCRAGD to contract with a third-party Federal Contractor, the U.S. Geological Survey, (USGS) for development of a Flood Early Warning System (FEWS) for Western Bandera County, Texas of the Upper Sabinal, and West Sabinal River watersheds. The study area includes a 10-mile river reach of the Sabinal River in western Bandera County from Vanderpool, Tx to Uvalde County at Utopia, Tx and includes an up-stream 7-mile river reach of the West Sabinal River from the confluence of the Sabinal River.

Similarly, a Flood Early Warning System (FEWS) a 3-year initial study area was recently completed (May 2019) that encompassed a 23-mile reach of the Medina River from the headwater confluence of Winans Creek to English Crossing Road above Medina Lake. The USGS developed a Flood Inundation Map (FIM) of this river reach using a Hydrologic Engineering Center-River Analysis System (HEC-RAS) hydraulic simulation model (U.S. Army Corps of Engineers, 2016 a, b). A flood atlas, consisting of a library of flood-inundation maps for a range of streamflow conditions, was developed and included on the USGS Flood Inundation Mapping Program (FIMP) website. https://pubs.usgs.gov/sir/2019/5067/sir20195067.pdf .

The Flood Inundation Maps (FIMS) depict estimates of the areal extent and depth of flooding corresponding to selected water levels (stages) at the USGS streamflow-gaging station 08178880 Medina River at Bandera, Texas.

The Sabinal River FEWS flood-inundation maps depict estimates of the areal extent and depth of flooding corresponding to selected gage heights (stages) at the USGS streamflow-gaging station 08197970 Sabinal River at Utopia, Tx. (herein after referred to as the “Utopia gage”). Water-surface elevations were computed for the stream reach by means of an unsteady-state two-dimensional diffusion wave model with the Hydrologic Engineer Center’s River Analysis System 5.0.7 (HEC-RAS; Davidian, 1984; U.S. Army Corps of Engineers, 2016a, b, c). A stage-discharge relation at the Utopia gage was synthetically developed using a regional regression equation (Asquith and others, 2013) to construct the model boundary condition inputs as well as a calibration target, and the July 2002 flood event was reconstructed as the highest modeled river stage. The hydraulic model was used to compute 35 layers of water-surface elevations for gage heights at half foot (ft) intervals referenced to the station datum and ranging from 7 ft, near bank full, to 28 ft. The model terrain was constructed using the digital elevation model, derived from high resolution Light Detection and Ranging Data (Lidar), of one meter (3.28 ft) horizontal

resolution with vertical accuracy of ± 42.8 cm (± 1.4 ft). These flood-inundation maps, in conjunction with the real-time stage data from the Utopia gage, are intended to help guide the public in taking individual safety precautions and intended to provide emergency management personnel with a tool to efficiently manage emergency flood operations and post flood recovery efforts. InFRM | Flood Decision Support Toolbox (usgs.gov)

1.2. Introduction

Over the past 30 years, the average statistics show annual flood losses in the United States at about $8 billion and nearly 100 fatalities per year. Bandera County is in the Texas Hill Country region, where high intensity rain rates and steep terrain contribute to flash flooding (Caran and Baker, 1986).

While floods are impossible to prevent completely, and there is no way to completely guarantee protection of life and property, many federal, state, and local agencies have demonstrated that the loss of life, injuries, and property damage can be greatly reduced with a FEWS in place.

The USGS - FEWS of the Sabinal River provides near real-time hydrologic data, available on the internet and many other social media web-based outlets. A user can view data of river stage, or rainfall in real-time, directly from the stream-gage station using the internet and can quickly access the specific flood map corresponding to the present river stage conditions. The flood atlas consists of a set of digital flood-inundation extent polygons and water depth grid maps derived from the gage height (river stage value) providing the user with corresponding land-surface inundation estimates and digital map overlays. Pre-defined user set thresholds can be established for each available hydrologic monitored condition at the stream-gage station, providing the user with email or text alerts when conditions reach or exceed a user pre-defined threshold. This allows for critical information to be provided to the user preceding significant flooding conditions.

The National Weather Service (NWS) Advanced Hydrologic Prediction Service (AHPS), using hydrologic simulation models, (including forecast prediction streamflow rates) are primarily based on USGS streamflow real-time hydrologic data throughout the United States (National Weather Service, 2018; U.S. Geological Survey, 2018a).

1.3. Objectives and Scopes

To help inform emergency managers, the public, and water resource decision makers about flooding events, the USGS in cooperation with BCRAGD, and a cooperative funding agreement with TWDB established a flood early warning tool set of the West Sabinal and Sabinal River watersheds in Western Bandera County. The tool set includes a monitoring network of the USGS continuous streamflow-gaging stations, and rainfall gauges for modeling development of a HEC-RAS hydraulic simulation model. Flood inundation maps were created and are made available to view in the USGS Flood Inundation Mapper (USGS FIM) website (U.S. Geological Survey, 2018b).

The original Sabinal River FEWS scope of work to be performed by the USGS, included the installation of two streamflow gaging stations and three in-stream pressure transducers within the study area. However, due to landowner access restrictions and limited access within contiguous proximity to locations acceptable for streamflow gages, including varying problematic onsite topographical conditions acceptable to the quality control of reliable hydrologic data collections within State or County right of ways (ROW), the USGS incorporated pre-existing streamflow and rainfall gages into the FEWS. Resulting with two streamflow gaging stations, one additional groundwater monitoring station that also included a high intensity rainfall monitor and the installation of five temporary pressure transducers along the Sabinal and West Sabinal River channels, within the study area. The transducers were installed within proximity of the highway right of way and were for supplementing and complementing additional data during a hydrologic event. The non-satellite telemetry pressure transducers were removed after one year due to non-collection of hydrologic stream data, resulting from the present, extended drought conditions. However, the pre-existing USGS streamflow and rainfall stations provided useful data for the FEWS and are considered reliable components in-leu of redundancy of streamflow gage installations. As described within the abstract narrative, a stage-discharge relation at the Utopia gage was also synthetically developed using a regional regression equation (Asquith and et.al, 2013) to construct the model boundary condition inputs as well as a calibration target and included historical data from the July 2002 flood event which was reconstructed as the highest modeled river stage. The hydraulic model was used to compute 35 layers of water-surface elevations for gage heights at half foot (ft) intervals referenced to the station datum and ranging from 7 ft, near bank full, to 28 ft.

1.4. Range of Modeled Stages

The HEC-RAS model was used to generate flood-inundation maps along a 10-mi study reach of the Sabinal River and a 7-mile study reach of the West Sabinal River, for a total of 35 stages at 0.5-ft intervals between 7 ft and 28 ft as referenced to the local datum of the Utopia gage. These stages correspond to elevations of 1,343 ft and 1,363 ft, NAVD 88, respectively. Discharges corresponding to the various stages were obtained from the regional regression method (Asquith and others, 2013) that was used to construct a synthetic stage-discharge rating curve for the Utopia gage.

The total drainage area of the Sabinal River Basin at the Utopia, Tx gage is 130 mi^2. The contributing area of the main Sabinal River watershed is 85 mi^2 (65%) and that of the West Sabinal River watershed is 45 mi^2 (35%).

A typical stage-discharge relation (herein after referred to as rating curve) shows a relation between river stages and corresponding streamflow discharge at a cross-section of a stream. The relation is different for every cross-section as it is a function of geometry, climate, and time. All topographic data used in this study are referenced vertically to NAVD 88 and horizontally to the North American Datum of 1983 (NAD 83). Cross-section elevation data were obtained from a digital elevation model (DEM) that was derived from light detection and ranging (lidar) data that were collected through the USGS 3D Elevation Program (3DEP; U.S. Geological Survey, 2017).

The regression equation translates geometry and the regional terrain and climate parameters into discharge. Since the channel geometry represented in cross-sectional flow area and top-width is a function of a river stage, the regression equation can be used as an alternative to a stage-discharge rating curve.

The USGS makes routine and hydrologic event-driven site visits to gaging stations to ensure accuracy of data and verification of quality assurance for computational modeling.

The rating curve is a key element for reporting real-time stream gage data at different river stages. It is also a key element for computational modeling because the roughness coefficient model parameters are adjusted to match the rating curve for accurate model calibration.

The hydrological field data in the study area was limited because of the short monitoring period of the Utopia gage (installed on January 15, 2020; U.S. Geological Survey, 2022a) and a lack of precipitation during the study. During the initial study period, the highest gage height recorded at the stream gage was only 5.34 ft (May 1, 2021, 14:45), which is lower than the lowest modeled stage, or a bank full flow stage of 7 ft. Given the lack of storm events, the data at the Utopia gage was not adequate to develop a full range rating curve needed to accurately estimate streamflow from stage. As an alternative, a synthetic rating curve was developed and applied to calibrate the model for higher stages.

1.5. Drought Status, Project Extension, and Synthetic Rating

Due to the present and significant drought conditions, Bandera County River Authority and Groundwater District (BCRAGD) received a project extension request from the 3rd party Federal Contractor, U.S. Geological Survey (USGS), specific to Texas Water Development Board contract number 1800012307 'Flood Early Warning System' (FEWS) of the Sabinal River watershed.

The project study extension request was due to unforeseen circumstances which are related to hydrologic variances of below normal rainfall data and severe drought related conditions.

A one-year project extension request was granted by TWDB to allow additional time for potentially improved hydrologic conditions to occur, which would greatly improve the foundation of data collection assembly. The new project completion date was re-scheduled to end on June 30, 2022, and with a new expiration date of September 30, 2022.

Unfortunately, during the approved project extension period the persistent drought conditions continued. There were intermittent periods of minimal rainfall with slightly above baseflow surface water gage-height events during the project's 4-year period. All FEWS - USGS streamflow and rainfall monitoring stations were operational.

Due to the continuing severe hydrologic drought conditions within the South Texas Region and inadequate related rainfall amounts to substantiate soil moisture and streamflow influence of the Sabinal River watershed, a 'Synthetic Rating' was applied to the study area by the USGS for creating the FEWS, FIM library. Preliminary data was prepared and assembled by Namjeong Choi, PhD Hydrologist USGS.

During which time the USGS put forth significant efforts of resources developing a synthetic stage discharge data assembly using a regionalized regression equation of the basin characteristics. These data were applied to a Generalized Additive Regression Model (GAM) to create a synthetic stage-discharge rating curve for the Sabinal River FEWS.

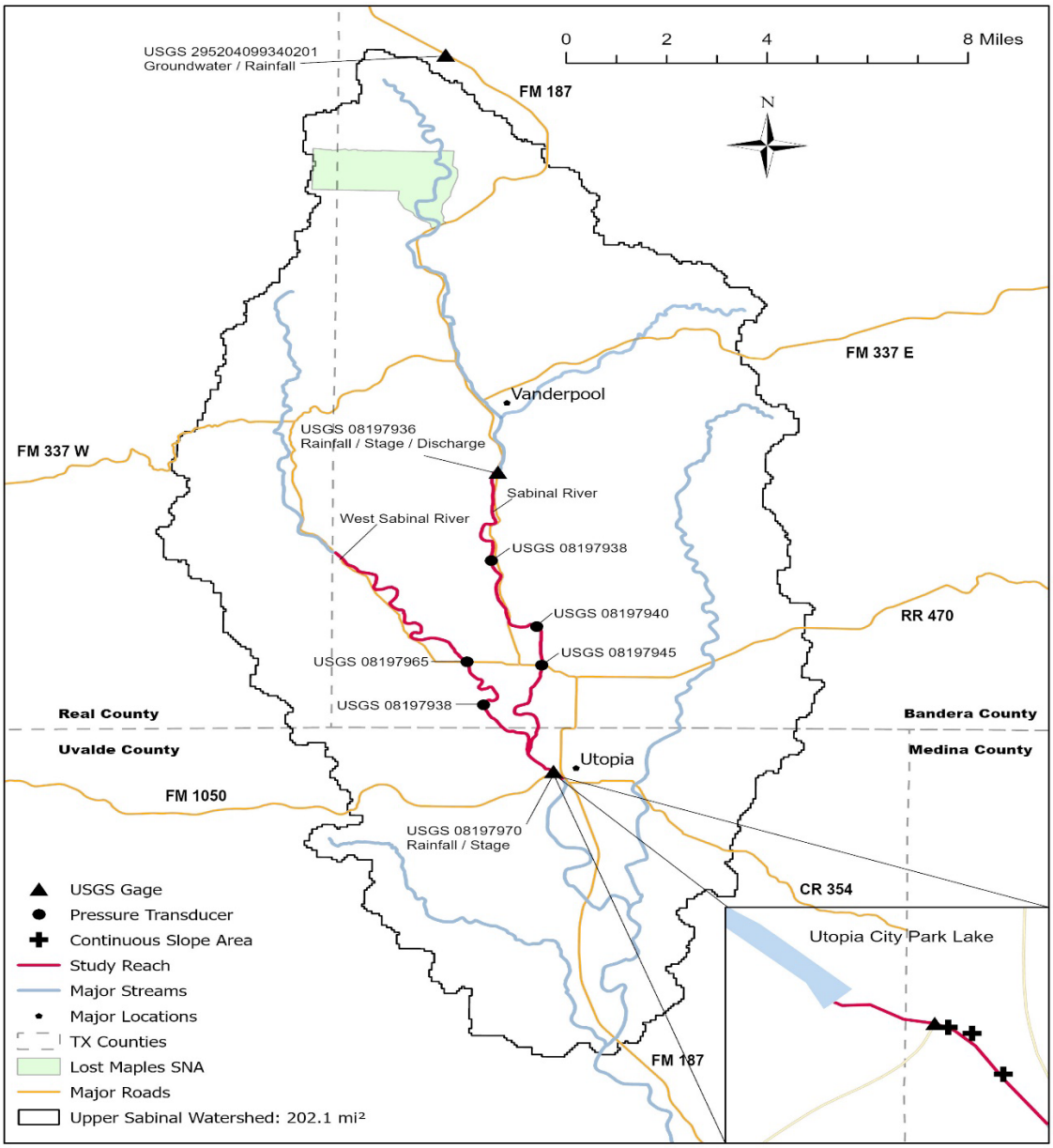

Figure 1 *– Study area map with USGS streamflow-gaging station locations.*

Note: Five temporary installations of USGS pressure transducers are referenced as informational purposes only, although were removed after one full year, due to the continual drought and lack of beneficial hydrologic occurrence

2. Annual Progress Report (A.P.R.) for the Period – September 01, 2023, to August 31, 2024, of the Upper Sabinal River Flood Early Warning System (FEWS) in Bandera and Uvalde Counties, Texas

TWDB Contract Number: 1800012307 / Sabinal River FEWS, A.P.R.-2024-002

To: Marla Waters | Flood Mitigation Grant Coordinator
Texas Water Development Board
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From: Larry B. Thomas, CFM,
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Contract Timeline

Contract Period	November 12, 2018 – August 31, 2021
Revised Contract Expiration Date	September 30, 2022
Progress Report Period	September 01, 2023 – August 31, 2024

2.1. USGS Task Completions / Ongoing Status (09/01/23 to 08/31/2024)

2.1.1. Task 1: 100% complete. Routine data collection and equipment maintenance – On going

- A USGS Stream Gage installation was completed Jan. 16, 2020, at the Sabinal Rv bridge located on FM-1050, below Utopia City Park at Utopia, Tx and is currently monitoring water surface stage and rainfall data**.**

- Hydrologic data of Rainfall totals and water surface stage values are available on the 'USGS TX' web site. USGS station ID, Sabinal Rv at Utopia, TX. Station No:08197970

Table 2 *– USGS Base Reference Stream Gage 08197970 at the Sabinal River Bridge at Utopia, Tx FM-1050 for the Sabinal River FEWS*

Station number/Type	Station name	Latitude and longitude	Data collected	Period of data collection	Changes made
08197970 USGS Base reference gage	Sabinal River at Utopia, Texas	29°36'44.16", -99°31'46.14"	Stage Precip.	January 16, 2020, to Present	NA

The following pre-existing USGS satellite telemetry hydrologic stations are available and maintained by USGS personnel. These USGS stations are routinely monitored daily by USGS and by BCRAGD during storm related events and are significant for providing storm related information of impending storms near and within the Sabinal River watershed:

Table 3 – Pre-existing – USGS Stream Gage / and Rainfall Monitors within the Sabinal River Watershed used for the FEWS.

Station number/Type	Station name	Latitude and longitude	Data collected	Period of data collection	Changes made
08197936 Pre-existing USGS Gage	Sabinal River below Mill Creek near Vanderpool, Texas	29°43'08.40" -99°32'55.32"	Stage Discharge Precip.	September 26, 2013, to Present	None
295204099340201 Pre-existing USGS Gage	Edwards GW well, Bandera County, Edwards Plateau	29°52'04.07" -99°34'01.88"	GWL-BLS	November 06, 2012, to Present	
			Precip.	June 05, 2018, to Present	Precip. Monitor Upgrade

2.1.2. Task 2: Calibration of a HEC-RAS model for study area. 100% complete including continual calibrations as needed.

NOTE: Due to the present drought related conditions within the study area and lack of significant rainfall, flow data have not occurred substantially for developing a standard USGS, stage / discharge rating for use. Although, the USGS applied a Synthetic Rating, illustrated within this A.P.R. and thoroughly detailed within the Final Report dated June 27, 2022.

The synthetic modeled rating simulation for the FIM, included a contributing, simulated percentage for the West Sabinal River at Utopia, Tx. drainage basin flow contributions. Thus, corresponding with a 10-mile river reach of the Sabinal River main channel and to a river stage of 28 feet at the U.S. Geological Survey stream gage at Utopia, Tx station ID – 08197970.

2.1.3. Task 3: Model scenarios and development of a flood atlas. 100 % complete

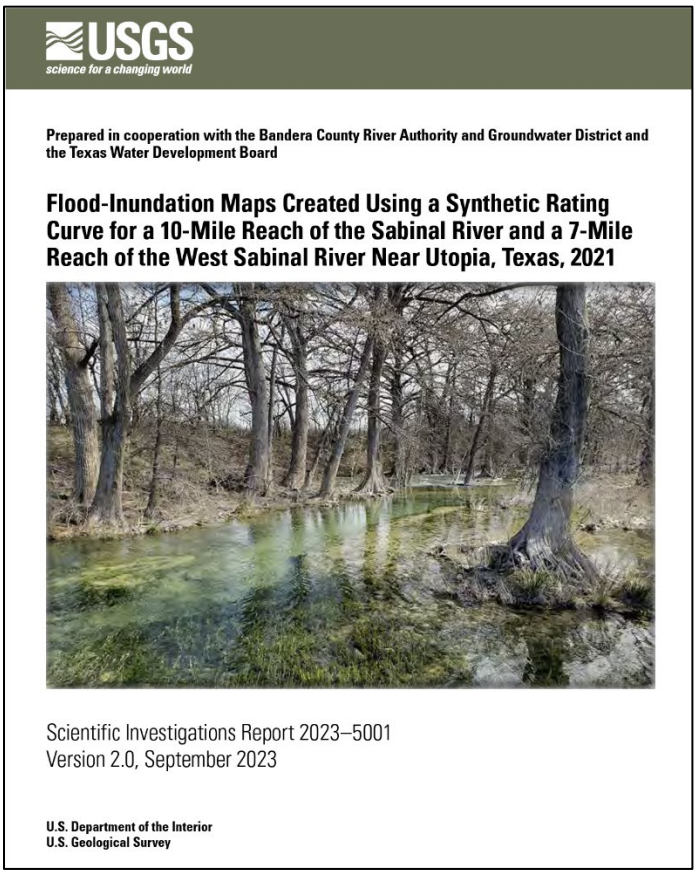
- Hydrologic data integration, on-going and continual development

2.1.4. Task 4: Reporting and integration with Flood Inundation Mapping Program (FIMP) Website – USGS Report publication and official data release. 100 % complete

- 100% assembled Department of the Interior (DOI) USGS publication public release date, September 28, 2023.

Flood-Inundation Maps Created Using a Synthetic Rating Curve for a 10-Mile Reach of the Sabinal River and a 7-Mile Reach of the West Sabinal River Near Utopia, Texas, 2021

Scientific Investigations Report 2023-5001
Prepared by the United States Geological Survey (UGS) in cooperation with the Bandera County River Authority and Groundwater District (BCRAGD) and the Texas Water Development Board (TWDB).
Flood-inundation maps were created using a synthetic rating curve for a 10-mile reach of the Sabinal River and a 7-mile reach of the West Sabinal River near Utopia, Texas, 2021 (usgs.gov)
By: Namjeong Choi, PhD Hydrologist USGS.



Development of Flood Atlas

The USGS has standardized the procedures for creating FIMS for flood-prone communities (U.S. Geological Survey, 2018b). Tasks specific to the development of the Sabinal River FEWS, FIMS were as follows:

1. Collect and compile topographic and bathymetric data for selected cross sections and geometric data for structures and bridges along the study area.
2. Estimate energy-loss factors (roughness coefficients) in the stream channel and flood-plain and determination of steady-flow data.
3. Compute water-surface profiles using the U.S. Army Corps of Engineers (USACE) HEC-RAS computer program (U.S. Army Corps of Engineers, 2016 a,b).
4. Produce estimated FIMS for a range of river stages using the HEC-RAS computer program and Esri, Inc. ArcGIS (Esri, Inc., 2018).
5. Prepare FIMS both as shapefile polygons that depict the areal extent of flood-inundation and as depth grids that provide the depth of floodwaters, for display on a USGS flood-inundation mapping application (U.S. Geological Survey, 2018b).

The USGS - FIMP website (https://water.usgs.gov/osw/flood_inundation) provides USGS flood-inundation study information to the public. The website links to the FIMP application that presents map libraries and provides detailed information on flood-inundation extents and gage heights for modeled sites are found at: InFRM | Flood Decision Support Toolbox (usgs.gov)

Disclaimer for Flood-Inundation Maps

The flood-inundation maps should not be used for navigation, regulatory, permitting, or other legal purposes. The USGS provides these maps "as-is" for a reference and emergency planning tool but assumes no legal liability or responsibility resulting from the use of this information.

2.2. BCRAGD Tasks Completed:

- A project expiration date extension was requested by the third-party Federal contractor USGS and approved by TWDB for this project for an approximately One-Year Term from the original expiration date of August 31, 2021. Quarterly USGS invoicing periods were adjusted proportionately with the approved extension period. Annual Progress Reports (A.P.R.) are required for each of five (5) consecutive annual periods beginning September 1st, 2022, through August 31st each year. A.P.R. number one (1) was completed August 31st, 2023.

- The previous project study extension request was due to unforeseen circumstances which are related to hydrologic variances of below normal rainfall data and severe drought related conditions.

Previous Contract Dates:

- Project Completion Date – 05/31/2021
- Expiration Date – 08/31/2021

Approved Extension of Contract Dates:

- Project Completion – 06/30/2022
- Expiration Date – 09/30/2022

Continued daily monitoring of the Sabinal River FEWS, USGS hydrologic stations were completed by BCRAGD personnel for Western Bandera County and the town of Utopia, Uvalde County Tx. Additional and separately funded monitoring stations included the Sabinal River at Vanderpool, Tx stream gage USGS Station Number - **08197936** and the rain-fall gauge located at the BCRAGD Edwards Well No.1, above Lost Maples State Natural Area, along the Edwards Plateau, USGS Station Number - **295204099340201**.

- All FEWS - USGS streamflow and rainfall monitoring stations remain operational, although due to severe drought conditions, there have been minimal hydrological effects within the Sabinal drainage basin. The lack of rainfall and extreme drought conditions within the Sabinal River watershed and throughout Western Bandera County, has resulted in declining surface water and groundwater levels.

- The primary USGS-FEWS base reference monitoring station Sabinal River at Utopia, Tx. USGS Station No.08197970 recorded a total accumulative rainfall amount of **22.81** inches for FY-24, (**Table *4***). Although due to the extreme drought related conditions the maximum instantaneous recorded rise in water surface stage, varied by only 0.65ft gage-height, **(Figure 2).**

Table 4 – USGS Rainfall Monitoring Gauges – Monthly Rainfall Totals FY-24

Station ID	Station Name	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
USGS 295204099340201	Edwards GW Well 1	0.17	0.67	0.43	0.42	0.45	0.85	0.22	0.99	1.02	1.16	2.74	1.31
USGS 08197936	Sabinal Rv below Mill Ck near Vanderpool	2.21	3.04	1.72	1.86	1.24	1.11	0.69	0.90	0.78	3.06	1.97	0..65
USGS 08197970	Sabinal Rv at Utopia	0.83	4.41	1.47	1.54	0.92	2.29	0.49	1.65	0.85	4.53	3.66	0.17

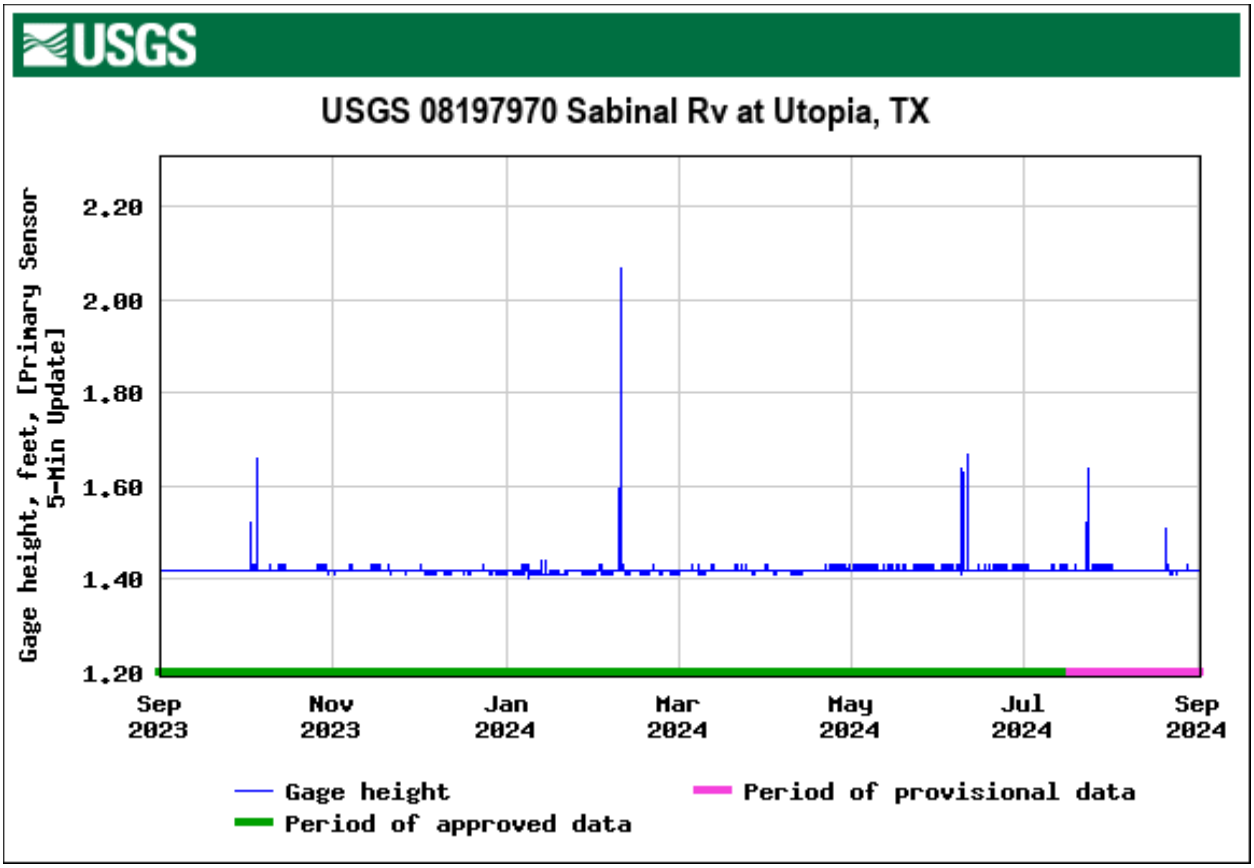


Figure 2 – Sabinal River at Utopia, Tx., USGS Stream gage Number 08197970 Water Surface Stage (gage-height ft.) September 01, 2023, to September 01, 2024

2.3. BCRAGD Completed and Planned Activities

2.3.1. Flood Reference Markings

BCRAGD is continuing to move forward with creating 'Reference Marks' (i.e., Vertical Datum Elevation Marks) on select low water crossings, bridge decks, and-or on bridge handrails of non-continuously monitored tributaries of the Sabinal and Medina River watershed locations. The selected sites are downstream locations from existing FEWS study areas. The elevations established are to be used as miscellaneous, 'tape-down' points for referencing water surface elevations and existing 'High Water Marks' (HWM) of post flood occurrence to North American Vertical Datum 1988 (NAVD 88). Reference Marks will be established, and elevations determined by conventional vertical datum level circuits completed by BCRAGD. In addition, this data may encompass USGS data for use with HEC-RAS modeling of miscellaneous tributary locations that are not continuously monitored for streamflow or water surface stage values. Appurtenance of this data particularly with the FEWS may add additional resources for critically needed information pertaining to prior inundation of downstream river crossings. The procedures of Vertical Datum level circuits at each location will follow USGS standard protocols.

2.3.2. Community Outreach

BCRAGD have met with Bandera City Officials recommending a city / county wide Flood Plan for evacuation purposes, to be utilized during a major flooding event. The City of Bandera and BCRAGD are working together utilizing BCRAGD's internal document of the Flood Action Plan as a template for illustrational purposes and development criteria, utilizing the FEWS of the Medina and Sabinal rivers.

2.3.3. Flood Safety Planning

A sub-committee team comprised of staff from BCRAGD, and Bandera County will be created for planning (most probable) selected evacuation routes preceding a significant flood event occurring in the western portion of the county. The base line for referencing information will include and associated with the FIM of the Sabinal River.

3. Summary

A series of 35 digital flood-inundation maps were developed using data collected at USGS streamflow-gaging station 08197970 Sabinal River at Utopia, TX. The flood-inundation maps cover a 10-mi down-stream reach of Sabinal River from the USGS streamflow-gaging station 08197936 Sabinal River below Mill Creek near Vanderpool, TX. to the Utopia gage and includes a 7-mile reach of the West Sabinal River. The flood-inundation maps were developed by using the U.S. Army Corps of Engineers (USACE) Hydrologic Engineering Center River Analysis System (HEC-RAS) program to compute water-surface elevations and delineate estimated flood-inundation extents and depths of flooding for selected stages. A synthetic stage-discharge relation for the Utopia gage was developed using a regional regression equation to calibrate the model. The highest river stage was determined as 28 ft at Utopia gage based on the estimated peak stage during the July 5, 2002, flood event. Differences between the synthetic rating and the model results for the 35 simulated stages at the Utopia gage were equal to or less than 2.20 ft with a root mean square error (RMSE) of 1.59 ft.

Each flood-inundation depth grid for each modeled layer is delineated at 0.5-foot (ft) intervals of water surface stage, referenced to the Utopia gage datum, and ranging from 7 ft gage-height near bank full to 28 ft, gage-height, which correlates the peak flow stage value determined during the July 5, 2002, flood. These flood-inundation maps are intended to help guide the public in taking individual safety precautions and provide emergency management personnel with a tool to efficiently manage emergency flood operations and post flood recovery efforts.

The Flood Decision Support Toolbox (http://webapps.usgs.gov/infrm/fdst/) with the USGS modeled Flood Atlas map library of the Sabinal River FEWS study area, and a Scientific Investigations Report (SIR) are completed and were previously planned for public release during the spring of 2023. However, the official public release, contingent upon the Department of the Interior report's approval process, had been delayed due to required revisions identified during USGS reports review process. Subsequently, due to the integrity of the synthetic regional regression analysis utilized for the development of a stage / discharge rating, the revised SIR and FEWS flood atlases were received and are available as of September 28, 2023.

Flood-Inundation Maps Created Using a Synthetic Rating Curve for a 10-Mile Reach of the Sabinal River and a 7-Mile Reach of the West Sabinal River Near Utopia, Texas, 2021

(https://doi.org/10.3133/sir20235001)

The project's deliverables adequately represent viable data representations and add value to stakeholders. Due to the continuing severe drought related conditions, the FEWS stream gage monitors have assisted with water conservation data accordingly for public and policy planners for drought related monitoring protocols.

End of Sabinal River Flood Early Warning System, Annual Progress Report ‘APR-2024-002, for the period September 01, 2023, to August 31, 2024, due to Texas Water Development Board no later than 30 days following 08/31/2024.

Submitted on September 24, 2024