

Public Comment Period

Infrastructure Improvements to the State's Existing Stream gage and Weather Station Networks

Draft Application for the Hurricane Harvey State Mitigation Competition – Housing and Urban Development Most Impacted and Distressed areas

The Texas Water Development Board (TWDB) is holding a period of public review and comment on its application to the Texas General Land Office Hurricane Harvey State Mitigation Competition – Housing and Urban Development Most Impacted and Distressed areas. We are applying for funding to amplify current efforts to collect data used in flood forecasting and analysis. The draft application documents follow this cover memo.

The period of public review and comment begins **October 8, 2020**, and ends at **5:00 P.M. on October 21, 2020**. If you wish to comment on the TWDB's draft application, please email comments to: PUBLIC-COMMENT@twdb.texas.gov

Please contact Dr. Carla Guthrie, Director of Surface Water, at Carla.Guthrie@twdb.texas.gov should you have any questions.

Project Summary

The 2019 *State Flood Assessment* for Texas identified “sound science and data [as] core elements of effective planning and flood mitigation.” In line with this principle, the TWDB has invested over \$9.6 million since 2016 to expand the state's existing U.S. Geological Survey (USGS) stream gage network and establish the TexMesonet weather station network to provide better data coverage to support a variety of flood planning, mitigation, and response activities. There is, however, still a critical need to expand those data collection efforts in areas affected by Hurricane Harvey because the existing network is inadequate.

Working with the USGS, National Weather Service, and other partners, TWDB staff has identified \$7.15 million in infrastructure improvements to the state's stream gage and weather station networks that are eligible for funding through the mitigation competition for Hurricane Harvey impacted areas. Project activities are located in Hurricane Harvey Housing and Urban Development and State Most Impacted and Distressed Areas as well as areas upstream that are hydrologically connected to Harvey-impacted areas. Proposed

Our Mission

Leading the state's efforts in ensuring a secure water future for Texas and its citizens

Board Members

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activities include: (1) installing 40 new weather stations, (2) installing 14 new stream gages, and (3) enhancing and modernizing another 122 gages to ensure high quality, reliable data are available in the region. In total, the project will improve 18 percent of the state's existing USGS stream gage network while increasing the total number of stream gages by 2 percent and the total number of TexMesonet weather stations by 57 percent. Annual maintenance costs associated with future ongoing site operation will be covered by funding from the TWDB, USGS, and local cooperators.

This posting contains the four components of a substantially complete application, including a scope of work, budget, identification of all sources of funding, and maps to identify location and beneficiaries.

Infrastructure Improvements to the State’s Existing Stream Gage and Weather Station Networks – Texas Water Development Board

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Texas Water Development Board

Hurricane Harvey State Mitigation Competition – Housing and Urban Development Most Impacted and Distressed Areas

*Application materials necessary for public comment provided below *

Title: Infrastructure Improvements to the State’s Existing Stream Gage and Weather Station Networks

GENERAL

Program: Hurricane Harvey State Mitigation Competition – HUD MID

Applicant: Texas Water Development Board

County: Multiple

Application Type: New

Council of Governments: N/A

Related Contacts: Contact – Jeff Walker, Executive Administrator

Authorized Representative – Sam Hermitte, Assistant Deputy Executive Administrator

Grant Administrator – Mark Wentzel, Manager River Science

Application Title: <u>Infrastructure improvements to the state’s existing stream gage and weather station networks</u>		
Applicant Delinquent on Federal Debt - No	Construction Application - No	Construction Pre-Application - No
Program Not Selected by State for Review - No		

MITIGATION NEEDS

Addressed Risk – The project addresses the following risks identified in the Action Plan:

Hurricanes/Tropical Storms/ Tropical Depressions <input checked="" type="checkbox"/>	Severe Coastal Flooding <input type="checkbox"/>	Riverine Flooding <input checked="" type="checkbox"/>
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Hazard, Risk Description - Describe how the risk(s) selected are impacting the proposed project area. Reference where adopted local mitigation efforts are planned or underway where appropriate.

Hurricanes, tropical storms and depressions, and riverine flooding remain persistent risks, along with coastal flooding, to the areas once affected by Hurricane Harvey. Of the 12 weather-related hazards investigated during development of the *State of Texas Hazard Mitigation Plan*, riverine flooding accounted for 7 percent of average annual property losses from 1996 through 2016. Additionally, riverine flooding is expected to account for 8 percent of all annual property losses and 6 percent of all crop losses according to hazard impact forecasts for 2019 through 2023 (TDEM, 2018). However, hurricanes and tropical storms and depressions are the costliest of all hazards facing Texas. Between 1996 and 2016, the southeast Texas region experienced 93 percent of all property losses statewide, 98 percent of all deaths, and more than 99 percent of all injuries related to these hazards.

Further, based on available Flood Insurance Rate Maps and 2010 census data, an estimated 2.8 million people, or 11 percent of the state's population, are exposed to high or moderate risk of riverine flooding in any given year. Southeast Texas—including many areas impacted by Hurricane Harvey—has the most residents exposed, with 23 percent of the 2010 population living or working in one of these risk zones (TWDB, 2019). In terms of future flood risk, increased levels of atmospheric moisture will lead to increased rainfall totals during storm events, including hurricanes and tropical storms (TDEM, 2018).

Following disastrous flooding in Texas in 2015, the Office of the Governor provided funding to the Texas Water Development Board (TWDB) for the purpose of installing a network of stream gages to enhance flood warning and floodplain management. Using this and subsequent funding provided by the Texas Legislature, the TWDB has invested \$9.6 million to establish stream gaging and weather station networks for flood protection and planning purposes. Specifically, the TWDB has funded the installation and ongoing operation and maintenance of 56 U.S. Geological Survey (USGS) stream gages and 4 USGS lake level gages statewide, with 21 of these having been installed in Harvey affected areas. The TWDB has also installed and continues to operate 70 TexMesonet weather stations, with 14 of these having been installed in Harvey affected areas.

Data and information from these networks are used by the public to understand current conditions and by entities such as the National Weather Service to establish adequate lead times for severe weather warnings, ultimately reducing loss to life and property. Moreover, the National Weather Service relies on accurate stream gage data to ensure river forecast models are properly calibrated for flood warning purposes. Real-time rainfall data also is crucial to forecasting storm events, including heavy rainfall distribution, and for calibrating rainfall radar data. Concurrent soil moisture data from these networks make it possible to determine how quickly soils are becoming saturated and unable to absorb additional precipitation (Nielson-Gammon, *et al.*, 2017).

Long-term, datasets collected from these networks will provide essential information for developing new flood models and improving the accuracy of existing models used for identifying flood risk or for mitigation planning. As more data are collected, statistical trends can be analyzed to better understand the relationship between rainfall, soil moisture, runoff, and subsequent flood events. Consequently, existing models used for hazard prediction, post-event impact assessments, and infrastructure and related development planning are necessarily improved. As Texas continues to grow, it is critical that our knowledge of past events is documented in order to inform future decisions to keep people and property out of harm's way.

Hazard Mitigation Actions - Describe how the proposed project will mitigate against the identified risks. Reference where adopted local mitigation efforts are being enhanced where appropriate. One overarching mitigation goal for the State of Texas relates specifically to this project—to *enhance the quality of vulnerability and risk assessments through the development and collection of data* (TDEM, 2018). This project expands the ongoing collection of stream flow, water level, and weather station data in Texas, specifically to accomplish effective flood planning and mitigation activities for communities at risk of riverine flooding and flooding from significant rain events associated with hurricanes and tropical storms/depressions. By expanding the state’s stream gage and weather station networks, more data will be available to delineate floodplains, calibrate flood models, and identify local flood risk. Further, the value of real-time data for use by meteorologists, first responders, and the public cannot be overstated. Accurate data is integral to the decision-making process that forecasters use to predict river heights and anticipate flash flooding based on heavy rain events.

Additionally, this project contributes to several categories of the state’s hazard mitigation strategy (TDEM, 2018), including:

1. *Prevention and Policy – actions intended to prevent [flood] risk and ensure that future development does not increase hazard losses.* Data from this project can inform structural and non-structural mitigation activities, such as capital improvement planning and zoning for land development, through the use of improved flood models and tools.
2. *Property Protection and Life-Safety – actions to modify buildings and/or surroundings to reduce vulnerability and risk associated with [flood].* Data generated by this project can be used to identify hazardous locations, to inform community warning systems, and to aid in appropriately engineering infrastructure such as culverts, bridges, levees, and detention ponds to reduce flood risk.
3. *Mitigation Planning and Public Education/Awareness – efforts to inform people regarding [flood] hazards and the actions necessary to avoid potential damage and injury.* This project offers data for both immediate use as well as for long-term trend analysis and planning of mitigation activities as noted above. Near real-time observation data on stream flow and weather conditions are available immediately and can be used by the public, first responders, decision-makers, and the National Weather Service to protect life and property.

Many local Hazard Mitigation Plans evaluate their flood risks based on data from existing USGS stream gages and weather stations (e.g., HCOHSEM, 2020), highlighting the current value of these networks as well as the added value that expansion of these networks will bring. The Harris County Multi-Hazard Mitigation Action Plan (HCOHSEM, 2020) credits weather stations and stream gages as providing critical data that allows decision makers to reduce the risk of property damage, injuries, and loss of life. Further, the TexMesonet.org website displays data collected by 15 partnering entities in the United States and Mexico who recognize the value of these data to mitigation efforts. Information such as this, collected by the Harris County Flood Control District (HCFCD) and displayed on the TexMesonet site through this partnership, proved invaluable to forecasters and first responders during Hurricane Harvey and more recent storm events. In addition, the HCFCD uses information collected through their weather station and gage networks to create post-flood reports, to identify the extent of damage from flooding, and to analyze the performance of structural projects during flood events. The data are also used in selecting sites for future mitigation projects. While many such stations and gages are in operation in and around Harris County, this project will expand the networks to less served areas of the state.

Added Resiliency Measures

Does the proposed project enhance mitigation efforts that are already completed or underway? Yes

The proposed project will expand and improve upon the existing U.S. Geological Survey (USGS) stream gage and TexMesonet weather station networks which have been established to provide better data coverage to support a variety of flood planning, mitigation, and response activities. Since 2016, the Texas Water Development Board (TWDB) has invested \$9.6 million to establish and expand stream gage and weather station networks for flood protection and planning purposes. Specifically, the TWDB has funded the installation and ongoing operation and maintenance of 56 USGS stream gages and four USGS lake level gages statewide, with 21 of these having been installed in Harvey affected areas. The TWDB has also installed and continues to operate 70 TexMesonet weather stations, with 14 of these having been installed in Harvey affected areas.

By building on the TWDB’s existing investment that has established stream gage and weather station networks for flood planning and protection, this project will leverage and enhance the state’s investment by providing another 14 stream gages and 40 weather stations in the area affected by Hurricane Harvey. Further, the project will enhance, update, and modernize another 122 gages to ensure the highest quality and most effective data are available in the region affected by Hurricane Harvey and at risk of impact from future hurricanes. In total, the project will improve 18 percent of the state’s existing USGS stream gage network while increasing the total number of gages by 2 percent and the total number of TexMesonet weather stations by 57 percent.

Select the type(s) of prior or current local efforts undertaken that, combined with the proposed project, will provide enhanced hazard mitigation:

Prior capital improvement project(s) <input checked="" type="checkbox"/>	Current capital improvement project(s) <input checked="" type="checkbox"/>	Short-range planning efforts <input type="checkbox"/>	Long-range planning efforts <input checked="" type="checkbox"/>
Community engagement <input type="checkbox"/>	Educational outreach <input type="checkbox"/>	Implementation of enhanced building codes <input type="checkbox"/>	Code enforcement <input type="checkbox"/>
Other related work which enhances hazard mitigation and/or resiliency through the proposed project. <input checked="" type="checkbox"/>	Other Hazard Mitigation Work – Improvement to data network infrastructure and communications infrastructure; hardening of stream gages to increase resiliency during storm events; public information		

Upload scope of work information, maps, and other applicable documentation for each local effort identified. Select the Document Template that contains 'Scope of work' as part of the template name.

Scope of Work

The 2019 *State Flood Assessment* for Texas identified “sound science and data [as] core elements of effective planning and flood mitigation” (TWDB, 2019). Since 2016, the Texas Water Development Board (TWDB) has worked to support such sound science by expanding coverage of stream gages and weather stations across the state to provide data that is foundational to localized flood risk assessment, delineation of floodplains, calibration of flood models and other tools for flood mitigation, and appropriate sizing of infrastructure such as culverts, bridges, levees, and detention ponds. Thus far, the TWDB has funded the installation and ongoing operation and maintenance of 56 U.S. Geological Survey (USGS) stream gages and 4 USGS lake level gages statewide, with 21 of these having been installed in Harvey affected areas. The TWDB has also installed and continues to operate 70 TexMesonet weather stations, with 14 of these having been installed in Harvey affected areas. Collectively, since 2016, the TWDB has spent \$9.6 million to develop and enhance stream gaging and weather station networks specifically for flood protection purposes.

Despite these advancements, significant opportunities to improve network infrastructure for both stream gages and weather stations remain. This project specifically seeks funding to provide for the cost of additional infrastructure and improvements to the state’s existing stream gage and weather station networks in areas impacted by flooding due to Hurricane Harvey in 2017. Annual maintenance costs associated with future ongoing operation of sites will be covered by funding from the TWDB, USGS, and other cooperators.

Justification

Successful flood mitigation planning to minimize future loss of life and property depends on foundational data collected from such networks. In addition, immediately before and during flooding events, data from these networks provides crucial information necessary for flood warning and forecasting to minimize loss of life and property. When stream gages and weather stations are spread sparsely across the landscape, or missing entirely from an area, decision makers are forced to rely on data that may not accurately reflect local conditions. In such cases, lack of data leaves local authorities and the public unaware of their true flood risk.

This project is well aligned with both state and local Hazard Mitigation Plans that identify flood gages and monitoring systems as a strategy to support mitigation planning and public awareness. Further, the project directly addresses one of the eight state hazard mitigation goals, specifically “to enhance the quality of vulnerability and risk assessments through the collection, organization, and analysis of data”, while also contributing to the attainment of the seven remaining goals, including understanding the impact of hazards and developing policies and strategies to manage such risk (TDEM, 2018).

Considering the relatively large risk that riverine and coastal flooding poses for Texas, there are many opportunities to expand stream gaging and weather station networks to benefit the state. Texas consistently ranks in the top 1 to 5 of all states in terms of annual economic damages and deaths due to flooding, and Texas has more Special Flood Hazard Area as designated by the U.S. Federal Emergency Management Administration than any other state. Despite this high exposure to flood risk, Texas ranks 14th to last among states in terms of USGS stream gages per land area and 8th to last in terms of USGS stream gages per population. Moreover, some USGS streamflow gages in

Texas only provide the height of water in the river channel (stage) and do not provide flow-volume data. Other streamflow gages require modernization of gage vertical datums (also known as the surface elevation of the gaging equipment) and communications equipment in order to be of greatest value during flood events. Then, others have been damaged during recent floods and require repairs or improvements to ensure they are resilient and remain continuously operable during future flood events.

Weather station coverage is generally adequate in most urban areas; however, smaller cities and rural areas across the state lack access to high-quality weather station infrastructure. These gaps impede forecasting and warning of flood events as well as access to hydrologic data for adequate localized flood risk identification and mitigation. The proposed weather stations will provide not only high-quality precipitation measurements but also antecedent soil moisture—a key piece of information required for accurately estimating rainfall-runoff. Knowledge of antecedent soil moisture conditions is critical for understanding flood risks in southeast Texas and across the state. Additionally, soil moisture and precipitation data aid in numerous ways beyond flood hazard prediction, such as infrastructure design and construction for structural flood mitigation activities. TexMesonet data, much like stream gage data, is beneficial to the state beyond the variety of flood applications and aids in mitigating other hazards identified in the State Hazard Mitigation Plan (TDEM, 2018), such as drought, wildfires, and expansive soils. These data are also beneficial to the state's economy as related to agricultural irrigation, drought preparedness, and water supply planning.

This project is proposed for areas impacted by Hurricane Harvey because the existing network of stream gages and weather stations is inadequate and compromises Texas' ability to mitigate flood risk for existing infrastructure and to make data-informed investments to reduce flood risk to future infrastructure.

Purpose

Working with the USGS, National Weather Service, and other partners, TWDB staff have identified \$7.15 million of infrastructure improvements to stream gage and weather station networks eligible for funding through the mitigation competition for Hurricane Harvey impacted areas (Figure 1). Project activities are located in Hurricane Harvey HUD and State MID areas as well as areas upstream that are hydrologically connected to Harvey-impacted areas. Data collection at these sites provides valuable information for future flood planning and warning in Hurricane Harvey affected counties. The proposed project includes the following tasks:

Task 1: Installation of TexMesonet weather station infrastructure – 40 new stations

Task 2: Installation of USGS stream gage infrastructure – 14 new gages

Task 3: Enhancement of USGS stream gage infrastructure – provide full-range flow data at 8 gages

Task 4: Repair and resiliency improvements to USGS stream gage infrastructure – 72 gages

Task 5: Modernization of USGS stream gage infrastructure – update vertical datums and communication equipment for 42 gages

In total, this project will improve 18 percent of the state's existing USGS stream gage network while increasing the total number of gages by 2 percent and the total number of TexMesonet weather stations by 57 percent. All improvements will provide valuable data to mitigate future flood risk in

Hurricane Harvey HUD and State MID areas related to Hurricane Harvey. Ongoing operation and maintenance costs related to these infrastructure improvements will be covered by the TWDB, USGS, and existing partners.

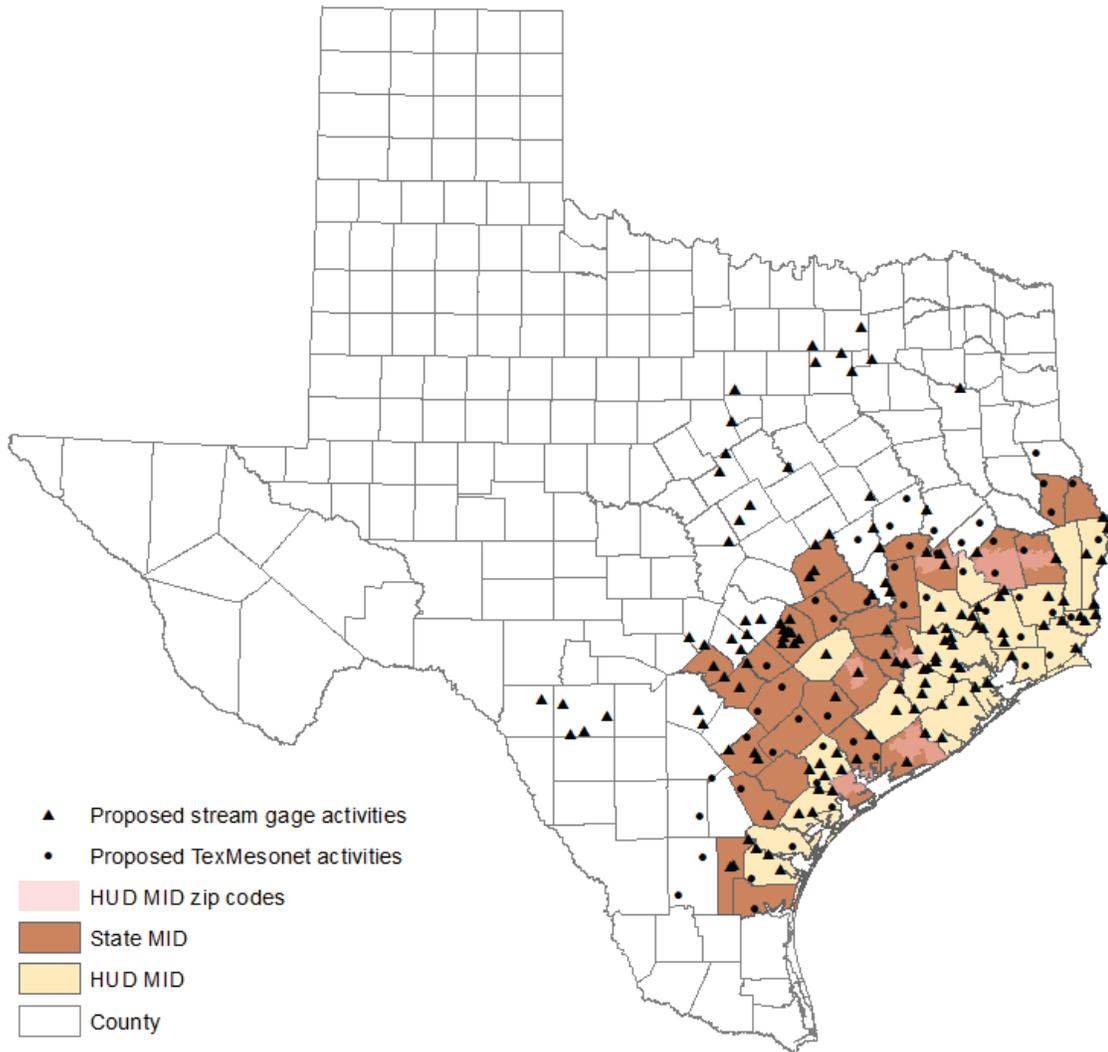


Figure 1. Proposed project locations for improving the state's stream gage (black triangles) and weather station (black circles) networks.

Methodology

Task 1: Installation of TexMesonet weather station infrastructure

This project proposes to install a minimum of 40 multi-parameter weather stations with 5-minute data retrieval intervals, each operated on the FirstNet public safety wireless network to ensure access to data during critical weather events. Within Harvey-impacted and immediate contributing areas, 50 site locations have been identified that can enhance weather station coverage for areas currently underserved by existing infrastructure (Figure 2; Appendix 1.1). Locations selected are consistent with the TexMesonet build-out plan, which is based on guidance from the National Weather Service as contained within a feasibility study on developing a statewide network (Nielson-Gammon, *et al.*, 2017), and is consistent with siting procedures of the World Meteorological Association and the National Oceanic and Atmospheric Administration. Due to possible constraints in site suitability or securing site access agreements, the TWDB proposes to install weather stations at a minimum of 40 of these identified sites.

Each weather station will consist of an array of sensors, mounted on or near a 10-meter tower, that will measure

- 2- and 10-meter wind velocity and direction,
- 2- and 9-meter air temperature,
- 2-meter relative humidity,
- 5-, 10-, 20-, and 50-centimeter soil moisture,
- 5-, 10-, 20-, and 50-centimeter soil temperature,
- barometric pressure,
- solar radiation,
- rainfall using a weighing rain gage, and
- rainfall using a tipping bucket rain gage.

Additionally, calculated measurements at each location will include

- wind chill,
- wind gust,
- heat index, and
- dew point.

Data collected at each of these locations will be publicly available to view in near-real time and to download from TexMesonet.org. Additionally, data will be fed to the Meteorological Assimilation Data Ingest System (MADIS) and to the National Weather Service through Synoptic Data Services. TWDB staff will seek site access agreements with landowners within five miles of the proposed installation sites. Once no-cost access agreements have been executed, installation of weather station infrastructure will be completed via contracted services in accordance with standard TexMesonet station installation procedures. Depiction of a typical TexMesonet weather station is shown in Figure 3. All ongoing operation and maintenance will be conducted by the TWDB.

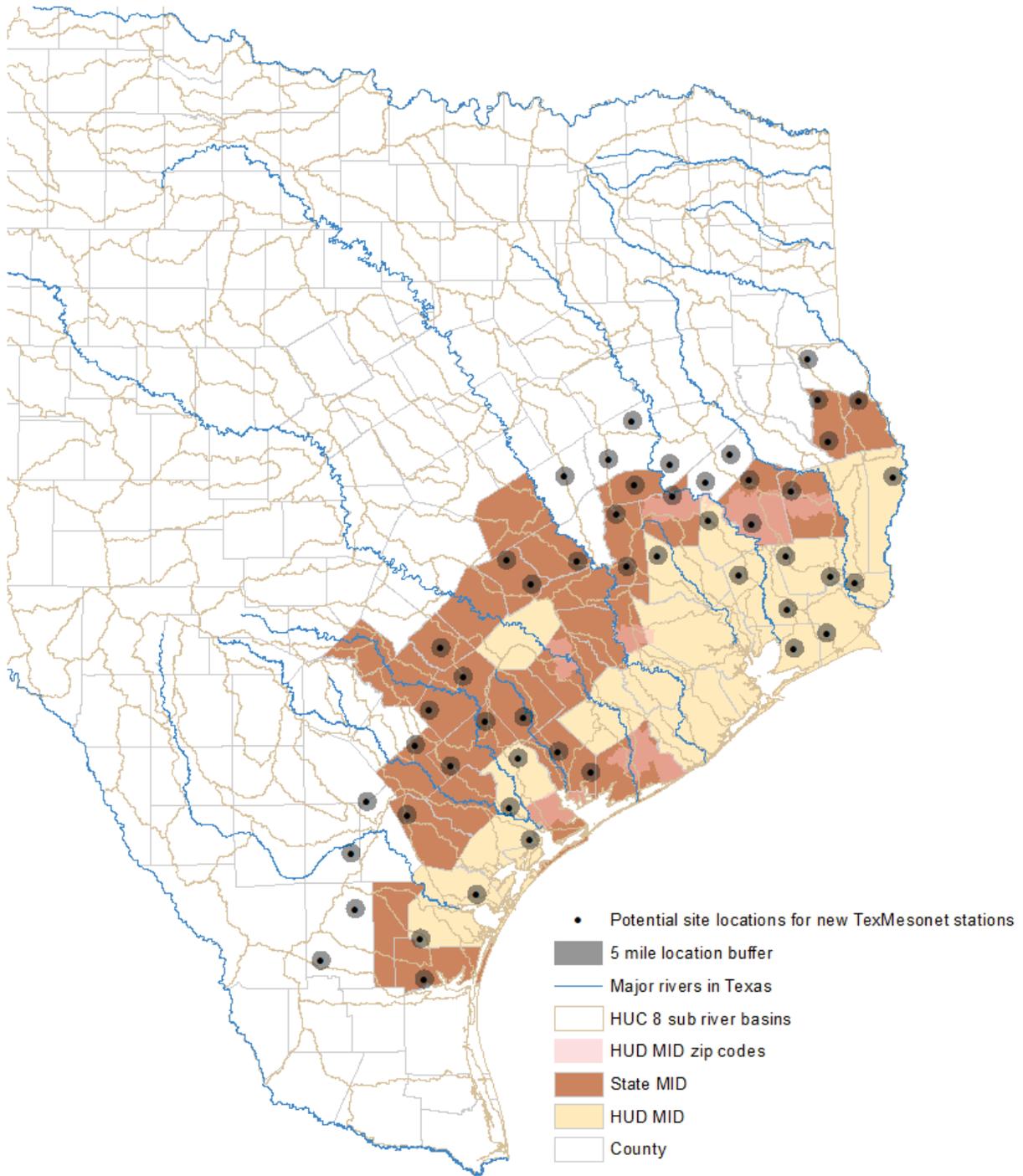


Figure 2. Potential site locations (black circles with shaded 5-mile buffer) for new TexMesonet weather station infrastructure (Task 1).



Figure 3. TexMesonet weather station at Big Dog Ranch (Station ID #51, Display ID LMBDR; Lampasas County, Texas).

Task 2: Installation of USGS stream gage infrastructure

This project proposes to install 14 new USGS stream gage stations. Locations were chosen to improve flood planning, warning, and forecasting and were selected in consultation with staff from the USGS and the National Weather Service as well as local stakeholders (Figure 4; Appendix 1.2). Installations will include instrumentation in or near the river channel and data loggers and communications equipment in gage housing raised above recent flood elevations. USGS staff will select and install the most appropriate gaging equipment based on specific site conditions. Examples of gage stations are shown in Figure 5.

Gaging equipment continuously measures and records the height of water in the channel (stage) which, by itself, has limited value. A rating curve that describes the relationship between stage and discharge (the volume of water that passes the gage during a specific amount of time) is required to obtain discharge measurements from the gage. To develop and maintain an accurate rating curve, USGS staff visit the site with specialized equipment to measure flow while noting the associated stage. Flow measurements cover the entire range of flows (from low flows to flood flows); are repeated frequently to account for changes in the river channel; and are the largest contributor to the annual cost of operating and maintaining a stream gage. Most station installations will be located at bridge crossings that provide ready access for making flow measurements, but one location will require construction of a cableway to allow for the collection of flow measurements during flood conditions. After installation of stream gages, annual operation and maintenance will be conducted by the USGS with funding from the TWDB, USGS, and the following local cooperators: Bastrop and Brazoria counties; Fort Bend County and Willow Creek drainage districts; and the Lavaca-Navidad and Trinity river authorities.

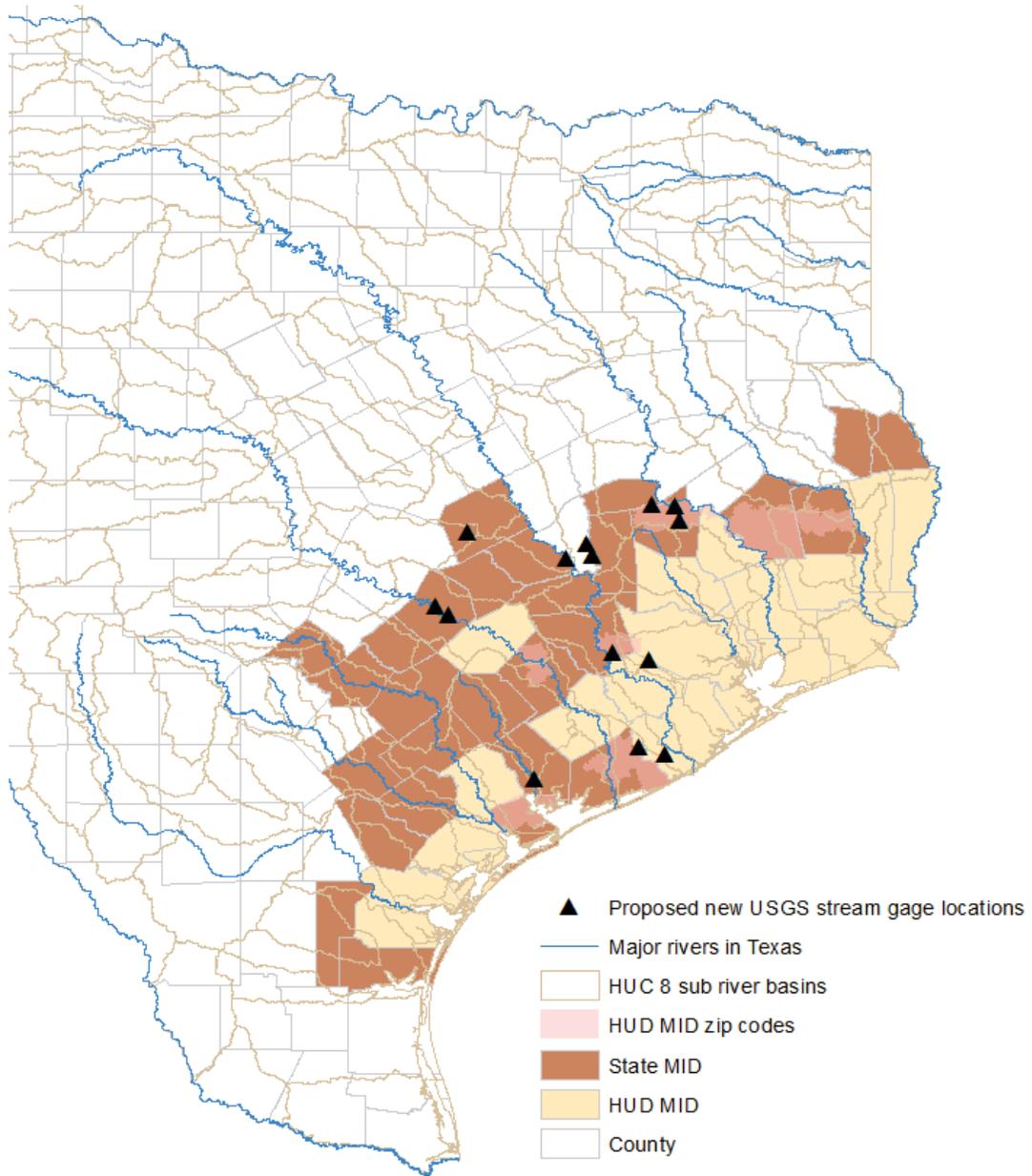


Figure 4. Proposed site locations for installing new USGS stream gage infrastructure (black triangles; Task 2).



Figure 5. USGS stream gage station on the Blanco River at Wimberly (USGS #08171000, Hays County, Texas; left) and a schematic of a typical USGS stream gage (right; *Credit: L.S. Coplin, USGS*).

Task 3: Enhancement of USGS stream gage infrastructure

This project proposes to enhance eight existing USGS stream gage stations by installing the necessary infrastructure to provide the full range of flow data that can occur within a river channel (Figure 6; Appendix 1.3). Presently, all gages identified for enhancement either report only stage (river height) or a limited range of lower flows. However, measuring the full range of flows is necessary for accurately capturing river conditions during high (flood) flow events. To achieve full-range monitoring capability, enhancements will consist of installing additional infrastructure, such as catwalks and cableways, for measuring flows during flood events and/or additional equipment to measure the velocity of river flows. Though accurate measurements of high flow events are of interest to flood planners and emergency responders, not all locations are suitable for collecting the full range of flows. The locations selected for this project were chosen in consultation with the USGS based on site suitability and the availability of a cooperator to pay for the additional associated ongoing operation and maintenance costs. After enhancements, annual operation and maintenance will be conducted by the USGS with funding from the TWDB, USGS, and the Brazos and Lower Colorado river authorities.

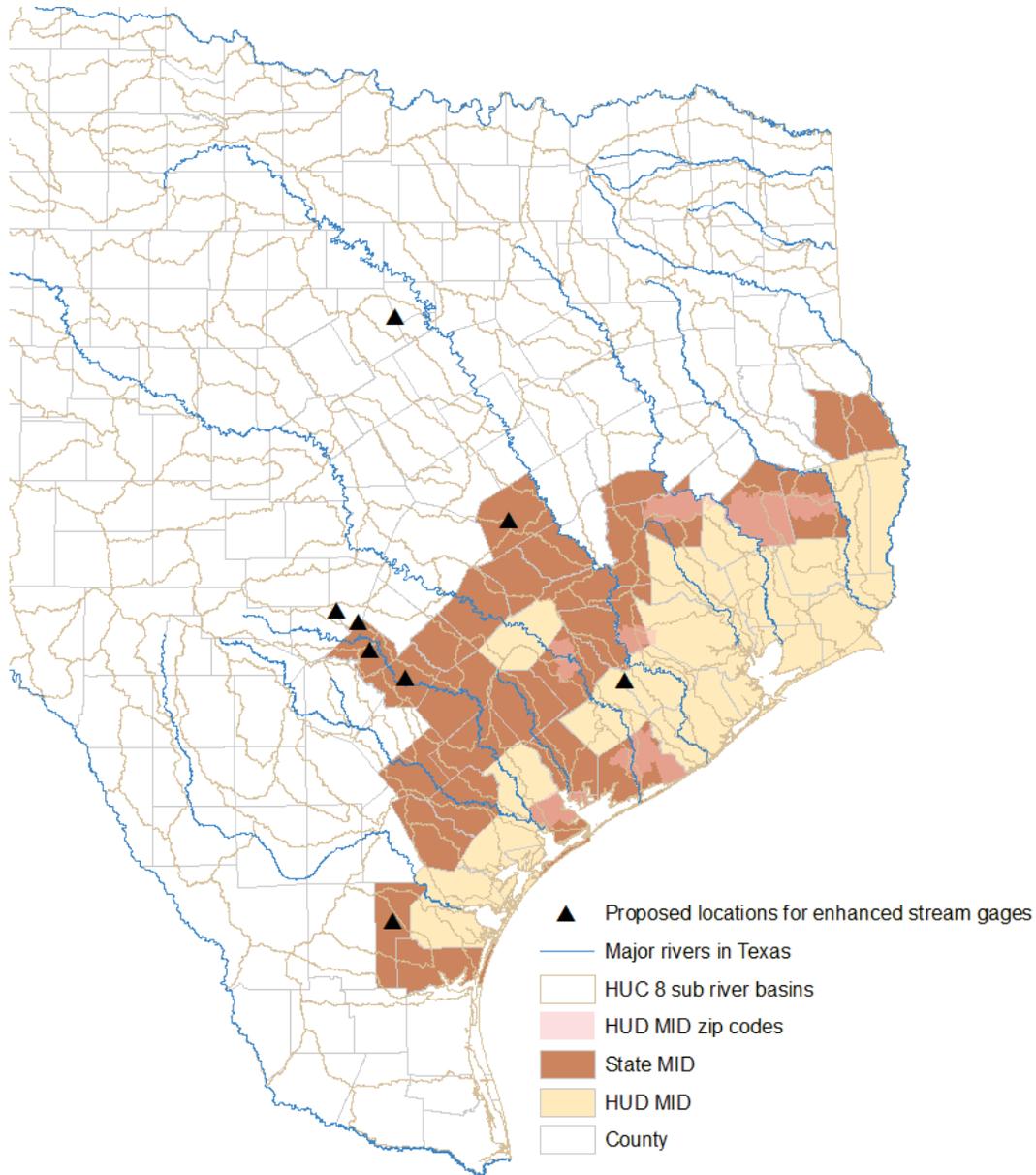


Figure 6. Proposed USGS stream gage locations to be enhanced to report full-range flow data (black triangles; Task 3).

Task 4: Repair and resiliency of USGS stream gage infrastructure

This project proposes to repair 72 existing USGS stream gages that have sustained flood damage, while at the same time upgrading the station infrastructure to increase resiliency to future flood events (Figure 7; Appendix 1.4). If necessary, these gages also will receive modernization upgrades as described below (see Task 5). Activities to be completed for this task include installing new and elevated gage housings, relocating gages to safer locations, replacing equipment that was lost and/or damaged during recent floods, and clearing debris and vegetation from river cross-sections.

Locations were chosen in consultation with the USGS based on damages reported by their area offices. Repair and resiliency activities will not increase annual operation and maintenance costs for these gages, which will continue to be paid for by the TWDB, USGS, the U.S. Army Corps of Engineers, and the following local cooperators: the Brazos, Guadalupe-Blanco, Lower Colorado, Sabine, San Antonio, San Jacinto, and Trinity river authorities; cities of Austin, Dallas, Houston, and San Antonio; Edwards Aquifer Authority; Fort Bend Subsidence District; Harris County Flood Control District; Lower Neches Valley Authority; and Sabine River Compact Administration.

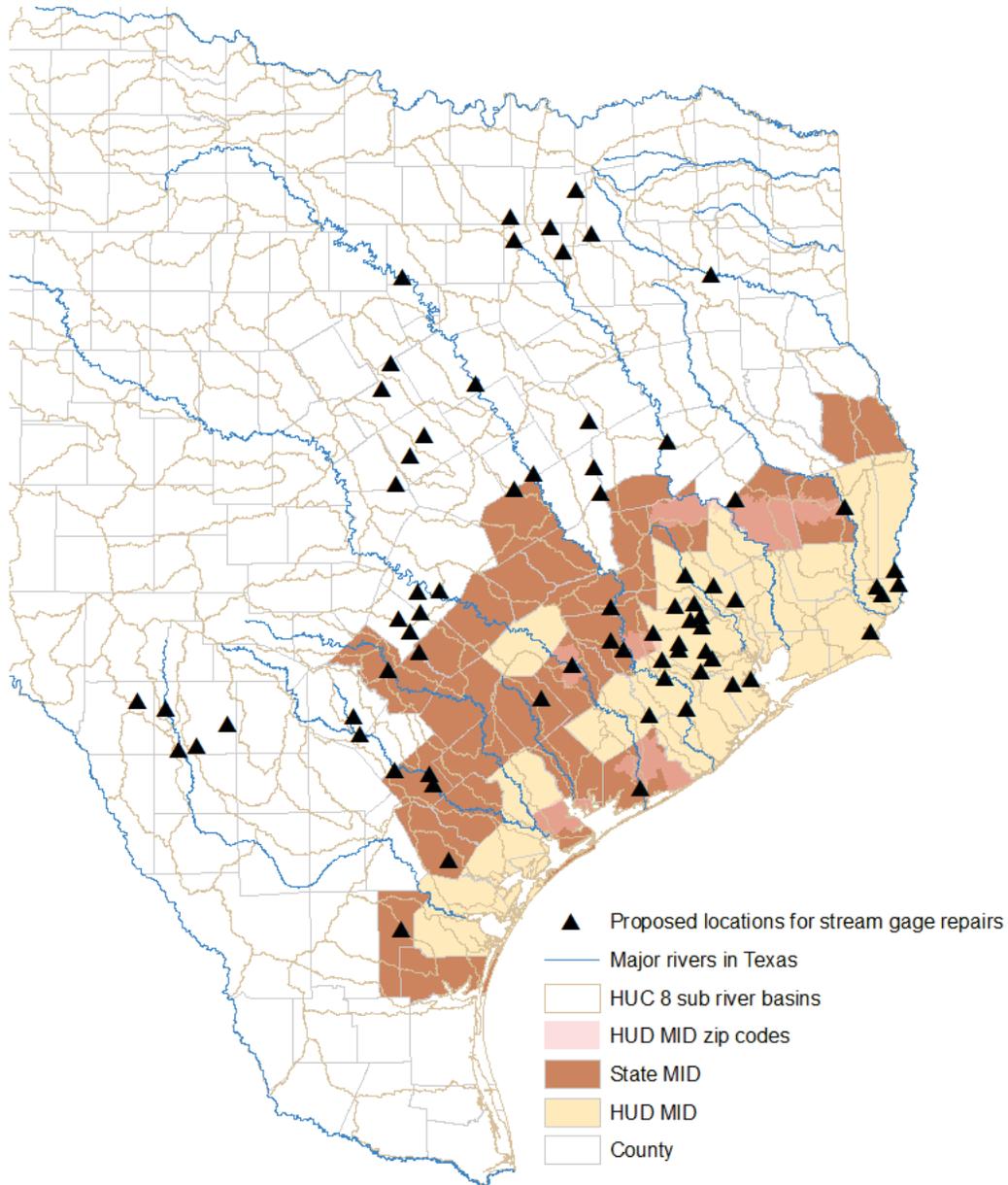


Figure 7. Proposed USGS stream gage locations to be repaired and made more resilient to future flood events (black triangles; Task 4).

Task 5: Modernization of USGS stream gage infrastructure

This project proposes to modernize 42 existing USGS stream gage stations in need of communications upgrades or revision of reference points used to make gage measurements (gage datums) as determined by the USGS (Figure 8; Appendix 1.5). Communication upgrades will increase the likelihood that gages can continue to transmit data during storm events. Many older gage stations require datum revisions because they were originally surveyed to collect data relative to the National Geodetic Vertical Datum of 1929 (NGVD 29). New gages collect data relative to the North American Vertical Datum of 1988 (NAVD 88). NAVD88 is more compatible with modern surveying methods; is more accurate than NGVD29; and is the standard for new Federal Emergency Management Agency flood planning efforts. Modernizing all gages relative to NAVD 88 will be a significant infrastructure improvement allowing for direct comparison of all data collected within the gage network. Modernization activities will not increase annual operation and maintenance costs for these gages, which will continue to be paid for by the TWDB, USGS, U.S. Army Corps of Engineers, and the following local cooperators: the Guadalupe-Blanco, Lavaca-Navidad, Lower Colorado, Sabine, San Antonio, and Trinity river authorities; cities of Corpus Christi and Houston; Coastal Water Authority; Lower Neches Valley Authority; and Sabine River Compact Administration.

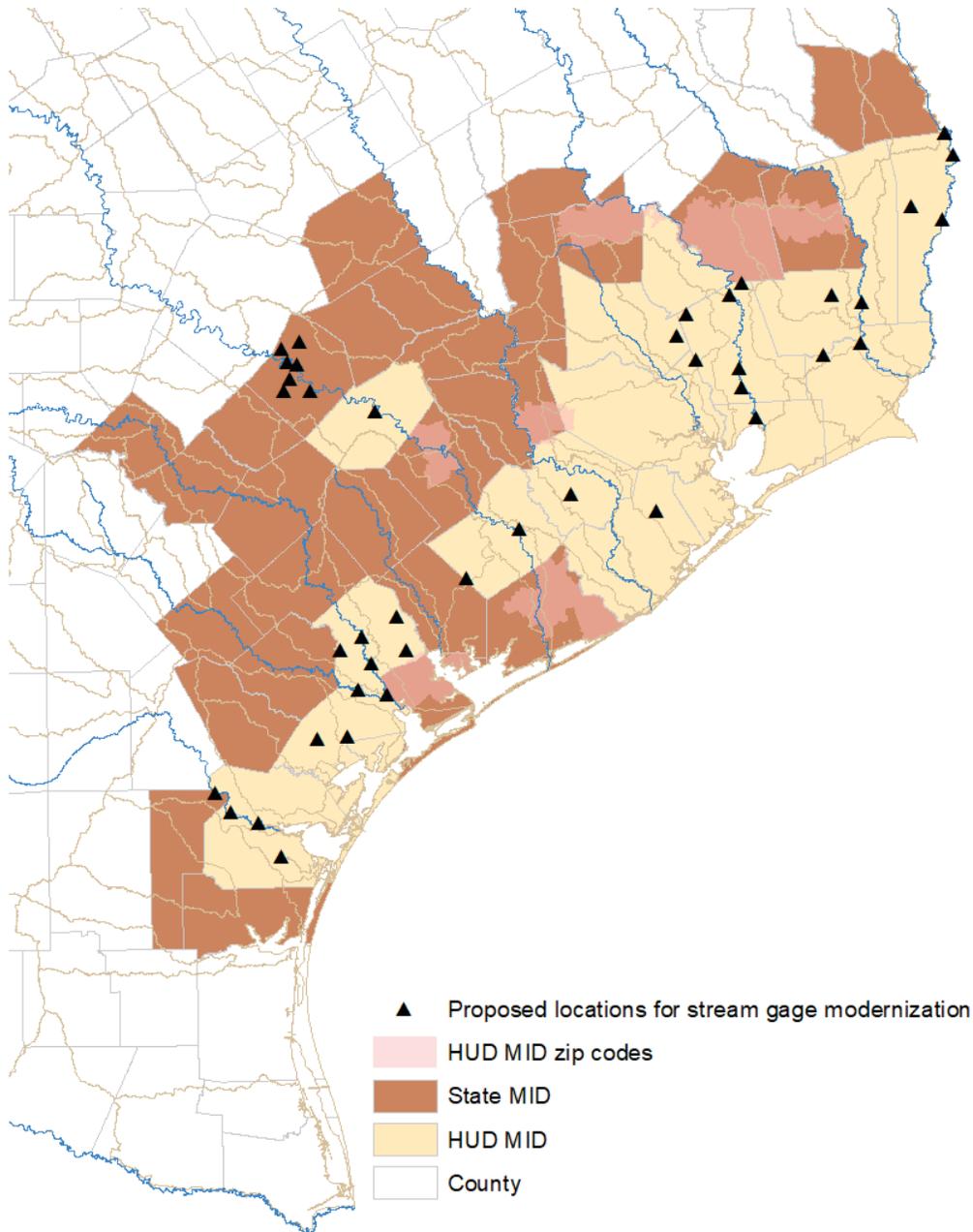


Figure 8. Proposed USGS stream gage locations to be modernized with updated gage datums and communications equipment (black triangles; Task 5).

Literature Cited

HCOHSEM (Harris County Office of Homeland Security and Emergency Management), 2020, Harris County Multi-Hazard Mitigation Action Plan, Volume 1 – Area-Wide Elements: Harris County, Office of Homeland Security and Emergency Management, 504 p.

Nielsen-Gammon, J.W., G. Fipps, T. Caldwell, D.B. McRoberts, D. Conlee, 2017, Feasibility study for development of statewide evapotranspiration network. Final report issued for contract #1613581995 to the Texas Water Development Board, 97pp.

TDEM (Texas Division of Emergency Management), 2018, State of Texas Hazard Mitigation Plan: Texas Department of Public Safety, Division of Emergency Management, 422 p.

TWDB (Texas Water Development Board), 2019, State Flood Assessment: Report to the 86th Texas Legislature, 54 p.

Budget

Task	Cost
Task 1: Installation of TexMesonet weather station infrastructure	\$1,408,800
Task 2: Installation of USGS stream gage infrastructure	\$1,168,975
Task 3: Enhancement of USGS stream gage infrastructure	\$ 901,140
Task 4: Repair/resiliency of USGS stream gage infrastructure	\$3,409,028
Task 5: Modernization of USGS stream gage infrastructure	\$ 263,550
Project Total	\$7,151,493

Sources of Funding

All funds for the proposed *Infrastructure Improvements to the State's Existing Stream Gage and Weather Station Networks* are requested from the Hurricane Harvey State Mitigation Competition. Beyond the scope of this project, costs associated with ongoing maintenance and operation of stream gages and weather station networks will be paid for by the TWDB, USGS, U.S. Army Corps of Engineers, and the following local cooperators: the Brazos, Guadalupe-Blanco, Lavaca-Navidad, Lower Colorado, Sabine, San Antonio, San Jacinto and Trinity river authorities; cities of Austin, Corpus Christi, Dallas, Houston and San Antonio; Fort Bend County and Willow Creek drainage districts; Coastal Water Authority; Edwards Aquifer Authority; Fort Bend Subsidence District; Harris County Flood Control District; Lower Neches Valley Authority; and Sabine River Compact Administration.

APPENDIX 1

Appendix 1.1. Installation of TexMesonet weather station infrastructure (Task 1).

Item number	Site Name	County	Latitude	Longitude
1	Bee 1	Bee	28° 33' 19"	97° 55' 31"
2	Burleson 1	Burleson	30° 25' 26"	96° 24' 35"
3	Caldwell 1	Caldwell	29° 48' 13"	97° 36' 33"
4	Chambers 1	Chambers	29° 42' 17"	94° 34' 14"
5	DeWitt 1	DeWitt	28° 54' 59"	97° 32' 49"
6	DeWitt 2	DeWitt	29° 14' 37"	97° 14' 20"
7	Duval 1	Duval	27° 28' 21"	98° 40' 19"
8	Duval 2	Duval	27° 51' 24"	98° 22' 37"
9	Gonzales 1	Gonzales	29° 20' 17"	97° 43' 07"
10	Gonzales 2	Gonzales	29° 35' 02"	97° 25' 20"
11	Grimes 1	Grimes	30° 46' 00"	96° 03' 39"
12	Grimes 2	Grimes	30° 22' 20"	95° 58' 55"
13	Hardin 1	Hardin	30° 23' 52"	94° 36' 17"
14	Hardin 2	Hardin	30° 13' 42"	94° 13' 39"
15	Houston 1	Houston	31° 07' 44"	95° 34' 34"
16	Jackson 1	Jackson	29° 00' 07"	96° 37' 24"
17	Jackson 2	Jackson	28° 50' 23"	96° 21' 12"
18	Jefferson 1	Jefferson	29° 48' 27"	94° 17' 07"
19	Karnes 1	Karnes	29° 04' 43"	97° 50' 40"
20	Kleberg 1	Kleberg	27° 19' 04"	97° 48' 28"
21	Lavaca 1	Lavaca	29° 16' 10"	96° 54' 45"
22	Lee 1	Lee	30° 26' 57"	97° 01' 16"
23	Lee 2	Lee	30° 15' 44"	96° 48' 36"
24	Leon 1	Leon	31° 10' 52"	96° 06' 37"
25	Leon 2	Leon	31° 27' 42"	95° 53' 13"
26	Liberty 1	Liberty	30° 16' 26"	95° 01' 08"
27	Liberty 2	Liberty	30° 00' 15"	94° 36' 40"
28	Live Oak 1	Live Oak	28° 39' 37"	98° 15' 53"
29	Madison 1	Madison	30° 58' 44"	95° 53' 10"
30	McMullen 1	McMullen	28° 16' 33"	98° 24' 19"
31	Montgomery 1	Montgomery	30° 26' 46"	95° 42' 38"
32	Newton 1	Newton	30° 57' 07"	93° 38' 21"
33	Nueces 1	Nueces	27° 37' 26"	97° 49' 47"
34	Orange 1	Orange	30° 10' 22"	94° 01' 09"
35	Polk 1	Polk	30° 58' 58"	94° 53' 09"
36	Polk 2	Polk	30° 39' 22"	94° 53' 03"
37	Refugio 1	Refugio	28° 20' 46"	96° 53' 17"
38	Robertson 1	Robertson	31° 03' 48"	96° 29' 44"
39	Sabine 1	Sabine	31° 32' 06"	93° 54' 11"
40	San Augustine 1	San Augustine	31° 33' 22"	94° 15' 16"

Appendix 1.1 (continued). Installation of TexMesonet weather station infrastructure (Task 1).

Item number	Site Name	County	Latitude	Longitude
41	San Augustine 2	San Augustine	31° 14' 44"	94° 10' 55"
42	San Jacinto 1	San Jacinto	30° 41' 31"	95° 15' 25"
43	San Patricio 1	San Patricio	27° 56' 49"	97° 21' 04"
44	Shelby 1	Shelby	31° 51' 53"	94° 19' 32"
45	Trinity 1	Trinity	30° 59' 06"	95° 16' 16"
46	Trinity 2	Trinity	31° 10' 46"	95° 02' 29"
47	Tyler 1	Tyler	30° 53' 08"	94° 31' 37"
48	Victoria 1	Victoria	28° 35' 46"	97° 03' 02"
49	Victoria 2	Victoria	28° 57' 44"	96° 58' 06"
50	Walker 1	Walker	30° 53' 25"	95° 33' 48"

Appendix 1.2. Installation of new USGS stream gage infrastructure (Task 2).

Item number	Gage number	Site name	Cooperator	County	Latitude	Longitude
1	n/a	Alum Ck at SH71 nr Bastrop	Bastrop County	Bastrop	30° 4'4.14"	97°13'9.31"
2	n/a	Piney Ck at SH95 nr Bastrop	Bastrop County	Bastrop	30° 8'3.76"	97°18'57.60"
3	n/a	San Bernard at FM521	Brazoria County	Brazoria	29° 0'39.32	95°35'17.54"
4	n/a	Linneville Bayou	Brazoria County	Brazoria/ Matagorda	29° 4'11.17"	95°47'20.50"
5	n/a	Navasota River at SH30	Fort Bend County Drainage District	Brazos/ Grimes	30°36'26"	96°10'53"
6	n/a	Lavaca River at FM 616 nr Lolita	Lavaca Navidad River Authority	Jackson	28°49'56.70"	96°34'39.20"
7	n/a	Harmon Creek at SR 19	Trinity River Authority	Walker (Zip 77320)	30°46'57.19"	95°28'40.65"
8	n/a	Nelson Creek at FM 3478	Trinity River Authority	Walker (Zip 77320)	30°53'37.69"	95°30'52.56"
9	n/a	Bedias Creek at FM 247	Trinity River Authority	Walker (not Zip 77320)	30°54'19.66"	95°40'59.82"
10	n/a	Lower Navasota River	Texas Water Development Board	Grimes	30°30'46.80"	96° 8'16.80"
11	n/a	Brazos River at or near Washington	Texas Water Development Board	Burleson	30°29'38.40"	96°20'24.00"
12	n/a	Brushy Creek, before Rockdale on Little River	Texas Water Development Board	Milam	30°41'38"	97°04'42"
13	n/a	Buffalo Bayou at Westheimer Parkway	Willow Fork or Fort Bend Drainage District	Fort Bend	29°43'32.27"	95°42'31.32"
14	n/a	Bessie's Creek at I-10/ FM 1489/ or Hunt Rd.	Willow Fork or Fort Bend Drainage District	Fort Bend	29°46'49.08"	95°58'43.68"

Appendix 1.3. Enhancement of USGS stream gage infrastructure (Task 3).

Item number	Gage number	Site name	Cooperator	County	Latitude	Longitude
1	08106350	Little River at Rockdale	Brazos River Authority	Milam	30°45'38"	97°00'49"
2	LCRA 6637	San Bernard at East Bernard	Lower Colorado River Authority	Fort Bend/ Wharton	29°31'58.51"	96° 3'18.90"
3	08091250	Paluxy River at FM 2870 near Bluff Dale	Texas Water Development Board	Hood	32°18'07.96"	97°57'34.66"
4	08167870	Bear Creek at FM 2722	Texas Water Development Board	Comal	29°48'30.60"	98°13'49.01"
5	08169780	Geronimo Creek near Seguin	Texas Water Development Board	Guadalupe	29°35'26.24"	97°56'05.25"
6	08170800	Blanco River at Crabapple Road near Blanco	Texas Water Development Board	Blanco	30°06'09.3"	98°30'38.4"
7	08170890	Little Blanco River at FM 32 near Fischer	Texas Water Development Board	Blanco	30°01'14.9"	98°19'50.0"
8	08211800	San Diego Ck at Alice	Texas Water Development Board	Jim Wells	27°45'59.9"	98°04'32.0"

Appendix 1.4. Repair and resiliency of USGS stream gage infrastructure (Task 4).

Item number	Gage number	Site name	Cooperator	County	Latitude	Longitude
1	08090800	Brazos River near Dennis	Brazos River Authority	Parker	32°36'56"	97°55'32"
2	08098290	Brazos River near Highbank	Brazos River Authority	Falls	31°08'02"	96°49'29"
3	08110430	Big Creek near Freestone	Brazos River Authority	Limestone	31°30'24"	96°19'28"
4	08110500	Navasota Easterly	Brazos River Authority	Leon	31°10'12"	96°17'51"
5	08110800	Navasota OSR	Brazos River Authority	Robertson	30°58'25"	96°14'29"
6	08116650	Brazos River near Rosharon	Brazos River Authority	Fort Bend	29°20'58"	95°34'56"
7	08111500	Brazos River near Hempstead	Brazos River Authority; Corps of Engineers, Fort Worth District	Washington	30°07'44"	96°11'15"
8	08155240	Barton Creek at Lost Ck Blvd	City of Austin	Travis	30°16'26"	97°50'40"
9	08158600	Walnut Creek at Webberville Rd, Austin	City of Austin	Travis	30°16'59"	97°39'17"
10	08158700	Onion Creek near Driftwood	City of Austin	Hays	30°04'58"	98°00'27"
11	08158827	Onion Creek at Twin Creeks Road near Manchaca	City of Austin	Travis	30°07'34"	97°49'15"
12	08055560	Elm Fork Trinity River at Spur 348 Irving	City of Dallas Water Utilities Department	Dallas	32°52'24"	96°55'50"
13	08070200	East Fork San Jacinto near New Caney	City of Houston	Montgomery	30°08'43"	95°07'29"
14	08075110	Brays Bayou at MLK Blvd	City of Houston; Harris County Flood Control District	Harris	29°42'51"	95°20'20"
15	08068275	Spring Creek near Tomball	City of Houston; San Jacinto River Authority	Montgomery	30°07'11"	95°38'45"

Appendix 1.4 (continued). Repair and resiliency of USGS stream gage infrastructure (Task 4).

Item number	Gage number	Site name	Cooperator	County	Latitude	Longitude
16	08053000	Elm Fork Trinity River nr Lewisville	Corps of Engineers, Fort Worth District	Denton	33°02'44"	96°57'39"
17	08059350	Indian Creek Farmersville	Corps of Engineers, Fort Worth District	Collin	33°13'30"	96°22'23"
18	08093100	Brazos River near Aquilla	Corps of Engineers, Fort Worth District	Bosque	31°48'44"	97°17'51"
19	08100000	Leon River near Hamilton	Corps of Engineers, Fort Worth District	Hamilton	31°47'19"	98°07'16"
20	08100500	Leon River at Gatesville	Corps of Engineers, Fort Worth District	Coryell	31°26'05"	97°45'30"
21	08101000	Cowhouse Creek at Pidcoke	Corps of Engineers, Fort Worth District	Coryell	31°17'05"	97°53'05"
22	08103800	Lampasas River near Kempner	Corps of Engineers, Fort Worth District	Lampasas	31°04'45"	98°00'59"
23	08169500	Guadalupe River at New Braunfels	Corps of Engineers, Fort Worth District; Guadalupe Blanco River Authority	Comal	29°41'52"	98°06'23"
24	08042522	Taylor Alligator Bayou	Corps of Engineers, Galveston District	Chambers	29°51'43"	93°58'57"
25	08068700	Cypress Creek at Sharp Rd near Hockley	Corps of Engineers, Galveston District	Harris	29°55'15"	95°50'24"
26	08072350	Buffalo Fulshear	Corps of Engineers, Galveston District	Fort Bend	29°43'22"	95°46'01"
27	08072800	Langham Creek near Addicks	Corps of Engineers, Galveston District	Harris	29°50'08"	95°37'32"
28	08073100	Langham Creek at Addicks Reservoir Outflow near Addicks	Corps of Engineers, Galveston District	Harris	29°47'25"	95°37'26"
29	08077600	Clear Creek near Friendswood	Corps of Engineers, Galveston District	Galveston	29°31'02"	95°10'42"

Appendix 1.4 (continued). Repair and resiliency of USGS stream gage infrastructure (Task 4).

Item number	Gage number	Site name	Cooperator	County	Latitude	Longitude
30	08117500	San Bernard Boling	Corps of Engineers, Galveston District	Fort Bend	29°18'48"	95°53'37"
31	08040600	Neches River near Town Bluff	Corps, Ft Worth District & Lower Neches Valley Authority	Jasper	30°47'27"	94°09'03"
32	08192000	Nueces River below Uvalde	Edwards Aquifer Authority	Uvalde	29°07'25"	99°53'40"
33	08204005	Leona River near Uvalde	Edwards Aquifer Authority	Uvalde	29°09'15"	99°44'35"
34	08111850	Brazos River at San Felipe	Fort Bend Subsidence District	Waller (Zip 77423)	29°48'30"	96°05'44"
35	08171400	San Marcos at Martindale	Guadalupe Blanco River Authority	Caldwell	29°49'56"	97°50'33"
36	08171300	Blanco River near Kyle	Guadalupe Blanco River Authority, Texas Water Development Board	Hayes	29°58'45"	97°54'35"
37	08068900	Cypress Creek at Stuebner-Airline Road near Westfield	Harris County Flood Control District	Harris	30°00'23"	95°30'42"
38	08069000	Cypress Creek near Westfield	Harris County Flood Control District	Harris	30°02'08"	95°25'43"
39	08074500	Whiteoak Bayou at Houston	Harris County Flood Control District	Harris	29°46'30"	95°23'49"
40	08075400	Sims Bayou at Hiram Clarke St, Houston	Harris County Flood Control District	Harris	29°37'07"	95°26'45"
41	08075900	Greens Bayou at Hwy 75	Harris County Flood Control District	Harris	29°57'24"	95°25'04"
42	08077637	Clear Lake Second Outflow Channel	Harris County Flood Control District	Galveston	29°33'15"	95°01'32"
43	08161000	Colorado River at Columbus	Lower Colorado River Authority	Colorado (Zip 78934)	29°42'22"	96°32'12"

Appendix 1.4 (continued). Repair and resiliency of USGS stream gage infrastructure (Task 4).

Item number	Gage number	Site name	Cooperator	County	Latitude	Longitude
44	08017300	South Fork Sabine River near Quinlan	Sabine River Authority	Hunt	32°53'52"	96°15'11"
45	08031000	Cow Bayou near Mauriceville	Sabine River Compact Administration	Orange	30°11'10"	93°54'30"
46	08178800	Salado Creek at Loop 13, San Antonio	San Antonio River Authority	Bexar	29°21'25"	98°24'45"
47	08188060	San Antonio at Hwy 72	San Antonio River Authority	Karnes	28°50'55"	97°44'14"
48	08181800	San Antonio River near Elmendorf	San Antonio Water System	Bexar	29°13'19"	98°21'20"
49	08067650	WF San Jacinto River below Lake Conroe near Conroe	San Jacinto River Authority	Montgomery	30°20'31"	95°32'34"
50	08068450	Panther Branch near Spring	San Jacinto River Authority	Montgomery	30°08'03"	95°28'39"
51	08070500	Caney Creek near Splendora	San Jacinto River Authority	Harris	30°15'34"	95°18'08"
52	08111700	Mill Creek Bellville	Texas Water Development Board	Austin	29°52'51"	96°12'18"
53	08162501	Colorado River Wadsworth	Texas Water Development Board	Matagorda (Zip 77414)	28°46'27"	95°59'51"
54	08164300	Navidad River nr Hallettsville	Texas Water Development Board	Lavaca	29°28'00"	96°48'45"
55	08183500	San Antonio at Falls City	Texas Water Development Board	Karnes	28°57'05"	98°03'50"
56	08190000	Nueces Laguna	Texas Water Development Board	Uvalde	29°25'42"	99°59'49"

Appendix 1.4 (continued). Repair and resiliency of USGS stream gage infrastructure (Task 4).

Item number	Gage number	Site name	Cooperator	County	Latitude	Longitude
57	08198500	Sabinal at Sabinal	Texas Water Development Board	Uvalde	29°18'52"	99°28'50"
58	08211900	San Fernando Creek near Alice	Texas Water Development Board	Jim Wells	27°46'20"	98°02'00"
59	08065350	Trinity River near Crockett	Trinity River Authority	Houston	31°20'18"	95°39'22"
60	08019200	Sabine River near Hawkins	US Geological Survey	Wood	32°33'35"	95°12'23"
61	08030500	Sabine River near Ruliff	US Geological Survey	Newton	30°18'13"	93°44'37"
62	08030520	Sabine River at Intl Paper	US Geological Survey	Orange	30°11'59"	93°43'06"
63	08031020	Cole Creek at I-10	US Geological Survey	Orange	30°07'56"	93°51'50"
64	08061540	Rowlett Creek near Sachse	US Geological Survey	Dallas	32°57'35"	96°36'51"
65	08061750	E Fork Trinity River near Forney	US Geological Survey	Kaufmann	32°46'27"	96°30'12"
66	08066175	Kickapoo Creek at Onalaska	US Geological Survey	Polk (Zip 77351)	30°53'12"	95°04'49"
67	08094800	North Bosque River at Hico	US Geological Survey	Hamilton	31°58'35"	98°01'57"
68	08098300	Little Pond near Burlington	US Geological Survey	Milam	31°01'35"	96°59'17"
69	08114000	Brazos River Richmond	US Geological Survey	Fort Bend	29°34'56"	95°45'27"
70	08186500	Ecleto Creek near Runge	US Geological Survey	Karnes	28°55'12"	97°46'19"

Appendix 1.4 (continued). Repair and resiliency of USGS stream gage infrastructure (Task 4).

Item number	Gage number	Site name	Cooperator	County	Latitude	Longitude
71	08189700	Aransas River near Skidmore	US Geological Survey	Bee	28°16'56"	97°37'14"
72	08190500	West Nueces near Bracketville	US Geological Survey	Kinney	29°28'52"	100°14'21"

Appendix 1.5. Modernization of USGS stream gage infrastructure (Task 5).

Item number	Gage number	Site name	Cooperator	County	Latitude	Longitude
1	08211200	Nueces River at Bluntzer	City of Corpus Christi	Nueces	27°56'15"	97°46'32"
2	08211500	Nueces River at Calallen	City of Corpus Christi	Nueces	27°52'58"	97°37'30"
3	08067070	Coastal Water Authority Canal near Dayton	City of Houston; Coastal Water Authority	Liberty	29°57'40"	94°48'36"
4	08041700	Pine Island Bayou near Sour Lake	Corps of Engineers, Ft. Worth District	Jefferson	30°06'21"	94°20'04"
5	08067252	Trinity River at Wallisville	Corps of Engineers, Galveston	Chambers	29°48'44"	94°43'52"
6	08115000	Big Creek near Needville	Corps of Engineers, Galveston	Fort Bend	29°28'18"	95°48'10"
7	08041500	Village Creek near Kountze	Corps of Engineers, Galveston District	Hardin	30°23'52"	94°15'48"
8	08067000	Trinity River at Liberty	Corps of Engineers, Galveston District	Liberty	30°03'27"	94°49'05"
9	08176500	Guadalupe River at Victoria	Corps, Ft. Worth District	Victoria	28°47'34"	97°00'46"
10	08041500	Neches River at Evadale	Corps, Ft. Worth District and Lower Neches Valley Authority	Jasper	30°21'20"	94°05'35"
11	08162000	Colorado River at Wharton	Corps, Galveston District and Lower Colorado River Authority	Wharton	29°18'32"	96°06'13"
12	08177500	Coletto Creek near Victoria	Guadalupe-Blanco River Authority	Victoria	28°43'51"	97°08'18"
13	08177520	Guadalupe River near Bloomington	Guadalupe-Blanco River Authority	Victoria	28°39'43"	96°57'55"
14	08188800	Guadalupe River near Tivoli	Guadalupe-Blanco River Authority	Refugio	28°30'20"	96°53'04"

Appendix 1.5 (continued). Modernization of USGS stream gage infrastructure (Task 5).

Item number	Gage number	Site name	Cooperator	County	Latitude	Longitude
15	08164504	East Mustang Creek near Louise	Lavaca-Navidad River Authority	Wharton	29°04'14"	96°25'01"
16	08160400	Colorado River above La Grange	Lower Colorado River Authority	Fayette	29°54'44"	96°54'13"
17	LCAR 5476	Colorado River at Sim Gideon River Plant	Lower Colorado River Authority	Bastrop	30° 9'11"	97°20'45"
18	LCRA 5450	Colorado River near Utley	Lower Colorado River Authority	Bastrop	30°10'2"	97°24'11"
19	LCRA 5464	Wilbarger Creek near Elgin	Lower Colorado River Authority	Bastrop	30°13'55"	97°25'57"
20	LCRA 5473	Big Sandy Creek near Elgin	Lower Colorado River Authority	Bastrop	30°15'55"	97°19'41"
21	LCRA 5521	Cedar Creek near Bastrop	Lower Colorado River Authority	Bastrop	30° 4'58"	97°23'26 "
22	LCRA 5524	Walnut Creek near Bastrop	Lower Colorado River Authority	Bastrop	30° 1'40"	97°25'35"
23	LCRA 5525	Colorado River near Upton	Lower Colorado River Authority	Bastrop	30° 1'21"	97°16'28"
24	08041780	Neches River Saltwater Barrier at Beaumont	Lower Neches Valley Authority	Orange	30°09'24"	94°06'51"
25	08041000	Big Cow Creek near Newton	Sabine River Authority	Newton	30°49'08"	93°47'08"
26	08026000	Sabine River at Toledo Bd Res near Burkeville	Sabine River Compact Administration	Newton	31°10'25"	93°33'57"
27	08028500	Sabine River near Burkeville	Sabine River Compact Administration	Newton	31°03'50"	93°31'10"
28	08029500	Sabine River near Bon Wier	Sabine River Compact Administration	Newton	30°44'49"	93°36'30"

Appendix 1.5 (continued). Modernization of USGS stream gage infrastructure (Task 5).

Item number	Gage number	Site name	Cooperator	County	Latitude	Longitude
29	08188570	San Antonio River near McFaddin	San Antonio River Authority	Refugio	28°31'53"	97°02'34"
30	08071000	Peach Creek at Splendora	Texas Water Development Board	Montgomery	30°13'57"	95°10'05"
31	08164600	Garcitas Creek near Inez	Texas Water Development Board	Victoria	28°53'28"	96°49'08"
32	08164800	Placedo Creek near Placedo	Texas Water Development Board	Victoria	28°43'30"	96°46'07"
33	08189200	Copano Creek near Refugio	Texas Water Development Board	Refugio	28°18'12"	97°06'44"
34	08189500	Mission River at Refugio	Texas Water Development Board	Refugio	28°17'30"	97°16'44"
35	08211520	Oso Creek at Corpus Christi	Texas Water Development Board	Nueces	27°42'40"	97°30'06"
36	08066300	Menard Creek near Rye	Trinity River Authority	Liberty	30°28'53"	94°46'47"
37	08025360	Sabine River at Toledo Bend Powerhouse near Burkeville	US Geological Survey	Newton	31°10'25"	93°33'57"
38	08066500	Trinity River at Romayor	US Geological Survey	Liberty	30°25'30"	94°51'02"
39	08070000	East Fork San Jacinto River near Cleveland	US Geological Survey	Liberty	30°20'11"	95°06'14"
40	08071280	Luce Bayou above Lake Houston near Huffman	US Geological Survey	Liberty	30°06'34"	95°03'35"
41	08078000	Chocolate Bayou near Alvin	US Geological Survey	Brazoria	29°22'17"	95°19'22"
42	08211000	Nueces River near Mathis	US Geological Survey	San Patricio	28°02'17"	97°51'36"