Report P3A Flood Decision Support Gauge Network

Project 0-7095-01 Flood Assessment System for TxDOT

30 June 2024

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Introduction

The project was initiated on 26 February 2024, and is a continuation of Project 0-7095 “Evaluate Improved Streamflow Measurement at TxDOT Bridges”, which ran from 1 September 2020 to 31 October 2023. During that project, 80 RQ-30 radar gauges were installed on TxDOT bridges. During this continuation project, these gauges are being calibrated and the discharge and water level data from them is being incorporated into the Flood Decision System for TxDOT (FAST). This is the first of three progress reviews for Task 3, Flood Decision Support Gauges. The schedule for these reports is shown in Table 1.

Report	Due Date	Months from Project Initiation
P3A	June 2024	4
P3B	June 2025	16
P3C	June 2026	28

Table 1. Schedule of P3 reports

RQ-30 Gauge Network

The location of the gauges in the RQ-30 gauge network is shown in Figure 1, in which the length of record in years at each gauge is symbolized by a circle.

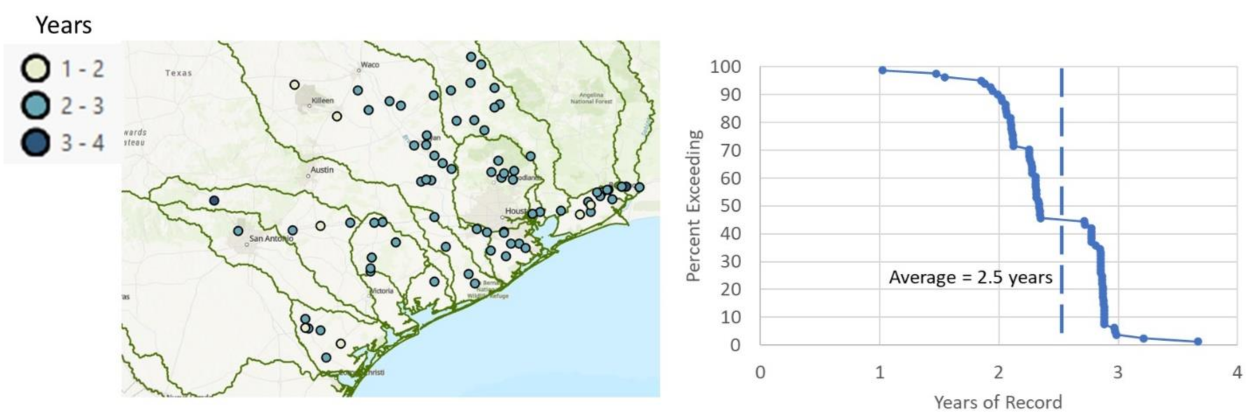


Figure 1. Length of measured record at RQ-30 streamflow sites.

The longest record is 3.67 years at gauge 08167000 Guadalupe River at Comfort, Tx, a site which was carried over from the first streamflow Project 5-9054-01, “Streamflow Measurment at TxDOT Bridges”, which ran from 2017 to 2019. The first site installed in the follow-on Project 0-7095, “Evaluate Streamflow Measurement at TxDOT Bridges” was on 4/14/21 at site 08031020, Cole Ck at I-10 nr

Orange, Tx. The last site installed in that project was on 6/22/2023, and was site, 08041945, N Fk Taylors Bayou at IH 10 nr Hamshire, Tx, whose installation was delayed by bridge construction at that location. A total of 197 station-years of water surface elevation and velocity data have been recorded at these gauges. All sites have at least one year of measured water level and velocity record. All sites are currently functioning satisfactorily.

Number of ADCP Measurements

Considering Project 0-7095 and its extension, Project 0-7095, a total of 247 ADCP measurements have beenmade at 54 of the 80 RQ-30 sites. The distribution of the measurements in space and time is shown in Figure 2. . Discharge measurements slowed starting 1 June 2023 because of extreme drought that kept water flows at low-flow and no-flow conditions There were 24 ADCP measurements made in the unfunded period between the two projects (1 November 2023 to 26 February 2024), and a further 28 measurements have been made since the FAST project began on 26 February 2024.

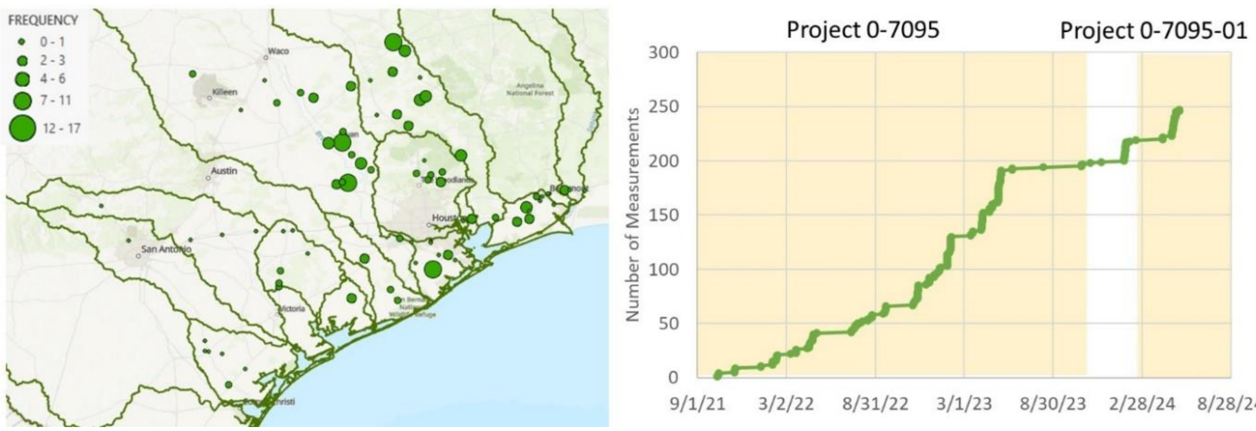


Figure 2. Distribution ADCP measurements in space and time.

The distribution of the number of measurements per site is shown in Figure 3. For the 54 sites which have measurements, the median number of measurements per site is 3. The most measured site is 08111110, New Year Ck at FM 1155 nr Chappel Hill, Tx, which is a testbed site used for validating road and bridge flooding, and gauge data assimilation.

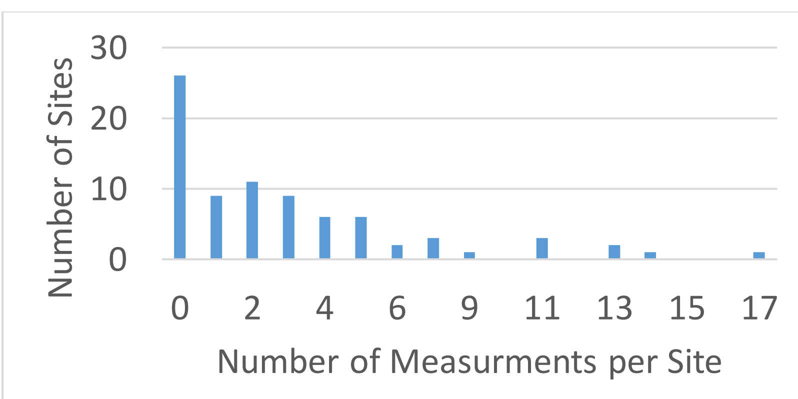


Figure 3. Number of ADCP measurements per RQ-30 Site.

Site Calibration

The RQ-30 gauge measures water surface elevation, h, and surface velocity at one point on the water surface V_s. The stream cross-sectional area, A(h), has been surveyed at each measurement site and is known as a function of h. The average velocity on the stream cross-section, V, is computed as a product of a calibration factor, k(h), and the surface velocity, $V = k(h)V_s$, in which the calibration factor k(h) is a function of the water surface elevation. The discharge is then computed as $Q = V*A(h)$.

A method has been devised for determining k(h) from Acoustic Doppler Current Profiler (ADCP) measurements of flow at the stream gauge site. Generally, at least two ADCP measurements are needed to do this computation, one with the water in the stream channal and another with water in the floodplain. So far, 20 stream gauge sites have been calibrated using this method with varying degrees of confidence, as shown in Table 2.

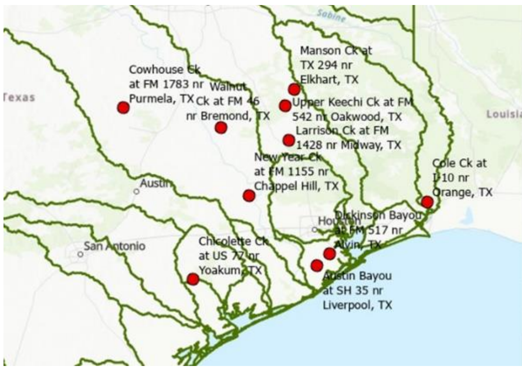
Site	Site Name	Measurements
08031005	Cow Bayou at IH 10 nr Vidor, TX	4
08041940	Green Pond Gully at FM 365 nr Fannett, TX	8
08041970	Mayhaw Bayou at SH 73 nr Hamshire, TX	5
08042539	Spindletop bayou at SH 65 nr Stowell, TX	5
08065310	Upper Keechi Ck at FM 542 nr Oakwood, TX	5
08065925	Nelson Creek at FM 247 nr Huntsville, TX	4
08066087	Gail Ck at FM 1280 nr Lovelady, TX	6
08067280	Turtle Bayou at I-10 nr Hankamer, TX	6
08067505	Cedar Bayou at I-10 nr Mont Belvieu, TX	5
08070220	Caney Ck at FM 1097 nr Willis, TX	8
08070550	Spring Branch at SH 242 nr Splendora, TX	4
08077640	Dickinson Bayou at FM 517 nr Alvin, TX	4
08078400	Austin Bayou at SH 35 nr Liverpool, TX	13
08102730	Leon River at FM 436 nr Little River Academy, TX	3
08108705	Little Brazos Rv at SH 6 nr Reagan, TX	2
08108710	Walnut Ck at FM 46 nr Bremond, TX	4
08111051	Carters Ck at FM 60 nr College Station, TX	13
08111070	Navasota Rv at SH 6 nr Navasota, TX	11
08111110	New Year Ck at FM 1155 nr Chappel Hill, TX	14
08117403	West Bernard Ck at US 59 nr Hungerford, TX	4

Calibration Standard	
Good	Nelson Creek at FM 247 nr Huntsville, TX
Better	Caney Ck at FM 1097 nr Willis, TX
Best	Dickinson Bayou at FM 517 nr Alvin, TX

Table 2. Calibration of RQ-30 stream gauge sites.

Bathymetry Surveys

Field measurement data are beginning to be collected at 10 RQ-30 sites to support Hydrodynamic Modeling to be done by Jon Nelson of the firm River Mechanics, a subcontractor to the FAST project. The distribution of the proposed 10 sites is shown in Figure 4. To date, bathymetry data for two sites has been collected, and it is anticipated that one further site will have bathymetry data collected during this summer. The first site for which bathymetry was collected was New Year Creek at FM 1155, the project's best understood location, where significant road flooding has occurred during the project period.



Site No.	Site Name	Data Collected
08031020	Cole Ck at I-10 nr Orange, TX	
08065080	Manson Ck at TX 294 nr Elkhart, TX	
08065310	Upper Keechi Ck at FM 542 nr Oakwood, TX	
08065820	Larrison Ck at FM 1428 nr Midway, TX	
08077640	Dickinson Bayou at FM 517 nr Alvin, TX	
08078400	Austin Bayou at SH 35 nr Liverpool, TX	Yes
08100950	Cowhouse Ck at FM 1783 nr Purmela, TX	
08108710	Walnut Ck at FM 46 nr Bremond, TX	
08111110	New Year Ck at FM 1155 nr Chappel Hill, TX	Yes
08163880	Chicolette Ck at US 77 nr Yoakum, TX	

Figure 4. Proposed locations for for bathymetry measurement and hydrodynamic modeling.

Each bathymetric survey consists of dense point clouds surveyed using a combination of Real Time Network (RTN) and total station surveying. Ground elevations beneath the bridge are manually surveyed to replace Lidar data, which can be inaccurate underneath bridges. Additionally, any culverts or bypasses that affect discharge passing the gauging station are identified and documented.

Figure 5. Manually surveyed point cloud around the New Year Ck at FM 1155 nr Chappell Hill, TX bridge location to create higher qualty bathymetric elevation models near the bridge where Lidar struggles to acquire data.

Conclusion

The location and installation of 80 RQ-30 gauges was completed during Project 0-7095, and the gauges have continued to operate satisfactorily. They now have an average of 2.5 station-years of record at each site, and a total of 197 station-years of data have been recorded across the RQ-30 network. The gauges measure water surface elevation and velocity, and allow discharge to be computed directly as the product of average cross-section velocity and area, once the gauge is adequately calibrated.

A total of 247 ADCP measurements have been made at 54 of the sites with a median number of 3 measurements at these sites. A method has been developed to use the ADCP data for velocity across the stream cross-section to calibrate the ratio of the surface velocity to the mean velocity. This method has so far been applied to 20 RQ-30 sites. This allows for the discharge to be computed at those sites. A method is needed to automate this gauge calibration approach so that it can be systematically applied to all the ADCP measurements collected across the RQ-30 network.

Detailed studies of stream bathymetry and hydrodynamic modeling are starting at 10 sites, beginning with Site 08111110 New Year Ck at FM 1155 nr Chappel Hill, Tx, which is a test bed site for flood modeling and mapping.