Report P3C: Flood Decision Support Gauge Network

Project 0-7095-01: Flood Assessment System for TxDOT (FAST)

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Prepared by: Jody Avant, US Geological Survey, Scott Grzyb, US Geological Survey

1. Introduction

This report, P3C, represents the third and final progress milestone for Task 3 of the Flood Assessment System for TxDOT (FAST) project, TxDOT's initiative to enhance flood awareness and mitigation through a strategic network of streamflow monitoring at select bridge crossings. The preceding reports, P3A (June 2024) and P3B (June 2025), documented the establishment and ongoing calibration of the RQ-30 radar gauge network and its integration into the Flood Decision Support Toolbox (FDST). The current report focuses on the principal accomplishments achieved during the most recent reporting period: the introduction of satellite telemetry to improve data reliability, continued progress on integration of gauge data into the FDST, and the development of a software tool to support and partially automate the calibration of surface-velocity gauges to mean-channel velocity.

The FAST project, officially launched on February 26, 2024, is a continuation of Project 0-7095 and Project 5-9054 before it. Collectively, these efforts reflect TxDOT's commitment to developing science-driven tools to reduce the risks posed by flooding at transportation infrastructure. This document summarizes the essential updates from the past year and outlines the remaining work as the project moves toward completion.

2. RQ-30 Gauge Network Status

The network of 80 RQ-30 radar streamflow gauges remains nearly fully operational, with all but two sites currently transmitting surface velocity and water-level data. While the three sites previously reported as non-operational in P3B—affected by vandalism, bridge construction, and equipment malfunction—have since been relocated and restored, two new outages have occurred. One site is offline after being destroyed by a vehicle collision, with reconstruction plans underway. The second site is temporarily offline due to an ongoing bridge replacement project. These current outages are unrelated to the previous ones mentioned in P3B.

USGS field crews have continued semiannual site visits in accordance with Subtask 3.1, focusing on equipment inspection, battery replacement, solar panel cleaning, discrete discharge measurements, and verification of elevation readings using installed wire-weight reference devices. All operational gauges have been checked and verified within the past 12 months, and updated field-visit logs have been compiled. Corrections were applied where necessary to ensure consistent elevation referencing against independent wire-weight or surveyed benchmarks.

A total of 338 ADCP measurements at RQ-30 sites have been made as of 30 June 2026. The ADCP measurements have increased from 310 as of 30 June 2025 to 338 as of 30 June 2026. The number of RQ-30 sites with at least one measurement has increased from 65 to 67, so there are only 13 sites without any measurements. Keep in mind that three sites were relocated in the last year where the measurement count was reset to zero.

The increased number of ADCP measurements brings the total number of sites with calibration-quality data to 45. Measurements were strategically timed to capture both moderate and high-flow events, supporting Subtask 3.2 which calls for dual-condition calibration (one in-channel and one in floodplain).

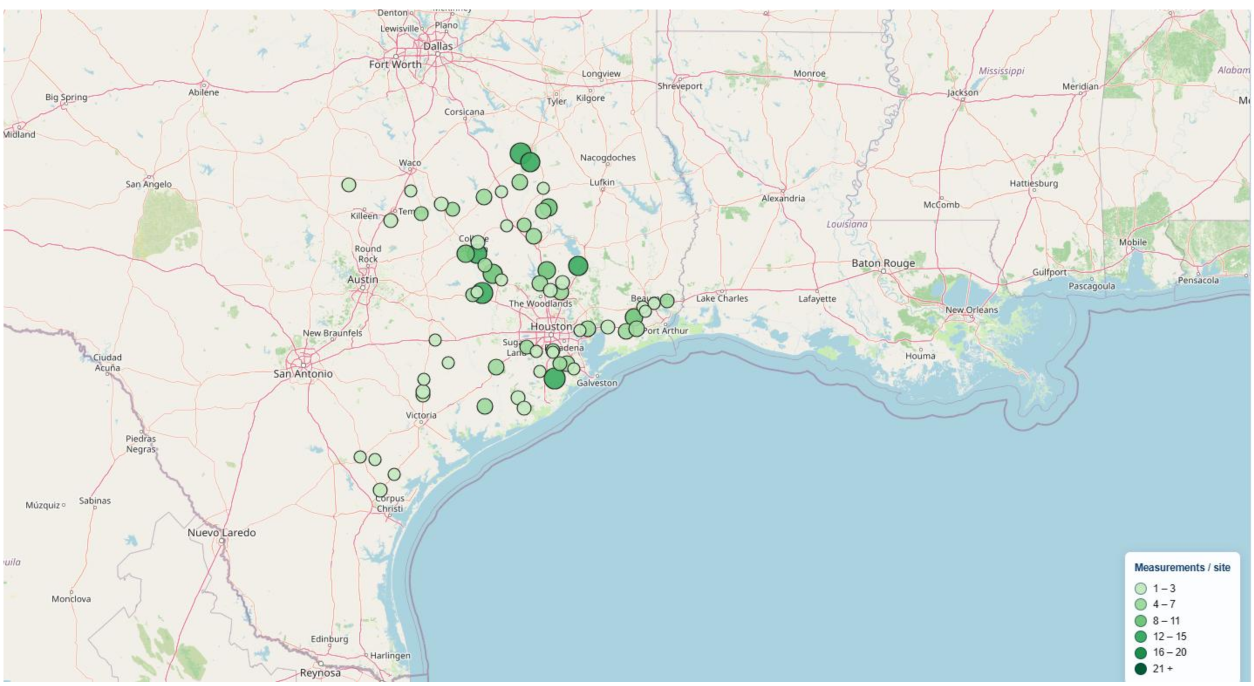

Figure 1.*Heat map of ADCP measurements at RQ-30 gauge sites.*

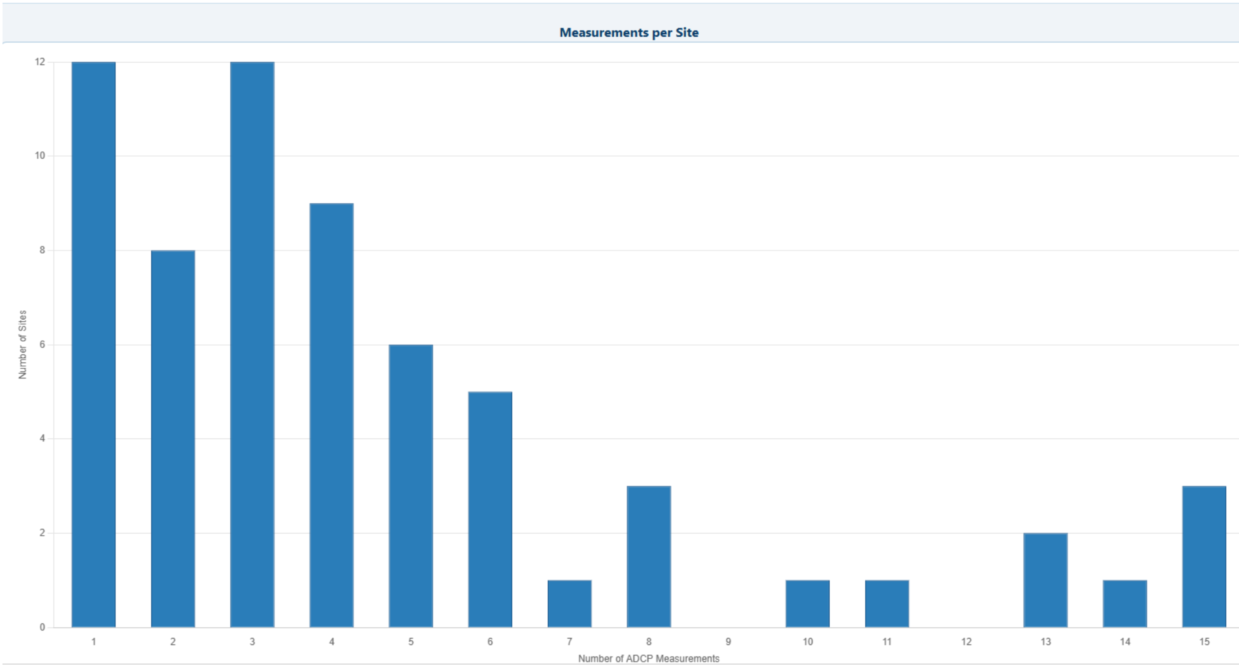

Figure 2. *Histogram shows the number of ADCP measurements per site.*

3. Iridium Satellite Telemetry

A persistent challenge across the RQ-30 network has been the reliable transmission of real-time data, especially during extreme weather events. Gaps in the record can arise from several sources, including internal and external database issues and physical limitations of cellular transmission, the latter being most pronounced at sites with marginal cell coverage. To address these gaps, the project has begun deploying Iridium satellite telemetry as an alternative transmission pathway.

Iridium is a commercial satellite network that provides global data coverage independent of terrestrial cellular infrastructure. Because transmission does not depend on local cell signal strength, Iridium offers a transmission path at locations where cellular service is intermittent or unavailable. Data transmitted via Iridium is received through the Local Readout Ground Station (LRGS) network and routed into the USGS data infrastructure alongside conventionally transmitted data. The general flow of data from the field collection platforms through the satellite and ground-station network is illustrated in Figure 3.

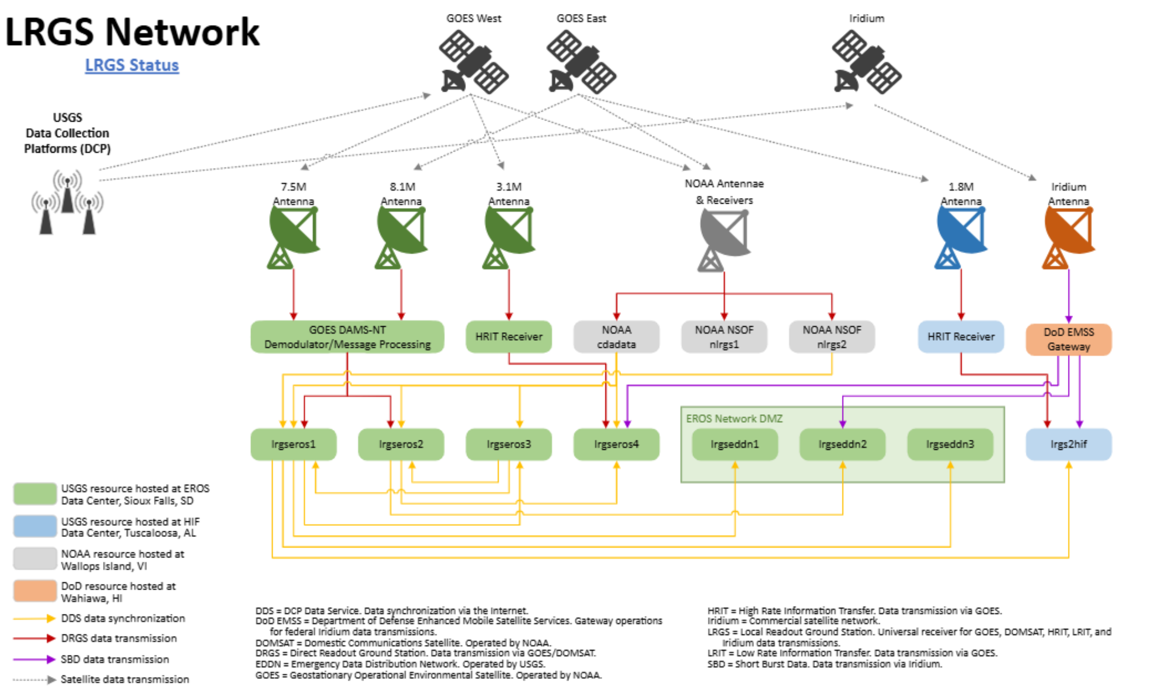

Figure 3. *LRGS Network diagram showing the data path from USGS Data Collection Platforms through the GOES and Iridium satellite networks to the ground-station and data-distribution infrastructure.*

In support of this effort, Sutron XLINK data loggers/transmitters have been installed at selected sites to replace the previously used MRL-7 units. Both units serve as data loggers and transmitters; the MRL-7 supports cellular transmission, while the XLINK additionally supports Iridium satellite transmission. At the sites equipped with the XLINK, the cellular and satellite paths are being operated concurrently for testing and comparison purposes.

To date, the XLINK has been physically installed at 21 of the 80 sites, of which 16 are currently transmitting via Iridium. The remaining 5 sites are awaiting Iridium transmission cards that are currently backordered, with availability expected in November 2026. The sites selected for installation represent a subset of the network chosen to support evaluation of the satellite telemetry under a range of conditions.

Early results from the concurrent operation are encouraging. Figure 4 compares the gauge-height record from the cellular (modem) path and the Iridium path at site 08104870, S Fk San Gabriel Rv at Hwy 183 nr Leander, TX, during a storm event in late May 2026. During intervals when the cellular path was missing data, the Iridium path continued to return a complete record. The comparison suggests that, at sites with marginal cellular coverage, the satellite path can provide a more continuous record.

Figure 4. *Gauge height at site 08104870, S Fk San Gabriel Rv at Hwy 183 nr Leander, TX, May 26–29, 2026. Blue trace = cellular (modem) transmission; red trace = Iridium satellite transmission. Where the cellular record contains gaps, the Iridium record remains continuous.*

4. FDST Integration

The operational gauges continue to be integrated into USGS's Flood Decision Support Toolbox (FDST) in alignment with Subtask 3.3. The FDST is a web-based system that visualizes inundation extents linked to streamflow conditions across the state. Each site under consideration undergoes a model-fit check to confirm that synthetic or empirical rating curves can support the required flood-mapping interface, and a pipeline has been established between field teams, modelers, and the FDST team to prioritize qualified sites for inclusion in upcoming toolbox updates. A comprehensive evaluation has been completed for all RQ30 sites to determine their suitability for integration into the FDST. Based on this assessment, 43 sites have been successfully incorporated and are currently active within the FDST. An additional 30 sites were found to be unsuitable for inclusion. These sites exhibited one or more limiting factors, including pronounced compound-flooding influences, poor model fit with the site-specific rating curve, or model edge effects. Four sites are in the library review process, and the three remaining sites are pending upload to the tool.

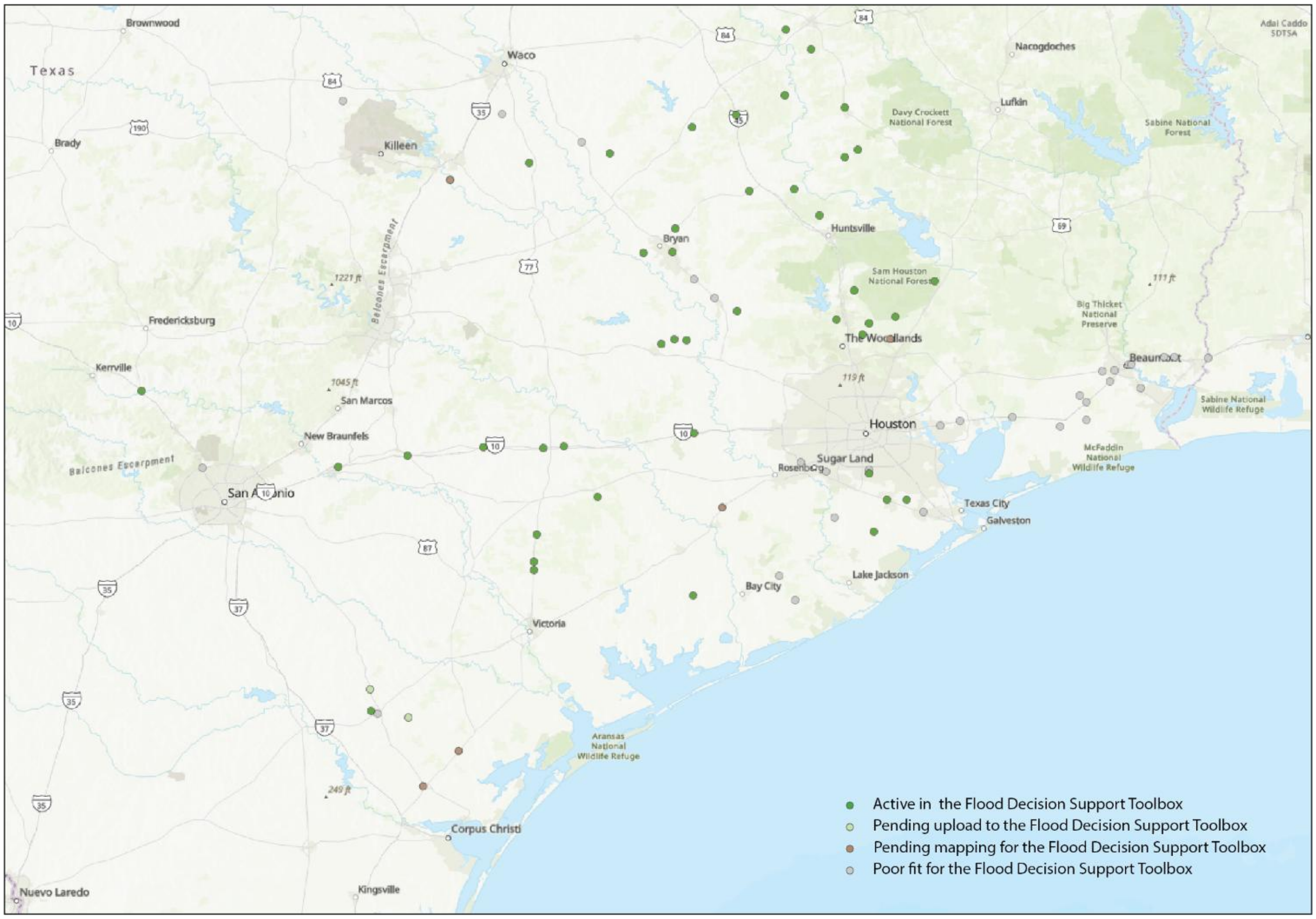

Figure 5. *Map showing locations of the RQ30 sites and Flood Decision Support Toolbox status.*

5. K-Factor Calibration Tool

A central objective of the FAST project is the calibration of the RQ-30 gauges so that the surface velocity measured by the radar can be converted into a mean-channel velocity and, with the surveyed cross-sectional area, into discharge. This relationship is expressed through a calibration factor, $k(h)$, that varies with water-surface elevation: the mean velocity V is the product of the calibration factor and the measured surface velocity ($V = k(h) \cdot V_{surface}$), and discharge follows as $Q = V \cdot A(h)$. The need to automate this calibration so it can be applied systematically across the network was identified as an outstanding task in the P3A conclusion. A significant accomplishment of this reporting period is the creation of a software application that supports this calibration workflow, which is currently undergoing testing.

The application brings the full calibration process into a single environment. It loads surveyed cross sections and existing rating tables, retrieves field discharge measurements directly from the USGS database, and accepts processed Acoustic Doppler Current Profiler (ADCP) measurements as the basis for deriving the calibration factor. From these inputs the tool builds stage-discharge rating curves and computes the surface-to-mean velocity factor as a function of stage. Supporting elements include tools for estimating channel roughness, adjusting an imported rating to honor recent field measurements, inspecting hydraulic geometry across the range of stage, and exporting rating tables and calibration-factor tables for downstream use. A workflow for computing discharge directly from a set of surface-velocity readings across a cross section is also included, along with a validation module that compares predicted discharge against measured discharge using standard goodness-of-fit measures. While many of these elements support the broader rating workflow, together they provide the surrounding framework within which the calibration factor is derived and checked.

The method used to derive the calibration factor from a full ADCP transect is a newer approach developed under this project. In broad terms, it reconstructs how the relationship between surface velocity and mean velocity changes with stage by progressively analyzing the measured velocity field from the water surface downward, building up the calibration factor across a range of synthetic water levels from a single high-flow measurement. The intent is to extract more calibration information from each measurement than a single value, and to do so in a way that is transparent and repeatable. The approach is presently in testing.

A notable outcome of the testing to date is that the calibration factors produced by the tool are broadly consistent with the values generated by the established commercial k-factor processing software, while making the underlying calculation visible and adjustable rather than relying on a closed internal procedure. This consistency provides initial confidence in the method. Although the tool remains under active testing and refinement, the initial results appear promising.

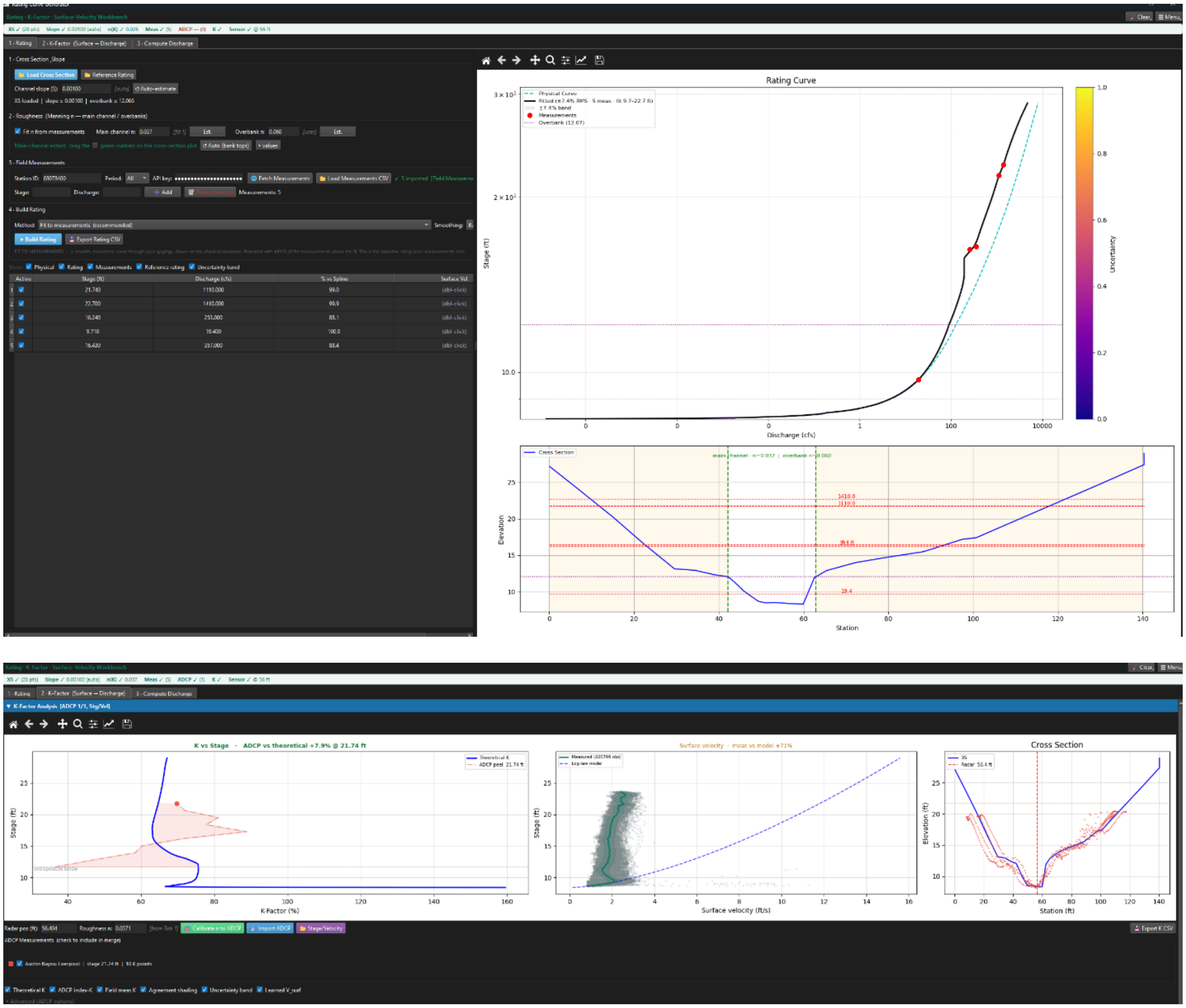

Figure 6. *Figure showing the initial K-Factor calibration tool.*

6. Conclusion

During this reporting period the FAST project's gauge-network components have advanced on several fronts. Three sites that were previously down have been relocated and returned to service. The introduction of Iridium satellite telemetry, supported by the installation of Sutron XLINK data loggers at a subset of sites, has begun to address long-standing gaps in data transmission, with early concurrent-operation results indicating improved record reliability at sites with marginal cellular coverage. Integration of gauge data into the FDST has continued, and a software tool has been developed to support and partially automate the calibration of surface-velocity gauges to mean-channel velocity.

In the period ahead, work will focus on completing the Iridium deployment as backordered transmission hardware becomes available, continuing the evaluation of concurrent cellular and satellite telemetry, advancing the integration of additional sites into the FDST, and completing testing of the calibration tool so that it can be applied systematically across the network. The upcoming final project reporting will consolidate these developments and outline the pathway toward operational deployment.