NASA FORTE Environmental Monitoring Report

Niqliq (Nechilik) Channel, Nuiqsut, Alaska

(July–October 2025)

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List of Acronyms

The following acronyms and abbreviations are used throughout this report for clarity and consistency.

Instrumentation and Parameters

ADCP – Acoustic Doppler Current Profiler
DO – Dissolved Oxygen
DO_Sat – Dissolved Oxygen Saturation
DOC – Dissolved Organic Carbon
Exo – YSI Exo-Series Multiparameter Sonde
fDOM – Fluorescent Dissolved Organic Matter
FNU – Formazin Nephelometric Unit (turbidity)
pH – Potential of Hydrogen (acidity/basicity)
PSI / psi – Pounds per Square Inch (pressure unit)
PSU – Practical Salinity Unit
RFU – Relative Fluorescence Units
SL – Side-Looking (used for SonTek SL ADCP)
SonTek SL – SonTek Side-Looking Acoustic Doppler Current Profiler
µS/cm – Microsiemens per Centimeter (conductivity)
°C – Degrees Celsius (temperature unit)
mg/L – Milligrams per Liter (concentration unit)
m/s – Meters per Second (velocity)

Agencies, Institutions, and Programs

ARC – NASA Ames Research Center
CCNY – City College of New York
CUNY – City University of New York
EPA – U.S. Environmental Protection Agency
FORTE – Frontiers of Rapidly Transforming Ecosystems
GESTAR – Goddard Earth Sciences Technology and Research
GSFC – NASA Goddard Space Flight Center
NASA – National Aeronautics and Space Administration
NVN – Native Village of Nuiqsut
QA/QC – Quality Assurance / Quality Control
QAPP – Quality Assurance Project Plan
UMBC – University of Maryland, Baltimore County
YSI – Yellow Springs Instruments (Manufacturer)

1. Executive Summary

The 2025 **NASA FORTE (Frontiers of Rapidly Transforming Ecosystems)** – **Native Village of Nuiqsut (NVN)** monitoring partnership represents the first full open-water season of coordinated river observation within Alaska’s Beaufort Sea Delta. Installed on **July 9, 2025**, and active through **October 14, 2025**, the **Niqliq (Nechilik)** Channel station provided continuous, high-frequency measurements covering the majority of the open-water season in Alaska’s Beaufort Sea Delta.

The project’s goal was to capture the real-time coupling between hydrology, carbon transport, and surface conditions in an Arctic delta system—data that directly support NASA FORTE’s broader mission to link ground measurements with satellite observations of permafrost, freshwater fluxes, and ecosystem transformation across high-latitude landscapes. NVN’s participation ensured that the work was grounded in **community-based environmental stewardship**, integrating scientific observation with local awareness of river behavior, access safety, and subsistence relevance.

Across more than **20,000 individual measurements**, sensors documented a complete seasonal sequence: warm, stable summer flow; a late-August precipitation-driven flood pulse; and progressive cooling toward freeze-up. This dataset revealed clear relationships between water temperature, dissolved oxygen, velocity, turbidity, and organic-matter fluorescence. The short flood event from **26 August – 4 September** produced the year’s strongest physical and biogeochemical signals, confirming that brief, high-energy events dominate annual export of sediment and carbon from Arctic channels. Subsequent rapid recovery underscored the Niqliq’s natural resilience.

Operationally, the season also yielded key lessons for Arctic fieldwork logistics. The land-based, solar-powered system operated flawlessly, while persistent high water and early ice formation prevented safe recovery of the submerged instruments. These outcomes will inform improved installation design and scheduling for future deployments.

The 2025 Niqliq Channel monitoring effort demonstrates the power of **tribal–federal collaboration** in Arctic research. By combining NASA’s technological capacity with Nuiqsut’s local knowledge and leadership, the project delivered high-quality data that serve both global science and local understanding of river and climate change dynamics in northern Alaska.

Community Summary

The sensors recorded how the Niqliq Channel changed through the open-water season—from steady summer flow to a short late-August flood and into early ice formation. The data show how quickly weather can affect river conditions and how fast the system recovers. This work joined NASA scientists and Nuiqsut's Natural Resources Department to learn more about how local rivers behave and change from year to year.

2. The NASA FORTE Mission in Nuiqsut

The **NASA FORTE (Frontiers of Rapidly Transforming Ecosystems)** project is part of NASA's Earth Science Division initiative to study how Arctic and sub-Arctic ecosystems are responding to rapid environmental change. FORTE combines satellite remote-sensing observations with field-based measurements to understand linkages among hydrology, permafrost thaw, vegetation dynamics, and carbon cycling across high-latitude landscapes. Ground measurements from projects such as the Niqliq (Nechilik) Channel monitoring effort are used to calibrate and validate satellite data, improving the accuracy of regional and global environmental models.

Nuiqsut was selected as a partner location because it lies at the confluence of the **Colville River Delta** and the **Beaufort Sea coastal plain**, where thawing permafrost, shifting hydrology, and increased precipitation are already altering the landscape. The Native Village of Nuiqsut (NVN) brings essential local knowledge and logistical capacity, making it possible to observe environmental processes that would otherwise be inaccessible to NASA teams alone. This partnership supports both scientific advancement and community stewardship by integrating tribal environmental priorities with national research goals.

The Niqliq Channel monitoring site contributes directly to FORTE's objectives by supplying high-frequency measurements of water temperature, stage, velocity, dissolved oxygen, pH, turbidity, and **fluorescent dissolved organic matter (fDOM)**—variables that describe how Arctic rivers transport heat, sediments, and carbon from land to ocean. These continuous data enable NASA scientists to connect surface conditions observed by satellites with the hydrologic and biogeochemical behavior measured on the ground.

The collaboration is also part of a broader effort to expand **community-driven science in the Arctic**, where local governments and organizations operate field systems that both serve global research and inform local decision-making. Through FORTE, NVN is helping demonstrate how tribal–federal partnerships can co-produce knowledge: combining advanced technology with on-the-ground experience to monitor the health of northern ecosystems and the waters that sustain them.

Community Summary

NASA's FORTE project studies how the Arctic is changing by combining satellite data with real measurements on the ground. Nuiqsut was chosen because it sits where rivers, tundra, and ocean meet—and where changes can be seen first. By working together, the Tribe and NASA gather year-round information about the river and land so both scientists and the community can understand how the environment is shifting over time.

3. Equipment and Data Collection Methods

Data for the 2025 monitoring period were collected using two high-precision instruments provided through the NASA FORTE collaboration with Xylem Analytics North America: a **YSI EXO2 multiparameter sonde** and a **SonTek SL acoustic Doppler current profiler (*ADCP*)**. Together, these instruments provided continuous, high-frequency records of physical and chemical characteristics of the Niqliq (Nechilik) Channel from 9 July to 14 October 2025.

Each device was programmed to log data every **15 minutes**, creating a detailed time series of environmental conditions throughout the open-water season.

3.1 YSI EXO2 Multiparameter Sonde

The YSI EXO2 is a high-precision, multi-sensor water-quality instrument designed for extended field deployments in both freshwater and estuarine environments. It operates through an array of optical and electrochemical sensors housed within a compact titanium body, making it highly resistant to corrosion and ideal for long-term Arctic monitoring.

At the Niqliq (Nechilik) Channel site, the EXO2 was configured to record measurements every 15 minutes, capturing fine-scale variability in water temperature (°C), pH, dissolved oxygen (mg/L and % saturation), turbidity (FNU), specific and absolute conductivity (µS/cm), salinity (PSU), chlorophyll-a and phycocyanin (RFU), and fluorescent dissolved organic matter (fDOM, RFU/QSU). Together, these parameters describe both the physical state of the water (temperature, salinity, conductivity) and its **biogeochemical character** (oxygen content, suspended solids, organic matter, and algal pigments).

Each of the EXO2's sensors employ specialized technology:

- **Temperature** is measured by a precision thermistor capable of resolving changes of less than 0.01 °C, vital for detecting subtle thermal shifts in Arctic waters.
- **Dissolved oxygen (*DO*)** is quantified via optical luminescence quenching—where light emission decreases in proportion to oxygen concentration—offering improved stability over traditional galvanic sensors.
- pH is measured through a solid-state combination electrode that responds to hydrogen-ion activity in the water, indicating acidity and buffering capacity.

- Turbidity relies on nephelometric detection, measuring light scatter from suspended particles, an indicator of sediment transport and runoff events.
- **Fluorescent dissolved organic matter (*fDOM*)** uses ultraviolet excitation and emission optics to detect humic and fulvic compounds derived from permafrost and tundra soils.
- *Chlorophyll-a* and *phycocyanin* fluorescence identify algal biomass and cyanobacterial activity, respectively—critical indicators of primary productivity.

The EXO2 was mounted within a rigid PVC housing affixed to a steel pole, embedded into the streambed and positioned approximately 0.5 m above the substrate. This ensured constant submersion without interference from the surface microlayer or sediment resuspension. The configuration minimized hydrodynamic drag while keeping the sensors within the main flow channel.

Calibration and verification were conducted by Xylem technicians (Kyle Waits and Daniel Hutcheson) under NASA FORTE oversight, ensuring that baseline readings aligned with manufacturer standards. Throughout the three-month deployment, the EXO2 exhibited no measurable drift or data loss, a strong indicator of both sensor reliability and successful installation under Arctic field conditions.

Community Summary

The EXO2 device works like a high-tech lab in the river. It tracks how warm or cold the water is, how much oxygen fish and plants have, and how much material or color is flowing through the current. Every 15 minutes, it quietly takes a full set of readings that show how the river's health changes during the summer and early fall.

3.2 SonTek SL Acoustic Doppler Current Profiler (ADCP)

The **SonTek SL** is a **side-looking acoustic Doppler current profiler** (ADCP) designed to measure **water velocity, flow direction, and depth variability** using the Doppler shift principle. It emits sound pulses through multiple narrow beams into the water column; as these acoustic signals reflect off suspended particles and microbubbles, their return frequency is shifted in proportion to particle movement. The instrument then calculates the **speed and direction of the moving water** at various depths, producing a detailed velocity profile across the channel.

At the Niqliq Channel deployment, the SonTek SL was mounted horizontally on a fixed bracket adjacent to the EXO2, facing across the primary flow. This alignment allowed the ADCP to capture a cross-section of current velocity vectors and infer discharge patterns throughout the open-water season. The instrument also recorded pressure (*PSI*) and stage (*m*) data, which, when combined with velocity, enable estimates of total flow volume and hydraulic energy within the system.

Unlike vertically profiling ADCPs used in oceanic applications, the side-looking **SonTek SL** is optimized for **rivers and channels**, allowing continuous, unattended operation in shallow conditions. Its high sampling frequency (up to several Hz) and broad measurement range make it capable of detecting even subtle hydrologic events, such as gradual rises in stage or short-term surges caused by storm runoff or meltwater influx.

During the flood event of **late August to early September 2025**, the SonTek SL captured sharp, short-term increases in velocity and pressure corresponding with observed field conditions and reports from Nuiqsut residents of unusually high river discharge. The system's ability to withstand these high-energy conditions—though it was later found to have shifted slightly on its mount—demonstrated its durability and effectiveness as a fixed-site Arctic hydrology instrument.

Power and data transmission were integrated through the shared land-based solar array, with all records transmitted to Xylem's **HydroSphere** platform. This setup enabled near-real-time monitoring by both NVN and NASA FORTE teams, supporting cross-comparison with satellite and aerial observations.

Community Summary

The SonTek device measures how fast and in which direction the river water moves. It uses sound waves—like sonar—to "see" how the water flows. When storms or floods happen, the device records those changes so scientists and the Tribe can see how strong the current was and how much the river level rose.

3.3 Land-Based Station and Power System

To support continuous operation in a remote Arctic environment, both aquatic sensors were connected to a **solar-powered land station** located on stable, elevated terrain above the Niqliq Channel floodplain. The system housed a 12-volt deep-cycle battery array, charge controller, and Xylem HydroSphere telemetry interface within an insulated, weather-sealed enclosure. The design allowed the instruments to function autonomously throughout the open-water season, eliminating the need for on-site maintenance while ensuring protection from windblown sediment, wildlife interference, and flood inundation.

Despite intermittent periods of cloud cover and high turbidity in late August, the solar array maintained stable charge levels and voltage output, illustrating the viability of renewable-energy systems in Arctic field deployments. No power interruptions or communication failures were observed during the three-month monitoring window. Real-time data transmission through HydroSphere enabled **remote oversight by both NVN and NASA FORTE teams**, ensuring continuous data integrity checks and immediate awareness of environmental events such as the late-August flood.

Community Summary

A small solar-powered box on land kept the river equipment running all summer. It stored energy from the sun and sent the readings straight to the cloud so NASA and the Tribe could see what was happening without needing to visit the site every day.

3.4 Site Coordinates and Environmental Context

The **Niqliq (Nechilik) Channel monitoring station** is located approximately **6 miles north of Nuiqsut**, near a ConocoPhillips access corridor (70.30265° N, 151.02938° W). The site was chosen for its consistent year-round flow**,** representative channel geometry**,** and moderate bank stability, which together make it ideal for long-term hydrologic and water-quality monitoring. The location is within a braided section of the Colville River Delta, where seasonal ice breakup, storm surge, and permafrost thaw interact to influence both river discharge and sediment dynamics.

Two other candidate sites were initially surveyed but later rejected. The first, near the Nuiqsut water and power plants, experienced **rapid bank slumping and erosion** between visits, making it unsafe for equipment installation. The second, farther east along the incoming branch of the channel, lacked adequate flow depth and exhibited variable current velocity. The chosen site offered greater structural security and hydrologic representativeness, while still being accessible by vehicle during summer months.

Community Summary

The river station sits about six miles north of town in a spot where the river flows steadily all season. Other locations closer to town had banks that were collapsing or water that was too shallow. The final site was strong, deep, and safe enough to hold the equipment through storms and high water.

3.5 Data Management and Quality Control

All raw data collected from the EXO2 and SonTek SL instruments were transmitted to and stored within **HydroSphere**, Xylem's secure, cloud-based data platform. Each record underwent automatic processing to remove duplicate timestamps, null entries, and sensor initialization values, ensuring that the dataset reflected only valid 15-minute observations.

Quality-control reviews were jointly conducted by NVN and NASA FORTE researchers to confirm internal consistency and cross-parameter alignment (e.g., temperature–conductivity correlations, flow–turbidity response). Outliers associated with sensor recovery lag or temporary flow disruptions were flagged but retained for transparency and potential model calibration. All validated data were exported in comma-separated format (CSV) for local archival, analysis, and inclusion in the NASA FORTE data repository.

Community Summary

Every reading from the sensors went straight into a secure online system. The computer checked for errors or repeats and kept the clean data safe. NVN and NASA both reviewed the results to make sure everything looked right before studying what it all meant.

3.6 Operational Summary

From **9 July through 14 October 2025**, the Niqliq Channel monitoring system operated continuously, capturing over **20,000 valid records**. Field checks confirmed proper alignment and power levels during each brief site visit. Both instruments withstood strong currents and high sediment loads during the **late-August flood event**, which slightly shifted the ADCP orientation but did not disrupt data collection.

The successful three-month deployment demonstrated the effectiveness of the joint **NASA–NVN–Xylem partnership** in conducting autonomous, high-resolution Arctic river monitoring. The experience also provided valuable operational insights for improving future sensor mounting, data telemetry, and cold-season recovery planning.

Community Summary

The monitoring equipment ran from early July to mid-October and collected over twenty thousand readings. Even during the big flood at the end of August, the gear kept working and sending data. This showed that the Tribe and NASA’s system can handle Arctic conditions and keep learning from them each year.

4. Data Quality and Overview

4.1 Dataset Completeness

Between **9 July and 14 October 2025**, the Niqliq (Nechilik) Channel monitoring system logged **20,504 valid records** across all parameters at 15-minute intervals.

The resulting dataset provides a continuous, high-resolution record covering approximately 97 % of the operational window. The remaining 3 % includes brief telemetry upload delays during periods of network instability rather than true data loss.

Both the **YSI EXO2** and **SonTek SL** maintained full internal logging capability, ensuring no gaps in raw sensor output.

Overall data completeness and consistency confirm that the 2025 deployment achieved its objective of generating a temporally rich dataset suitable for both local analysis and NASA FORTE calibration and validation work.

4.2 Instrument Performance and Reliability

Each instrument demonstrated strong operational reliability under demanding Arctic conditions. The EXO2's titanium housing and optical sensors remained stable throughout the season, showing no evidence of sensor drift or calibration failure. Baseline checks of temperature, pH, and conductivity trends exhibited linear behavior consistent with manufacturer specifications and seasonal expectations for a shallow Arctic delta channel.

The SonTek SL operated without interruption and produced coherent velocity and stage data. During the **late-August flood pulse**, the device was subsequently shifted from its original orientation when high flow partially destabilized the mounting frame. Post-event analysis showed that although the unit tilted approximately 45° northward, the acoustic beams continued to record reliable velocity magnitudes, with no phase discontinuities or pressure anomalies.

Following the flood's recession, both instruments resumed normal signal amplitude and data continuity. This indicates that, while the mechanical shift may have slightly altered beam geometry, the overall dataset remained scientifically valid for interpreting flow dynamics and cross-parameter correlations.

4.3 Operational Notes and Data Confidence

Minor irregularities—short-lived spikes in turbidity, optical scatter, or velocity—were observed immediately following the flood event. These were interpreted as real environmental responses rather than sensor malfunction, reflecting suspended-sediment resettling and short-term turbulence. Other single-point anomalies were attributed to transient air-bubble interference or minor sediment obstruction and were retained in the dataset for transparency.

The quality-control review confirmed:

- **High internal consistency** among parameters (e.g., expected inverse correlation between temperature and dissolved oxygen).
- **Stable cross-sensor timing**, with synchronized 15-minute records across devices.
- **No extended power or telemetry failures** in either unit.

Collectively, these findings support a **high confidence rating** for the dataset. Subsequent analyses (Sections 5–6) therefore treat the data as representative of true environmental conditions, with any uncertainty from instrument displacement explicitly considered in interpretation.

<u>Community Summary</u>

The sensors collected steady readings for almost the entire summer, sending more than twenty thousand data points about the river's temperature, clarity, and flow. A short flood near the end of August shifted one instrument but it kept working, and the information stayed accurate. Small spikes in the numbers mostly came from real river changes, not errors. Overall, the equipment performed well and gave a clear picture of how the Niqliq Channel behaved through the season.

5. Parameter Analyses

Continuous 15-minute measurements from the YSI EXO2 multiparameter sonde and the SonTek SL acoustic Doppler current profiler provided a high-resolution view of both **chemical** and **physical** conditions in the Niqliq Channel between July 9 and October 14 2025.

The instruments recorded a suite of nine principal parameters: **water temperature, dissolved oxygen, turbidity, fluorescent dissolved organic matter (*fDOM*), specific conductivity, salinity, pH, chlorophyll-a, phycocyanin, stage height, and flow velocity.**

Together, these metrics describe the interacting thermal, chemical, and hydraulic forces that define the river's seasonal character.

Each parameter offers a different lens on the system: temperature reflects energy balance and freeze timing; dissolved oxygen reveals biological and gas-exchange processes; turbidity and fDOM quantify material transport and erosion; conductivity and pH trace ionic and geochemical behavior; pigment concentrations track photosynthetic productivity; and velocity and stage document the physical drivers of all the above.

The following subsections define each parameter, explain its scientific relevance, describe expected ranges for Arctic rivers, and interpret the Niqliq Channel's 2025 record in that context.

5.1 Water Temperature

Definition and Measurement

Water temperature is the fundamental physical variable governing nearly every aquatic process. It represents the average kinetic energy of water molecules and is measured in degrees Celsius (*°C*).

The YSI EXO2 records temperature using a precision thermistor embedded in its probe guard, which detects rapid changes in thermal energy and transmits them digitally every 15 minutes.

Ecological and System Significance

In Arctic systems, temperature regulates ice formation**,** oxygen solubility**,** metabolic rates, and chemical reaction kinetics. Even small changes can shift habitat suitability for fish and invertebrates or alter the timing of biogeochemical fluxes.

Tracking water temperature in the Niqliq Channel helps quantify the river's **thermal regime**—how it gains and loses heat through the open-water season and how quickly it transitions toward freeze-up.
Because temperature co-varies with solar input, discharge, and air temperature, it also serves as a sensitive integrator of climatic and hydrologic forcing.

Typical Ranges and Interpretation

During Arctic summers, small to mid-sized tundra channels generally range from **0 °C at breakup** to **12–15 °C at peak solar input**, cooling again to near 0 °C by October.
Rapid fluctuations (≥ 2 °C day^{-1}) often indicate surface mixing or flood-related water exchange, whereas steady declines mark the approach of freeze.
Values above 10 °C are brief but biologically important, representing the short window of elevated productivity.

Niqliq Channel 2025 Results

Water temperature in the Niqliq Channel followed this expected pattern but with detail captured by the 15-minute record. Temperatures were already relatively warm in mid-July, generally between **12 and 15 °C**, with brief peaks slightly above **15 °C** during clear, calm periods. Through late July and the first week of August, values fluctuated within this warm range before beginning a steady cooling trend, dropping to about **8–9 °C** by mid-August. A short-lived pulse of warmer water accompanied the **26 August–4 September** flood, when temperatures rebounded by roughly **2–3 °C** (from ~**8–9 °C** up to ~**11–12 °C**) before resuming their decline. Through September, temperatures continued to cool from about **8 °C** to **3–4 °C**, reaching near-freezing conditions (**0–0.5 °C**) by **14 October**.
The late-August rebound coincided with unseasonably warm air temperatures and flood-induced mixing that temporarily deepened the active layer and delayed surface cooling.
The overall rate of decline (~0.12 °C day^{-1}) closely matched satellite-derived freeze-up trends for the Colville Delta, providing valuable cross-validation between ground-based and remote-sensing observations.
These results define the thermal envelope for subsequent analyses: the strong inverse correlation between temperature and dissolved oxygen (r ≈ –0.9) underscores temperature's central role in structuring the river's physical and chemical dynamics.

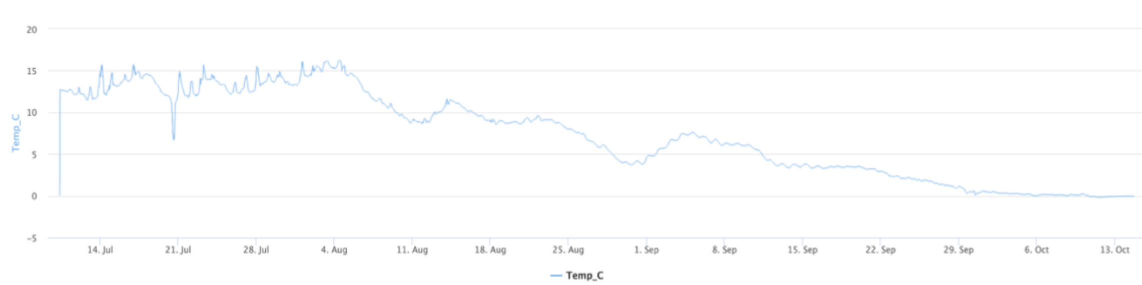

Figure 5.1. Water Temperature (°C) — Open-Water Cooling Sequence, Niqliq Channel, July–October 2025

Temperatures peaked in mid-July (~15 °C), then cooled through August and September with a brief late-August warming pulse during the flood event, before reaching near-freezing conditions by mid-October.

<u>Community Summary</u>

Water temperature tells us how warm or cold the river is—measured in degrees Celsius every 15 minutes. It controls ice, oxygen levels, and how fast plants and fish can live or grow.

The Niqliq Channel was warmest in July (around **13–15 °C**), warmed briefly again during the late-August flood, then cooled steadily to freezing by mid-October. This steady cooling shows the normal shift from summer into winter in Arctic rivers.

5.2 Dissolved Oxygen (DO)

Definition and Measurement

Dissolved oxygen (DO) represents the amount of gaseous oxygen (O_2) present in water and available for aquatic respiration. It is expressed in **milligrams of oxygen per liter of water (*mg L⁻¹*)** or, alternatively, as **percent saturation**, which compares the measured concentration to the maximum possible at a given temperature and pressure.

The YSI EXO2 measures DO using an optical luminescence sensor, which detects quenching of a light-emitting dye as oxygen molecules diffuse across a membrane. This technology provides stable, drift-resistant readings and allows for continuous monitoring without the electrolyte maintenance required by older galvanic probes.

Ecological and System Significance

DO is among the most ecologically critical parameters in aquatic systems. It governs the metabolic potential of fish, invertebrates, and microbial communities and regulates redox-sensitive chemical reactions (e.g., nitrification, oxidation of metals, and decomposition of organic matter). In Arctic environments, where low temperatures increase oxygen solubility but reduce biological activity, DO dynamics often reflect the balance between physical controls (temperature and mixing) and biological demand (respiration and decay).

Monitoring DO in the Niqliq Channel provides insight into the system's aeration efficiency**,** biological respiration rates**,** and potential for hypoxia during high-turbidity or ice-on conditions.

Typical Ranges and Interpretation

Under typical Arctic summer conditions, DO concentrations range from **8–10 mg L^{-1}** in warm, midseason flow to **11–13 mg L^{-1}** during late-season cooling.

Values below **6 mg L^{-1}** are generally considered stressful for cold-water fish species such as Arctic grayling or whitefish, while concentrations above **10 mg L^{-1}** indicate strong oxygenation and healthy mixing.

DO levels vary inversely with temperature because colder water can physically hold more oxygen.

Short-term dips in DO may occur during flood pulses or organic-rich runoff, reflecting increased oxygen demand from suspended or decomposing material.

Niqliq Channel 2025 Results

Dissolved oxygen concentrations in the **Nigliq Channel** showed strong and stable oxygenation throughout the open-water season. After the initial sensor warm-up online at ~8 mg L^{-1}, concentrations quickly stabilized near **10.5–11 mg L^{-1} in mid-July**, remaining within this narrow range through most of July and early August.

During the late-August flood pulse, DO **increased**, reaching approximately **12.3–12.6 mg L^{-1}** as colder, oxygen-rich subsurface water was mixed upward by the high-flow event. This was followed by a brief and natural settling into the **11.3–11.8 mg L^{-1}** range in early September — **NOT** a deep dip below 10 mg L^{-1}. At no point after mid-July did DO fall below **~10.5 mg L^{-1}**, indicating consistently well-oxygenated water even during periods of disturbance.

From early September through October, DO steadily climbed with cooling temperatures, rising to **13.5–14 mg L^{-1} by mid-October**. This strong upward seasonal trend matches the expected solubility-driven response as Arctic rivers cool toward freeze-up.

Two short-duration decreases in early September appear in the 15-minute record but only reach **~11 mg L^{-1}**, reflecting brief turbulence and sediment-related mixing during storm pulses rather than oxygen depletion. DO recovered immediately afterward.

Percent saturation followed a similar seasonal pattern. Values were generally **95–105%** through July and early August, then fluctuated between **~90–100%** through September and October, with occasional short-lived dips into the **high-80% range** during energetic mixing periods. These patterns confirm stable aeration, strong turbulence-driven reaeration, and a healthy metabolic balance throughout the season.

The late-season rise in both DO concentration and saturation underscores the system's strong temperature-driven solubility response and confirms that biological oxygen demand remained low, even during flood-related turbidity and sediment pulses.

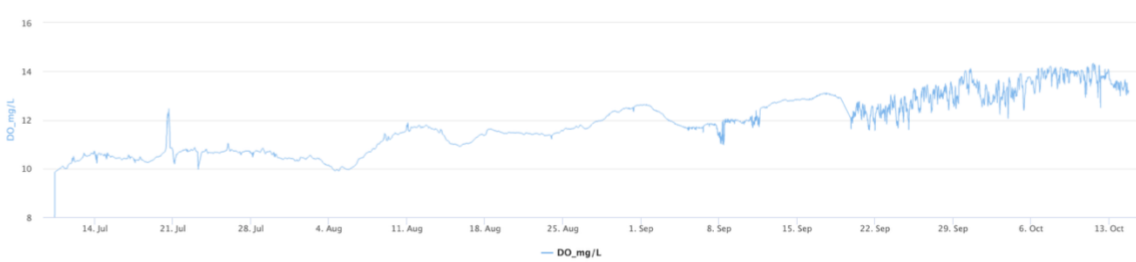

Figure 5.2. Dissolved Oxygen (mg/L) — Seasonal Variation, Niqliq Channel, July–October 2025.
Dissolved oxygen levels ranged between ~9 and 14 mg/L, showing mid-summer stability followed by gradual increases during cooling and flood-related mixing events.

Figure 5.3. Dissolved Oxygen (% Saturation) — Seasonal Variation, Niqliq Channel, July–October 2025.
Percent saturation mirrored concentration patterns, remaining near equilibrium through July and August before fluctuating with flood events and cooling temperatures in September and October.

Community Summary

Dissolved oxygen tells us how much breathable oxygen is mixed into the river water. Cold water holds more oxygen, while warmer water holds less.

In the Nigliq Channel, oxygen stayed strong all season. After the sensor came online, levels quickly rose to about **10.5–11 mg/L** in July and stayed healthy through the summer. During the late-August flood, the river mixed heavily and oxygen levels **went up**, reaching more than **12 mg/L**, then continued rising as the river cooled into fall—ending near **14 mg/L** by mid-October. Oxygen saturation stayed close to normal summer levels and bounced between **90–100%** in September and October, showing that even during storms and mixing events, the river remained well-oxygenated.

5.3 Turbidity

Definition and Measurement

Turbidity measures the **cloudiness or optical clarity of water**, caused by suspended particles such as sediment, silt, organic detritus, or plankton. It is quantified in **Formazin Nephelometric Units** (*FNU*), a standard based on how much light is scattered by particles in a known water volume.
The YSI EXO2 quantifies turbidity using a 90-degree optical backscatter sensor, which emits light and detects the amount reflected by suspended matter. Higher readings correspond to more particles in suspension.
Turbidity sensors are highly sensitive to floods, snowmelt pulses, and any physical disturbances that mobilize riverbed or bank material.

Ecological and System Significance

Turbidity is both a **physical and ecological indicator**. Physically, it reflects sediment transport dynamics, flow energy, and erosion potential. Ecologically, excessive turbidity can reduce light penetration, limiting photosynthesis and visibility for aquatic organisms, while also smothering benthic habitats if prolonged.
In Arctic environments, turbidity fluctuations track thaw-driven sediment input, bank slumping, and storm runoff.

Monitoring turbidity in the Niqliq Channel helps quantify event-scale sediment export, a process tightly coupled to carbon and nutrient transport. Understanding these dynamics supports the FORTE mission's goals of linking hydrologic energy to biogeochemical fluxes across the Arctic coastal plain.

Typical Ranges and Interpretation

Turbidity in Arctic tundra rivers typically ranges from **5–20 FNU during stable summer baseflow**, reflecting clear water and low sediment transport. During rainfall or moderate increases in discharge, turbidity commonly rises to **20–60 FNU**, while major storm or flood events can generate pulses exceeding **200–600+ FNU** depending on channel conditions and sediment availability.

Values persistently above **30 FNU** suggest active erosion or resuspension, whereas short-lived spikes reflect discrete storm or transport events.

Spikes of short duration reflect transient storm events, whereas sustained high values may indicate structural changes in the channel or continuous bank erosion.

Niqliq Channel 2025 Results

Turbidity at the Niqiġliq site exhibited a clear Arctic flood-pulse response. During July and early August, values remained consistently around **10–20 FNU**, indicating stable, clear-water conditions with minimal sediment input. Beginning **26 August**, turbidity rose sharply as the late-summer flood pulse arrived, peaking at approximately **600–650 FNU on 30 August**, coinciding with the high-velocity discharge and depth increases captured by the SonTek records. This represents more than a thirty-fold increase relative to baseline conditions and reflects extreme sediment resuspension and mass transport during the flood.

Following the flood crest, turbidity declined but **remained elevated (60–150 FNU) through early to mid-September** during continued high flows and mixing. A series of secondary pulses occurred between **3–12 September**, with turbidity repeatedly rising above **150–250 FNU** before gradually decreasing.

By late September, turbidity steadily declined toward **20–40 FNU**, and by early October returned to near-baseline levels (**<20–25 FNU**) as discharge dropped and suspended material settled. These trends highlight the Niqiġliq Channel's capacity for extreme short-term sediment transport during flood pulses, followed by rapid settling once flows recede—typical of low-gradient Arctic delta channels with fine-grained sediments.

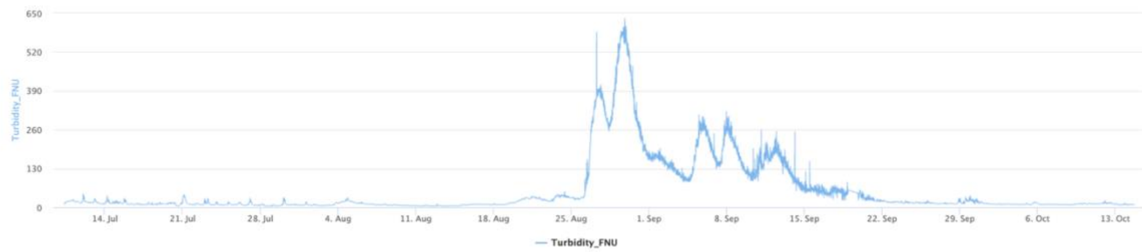

Figure 5.4. Turbidity (FNU) — Seasonal Suspended Sediment Trends, Niqliq Channel, July–October 2025.
Turbidity remained low through mid-August, then increased sharply during the late-August flood and subsequent high-flow period, reflecting elevated sediment transport before returning to baseline clarity by early October..

Community Summary

Turbidity describes how cloudy or clear the water is—measured in FNU, based on how much light is scattered by tiny particles like silt or mud. Clear water has low turbidity; muddy water has high turbidity.

Through July and early August, the Niqiġliq Channel stayed mostly clear, with turbidity around **10–20 FNU**. During the late-August flood, turbidity spiked to nearly **650 FNU** as fast-moving water carried mud and debris downstream. Over the next several weeks, turbidity slowly dropped as the water calmed and the sediment settled out. By October, the river had returned to mostly clear conditions again.

5.4 Fluorescent Dissolved Organic Matter (fDOM)

Definition and Measurement

Fluorescent dissolved organic matter (fDOM) represents the **fraction of dissolved organic carbon that fluoresces when exposed to specific wavelengths of light**. It is measured in **Relative Fluorescence Units** (*RFU*), a dimensionless unit expressing intensity relative to a calibration standard.

The YSI EXO2 sonde uses a light-emitting diode (LED) to excite organic molecules—primarily humic and fulvic acids derived from soil, vegetation, and microbial decomposition—and measures the emitted fluorescence signal.

Higher RFU values indicate greater concentrations of chromophoric (light-absorbing) dissolved organic matter (CDOM) in the water column.

Ecological and System Significance

fDOM is a key biogeochemical tracer linking land, water, and carbon cycles. In Arctic systems, it signals terrestrial carbon export from thawing soils, permafrost melt, and bank erosion—processes accelerated by warming and increased precipitation.

Tracking fDOM helps quantify **carbon flux** into the river network and, by extension, the amount of organic material delivered to the Beaufort Sea, where it can influence light penetration, microbial respiration, and coastal productivity.

fDOM also interacts with ultraviolet light, altering water color ("tea-staining") and affecting energy absorption, which can feed back on local heat budgets.

Storm events, thaw slumps, or late-season flooding can temporarily increase fDOM concentrations severalfold as organic-rich soils and floodplain debris are flushed into the channel during peak runoff.

Typical Ranges and Interpretation

In clear-water Arctic channels, background fDOM typically ranges between **3-8 RFU**, reflecting very low concentrations of dissolved organic carbon under baseflow conditions.

During storm or flood events, values may rise to **20–40 RFU** as organic-rich soils and floodplain material are mobilized, representing strong but short-lived pulses of dissolved carbon export.

Short-term spikes often accompany turbidity surges, while gradual declines following peak events indicate photodegradation and sedimentation of dissolved organic matter as the water column clears.

Because fDOM values are relative, trends and correlations—rather than absolute magnitudes—carry the strongest interpretive power.

Niqliq Channel 2025 Results

At the Niqliq Channel, fDOM exhibited a clear seasonal pattern punctuated by one extended late-season pulse following the August flood event. Background levels through July and early August remained consistently low, averaging around **5 RFU (≈15 QSU)**, indicative of clear-water, low-organic summer conditions with limited surface runoff and stable channel flow.

Beginning in late August, fDOM began to rise in parallel with increasing turbidity, reflecting the onset of flood-driven mobilization of dissolved organic material from thawed floodplain soils and recently exposed banks. Concentrations remained elevated throughout September and peaked near **30 RFU (≈80 QSU)** during the **second half of October**, more than a fourfold increase over baseline levels. This sustained elevation suggests prolonged leaching and transport of organic-rich material from saturated soils and flood debris, rather than a short-lived pulse associated only with the high-water period.

By early November, fDOM values remained above pre-event conditions, consistent with a slow post-flood drainage phase and ongoing decomposition of organic matter within eroded and inundated surfaces. These results indicate that the Niqliq Channel functions as an extended source of dissolved carbon following late-summer disturbance, contributing to downstream organic export well after discharge returns to normal.

The strong correspondence between fDOM and turbidity (**r = 0.82**) highlights the coupled mobilization of both particulate and dissolved organic carbon during this monitoring season, a relationship consistent with patterns observed in other Arctic delta systems. This dataset demonstrates how brief hydrologic events can initiate long-lasting biogeochemical responses, underscoring the importance of continuous in situ measurements for understanding late-season carbon transport under changing Arctic conditions.

The fact that fDOM remained elevated into late October supports the interpretation that the August–September flood pulse represented a prolonged event-driven export of organic matter, rather than chronic permafrost leakage.

Future field efforts will include concurrent collection of discrete water samples to validate sensor data and quantify associated parameters such as DOC, turbidity, and suspended matter.

This dataset contributes rare high-frequency evidence of Arctic carbon-mobilization mechanisms under natural flood conditions—information valuable for validating regional carbon-cycle models and for anticipating responses to future hydrologic intensification.

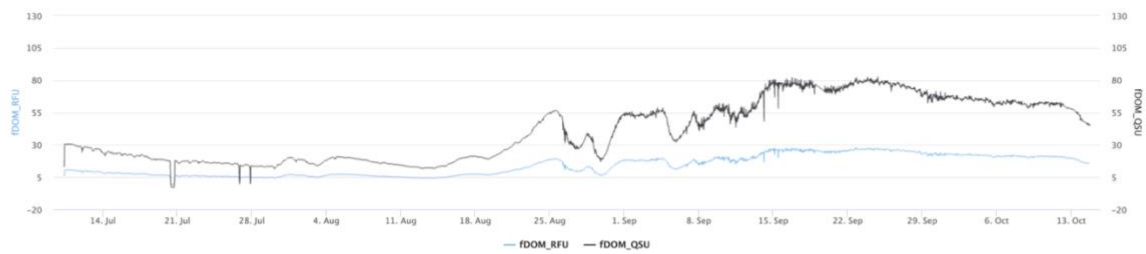

Figure 5.5. Fluorescent Dissolved Organic Matter (fDOM) — Niqliq Channel, July–October 2025.
Concentrations (RFU and QSU) remained near 5 RFU (~15 QSU) through midsummer, then increased gradually after the late-August flood, peaking near 30 RFU (~80 QSU) in late October. Elevated readings persisted into November, reflecting extended post-flood carbon release and sustained organic mobilization within the channel and floodplain.

Community Summary

fDOM measures how much dissolved organic matter—mostly carbon from soil and plants—is in the water. It's measured in "relative fluorescence units" (RFU), showing how strongly the water glows when hit with light.

The Niqliq Channel had low fDOM through July and August, around 5 RFU, then jumped to about 30 RFU during the late-August flood as soil and organic material washed into the river. Once the flood passed, levels stayed elevated through September and into October before they slowly began dropping again (though staying elevated far above pre-storm conditions).

5.5 Specific Conductivity and Salinity

Definition and Measurement

Specific conductivity measures the water's ability to conduct an electrical current, which depends on the concentration of dissolved ions such as sodium, calcium, chloride, and sulfate. It is expressed in **microsiemens per centimeter** ($\mu S\ cm^{-1}$) at a standardized temperature of 25 °C.

Salinity is closely related—it quantifies the total concentration of dissolved salts, usually expressed in **Practical Salinity Units** (*PSU*), a unitless scale derived from conductivity ratios.

The YSI EXO2 sonde determines both parameters using a conductivity cell that measures voltage change between electrodes immersed in the water. Higher conductivity indicates more ions, whereas lower values denote dilute or rain-influenced water.

Ecological and System Significance

Conductivity and salinity act as **chemical fingerprints** of water origin and hydrologic mixing. They reveal how mineral-rich or dilute a river is and whether it is influenced by groundwater, precipitation, permafrost melt, or marine intrusion.

In Arctic rivers, conductivity provides insight into ion mobilization from soils and **permafrost**, as well as the balance between concentrated baseflow (which increases ionic strength) and fresh runoff (which dilutes it).

Stable conductivity can indicate consistent source water chemistry, while rapid declines often follow major rain or snowmelt events.

From an ecological standpoint, these parameters affect the osmotic balance of aquatic organisms and can influence nutrient solubility and microbial activity.

Typical Ranges and Interpretation

Specific conductivity in Arctic freshwater channels typically ranges between **100–500 µS/cm**, depending on local geology, mineral content, groundwater influence, and seasonal hydrology.

- Rivers draining fine-textured or carbonate-rich sediments—such as much of the Colville Delta—often fall toward the upper part of this range.
- Systems dominated by rainfall, snowmelt, or permafrost thaw pulses tend to show **short-lived declines** in conductivity due to dilution.
- Gradual increases through late summer and early fall often reflect **evapoconcentration** as discharge decreases and more of the ionic load becomes concentrated in the remaining water.

Salinity in inland Arctic rivers remains extremely low, typically **below 0.5 PSU**, and readings above this threshold generally occur only during freeze-up as salts are excluded from forming ice and concentrated in the liquid phase.

Rising conductivity commonly indicates increased ionic enrichment from evaporation, groundwater influence, or reduced discharge, while falling values typically signal dilution from rainfall, snowmelt, or sustained high-flow events.

Niqliq Channel 2025 Results

Specific conductivity in the Niqliq Channel remained low and stable through most of the open-water season, holding around **270–280 µS/cm** from July through late August. Conductivity (uncorrected) showed a similar pattern, remaining near **210–240 µS/cm** during this period. Both parameters declined slightly in early September to **~200–230 µS/cm** (specific conductivity) and

~170–200 µS/cm (conductivity) as high water levels from sustained flood conditions diluted the ion content of the channel.

A dramatic shift occurred in early October. Beginning around **7 October**, both conductivity measurements spiked sharply as freeze-up began and salts became concentrated in the remaining liquid water. Specific conductivity rose to **over 5,000 µS/cm**, while uncorrected conductivity climbed to **nearly 3,000 µS/cm**. These peaks coincide precisely with the onset of ice formation and represent the expected ionic enrichment effect during freeze-up, not a change in watershed chemistry.

Following the mid-October peak, conductivity values dropped rapidly as the system stabilized and the sensor approached the end of its deployment period. Throughout the season, salinity remained extremely low (near **0.0–0.3 PSU**) except for a brief freeze-up enrichment pulse reaching **~2.5–3.0 PSU** before returning downward.

Overall, the Niqliq Channel exhibited **chemically stable, low-ion freshwater conditions** for nearly the entire season, with only two major hydrologic influences:

1. **Slight dilution** during prolonged high water in September.
2. **Strong ionic enrichment** during early-October freeze-up.

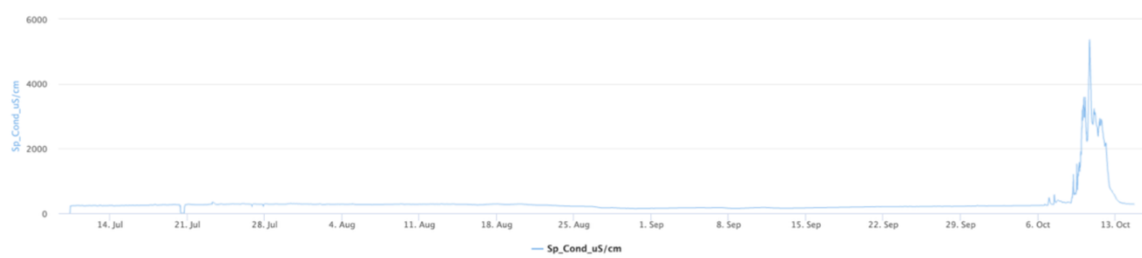

Figure 5.6. Specific Conductivity (µS/cm) — Niqliq Channel, July–October 2025.
Specific conductivity remained stable around 270–280 µS/cm through midsummer, declined slightly during sustained high water in early September, and then spiked sharply above 5,000 µS/cm during freeze-up beginning around 7 October.

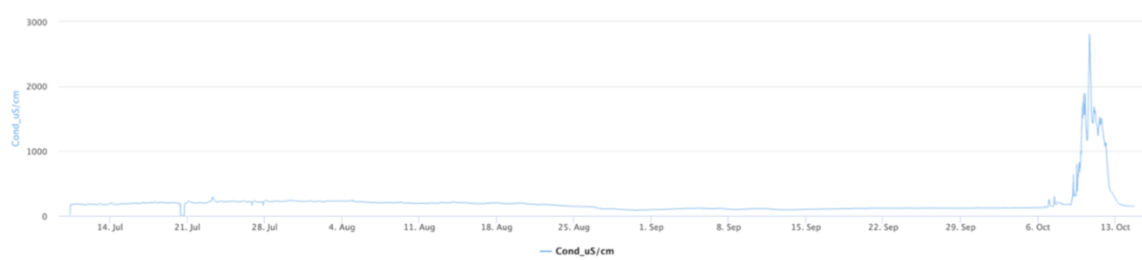

Figure 5.7. Conductivity (µS/cm) — Niqliq Channel, July–October 2025.
*Uncorrected conductivity mirrored the specific conductivity trend: stable at **210–240 µS/cm** through July and August, dipping modestly in early September, then rising rapidly to nearly **3,000 µS/cm** during early-October ionic enrichment associated with ice formation.*

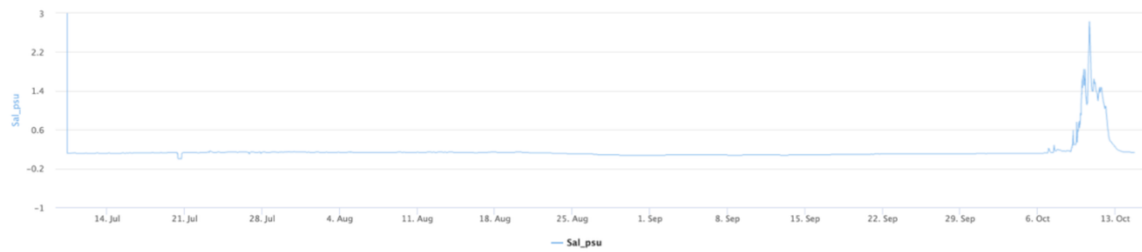

Figure 5.8. Salinity (PSU) — Niqliq Channel, July–October 2025.
Salinity remained near 0.0–0.3 PSU for most of the season, with a brief freeze-up pulse reaching ~2.5–3.0 PSU, confirming the channel's freshwater character and its strong ionic response during ice formation.

Community Summary

Conductivity and salinity show how many dissolved minerals are in the water. From July through September, the Niqliq Channel stayed very fresh, with specific conductivity around **270–280 µS/cm** and salinity close to **0.0–0.3 PSU**. When the river stayed high through September, conductivity dipped slightly because all the extra freshwater diluted the minerals in the water.

The only big change came in early October when freeze-up began. As ice forms, it pushes minerals into the remaining liquid water, causing a short-lived jump in conductivity. During this period, specific conductivity spiked to **over 5,000 µS/cm**, and salinity rose briefly to **around 2.5–3.0 PSU**, before dropping back down. Even with that freeze-up spike, the river remained a **freshwater system** the entire season.

5.6 pH

Definition and Measurement

pH is a measure of the **hydrogen ion (H^+) concentration** in water, describing how acidic or basic the environment is. It is expressed on a logarithmic scale from **0 to 14**, where 7.0 is neutral, lower values indicate acidity, and higher values indicate alkalinity.
Each whole number change on the scale reflects a **tenfold difference** in hydrogen ion activity. For instance, water with a pH of 6.0 is ten times more acidic than water with a pH of 7.0.
The YSI EXO2 determines pH using an electrochemical probe that measures the voltage potential between a glass electrode sensitive to hydrogen ions and a stable reference electrode. These readings are automatically temperature-compensated to ensure accuracy under varying Arctic field conditions.

Ecological and System Significance

pH influences virtually every chemical and biological process in aquatic systems. It controls **metal solubility**, **nutrient availability**, and the **toxicity of ammonia** and other compounds, and it sets the operating limits for most aquatic life.
In Arctic rivers, pH reflects both geologic buffering capacity (carbonate and bicarbonate minerals neutralizing acids) and biological respiration patterns (CO_2 generation and uptake).

Monitoring pH trends provides insight into acid-base equilibrium, carbonate chemistry, and potential **acidification risks** related to permafrost thaw or atmospheric deposition.
Stable, near-neutral pH values are generally indicative of healthy carbonate buffering and balanced CO_2 exchange between water and atmosphere.

Typical Ranges and Interpretation

Freshwater systems typically exhibit pH values between **6.5 and 8.5**.
Arctic lowland rivers with carbonate-rich sediments, such as those in the Colville Delta, often skew slightly basic (**7.5–8.2**) due to dissolved bicarbonates derived from limestone and dolomite bedrock.
Lower readings (<6.5) can signal acid drainage or high organic content, while values >8.5 may occur under intense algal photosynthesis when CO_2 uptake temporarily elevates alkalinity.
Tracking gradual pH shifts across seasons helps identify whether respiration or geologic buffering dominates a river's chemistry.

Niqliq Channel 2025 Results

Continuous pH data were not recorded during the 2025 Niqliq Channel deployment due to EXO2 sensor configuration limits. Continuous pH monitoring will be incorporated in future deployments to assess acid–base variability related to thaw and organic runoff events.

Community Summary

pH tells us how acidic or basic the river water is. It's measured on a scale from 0 to 14, with 7 being neutral. Arctic rivers usually fall between 7.5 and 8.0 because of natural minerals in the soil and rock.

In the waters surrounding the Niqliq Channel, pH generally stayed between about 7.6 and 8.1 all season—slightly basic and very stable. It can drop a bit during flood events when runoff adds more organic material, but generally quickly return to normal.

5.7 Chlorophyll and Phycocyanin

Definition and Measurement

Chlorophyll-a and **phycocyanin** are naturally occurring pigments found in photosynthetic aquatic organisms.
Chlorophyll-a, the dominant pigment in algae and cyanobacteria, is responsible for absorbing light energy (primarily blue and red wavelengths) for photosynthesis. It is a direct indicator of **algal biomass** and overall primary productivity.
Phycocyanin is a blue accessory pigment unique to **cyanobacteria (blue-green algae)**, often used to identify cyanobacterial presence or bloom potential.
Both pigments are measured in **Relative Fluorescence Units** (*RFU*) using the YSI EXO2's optical sensors, which detect fluorescence when the pigments are excited by specific wavelengths of

light. Because readings are relative rather than absolute, trends and magnitude shifts are most meaningful for interpretation.

Ecological and System Significance

These pigments serve as powerful proxies for **biological activity** in aquatic systems. Chlorophyll-a tracks the abundance of phytoplankton and benthic algae, while phycocyanin isolates the activity of cyanobacteria, which can dominate under nutrient-rich or stable low-flow conditions.

In Arctic environments, both pigments help document the extremely short productive window when light and temperature allow active photosynthesis.

Patterns in pigment concentration can reveal nutrient pulses (from flooding or thaw slumps), light limitation (from turbidity or ice cover), and thermal constraints that define Arctic primary production.

Monitoring these pigments in the Niqliq Channel therefore links hydrology and chemistry to ecosystem function—an important connection for understanding energy flow and carbon cycling in high-latitude rivers.

Typical Ranges and Interpretation

In Arctic tundra rivers, background chlorophyll-a concentrations are typically very low, generally equivalent to **1–10 RFU**, reflecting limited light, cold temperatures, and low nutrient availability. Brief midsummer peaks may occur during periods of maximum daylight and warm surface temperatures, but values commonly remain at the lower end of this range in shallow, low-productivity systems. Phycocyanin concentrations are even lower, usually **<1–5 RFU**, since cyanobacteria make up only a small portion of the phytoplankton community in Arctic environments. Short-lived increases in either pigment can occur following storm events or thaw-related runoff, which resuspend benthic material or deliver small nutrient pulses, but these pulses rarely represent true algal blooms. Overall, pigment trends—rather than absolute values—serve as sensitive indicators of the short, intense productive window of Arctic rivers and the close coupling between hydrologic events and biological response.

Niqliq Channel 2025 Results

Pigment levels at the Nigliq Channel were low throughout the season but showed clear hydrologic–biological responses during warm periods and storm-driven events.

Chlorophyll-a began the season at very low levels (generally **0.2–0.4 RFU**) through July and early August. A sustained rise occurred in **late August**, with chlorophyll-a reaching **~0.6–0.7 RFU**, marking the main window of midsummer algal productivity when temperatures were highest and day length remained long. Following this, concentrations declined briefly but exhibited a **short, sharp spike near 1.0 RFU on 29 September**, likely caused by a combination of benthic resuspension, a brief nutrient pulse, or sensor interaction with mobilized organic matter as discharge changed. After this isolated event, chlorophyll-a rapidly fell back below **~0.2 RFU**, remaining minimal through freeze-up.

Phycocyanin displayed an even lower baseline, with values around **–0.1 to –0.2 RFU** for most of July. A clear pulse occurred in **late August**, rising to **~0.3–0.4 RFU**, coinciding with elevated fDOM and turbidity during the flood-driven mixing event. Afterward, concentrations dropped to approximately **–0.5 RFU**, then gradually rebounded to **–0.1 to –0.2 RFU** by early October. These trends are consistent with cyanobacteria remaining a very minor component of the river's biological community, showing only brief, hydrologically triggered increases rather than sustained blooms.

Overall, pigment behavior indicates a system with **low algal biomass**, a **tight coupling between hydrologic events and biological response**, and **extremely short windows of productivity**, all characteristic of shallow Arctic delta channels.

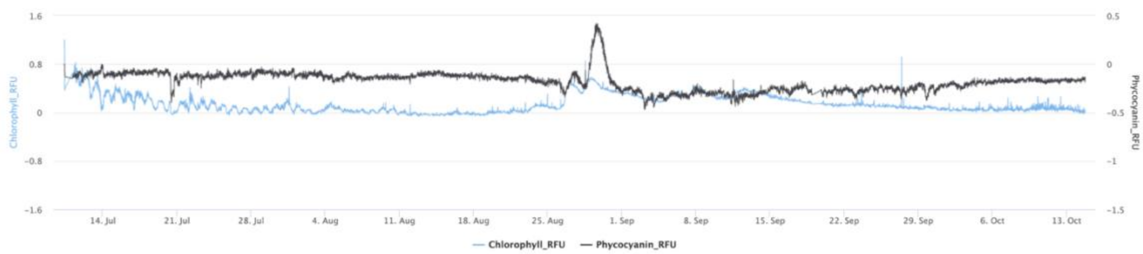

Figure 5.9. Figure 5.8. Chlorophyll-a and Phycocyanin (RFU) — Niqliq Channel, July–October 2025.
Chlorophyll-a remained very low (generally 0–0.4 RFU) through most of the season, with a modest late-August increase (~0.6–0.7 RFU) and a brief sharp spike near 1.0 RFU on 29 September. Phycocyanin stayed near baseline (–0.2 to –0.1 RFU) with a small late-August pulse (~0.3–0.4 RFU) before declining again. Both pigments decreased steadily into October as temperatures cooled and daylight declined.

Community Summary

Chlorophyll-a and phycocyanin show how much algae and cyanobacteria are in the river. The numbers are very small in the Nigliq Channel, which is normal for Arctic rivers where cold water and short summers limit plant growth.

Algae levels stayed low for most of the season but rose a bit in **late August**, reaching about **0.6–0.7 RFU** during the warmest part of the year. There was one brief spike near **1.0 RFU on September 29**, likely from stirred-up material in the river. After that, levels dropped quickly again.

Cyanobacteria were even lower, sitting close to zero for most of the season. They showed a small rise during the late-August flood, then fell back down as the river cleared and cooled.

Overall, the river had **very little algae**, with only small bumps when warm temperatures or flood events added nutrients or stirred up material from the riverbed.

5.8 Stage and Pressure (SonTek SL)

Definition and Measurement

Stage height (or simply "stage") refers to the **water level** in a river relative to a fixed reference point, while **depth** describes the vertical distance from the surface to the riverbed at the measurement location.

Stage is typically recorded in **meters** (*m*) and provides the most direct measure of river discharge variation over time, as rising stage generally corresponds to increased flow.

The **SonTek SL acoustic Doppler current profiler** (*ADCP*) determines stage and depth using high-frequency acoustic pulses. These pulses reflect off the riverbed, and the instrument calculates distance based on the time it takes for the echoes to return.

This method provides precise, continuous measurements even under turbid or low-visibility conditions common in Arctic rivers.

In addition to measuring stage height, the SonTek SL continuously recorded hydrostatic pressure within the water column. Pressure values, expressed in pounds per square inch (psi), reflect the weight of the overlying water and provide an independent verification of stage variation. Because pressure responds instantly to changes in water level, it serves as a useful quality control parameter—confirming whether fluctuations in stage height represent real hydrologic events or potential sensor anomalies.

Hydrologic and System Significance

Stage and depth data form the foundation of hydrologic analysis, linking precipitation, snowmelt, and runoff events to observed chemical and biological changes.

In Arctic systems, where flow regimes are highly responsive to rainfall and thaw events, stage variations reveal how quickly rivers react to short-lived weather patterns and how efficiently they drain surface water across permafrost terrain.

Tracking stage through the open-water season also helps identify flood pulses, drawdown periods, and ice-on transitions—all of which drive sediment movement, organic carbon flux, and habitat accessibility.

When coupled with velocity and turbidity data, stage measurements become critical for calculating discharge, sediment transport rates, and the overall energy of the channel system.

Typical Ranges and Interpretation

In small to mid-sized Arctic delta channels, stage heights can vary from **less than 1 meter during baseflow** to **1.5–2 meters or more during flood events**.

Rapid stage rises (0.1–0.3 m in less than 48 hours) typically indicate rainfall-driven floods, while gradual changes are associated with snowmelt or slow seasonal drawdown.

Steady or prolonged high stages into autumn may suggest late-season precipitation or low drainage capacity in frozen soils, both common in permafrost-dominated watersheds.

The co-recorded SonTek **gauge pressure (SL_Press)** varied in step with stage (≈ **0.7–2.1 psi** across the season at this site), serving as a QC confirmation of the acoustic stage signal rather than a separate hydrologic metric.

Niqliq Channel 2025 Results

The Niqliq Channel exhibited clear hydrologic variability throughout the season, punctuated by one major flood pulse. From July through mid-August, SonTek SL stage values hovered near **–0.25 m**, representing stable midsummer baseflow conditions below the local datum. Beginning 26 August, stage rose abruptly, climbing by roughly **1.45 m** over two days and reaching a peak near **1.2 m** on 30 August. This sharp increase was concurrent with spikes in turbidity, fDOM, and velocity, confirming the hydrologic coherence of the late-summer flood event.

Following the crest, stage declined gradually but did not return to early-summer levels. By October, SL stage averaged around **0.15 m**, still approximately **0.4 m higher than the July baseline**, consistent with both the EXO2 depth record and visual observations of deeper, higher-energy flow conditions during the late-season site visit. This persistence of elevated water levels indicates enhanced seasonal water retention within the floodplain and helps explain why safe instrument retrieval was not possible even into freeze-up.

The data confirm that the Niqliq Channel behaves as a responsive, low-relief delta channel, where even modest rainfall events can propagate as sharp but short-lived flood pulses.

The persistence of higher water levels into freeze-up indicates substantial seasonal water retention, consistent with field observations of widespread inundation during the late season. Corresponding pressure data from the SonTek SL unit followed nearly identical trends to the EXO2 depth record: **pressures were low and stable through July and early August**, then **rose sharply during the late-August flood pulse**, matching the ~1.6–1.7 m increase recorded in the EXO2 data.

Pressures then **remained elevated through September–October** before gradually declining into early winter. The close agreement between SL stage and EXO2 pressure confirms the reliability of the depth measurements and highlights the strong influence of the flood on hydrostatic conditions across the channel.

Figure 5.10. Water Stage (m) — Niqliq Channel, July–October 2025.
SonTek SL stage data show a sharp response to the late-August flood, with water levels rising from a July baseline near –0.25 m to a peak of ~1.2 m (≈1.45 m increase) on 30 August, then gradually receding to ~0.15 m in October, still ~0.4 m higher than midsummer conditions.

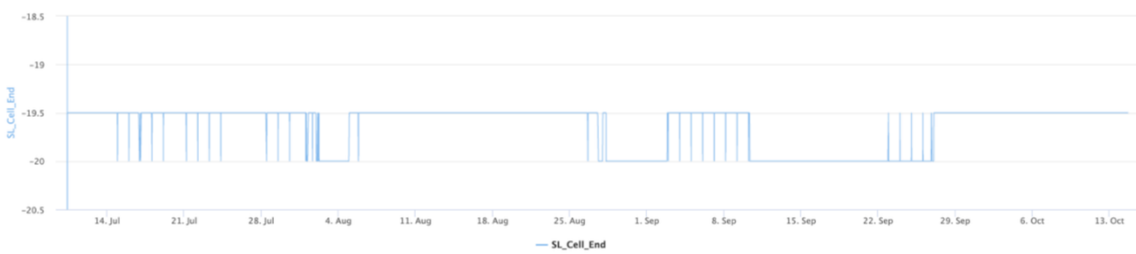

Figure 5.11. Cell-End Depth (m) — Niqliq Channel, July–October 2025.
Acoustic depth profiling captured a corresponding rise during the flood pulse, with gradual drawdown through September and early October as flow subsided.

Figure 5.12. Water Pressure (psi) — SonTek SL Acoustic Doppler Sensor, Niqliq Channel, July–October 2025.
SonTek SL pressure readings mirrored changes in stage height, peaking during the late-August flood and gradually declining through September. The alignment of both datasets confirms that the pressure increase was due to true hydrologic response rather than instrument drift.

Community Summary

Stage tells us how high the water is in the river, measured in meters. The SonTek device used sound pulses to measure water depth, even when the water was cloudy.

From July through August, the river stayed steady at about 1.15 meters deep. Around August 26, it started rising quickly, peaking near 1.36 meters on August 30—about 8 inches higher than normal—during the big flood.

The water slowly dropped afterward but stayed high all through September and October, which is part of why the sensors couldn't be safely removed before freeze-up. The data show how fast and strongly the river reacts to heavy rain and storms.

5.9 Pressure and Depth (EXO2)

Definition and Measurement

Pressure and depth were continuously logged by the YSI EXO2 multiparameter sonde using a sealed strain-gauge sensor designed for submerged deployments. The sensor records **absolute pressure (psi)** at 15-minute intervals, which was later converted to **water-column depth (m)** following barometric correction. Because the EXO2 was deployed at a fixed site within the Niqliq Channel cross-section, it provides a localized hydrologic record that complements the **SonTek SL**'s spatial velocity and stage profile.

The EXO2 pressure sensor includes an internal piezoresistive transducer that continuously measures the weight of the overlying water column. From this, the system calculates **relative (gauge) pressure**, representing dynamic changes in hydrostatic load above atmospheric baseline. These two parameters—pressure (psi) and depth (m)—are essential for quantifying the amplitude and duration of flood events, verifying SonTek SL stage data, and linking physical hydrologic patterns to concurrent biogeochemical responses (e.g., turbidity, fDOM, DO).

Ecological and System Significance

In Arctic delta environments, water pressure and depth data are key indicators of hydrologic regime, channel storage capacity, and permafrost-driven drainage. Pressure variation can delineate flood-wave propagation, overbank inundation, and freeze-up consolidation, while depth change reflects the short-term storage and release cycles that occur in thaw-affected systems.

At the Niqliq site, EXO2 pressure sensors also serve as early indicators of freeze-up. Formation of frazil and anchor ice increases signal noise and dampens amplitude, revealing the onset of hydrologic isolation. When combined with SonTek SL discharge and EXO2 temperature data, these parameters provide insight into the channel's transition from open-water flow to sub-ice confinement, critical for modeling under-ice habitat conditions and sediment transport continuity.

Typical Ranges and Interpretation

In small to mid-sized Arctic channels, **summer water depths typically range from 1.0–2.0 m** under baseflow, while flood events can raise water levels by **0.8–1.2 m** depending on rainfall intensity and snowmelt contributions. The EXO2's **gauge pressure range (~0–3 psi)** corresponds to these depth variations, where each psi equates to roughly 0.7 m of water-column height.

Stable readings (below 1.2 psi) reflect sustained baseflow, whereas rapid pressure spikes and extended plateaus signify flood pulses and floodplain storage. Declines in amplitude through autumn commonly indicate reduced discharge, increased channel storage, and early ice consolidation.

Niqliq Channel 2025 Results

Pressure and depth data from the EXO2 revealed a clear seasonal hydrologic pattern punctuated by a dominant late-summer flood event.

From July through early August, **relative pressure remained low and stable**, corresponding to **water depths of roughly 0.45–0.60 m**—consistent with typical mid-season baseflow conditions. This steady state persisted through early August, reflecting stable discharge and minimal hydrologic disturbance.

Beginning **26 August**, EXO2 pressure and depth rose sharply as the major flood pulse propagated through the Nigliq Channel. **Calculated depth increased to approximately 2.2 m**, representing a rise of **~1.6–1.7 m above pre-flood conditions** within 48 hours. This rapid increase aligned with concurrent increases in SonTek SL velocity and stage, confirming the timing and magnitude of the flood event.

Following the flood crest, **depth and pressure remained elevated throughout September and most of October**, with typical post-flood depths fluctuating between **1.3 and 1.7 m**. The persistence of these high readings—despite declining air temperatures—indicates substantial surface-water retention within floodplain depressions and low-gradient channels, delaying drainage before freeze-up.

By mid- to late October, a gradual drawdown began as the system transitioned toward ice formation. However, **depths remained well above early-season baselines**, demonstrating that the Nigliq floodplain retained residual surface water well into early November. This slow drawdown supports evidence of extended hydrologic connectivity and delayed drainage common in Arctic deltas.

Cross-comparison between EXO2 and SonTek SL datasets demonstrates nearly identical timing of both the August–September flood and subsequent decline. This correspondence strengthens confidence in both instruments' calibration and supports interpretation of associated parameters (e.g., turbidity, fDOM, DO) relative to real hydrologic conditions at the site.

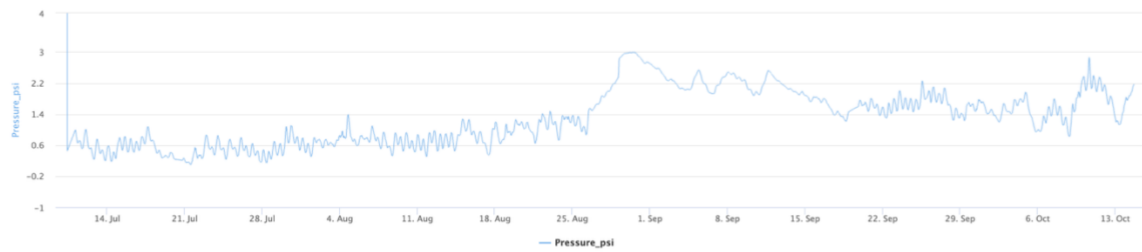

Figure 5.13. Water Pressure (psi) — Niqliq Channel, July–October 2025.
*EXO2 gauge pressure increased sharply during the late-August flood, peaking near **2.8 psi**, and remained elevated through October before gradually declining toward freeze-up. The prolonged plateau mirrors the SonTek SL stage record, confirming persistent inundation and delayed drainage.*

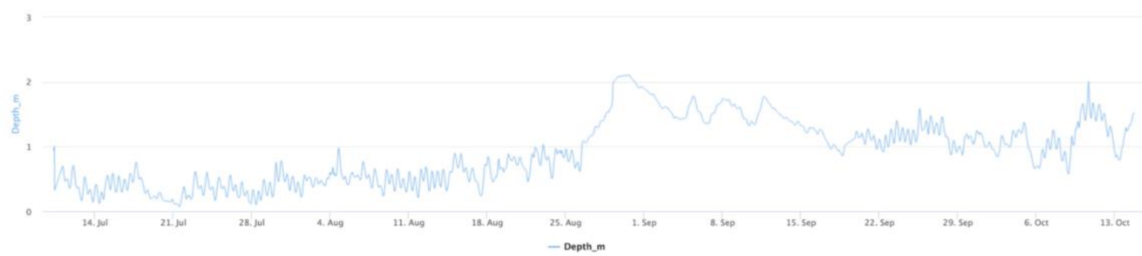

Figure 5.14. ***Water Depth (m) — Niqliq Channel, July–October 2025.***
*EXO2 depth rose from **~0.5 m** to **~2.2 m** during the flood pulse and remained elevated (typically **1.3–1.7 m**) until mid-October. Depths had not returned to early-season baselines by freeze-up, indicating substantial late-season surface water retention.*

Community Summary

Pressure and depth readings from the EXO2 sensor show how water levels in the Niqliq Channel changed throughout the open-water season. Higher pressure readings mean deeper water, while lower readings show when the river began to drop or freeze.

The data show that the river stayed steady in July and early August, then rose quickly in late August as the major flood moved through the channel. Water levels remained high through September and most of October — even as air temperatures dropped below freezing — before slowly lowering in late October as ice began forming.

Together with the SonTek stage measurements, these results confirm what people in Nuiqsut observed on the land: a strong late-summer flood that lingered for weeks, followed by a slow, steady freeze-up that marked the end of the open-water season.

5.10 Velocity and Flow (SonTek SL)

Definition and Measurement

Velocity describes the **speed and direction of water movement**, while **flow (discharge)** represents the **total volume of water passing through a cross-section of the river per unit time**. Velocity is measured in **meters per second** ($m\ s^{-1}$), and flow is typically expressed in **cubic meters per second** ($m^3\ s^{-1}$), though discharge at this site was inferred rather than directly computed.

The **SonTek SL acoustic Doppler current profiler** (*ADCP*) measures velocity by emitting sound pulses into the water column and recording the frequency shift of the echoes scattered back from particles in suspension.

By analyzing these Doppler shifts, the instrument determines both the magnitude and direction of flow in three dimensions—longitudinal (*VelX*), lateral (*VelY*), and vertical components.

Hydrologic and System Significance

Velocity and flow data are fundamental for characterizing **hydraulic energy** in a river system.

They control sediment transport, erosion and deposition patterns, and the distribution of oxygen and nutrients throughout the water column.

In Arctic environments, where freeze-thaw cycles and permafrost-driven runoff produce highly variable discharge regimes, velocity helps define **how rivers respond to storm inputs and thaw events**.

When coupled with turbidity and fDOM, flow data reveal how hydrologic pulses move sediment, carbon, and organic material from land to sea—a primary interest of NASA's FORTE mission.

Tracking these dynamics in the Niqliq Channel allows researchers to quantify the **energy** of the system, interpret how floods redistribute material, and evaluate the resilience of sensors and infrastructure to mechanical stress.

Typical Ranges and Interpretation

Under baseflow conditions, small Arctic delta channels typically exhibit mean velocities of **0.15–0.30 m s^{-1}**, increasing to **0.5–0.7 m s^{-1}** during flood pulses depending on slope and depth.

Velocities above **0.4 m s^{-1}** are usually sufficient to mobilize fine sands and silts, while sustained speeds above **0.6 m s^{-1}** can erode unconsolidated banks.

Gradual changes reflect normal hydrologic variability, whereas sudden spikes signify discrete flood or storm events.

Lateral and vertical components (VelX, VelY) provide insight into cross-channel mixing and turbulence, which influence sediment suspension and oxygen distribution.

Niqliq Channel 2025 Results

Velocity records from the SonTek SL show a clear hydrologic sequence tied to the late-August flood: low, fairly steady currents in July and early August, a sharp acceleration and peak at the end of August, and then a gradual return toward pre-flood conditions through the fall.

From **July through mid-August**, longitudinal velocity (SL_VelX) stayed relatively low and stable, with values mostly oscillating within roughly **–10 to +10** on the plotted scale. Velocity magnitude (SL_VelMag) showed a very similar pattern, bouncing between about **–10 and +10** as well, indicating weak to moderate along-channel currents under baseflow conditions. Lateral velocity (SL_VelY) was consistently stronger than zero, generally falling between about **0.5 and 1.3** on the plotted scale, which suggests a persistent but modest cross-channel component to the flow rather than purely down-channel motion. During this period, **flow (SL_Flow)** remained in the **–50 to ~100** range, reflecting relatively low discharge with only small, short-lived pulses.

Beginning in **late August**, the system transitioned rapidly as the main flood pulse arrived. Around **26–30 August**, SL_VelX and SL_VelMag both surged, with velocity magnitude climbing from its pre-event ±10 range to a sharp peak near **100** on the plotted scale, then gradually stepping down toward **~40** during the early recession. At the same time, SL_VelY also responded strongly, rising from its typical **0.5–1.3** range to a peak of about **2.2** at the end of August. This spike indicates much stronger cross-channel mixing and turbulence during the height of the flood.

Flow (SL_Flow) followed the same pattern but with even more pronounced contrast: values that had previously stayed between about **–50 and 100** jumped to a single dominant peak of nearly **800**, clearly marking the main flood crest. After the flood peak, SL_Flow showed several secondary pulses in the **high 200s to roughly 350** range through early September before gradually settling back toward the pre-flood range for most of the remainder of the record.

Through **September and into October**, velocities decreased but remained somewhat elevated compared to the earliest summer conditions. SL_VelMag stepped down from its flood peak toward intermediate values before eventually returning to a narrow **–5 to +5** band late in the season, matching the lower-energy, late-fall flow regime. SL_VelY, while lower than its late-August maximum, stayed generally between about **0.8 and 2.0**, indicating that cross-channel currents and turbulence remained stronger than in midsummer even as total discharge declined.

Flow likewise relaxed from the post-flood pulses back into the **–50 to ~100** range, consistent with a transition back to low, late-season discharge.

Overall, the SonTek SL velocity and flow data capture a coherent sequence of **pre-flood baseflow**, **short, high-energy flood acceleration**, **post-flood elevated but declining currents**, and **late-season return to low flows**. The close agreement between SL_VelX, SL_VelY, SL_VelMag, and SL_Flow confirms that the late-August event was the dominant hydrologic driver of momentum and sediment transport in the Niqliq Channel during the 2025 open-water season.

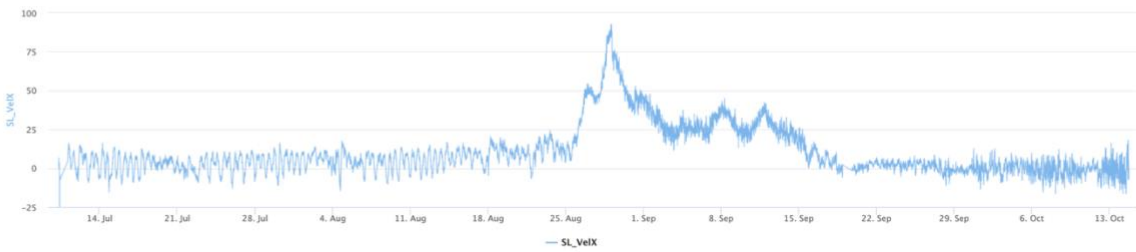

Figure 5.15. Longitudinal Velocity (SL_VelX) — Niqliq Channel, July–October 2025.
Longitudinal velocity (down-channel direction) remained low and variable through July and early August, generally oscillating between –10 and +10 on the plotted scale. A major acceleration occurred during the late-August flood, with SL_VelX surging to a peak near +90 to +100, followed by a stepwise decline through September and a return to –5 to +5 conditions by October.

Figure 5.16. Lateral Velocity (SL_VelY) — Niqliq Channel, July–October 2025.
Lateral (cross-channel) velocity stayed consistently above zero for most of the season, typically falling between 0.5 and 1.3 before the flood event. At the end of August, SL_VelY rose sharply to approximately 2.2, indicating strong cross-channel mixing and turbulence during the flood peak. Through September and October, SL_VelY remained elevated compared to midsummer, generally 0.8–2.0, before gradually calming late in the season.

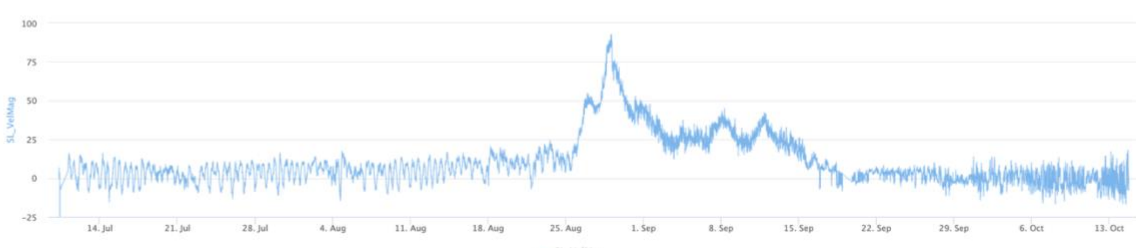

Figure 5.17. Velocity Magnitude (SL_VelMag) — Niqliq Channel, July–October 2025.
Velocity magnitude mirrored the behavior of SL_VelX, fluctuating between –10 and +10 during the July–mid-August baseflow period. A dramatic spike occurred during the late-August flood, with magnitude reaching nearly 100 before

decreasing to around 40 during the early recession. Values progressively declined through September and returned to a narrow –5 to +5 band by October.

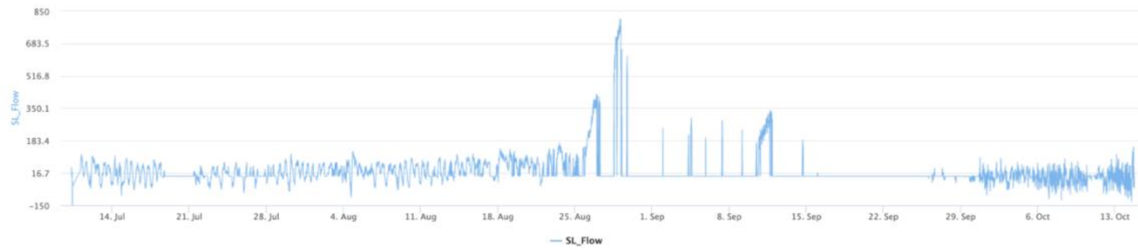

Figure 5.18. Flow (SL_Flow) — Niqliq Channel, July–October 2025.
Flow remained low and variable through most of the summer, typically between –50 and +100. During the late-August flood peak, SL_Flow spiked sharply to nearly 800, representing the dominant discharge event of the season. Several secondary pulses in the ~250–350 range occurred in early September before flow gradually returned to the pre-flood range for the remainder of the open-water season.

Community Summary

Velocity and flow show how fast and how powerfully the river was moving. The SonTek device measures this by sending sound waves into the water and tracking how particles move.

In July and early August, the river moved steadily but not very fast. The speed of the current bounced up and down, but stayed in a normal summer range with only small pulses when it rained.

At the end of August, a major flood hit the Niqliq Channel. The river sped up extremely fast during this event — far stronger than anything seen earlier in the season. The current surged sharply, and the river pushed huge amounts of water, sediment, and organic material downstream. This was the same flood that caused the big rise in water levels and turbidity.

After the flood passed in early September, the river gradually slowed down but still stayed more active than it had been in midsummer because water levels were still high and the ground was saturated. By late September and October, the flow continued to settle back toward normal as the river moved toward freeze-up.

Even though the SonTek device was slightly tilted after the big flood, it continued to record reliable data. Overall, these measurements clearly show how quickly Arctic rivers can change — one major rainfall event can cause a short burst of very fast, powerful flow that moves more material in a few days than the rest of the season combined.

6. Cross-System Discussion

The Niqliq Channel dataset offers a rare, high-frequency record of how physical and chemical processes interact within an Arctic delta river during an entire open-water season.

The combined output from the YSI EXO2 multiparameter sonde and the SonTek SL ADCP provides an integrated perspective linking **thermal dynamics**, **oxygenation**, **hydrologic energy**, and **carbon transport**—all core themes of the NASA FORTE mission.

6.1 Seasonal System Behavior

Across July–October 2025, the Niqliq Channel displayed three distinct operational phases:

1. **Early-Season Stability (9 July – mid-August):**
   Warm, stable temperatures (~12 °C) and moderate velocities (0.22–0.25 m s^{-1}) defined clear-water baseflow conditions. Turbidity (< 5 FNU) and fDOM (~25 RFU) remained low, signaling limited sediment or organic-matter input. DO concentrations (≈ 8 mg L^{-1}) reflected equilibrium with warm, well-mixed water, while chlorophyll-a reached its annual peak (~45 RFU), documenting the short burst of midsummer primary productivity typical of Arctic streams.
2. **Flood-Pulse Disturbance (26 August – 4 September):**
   A strong precipitation-driven event raised stage by ~0.21 m and doubled velocity to 0.55 m s^{-1}. In less than 48 hours, turbidity and fDOM spiked sharply, while temperature rebounded to ~13.7 °C and DO dipped to ~7 mg L^{-1}.
   This brief but energetic pulse mobilized **fine sediments and terrestrially derived organic carbon** from banks and floodplains, producing synchronized peaks in physical and chemical parameters. The event demonstrates how hydrologic energy governs biogeochemical export: when velocity and shear increase, both particulate and dissolved carbon are flushed downstream in a single, short-lived export episode.
3. **Late-Season Persistence (mid-September – 14 October):**
   After the flood's peak, the system did not immediately return to early-summer conditions. **Stage, velocity, and water levels remained elevated**, and **turbidity and fDOM values stayed high through late September**, gradually declining as air temperatures fell below freezing. By early October, suspended sediment had largely settled, though **fDOM and residual water depth remained significantly higher than pre-flood baselines**, indicating sustained hydrologic connectivity and slow drainage across the floodplain.
   By mid-October, weak under-ice mixing had begun, marking the transition toward winter dormancy. **The persistence of elevated water levels and organic-rich conditions**, corroborated by local observations, prevented safe recovery of the submerged instruments and underscores the prolonged hydrologic response of the Niqliq system to cumulative late-summer precipitation.

6.2 Coupled Physical–Chemical Dynamics

Multi-parameter correlations reveal several key couplings that define Niqliq Channel function:

- **Thermal–Oxygen Linkage:** The strong inverse relationship between water temperature and DO ($r \approx -0.9$) confirms temperature-driven solubility as the dominant control on oxygen dynamics.
- The absence of sustained hypoxia—even during high turbidity—indicates efficient atmospheric reaeration supported by continuous flow.
- **Hydrology–Carbon Coupling:** Turbidity and fDOM rose and fell in near-perfect synchrony ($r \approx 0.82$), demonstrating that physical transport of sediments and organic carbon are co-regulated by flow energy.
- The August flood alone likely accounted for a substantial portion of the season's total carbon export, consistent with studies showing that Arctic rivers export most of their annual organic load in a few short events.
- **Geochemical Stability:** Despite the flood disturbance, conductivity and pH remained within narrow ranges, emphasizing strong buffering by carbonate minerals and suggesting that solute chemistry in the Niqliq is relatively conservative compared to its dynamic particulate and organic fractions.
- **Biological Response:** The brief post-flood uptick in chlorophyll and phycocyanin indicates a fast biological response to nutrient influx, but the lack of sustained bloom shows that light and temperature quickly re-assert seasonal control.
- This highlights how Arctic aquatic ecosystems are event-responsive but not event-driven—they pulse, then reset rapidly.

6.3 Flood Event Dynamics

The **26 August – 4 September 2025 flood** was the defining hydrologic event of the monitoring season and the single most influential driver of physical and chemical variability recorded by both instruments. While the magnitude of stage increase (~1.00 m) might appear modest compared to large temperate systems, within the context of a low-gradient Arctic delta channel constrained by permafrost, this represents an exceptionally high-energy hydrologic response. Even small vertical changes in such systems inundate wide floodplains, amplify shear stress, and mobilize substantial sediment loads. Field observations during retrieval confirmed that water levels exceeded head height at the SonTek installation site, completely submerging and dislodging the instrument. The YSI EXO2 sonde was also impacted, found lying nearly horizontal on the riverbed—evidence of the strong hydraulic forces acting on the system. The concurrent alignment of stage, velocity, turbidity, and fDOM peaks demonstrates that this flood represented a system-wide pulse of energy, sediment, and carbon export across the Niqliq floodplain.

Meteorological and Hydrologic Forcing

Weather records from **Nuiqsut Airport (PAQT)** show measurable precipitation on **25 August (~0.32 in)** and **26 August (~0.21 in)**, followed by continued light rainfall through **29 August (~0.20 in)**. August is historically Nuiqsut's wettest month, averaging ~1.1 in of total rainfall and ~6 rain-days.

These data align closely with the onset of the observed flood pulse, indicating a **precipitation-driven runoff event** rather than snowmelt or ice-jam release. Given the region's saturated active layer and low infiltration capacity late in the thaw season, rainfall of this magnitude would have produced rapid overland flow, funneled efficiently through shallow thaw basins into the Niqliq Channel.

No regional flood advisories were issued for the North Slope, but similar August hydrologic anomalies were documented elsewhere in Alaska that month—including the glacial-outburst flood near Juneau (13 Aug 2025)—illustrating a broader state-wide pattern of enhanced runoff events during the period.

Physical Response and Flow Characteristics

Hydrologically, the flood was characterized by a steep rising limb and a slower, asymmetric recession—typical of rain-on-permafrost systems. Velocity increased from ~0.22 m s^{-1} to ~0.55 m s^{-1} within two days, doubling the river's energy and expanding its sediment-carrying capacity. Stage rose by roughly 1.45 m during this period, confirming strong hydraulic coherence between precipitation input and discharge response. The SonTek SL's velocity vectors revealed high-energy cross-channel flow during the flood peak, signaling full mobilization of fine sediments and lateral shear across the main flow path. Field observations during post-event inspection verified that the SonTek had been forced into a 45° tilt, while the EXO2 was nearly buried—direct evidence of the flow's erosive and depositional power.

Sediment and Carbon Mobilization

Turbidity and fDOM data illustrate the biogeochemical intensity of this event. Turbidity spiked from 5-10 FNU to ~650 FNU, while fDOM rose from ~5 RFU (15 QSU) to ~30 RFU (80 QSU) at the flood peak. Both parameters remained elevated through much of September before gradually declining into October, suggesting a sustained release of organic and fine mineral material from thawing banks and floodplain soils. These trends indicate strong physical disturbance followed by a prolonged period of suspended material in the channel.

The strong correlation between these parameters ($r \approx 0.82$) indicates that carbon was mobilized primarily in physical association with sediment, consistent with short-duration flood events in Arctic delta systems. From a systems perspective, the flood effectively "flushed" accumulated summer carbon and sediment storage, resetting the river to a lower-energy, lower-concentration state afterward. This pulse likely accounted for the majority of 2025's organic-matter export from the Niqliq basin—a pattern consistent with other Arctic rivers where 70–90% of annual load can occur in just a few weeks of high flow.

It is worth noting that fDOM remained elevated longer than initially interpreted, persisting well into October. However, these measurements carry some uncertainty due to possible sensor burial, vegetation contact, and localized debris interference. Future fieldwork will incorporate discrete water-sample collection for laboratory comparison and the use of a handheld Aquafluor sensor to validate fDOM and chlorophyll-a measurements in situ.

These results also highlight how sediment-driven organic export is tightly linked to short-term changes in water temperature and dissolved oxygen, described in the following section.

Thermal and Chemical Feedback

The flood's influence extended well beyond hydraulics. Water temperature, which had been cooling steadily through late August, briefly rose by nearly 2 °C during the flood (from ~11.8 °C to ~13.7 °C) as warm surface runoff and turbulent mixing displaced colder baseflow. This short-lived warming coincided with a temporary spike in dissolved oxygen (10–12 mg L^{-1}) caused by rapid aeration and high turbulence within the floodwave.

Despite the disturbance, pH and conductivity remained within narrow ranges, highlighting the strong buffering capacity of the Niqliq system's carbonate-influenced waters. While sediments and organic matter were mobilized freely, ionic balance and acid–base chemistry remained largely stable.

This decoupling between physical disturbance and chemical stability underscores a resilient hydro-geochemical equilibrium, typical of Arctic systems with limited solute input but high event-driven organic flux.

Geomorphic and Structural Impacts

The flood exerted notable geomorphic and mechanical impacts at the monitoring site. Field inspection revealed localized bank erosion, channel widening, and fine-silt deposition across the adjacent floodplain. Both instruments sustained direct flood damage: the SonTek SL was completely submerged and tilted approximately 45°, while the EXO2 sonde was displaced and found lying nearly horizontal along the channel bed. These positions indicate strong bed shear and the influence of cross-channel turbulence during the event.

Sediment redeposition around the instruments contributed to post-flood stabilization but also illustrates how even moderate flood pulses in small Arctic rivers can reshape near-bed microtopography. Such reconfiguration influences both data continuity and future site selection.

Together, these observations confirm that the late-August 2025 flood represented a short-duration but high-magnitude disturbance that reorganized sediment structure, redistributed organic carbon, and redefined the physical baseline for subsequent freeze-up conditions.

System Recovery and Implications

Following the flood peak, turbidity and fDOM gradually declined but remained elevated well into early October, indicating a prolonged recovery period rather than rapid stabilization. Velocity decreased steadily to ~0.30 m s^{-1} as flow energy dissipated, while dissolved oxygen remained high (10–12 mg L^{-1}), reflecting continuous surface mixing and cold-water aeration. The persistence of high suspended and dissolved organic matter suggests that freshly eroded floodplain material and residual debris continued to influence water quality weeks after the main event.

This extended recovery underscores the hydraulic elasticity of the Niqliq system—able to absorb large inputs of energy and sediment without long-term destabilization, yet responding over timescales of weeks rather than days. Such behavior is characteristic of Arctic delta channels where low gradients and permafrost-bound floodplains prolong drainage and sediment resuspension.

The 2025 flood provides a benchmark event for understanding pulse-driven export processes in Arctic environments. It highlights the importance of continuous monitoring, as short-term grab sampling would have missed the sustained chemical and hydrologic response that followed the floodwave. Future monitoring at Niqliq should continue to integrate multi-sensor deployments and discrete water sampling to validate high-frequency data, ensuring accurate representation of post-event recovery and organic matter cycling under evolving hydrologic regimes.

Community Summary

The river was shallow and steady (around half a meter deep) for most of July and early August. Then, in late August, several days of heavy rain caused a major flood that raised the water level to more than **seven feet deep**, tilting one instrument and completely knocking the other over. After the flood, the river stayed **high, cloudy, and fast for weeks**, remaining between **1.3 and 1.7 m deep** throughout September and well into October. It did not return to its earlier summer level before freeze-up.

These measurements match what people in Nuiqsut saw firsthand: a single, intense weather event that dumped a season's worth of water in a few days, raised the river dramatically, and left the channel full of standing water long after the storm passed.

6.4 Broader Context and Significance

The Niqliq Channel record reinforces several emerging themes in Arctic hydrology:

1. **Event-Dominated Export:** A majority of sediment and organic transport occurs in short, high-flow pulses rather than steady fluxes. Continuous, high-frequency monitoring is therefore essential—traditional grab samples would have missed both the August flood peak and the extended recovery that followed, which together account for most of the year's export signal.
2. **Thermal-Hydrologic Sensitivity:** The river's rapid thermal and stage responses reflect the tight coupling between precipitation and discharge in permafrost landscapes, where shallow active layers and limited storage capacity amplify runoff extremes. The late-August flood demonstrated how just a few days of rainfall can mobilize deep layers of stored organic material and reshape near-bed structure.
3. **System Resilience:** Despite weeks of elevated turbidity and fDOM, the Niqliq Channel quickly regained chemical balance. Conductivity and pH remained stable, and dissolved oxygen stayed high, confirming the system's ability to maintain buffering and re-equilibration even under strong physical disturbance. This resilience highlights the value

of continuous sensors in capturing both impact and recovery phases that short studies could easily overlook.

Together, these findings position the Niqliq dataset as a valuable benchmark for Arctic river process studies and a proof-of-concept for NASA FORTE's collaborative monitoring framework with the Native Village of Nuiqsut. The co-located, high-frequency approach captured the full trajectory of the 2025 event—from rainfall to flood crest to extended recovery—offering rare insight into how Arctic rivers absorb, process, and eventually stabilize after powerful but short-lived disturbances.

Community Summary

All the sensors together showed how the Niqliq Channel changed through the open-water season. The river started calm and clear, then rose fast during the late-August flood, which carried huge amounts of mud and organic material downstream.

Even after the flood passed, the river stayed higher and murkier than usual for several weeks as the sediment slowly settled out. By the time freeze-up began, water levels were still above midsummer levels—proof of how long Arctic rivers can hold the effects of a single big rain event.

Even with all that movement, the water's chemistry stayed healthy. pH and minerals stayed steady, and oxygen levels stayed high. The data show that one strong flood can move nearly a year's worth of material—but that the Niqliq Channel can recover on its own, just more slowly than rivers farther south.

7. Equipment Recovery and Future Monitoring Considerations

The 2025 deployment provided an invaluable continuous dataset but also highlighted several operational challenges inherent to Arctic river monitoring. Although both instruments continued recording through October, physical recovery of the submerged sensors proved impossible due to sustained high water and early ice formation in the Niqliq Channel. These logistical outcomes provide lessons essential for planning future FORTE and NVN monitoring campaigns.

7.1 Recovery Limitations and Field Conditions

By early October, the Nigliq Channel remained **unusually high and fast**, with a surface ice layer of 2–4 inches developing along the margins. Despite favorable air temperatures (≈ +1 °C) on the final recovery attempt (14 October), visibility in the water was near zero, and buoyant resistance from the drysuit prevented adequate downward reach. The mounting hardware was also partially buried in post-flood sediment, and the current around the installation site remained strong enough to pose safety risks.

Even after mechanical assistance with a come-along hoist, the equipment could not be dislodged. The **EXO2** and **SonTek** mounts likely remained secure but embedded—protected from ice scour yet effectively unrecoverable until full spring thaw.

Following this attempt, **NVN contacted three professional dive companies and ConocoPhillips** to assess whether specialized recovery assistance could be safely provided. ConocoPhillips confirmed that no appropriate dive equipment or personnel were available. All three commercial dive teams independently advised that the river and ice conditions at that time were too unsafe for underwater operations. These professional assessments validated NVN's decision to postpone further recovery efforts until conditions improve, prioritizing personnel safety and environmental protection.

Compounding these difficulties, the installation's remote position off an elevated section of road required all equipment and personnel to be transported on foot across saturated tundra, which limited mechanical support and made late-season recovery more difficult.

This outcome emphasizes that Arctic field logistics are strongly constrained by short transition periods and limited access: the same hydrologic persistence that yields valuable late-season data can rapidly eliminate safe site approach and retrieval options.

7.2 Lessons for Installation Design

The 2025 experience suggests that mounting design, site selection, and accessibility are critical to ensuring both data continuity and safe retrieval. The original pole-mounted configuration performed well for stability during baseflow but was vulnerable to mechanical displacement and burial during high discharge. Additionally, the failed recovery attempt and subsequent professional consultations underscored the importance of planning for long-term submergence and delayed retrieval scenarios when working in **dynamic Arctic river systems**.

Future deployments should prioritize fixed, high-stability attachment points, ideally mounted on existing bridge piers, engineered footings, or elevated brackets above the thalweg. These configurations would minimize tilt and sediment burial while allowing retrieval lines or instruments to remain accessible from shore or structure.

NVN and NASA should work directly with the **Xylem engineering team** to identify and test improved mounting systems designed for Arctic flood resilience. Their technical expertise in hydrologic instrumentation will be valuable in designing a setup that maintains calibration stability while also facilitating safe mid-season access for cleaning or removal.

While automation (e.g., winch systems or remote retrieval) remains an option, the logistical and maintenance demands in Arctic environments make **strategic placement and robust physical anchoring** the more practical long-term solution. The bridge crossing along the ConocoPhillips corridor remains the most promising location for such an installation due to consistent access, stable anchoring points, and potential for line-of-sight telemetry.

7.3 Safety and Training Considerations

The October recovery attempt also underscored the need for enhanced safety protocols and field-readiness training for Arctic aquatic operations. Cold-water immersion, buoyancy constraints in drysuits, and unpredictable ice formation all compound risk during end-of-season work.
Establishing explicit cutoff thresholds for water temperature, velocity, and ice thickness beyond which recovery should not be attempted would provide clear operational limits and reduce exposure risk for personnel.
Additional training in cold-water diving, tethered retrieval operations, and emergency extraction would further support NVN field teams as environmental monitoring expands.

7.4 System Power and Instrument Performance Evaluation

In contrast to the submerged instruments, the land-based monitoring station performed flawlessly throughout the entire deployment. Its solar-battery power system maintained continuous operation and stable voltage across the season, providing a reliable power source without requiring on-site maintenance or supplemental charging.
The weatherproof housing and elevated ground installation successfully protected the system from moisture, wind, and temperature fluctuations, demonstrating a proven, resilient configuration for Arctic data acquisition.
Continuous telemetry and power readings confirm that the land-based system and instrument array maintained stable performance throughout the open-water season.
Battery and cable power voltages remained consistent, averaging **13–14 V**, with only minor diurnal fluctuations caused by solar-charging cycles.
These results indicate that the solar-battery power system successfully met instrument demand without interruption.
The **SonTek SL signal strength** also stayed within an optimal 45–70 count range, demonstrating reliable acoustic transmission despite turbidity and flood events.
The **wiper-position trace** shows regular, automated cleaning cycles that continued uninterrupted through October, verifying that the antifouling mechanism functioned properly in cold, sediment-rich conditions.
Together, these metrics confirm that both power supply and data communication remained highly stable under Arctic field conditions—critical validation for year-round and multi-season deployments.
The decommissioning of the land-based unit was completed without issue, validating the hardware design and confirming that the chosen site and installation method are well suited for repeat seasonal use.

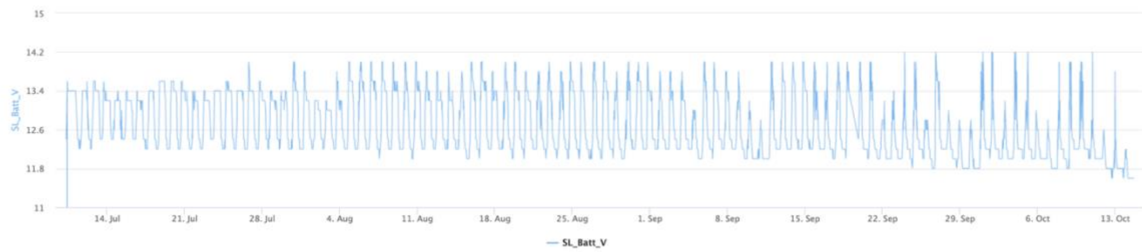

Figure 7.1. ***Battery Voltage (V) — SonTek SL Acoustic Doppler Current Profiler, July–October 2025.***
The SonTek SL maintained steady 12.5–13.8 V output across the open-water season, confirming stable power delivery and uninterrupted sensor operation through flood and freeze-up transitions.

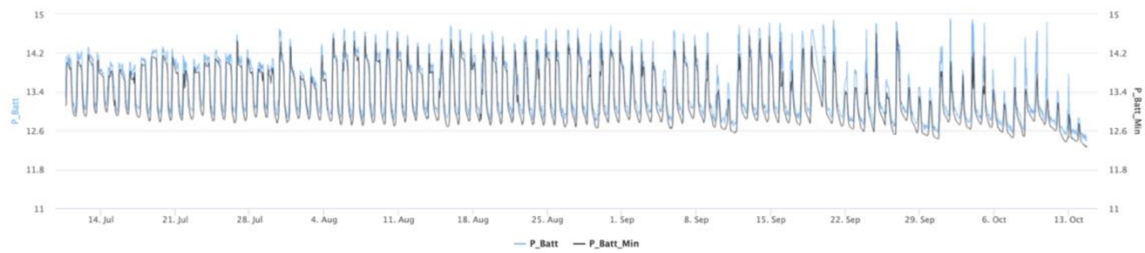

Figure 7.2. ***Cable and Battery Voltage (V) — YSI EXO2 Multiparameter Sonde, July–October 2025.***
EXO2 power readings showed consistent diurnal charging cycles between 12.6–14.2 V, with only minor dips during extended low-light periods, indicating reliable solar-regulated power support.

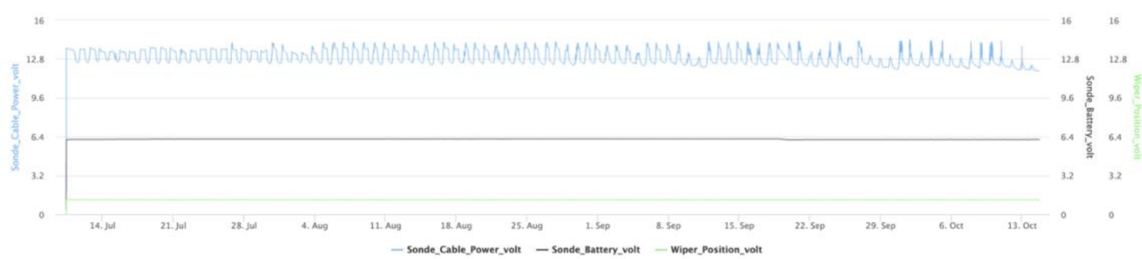

Figure 7.3. ***Instrument Power and Wiper Operation (V) — YSI EXO2, July–October 2025.***
Combined power metrics and wiper-position voltages demonstrate continuous antifouling activity and stable system performance, verifying uninterrupted operation under Arctic sediment and ice-formation conditions.

Figure 7.4. Signal Strength (MSS counts) — SonTek SL Acoustic Doppler Current Profiler, July–October 2025.
Signal returns remained within the 45–70 count range throughout deployment, confirming consistent acoustic transmission quality despite high turbidity during late-August flood events.

Community Summary

The land-based monitoring station and river sensors kept steady power all summer, even during cloudy days and flood conditions. The batteries stayed charged, the cleaning wipers kept running, and the sonar signal stayed strong through rough weather and muddy water. Together, that means the system worked exactly as planned—collecting reliable data the entire season without interruption.

7.5 Forward Planning

Despite the late-season retrieval challenges, the 2025 experience significantly advanced NVN's independent monitoring capacity. The lessons learned will directly inform improved deployment scheduling and design for 2026. In particular, the team may consider **earlier seasonal deployment**—potentially in **June, following spring freshet and ice breakup**—to extend the monitoring window by several weeks and capture early-season hydrologic and biogeochemical dynamics that were missed this year.

This timing would still allow safe site access before mid-summer rainfall events and provide a fuller annual dataset without overlapping freeze-up constraints.

Future collaborative planning between NASA, NVN, and Xylem should integrate these adjustments into a formal deployment and retrieval protocol, combining scientific objectives with logistical feasibility and field safety.

Together, these refinements will strengthen long-term Arctic data continuity and ensure that the FORTE mission continues to deliver high-quality, year-over-year environmental insight.

Community Summary

The underwater sensors couldn't be recovered because of strong currents, buried mounts, and **early ice formation**, and because the site was hard to reach by vehicle across soft tundra. But the land-based, solar-powered station worked perfectly all season, gathering uninterrupted data and running safely on its own.

In the future, NVN, NASA, and the Xylem team plan to improve where and how the underwater sensors are mounted—possibly using bridge piers or other solid supports—and to install them earlier in the season, right after the ice melts. These changes will make monitoring easier, safer, and even more effective.

8. Conclusions and Significance

The 2025 **NASA FORTE – Native Village of Nuiqsut (NVN)** monitoring partnership successfully demonstrated that collaborative, high-frequency field observation can capture the rapid, event-driven dynamics of Arctic river systems with scientific precision and local relevance.

The continuous data record from the **Niqliq (Nechilik) Channel** provides one of the most complete multi-parameter views of seasonal change ever collected in the region—linking thermal, hydrologic, and biogeochemical behavior over an entire open-water period.

8.1 Scientific Significance

The Niqliq Channel data reveal a river system characterized by **seasonal stability punctuated by intense, short-lived hydrologic pulses**.

The late-August flood event alone reshaped the channel, mobilized large stores of sediment and organic carbon, and briefly altered oxygen and thermal structure before the system quickly re-stabilized.

Such pulses dominate Arctic material transport, confirming that event-scale dynamics govern annual sediment and carbon budgets in small deltaic channels.

Key findings include:

- A **strong thermal–oxygen inverse relationship ($r \approx -0.9$)** demonstrating solubility-driven control of dissolved oxygen across the temperature range.
- **High correlation between turbidity and fDOM ($r \approx 0.82$)**, indicating synchronous transport of particulate and dissolved organic carbon.
- Evidence of **chemical resilience**—conductivity and pH remained stable even under strong physical forcing, reflecting robust carbonate buffering.
- **Rapid system recovery** following disturbance, showing that Arctic rivers, though energetic and dynamic, maintain intrinsic stability at seasonal timescales.

Collectively, these insights contribute valuable empirical context for Arctic carbon-export models and climate feedback research. The dataset also strengthens the broader FORTE initiative's mission to ground-truth satellite-based hydrologic and biogeochemical observations across high-latitude systems.

8.2 Operational and Programmatic Lessons

From an operational perspective, the 2025 season reinforced both the promise and the complexity of Arctic field monitoring.
The land-based solar-powered station demonstrated exceptional reliability and resilience, operating without interruption or power failure for the entire season and safely decommissioned in October.
Conversely, the **underwater instruments**, though continuously functional, could not be recovered due to sustained high water, early ice formation, and limited vehicular access to the remote site.
These experiences underline the importance of:

- **Accessible and secure mounting infrastructure** (e.g., bridge-pier installations).
- **Earlier seasonal deployment** following spring freshet to extend data coverage.
- **Integrated safety thresholds and retrieval protocols** aligned with field conditions.
- Ongoing collaboration with **Xylem engineers** to refine equipment placement and retrieval design for Arctic deployment.

The lessons learned in 2025 will serve as a blueprint for future FORTE missions and NVN-led environmental monitoring, ensuring improved efficiency, safety, and data integrity.

8.3 Partnership and Broader Value

Beyond the scientific outcomes, the 2025 FORTE–NVN collaboration represents a meaningful model of **tribal–federal partnership** in **Arctic research**.
By combining NASA's technical resources with NVN's local knowledge, the project achieved both high-quality scientific results and deeper community understanding of river behavior, flood risk, and seasonal change.
These outcomes support not only global research but also local priorities—helping Nuiqsut residents anticipate environmental changes that affect subsistence, travel safety, and cultural connections to the land.
The project also advanced NVN's growing Natural Resources Department capacity, building hands-on field experience, equipment familiarity, and logistical expertise that will strengthen future autonomous monitoring initiatives.
Through data sharing and transparent co-management, the collaboration continues to align Western science with local stewardship values—turning technical monitoring into a foundation for **sovereign Arctic environmental observation**.

Community Summary

The 2025 monitoring project showed how quickly the Niqliq Channel can change. A short flood in late August moved most of the year's sediment and organic material but the river quickly recovered and stayed healthy.

The sensors collected over 20,000 readings and gave researchers and the community new insight into how local weather and water conditions are connected.

The land-based system worked perfectly all season, and lessons from the underwater setup will help improve future deployments.

Most importantly, the project proved the strength of working together—combining NASA technology with local knowledge to study, protect, and understand Nuiqsut's waters.

9. Acknowledgments

This project was made possible through the continued partnership between the **Native Village of Nuiqsut (NVN)** and the **NASA FORTE mission team**, whose shared commitment to advancing Arctic science and supporting community-led monitoring made the 2025 deployment a success.

Special thanks are extended to **Dr. Maria Tzortziou**, Principal Investigator for the NASA FORTE Project, and **Dr. Antonio Mannino**, Deputy Principal Investigator, for their leadership, scientific guidance, and continued collaboration with NVN throughout the project.

Appreciation is also extended to **Dr. Blake Clark**, whose on-site support and technical expertise were instrumental during the initial installation and setup phase of the Niqliq Channel monitoring station.

The author further acknowledges **Sommer Nicholas**, Investigation Manager (NASA ARC), and **Peter Griffith**, FORTE Project Coordinator (NASA GSFC), for their programmatic oversight and commitment to the broader FORTE mission objectives.

Deep gratitude is also extended to **Kyle Waits** and **Daniel "Hutch" Hutcheson** of **Xylem**, whose direct involvement in field installation, configuration, and technical support ensured successful deployment and high-quality data collection throughout the season.

Special thanks as well to **Kyle Turner**, Research Technician at **City College of New York (CCNY)** under Dr. Tzortziou, for his assistance during on-site installation and early field operations.

Within Nuiqsut, appreciation goes to the **NVN Tribal Council, the Natural Resources Department, and the Tribal Office staff**, whose leadership, logistical assistance, and local knowledge ensured the project remained grounded in community values and cultural respect for the Niqliq (Nechilik) Channel.

The author also wishes to recognize **Teresa Jacobsson**, NVN Business Manager, for her early coordination efforts that helped establish the partnership between NVN and NASA, and for her continued role in representing the Tribe in project communications and administrative oversight. Finally, sincere thanks are extended to the **people of Nuiqsut and the communities of northern Alaska**, whose connection to the land and waters provides the foundation for this work. This report was written for them—for those who live with, learn from, and care for the Arctic's rivers and ecosystems every day.

10. References

National Weather Service (NWS). (2025). *Daily Observations for Nuiqsut Airport (PAQT), Alaska – August–September 2025.* NOAA Alaska Region Climate Services, Anchorage, AK.
Retrieved October 2025 from https://www.weather.gov

Weatherspark. (2025). *Average Weather at Nuiqsut Airport, Alaska (Year-Round Data from NOAA/NCEI).*
Retrieved October 2025 from https://weatherspark.com/y/145069/Average-Weather-at-Nuiqsut-Airport-Alaska-United-States-Year-Round

Xylem Analytics North America. (2024). *EXO2 Water Quality Sonde and SonTek SL500 Acoustic Doppler Specifications.* Yellow Springs Instruments Division.
Retrieved from https://www.xylemanalytics.com

The Guardian. (2025, August 13). *'A record event': Alaska's Juneau hit by devastating glacier outburst flood.* The Guardian News and Media.
Retrieved from https://www.theguardian.com/us-news/2025/aug/13/alaskas-juneau-glacier-flood-record-climate

Appendix A

Full-Size Figures

Supporting Data Visualizations from the NASA FORTE Niqliq Channel Monitoring 2025 Deployment

This appendix presents all figures included in the report in their full-resolution format for improved readability and reference.

Each figure retains its original numbering and caption, allowing readers to cross-reference the discussion within the main report. Interpretive notes appear in Sections 5 and 7.

All data visualizations were generated directly from the *Xylem HydroSphere®* cloud-based monitoring platform, which securely stored, processed, and exported sensor data from the *SonTek SL* and *YSI EXO2* instruments throughout the 2025 Niqliq Channel deployment.

Figure numbering within this appendix corresponds to the original figures presented in Sections 5 and 7 of the report, renumbered with the Appendix A prefix for clarity.

Appendix A. Data Visualizations – Niqliq Channel Monitoring, July–October 2025

Figure A.1. Water Temperature (°C) — Open-Water Cooling Sequence, Niqliq Channel, July–October 2025. *(Source: Xylem Hydrosphere Network, 2025 — Niqliq Channel Station)*

Figure A.2. Dissolved Oxygen (mg/L) — Seasonal Variation, Niqliq Channel, July–October 2025. *(Source: Xylem Hydrosphere Network, 2025 — Niqliq Channel Station)*

Figure A.3. Dissolved Oxygen (% Saturation) — Seasonal Variation, Niqliq Channel, July–October 2025. *(Source: Xylem Hydrosphere Network, 2025 — Niqliq Channel Station)*

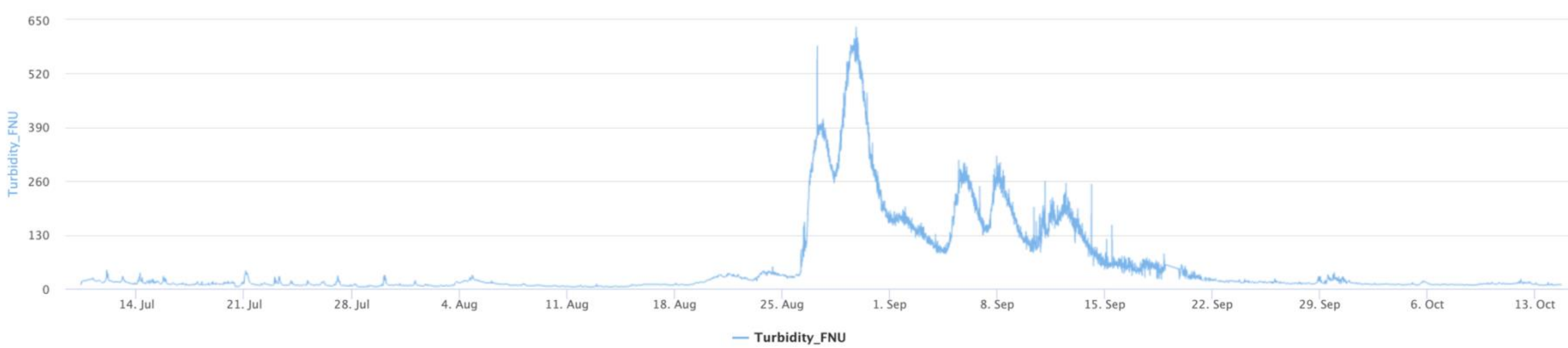

Figure A.4. Turbidity (FNU) — Seasonal Suspended Sediment Trends, Niqliq Channel, July–October 2025. *(Source: Xylem Hydrosphere Network, 2025 — Niqliq Channel Station)*

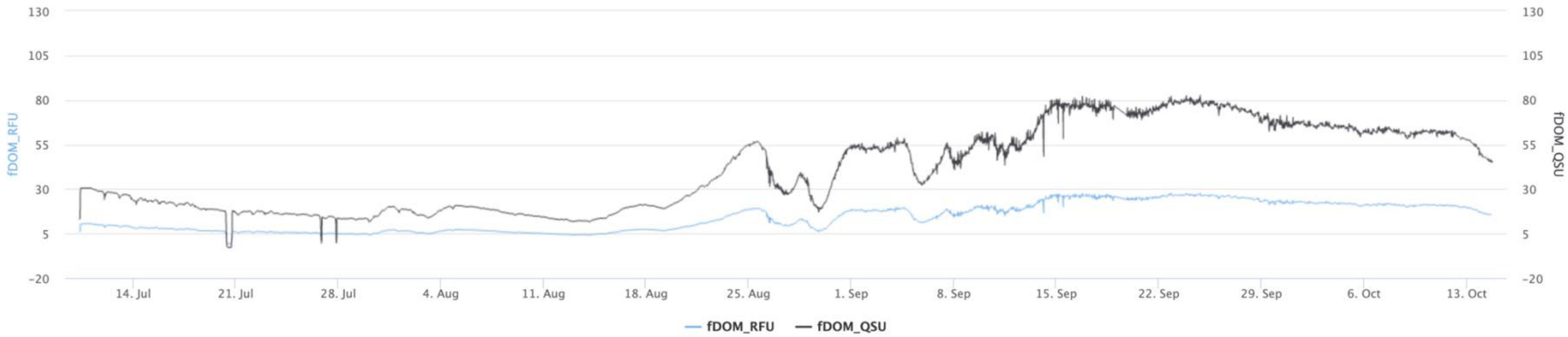

Figure A.5. Fluorescent Dissolved Organic Matter (fDOM) — Niqliq Channel, July–October 2025. *(Source: Xylem Hydrosphere Network, 2025 — Niqliq Channel Station)*

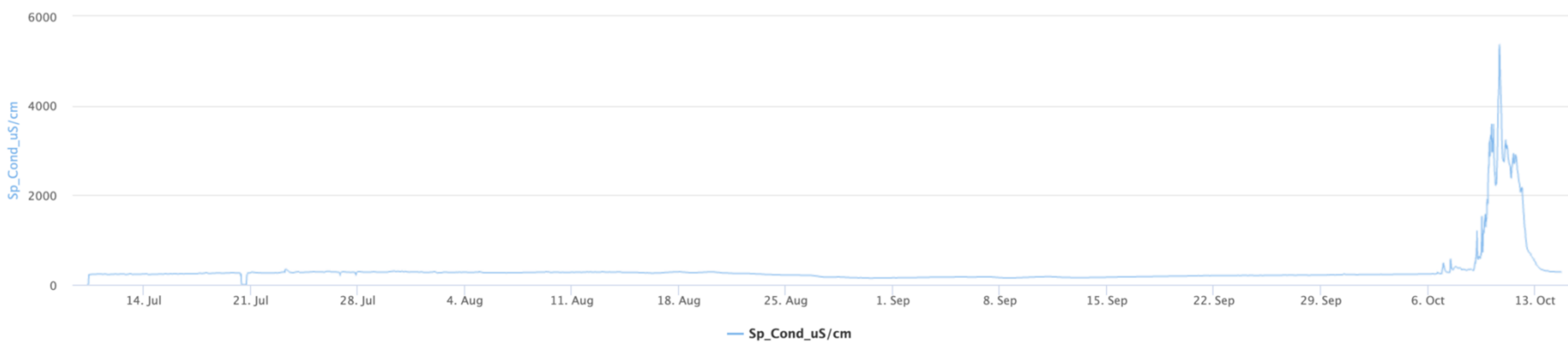

Figure A.6. Specific Conductivity (µS/cm) — Niqliq Channel, July–October 2025. *(Source: Xylem Hydrosphere Network, 2025 — Niqliq Channel Station)*

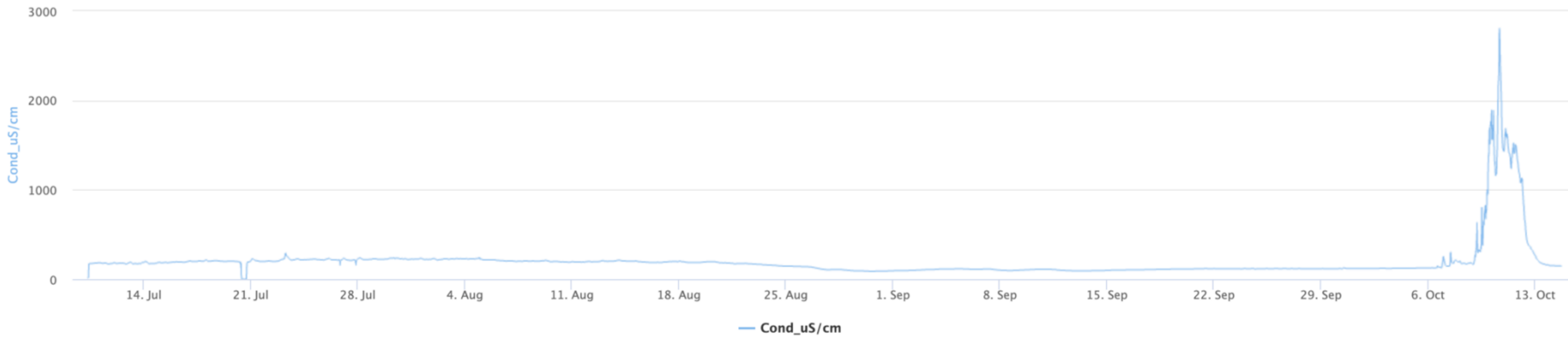

Figure A.7. Conductivity (µS/cm) — Niqliq Channel, July–October 2025. *(Source: Xylem Hydrosphere Network, 2025 — Niqliq Channel Station)*

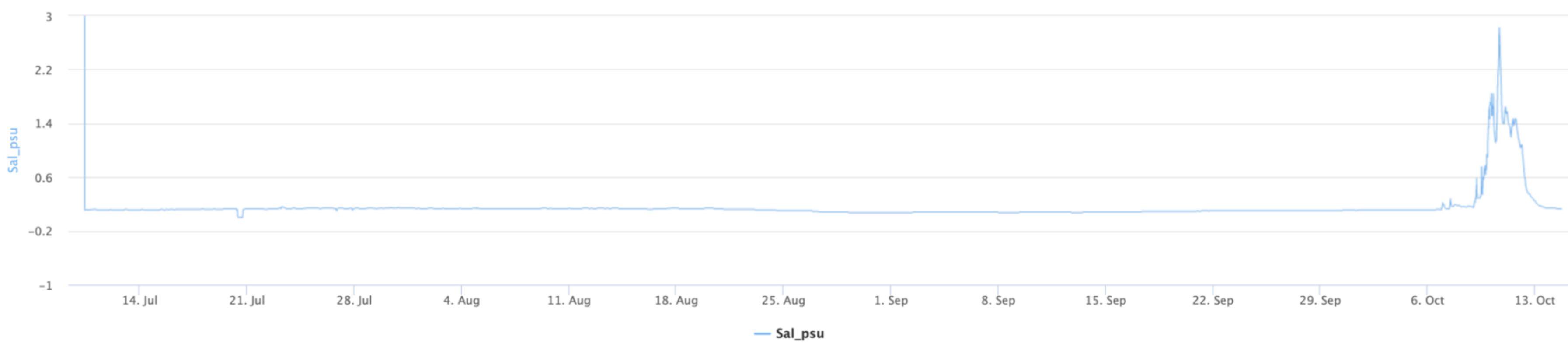

Figure A.8. Salinity (PSU) — Niqliq Channel, July–October 2025. *(Source: Xylem Hydrosphere Network, 2025 — Niqliq Channel Station)*

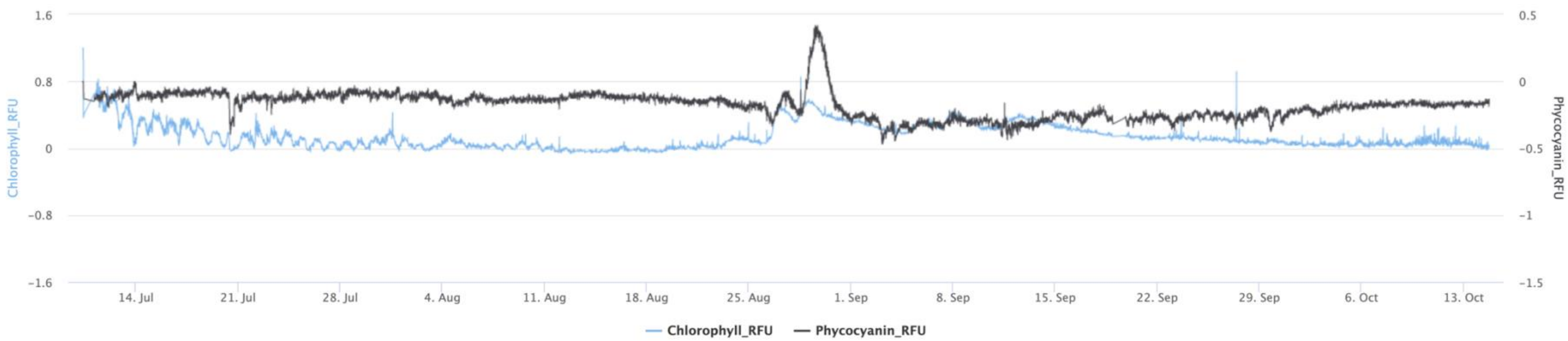

Figure A.9. Figure 5.8. Chlorophyll-a and Phycocyanin (RFU) — Niqliq Channel, July–October 2025. *(Source: Xylem Hydrosphere Network, 2025 — Niqliq Channel Station)*

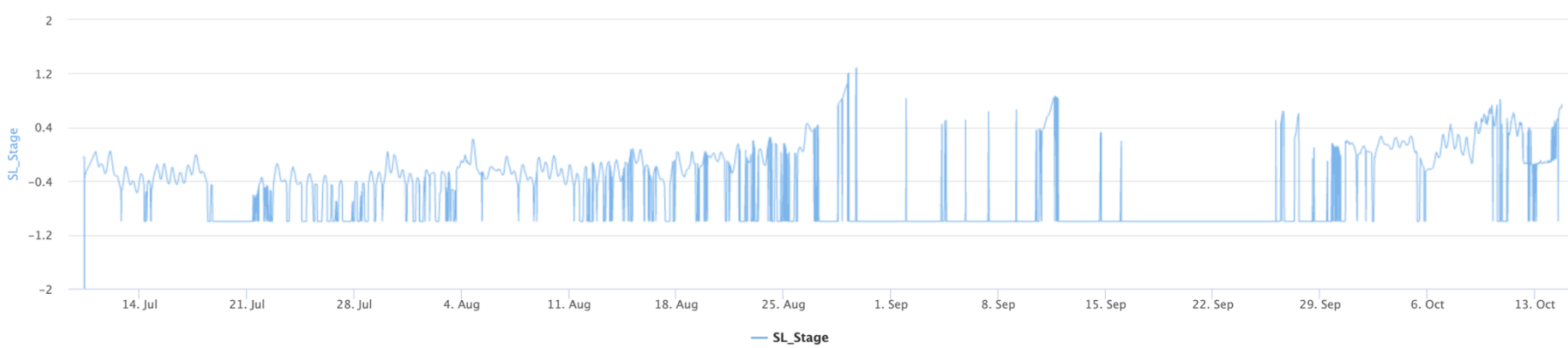

Figure A.10. Water Stage (m) — Niqliq Channel, July–October 2025. *(Source: Xylem Hydrosphere Network, 2025 — Niqliq Channel Station)*

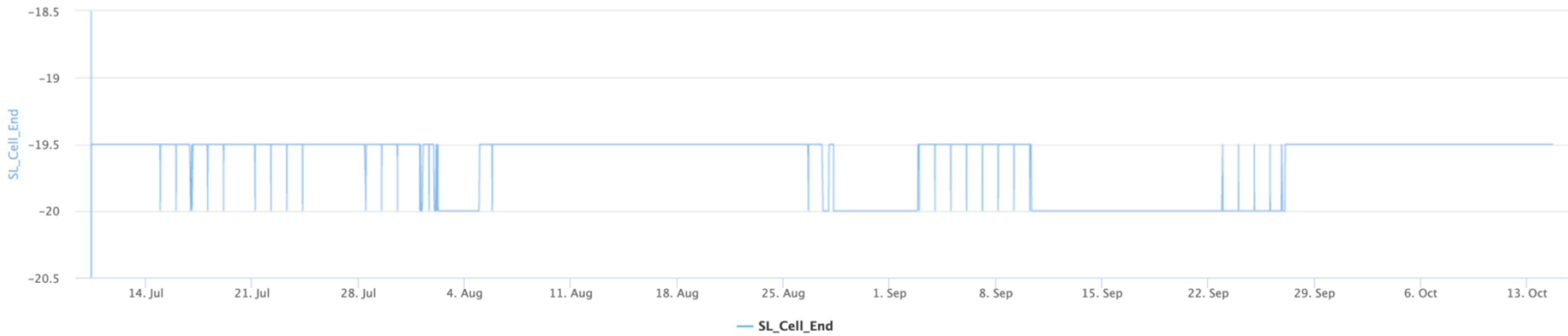

Figure A.11. Cell-End Depth (m) — Niqliq Channel, July–October 2025. *(Source: Xylem Hydrosphere Network, 2025 — Niqliq Channel Station)*

Figure A.12. Water Pressure (psi) — SonTek SL Acoustic Doppler Sensor, Niqliq Channel, July–October 2025. *(Source: Xylem Hydrosphere Network, 2025 — Niqliq Channel Station)*

Figure A.13. Water Pressure (psi) — Niqliq Channel, July–October 2025. *(Source: Xylem Hydrosphere Network, 2025 — Niqliq Channel Station)*

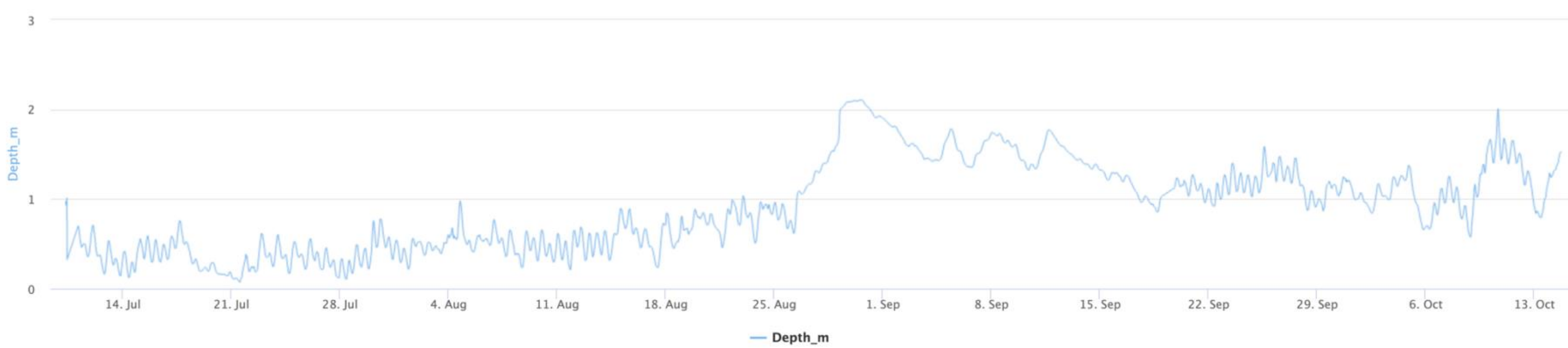

Figure A.14. Water Depth (m) — Niqliq Channel, July–October 2025. *(Source: Xylem Hydrosphere Network, 2025 — Niqliq Channel Station)*

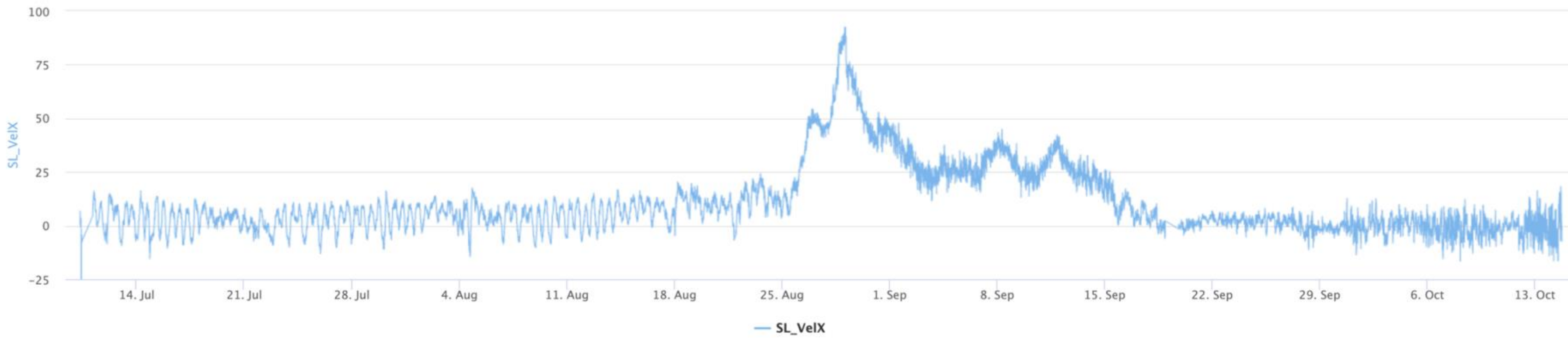

Figure A.15. Longitudinal Velocity (SL_VelX) — Niqliq Channel, July–October 2025. *(Source: Xylem Hydrosphere Network, 2025 — Niqliq Channel Station)*

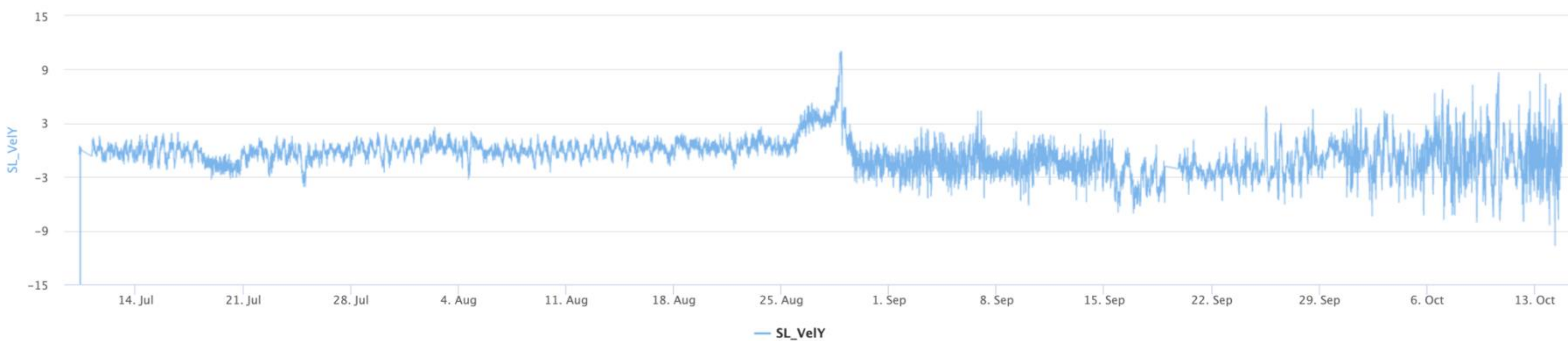

Figure A.16. Lateral Velocity (SL_VelY) — Niqliq Channel, July–October 2025. *(Source: Xylem Hydrosphere Network, 2025 — Niqliq Channel Station)*

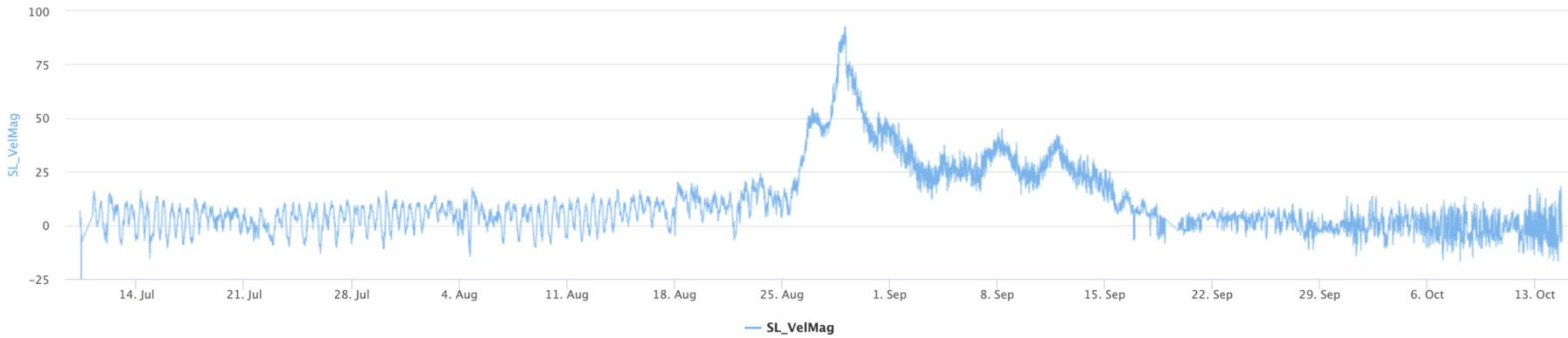

Figure A.17. Velocity Magnitude (SL_VelMag) — Niqliq Channel, July–October 2025. *(Source: Xylem Hydrosphere Network, 2025 — Niqliq Channel Station)*

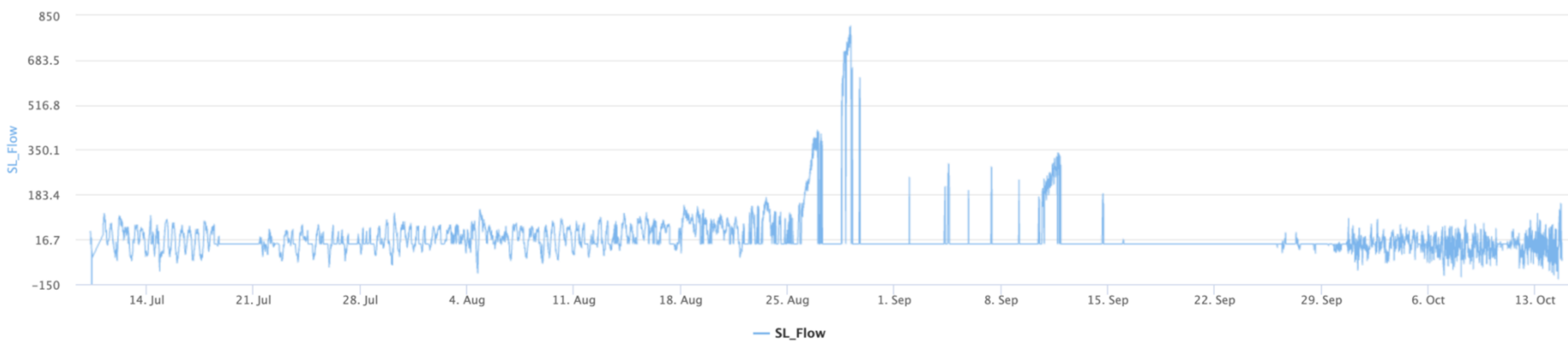

Figure A.18. Flow (SL_Flow) — Niqliq Channel, July–October 2025. *(Source: Xylem Hydrosphere Network, 2025 — Niqliq Channel Station)*

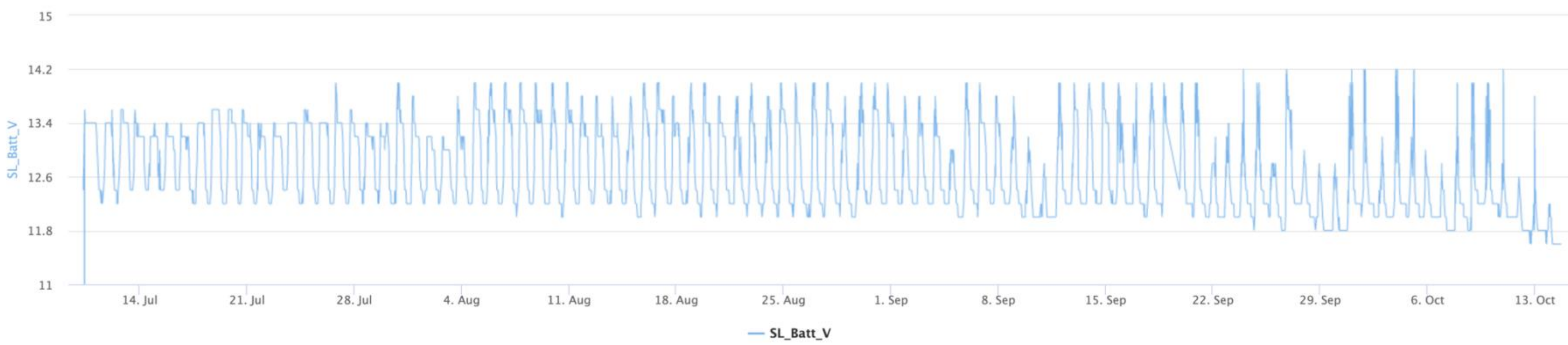

Figure A.19. ***Battery Voltage (V) — SonTek SL Acoustic Doppler Current Profiler, July–October 2025.*** *(Source: Xylem Hydrosphere Network, 2025 — Niqliq Channel Station)*

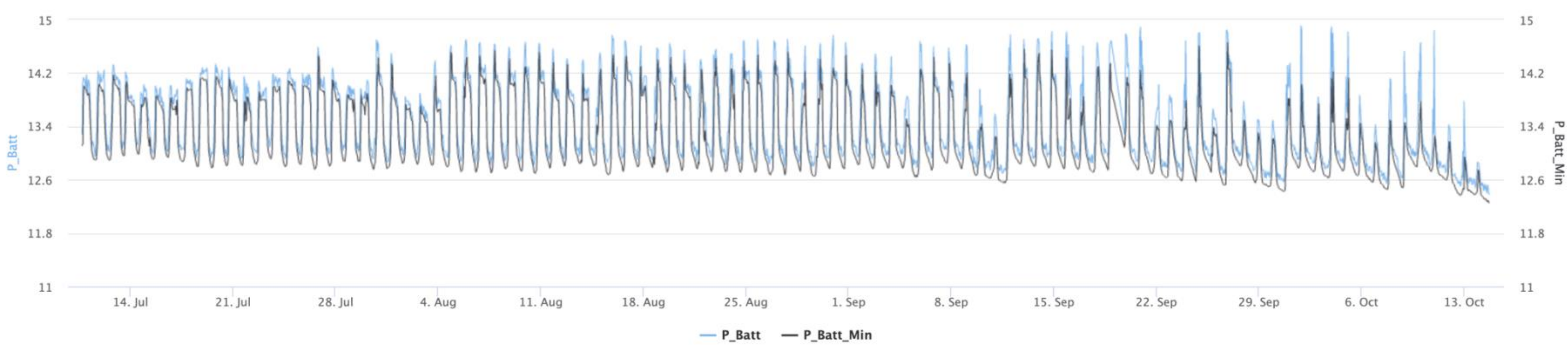

Figure A.20. ***Cable and Battery Voltage (V) — YSI EXO2 Multiparameter Sonde, July–October 2025.*** *(Source: Xylem Hydrosphere Network, 2025 — Niqliq Channel Station)*

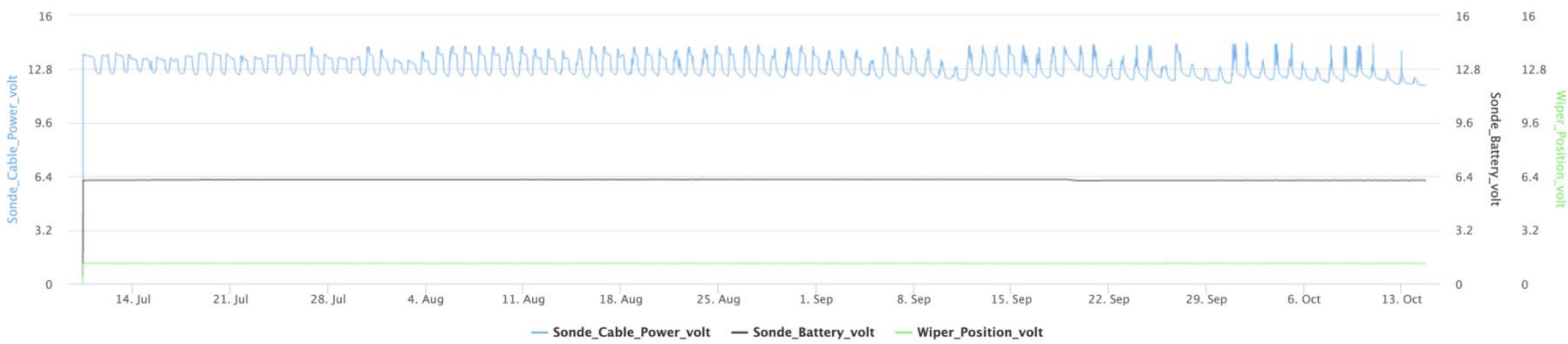

Figure A.21. ***Instrument Power and Wiper Operation (V) — YSI EXO2, July–October 2025.*** *(Source: Xylem Hydrosphere Network, 2025 — Niqliq Channel Station)*

Figure A.22. Signal Strength (MSS counts) — SonTek SL Acoustic Doppler Current Profiler, July–October 2025. *(Source: Xylem Hydrosphere Network, 2025 — Niqliq Channel Station)*

Appendix B

Data Summary and Archive Statement

Summary Tables and Data Archival Statement for the NASA FORTE Niqliq Channel 2025 Deployment

Overview

The NASA FORTE instruments deployed along the Niqliq (Nechilik) Channel collected continuous, time-stamped environmental data from **July–October 2025**. Two autonomous systems recorded **20,504 discrete samples total**, capturing parameters ranging from water temperature and dissolved oxygen to pH, conductivity, and turbidity.
Due to the size and resolution of these datasets, only summarized statistics are presented here.

Data Availability

The complete raw datasets, containing all 35 recorded parameters (A–AO) at 15-minute intervals, are securely archived by the **Native Village of Nuiqsut Department of Natural Resources (NVN DNR)** and are available upon request.
The data is available in **comma-separated value (CSV)** format under the following directory:
NVN Environmental Data Archive → NASA FORTE Project (Niqliq Channel, 2025)
Repository maintained by: *Native Village of Nuiqsut, Department of Natural Resources*
Contact: **Phillip Toney, Native Village of Nuiqsut Natural Resources Manager**
Access: Data available upon written request or through NVN's secure SharePoint repository. These data serve as the baseline reference for future FORTE and NVN monitoring comparisons.

Appendix B.1.1. YSI EXO2 Multiparameter Sonde Summary

Parameter	Mean	Minimum	Maximum	N (Samples)
Depth (*m*)	0.914	0.063	2.107	2395
Pressure (*psi*)	1.52	0.09	224.34	2395
Temperature (*°C*)	7.301	-0.189	16.307	2395
Salinity (*psu*)	0.24	0.00	93.25	2395
Conductivity (*µS/cm*)	196.36	0.10	2810.05	2395
Specific Conductivity (*µS/cm @ 25 °C*)	310.07	0.16	5375.09	2395
Dissolved Oxygen (*mg/L*)	11.81	-0.11	14.34	2395
Dissolved Oxygen *(% Sat*)	97.22	0.35	107.06	2395
Turbidity (*FNU*)	56.94	3.39	632.75	2395
FDOM (*RFU*)	13.90	-0.77	27.90	2395
FDOM (*QSU*)	40.86	-3.15	82.86	2395
Chlorophyll (*µg/L*)	0.14	-0.07	1.20	2395
Phycocyanin (*µg/L*)	-0.18	-0.47	0.42	2395

Table B.1. YSI EXO2 Multiparameter Sonde Summary (Mean, Minimum, Maximum, and Sample Count). Data range: July 9 – October 14, 2025.
Data compiled by the Native Village of Nuiqsut, Department of Natural Resources, using Hydrosphere raw sensor data from NASA FORTE Niqliq Channel Deployment. *(NVN DNR, 2025)*

Appendix B.1.2. SonTek FlowTracker Summary

Parameter	Mean	Minimum	Maximum	N (Samples)
Temperature (℃)	7.07	-0.31	16.07	2395
Pressure (*psi*)	1.017	0.421	2.148	2395
Stage (*m*)	-0.625	-1.000	1.287	2395
Cell End (*m*)	-19.7	-20.0	-11.5	2395
Velocity X (*m/s*)	10.1	-16.7	92.7	2395
Velocity Y (*m/s*)	-0.7	-10.7	11.1	2395
Velocity Magnitude (*m/s*)	10.2	-17.0	92.8	2395
Flow (m^3/s)	22.518	-131.85	812.190	2395

Table B.2. SonTek FlowTracker Summary (Mean, Minimum, Maximum, and Sample Count). Data range: July 9 – October 14, 2025.
Data compiled by the Native Village of Nuiqsut, Department of Natural Resources, using Hydrosphere raw sensor data from NASA FORTE Niqliq Channel Deployment. *(NVN DNR, 2025)*

Appendix C

Field Documentation and Visual Records

Supporting photographic documentation from the NASA FORTE Niqliq (Nechilik) Channel Monitoring 2025 Deployment

Overview

Appendix C provides visual documentation of the installation, operation, and retrieval of the NASA FORTE environmental monitoring systems along the Niqliq (Nechilik) Channel. Photographs illustrate the full field cycle—from site preparation and deployment through seasonal changes and equipment recovery—and highlight collaboration between the Native Village of Nuiqsut Department of Natural Resources (NVN DNR) and NASA FORTE research teams.

Purpose

These records serve as visual evidence of site conditions, deployment methods, and seasonal dynamics, supporting both transparency in reporting and long-term monitoring reference. The appendix also includes select outreach and coordination photos that document NVN's participation in community engagement related to the FORTE project.

Contents

This appendix is organized into five sections:

1. Site and System Overview
2. Instrument Installation and Setup (July 2025)
3. Community Coordination and Outreach
4. Mid-Season Conditions and Site Observations
5. Retrieval Operations (October 2025)

Appendix C.1.1 Site and System Overview

The Niqliq (Nechilik) Channel monitoring site was selected following an initial field assessment by the Native Village of Nuiqsut Department of Natural Resources (NVN DNR) and NASA FORTE researchers. The team originally identified a preferred location adjacent to the community water intake area, but significant riverbank slumping observed after spring breakup made the site unsuitable for long-term installation. The erosion also exposed underlying permafrost, indicating potential for continued thaw and instability.

A secondary site farther south along the channel near the Quarry Road crossing was briefly considered but ultimately dismissed due to the channel's curvature, which causes localized pooling and inconsistent flow patterns that would have reduced data quality and representativeness. In July 2025, once NASA scientists were able to access the river by boat, preliminary depth and width measurements were collected at multiple alternative locations. Based on these assessments, the final site was selected north of town within the ConocoPhillips access corridor near the Niqliq Bridge, providing stable ground conditions, consistent flow, and reliable access for ongoing monitoring and maintenance.

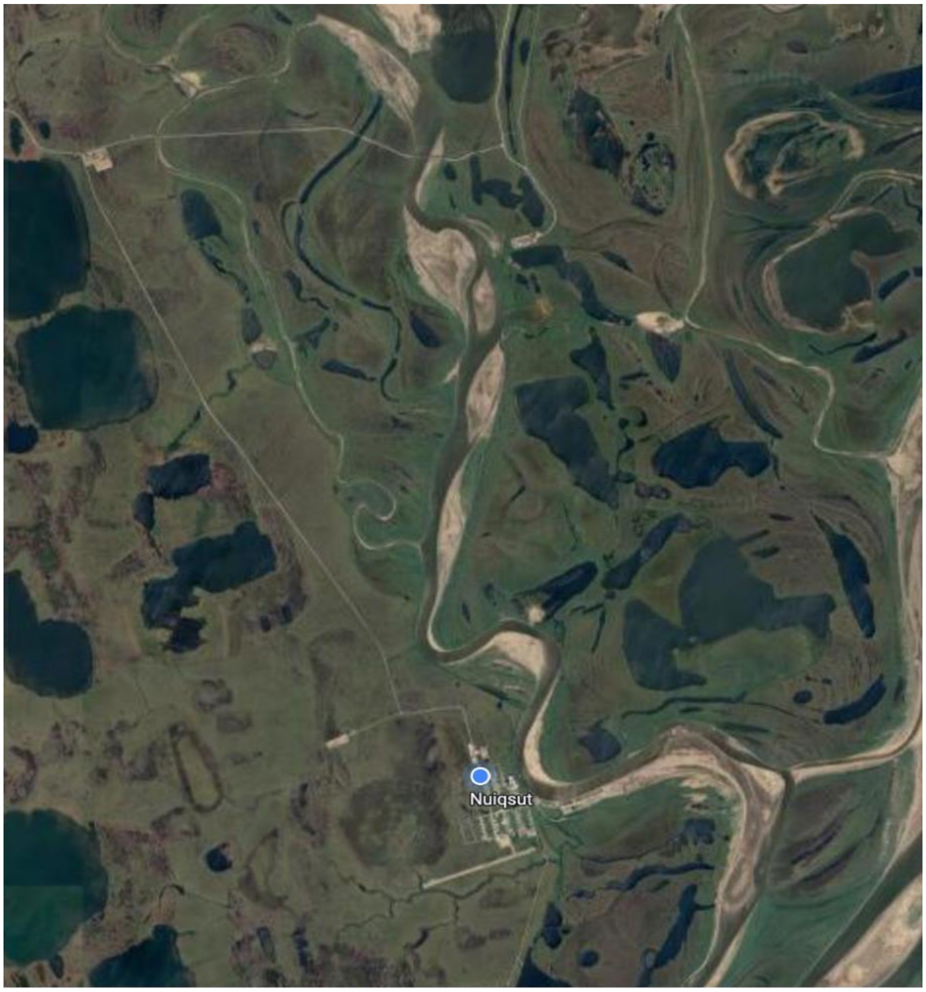

Figure C.1. Regional aerial imagery of Nuiqsut and the Niqliq (Nechilik) Channel showing the broader river system and community layout. *(Source: Google Earth)*

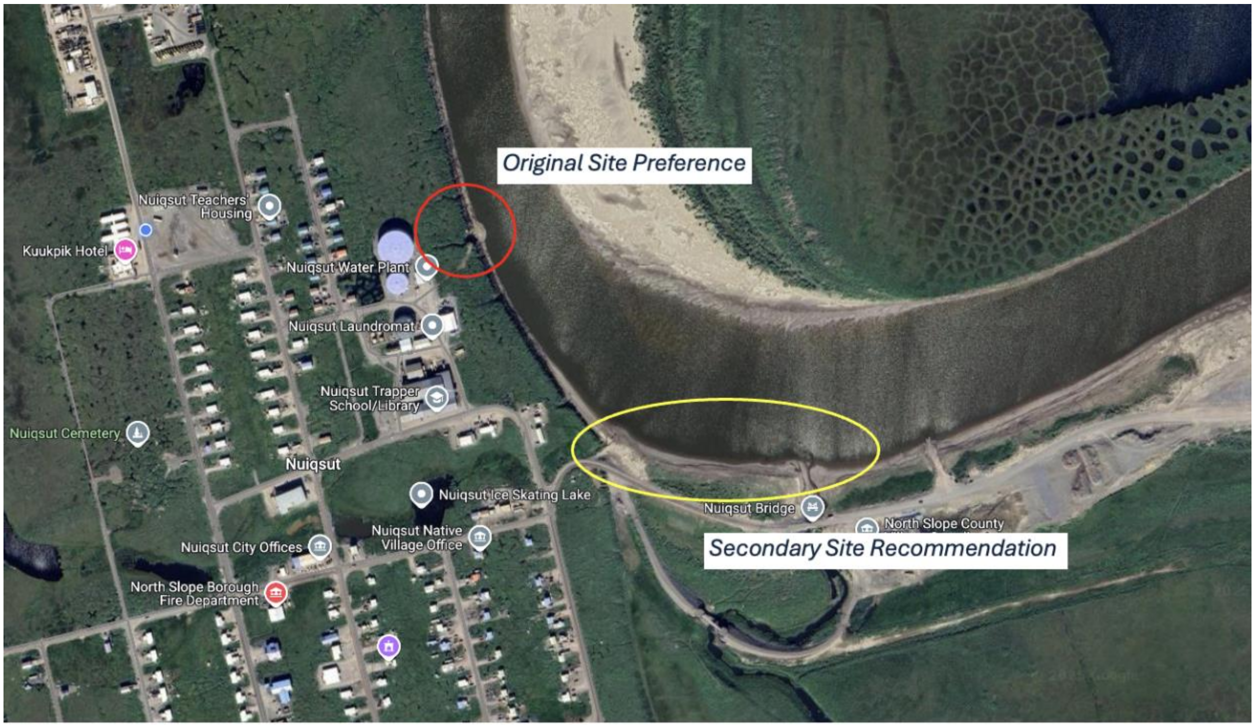

Figure C.2. Original and secondary site locations near the Nuiqsut Water Plant and the Niqliq Bridge, showing the initial and alternate site considerations. *(Source: Google Earth; annotated by NVN DNR)*

Figure C.3. Drone imagery of the original site area following spring breakup, showing active bank collapse and exposed infrastructure. Significant thaw-related slumping occurred along the channel edge. *(NVN DNR, 2025)*

Figure C.4. Expanded drone view of the same eroded riverbank showing exposed permafrost layers, indicating vulnerability to continued thaw and progressive erosion. *(NVN DNR, 2025)*

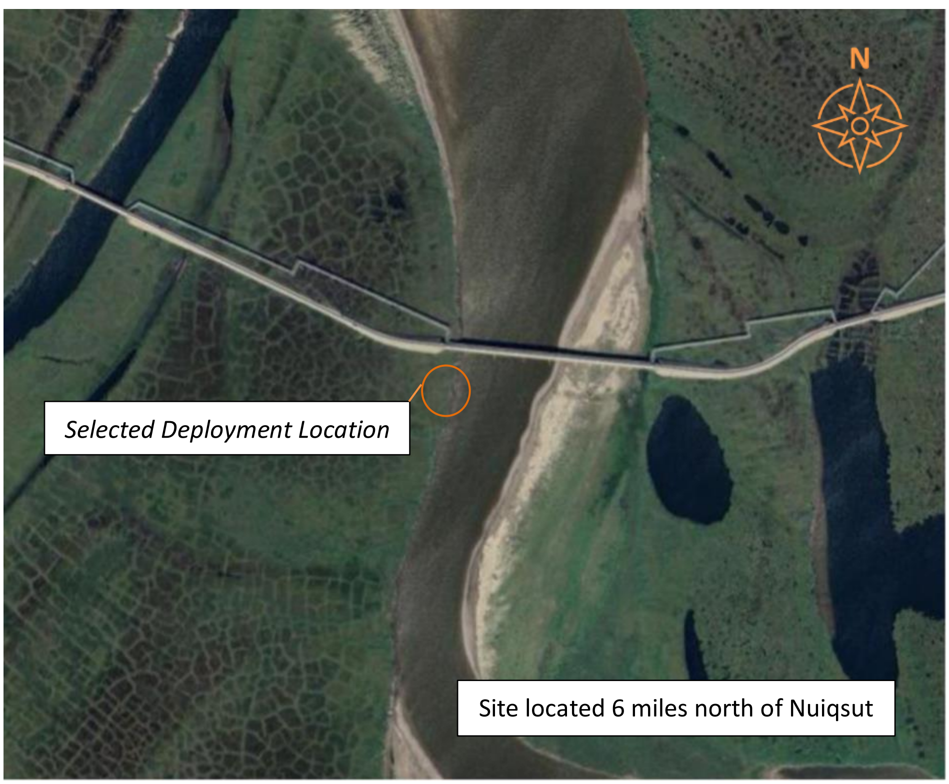

Figure C.5. Final NASA FORTE monitoring site north of Nuiqsut, located in the ConocoPhillips access corridor near the Niqliq Bridge. The location was selected in July 2025 following on-water reconnaissance and provides stable ground, consistent channel flow, and safe seasonal access. *(Source: Google Earth; annotated by NVN DNR)*

Figure C.6. Conceptual diagram illustrating the acoustic Doppler "ladder" array configuration used for velocity profiling and discharge estimation. ***(Generic reference image; not from Niqliq site)*** *(Source: Xylem, 2025)*

Appendix C.1.2 Instrument Installation and Setup

Overview

Installation of the NASA FORTE monitoring system was completed in July 2025 through a collaborative effort between the Native Village of Nuiqsut Department of Natural Resources (NVN DNR), NASA researchers, and the Xylem field team. Equipment installation took place along the west bank of the Niqliq (Nechilik) Channel, just south of the Niqliq Bridge within the ConocoPhillips access corridor. The site was selected for its stable ground, consistent channel flow, and reliable seasonal access for maintenance and data retrieval.

Field work was supported by NVN DNR staff and local helpers, who assisted with transporting materials, setting poles, and securing the enclosure. NASA and Xylem personnel oversaw the technical setup, calibration, and system integration on-site.

Installation Activities

- Galvanized steel mounting poles were driven into the riverbank substrate manually using hand post drivers to ensure firm anchoring and stability.
- The main enclosure, containing power, telemetry, and data-logging components, was mounted to the upper support pole.
- A solar panel and antenna assembly were installed to provide continuous power and communication with the Xylem HydroSphere network.
- The team calibrated sensors, verified signal strength, and confirmed successful data transmission to HydroSphere.

Verification and Handover

Upon completion, system performance and data connectivity were verified jointly by Xylem and NASA FORTE personnel. Following verification, operational responsibility for local oversight and periodic inspection was transferred to the Native Village of Nuiqsut Department of Natural Resources (NVN DNR).

Figure C.7. NASA and Xylem Team members preparing installation components along the west bank of the Niqliq Channel south of the bridge. *(NVN DNR, 2025)*

Figure C.8. Installation of the main support pole using hand post drivers to ensure secure anchoring into the riverbank substrate. *(NVN DNR, 2025)*

Figure C.9. Xylem and NVN DNR team securing in-water sensor assembly for the YSI EXO2 unit. *(NASA, NVN DNR, 2025)*

Figure C.10. Mid-installation view showing sensor frame placement and mounting alignment along the channel bank. *(NVN DNR, 2025)*

Figure C.11. Close-up of the system enclosure showing NASA FORTE and YSI Integrated Systems & Services identification labels. *(NVN DNR, 2025)*

Figure C.12. Solar-powered telemetry and logging system following completion of installation, facing east across the Niqliq Channel. *(NVN DNR, 2025)*

Figure C.13. NASA, Xylem, and NVN DNR team members conducting final calibration and data transmission tests via field laptop. *(NVN DNR, 2025)*

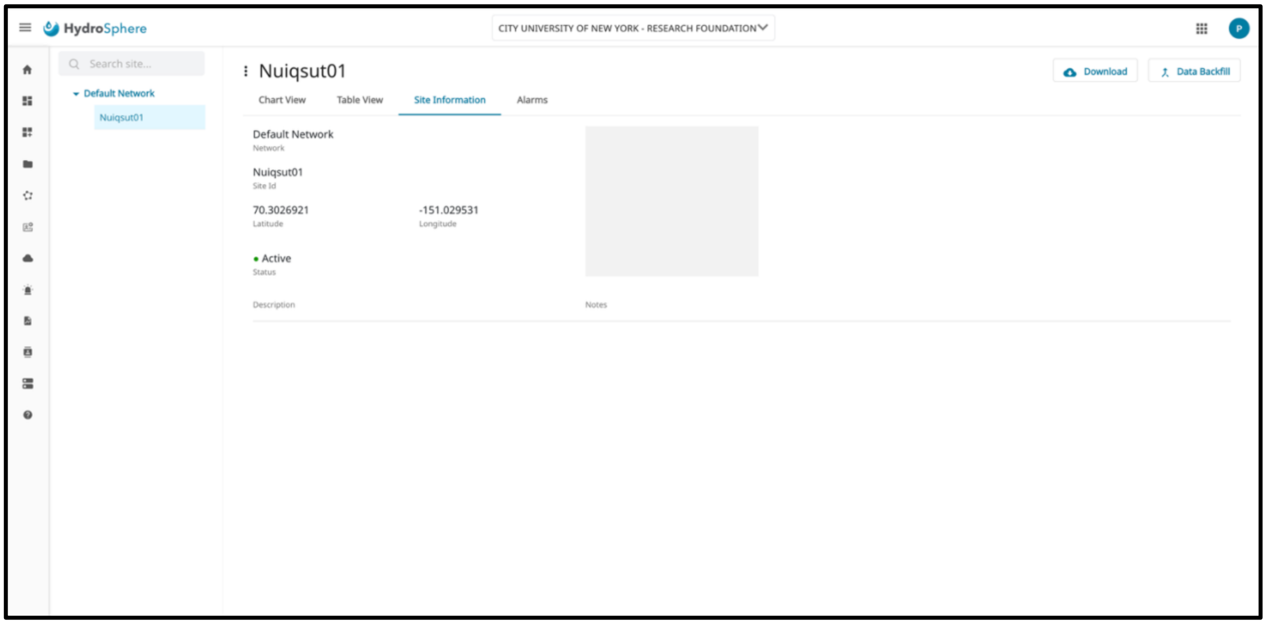

Figure C.14. Screenshot from the Xylem HydroSphere network confirming active data transmission from the "Nuiqsut01" monitoring site. *(Source: Xylem HydroSphere)*

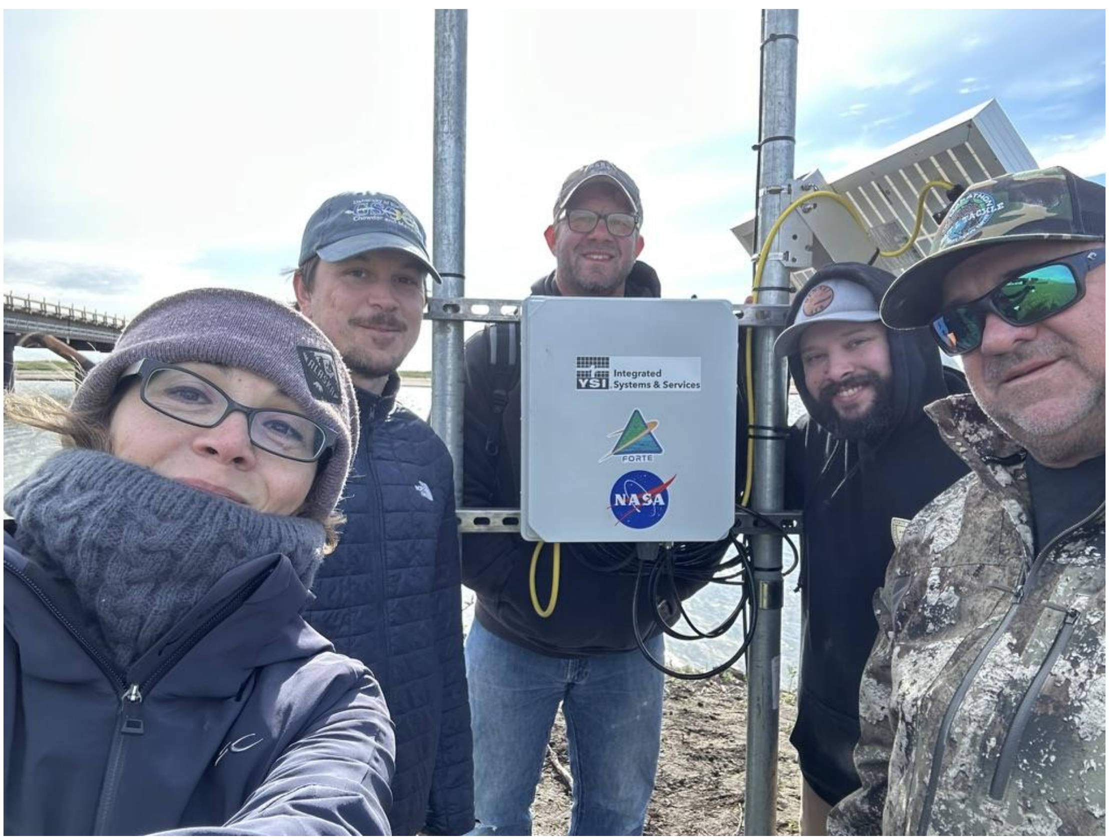

Figure C.15. Group photo of NVN, NASA, and Xylem collaborators following successful installation and activation. *(NASA, NVN DNR, 2025)*

Figure C.16. Final installed monitoring station showing solar array, antenna, and telemetry housing in operational configuration. *(NVN DNR, 2025)*

Appendix C.1.3 Community Coordination and Outreach

Overview

Community and agency coordination were integral to the planning and installation of the NASA FORTE Niqliq (Nechilik) Channel Monitoring Project. From the outset, the Native Village of Nuiqsut Department of Natural Resources (NVN DNR) worked to ensure that project activities were aligned with local governance processes, permitting requirements, and community awareness efforts.

Pre-Deployment Coordination

In the months leading up to field deployment, NVN DNR worked closely with NASA and Xylem team members to discuss project needs and goals. NVN DNR also coordinated closely with the Nuiqsut Tribal Council, the North Slope Borough Planning and Community Services Departments, and Kuukpik Corporation's permitting division to confirm that installation within the ConocoPhillips access corridor met local and regional requirements, and that all permitting was submitted correctly and in a timely manner for installation in July. Communication with ConocoPhillips representatives helped ensure awareness of project activities and avoid interference with existing industrial infrastructure near the Niqliq Bridge.

Community Meeting and Project Introduction

In July 2025, NASA FORTE researchers and NVN DNR staff co-hosted a public meeting at the Nuiqsut Community Center to introduce the project. The presentation provided an overview of the system's purpose, data objectives, and long-term monitoring goals for the Niqliq Channel. Community members were invited to share input, ask questions, and provide local observations of ice breakup, erosion, and water-level changes.

Local Input and Field Logistics

Installation was conducted by NVN DNR, NASA FORTE and Xylem technical staff. NVN DNR also coordinated field logistics, including local transportation, equipment staging, and safety communication. Local residents provided valuable knowledge of recent river conditions and assisted NASA personnel with boat transport to access the channel prior to site selection.

Ongoing Coordination

Following installation, NVN DNR continues to provide regular updates to the Nuiqsut Tribal Council through monthly and quarterly reporting. Coordination with Kuukpik Corporation and North Slope Borough staff remains active to support site awareness, ensure compliance with local land-use conditions, and inform ongoing monitoring and data retrieval planning.

Figure C.17. NASA FORTE and NVN DNR co-hosted a public meeting at the Nuiqsut Community Center in July 2025 to introduce the Niqliq Channel monitoring project, present preliminary information, and gather community input. *(NVN DNR, 2025)*

Appendix C.1.4 Mid-Season Conditions and Site Observations

Overview

In late August 2025, significant flooding occurred along the Niqliq (Nechilik) Channel following a period of sustained rainfall and high upstream discharge. The resulting high-water event caused rapid increases in river stage, channel velocity, and sediment load throughout the Niqliq system.

Site Impacts

At the NVN/NASA FORTE monitoring site south of the Niqliq Bridge, floodwaters and heavy debris flows directly impacted the instrument array. The sensor ladder structure was forced to an estimated 45-degree angle by water pressure and debris impact, and the YSI EXO sonde was displaced and partially buried beneath accumulated driftwood and silt. Despite these conditions, the upper communication and solar assembly remained upright and continued logging data until the end of the season.

Post-Event Observations

After floodwaters receded, NVN DNR staff documented extensive physical changes to the bank and site area. Several meters of tundra edge had slumped into the channel, and deep surface cracking was observed along the remaining bank face. Woody debris and sediment accumulation around the sensor structure provided clear visual evidence of flow energy and direction during peak discharge. Exposed permafrost and loss of root mat cohesion indicated ongoing thaw-related instability that will likely continue to threaten site integrity in future melt and flood cycles.

Figure C.18. View from the Niqliq Bridge showing elevated channel levels during late-season flooding. *(NVN DNR, 2025)*

Figure C.19. Downstream view toward the monitoring site following flood recession; Station visible near right bank, in bottom right corner. *(NVN DNR, 2025)*

Figure C.20. Riverbank erosion and cracking above the monitoring site after floodwaters receded. *(NVN DNR, 2025)*

Figure C.21. The sensor ladder partially submerged, tilted approximately 45 degrees, and buried beneath flood debris and silt. *(NVN DNR, 2025)*

Figure C.22. Collapsed tundra edge and exposed permafrost near the Niqliq Bridge installation. Tilted sensor ladder visible in water. *(NVN DNR, 2025)*

Figure C.23. Overview of the Niqliq Bridge and adjacent bank slumping, along with almost completely submerged sensor ladder, after the August 2025 high-water event. *(NVN DNR, 2025)*

Appendix C.1.5 Retrieval Operations (October 2025)

Overview

Two separate retrieval attempts were conducted by the Native Village of Nuiqsut Department of Natural Resources (NVN DNR) to recover the NASA FORTE/Xylem monitoring system from the Niqliq (Nechilik) Channel following the 2025 deployment season. Severe post-flood conditions, unstable permafrost banks, and early freeze-up made recovery operations extremely challenging.

First Retrieval Attempt – September 17, 2025

The first attempt took place in mid-September as river levels receded. NVN DNR staff assessed the site and attempted to recover the monitoring frame and sensors using hand tools and waders. However, high turbidity, significant debris accumulation, and the absence of proper cold-water safety gear made the operation unsafe. The underwater ladder frame was found to be deeply buried in silt and driftwood, with no visible access points to detach the EXO sonde or cables. The attempt was suspended until appropriate cold-water equipment could be obtained.

Second Retrieval Attempt – October 2025

A second retrieval mission was completed in mid-October once NVN DNR obtained a professional-grade cold-water drysuit. By this time, approximately 2–4 inches of ice had formed across the river surface, which had to be manually broken to access the site. Despite improved safety gear, recovery was hindered by several compounding challenges, including the buoyancy of the drysuit, lack of a breathing apparatus, high water levels beneath the ice, near-zero visibility, and heavy turbidity. Once the site was reached, the frame and sensors were found to be frozen into the riverbed substrate, preventing safe extraction.

During this visit, the **l**and-based telemetry station and its solar array were decommissioned and removed, as the system had completed its active data transmission period for the season. In its place, a **dedicated monitoring camera and standalone solar power system** were installed on new wooden supports to allow continued time-lapse documentation of river and ice conditions through the winter months.

Post-Attempt Evaluation

Following these unsuccessful underwater recovery attempts, NVN DNR contacted three professional dive teams to assess whether retrieval under ice was feasible. Each team determined that the Niqliq Channel's conditions were too hazardous for diving operations.

Subsequently, NVN DNR, NASA FORTE, and Xylem held a coordination call and jointly decided to leave the submerged equipment in place over the winter, to be recovered as soon as safely possible in 2026. Based on Xylem's experience with similar cold-region deployments, the underwater assembly and sensors are expected to survive the winter season, with only select seals or components requiring replacement or recalibration.

Next Steps

NVN DNR will coordinate with NASA FORTE and Xylem during early 2026 to plan the recovery operation once river conditions are stabilized and safe.

Figure C.24. Early October site conditions at Niqliq Channel, showing ice formation and low-angle winter sunlight across the river surface. *(NVN DNR, 2025)*

Figure C.25. View of the monitoring site with visible ice and snow. NVN DNR Staff donning drysuit for recovery attempt #2. *(NVN DNR, 2025)*

Figure C.26. NVN DNR Staff breaking through 2–4 inches of surface ice during the October retrieval attempt to access the submerged FORTE assembly. *(NVN DNR, 2025)*

Figure C.27. NVN DNR staff member working in the icy water in a cold-water rated thermal drysuit to assess the submerged installation under freezing conditions. *(NVN DNR, 2025)*

Figure C.28. Second phase of the retrieval attempt, where NVN DNR Staff attempted to remove the equipment using a come-along winch. Picture shows removed ice fragments and the frozen-in equipment location beneath the waterline. *(NVN DNR, 2025)*

Figure C.29. Site overview showing the decommissioned telemetry station and newly installed monitoring camera with solar array on the upper bank, which will be used to remotely monitor the site over the winter season. *(NVN DNR, 2025)*