CEE HydroSystems™

CASE HISTORY

CEE-USV™ Surveying on the Trans-Alaska Pipeline System.

Surveyors and engineers from Alyeska Pipeline, responsible for the 800-mile crude oil pipeline from the oilfield at Prudhoe Bay to the port of Valdez experienced a quantum leap in field work efficiency and data quality with the implementation of a USV survey program using the Trimble GNSS-equipped RTK CEESCOPE™ on board the CEE-USV™. With pipeline depth of burial surveys required annually for all river crossings, the USV offers huge efficiency improvements.

The 800 mile (1,287km) Trans-Alaska Pipeline System (TAPS) is the longest pipeline in the USA and carries over 500,000 barrels of crude oil per day through 48" pipe from the oilfield at Prudhoe Bay to the tanker terminal at Valdez.

The pipeline, owned and operated by the Alyeska Pipeline Service Company, crosses varied terrain and includes buried and raised sections, depending on the soil structure below the pipe. There are 34 major river crossings and nearly 500 small stream crossings along the route. The pipeline needs to be periodically surveyed and inspected to ensure asset integrity, safety, and spill mitigation. Part of the survey requirements are depth of burial surveys for the river crossings where the pipe is routed under the water. The pipeline design calls for a minimum burial depth where the pipe is covered by a certain thickness of sediment over the width of the crossing.

The 800-mile route of TAPS.

Adequate burial ensures the pipe is not exposed to dangerous scouring, particularly at high flow or flood conditions. Any exposed pipe could be subject to stress and presents a failure risk.

Alyeska Pipeline's survey engineers and subcontractors work together to evaluate each river crossing annually. Methods used have varied over the years but more recently, an acoustic Doppler current profiler (ADCP) has been used to measure the water velocity and depth simultaneously. The ADCP may be deployed from a manned boat or a tethered float for smaller cross sections. In order to conduct a survey using the ADCP, surveyors would deploy a tag line from one river bank to the other. While there is an access road running the length of the pipeline, simply getting from one side of the river to the other may take several hours by road at some locations. However, once the tag line was set up, the tethered float equipped with the ADCP was pulled across the river to develop cross section bathymetry data over the pipe. The surveys were time consuming, provided sparse data over the pipeline, were of suboptimal accuracy owing to the ADCP limitations and often could provide no data at all up or downstream of the pipe location.

Tethered float and ADCP used for previous surveys.

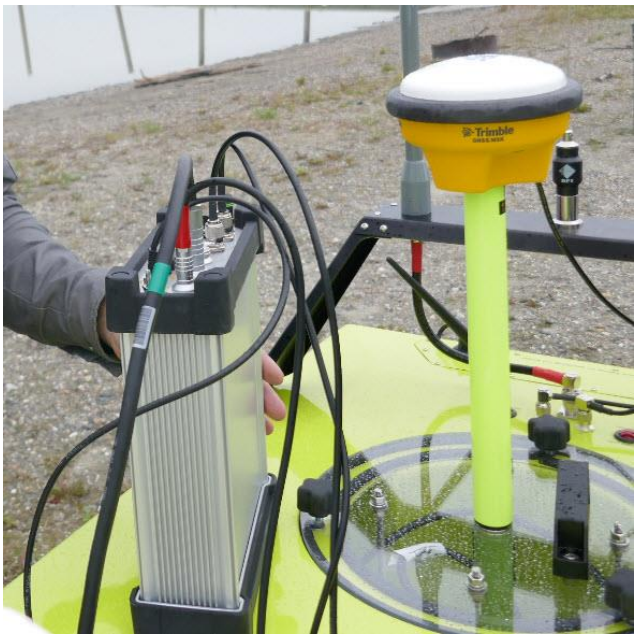
After introducing a successful airborne drone program for above-ground inspection, Alyeska conducted a review to discover new technology that might be available to help with the river cross sections. The following principal equipment selection criteria were used:

- Easy to mobilize, simplified design
- Robust for field transport
- Capability for high velocity flows
- Trimble GNSS

Alyeska surveyors operate Trimble RTK GNSS, and it was critical the new system was compatible with existing infrastructure. Alyeska chose the CEE-USV™ remotely-operated vehicle with CEESCOPE-LITE™ single beam survey system incorporating fully integrated Trimble RTK GNSS.

The CEE-USV™ with Trimble GNSS.

The new USV allows Alyeska surveyors to begin surveying almost immediately upon reaching each site, with tremendous time savings. The high performance capability of the USV at over 4m/s (13ft/sec) means surveys can be undertaken even with high flow conditions. After setting up the Trimble R10 RTK base station, the USV is powered-up and the CEESCOPE-LITE's built in UHF radio automatically locks to the base station and provides RTK corrections to the OEM Trimble RTK receiver inside. There are no data interconnects, for example between a rover smart antenna and the USV, instead the entire data package is integrated inside the RTK CEESCOPE-LITE. Indeed, there is only one major component in the data system, presenting a significant reduction in the potential for field downtime that could be costly for Alyeska's remote surveys.



Complete data system – CEESCOPE-LITE™.

The CEE-USV transmits survey data to the shore in real time, with Eye4Software Hydromagic acquisition software selected to provide a simplified user interface.

Surveying the Chena River crossing (Sept 2018).

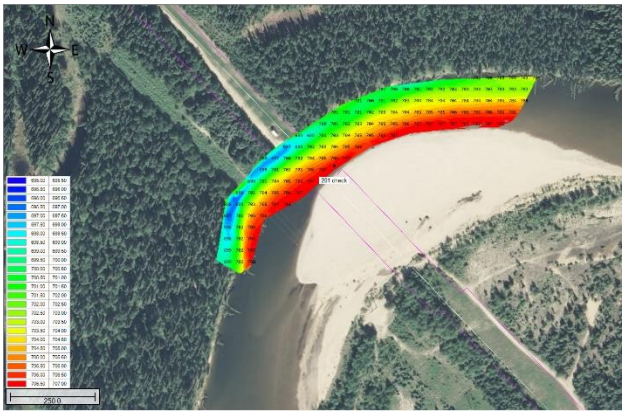
Real time cross section elevation profile views.

The pipeline location DXF background files are first imported into Hydromagic before the survey. This gives the surveyors an exact position of the pipe to allow good coverage at the most crucial locations. Aerial imagery can be overlaid on top of the pipeline map

to provide a useful background. All data are acquired in Alaska State Plane coordinates with elevations referenced to MSL as defined by the USA 2012 geoid model. Final bottom elevations are recorded in Hydromagic and simultaneously on the CEESCOPE-LITE's internal memory for redundancy. If needed, raw GNSS data may be recorded for a post-processed kinematic position solution.

The depth of burial of the pipeline under the river is subsequently calculated by subtracting the known pipe installation elevation from the bottom elevation as measured during the hydrographic survey.

Using the USV, data quality and density are greatly increased. It is now possible to expand coverage both up and downstream of the pipeline as the incremental time needed is short. This is important for monitoring of scour migration and movement of the river thalweg over time. Scour concerns may alleviate over time as the changing velocity profile moves the scour away from the pipe, or the reverse may be the case. One of the first USV surveys at the Chena river site showed just how far the river may migrate. Even since the last aerial photo was taken it is possible to see on the survey below that the thalweg is now over 30ft (10m) onto previously "dry land". In this case movement of the scour channel downstream is taking it away from the pipeline.



Chena River survey – Hydromagic elevation plot.

With any USV project, the GNSS integration – or lack of – is a crucial factor. Field issues arise from interfacing GNSS equipment outputting NMEA0183 messages through Bluetooth or serial cables, especially as surveyors are typically unfamiliar with these processes. The use of the Trimble RTK GNSS fully integrated into the USV system to eliminate these potential issues is a key real-world advantage for the Alyeska surveyors.