Bathymetry Projects: Hydrographic Survey or Land Survey Approach?

Shallow water bathymetric surveys with single beam echo sounders are typically undertaken with two generic types of equipment setup, that we broadly classify as either "Hydrographic Survey" or "Land Survey". The hydrographic approach provides better quality control, reduced opportunity for error, and more detailed results but with a more complex and higher cost setup. The land survey approach is lower cost, can be easier, but can leave more uncertainty in the finished survey. The process overview and strengths and weaknesses of each methodology are discussed here.

Land Survey Approach: CEE-LINE™

For surveyors who already own GNSS acquisition systems, it is attractive to use this equipment for bathymetry too. In recent years, GNSS software has increasingly allowed supplemental data inputs from echo sounders. Trimble Access, Leica Viva, Carlson SurvCE, Topcon Magnet Field all allow connection of an echo sounder through a Bluetooth or cabled serial interface. Some GNSS software still does not allow such an interface, so in certain cases it is not possible to use echo sounders in this manner but most packages in use today will offer this option.

For use with GNSS data collectors, the CEE HydroSystems CEE LINE™ echo sounder is a useful choice. Unlike many of its competitors, the CEE LINE™ uses a dedicated echo sounder processor and professional passive transducer – and not a "Smart" active transducer, so it can offer high grade bottom tracking. But the CEE LINE™ shares the same simplified "digital only" data output with its competitors. The connected data collector – for example Trimble TSC3 or Leica CS20 - logs the most recent depth at each GNSS position shot.

Land Survey – Pros:

Simplicity: Survey geodesy is managed by the data collector so datasets will be seamless with surrounding land survey data. There is no requirement for training on new software and basic echo sounders are typically less complex in operation. Indeed, the CEE-LINE™ is designed to have no buttons – just plug it in and it is pinging.

Cost: Simple echo sounders are used in this application, at a lower cost. Caution should be exercised however as very inexpensive primitive "smart transducers" are repackaged into survey echo sounders for this market segment. Performance of these devices, especially in shallow water, is poor.

Land Survey - Cons:

Survey management: The position display on the data collector is small and does not allow for detailed survey planning and execution; there is also no way to view depth profiles which means it is easy for poor quality data to go unnoticed. This only comes to light back in the office during editing. As the position shots will be taken relatively infrequently, say 1 or 2 per second, data density is low. If edits are required, datasets can become thin and gaps in coverage will appear.

Quality control: No true data validation is inherent in any digital depth echo sounder, as the output is simply the depth from the bottom tracking calculation, which must be trusted as accurate. There is no way to improve confidence in the sounding depth without routinely cross checking with a pole or line.

Latency: Technically for the 10Hz CEE LINE™ and practically for slower echo sounders with lower output rates, latency can be an issue. As the depth and position data are not tied together by any time stamp, the GNSS data collector can only record the last available depth when it takes a position measurement. For the CEE LINE™ this is a maximum of 0.1s before the position shot; for a slower sounder at 2Hz this is up to 0.5s before the GNSS shot. On a moving boat, this could introduce an error of up to 2.5m (8ft). This error can only be minimized by reducing the boat speed.

Hydrographic Survey Approach: CEE ECHO™ and CEESCOPE™

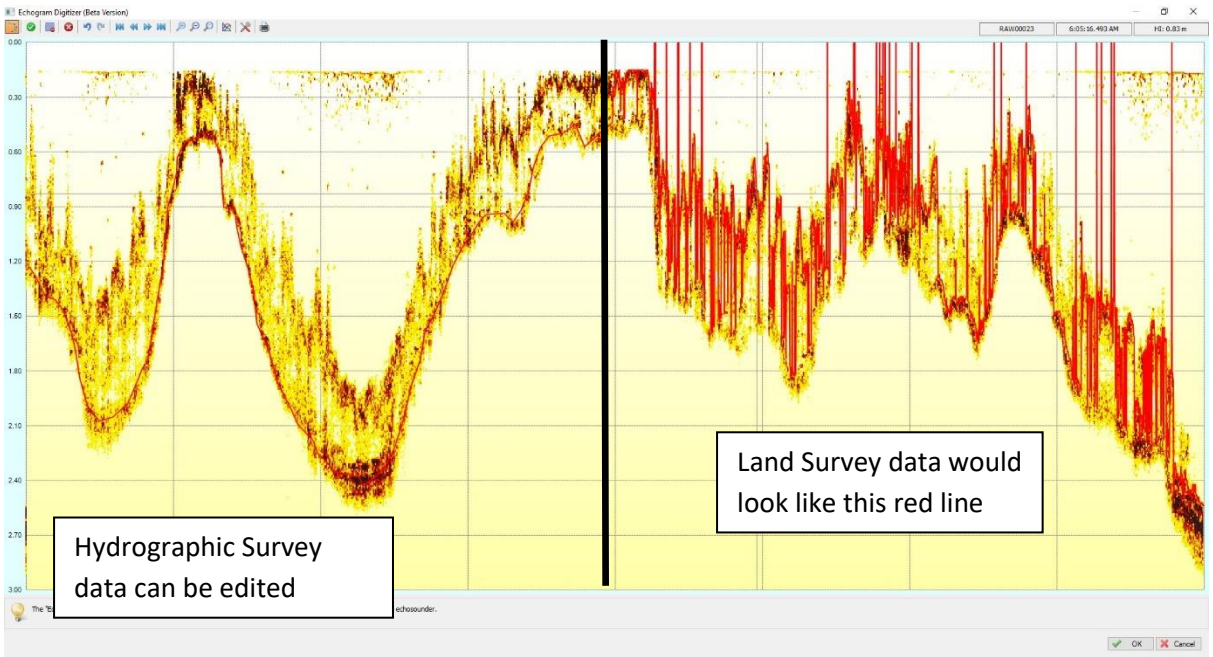
For surveyors requiring a more robust and professional hydrographic capability, using a GNSS data collector for acquisition is not adequate. The main divergence in the hydrographic approach is that hydrographic acquisition software such as Hydromagic, HYPACK or QINSy is used instead of the GNSS software. Survey data visualization is greatly improved, and – importantly – these packages unlock crucial quality control features of more advanced echo sounders such as the CEE HydroSystems CEE ECHO™ and CEESCOPE™ that are typically used in this approach.

The Hydrographic approach still allows the surveyor to use existing GNSS equipment, but the receiver is used to output position data into the echo sounder before being combined with depth data and sent to the acquisition PC. The data collector is no longer required except for initialization or to supply corrections if containing the SIM. Survey geodesy is managed by the hydrographic software, which will afford pre-loaded coordinate systems to exactly match land survey software as well as the ability to generate local / construction grids. Elevation is managed through geoid models loaded as required. Using CEE HydroSystems echo sounders, two options are available. The CEESCOPE™ has a fully integrated (RTK) GNSS so no third-party GNSS equipment is required. The CEESCOPE™ can

connect directly to a UHF base station through its own built-in radio, or access cell phone / VRS corrections. For users wishing to use existing GNSS receivers, the CEE ECHO™ is an echo sounder-only and takes the NMEA0183 output from the GNSS, through Bluetooth or RS232 cable as below.

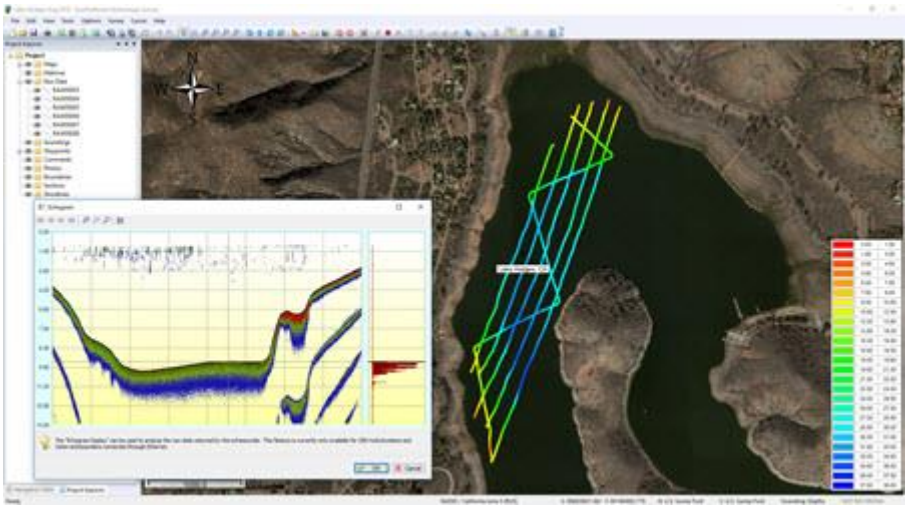
Hydrographic Survey – Pros:

Quality Control: Crucially, the full water column echogram (below) is displayed and recorded providing a detailed view of what the echo sounder is "seeing". Soundings can be corrected when digital depths misrepresent the "real" bottom, for instance if thick vegetation is present as shown below on an example echogram. The unedited data (right side) would be the output from any digital only "Land Survey" approach. The echogram and editing capability of the Hydrographic approach allows re-digitization to the true bottom, on the left. This quality control can be documented and serves as a record for any future survey scrutiny by clients, in addition to building confidence in the survey data for the operators.



Accuracy: The CEE ECHO™ and CEESCOPE™ mesh GNSS and depth data and apply a precise millisecond time stamp used in the software to exactly position soundings. Latency errors are eliminated. These echo sounders output data at up to 20Hz, leading to far greater detail and significantly more resilience – retaining good data even after substantial thinning during editing.

Survey Visibility: The real time view of the survey boat with the bathymetry data available in map and profile view greatly reduces the possibility of collecting bad data and leaving the site. Problems can be identified, and surveys can be adjusted “on the fly” to account for bathymetry results.



Dual Frequency Operation: Using a dual frequency transducer to obtain results related to sedimentation is only properly managed with hydrographic acquisition software to understand the context of the high and low frequency data, although it is possible to use dual frequency with a limited scope when operating in the land survey approach.

Hydrographic Survey – Cons:

Cost: The echo sounder equipment is more capable and therefore costlier; the software also must be purchased leading to a greater overall investment needed. For occasional small hydrographic jobs, this will not be justifiable.

Skills Training: The requirement for a new software package requires some user training. The available options differ significantly in their training requirements and range from being practically inaccessible without training to being intuitive and easily accessible. As the echo sounders are more complex, there are more facets of their operation that need to be properly understood to maximize the benefits of their use.

In summary, there is no “right” or “wrong” choice. Users must be aware of the shortcomings of the simplified “Land Survey” approach to determine whether a greater investment is needed to reach their project goals. For sure, the hydrographic approach will in every case lead to a better survey but this may not necessarily be warranted or even of value as determined by each job requirements.