

Canadian Hydrographic Service Standards for Hydrographic Surveys

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Hydrographic Survey Standards in Canada



- **About the Canadian Hydrographic Service (CHS)**
- **Canadian Hydrographic Survey Standards (Extensions to S-44)**
 - CHS Documents Relating to Hydrographic Survey Standards
 - Order of Surveys
 - Exclusive Order Surveys
 - Fixed Aids
 - CUBE Surface Guidelines
- **MBES, LiDAR and Optically Derived Bathymetry**
- **S-44 Identifying Requirements for 2025**

The Canadian Hydrographic Service



Organization of About 300 People in 5 Regional Offices (IOS, Victoria, BC, CCIW, Burlington, ON, IML, Mont Joli, PQ, BIO, Dartmouth NS, NWFC, St.John's NL) with a Headquarters Office in Ottawa.

CHS Currently Maintains About 950 Nautical Charts for Canada

Four Key Activities

- Production and Maintenance of Nautical Chart and Publications
- Hydrographic Survey and Mapping
- Monitoring of Tides and Water Levels
- Maritime Boundaries and Sovereignty

Clients We Serve

- Commercial Shipping
 - Recreational Boating
 - Fishing Industry
 - National Defence
 - Oil, Gas and Mineral Exploration
 - CCG (Search and Rescue, Aids to Navigation)
 - Science and Academia
- (Climate, Marine Environmental Protection, Habitat, Aqua



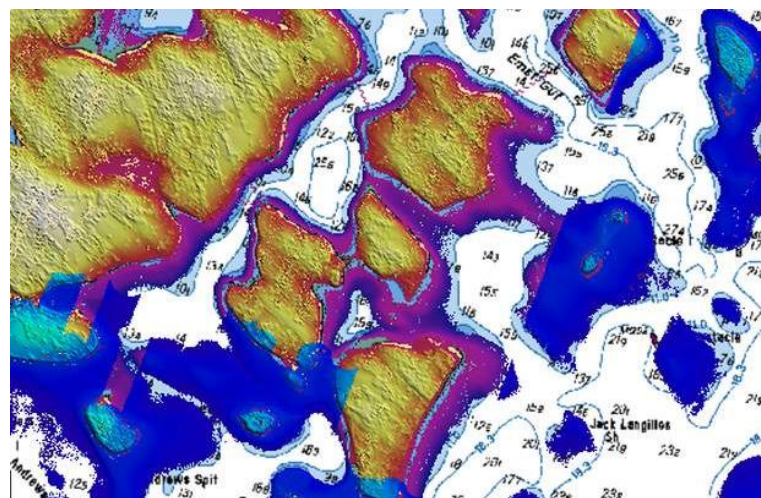
The Challenge of a Complex Canadian Coastline



- Canada has the longest coast line in the world.
 - Incredibly complex and challenging (nothing is simple)
 - Diverse climate (Arctic to Temperate)
 - Dramatically varying character
- CHS has the nautical charting mandate for all of Canada.
 - A Phenomenal challenge (Spatially)
 - Limited Resources available
- Always looking for ways to obtain better hydrographic data coverage in the Canadian coastal zone.
- The challenge of working in remote areas (especially the Arctic) is substantial.
- Looking at new technological approaches to collect hydrographic information for producing nautical publication (bathymetry, hazards and PLA features)



Worlds Longest Coastline



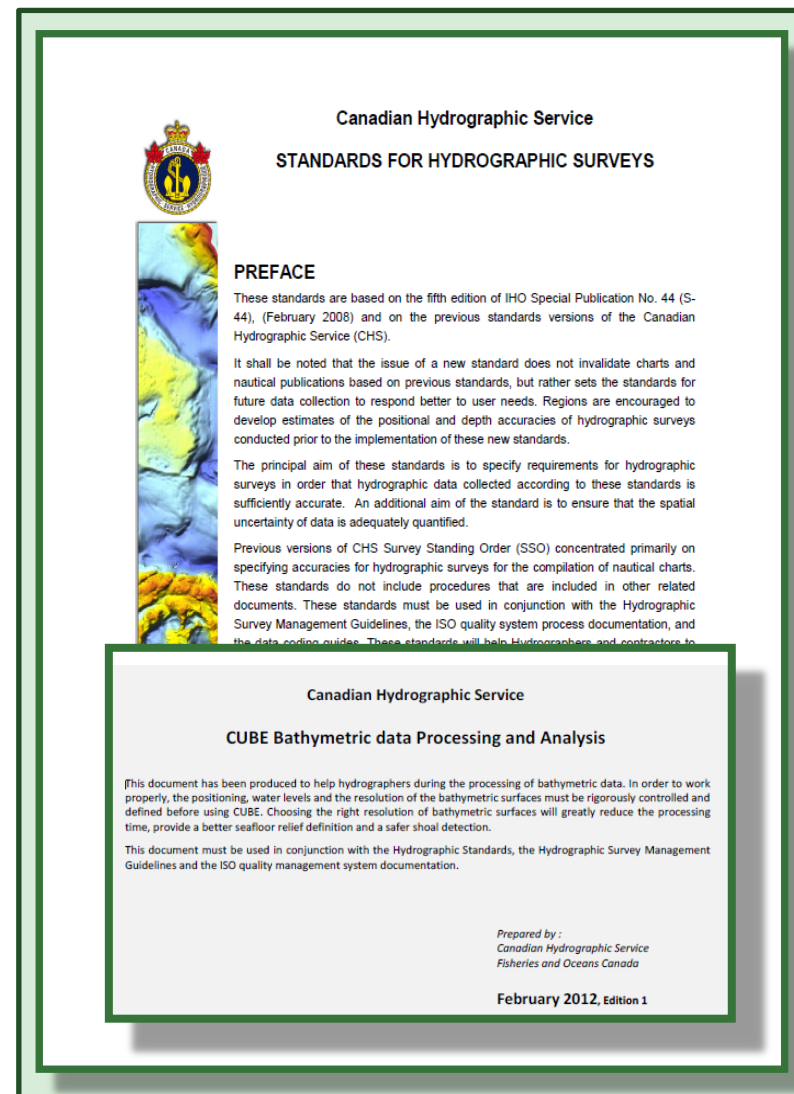
Complex Submerged Coastline (Mahone Bay Islands)

CHS Hydrographic Standards and Procedure Documentation



The CHS has 4 main documents that provide guidelines for conducting Hydrographic Surveys.

- 1) CHS Standards for Hydrographic Surveys (based on IHO S-44).
- 2) CHS - CUBE Bathymetric Data Processing and Analysis (Directly associated with CHS Standards for Hydrographic Surveys).
- 3) CHS Hydrographic Survey Management Guidelines.
- 4) ISO 9001:2015 Quality Management System Documentation.



CHS Standards for Hydrographic Surveying



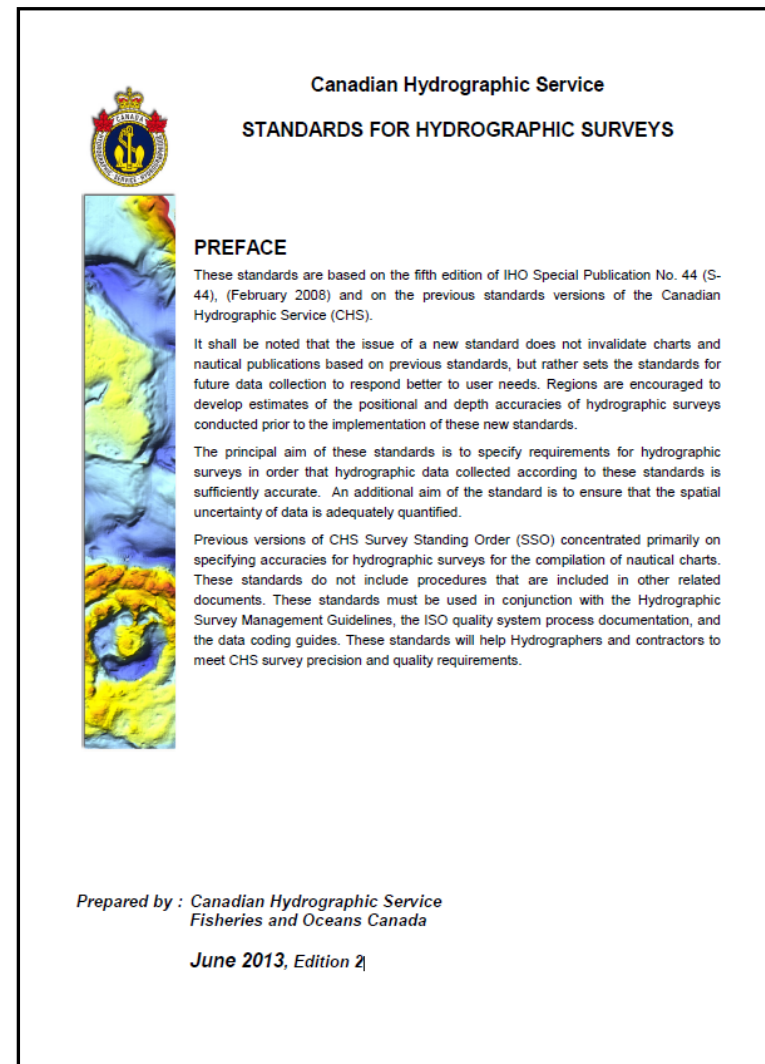
These Standards are based on the fifth Edition of IHO Special Publication S-44 and on previous standards versions of CHS.

They are intended to supplement the S-44 5th Edition and to:

- Provide a standard where data is collected according to specific CHS accuracy requirements.
- Ensure the spatial uncertainty of data is adequately quantified.

These standards differ from previous CHS Survey Standing Orders, in that they:

- Do not include procedures described in the Management Guidelines and ISO9001 QMS.
- Allow the specification of different accuracy requirements according to their importance for the safety of navigation.
- Strive to attribute all new data with statistical estimates of uncertainty.
-and some other things.



Classification of Bathymetry – Differences from S-44 5th ed.



Unlike IHO S-44 5th Edition The CHS Standard:

Orders of Survey:

Defines 6 Orders of Survey to accommodate both newer and older surveys that depict different accuracy requirements. (Includes Exclusive Order)

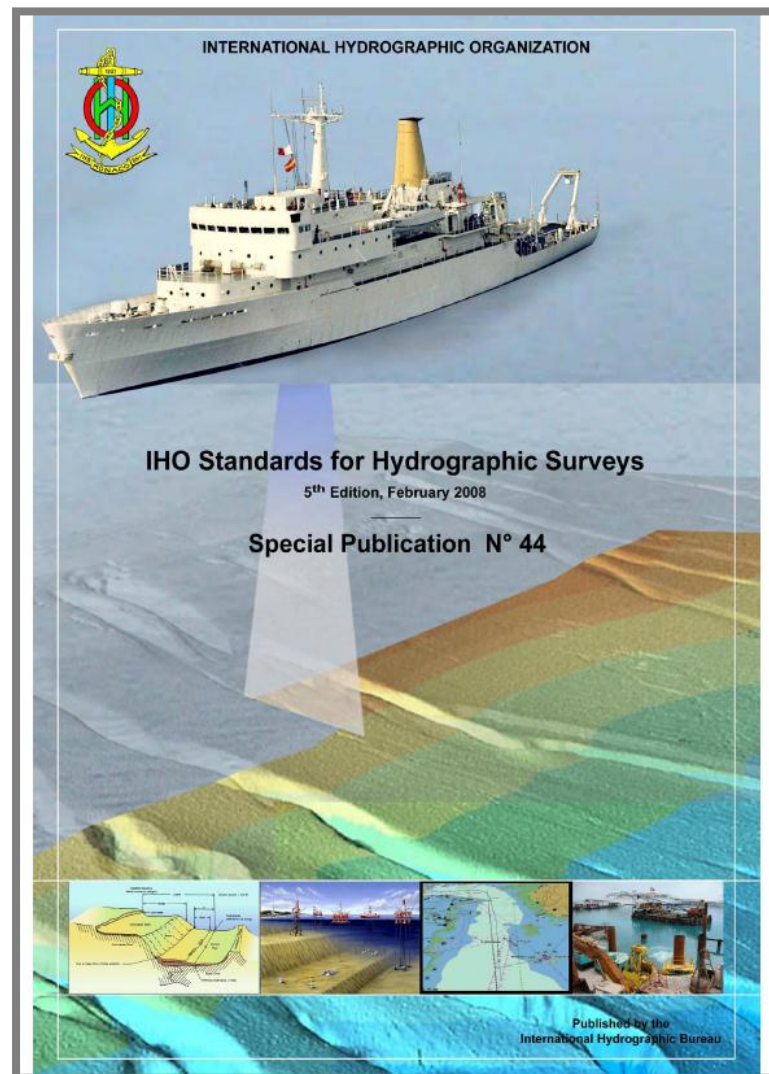
Classification of Surveys:

Divides its classification into 4 Components:

- 1) Horizontal Accuracy (H)
- 2) Vertical Accuracy (V)
- 3) Target Detection Capability (D)
- 4) Type of Coverage (C)

Bottom Search:

Does not make a 100% bottom search compulsory. In CHS it is strongly recommended to obtain 100% bottom search in all critical areas but in some special circumstances it may not be achievable.



The CHS Defines 6 orders of Survey – Exclusive, Special, 1a, 1b, 2 and 3

ORDER		Exclusive	Special	1a	1b	2	3 (Imprecise)
Examples of Typical Areas		Shallow water in Harbours, berthing areas, and associated critical channels with minimum under-keel clearances or engineering surveys	Harbours, berthing areas, and associated critical channels with minimum under-keel clearances	Areas shallower than 100 metres where under-keel clearance is less critical but <i>features</i> of concern to surface shipping may exist.	Areas shallower than 100 metres where under-keel clearance is not considered to be an issue for the type of surface shipping expected to transit the area.	Areas generally deeper than 100 metres where a general description of the sea floor is considered adequate.	All areas where the accuracies do not meet the requirements of the previous orders
H	Horizontal Accuracy (95% Confidence Level)	1m	2m	5m + 5% of depth	5m + 5% of depth	20m + 10% of depth	> 20m + 10% of depth
V	Depth Accuracy for Reduced Depths (95% Confidence Level) ⁽¹⁾	a = 0.15m b = 0.0075	a = 0.25m b = 0.0075	a = 0.5m b = 0.013	a = 0.5m b = 0.013	a = 1.0m b = 0.023	Same as order 2
D	System Detection Capability	Features > 0.5m cubed	Features > 1m cubed	Features > 2m cubed in depths up to 40 m; 10% of depth beyond 40m ⁽³⁾	N/A	N/A	N/A

Guidelines for single beam and punctual surveys

SBES	Maximum Line Spacing ⁽⁴⁾	The lesser of: 3x average depth or 25m in depths to 10m; or 50m in depth of 10-40m; or 100m in depths deeper than 40m. Closer line spacing may be required in doubtful areas.	The lesser of: 3x average depth or 200m. For Bathymetric LiDAR a spot spacing of 5x5 metres or less.	The lesser of: 3x average depth or 1000m.	N/A
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Exclusive Order versus Special Order

Increased Accuracy requirements to satisfy the needs of mariners that require the most accurate surveys and who are depending on critical under keel clearances for navigation through commercial waterways.

Dividing the Classes into 4 requirements allow the Horizontal, vertical, object detection and coverage to be classified separately. (e.g. a survey could have horizontal accuracy of better than 1 meter (Exclusive) but the depth accuracy is just better than Special Order. This allows each order to be assessed in relation to more than one class category.

Exclusive order is an extension of the Special Order surveys with a more stringent accuracy and target detect requirement.

ORDER		Exclusive	Special
Examples of Typical Areas		Shallow water in Harbours, berthing areas, and associated critical channels with minimum under-keel clearances or engineering surveys	Harbours, berthing areas, and associated critical channels with minimum under-keel clearances
H	Horizontal Accuracy (95% Confidence Level)	1m	2m
V	Depth Accuracy for Reduced Depths (95% Confidence Level) ⁽¹⁾	a = 0.15m b = 0.0075	a = 0.25m b = 0.0075
D	System Detection Capability	Features > 0.5m cubed	Features > 1m cubed

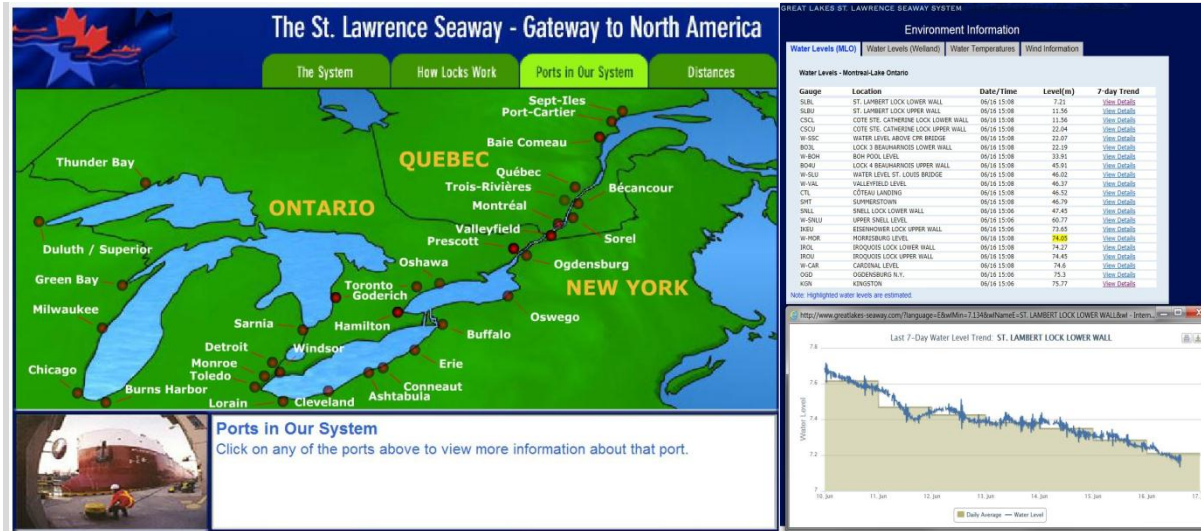
Type of coverage (M270)	
C	1. complete coverage (multibeam, multi-transducer, acoustically swept);
	2. systematic survey (single-beam echo sounder lines run parallel at pre-planned line spacing, LiDAR);
	3. sparse coverage (lead-line surveys, reconnaissance, track soundings, spot soundings);
	4. unsurveyed

EXCLUSIVE ORDER

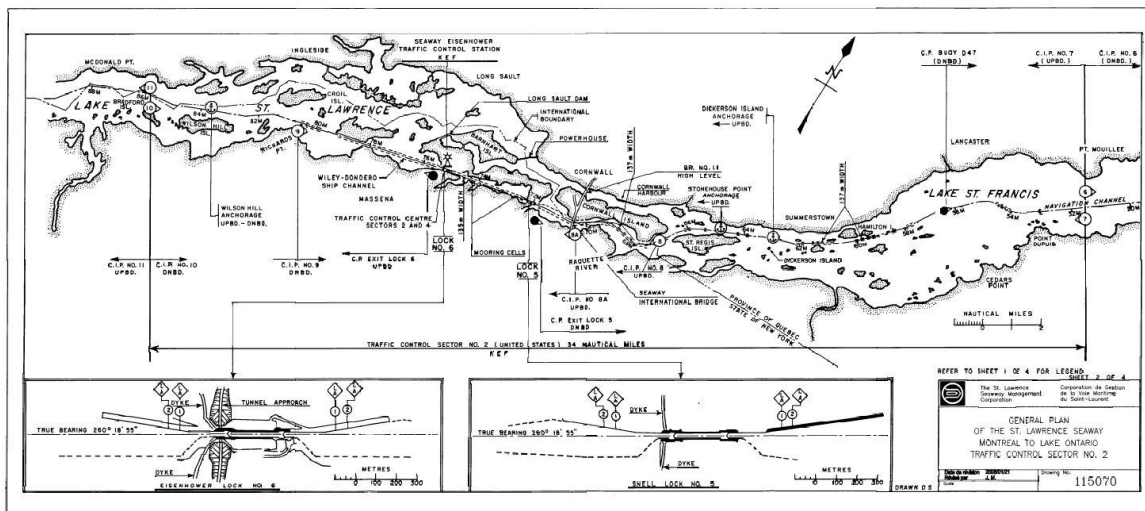
Exclusive Order hydrographic surveys are based on the IHO Special Order with higher accuracy and their use is intended to be restricted to shallow water areas (harbours, berthing areas and critical channels) where there is an optimal use of the water column and where specific critical areas with minimum under-keel clearance and bottom characteristics are potentially hazardous to vessels. This order also applies to high precision engineering surveys. All error sources must be minimized. Exclusive Order requires very precise positioning systems, closely spaced lines (when target detection is required) and a rigorous control on all aspects of the survey. The use of side scan sonar or multi-transducer arrays or high-resolution multibeam echo sounders is required to detect the feature size to be detected. In required areas, appropriate sounding equipment and methodologies must be employed in order to ensure that all features greater than 0.5m cubed are detected. The use of side scan sonar in conjunction with multibeam or multi-transducer echo sounders may be necessary in areas where pinnacles and dangerous obstacles may be encountered.



The Requirements for Exclusive Order



The need for Exclusive Order was first identified in the St Lawrence Seaway.



Critical Under Keel Clearances established the need for improved information and the development of a Draught Information Systems (DIS)

Benefits of the Draught Information System



Draught Information System (DIS)

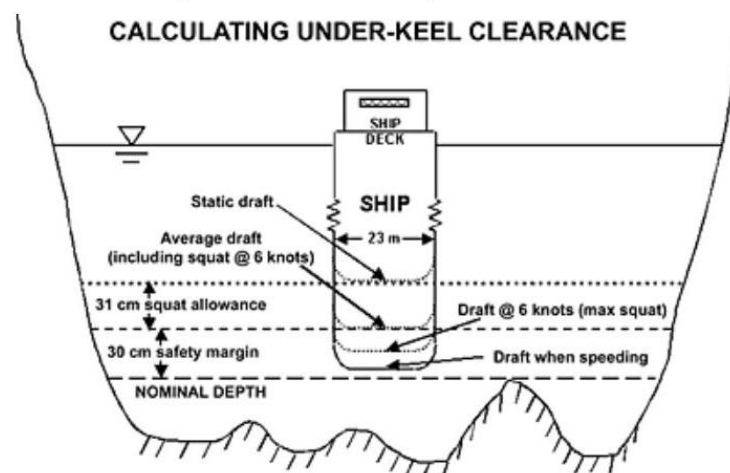
“The availability of this data on the bridge of the vessel will enable most vessels to maximize their drafts up to 26 feet 9 inches from the current Seaway permissible draft of 26 feet 6 inches. This increase of 3 inches would mean that the average Great Lakes vessel can carry an additional 250 to 400 tons of cargo. The investment in this equipment will result in greater operational and environmental efficiencies based on a tonne/mile matrix.”

The DIS is a program design to calculate and display under-keel clearance on the basis of:

- High Resolution Bathymetric data provided by the CHS
- Water levels, received automatically via Seaway AIS stations from a network of water level gauge stations (or set manually)
- Ship forward and after draft set by the user
- Ship Squat based on Seaway Squat models.



St. Lawrence Seaway Locks



Under-Keel Clearance Calculation

Standards for Positioning Nav Aids and Important Features

The positioning of objects under Exclusive order is significantly more demanding but positioning technology has improved to match this need since S-44 5th ed.

Exclusive order accuracies are now quite achievable using up-to date GNSS systems.

Table 2
Standards for Positioning of Navigation Aids and Important Features

	Exclusive Order		Special Order		Order 1a		Order 1b		Order 2	
	HOR	VER	HOR	VER	HOR	VER	HOR	VER	HOR	VER
Fixed aids to navigation and features significant to navigation	20cm	30cm	50cm	50cm	1m	1m	3m	2m	10m	3m
Mean position of floating aids to navigation.¹	5m	N/A	10m	N/A	15m	N/A	20m	N/A	25m	N/A
Natural Coastline (high and low water lines)	2m	N/A	5m	N/A	10m	N/A	20m	N/A	75m	N/A
Topographical features (not significant for navigation)	5m	30cm	10m	50cm	15m	1m	20m	2m	25m	3m
Overhead clearances	1m	30cm	3m	50cm	5m	1m	10m	2m	10m	3m
Range line and sector lights limits azimuths	All range lines and sector lights limits must be drifted to confirm the theoretical azimuth. The maximum difference between the theoretical and drift azimuths is : 0.5°									



Recommended Base Surface Resolutions

The table below is used as a guideline to optimize data acquisition and processing. To achieve the resolution the hydrographer must take into account the survey equipment and methodology. The depth where all data must be checked to ensure all shoals are included is 50 meters or less.

Table 1 : Recommended Base surface resolution

Depth up to	Surface resolution / Size of features detected	POSACC	SOUACC	Positioning system requirement	CHS Order	Comments
15m	0.25m	0.125m	<0.19	RTK PPK	Exclusive Special	
25m	0.50m	0.25m	<0.31	RTK PPK	Special	
50m	1.00m	0.50m	<0.45	PPP DGPS WASS C-Nav Starfix	Special	Shoal validation limit
100m	2.00m	1.00m	<1.39	Standalone post-processing	1	
100m+	5.00m+	2.50m+	<2.51+	Standalone GPS	2	
Notes: -CUBE surface resolution should have at least 5 pings per cell in order to achieve the resolution specified in column #2. -The location and the order of the survey are taken into account when determining the SVP, acquisition and tide reduction strategies to be used (i.e. distance from the tide station / gauge, sound speed at the transducer head, limit the swath angle, frequencies, etc.).						

CHS High Definition Bathymetry Trials

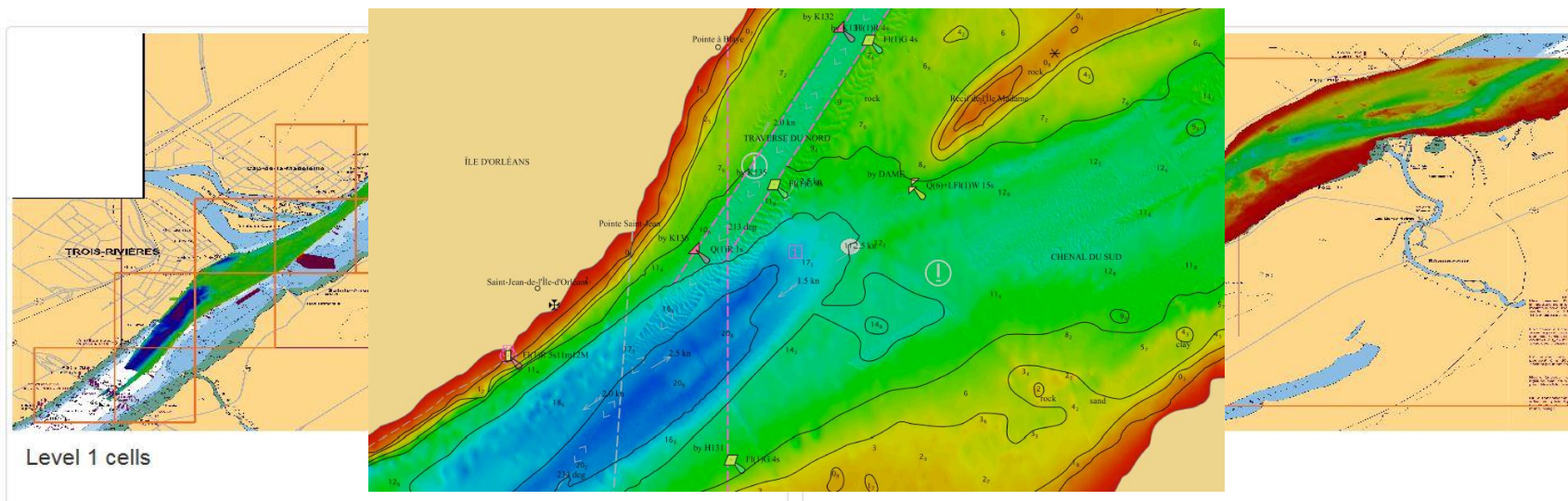
The Canadian Hydrographic Service (CHS) is involved in the development of the next standard to be used for bathymetric data named S-100. This new standard will permit the management of gridded bathymetric data in high definition. CHS wants to test and try technical solutions in collaboration with software manufacturers, mariners and other potential users of High Definition (HD) bathymetry. For this, CHS provides to interested persons datasets of HD bathymetry. The sector of Trois-Rivières harbour was selected for these initial trials.

The datasets include 18 HD bathymetry cells.

- 16 cells of level 1
- 2 cells of level 2

These datasets are available under license and may be used for tests and trials only.

If you wish to request a copy of the test data, please download and save a copy of the [Direct User Licence Agreement](#). You may complete it electronically or by hand. The portions of the licence to be filled in by the recipient are shown in blue text. Please return the completed DULA to CHS by fax at ☎ 613-996-9053 or by e-mailing the complete PDF file to ✉ CHSInfo@dfo-mpo.gc.ca.



A Hierarchy of Hydrographic Data Sources

These 3 hydrographic data sources form a hierarchical progression of accuracy and cost effectiveness.

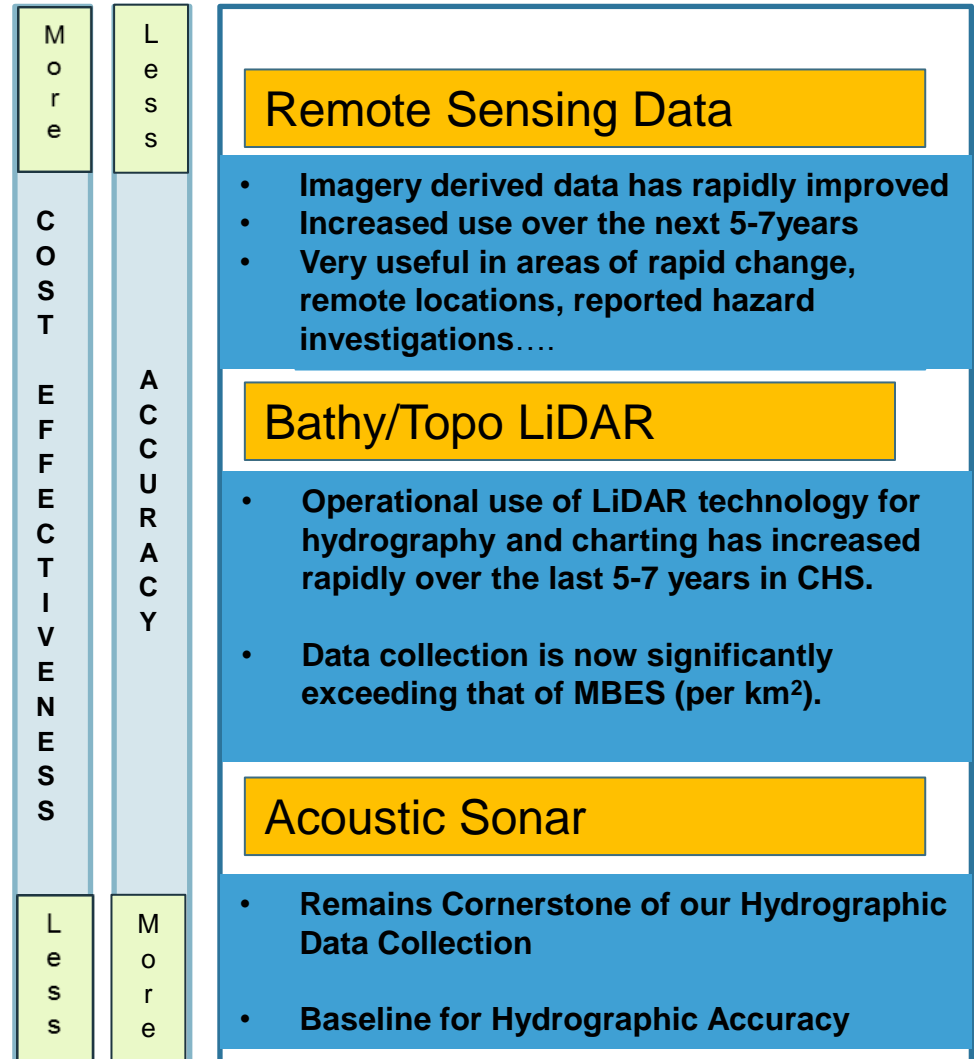
Acoustic Sonar has been the cornerstone of our hydrographic data.

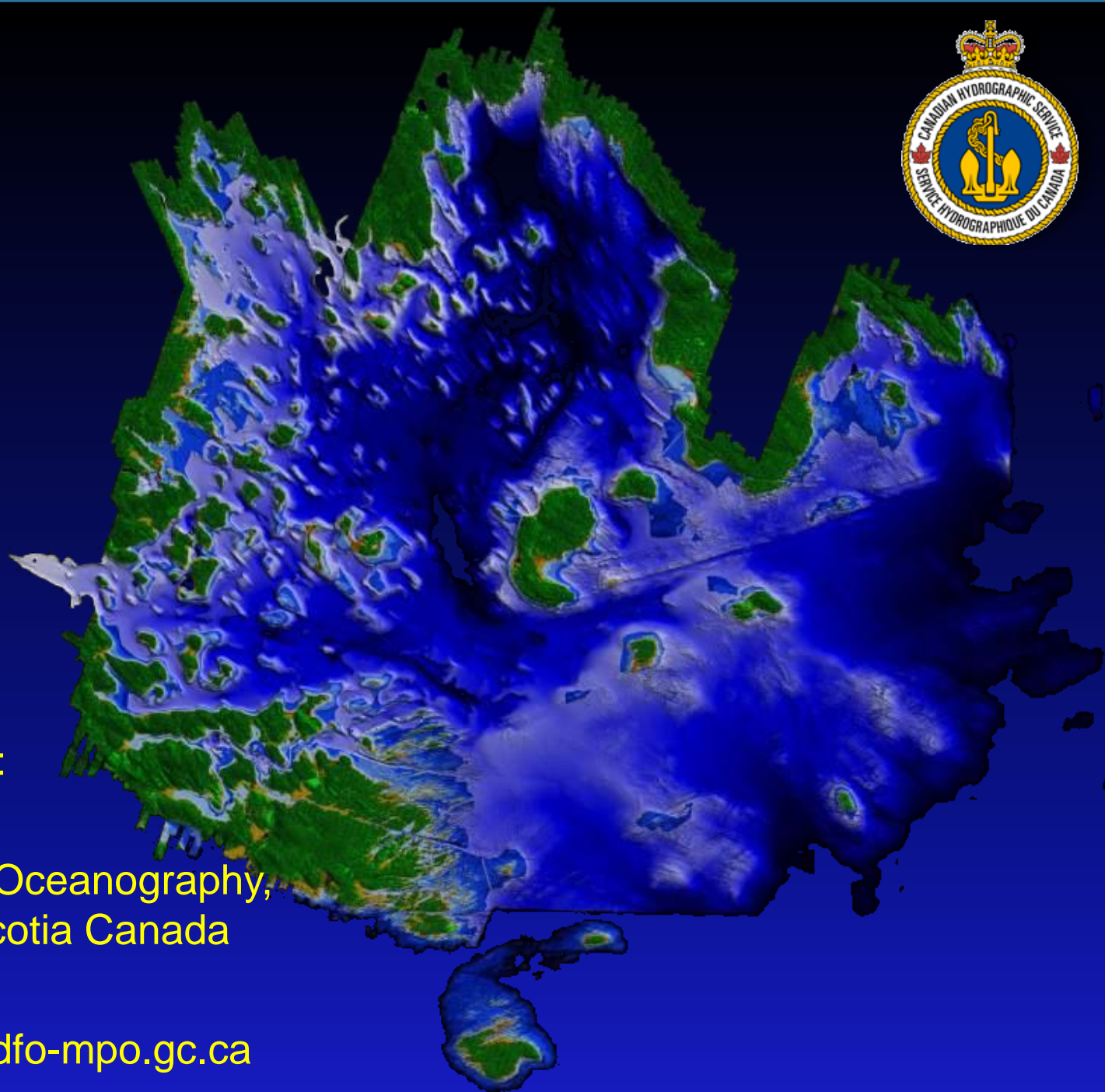
More recently we have been using other optics based technology to supplement traditional sonar.

- Remote Sensing Imagery
- Bathy/Topo LiDAR

Trade-off in Accuracy versus Cost Effectiveness.

Selecting the right technology to match the overall project requirements.





Thank You

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