Action DQWG10-8A
Guidance on stacked quality of bathymetric data. (draft version)

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Introduction
S-100WG has invited the DQWG to reconsider the DQWG position of allowing overlapping Group1 features in S-101 so as to provide an indication of data quality within swept areas in regard to:
- retaining the current DCEG modelling, which allows “vertically” overlapping Quality of Bathymetric Data features; and
- the possibility of an additional indication in the ECDIS where the depth range maximum value for an encoded Depth Area feature is populated as empty (null).

Group1 objects
The group1 objects form the basis of the chart. According to S-57 standard, these objects form the “skin of the earth”. To fulfil this function, the objects of this group have to meet certain quality criteria such as:
- completeness
- topological consistency
- positional accuracy (horizontal component, vertical component).

Recommended minimum data quality results for Group 1 objects:
- Completeness commission = 0%, there are no excess objects present
- Completeness omission = 0%,
- Topological consistency - rate of missing connections due to undershoot = 0%
- Topological consistency - rate of missing connections due to overshoot = 0%
- Topological consistency - rate of self-intersect errors = 0%
- Topological consistency - rate of invalid self-overlap errors = 0%
- Positional accuracy:

positional accuracy	root mean square error of planimetry	horizontal: Max RMSE = E/10000
	root mean square error	vertical: Max RMSE = V_{int} / 6

E = Denominator of the intended scale of mapping.
V_{int} = Normal contour line vertical interval

(values taken from INSPIRE_DataSpecification_EL_v3.0)

The following group1 objects exist:

Object	Definition	Mandatory attributes	Acronym
Depth Area	A depth area is a water area whose depth is within defined range of values.	DepthRangeValue	DRVAL1..2
Dredged Area	An area of the bottom of a body of water which has been deepened by dredging.	DepthRangeValue	DRVAL1
Floating Dock	A form of dry dock consisting of a floating structure of one or more sections which can be partly submerged by controlled flooding to receive a vessel, then raised by pumping out the water so that the vessel's bottom can be exposed.	None	None
Hulkes	A permanently moored ship	None	None
Land Area	The solid portion of the Earth's surface, as opposed to sea, water.	None	None
Ponton	A floating structure, usually rectangular in shape which serves as landing, pier head or bridge support.	None	None
Unsurveyed Area	An area for which no bathymetric survey information is available.	None	None

Group2 Objects
There are several group2 objects which can be classified as having BathymetricDataFeatures. An object that contains the element DepthValueRange is considered to apply to this criteria. The following group2 objects are:

Object	Definition	DRVAL?
Dry Dock	An artificial basin fitted with a gate or caisson, into which vessels can be floated and the water pumped out to expose the vessel's bottom. Also called graving dock.	DRVAL1
Deep Water Route Centreline	A deep water route is a route in a designated area, within defined limits, which has been accurately surveyed for clearance of sea bottom and submerged obstacles to a minimum indicated depth of water. The deep water route centreline indicates the centreline of a route, the width of which is not explicitly defined.	DRVAL1,2
Deep Water Route part	A deep water route is a route in a designated area, within defined limits, which has been accurately surveyed for clearance of sea bottom and submerged obstacles to a minimum indicated depth of water. The complete deep water route consists of one or more parts depending on the shape of the deep water route.	**DRVAL1**,2
Fairway	That part of a river, harbour and so on, where the main navigable channel for vessels of larger size lies. It is also the usual course followed by vessels entering or leaving harbours, called "ship channel."	DRVAL1
Gate	A structure that may be swung, drawn, or lowered to block an entrance of passageway.	DRVAL1
Swept area	An area that has been determined to be clear of navigational dangers to a specified depth.	**DRVAL1**
Recommended route centerline	A recommended route is a route of undefined width, for the convenience of ships in transit, which is often marked by centerline buoys.	DRVAL1,2
Recommended track	A track recommended to all or only certain vessels.	DRVAL1,2
Two way route part.	A two-way route is a route within defined limits inside which two-way traffic is established, aimed at providing safe passage of ships through waters where navigation is difficult or dangerous. A two-way route part is an area of a two-way route within which traffic flow is generally along one bearing (and possibly its reciprocal).	DRVAL1,2

DRVAL1 = The minimum (shoalest) value of a depth range.
DRVAL2 = The maximum (deepest) value of a depth range.

Dry Dock must be covered by Land Area. Gate must be covered by Depth Area or Land Area.

Relation Objects with DRVAL and QualityOfData

DQWG decision tree for the assessment of QualityOfBathymetricData consists of the following elements:

1. Status of assessment
2. Temporal
3. Feature detected
4. Completeness
5. Uncertainty thresholds

By definition assessment means to estimate the magnitude of quality of an item. To survey is to determine boundaries, size, position, shape, contour etc. of an item or object.

DepthArea and DredgedArea are thus always Assessed. Unsurveyed areas are always unassessed. Quality Oceanic is introduced such that there is an assessment of the area which is believed to be sufficient for surface navigation but may not be surveyed according to S-44 standards.

Deep Water Route Part and Swept Area are group2 object with DRVAL1 as mandatory attribute. Deep water route gives guaranteed clearance above a minimum depth (DRVAL1). Following the decision tree for the assessment, this means that the area is assessed, temporal changes are not present or accounted for, all features are detected, the area is completely surveyed and uncertainty is within acceptable limits. A Depth Area will then always lie underneath the Deep Water Route.

A Swept Area is by definition clear of navigational dangers of a specific depth. This means like Deep Water Route it will have to pass all five criteria of the decision tree. Under a Swept Area again a Depth Area must exist as the area has been surveyed, but not always fully to the sea bottom. One may question that if a mechanical sweep is done at a certain depth and the sweep has no contact with the sea floor, how completeness will be achieved? In case there is contact with the sea bottom how is completeness guaranteed? Unlike using Multibeam data there is no picture after acquisition, only vessel track.

Vertically overlapping of Quality Of Bathymetric Data Features is possible. However if only DRVAL1 is known but DRVAL2 is not and hence value set to NULL, one can argue that the area has not been assessed. It has only been assessed to the minimum depth. For a user who is interested in depth less than the DRVAL1 value, the object is assessed and may pass the quality criteria. The maximum depth of the user is thus needed as input to the system to finale determine the quality indicator.