Australian Government
Department of Defence

AUSTRALIAN HYDROGRAPHIC SERVICE

HSPT-1

CATZOC S-57 Point of View

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S57 Zones of Confidence

- ZOC developed for the electronic chart to give mariners a single indicator of the confidence that they can place in the nautical chart.
- Was extended to paper charts
- Each portion of a chart must have a ZOC category assigned.

S57 Zones of Confidence

Four main criteria:

- **Position Accuracy**
  - Horizontal Datum, positioning system
- **Depth Accuracy**
  - Vertical Datum, tided, motion sensor, cross-line comparisons
- **Seafloor Coverage**
  - Swathe system, Single Beam, Sonar Search, Line spacing, shoals investigated
- **Typical Survey Characteristics**
  - Controlled survey, hydrographic survey or other purpose
- **ZOC charted is the lowest value**

S57 specifies technology

1	2	3		4	5
ZOC [1]	Position Accuracy [2]	Depth Accuracy [3]		Seafloor Coverage	Typical Survey Characteristics [5]
A1	± 5 m + 5% depth	=0.50 + 1%d		Full area search undertaken. Significant seafloor features detected [4] and depths measured.	Controlled, systematic survey [6] high position and depth accuracy achieved using DGPS or a minimum three high quality lines of position (LOP) and a multibeam, channel or mechanical sweep system.
		Depth (m)	Accuracy (m)		
		10 30 100 1000	± 0.6 ± 0.8 ± 1.5 ± 10.5		
A2	± 20 m	= 1.00 + 2%d		Full area search undertaken. Significant seafloor features detected [4] and depths measured.	Controlled, systematic survey [6] achieving position and depth accuracy less than ZOC A1 and using a modern survey echosounder[7] and a sonar or mechanical sweep system.
		Depth (m)	Accuracy (m)		
		10 30 100 1000	± 1.2 ± 1.6 ± 3.0 ± 21.0		
B	± 50 m	= 1.00 + 2%d		Full area search not achieved; uncharted features, hazardous to surface navigation are not expected but may exist.	Controlled, systematic survey achieving similar depth but lesser position accuracies than ZOCA2, using a modern survey echosounder[5], but no sonar or mechanical sweep system.
		Depth (m)	Accuracy (m)		
		10 30 100 1000	± 1.2 ± 1.6 ± 3.0 ± 21.0		
C	± 500 m	= 2.00 + 5%d		Full area search not achieved, depth anomalies may be expected.	Low accuracy survey or data collected on an opportunity basis such as soundings on passage.
		Depth (m)	Accuracy (m)		
		10 30 100 1000	± 2.5 ± 3.5 ± 7.0 ± 52.0		
D	worse than ZOC C	Worse Than ZOC C		Full area search not achieved, large depth anomalies may be expected.	Poor quality data or data that cannot be quality assessed due to lack of information.
U	Unassessed - The quality of the bathymetric data has yet to be assessed				

AHO Appraisal Implementation of CATZOC

CATZOC allocated by HO	Data acquisition method			Comments
A1	MBES survey meeting required accuracies, full seafloor coverage and feature detection requirements			Restricted to hydrographic surveys conducted for safety of navigation; scientific research surveys or environmental surveys are not considered to meet the required methodology or feature detection requirements. LIDAR is not considered to meet the required feature detection requirements.
A2	MBES or SBES and SSS achieving required accuracies, full seafloor coverage and feature detection	LIDAR using scan settings and line spacing achieving full seafloor coverage and feature detection		Must be evidence of feature detection and investigations to determine least depths. Normally restricted to hydrographic surveys for safety of navigation; scientific research or environmental surveys unlikely to meet required methodology or feature detection requirements.
B	SBES survey meeting required accuracies, and meeting minimum RAN line spacing requirements for water depth	Scientific research or environmental MBES surveys meeting required accuracies and coverage equivalent to RAN line spacing requirements for water depth	LIDAR not achieving full seafloor coverage	Evidence of interlining and shoal investigations expected in shallow water. Sextant positioning using floating beacons is not considered to meet horizontal accuracy requirements.
C	Controlled systematic surveys not meeting ZOC B accuracy or	Opportunity soundings meeting required accuracy requirements		This category often contains controlled systematic hydrographic surveys which cannot meet ZOC B accuracy requirements once transformed to WGS84

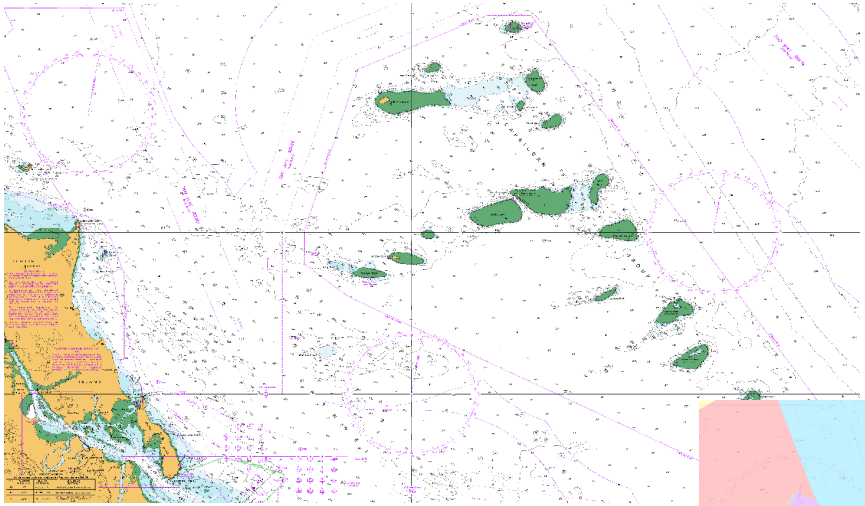
Current AHO Appraisal Process

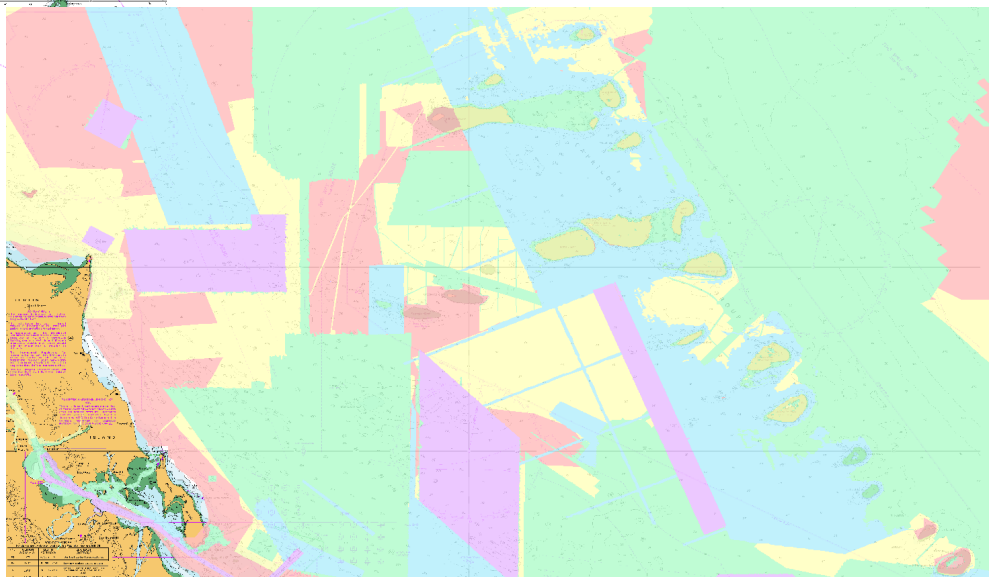
- **Visualise**
  - Visualise, Thin, Convert to common format
- **Determine accuracies achieved**
  - Examine Survey Report for achieved accuracies, feature detection, seafloor coverage
- **Shift to Chart Datums**
  - WGS84 and LAT
- **Allocate quality attributes**
  - Based on S57 ZOC criteria required for charting

ZOC Assessment Limitations

- **Lack of metadata**
  - Datums, methods, uncertainties achieved
- **Inconsistencies**
  - Artifacts in sounding dataset larger than claimed accuracies in Survey Report
- **Survey processing**
  - Tidal reduction method, data thinning/gridding
- **Survey Purpose**
  - Feature detection, least depths determined
- **Results in lower ZOC allocation than the survey could get**
  - Data deconfliction implications

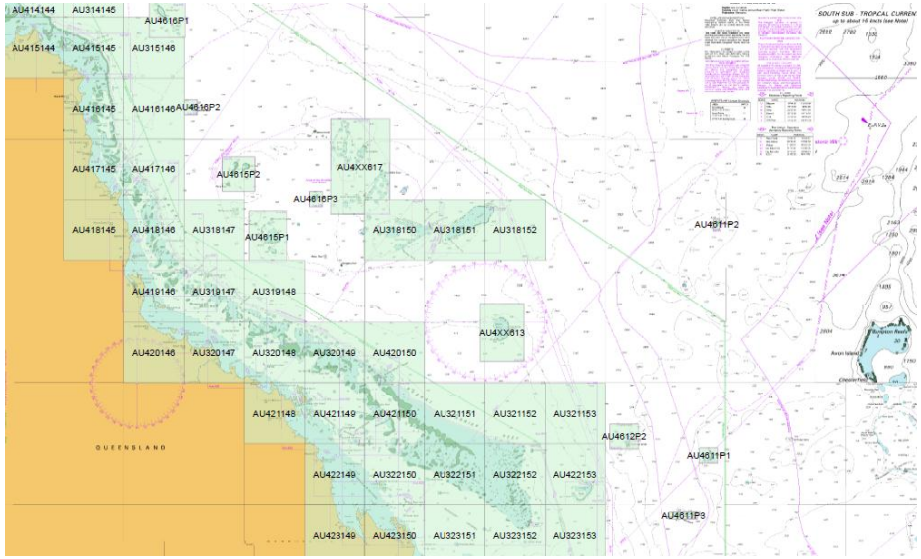
Next step is combining bathy for chart compilation



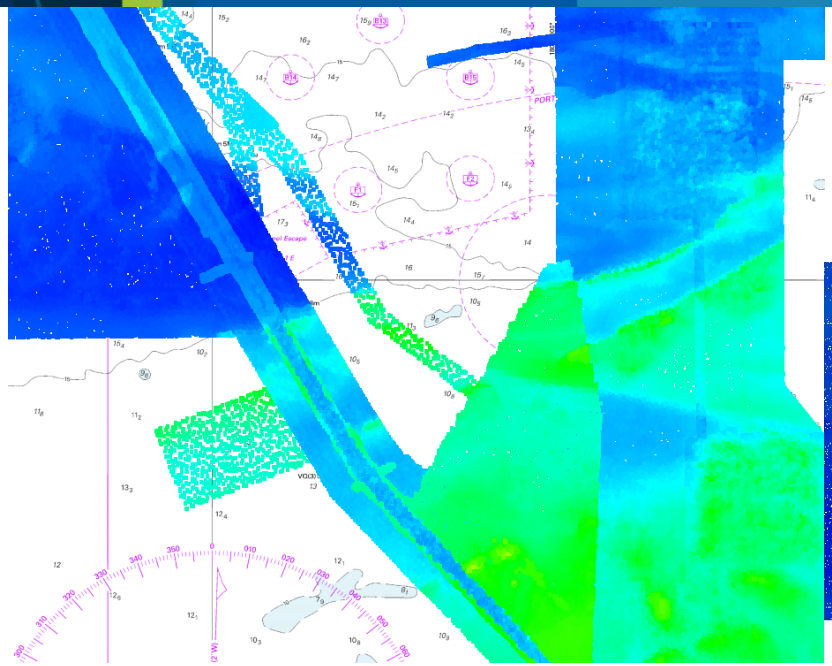


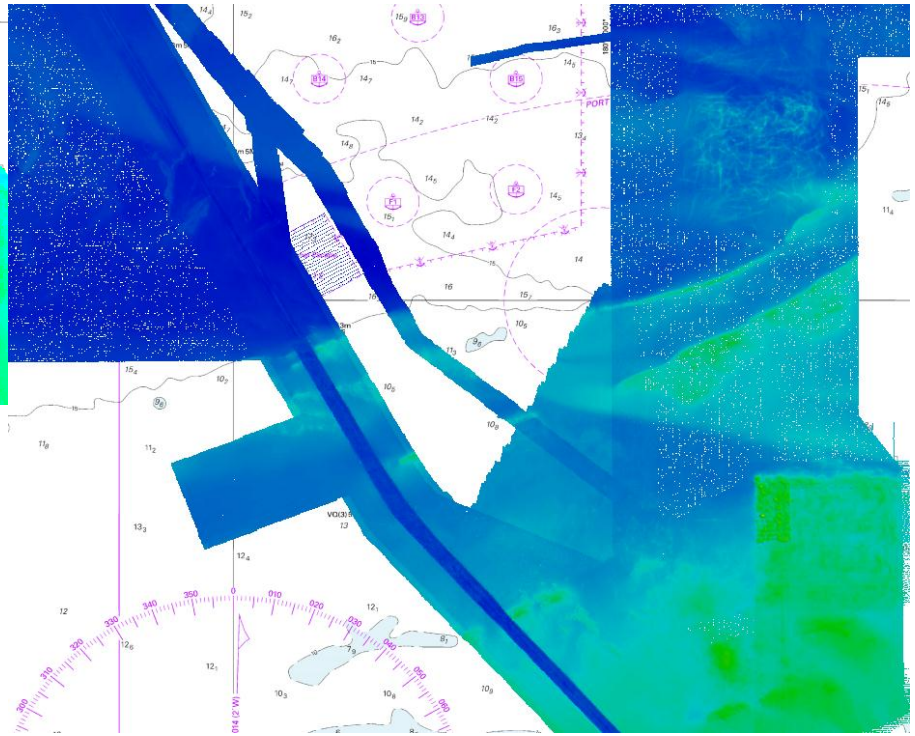
Caris Bathy Database Combine

- **Aim: One Combine Rule**
- **Combine all source each time**
  - Maintains source
- **Combine by 1° cells**
  - Speed
  - Manage changes



Deconfliction





Combine based on Quality Attributes

Attribute	Item/Description [Example or Format]	Value
CATZOC	Overall ZOC allocated	A1
depthv	Depth ZOC	A1
positn	Position ZOC	A1
seacov	Seafloor coverage	Y
surcha	Survey Characteristics	A1
SUREND	Survey end date	20170211
tmpvar	Seafloor Temporal Variation	***Likely to change***
OBJNAM	Survey ID	DSID3306688
feadet	Feature detection system	Kongsberg EM2040C (320kHz) multibeam
horpos	Horizontal positioning method	APPLANIX POS MV V5 RTK – Position and Orientation System. Differential Corrections: Marinestar HP GNSS Differential Service.
POSACC	Accepted positional accuracy	1.5
SOUACC	Accepted soundings accuracy	0.3
SURATH	Survey authority	MSQ – Hydrographic Services
surchg	Surveyor in charge	Brendan Elliott CPHS1
SURSTA	Survey start date	20160211
surtle	Survey title	GL030012 - Gladstone Calliope River Survey 2016
suunit	Survey Unit	QG Norfolk
swathe	Swathe system	Y
swpsys	Sweep system	N
TECSOU	Sounding technique	***echo-sounder*** ***mulit-beam***
verpos	Vertical positioning method	Soundings reduced to LAT using a linear model consisting both observed and

- **Quality Attributes**
- **Assigned to all validated bathymetry**
- **Bathy separated in areas of like quality**
- **Mandatory in Green used for current Combine Rules**

Deconfliction Rules

1. tmpvar = Event
2. depthv is least (best)
3. positn is least (best)
4. SUREND is greatest (most recent)
5. CATZOC is least (best)
6. Z value is least (shoalest)

Background – AHO Approach

- **Issues:**
  - Mis-alignment between S44 and S57
  - Grids
  - Feature detection
  - New technology (LIDAR, SDB, laser scanners)
  - Datum transformations to WGS84/LAT
  - TVU/THU of FSD

S44 Ed6 Questions

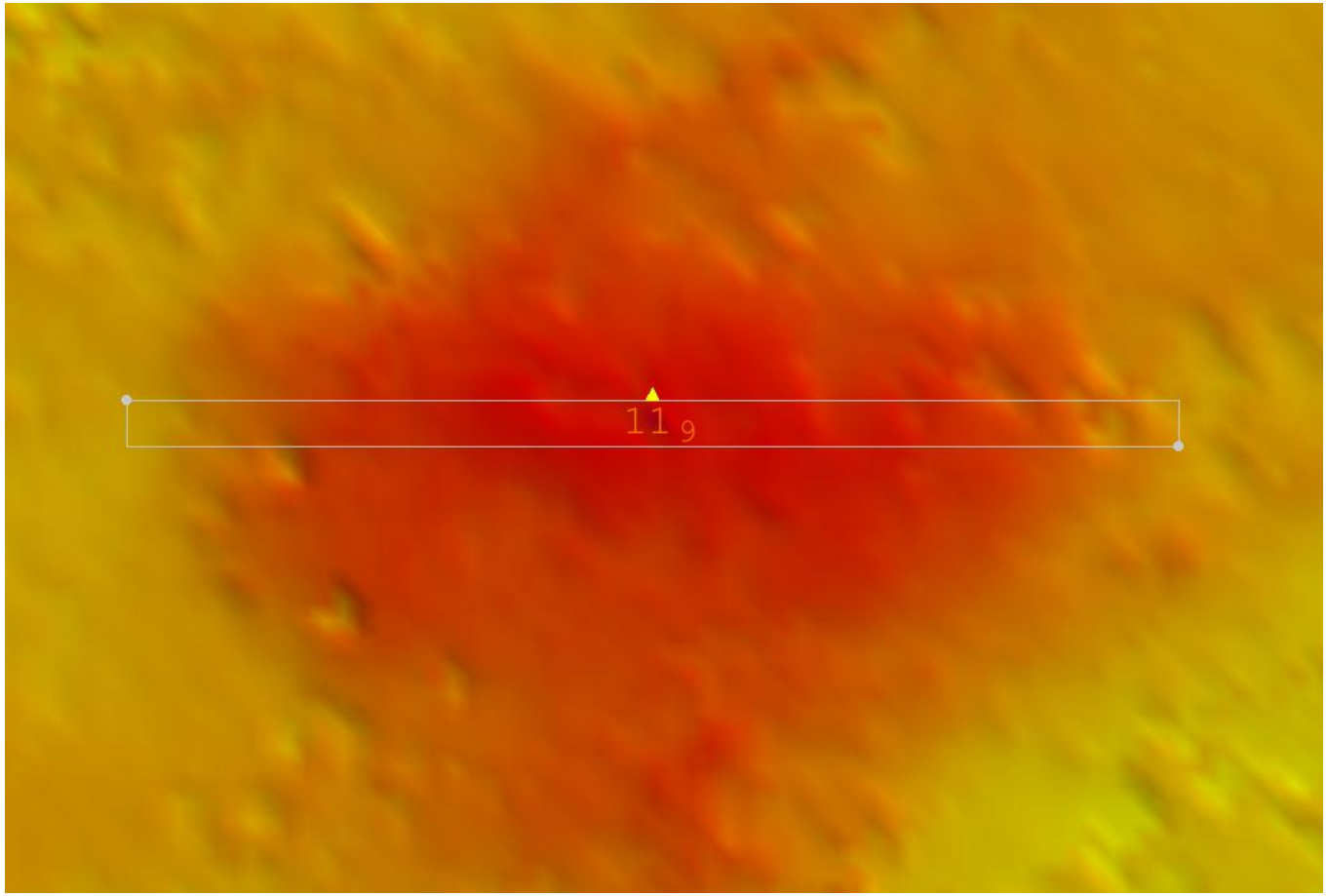
- **S44 for nautical charting / safety of navigation surveys only**
- **Safety of navigation means more than surface navigation**
  - Relates to feature detection requirements
- **Should S44 specify Datums**
  - Consistent with IHO product datums

S44 Ed6 Questions

- **Should S44 specify Mandatory Metadata**
  - Required for use in navigation products
  - Could assign a Metadata Quality Indicator
- **TVU / THU**
  - Applicable to final survey data not field soundings
- **Status of C-13**
  - Should S44 reference C-13 for definitions such as datums, feature detection etc

GRIDS

- **S44 specifications need to apply to the GRID not field soundings:**
  - TVU/THU
  - Features retained
  - Least Depths retained
  - Interpolation?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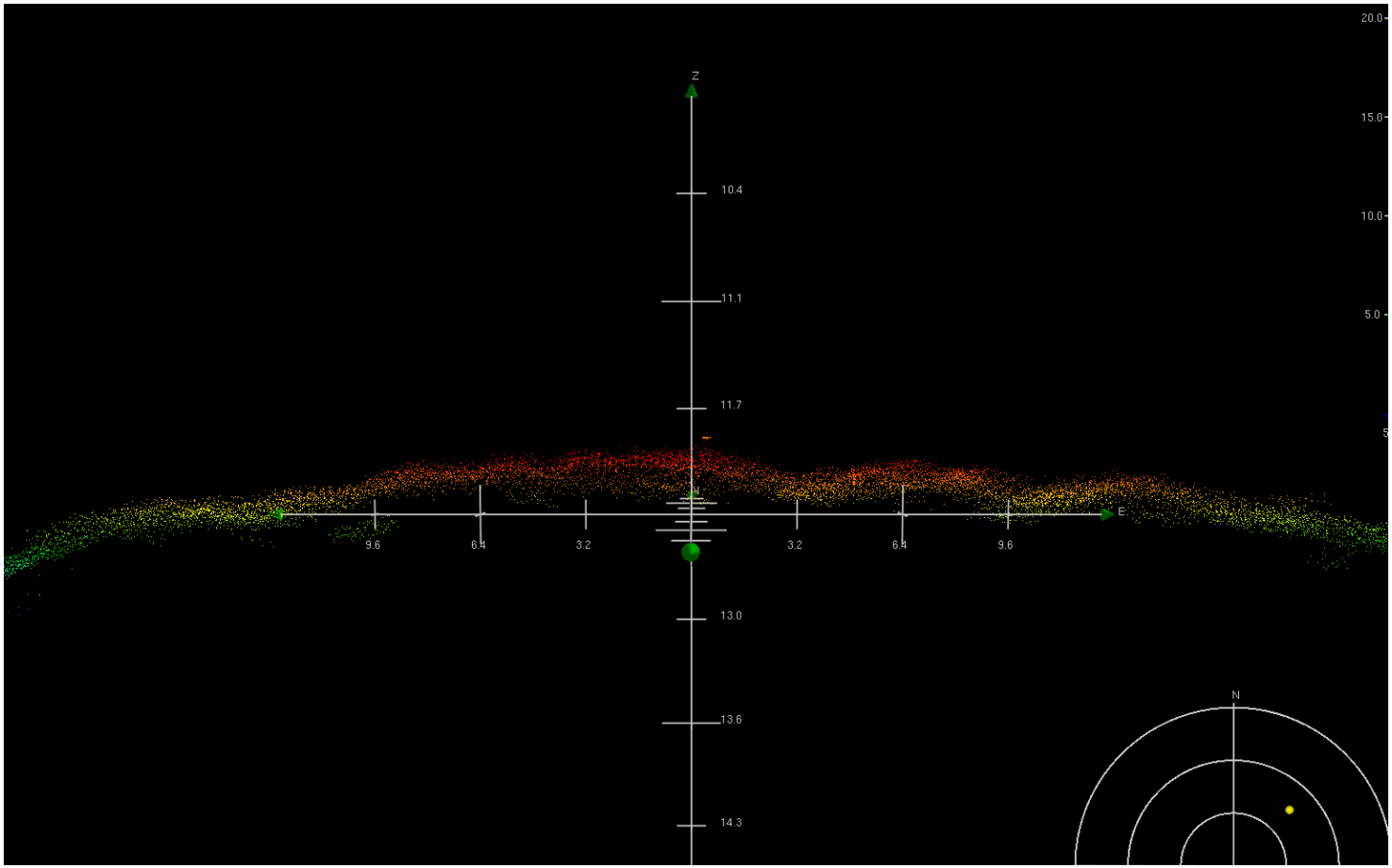
Z
10.4
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13.0
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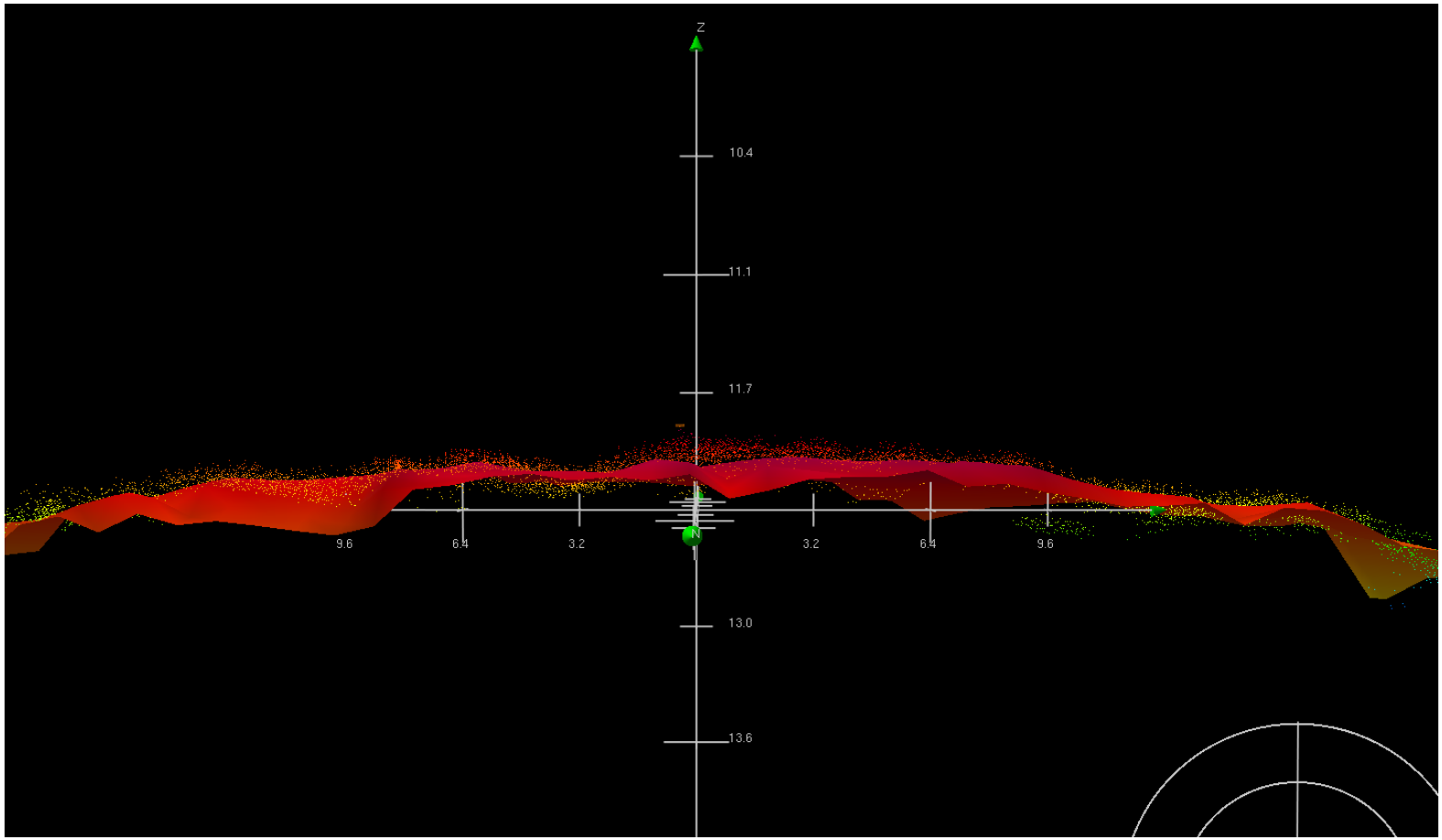
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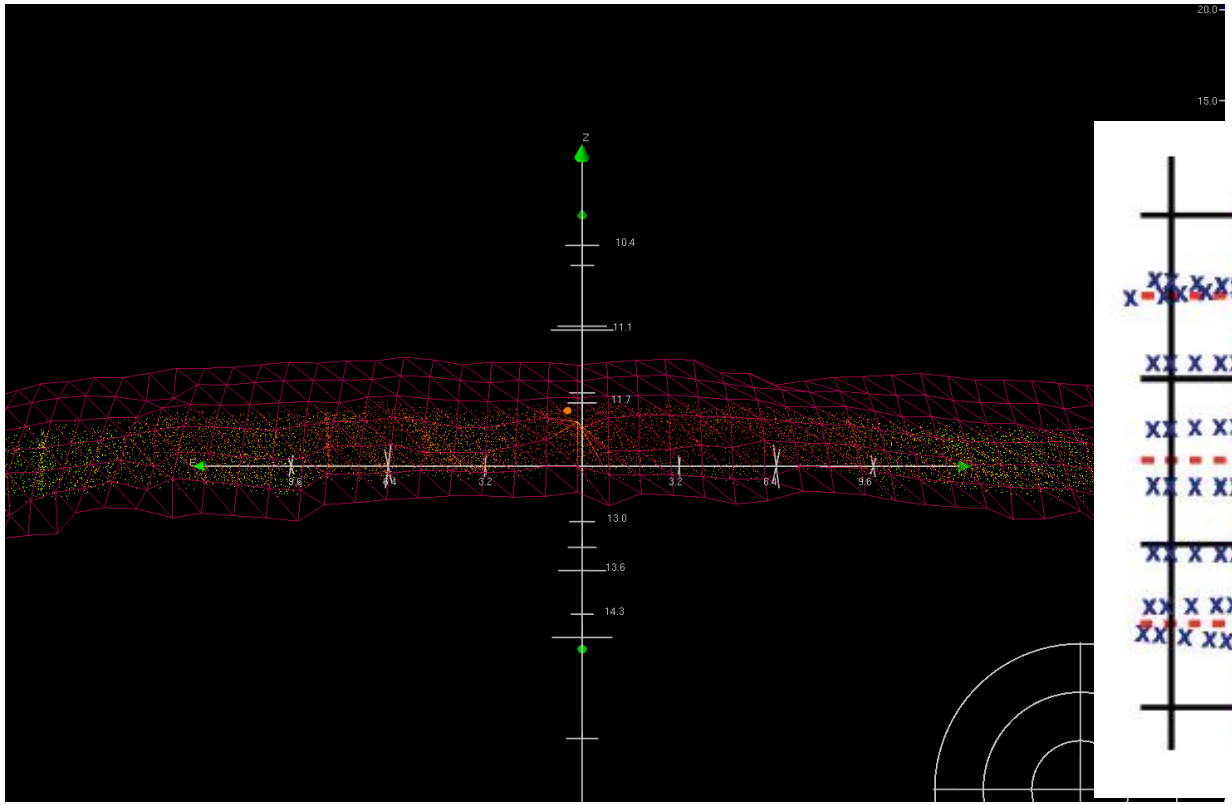
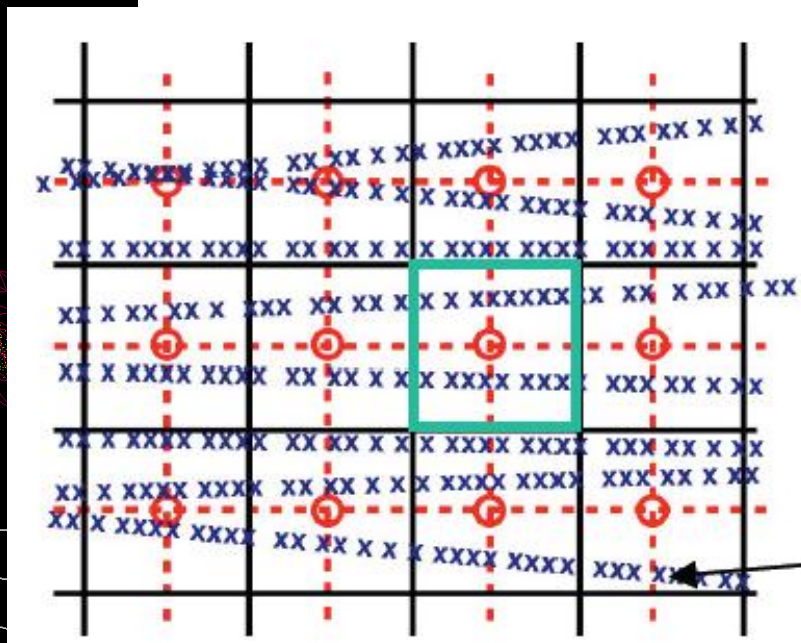
GRIDS – THU Implications

- Soundings vs Grid Nodes





Feature Detection

- **Should link to C-13 to specify:**
  - what is mean by ‘feature detection’ eg:5 pings on target
  - what is meant by ‘full sea floor search’
- **Why depth specific?**
  - 1m and 2m cube; 40m
  - Full seafloor search limited to 100m
  - AUV surveying

New Technology

- **Try and de-couple S44 from survey technology**
  - Will continue to change and date any spec
  - Impossible to predict the future
- **New navigation product technology**
  - S101 (eg: tmpvar)
  - UKC systems
  - Enhanced ENCs
  - Inland ENCs (SuAc 1.1)
  - Seafloor type (harder the bottom more critical TVU)

Survey Processing

- **GRIDS**
  - resolution
- **CUBE**
  - TPUs
- **Datum Transformation uncertainties**
- **Interpolation/Thinning/Filtering**

Background – Australian Ports Approach

- **PA Principles for Gathering and Processing Hydrographic Information in Australian Ports**
  - Supplement to S44
  - Performance standard do not specify process
  - Covers:
    - Personnel
    - Survey Frequency
    - Survey Methodology
    - Class of Survey
    - Documentation (Method Statement; Survey Report)

6.1.2 Bathymetric Data Quality

- Bathymetric data quality comprises the following:
  - completeness of data (For example, seafloor coverage).
  - currency of data (For example, temporal degradation);
  - uncertainty of data;
  - source of data;
- Data quality can be encoded at three different metadata levels (dataset, feature, feature instance).All positional (2D), vertical (1D), horizontal distance (1D) and orientation (1D) uncertainty attributes concern the 95% confidence level of the variation associated with all sources of measurement, processing and visualization error. Uncertainty due to temporal variation should not be included in these attributes.
- The meta feature for Bathymetric data quality is: Quality Of Bathymetric Data,

S101

S-101 Metadata Feature: Quality of Bathymetric Data (M_QUAL)				
Primitives: Surface				
Real World	*Paper Chart Symbol*	*ECDIS Symbol*		
S-101 Attribute	**S-57 Acronym**	**Allowable Encoding Value**	**Type**	**Multiplicity**
Category of temporal variation		1 : unassessed 2 : event 3 : likely to change 4 : likely to change but significant shoaling unlikely 5 : unlikely to change	EN	1,1
Depth range maximum value	(DRVAL2)		RE	0,1
Depth range minimum value	(DRVAL1)		RE	0,1
Features detected			C	1,1
Least depth of detected features measured			(S) BO	1,1
Significant features detected			(S) BO	1,1
Size of features detected			(S) RE	0,1
Full seafloor coverage achieved			BO	1,1
Horizontal position uncertainty	(POSACC)		RE	0,1
Survey date range			C	1,1
Date end	*(SUREND)*	ISO 8601:2004	(S) TD	1,1
Date start	*(SURSTA)*	ISO 8601:2004	(S) TD	0,1
Vertical uncertainty	*(SOUACC)*		RE	0,1

Comment [A37]: Category of temporal variation is also a spatial attribute. Will need to be reconciled (see comment at 2.4.7).

Comment [A38]: DQWG discussion: This may be optional in the final modeling.

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Deleted: Technique of vertical measurement ... [1]

Summary

- Update S44 for contemporary accuracies
- Align with S57 / S101 M_QUAL
- S44 remain focused on navigation/ charting surveys
- Grids not Soundings current bathy deliverable