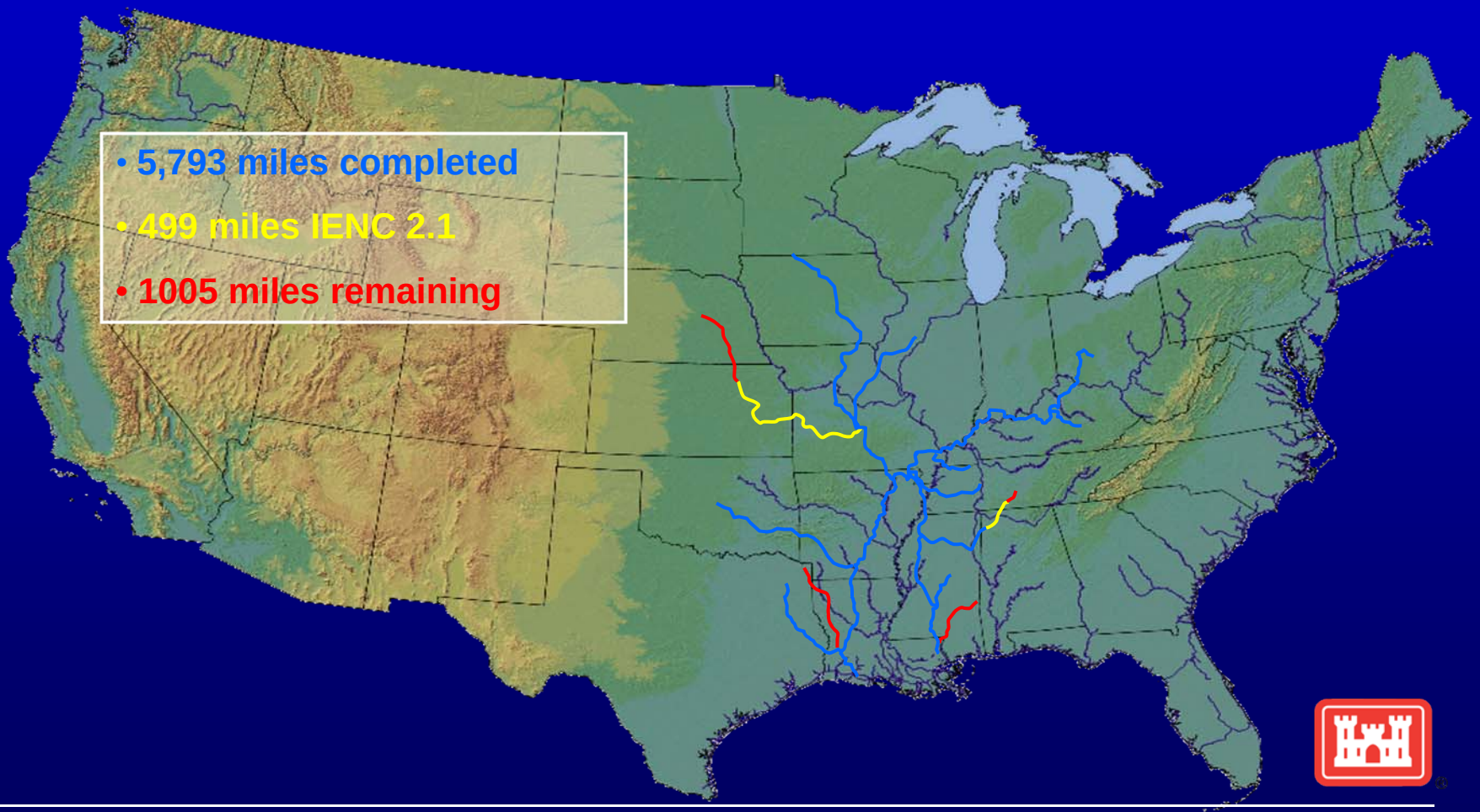
Development and Use of Bathymetric River Information Overlays

Dr. Lee Alexander, Univ. of New Hampshire
lee.alexander@unh.edu

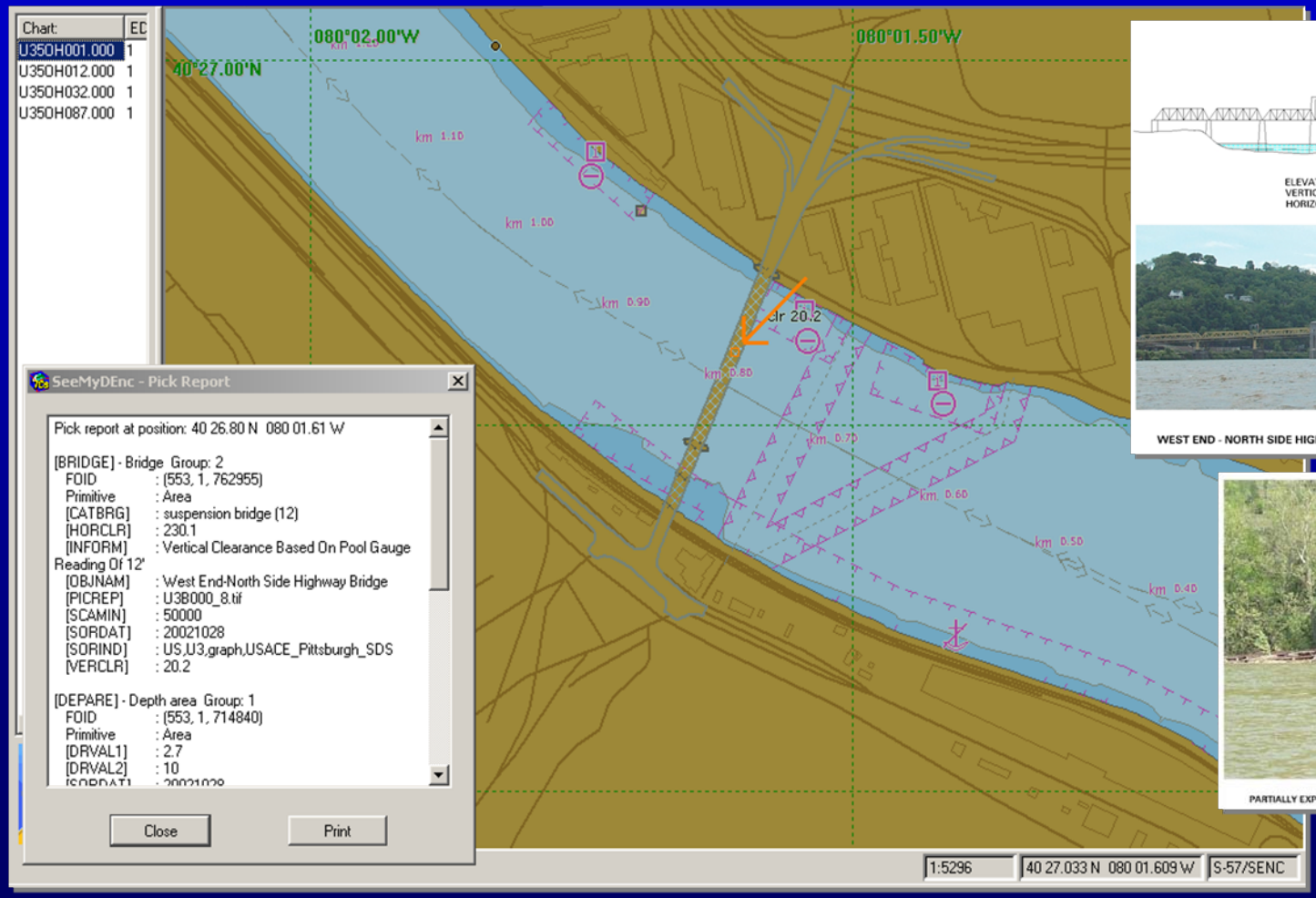
Inland ENC Coverage in USA

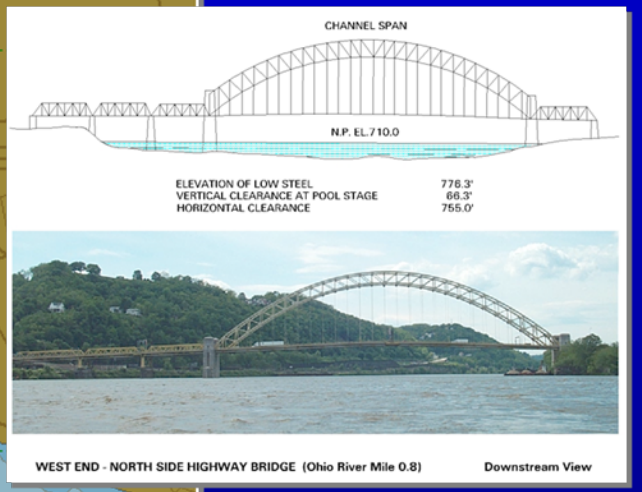
7297 mi. of inland waterways/rivers are scheduled for IENC Coverage



Primary Benefit of IENCs

Accurate, Up-to-Date Information on Inland Waterways





BUILDING STRONG®

Now that there is almost “complete” Inland ENC coverage…

- Need “better” electronic chart information:
  - From recent hydrographic surveys
  - Contains more precise/accurate depth information
    (e.g., soundings, contours, & depth areas at 10cm intervals)
  - Use as a supplemental layer to Inland ENCs
  - Display using alternative color schemes
  - Can be used for decision-support:
    - Under-keel clearance
    - Vertical draft
    - pre and post-dredging surveys

Bathymetric River Information Overlay (RIO)

R&D initiative to convert high-density hydro survey data into an IHO S-57 based RIO.

- Data from single-beam or multi-beam echosounder
- A supplemental layer to Inland ENCs
- Used with Inland ECDIS or ECS

Joint University – Industry R&D Project

University of New Hampshire & "Industry Partners":

HYPACK

SevenCs

CARIS

Overview

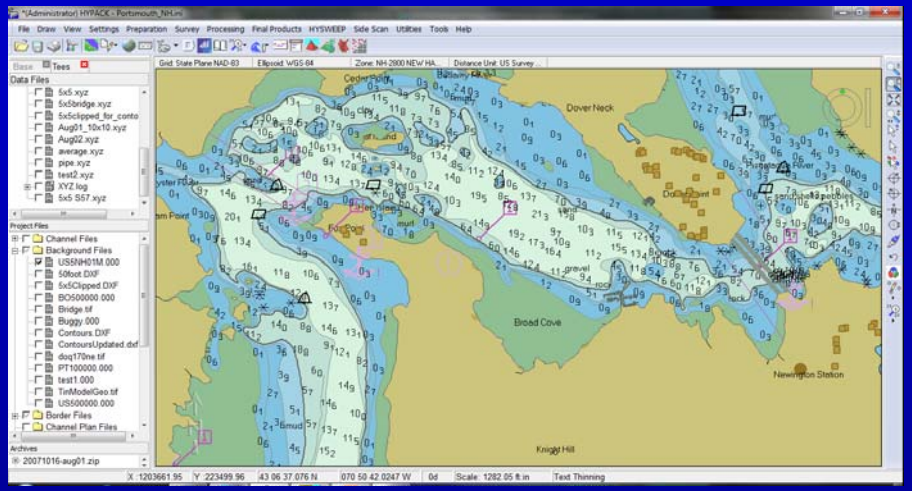
1. For each company (HYPACK, SevenCs, & CARIS) a brief explanation of:
   - Basic process/steps (hydro survey → database → Bathy RIO)
   - Software tools used
2. Some examples of how RIOs are used/displayed
   - USCG Buoy tenders on Ohio River
   - Columbia River (Oregon)
   - Europe, South America, & Asia
3. Bathy RIO Product Specification
   - Harmonization Group on Marine Information Overlays
   - [International] Inland ENC Harmonization Group

HYPACK

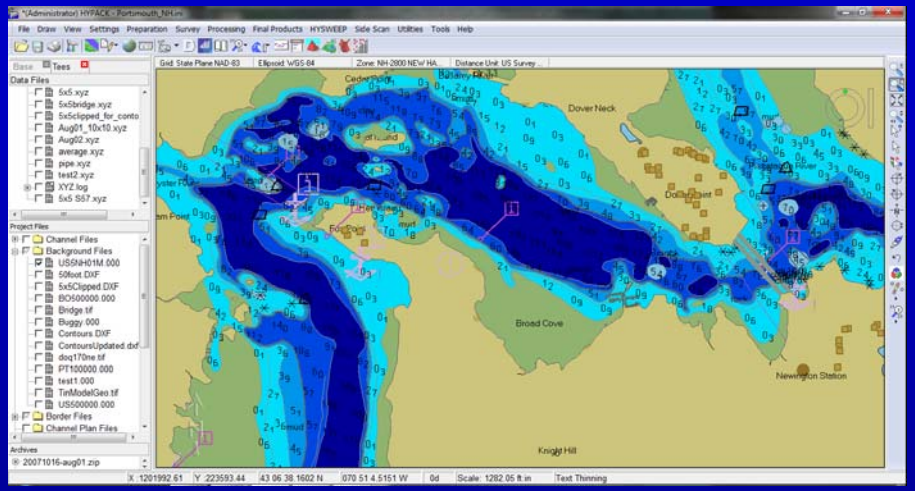
In *HYPACK 2012* release, new ways to produce & display S-57 data obtained from recent hydro surveys:

- Create new depth areas and contours at 10cm intervals.
- Remove “unused” contours from the display.
- Use new color schemes for the display of depth areas
- Adjust shallow and safety depths due to water level.
- Adjust shallow & safety depths based on under-keel clearance.
- Check for vertical clearance based on vessel air draft.

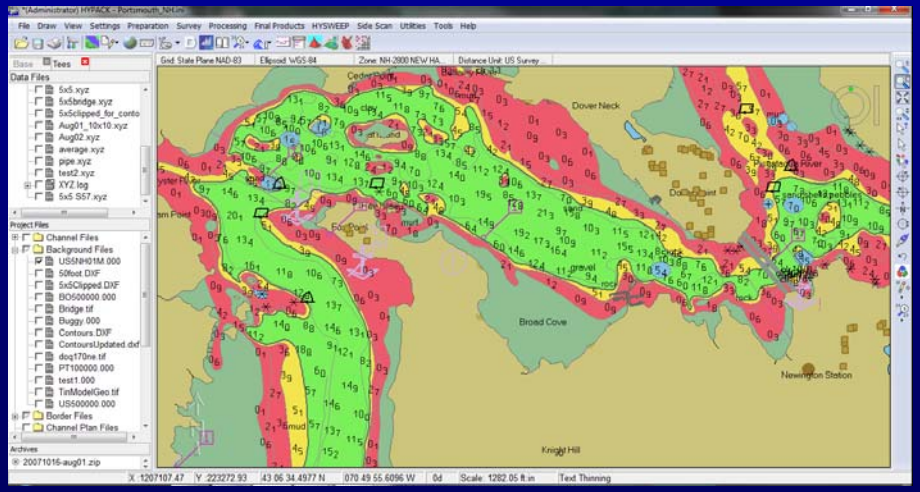
Alternative Color Schemes



Traditional IHO S-52



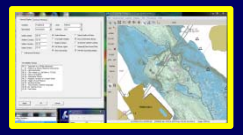
Bathymetric Blue



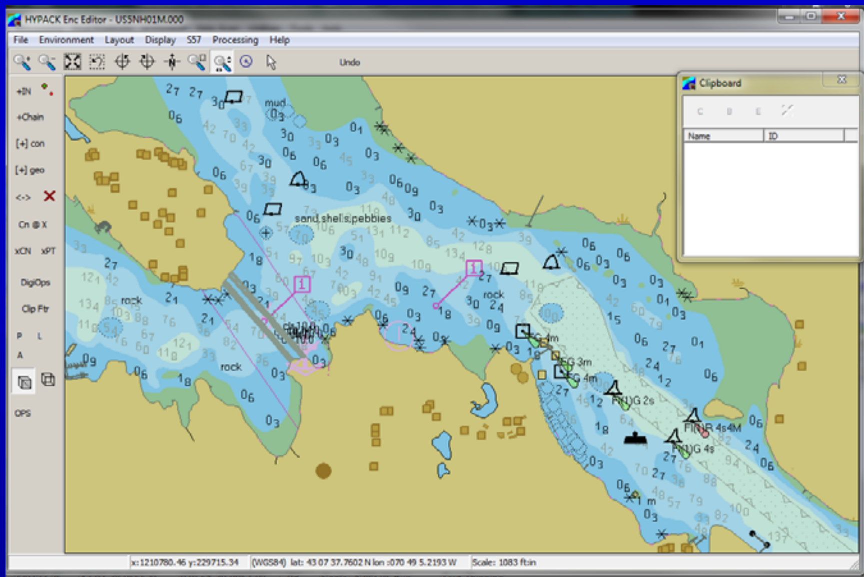
Red-Yellow-Green

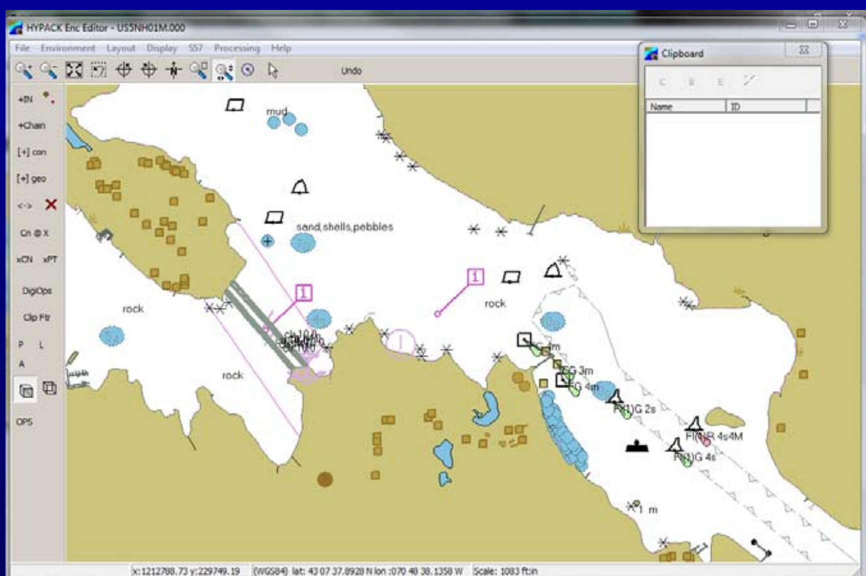
- These schemes are set in either the *HYPACK SHELL* or the *ENC EDITOR*.
- Will be maintained in subsequent programs (*HYPACK SURVEY, HYPLOT*, etc.)
- Click on the box below to launch the AVI that demonstrates the changing of the schemes in the *ENC EDITOR*.

AVI

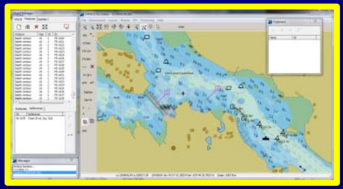


Removing Existing Depth Data



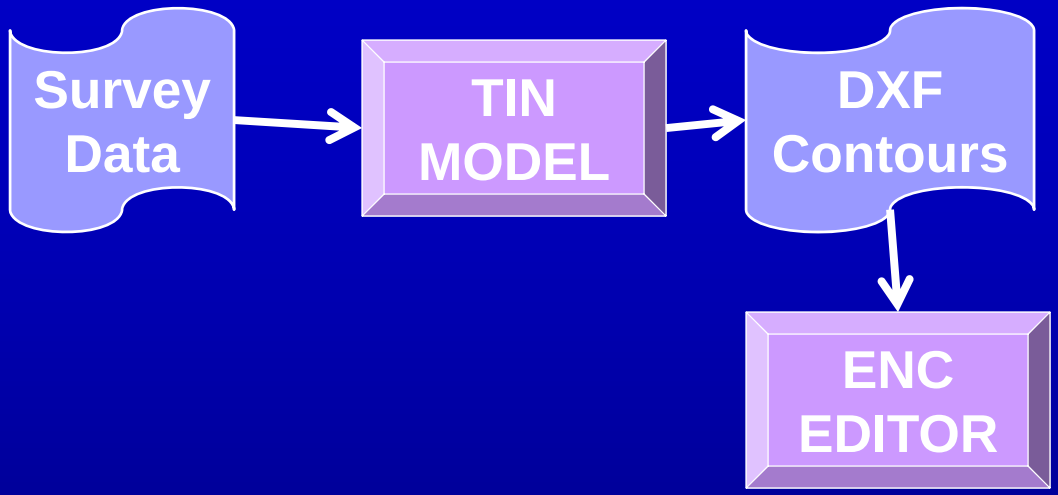


- Load an S-57 chart.
- Click 'Processing – Remove Depth Areas, Contours and Soundings'.

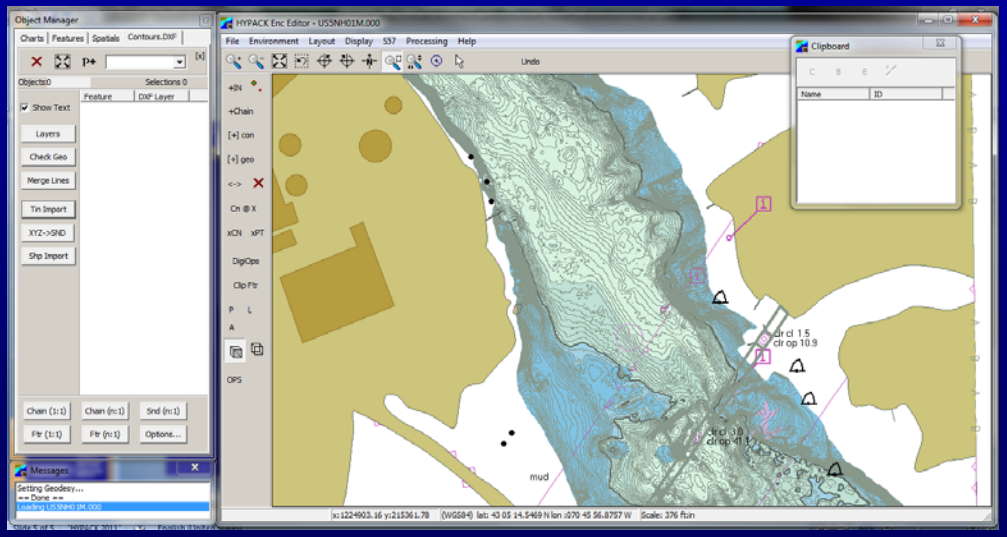


AVI

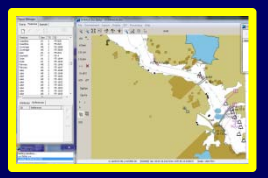
Creating New Depth Areas and Contours



- Create a new contour file from your most recent soundings in HYPACK's *TIN MODEL*.
- Import the DXF file into the *ENC EDITOR*.
- Automatically convert the polylines to S-57 Contour line features.
- Automatically convert the solid fill areas to S-57 Depth Areas.

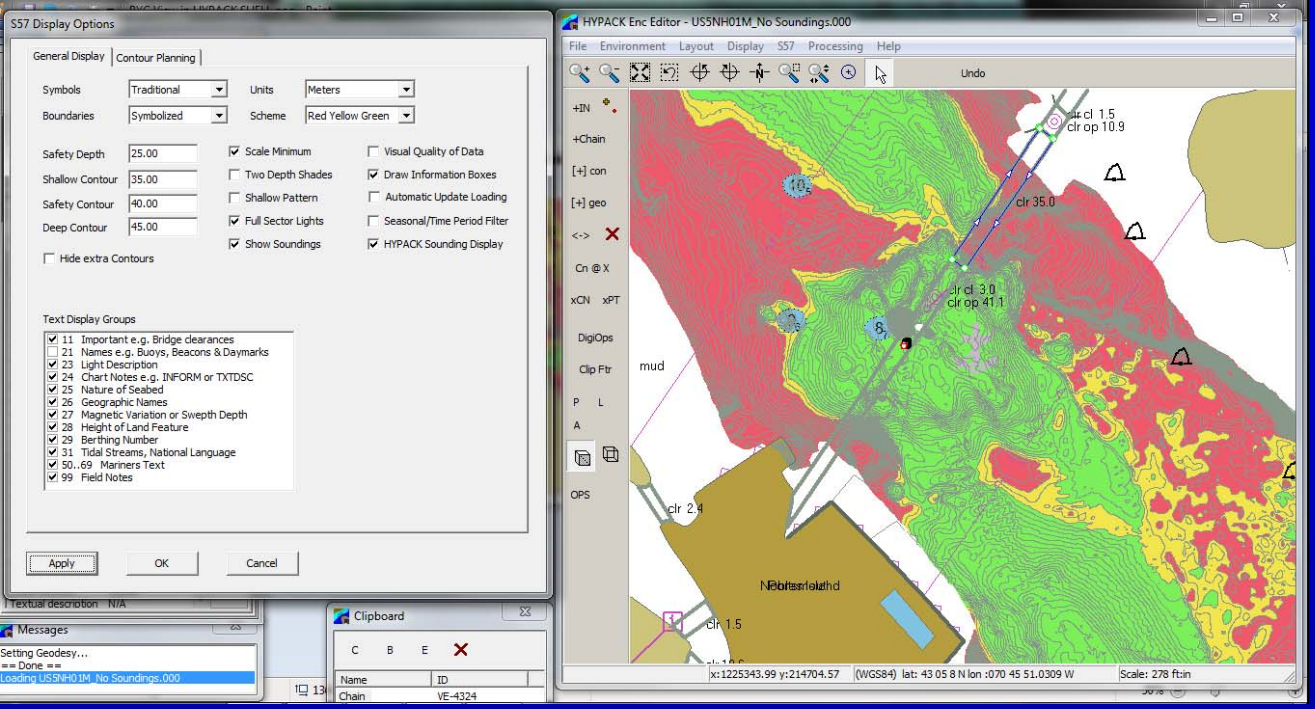


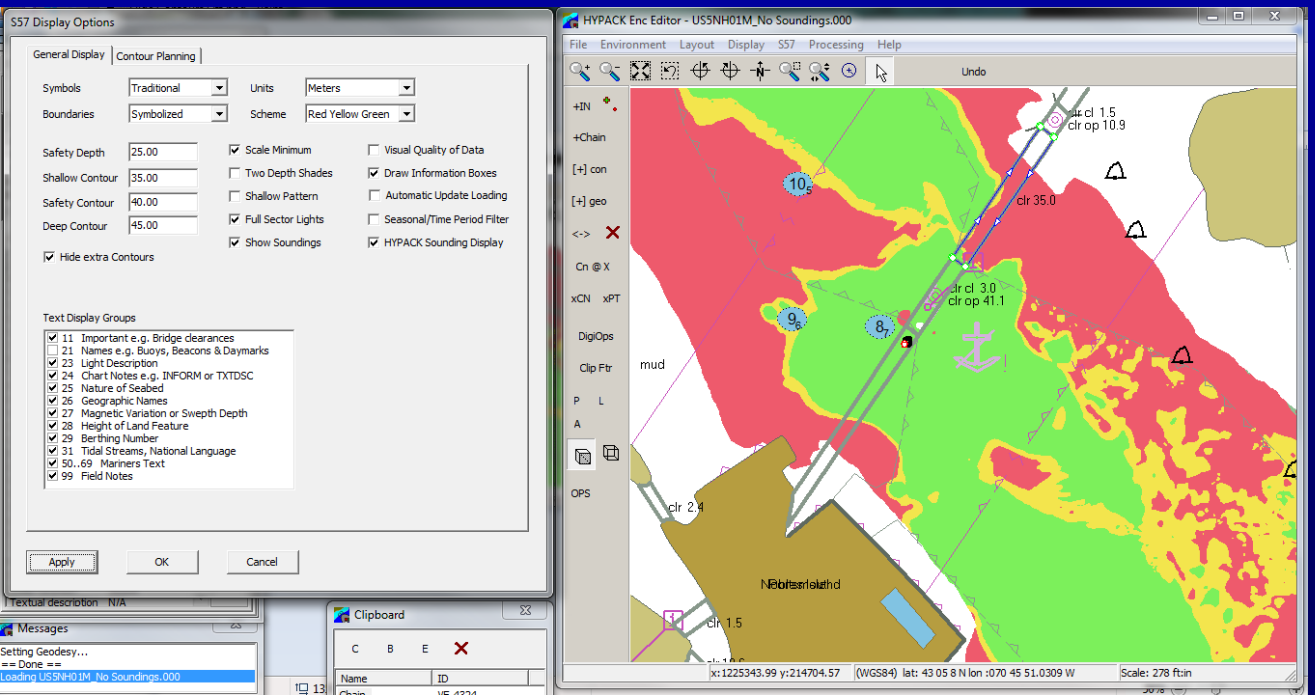
AVI



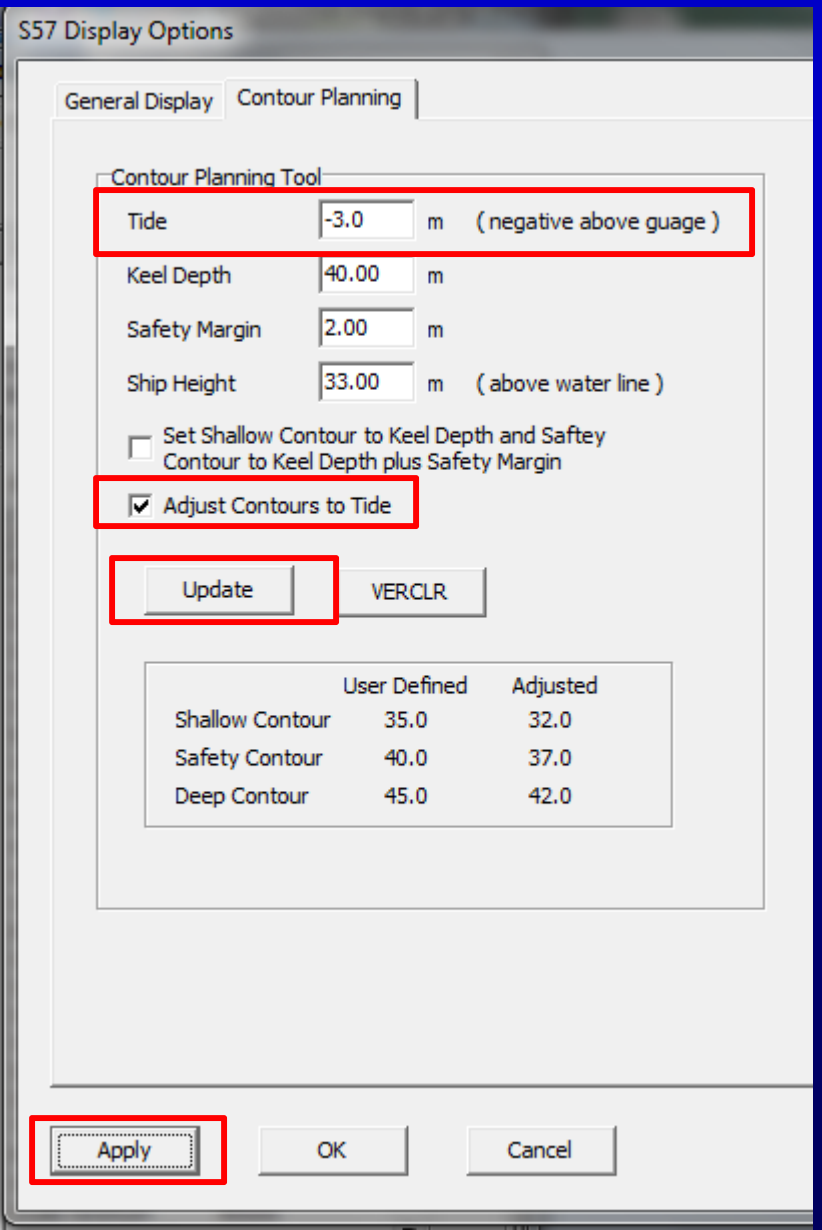
Hiding Unused Contours

- To remove “extra” (i.e., not needed) contours from the display, go to the Display Options window and change the ‘Hide Extra Contours’ check box.

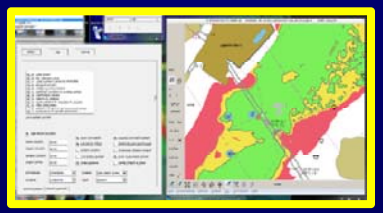




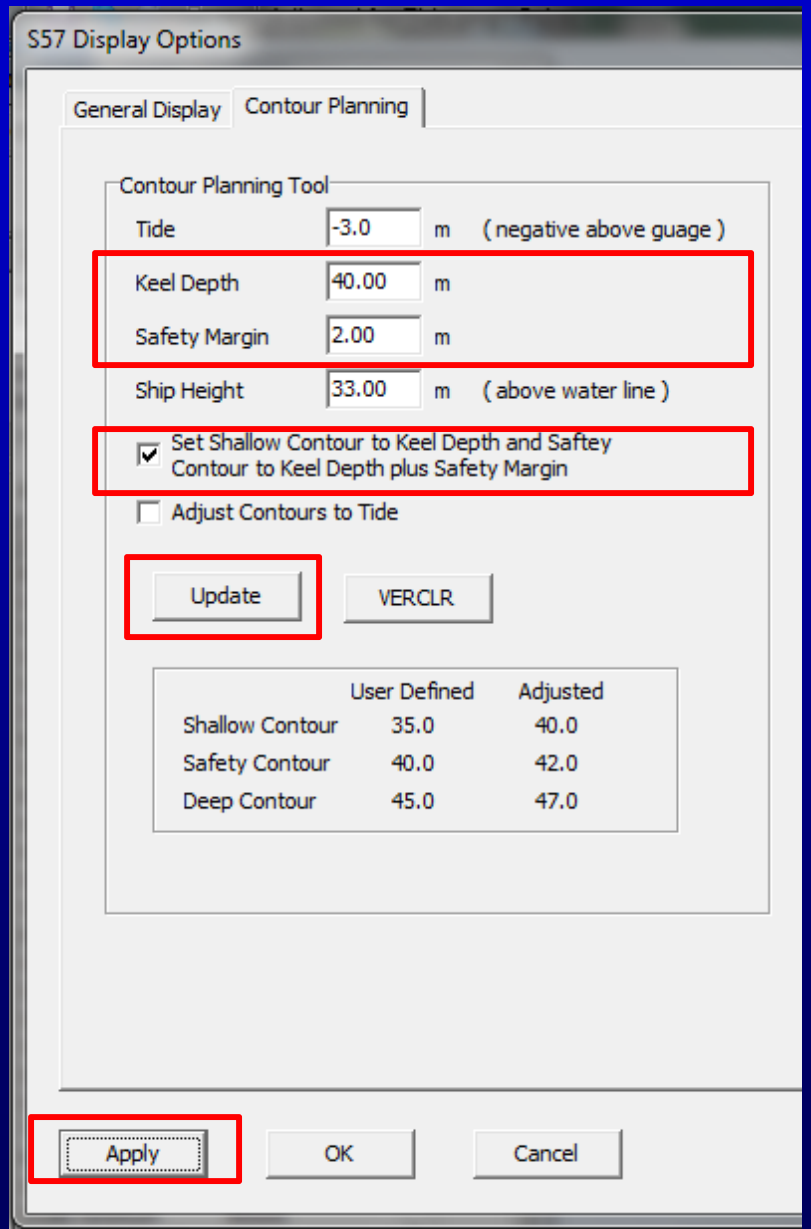
Adjusting Depth Areas for Water Level



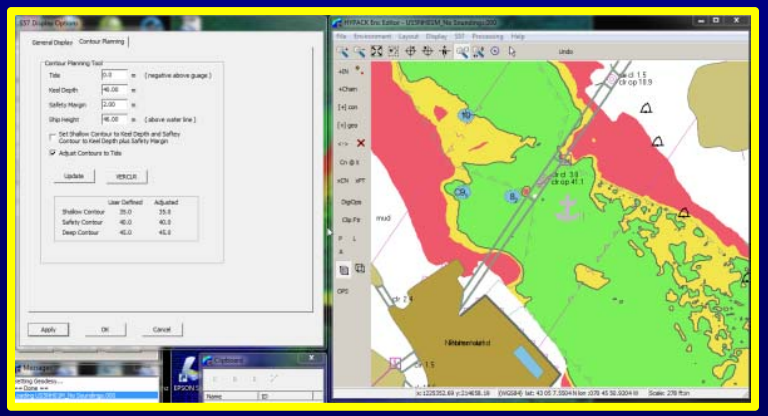
- Go to Display Options Window – Contour Planning tab.
- Enter the Tide
  - Negative if the water level is above gauge!
- Set ‘Adjust Contours to Tide’ to ‘On’.
- Click ‘Update’ to see the changes to the contour display.
- Click ‘Apply’ to see the changes in the chart display.

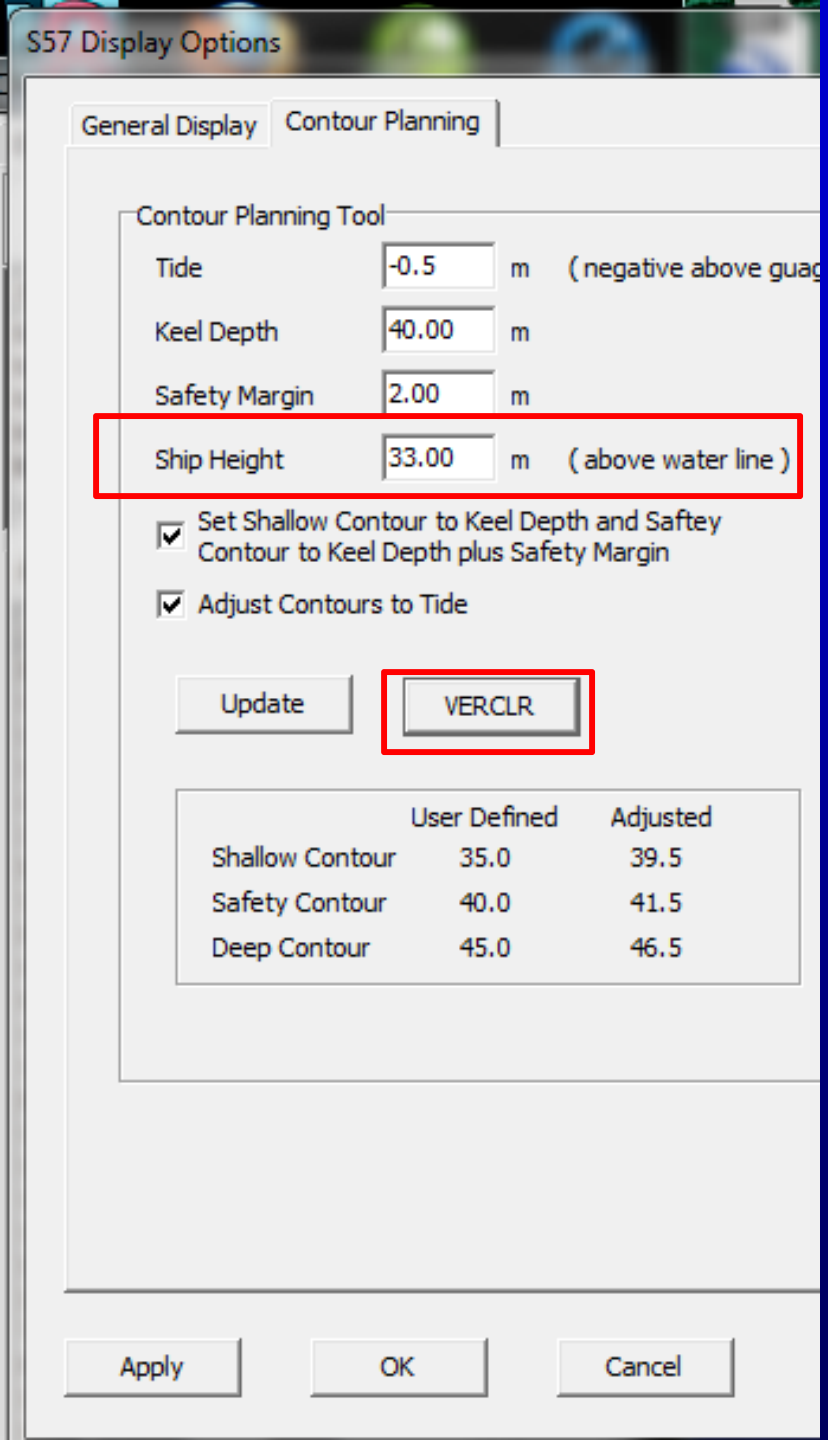


Adjusting Depth Areas for Under-keel Clearance



- Go to Display Options Window – Contour Planning tab.
- Enter the Keel Depth and Safety Margin.
- Check ‘Set Shallow Contour to Keel Depth….’ to ‘On’.
- Click ‘Update’ to see the changes to the contour display.
- Click ‘Apply’ to see the changes in the chart display.

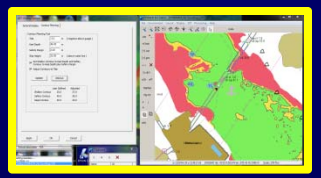




Vertical Clearance.

- Go to the Display Options Window – Contour Planning Tool.
- Set the 'Ship Height' value.
- Click 'Update' and then 'Apply'.
- Click the VERCLR button.
- A table will appear with a listing of the S-57 objects which the ship will not clear.

  Based on the current water level/tide conditions.



AVI

- All features will be standard in the *HYPACK 2012* release.
- HYPACK will modify the *HYPACK SURVEY* program to have the same *DYNAMIC* ENC display in the coming months.

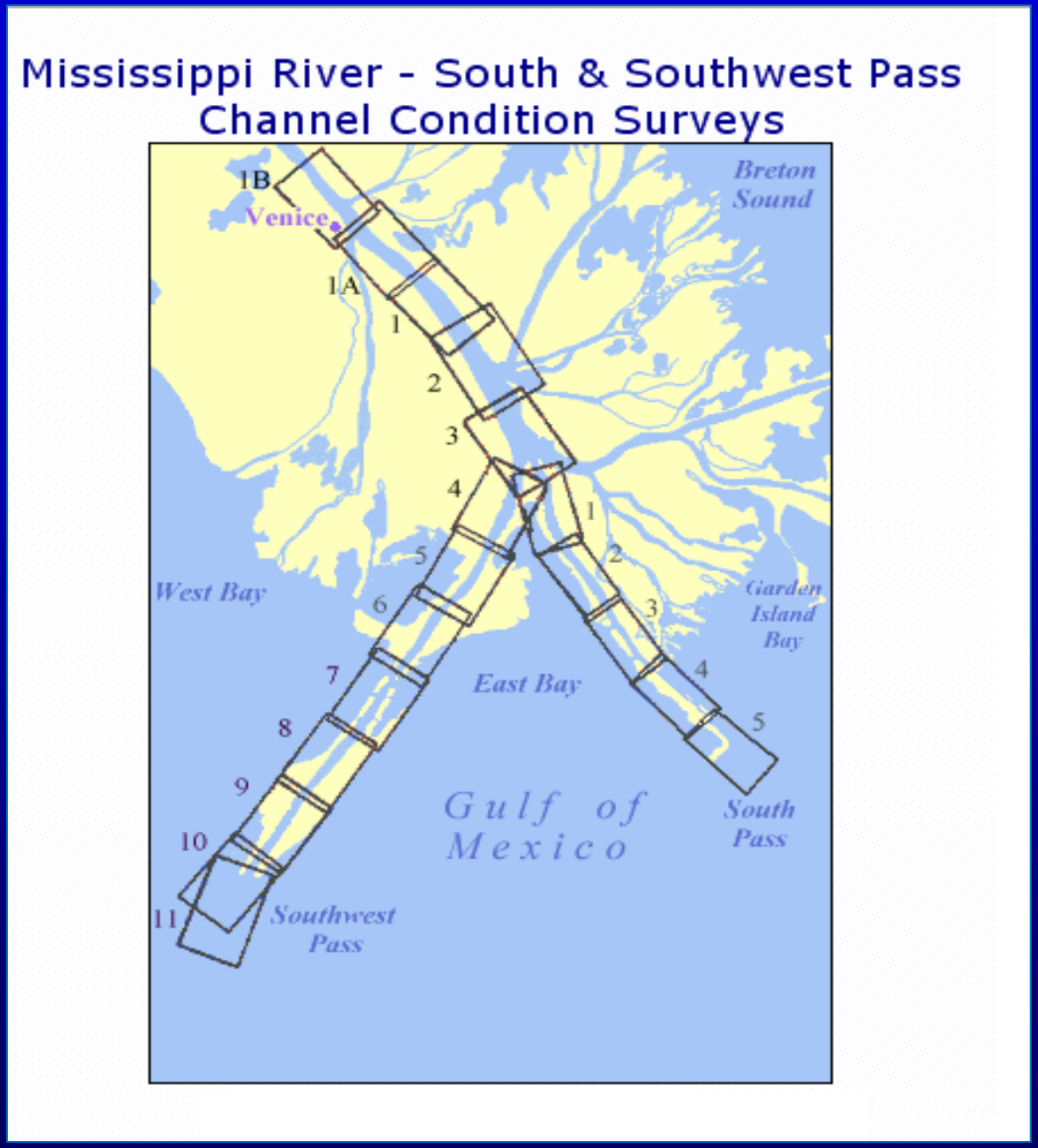
SevenCs

1. Testbed project conducted in Southwest Pass of Mississippi River
   - Source data from USACE channel condition surveys
   - Convert Depth Profiles to S-57 datasets.
   - Create S-57 sounding overlay to supplement ENC or IENCs using:
     Feature Manipulation Engine (FME) by Safe Software
     ENC Optimizer by SevenCs

2. Create a bathymetric ENC (bENC) using *ENC Designer*

Mississippi River
- South & Southwest Pass
Channel

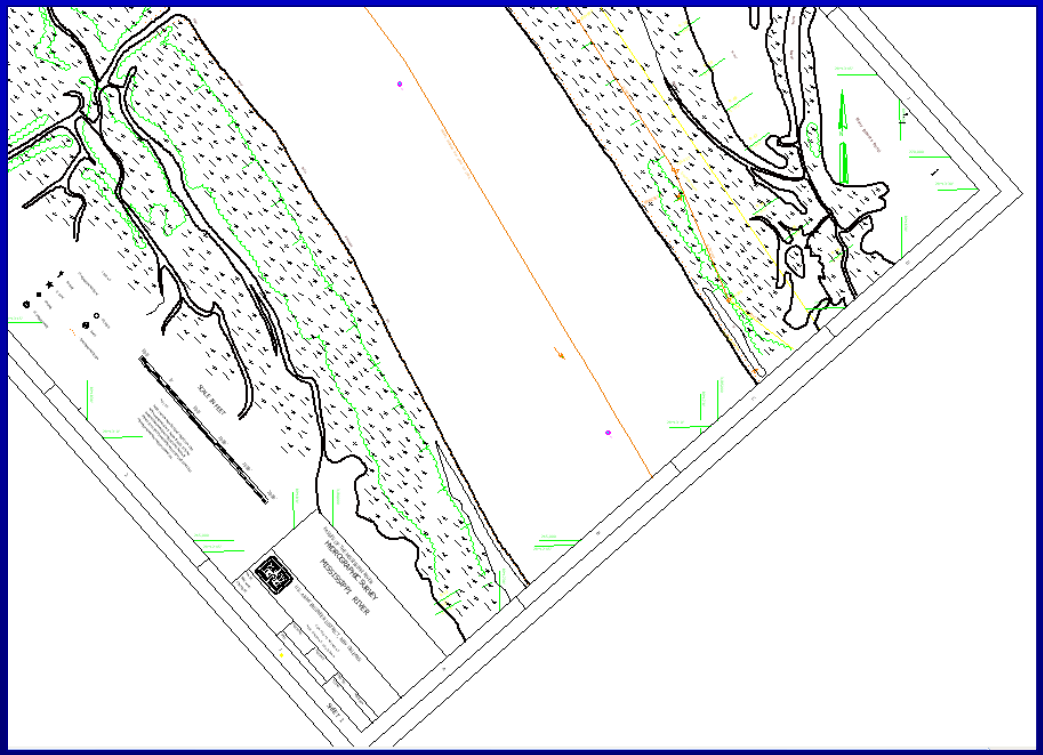
Channel Condition Survey Sheets



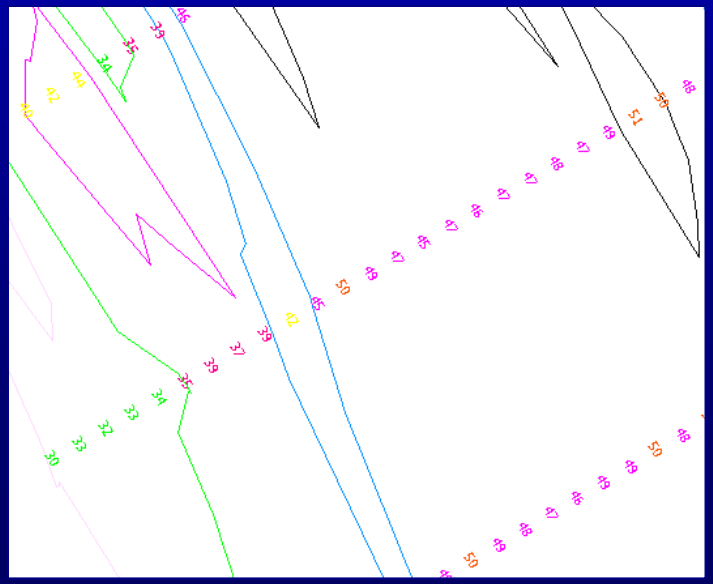
Source Data – Visualized

3935393.235	266768.851	-30.80
3935350.865	266742.116	-32.40
3935308.580	266715.434	-34.30
3935266.294	266688.751	-35.60
3935223.924	266662.016	-37.20
3935181.723	266635.387	-38.60
3935139.438	266608.705	-40.20
3935097.237	266582.076	-43.00
3935054.866	266555.341	-44.20
3935012.581	266528.659	-44.40
3934970.295	266501.977	-45.30
3934928.010	266475.295	-45.60
3934885.724	266448.613	-47.20
3934843.439	266421.931	-46.80
3934801.153	266395.248	-49.10

ASCII xyz data



DGN topography, channel framework, marginalia



DGN Depth Profiles and Contour Lines

SevenCs Processing – Workflow

3935393.235	266768.851	-30.80
3935350.865	266742.116	-32.40
3935308.580	266715.434	-34.30
3935266.294	266688.751	-35.60
3935223.924	266662.016	-37.20
3935181.723	266635.387	-38.60

Input Data (ASCII xyz)

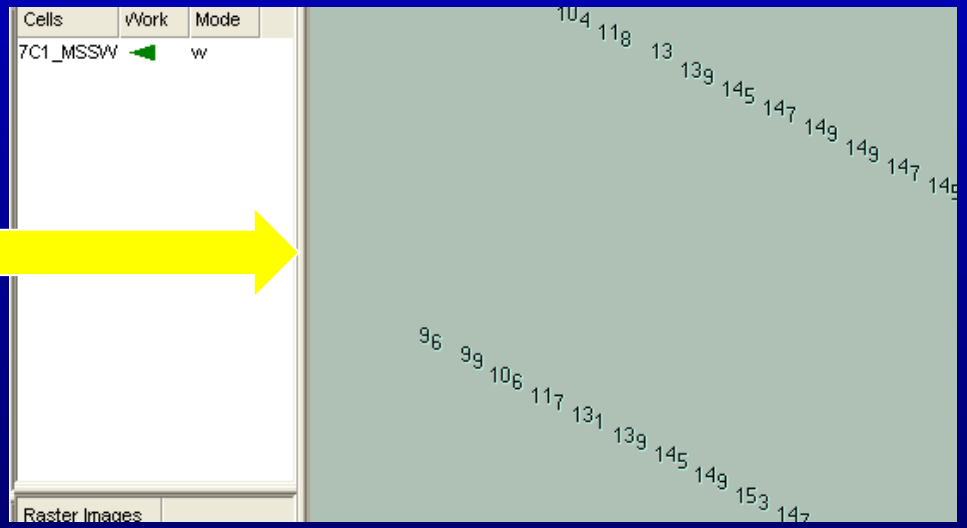
Automatic Conversion:

Components

A: FME

B: FME S-57 Writer

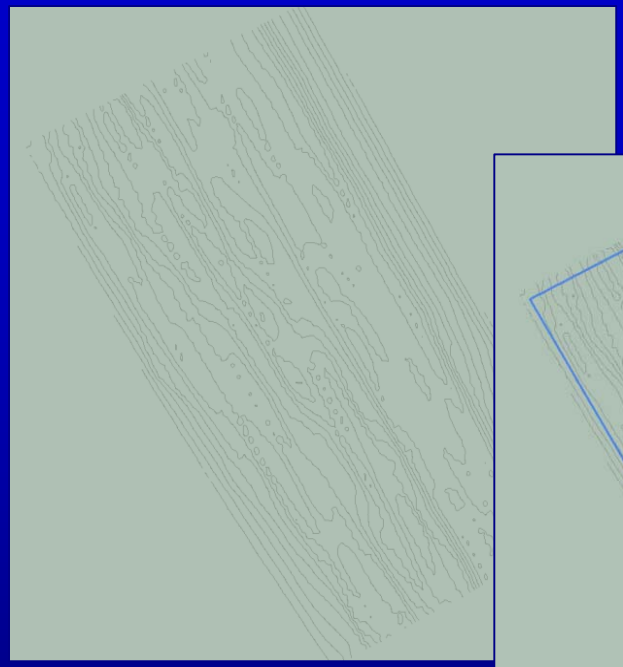
C: ENC Optimizer



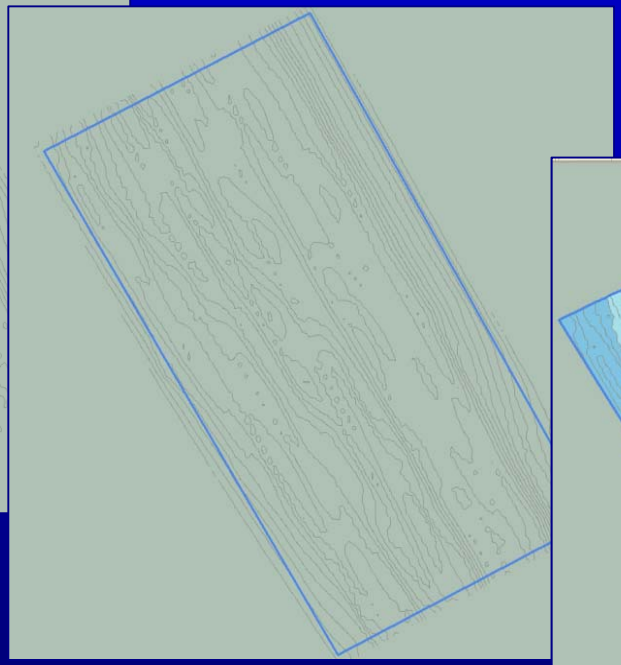
Data Conversion Process („Black Box“)

S-57 Sounding Overlay

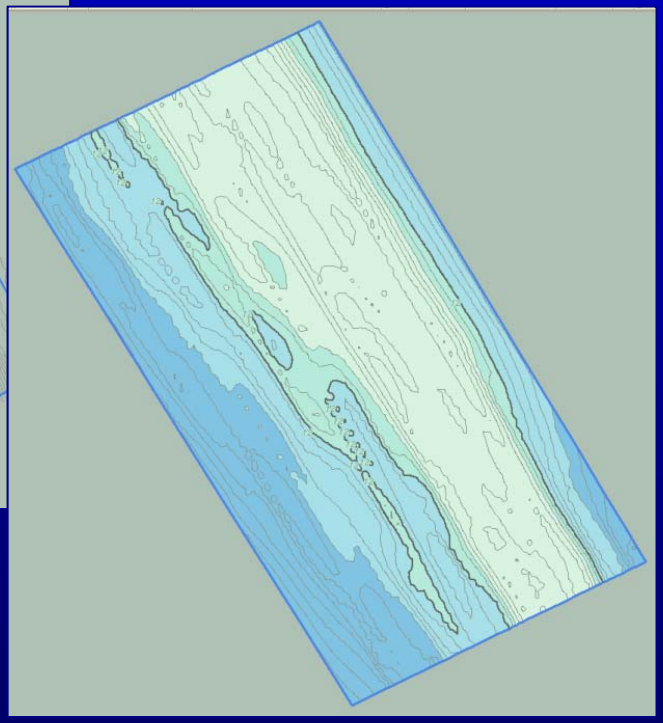
bENC Processing - Workflow



High density Contours

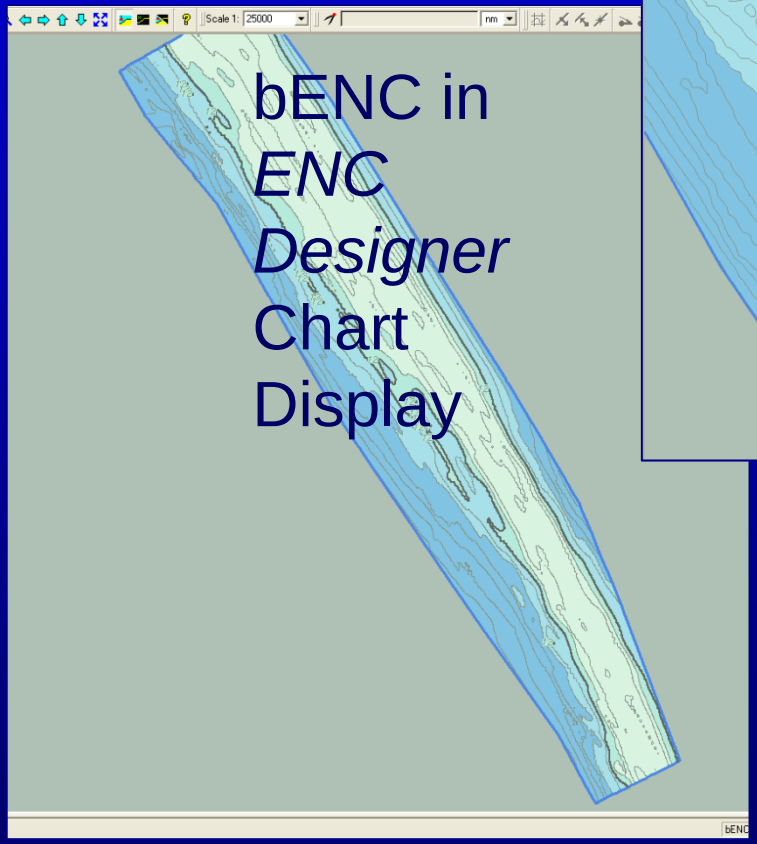


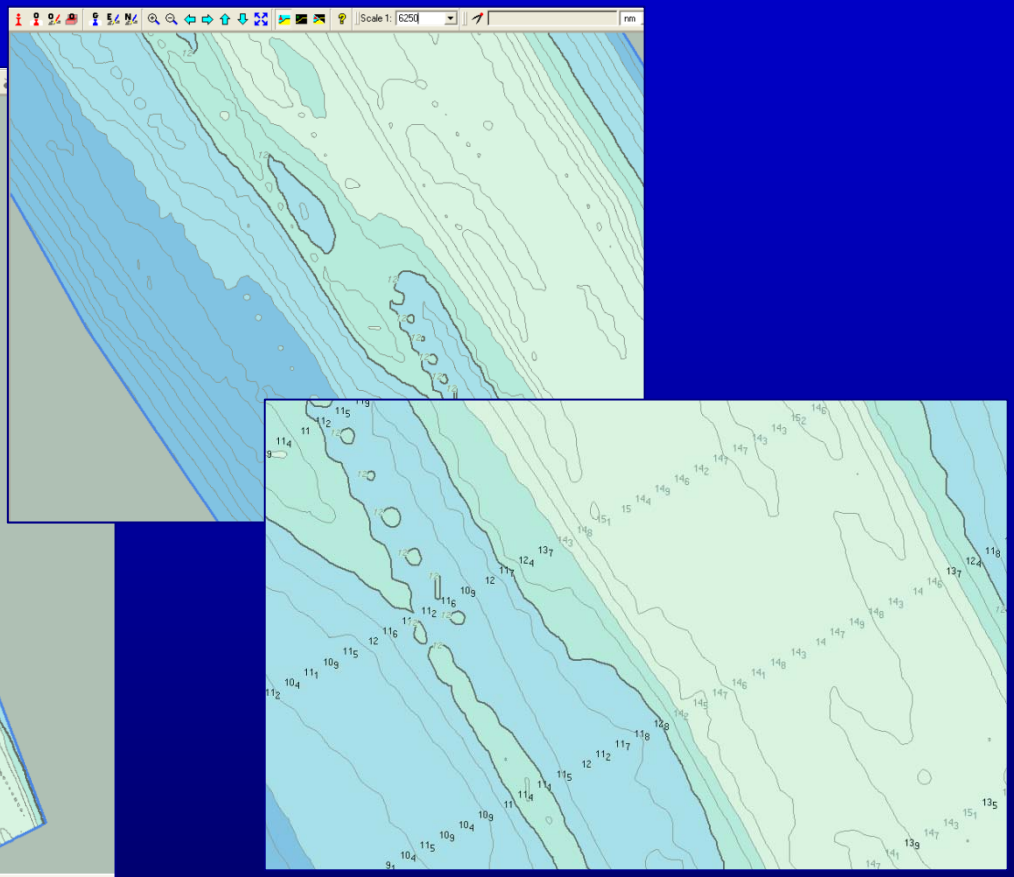
Cell outline polygon



bENC ready for QA

Bathymetric ENC (bENC)





bENC and
Sounding Overlay

SevenCs: Source data → bENCs

- Source data is suitable for the production of bathymetric ENCs.
- Production includes automated and manual processing.
- Overall production time about 3 hours.
- Additional display of detailed bathymetry.
- Detailed safety contours from latest survey data.
- Valuable information for navigation in shallow and narrow waters.
- Use of tidal corrections makes bENC “tide aware”.

CARIS

Depending on hydro survey data source, two possible steps:

1. Raw" survey data
   - Initially process with *CARIS HIPS*
   - examine/clean data using interactive & automated tools
2. Processed data (e.g., x, y, z)
   - Use *CARIS Bathy DataBase* to create a "true surface"
   - Includes contours, depth areas, and soundings

CARIS S-57 Composer used to create RIO Product
- Required spatial and feature editing
- QA based on IHO S-58 (consistency and completeness)

Bathymetric River Information Overlay Production Overview

Cameron McLeay, CARIS USA
cameron.mcleay@caris.com

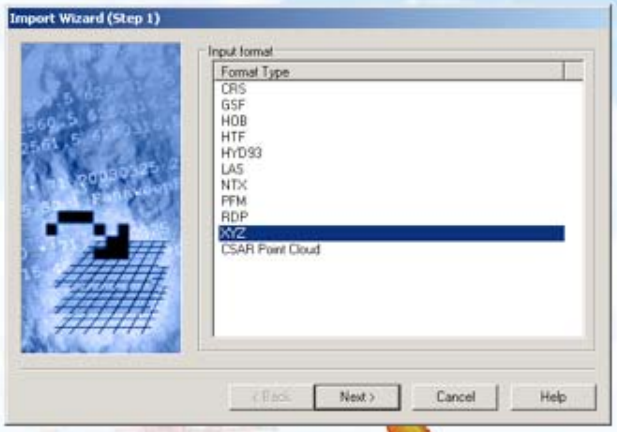
caris
www.caris.com

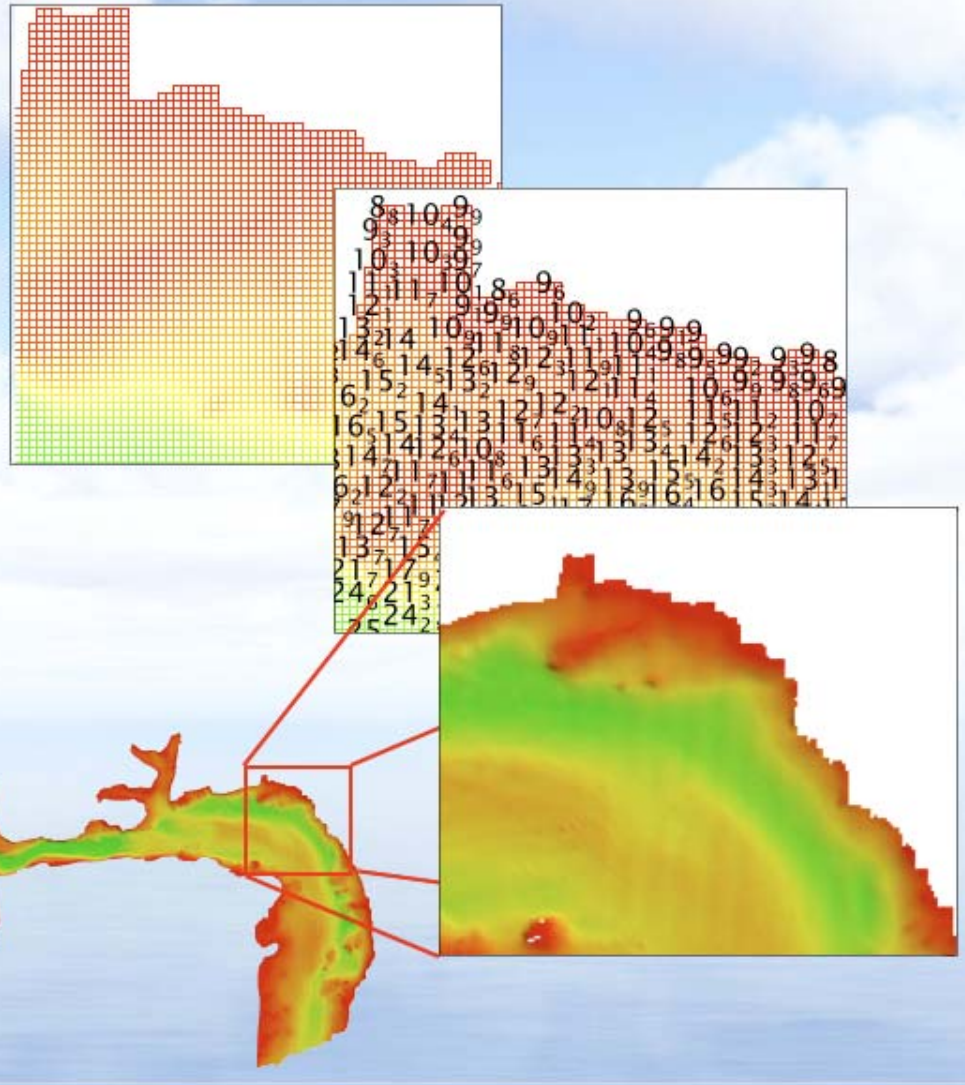
CARIS Ping-to-Chart Workflow

caris
www.caris.com

Bathy DataBASE Import

- USGS DEM
- BAG Surfaces
- ESRI ASCII Grid
- XYZ
- PFM
- CRS
- GSF
- HOB
- HTF
- LAS
- MDF
- NTX
- RDP
- HYD93
- CSAR Point Cloud
- CARIS BASE Surfaces





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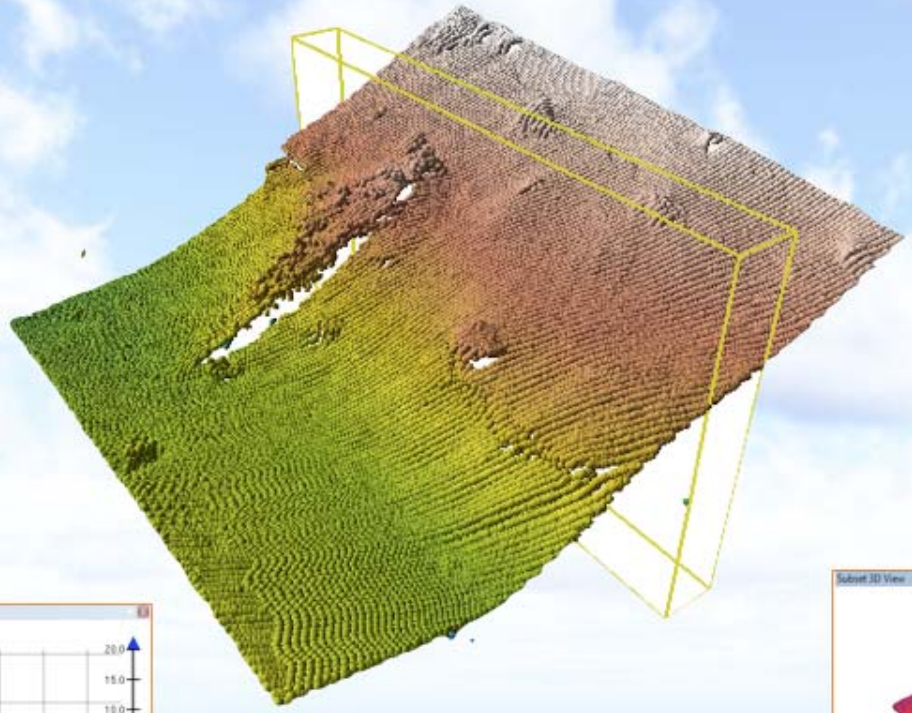
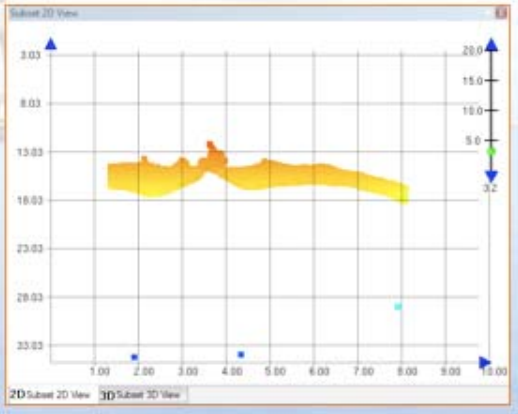
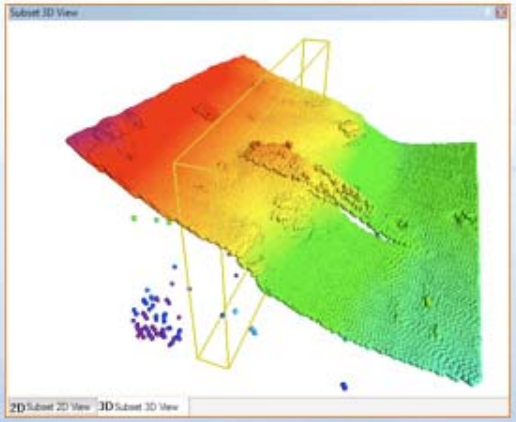
Bathy DataBASE Quality Control







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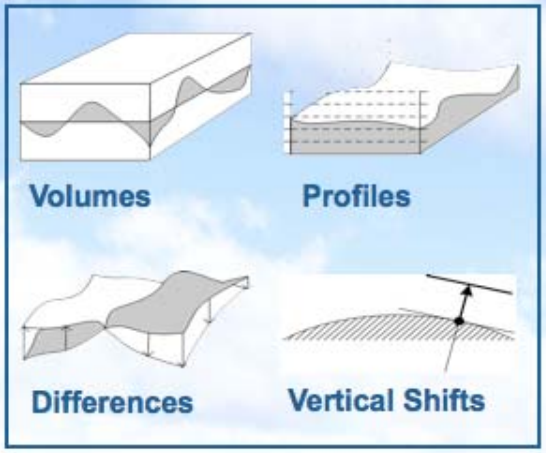
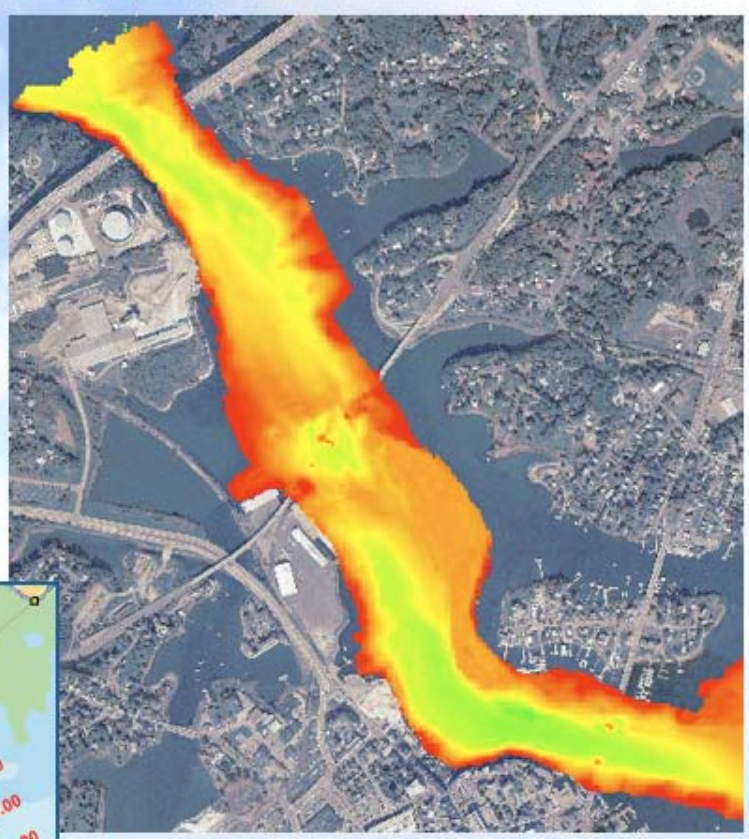
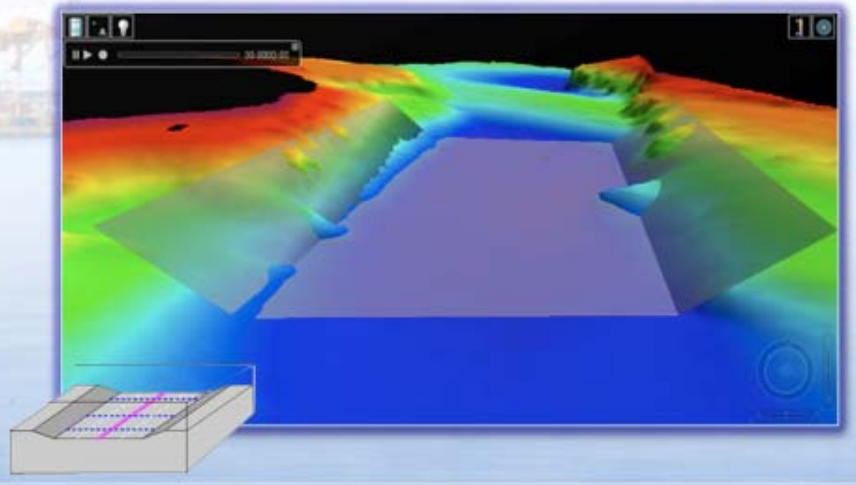
Analysis and Computations

- Shift Surface
- Combine
- Difference
- Slope & Aspect
- Extract
- Resample
- Channel models







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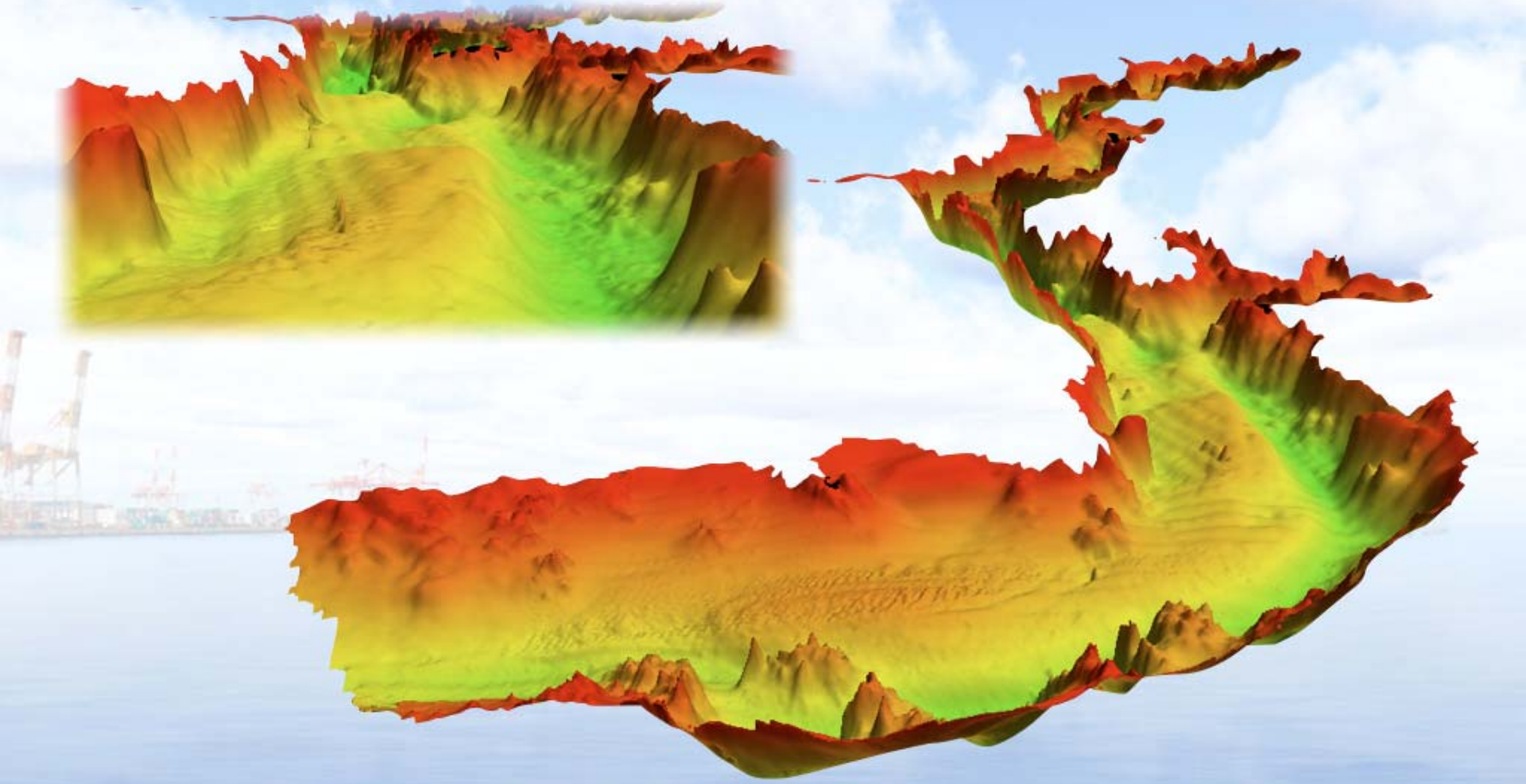
3D Visualization



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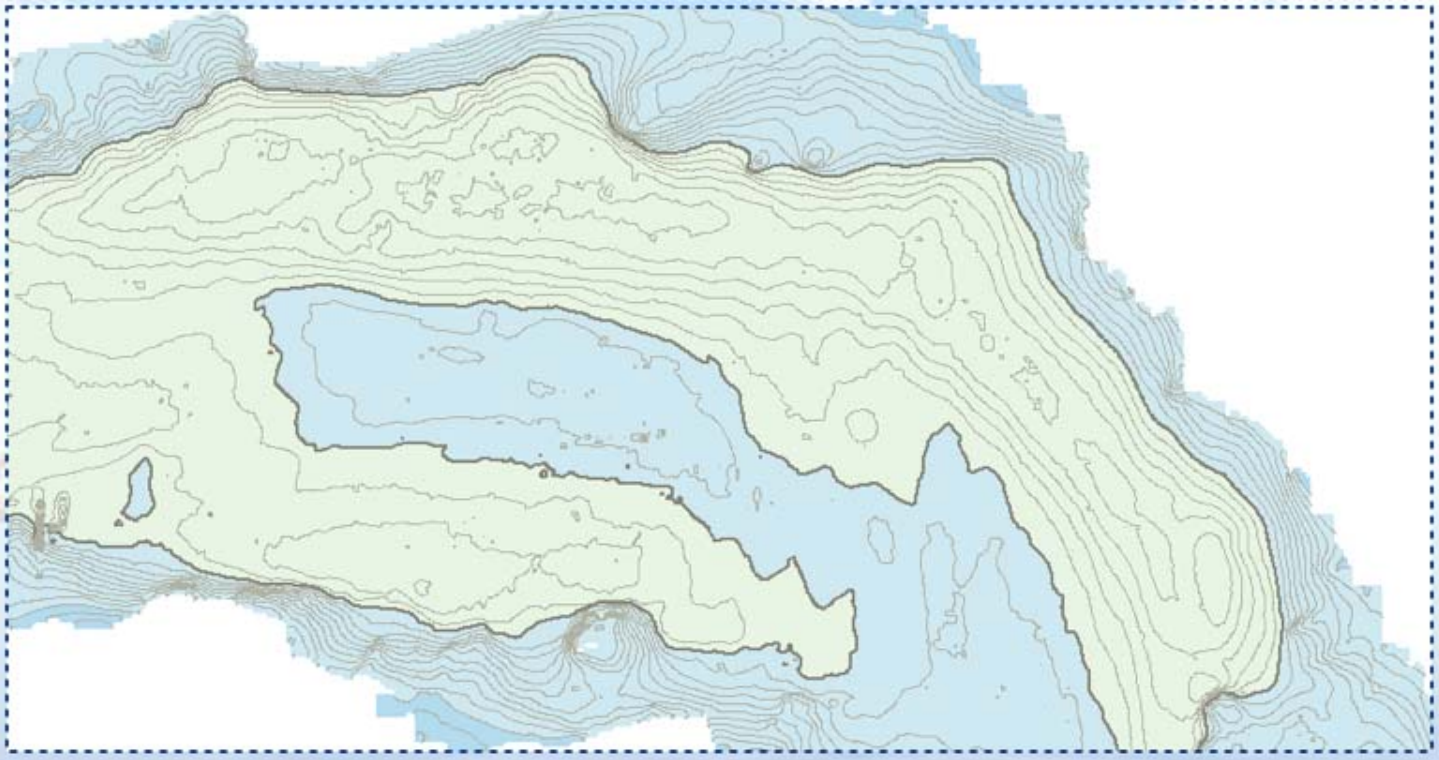
Bathymetry Products

- Depth Contours and Depth Areas
- Soundings

- Export to:
  - S-57
  - SHP
  - ASCII
  - KML
  - *etc* ...



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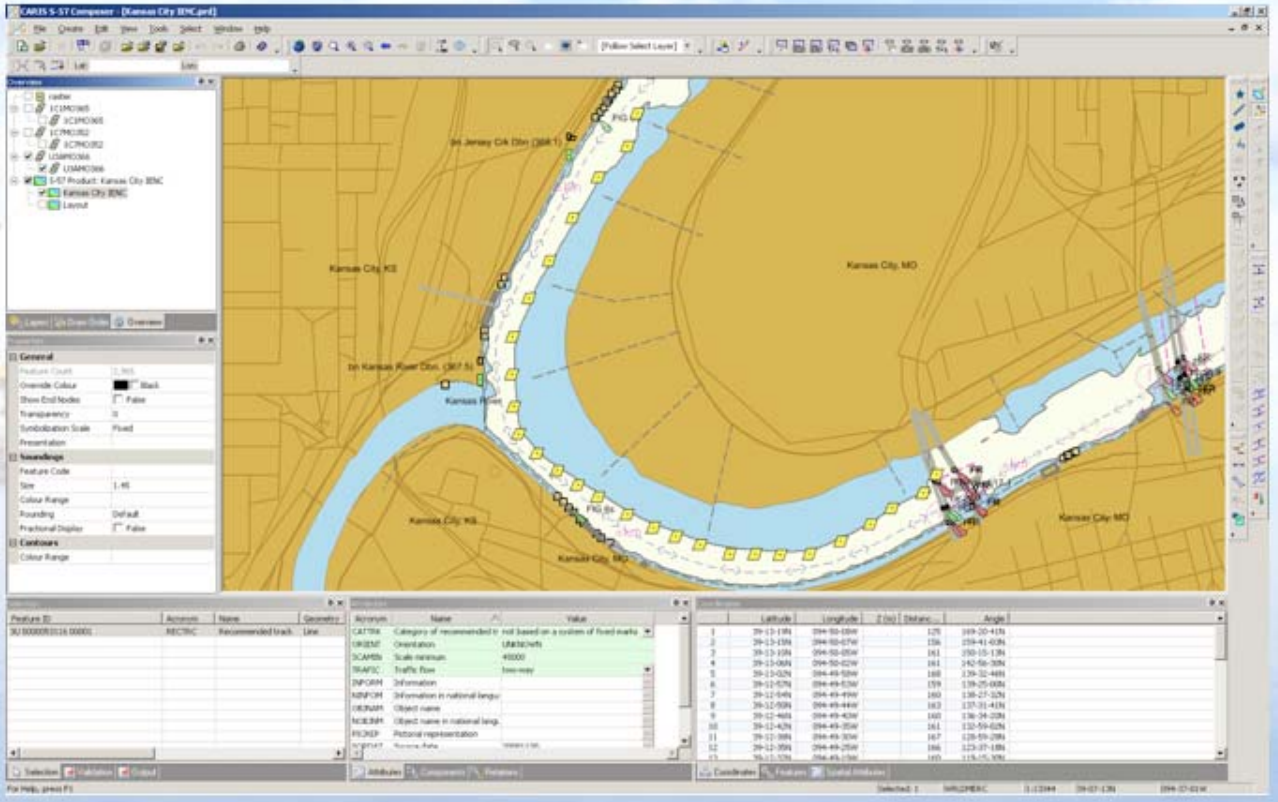
www.caris.com

S-57 Composer

Efficient Electronic Chart Production

- Provides the same robust object creation and editing tools as in CARIS HPD
- Work directly on S-57/DNC features, maintain topological relationships automatically
- View, query, add, edit, delete and validate S-57/DNC features in an intuitive workflow



Unified approach, One tool for…

- **RIO**
- **IENC**
- ENC
- AML
- DNC
- MIO

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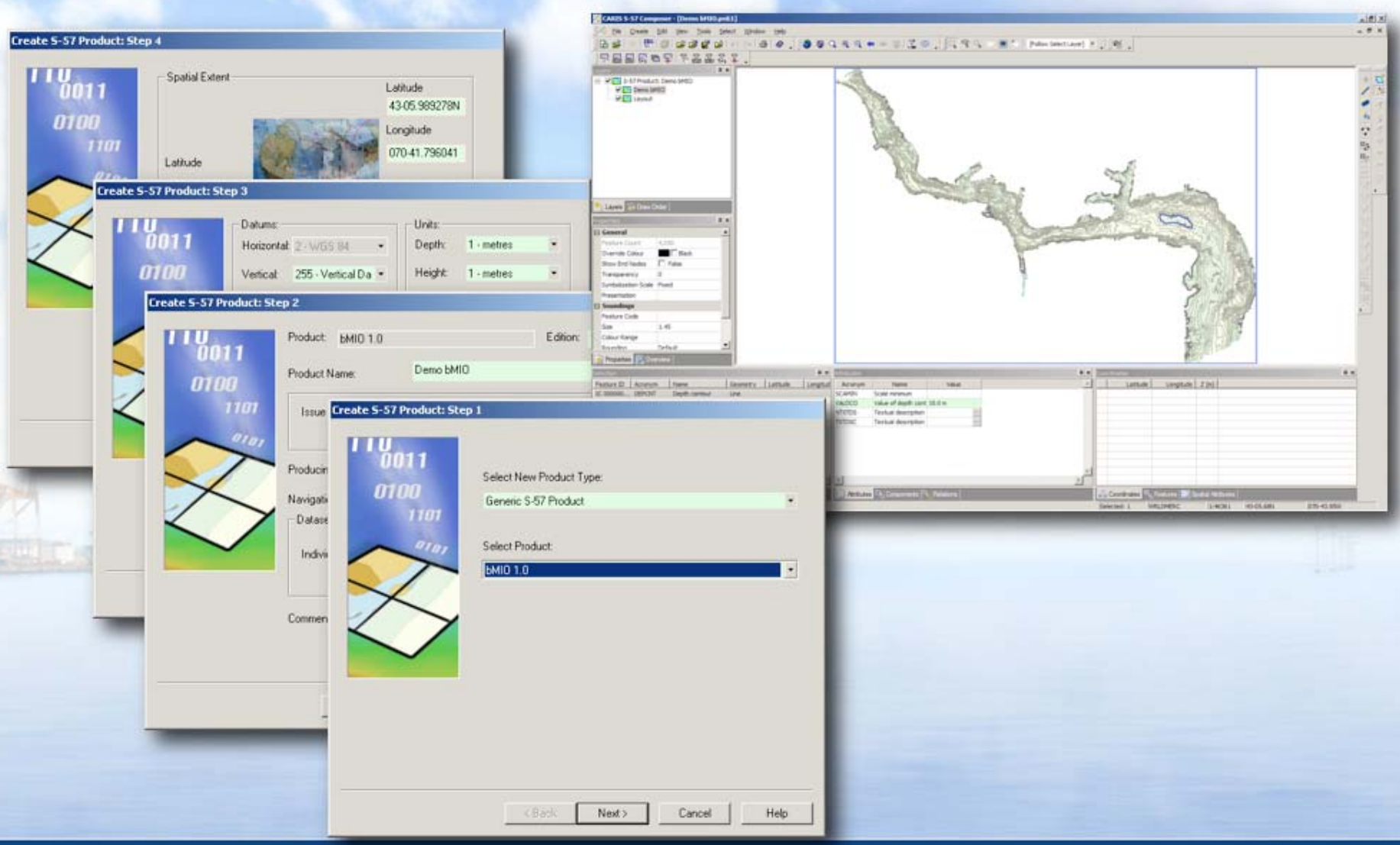
www.caris.com

S-57 Composer - Create Product



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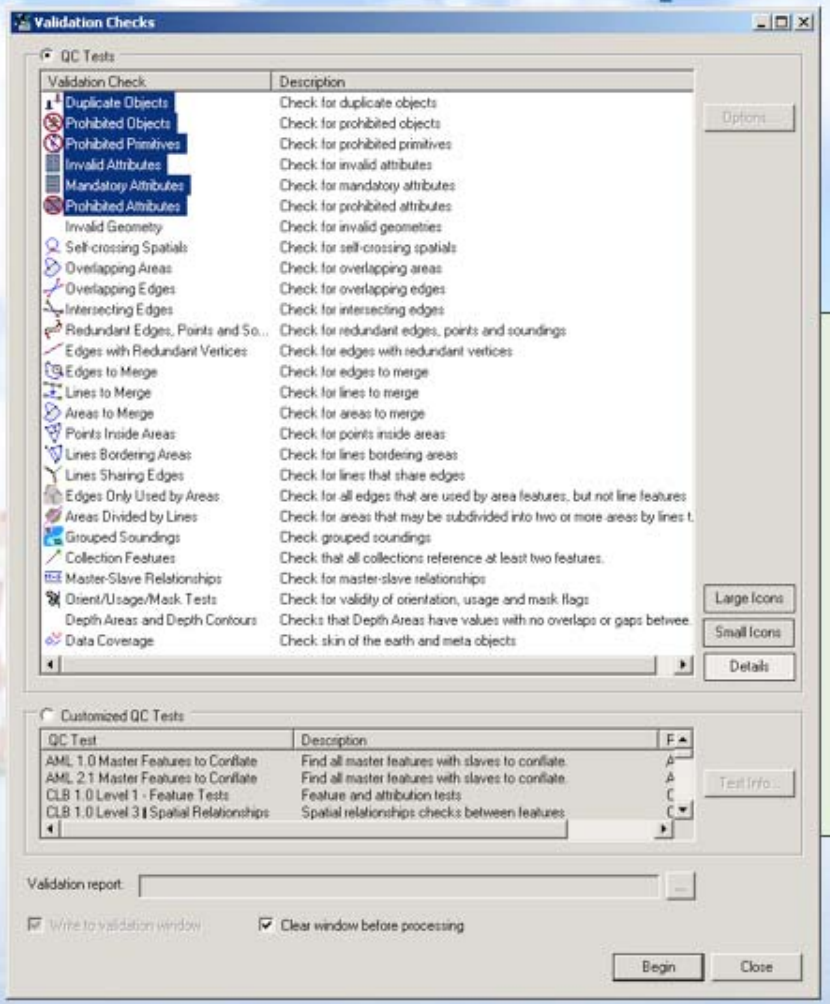
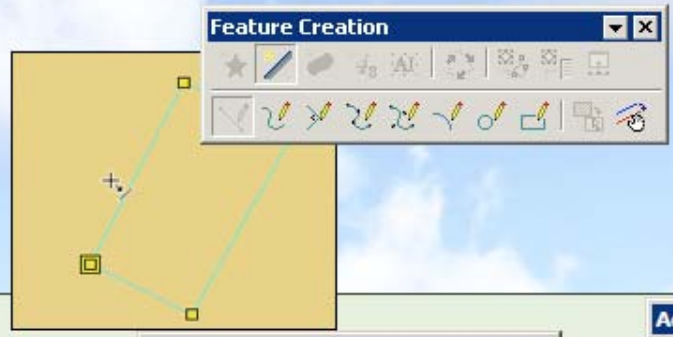
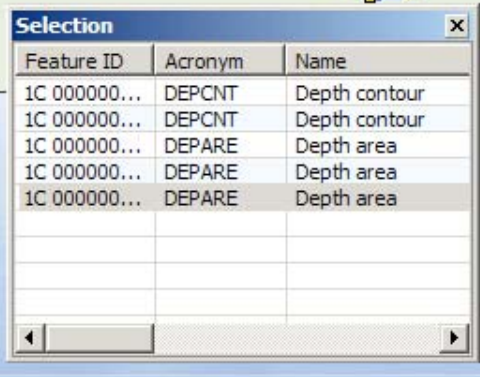
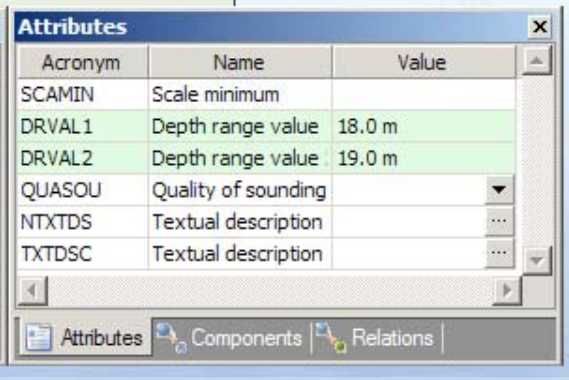
S-57 Composer - Edit and Validate





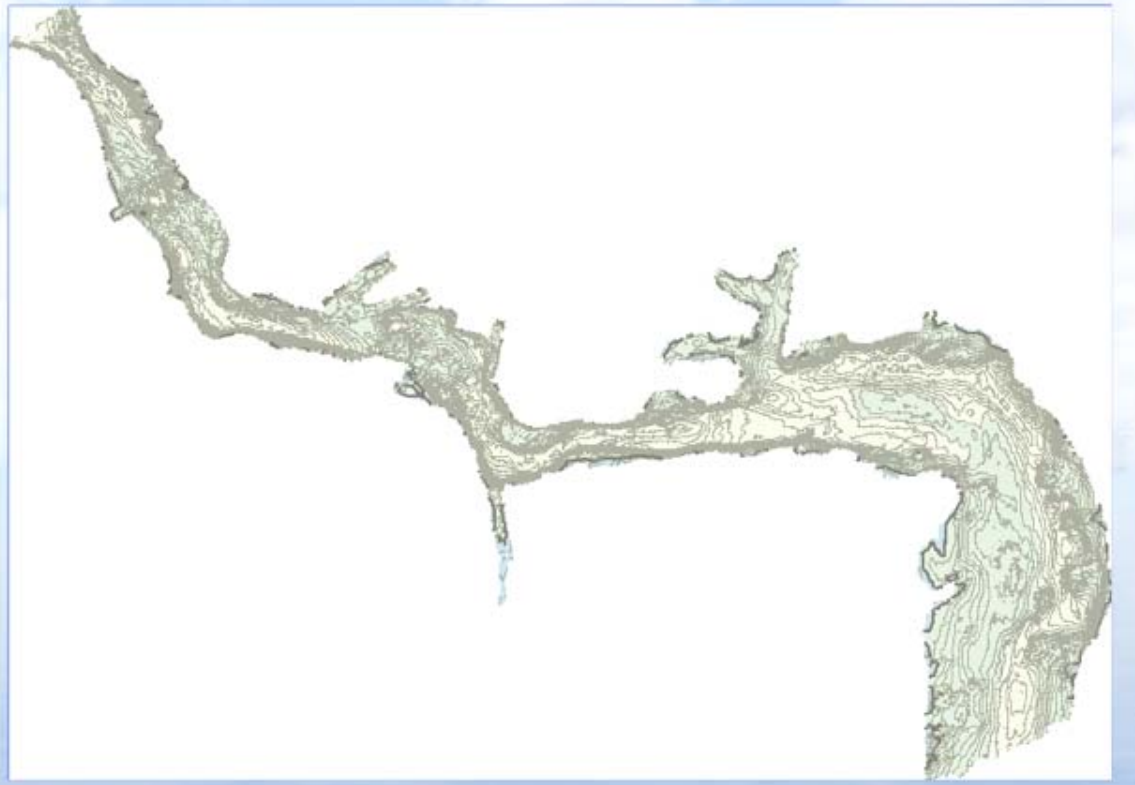




caris
www.caris.com

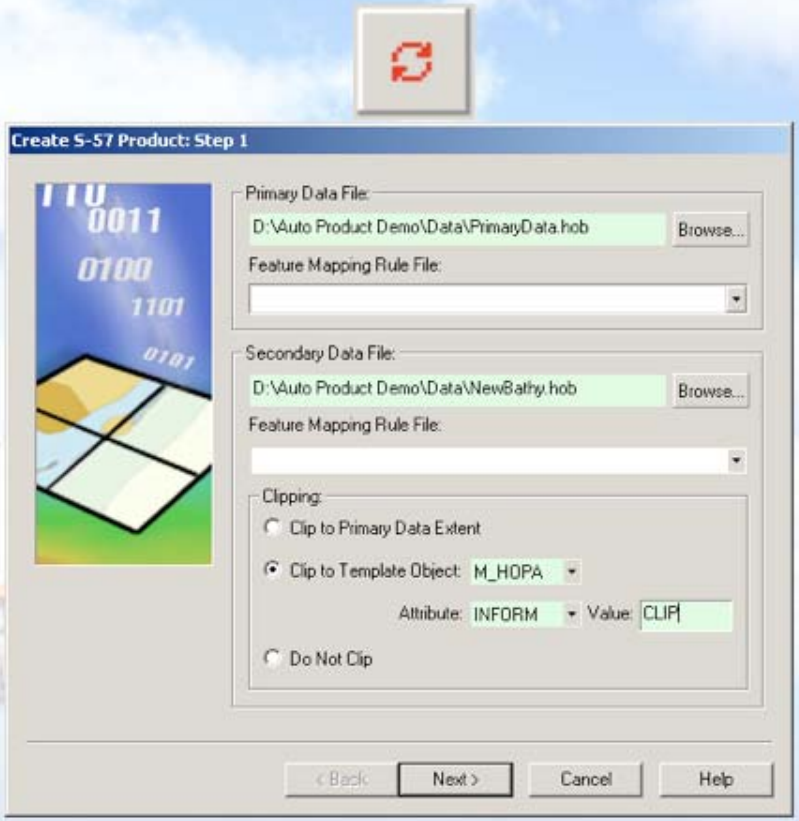
S-57 Composer - Export to Bathymetric RIO

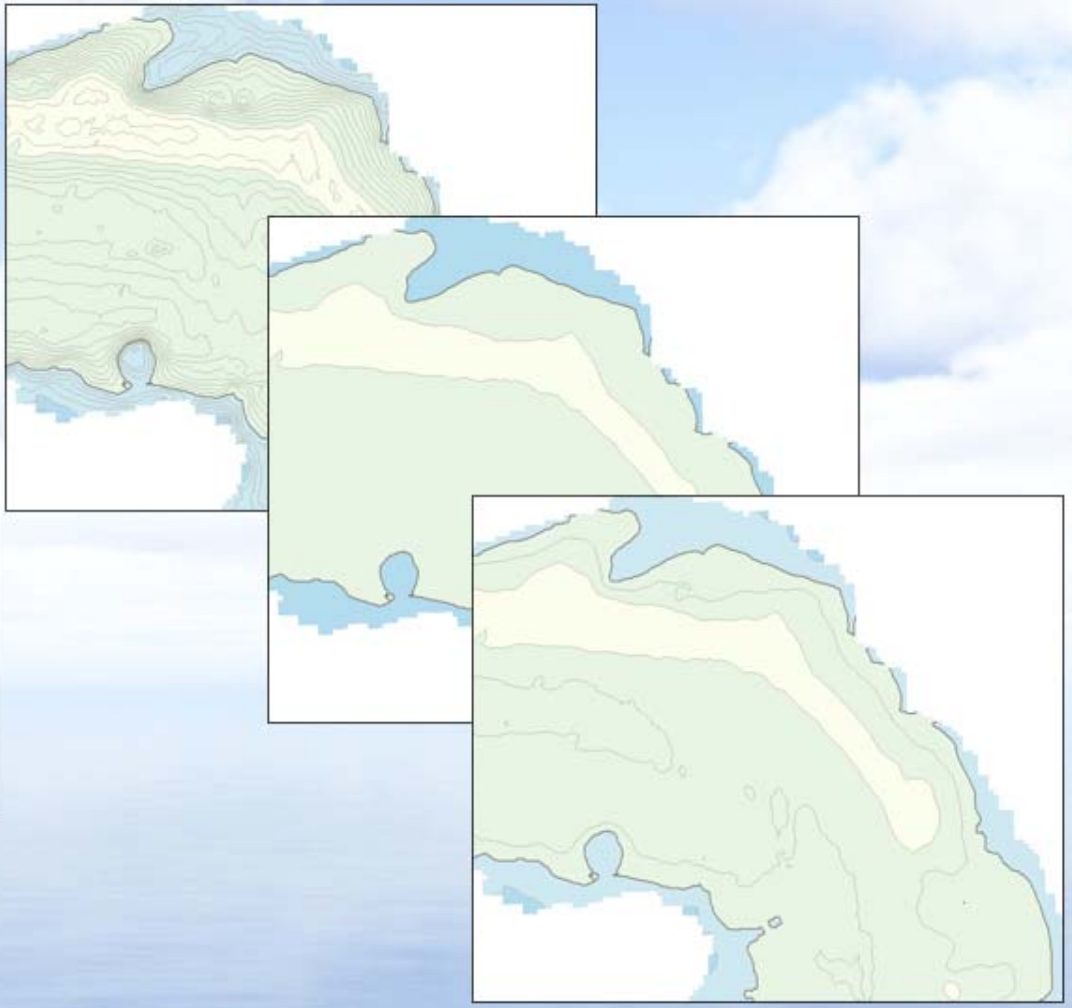
- Export to:
  - *Validated S-57*
    - **Bathy RIO**
    - IENC
    - ENC
    - MIO
    - AML
  - SHP
  - ASCII
  - KML
  - *etc …*

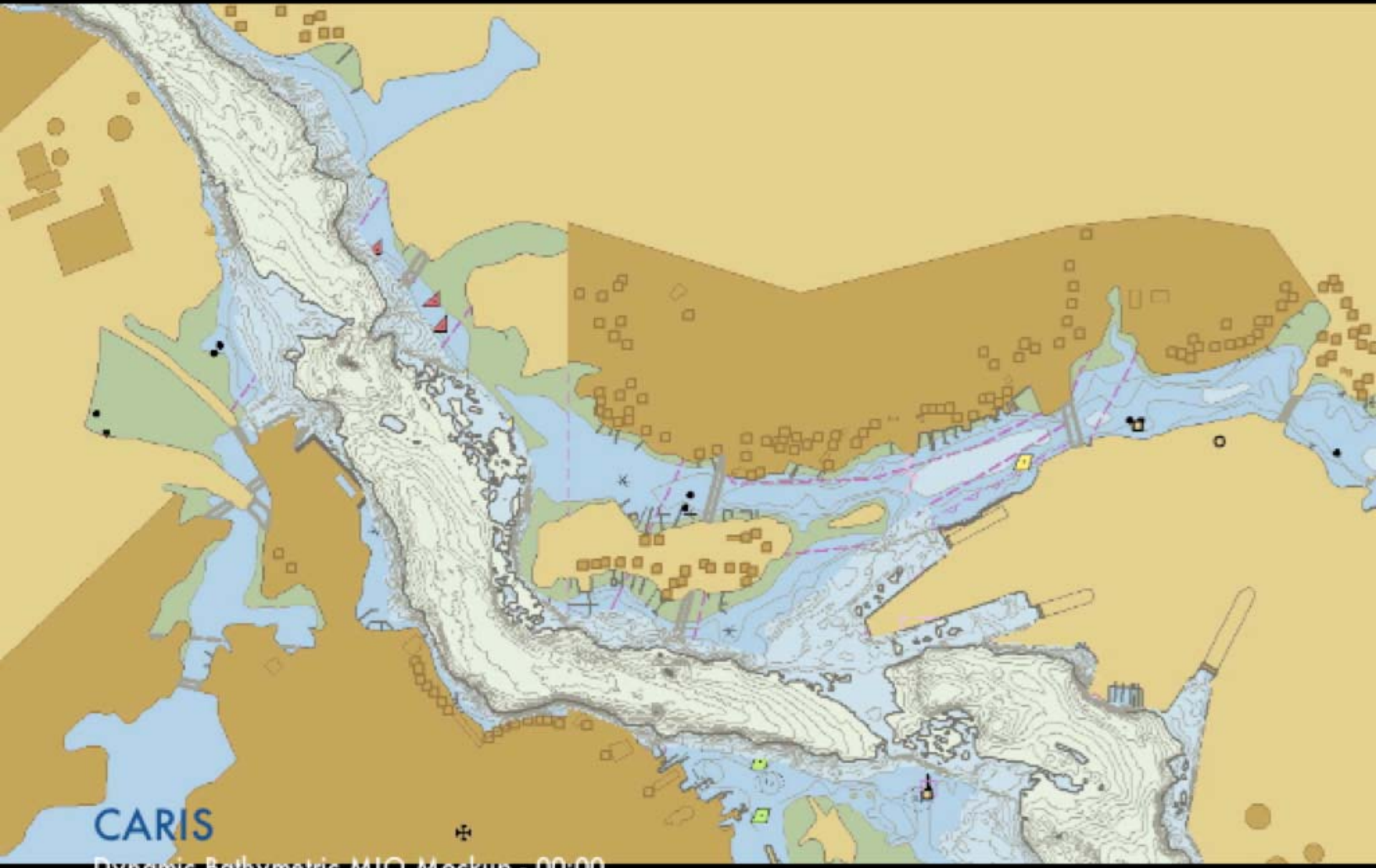


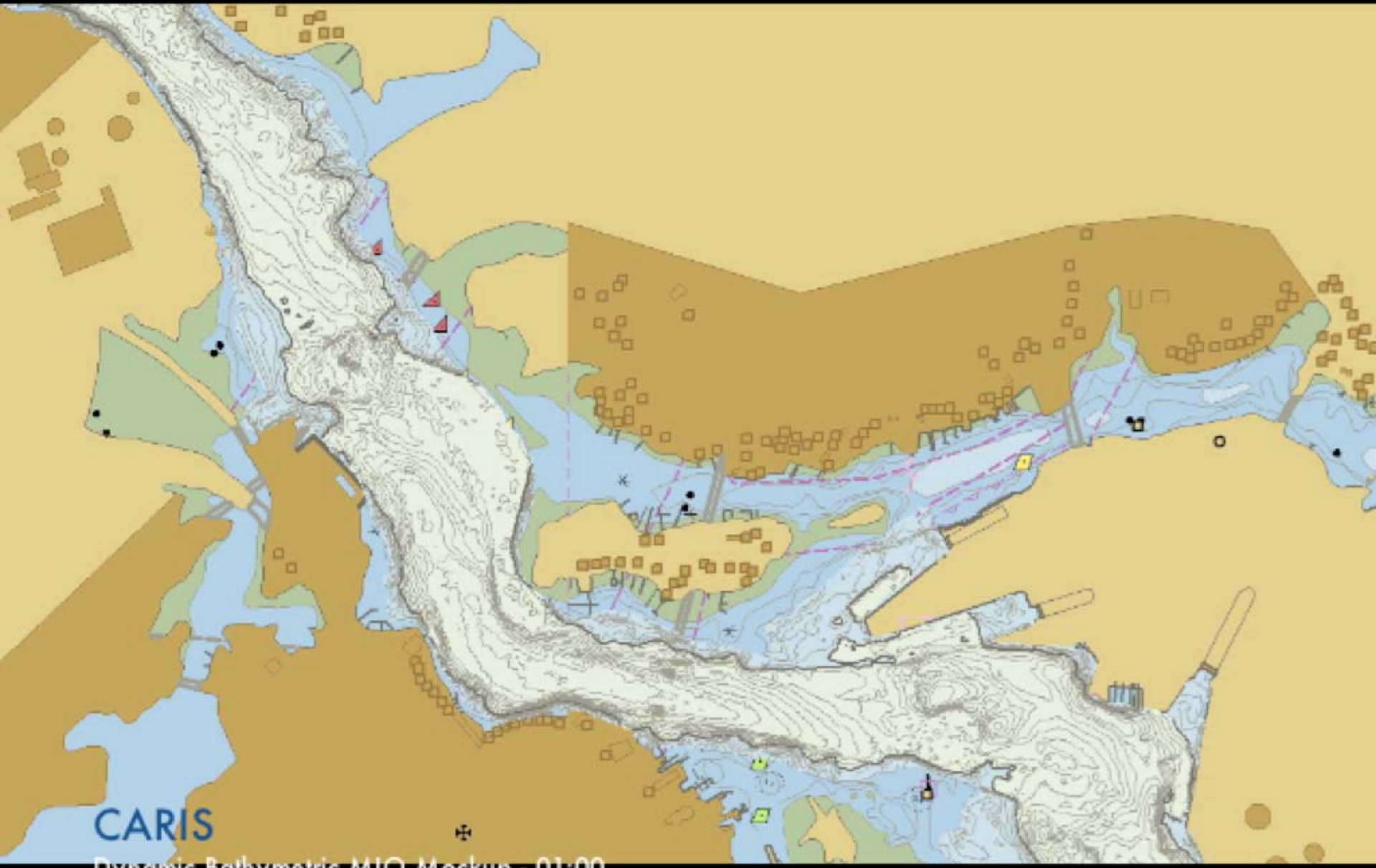
caris
www.caris.com

S-57 Composer - "Auto-Product"






CARIS
Dynamic Bathymetric MIO Mockup - 00:00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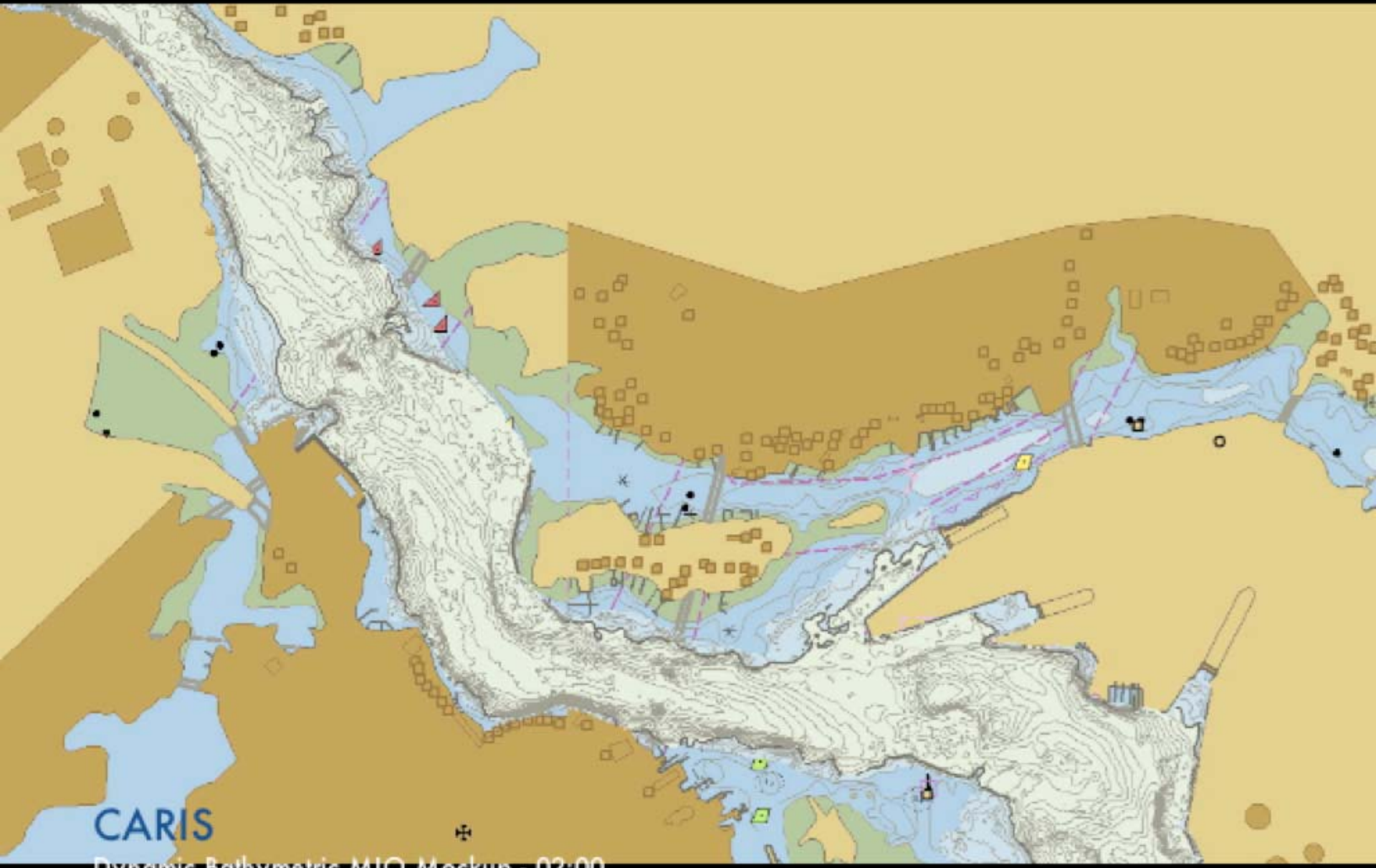
Dynamic Bathymetric MIO Mockup - 01:00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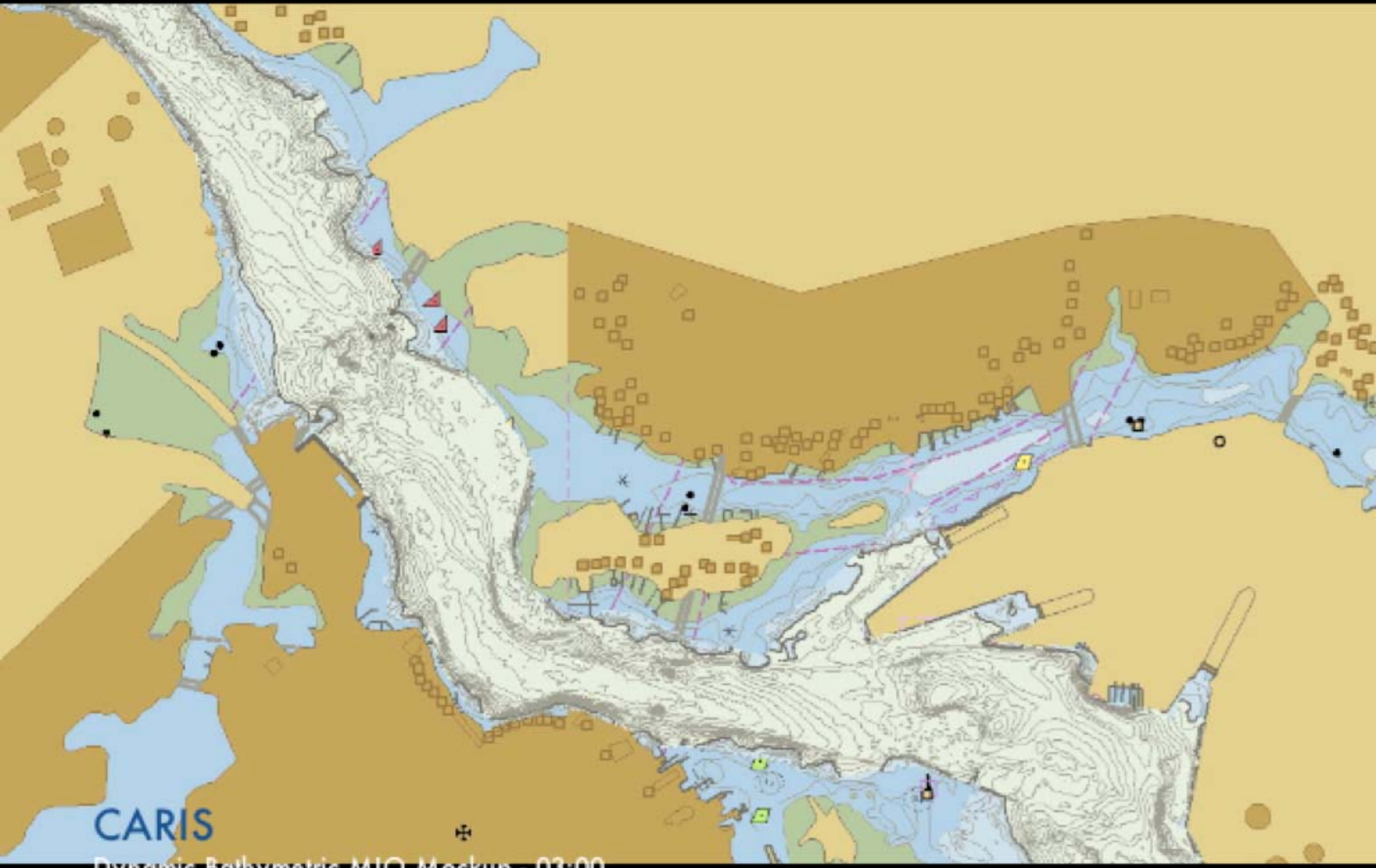
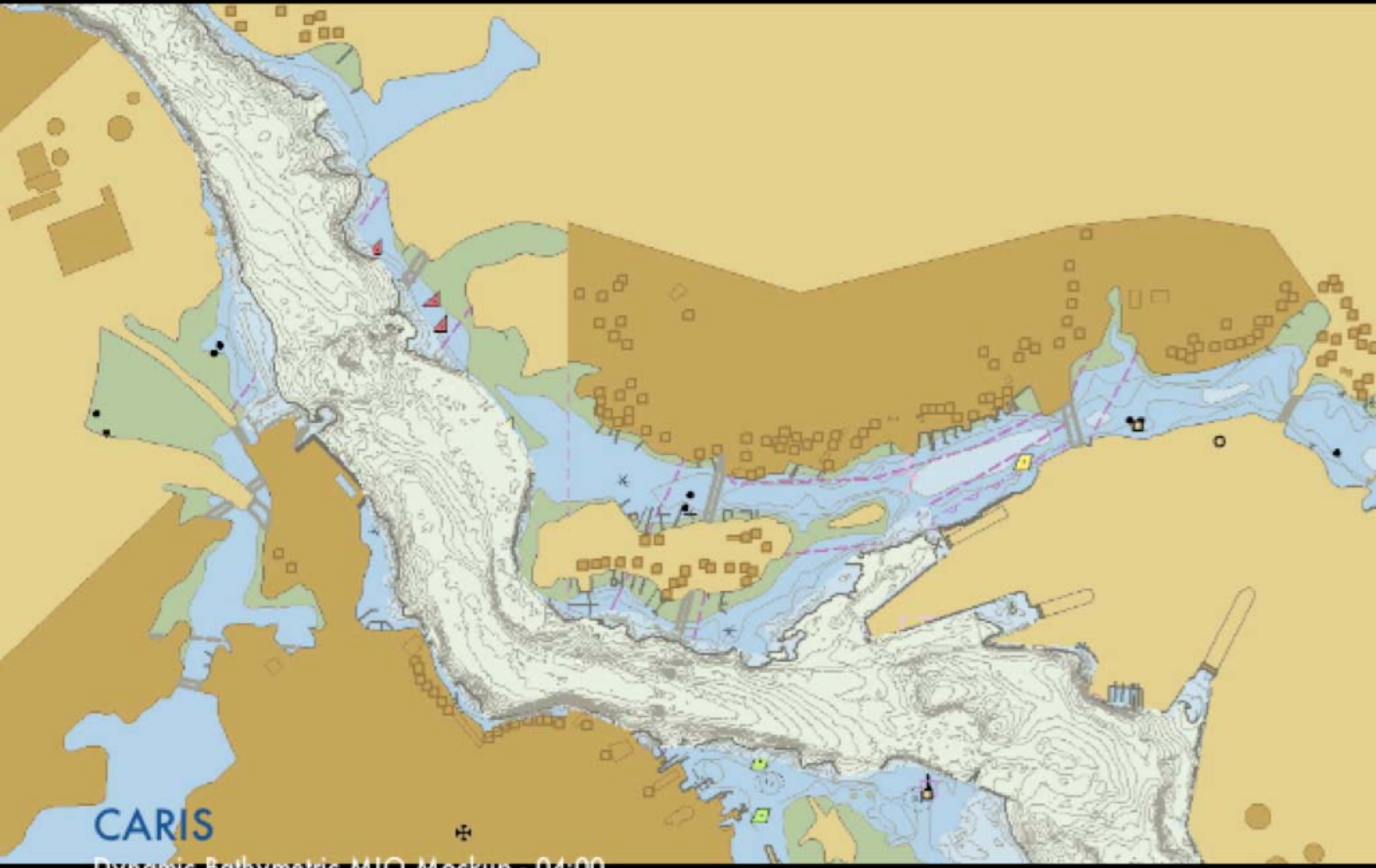
Dynamic Bathymetric MIO Mockup - 02:00


CARIS
Dynamic Bathymetric MIO Mockup - 03:00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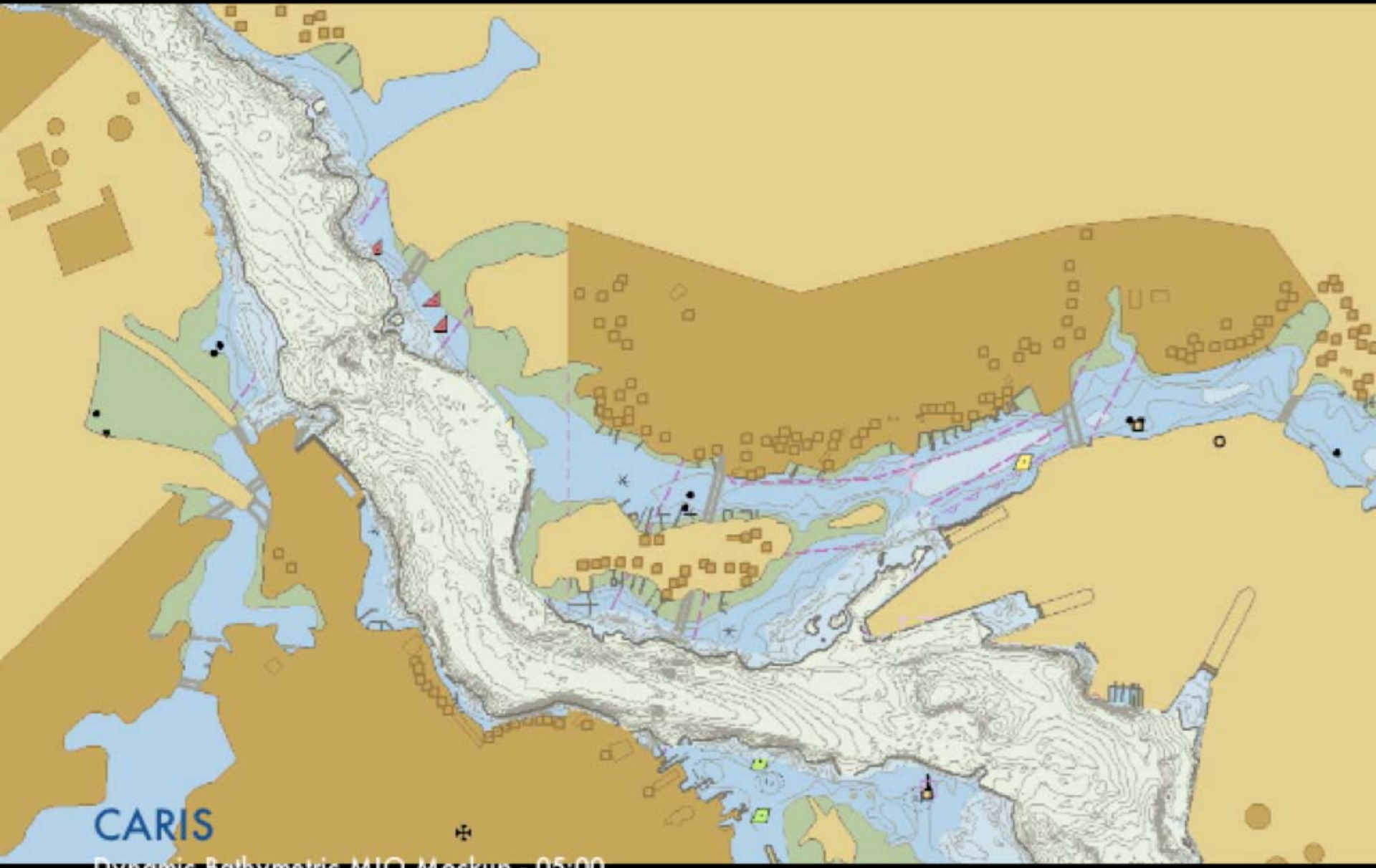
Dynamic Bathymetric MIO Mockup - 04:00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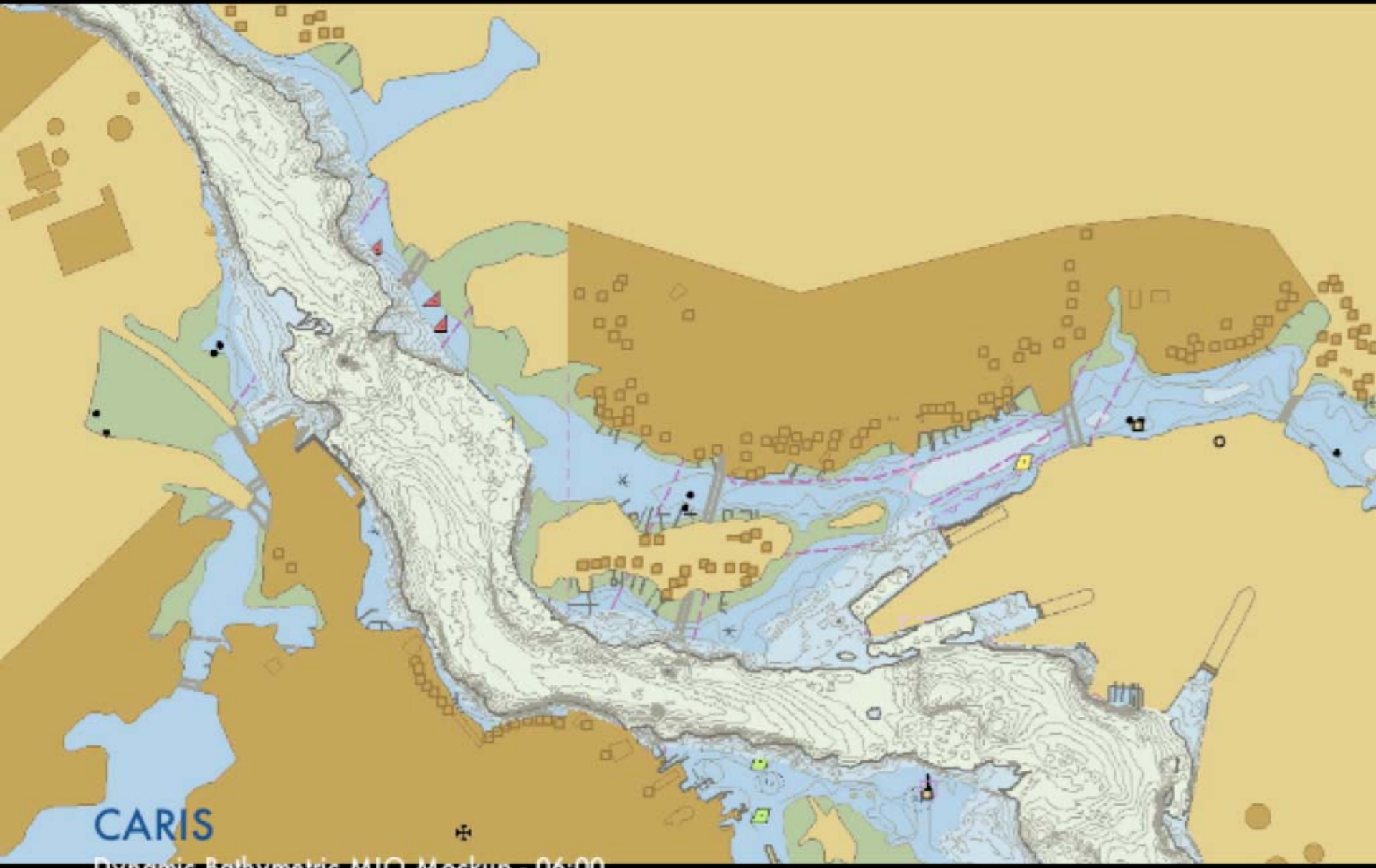
Dynamic Bathymetric MIO Mockup - 05:00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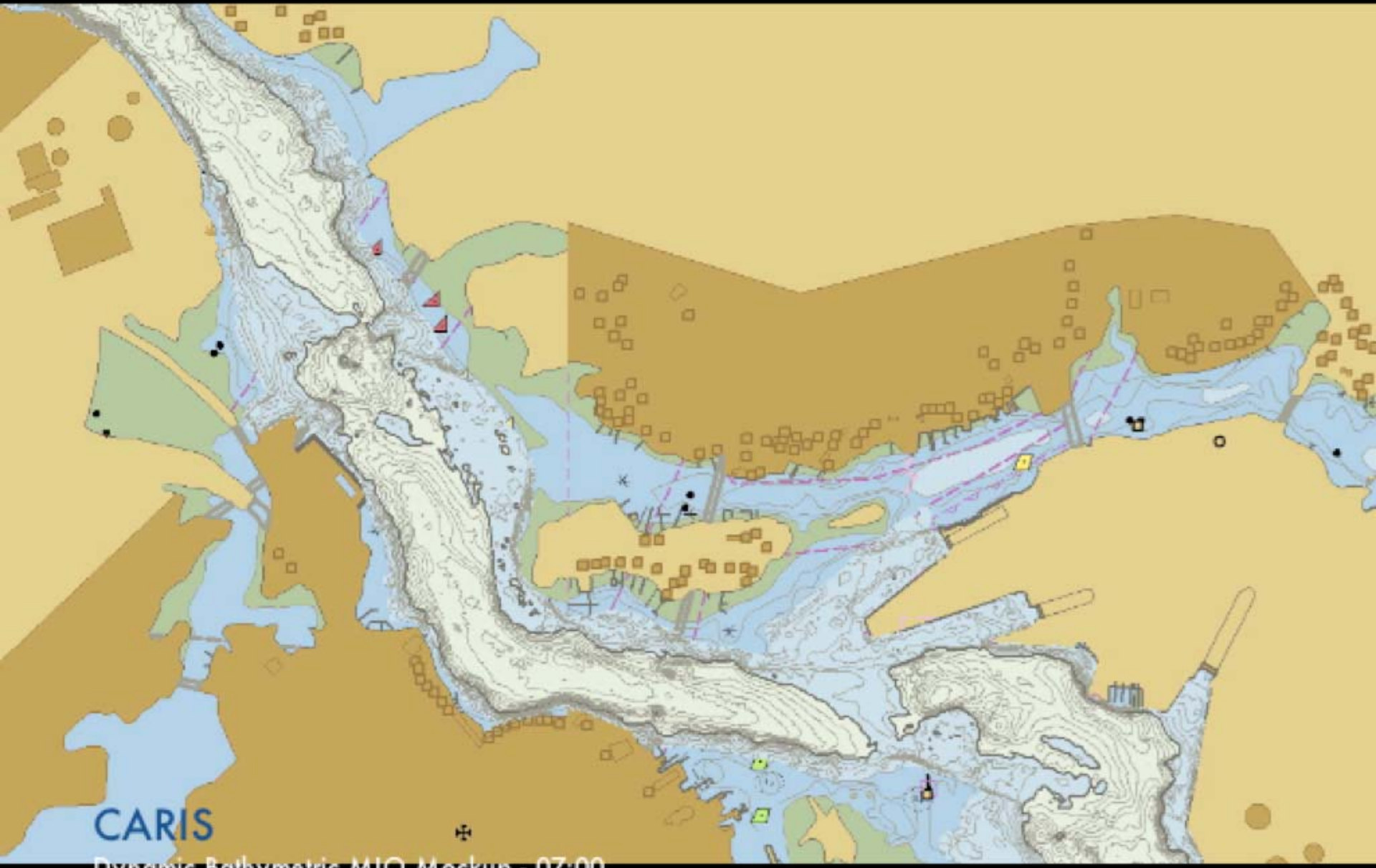
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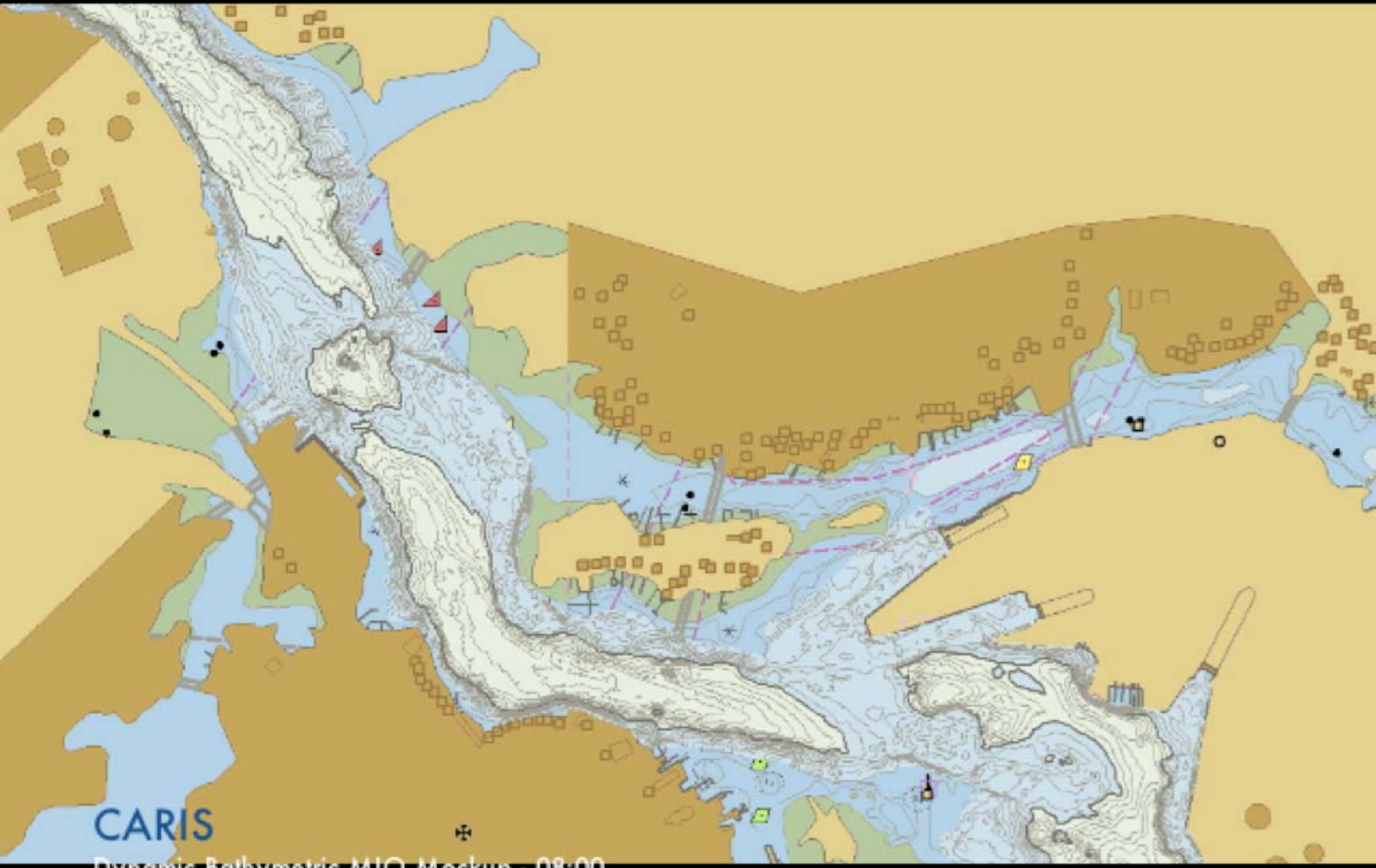
Dynamic Bathymetric MIO Mockup - 07:00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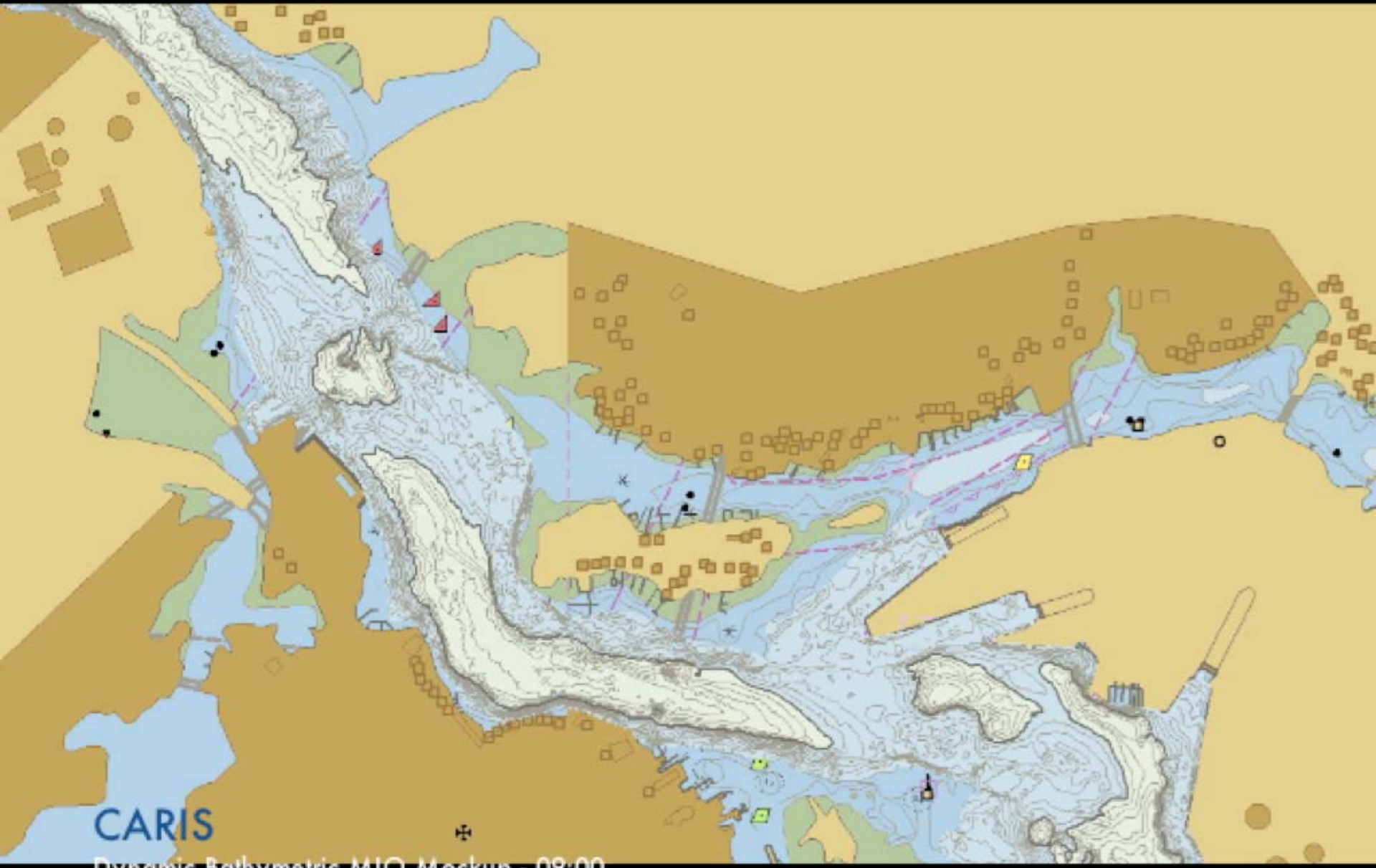
Dynamic Bathymetric MIO Mockup - 08:00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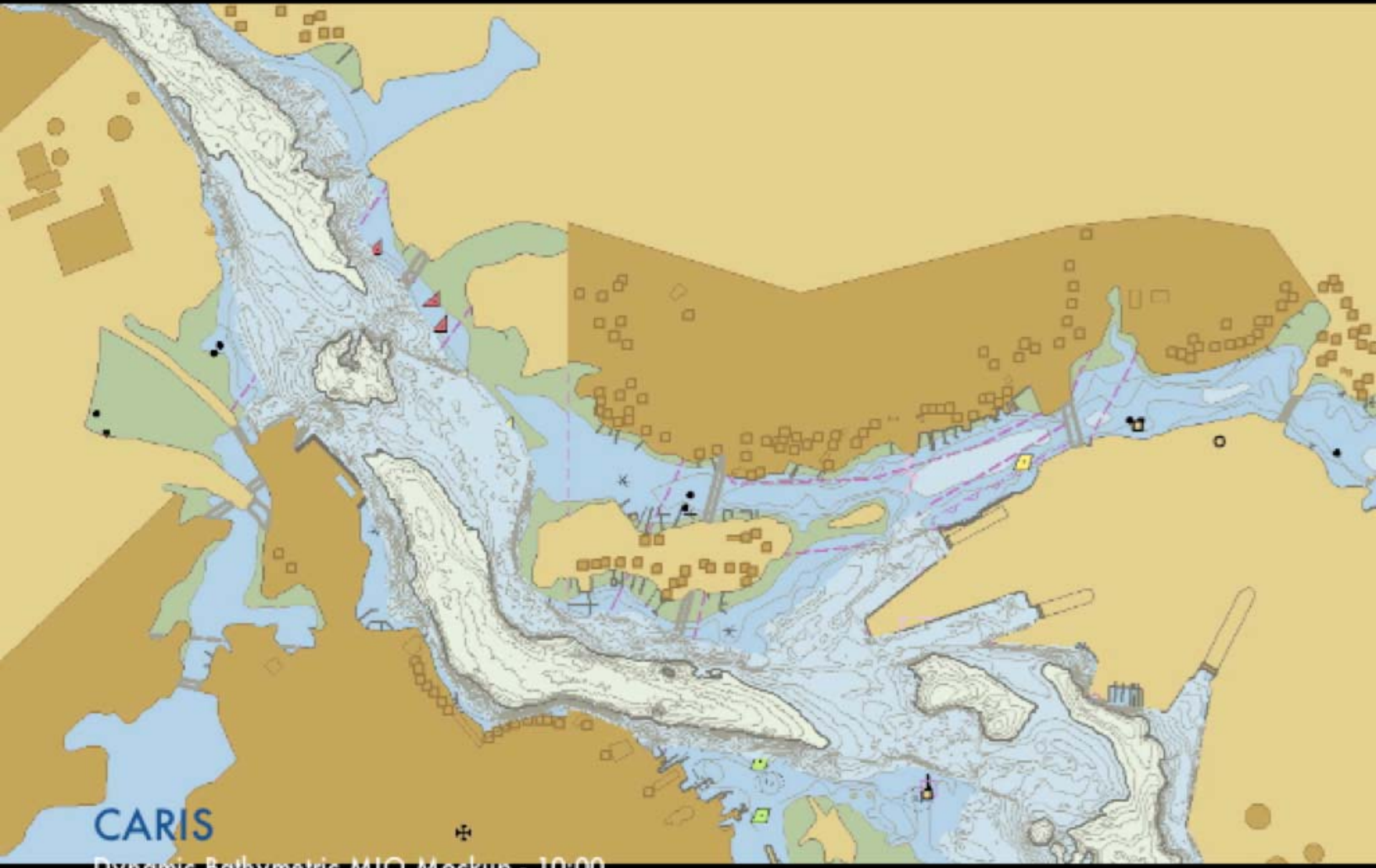
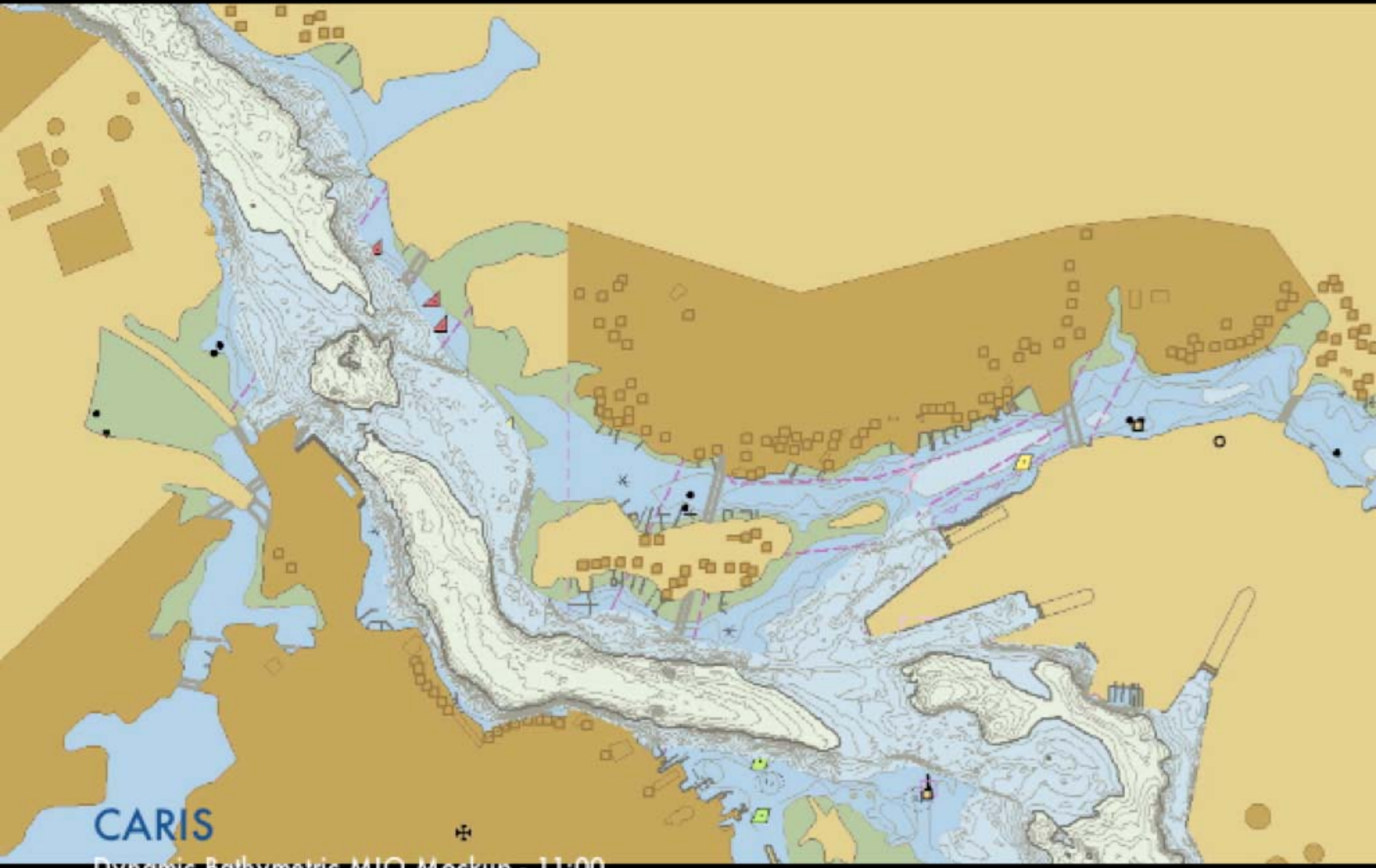
Dynamic Bathymetric MIO Mockup - 09:00


CARIS
Dynamic Bathymetric MIO Mockup - 10:00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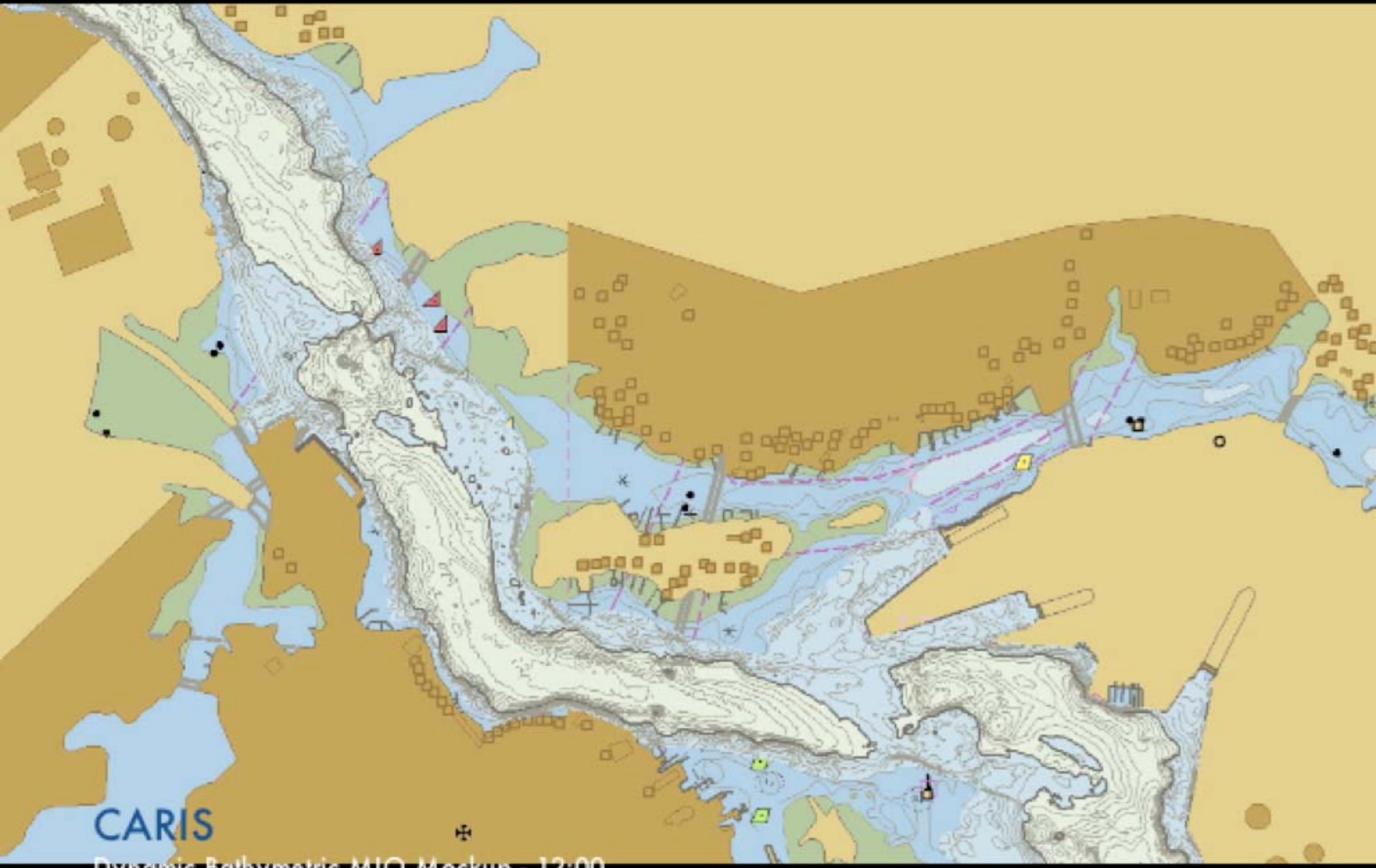
Dynamic Bathymetric MIO Mockup - 11:00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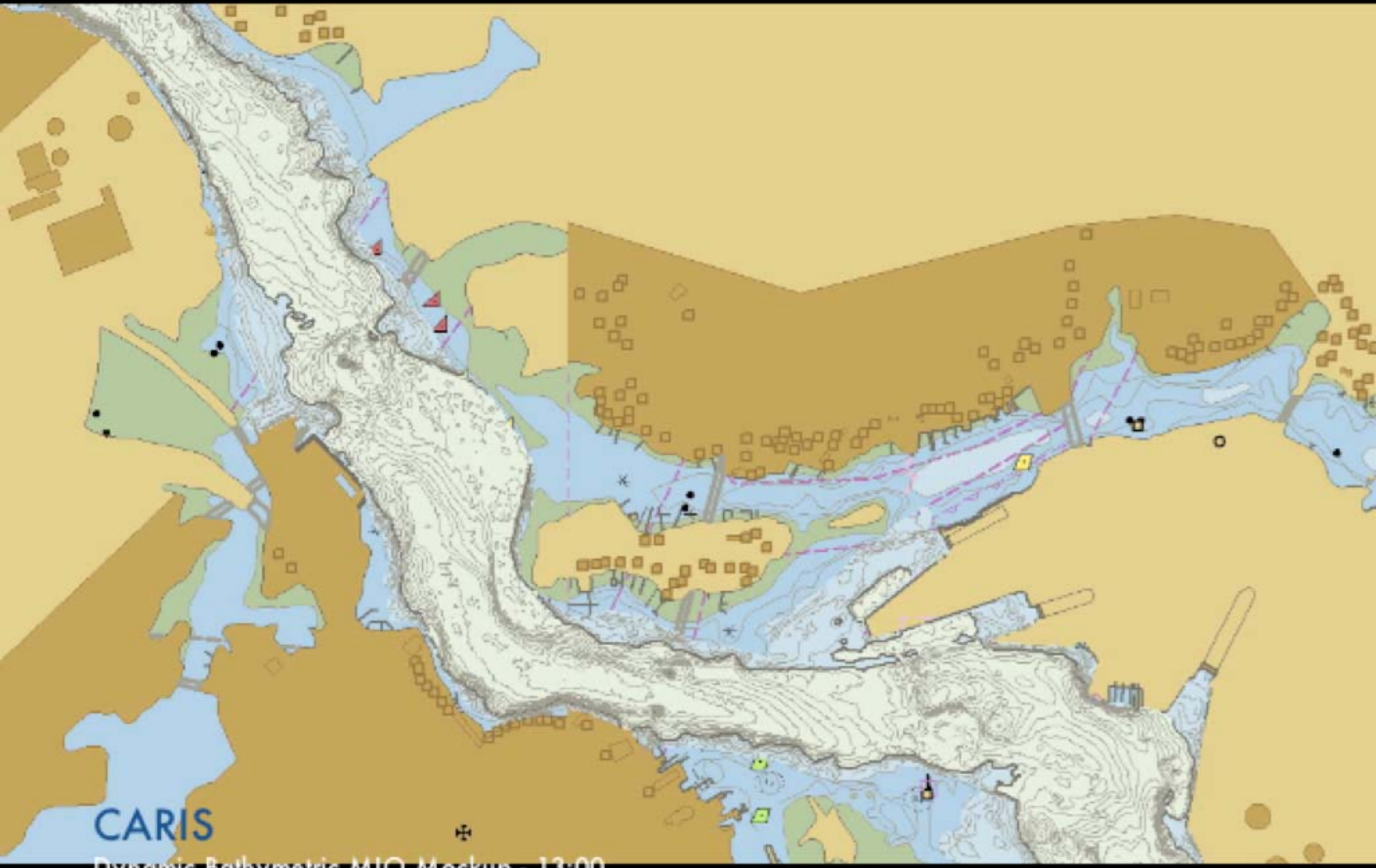
Dynamic Bathymetric MIO Mockup - 12:00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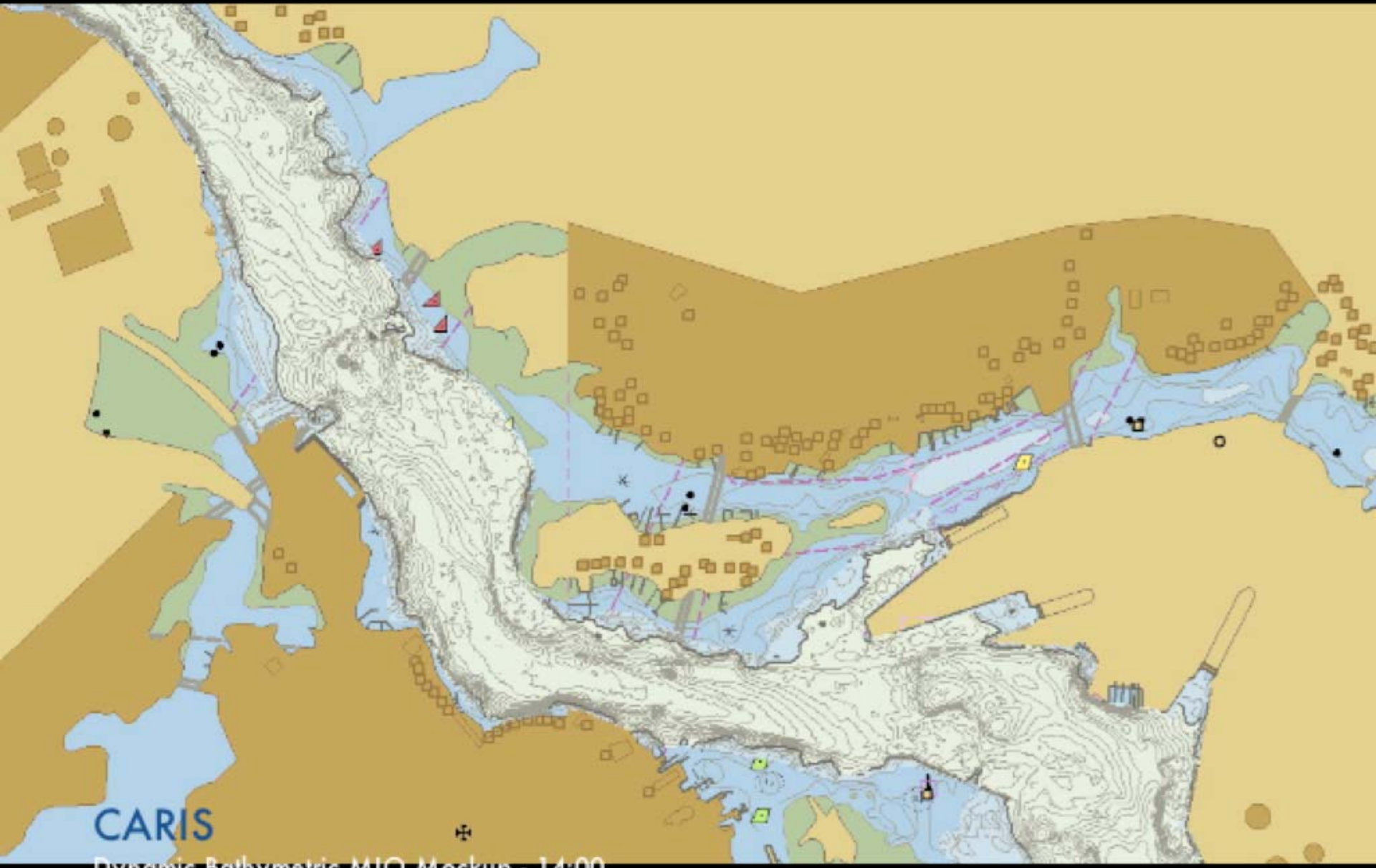
Dynamic Bathymetric MIO Mockup - 13:00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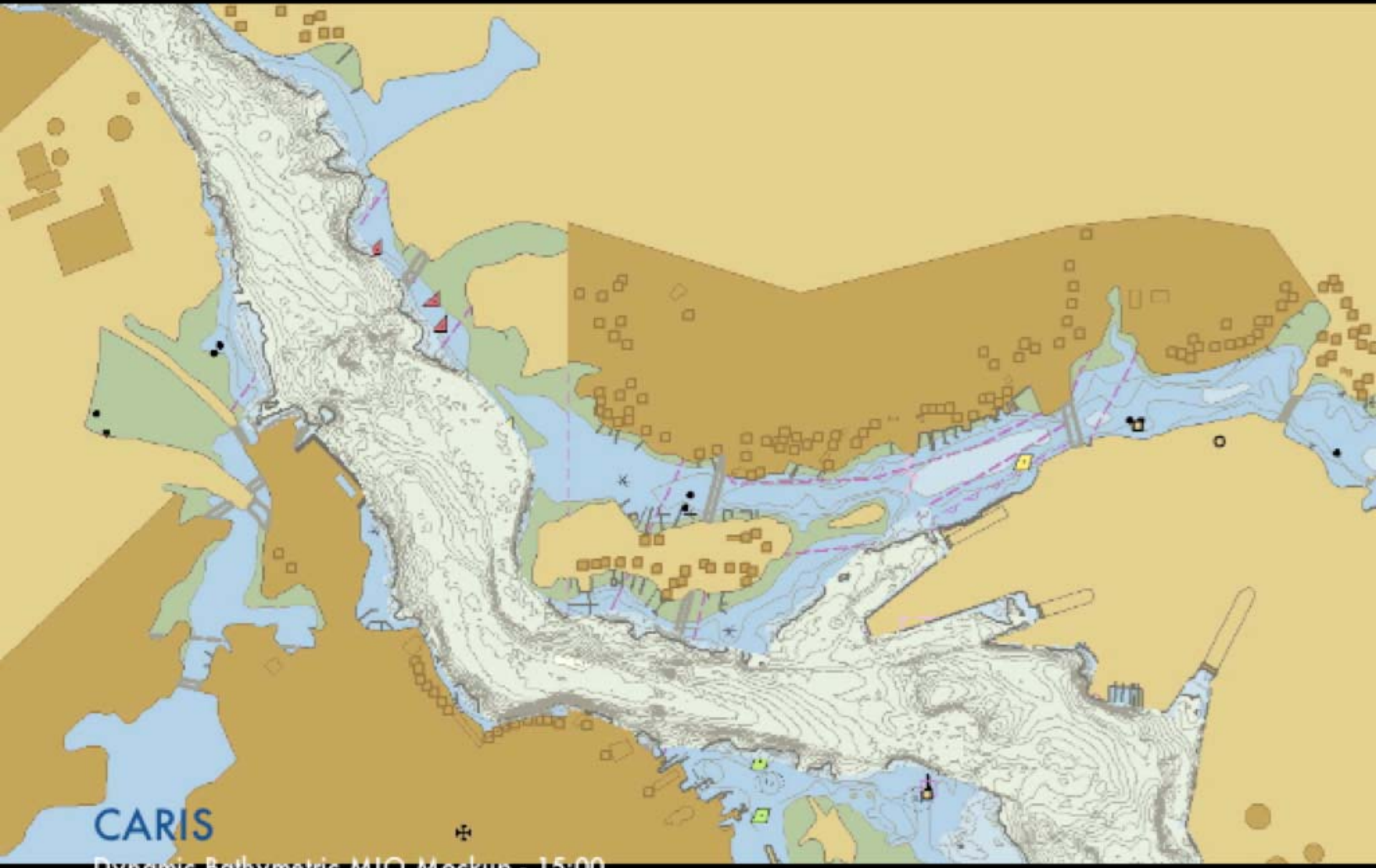
Dynamic Bathymetric MIO Mockup - 14:00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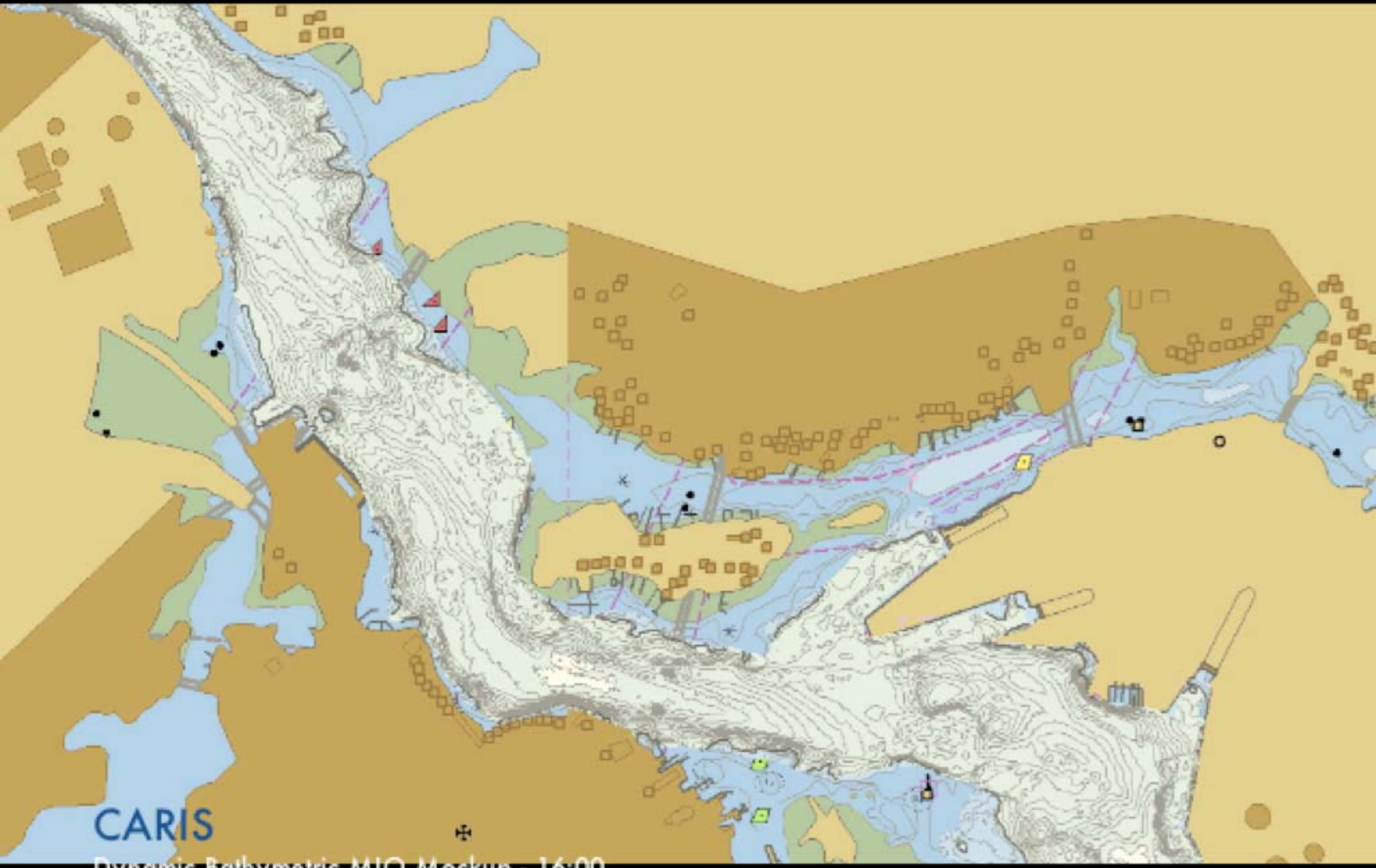
Dynamic Bathymetric MIO Mockup - 15:00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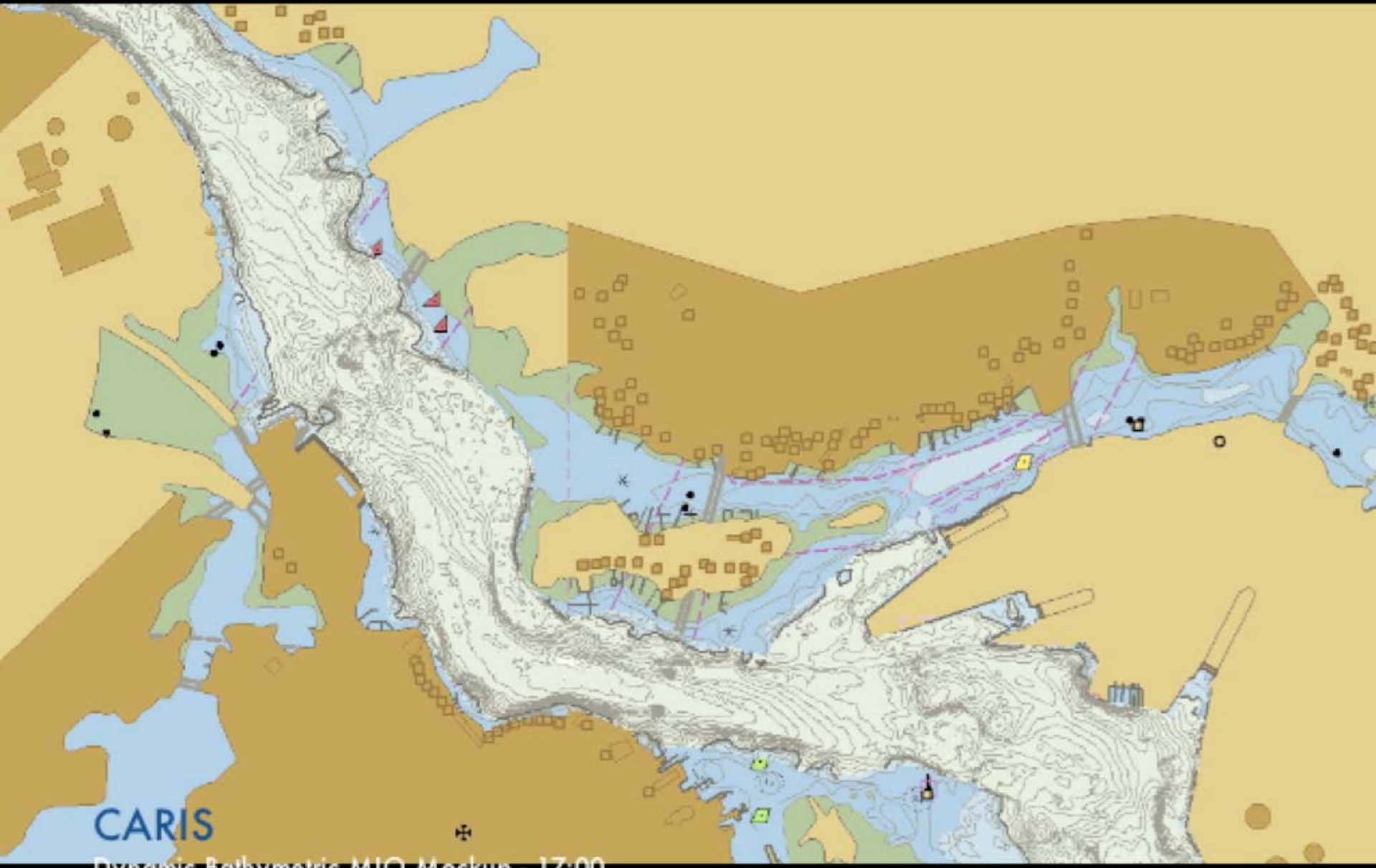
Dynamic Bathymetric MIO Mockup - 16:00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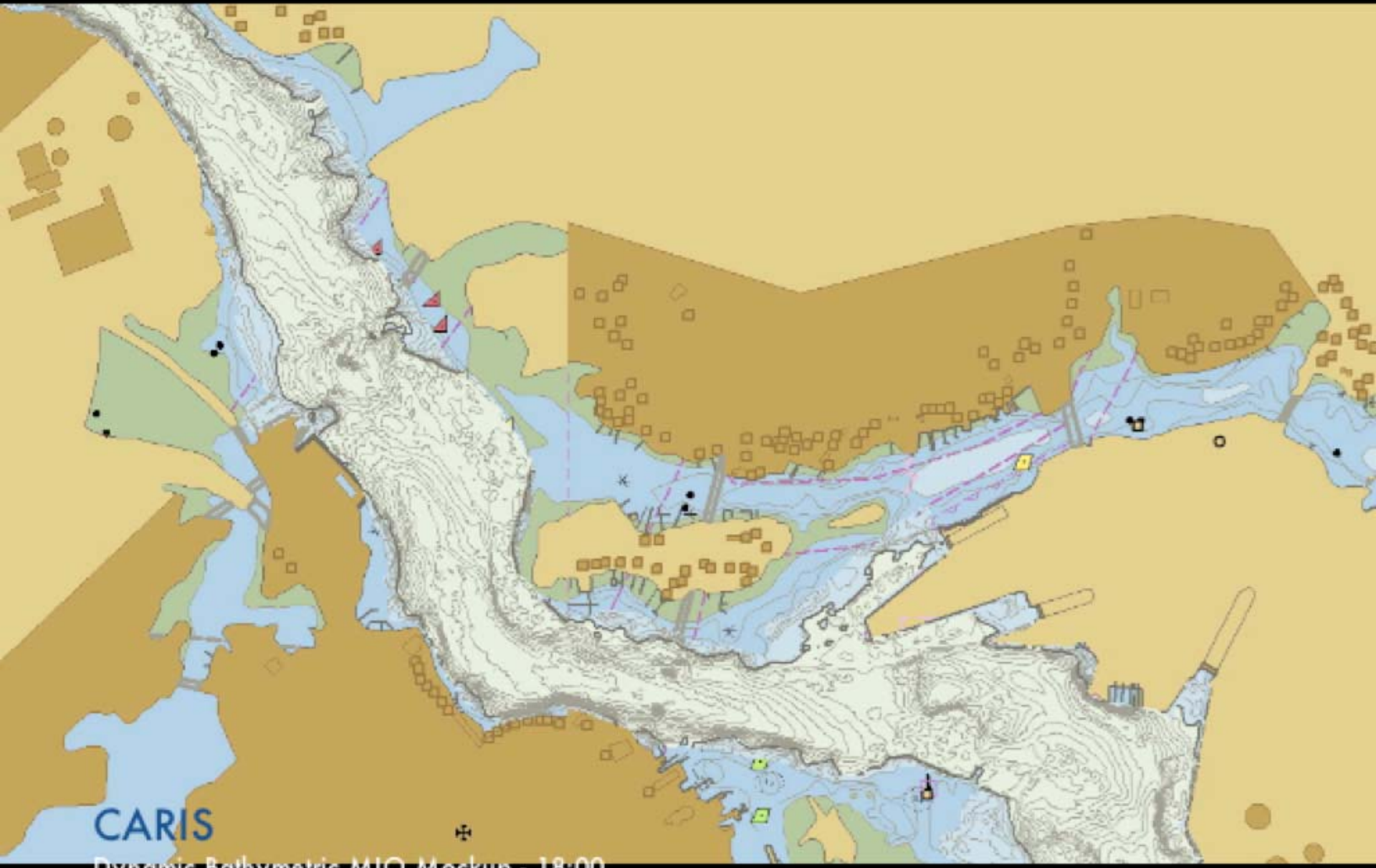
Dynamic Bathymetric MIO Mockup - 17:00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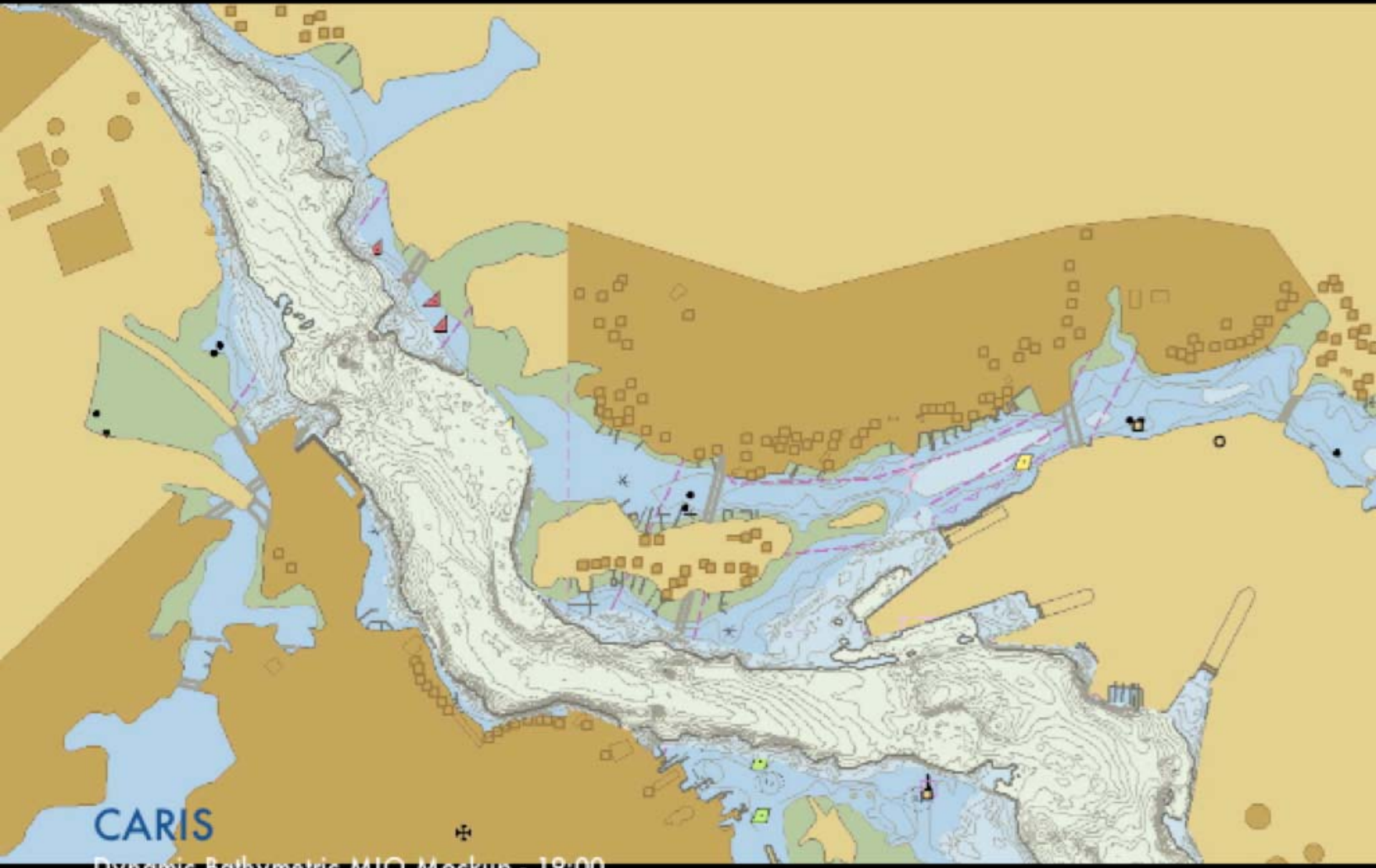
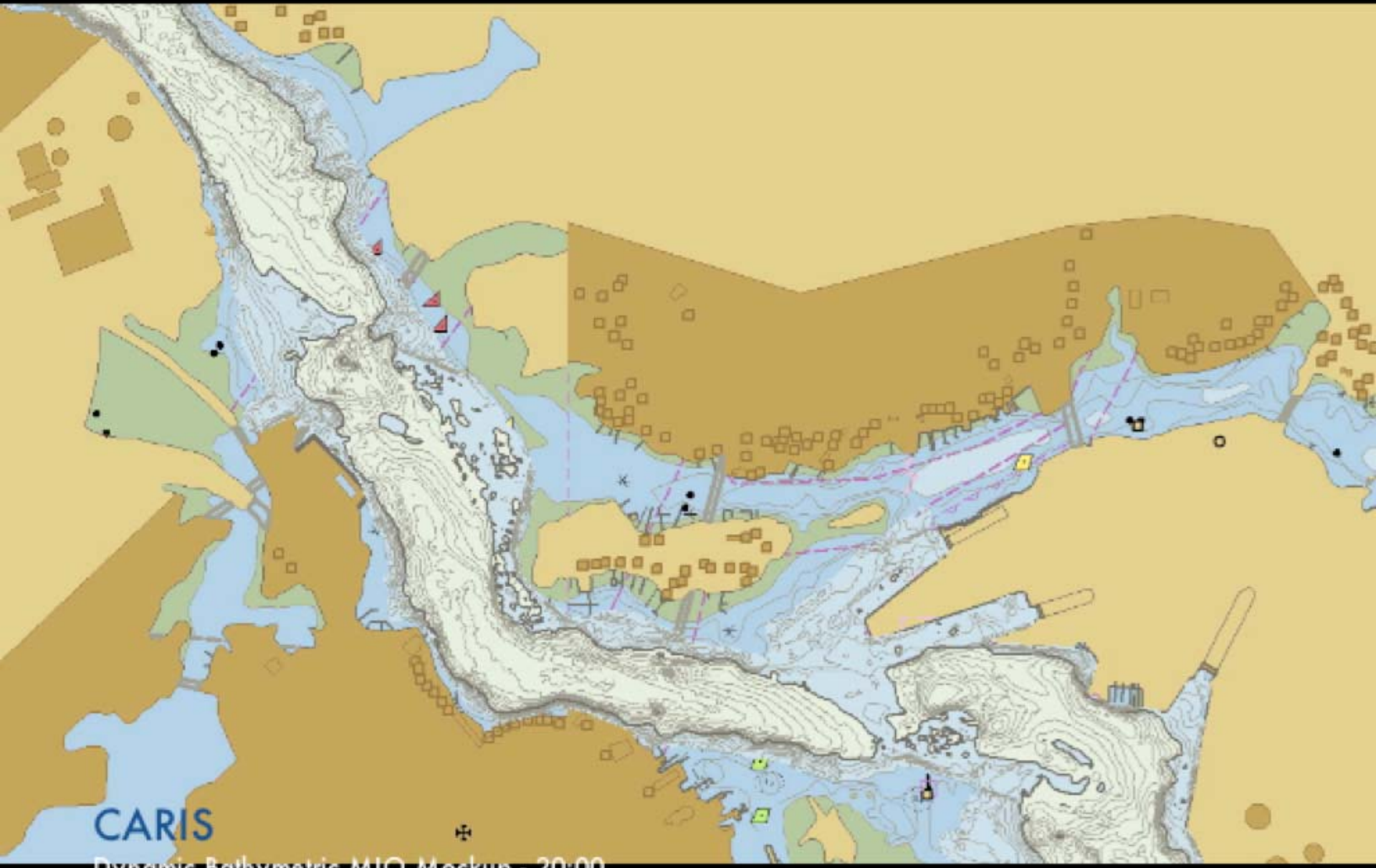

CARIS
Dynamic Bathymetric MIO Mockup - 19:00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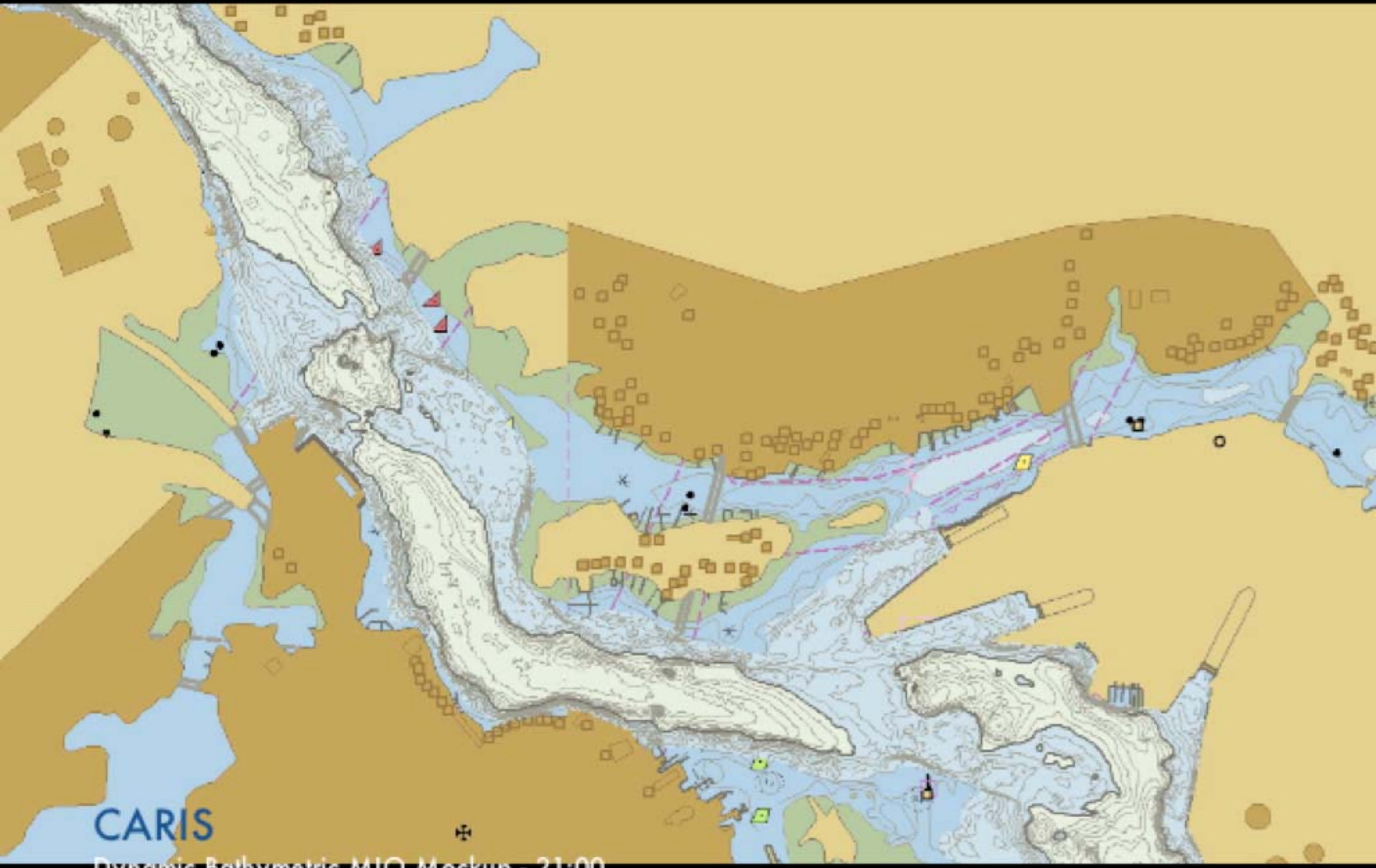
Dynamic Bathymetric MIO Mockup - 20:00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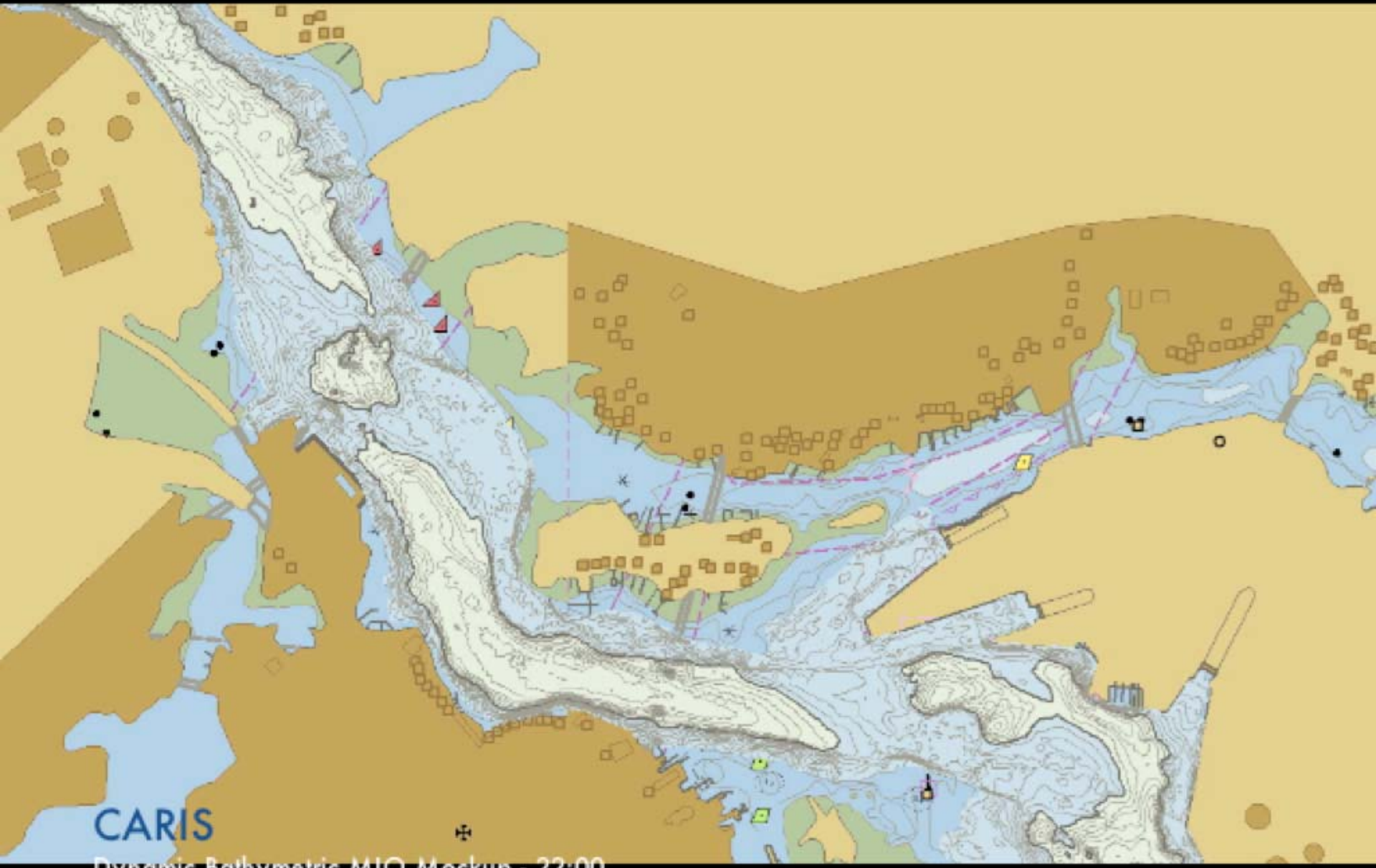
Dynamic Bathymetric MIO Mockup - 21:00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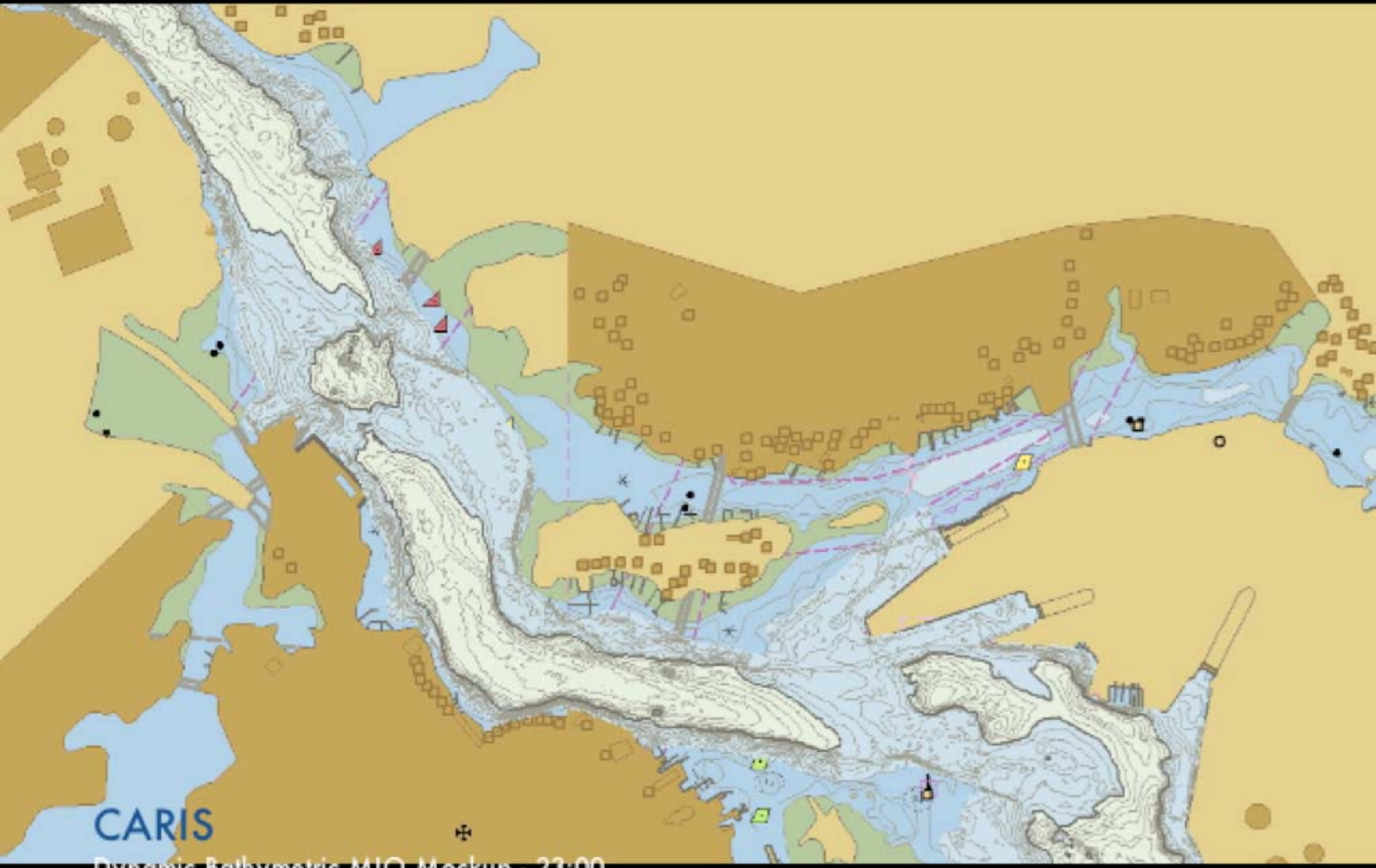
Dynamic Bathymetric MIO Mockup - 22:00


CARIS
Dynamic Bathymetric MIO Mockup - 23:00

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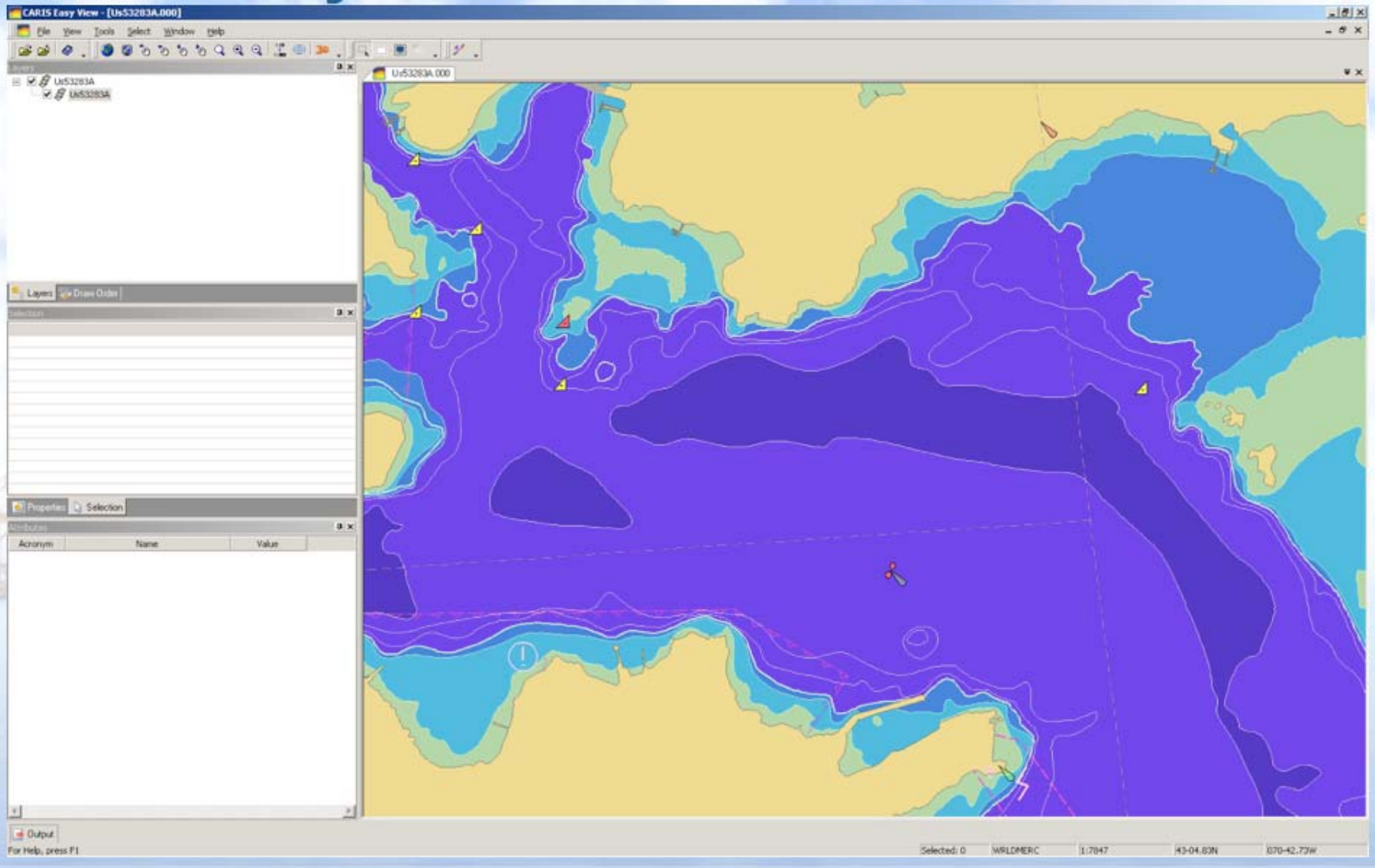
Bathymetric Blue Colour Scheme



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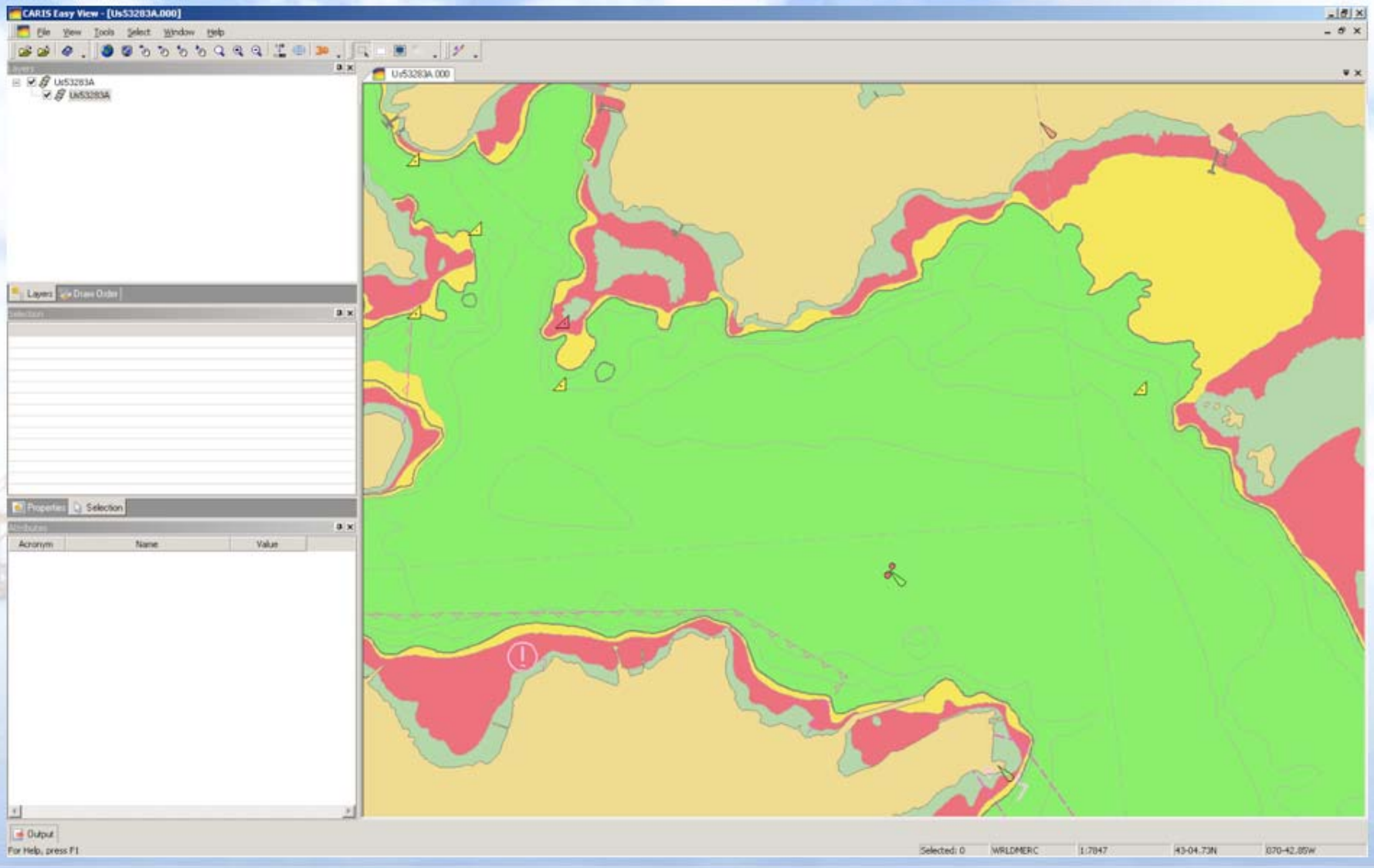
Red-Yellow-Green Colour Scheme



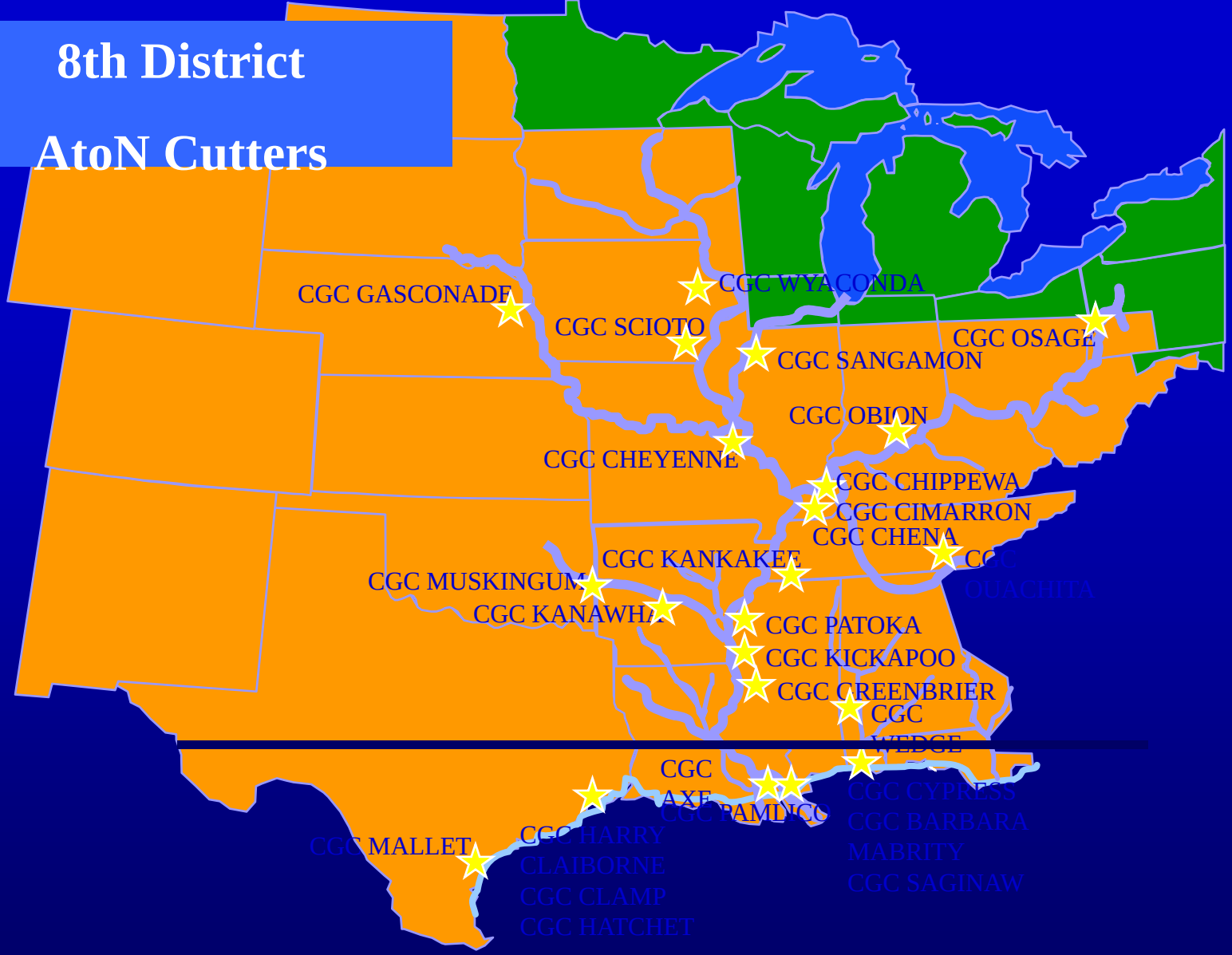
caris
www.caris.com

CARIS Ping-to-Chart Workflow

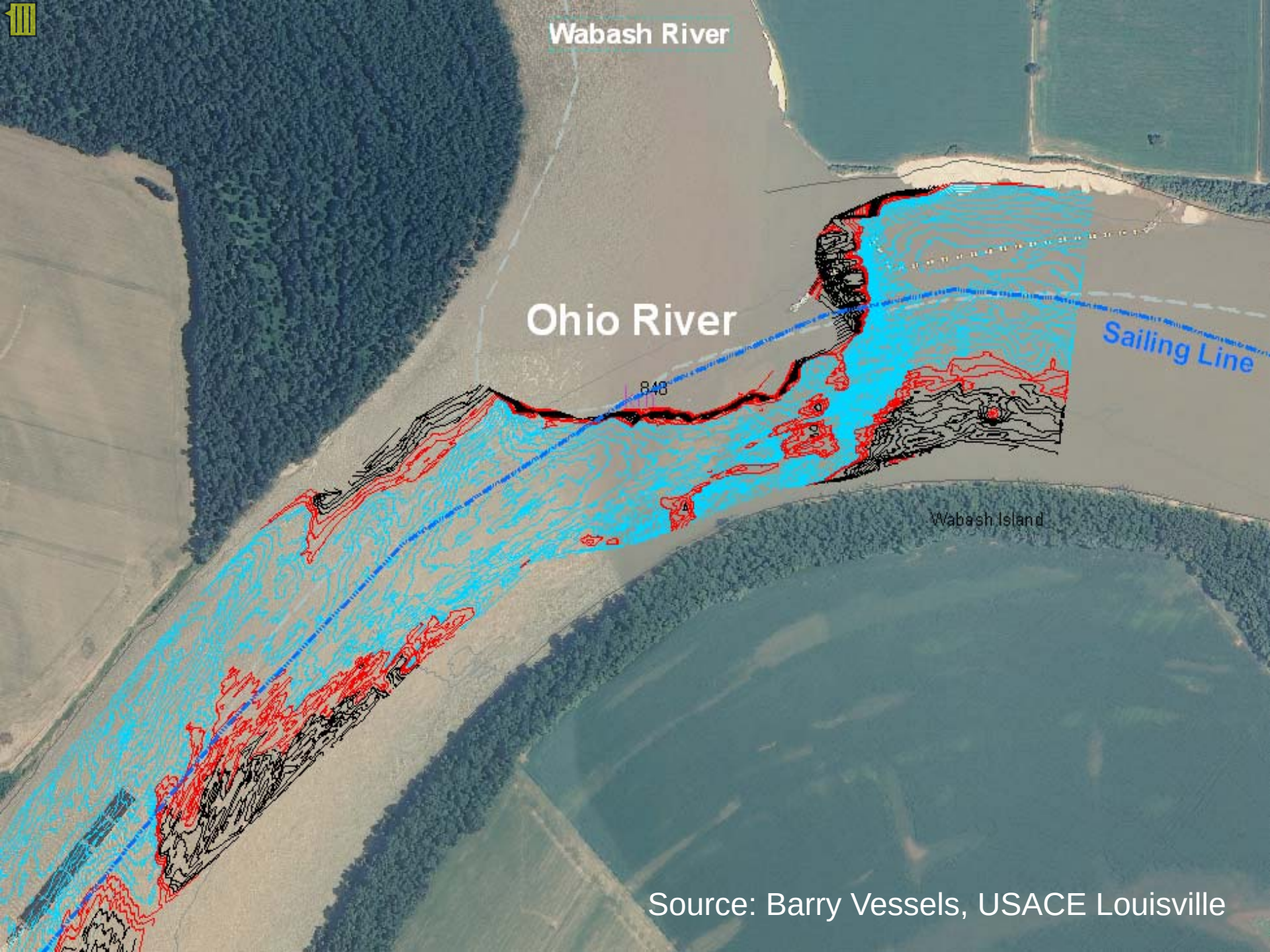
BUOY TENDER OPERATIONS ON THE WESTERN RIVERS

8th District

AtoN Cutters



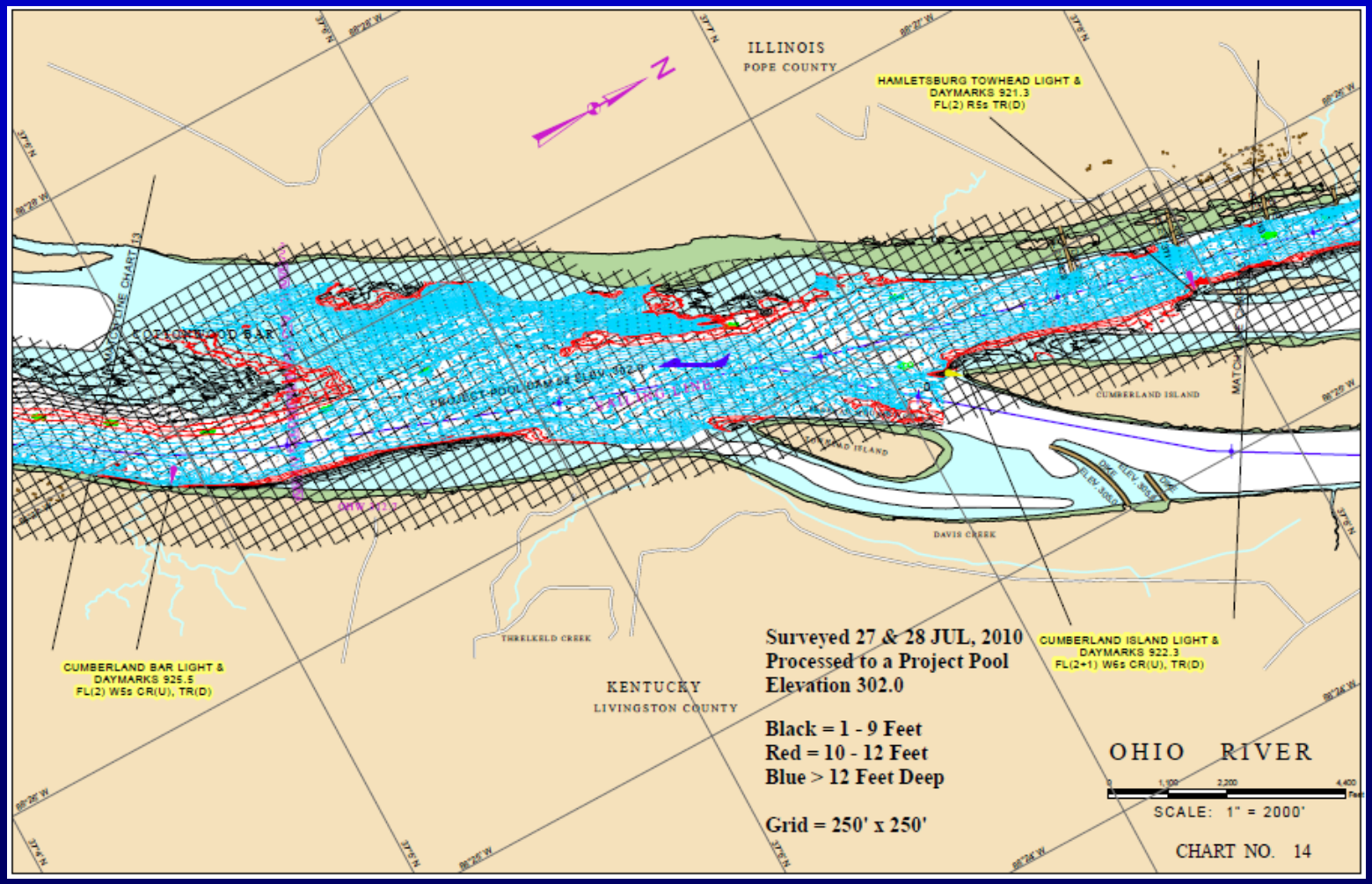
17 Inland Rivers Cutters



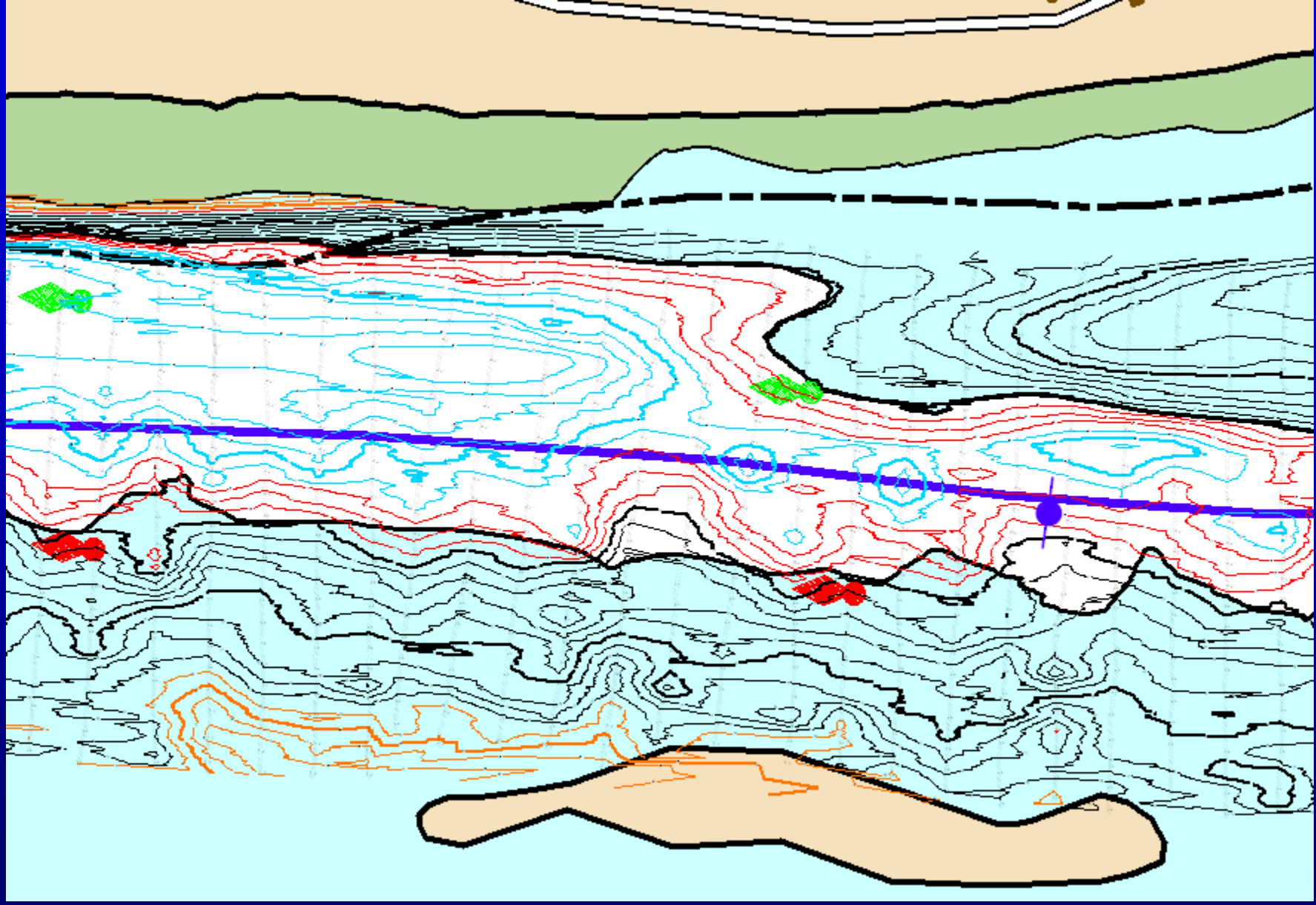
Source: Barry Vessels, USACE Louisville

Recon Survey with X-sections at 200’ Intervals

Channel Condition Report on Web



Source: Barry Vessels, USACE Louisville

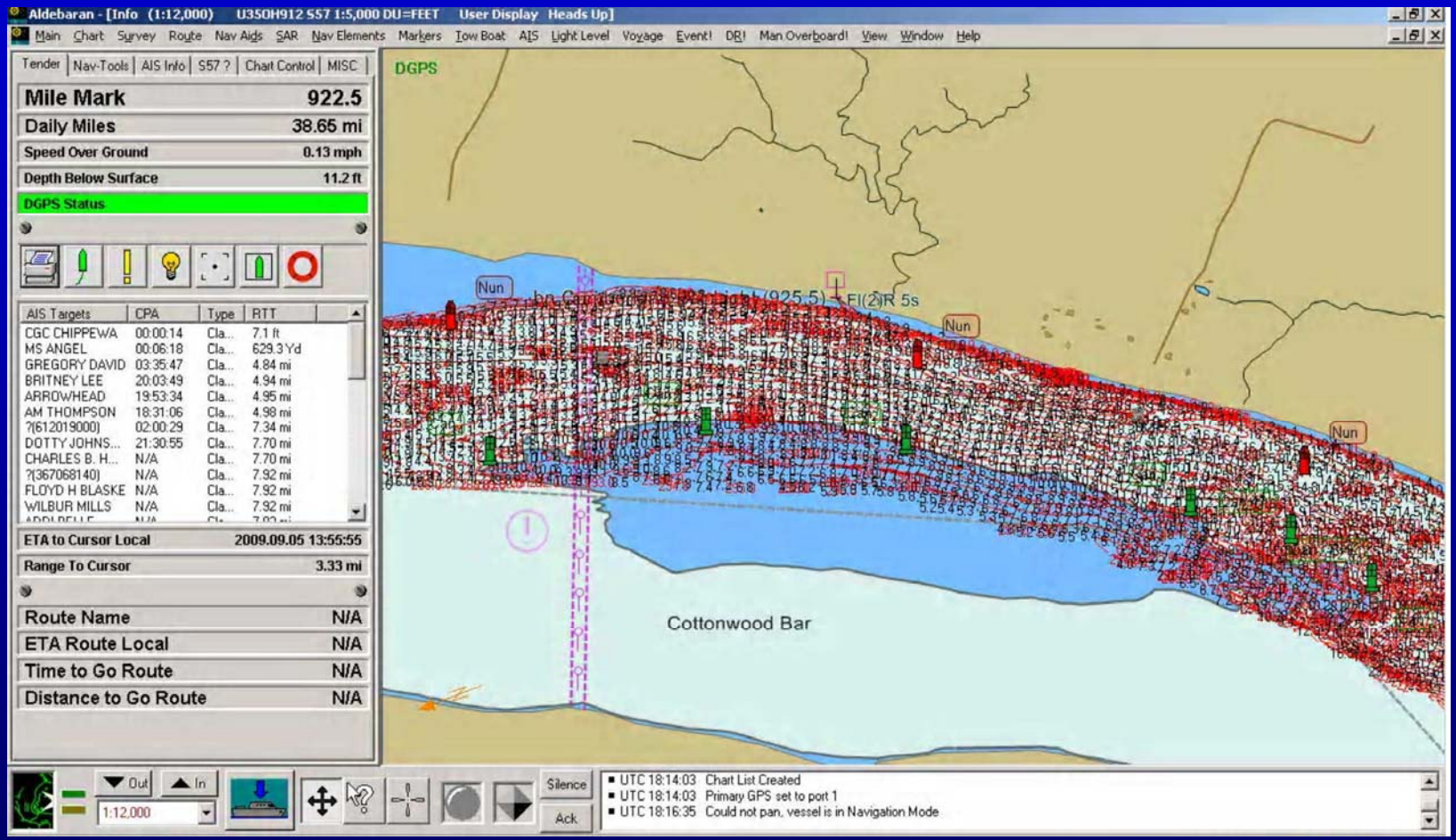


2010 Recon Survey - 200’ x-sections

Source: Barry Vessels, USACE Louisville

Aldebaran II – Buoys Program

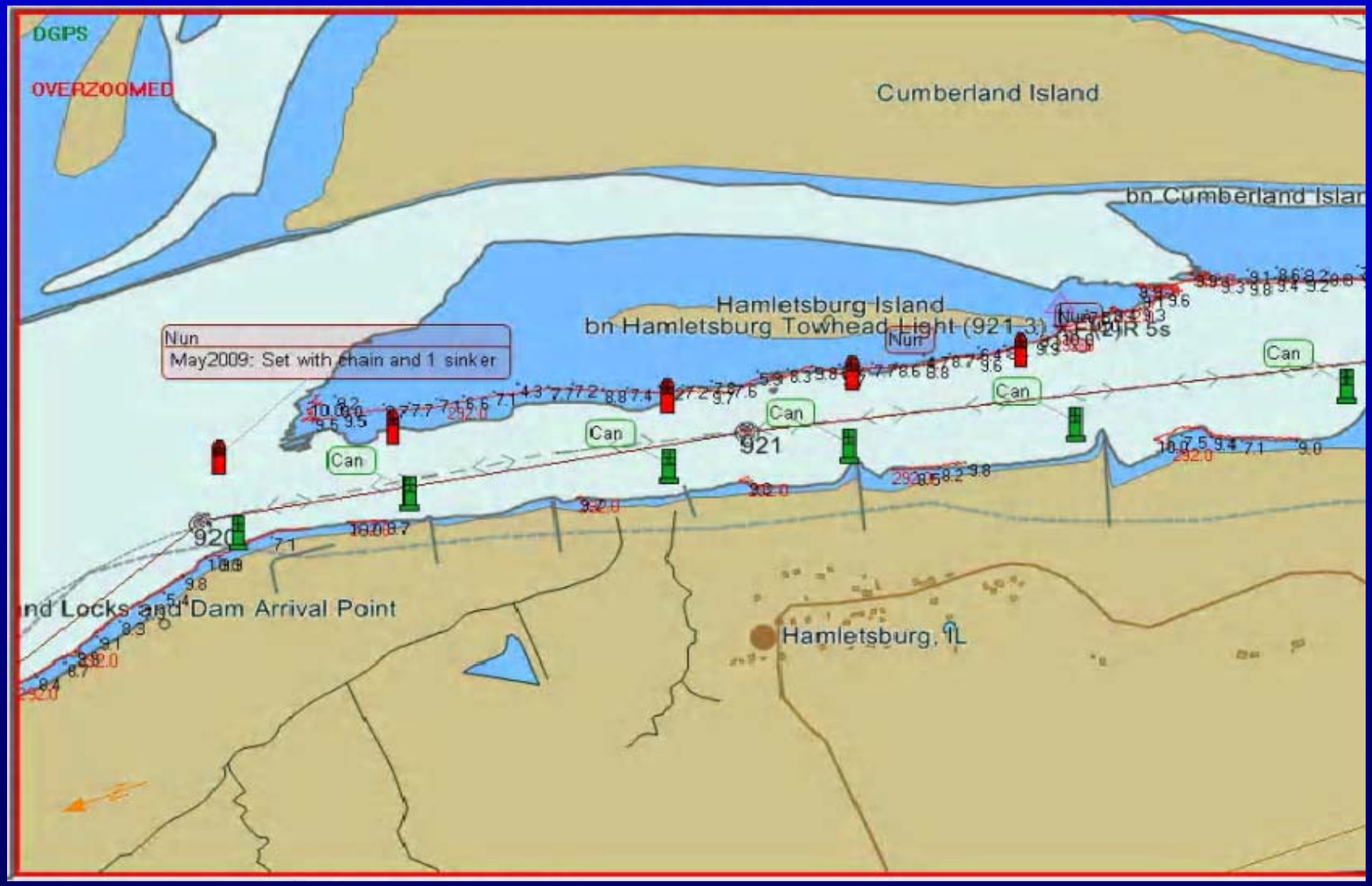
Survey Overlay – OHR MI 925 to 926



S-57 Overlay with Corps Survey

Source: Barry Vessels, USACE Louisville

- Filtered Survey Overlay – set to 10 Feet

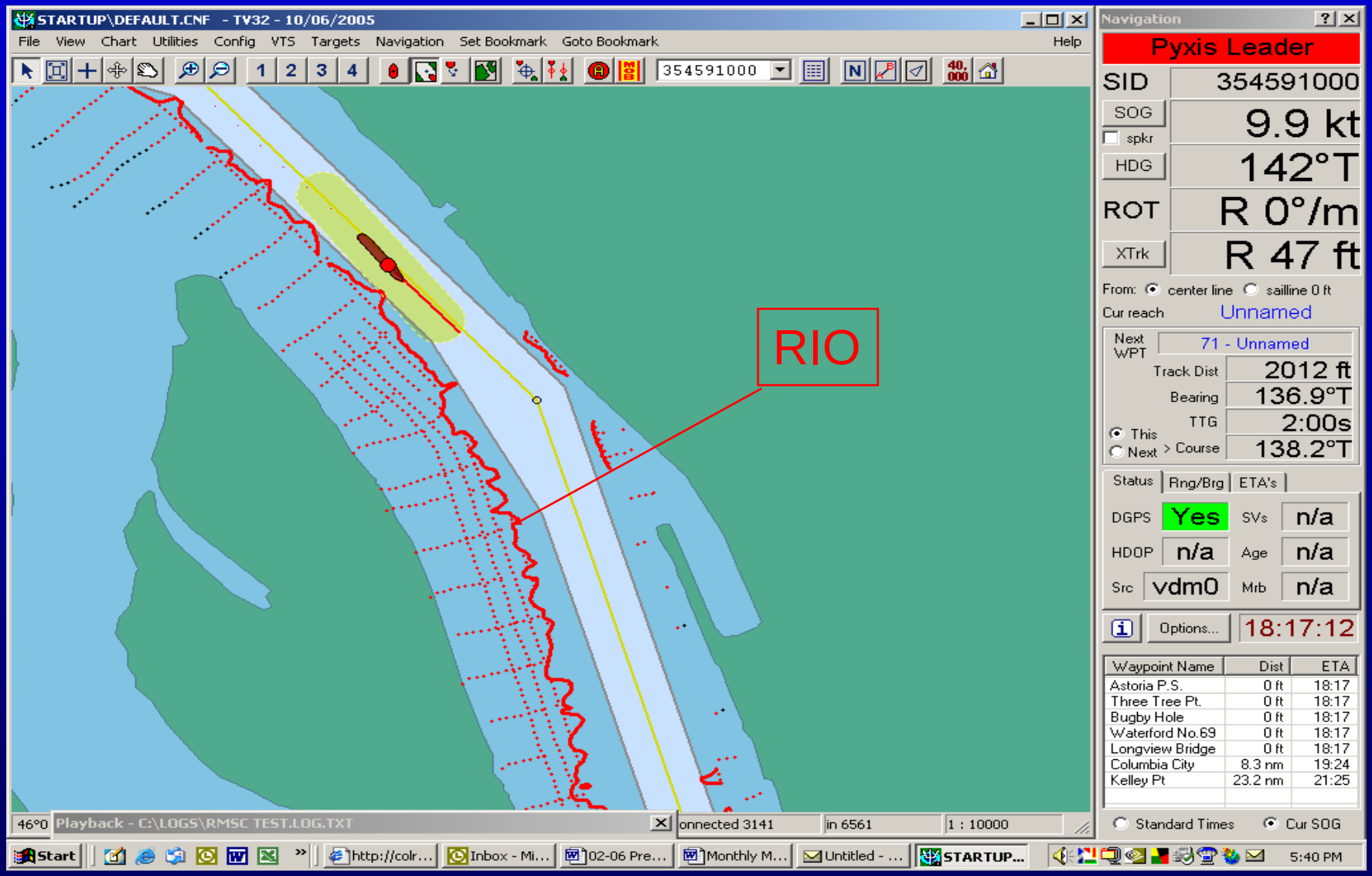


Source: Barry Vessels, USACE Louisville

Benefits

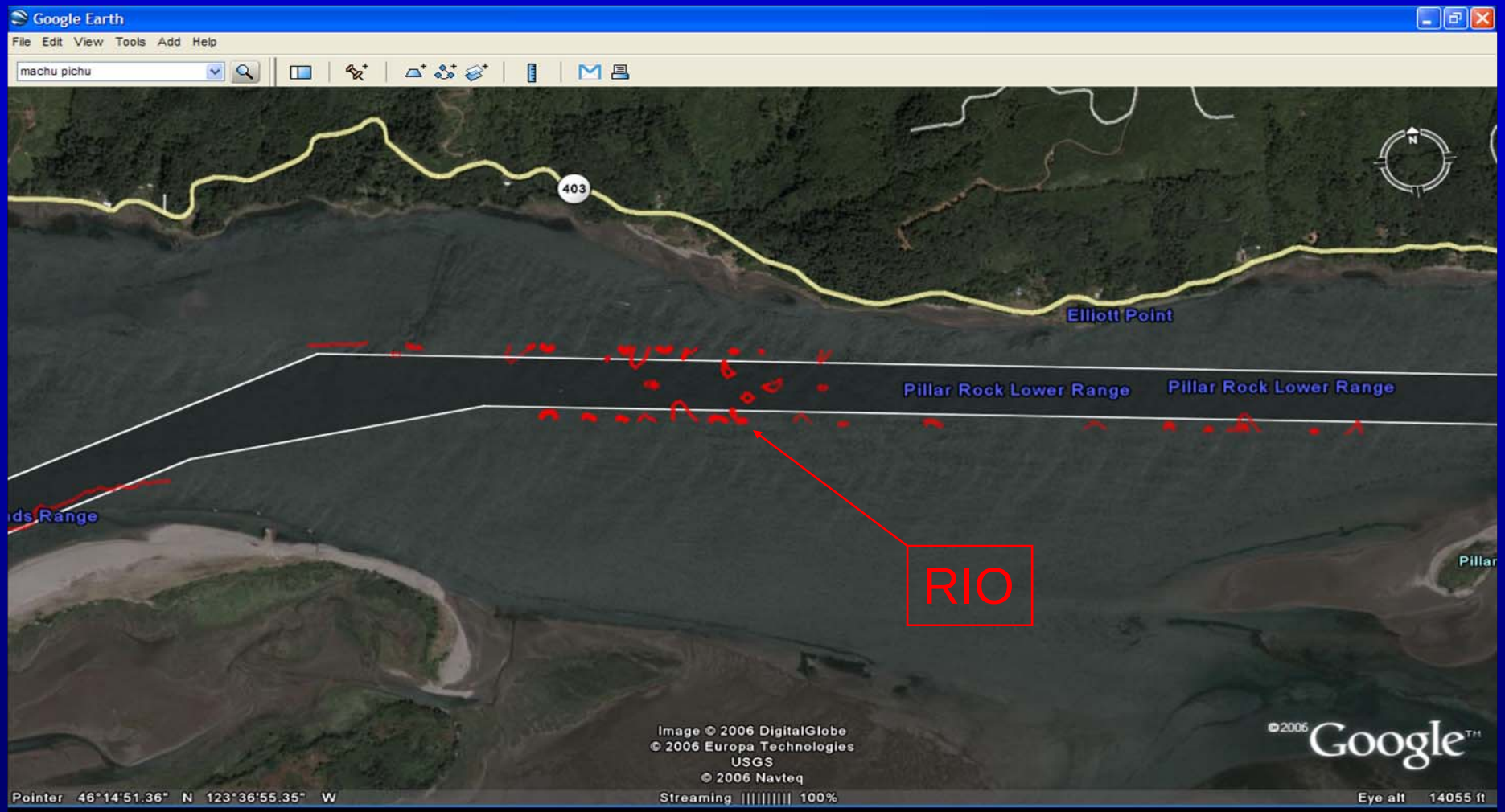
- CG Estimated $35,000+ Savings using Corps Surveys per run (Fuel, Time, and Plant Cost)
- The Lower Ohio Tender makes about 30-35 runs per year – 17 Tenders/Cutters Inland Rivers
- Less Fuel Usage/Greener Environment/ Safer More Efficient Navigation System
- USACE Savings to Prevent ONE Emergency Dredge Cut > $500K

River Information Overlay (RIO) on Electronic Chart
Columbia River, Oregon, USA



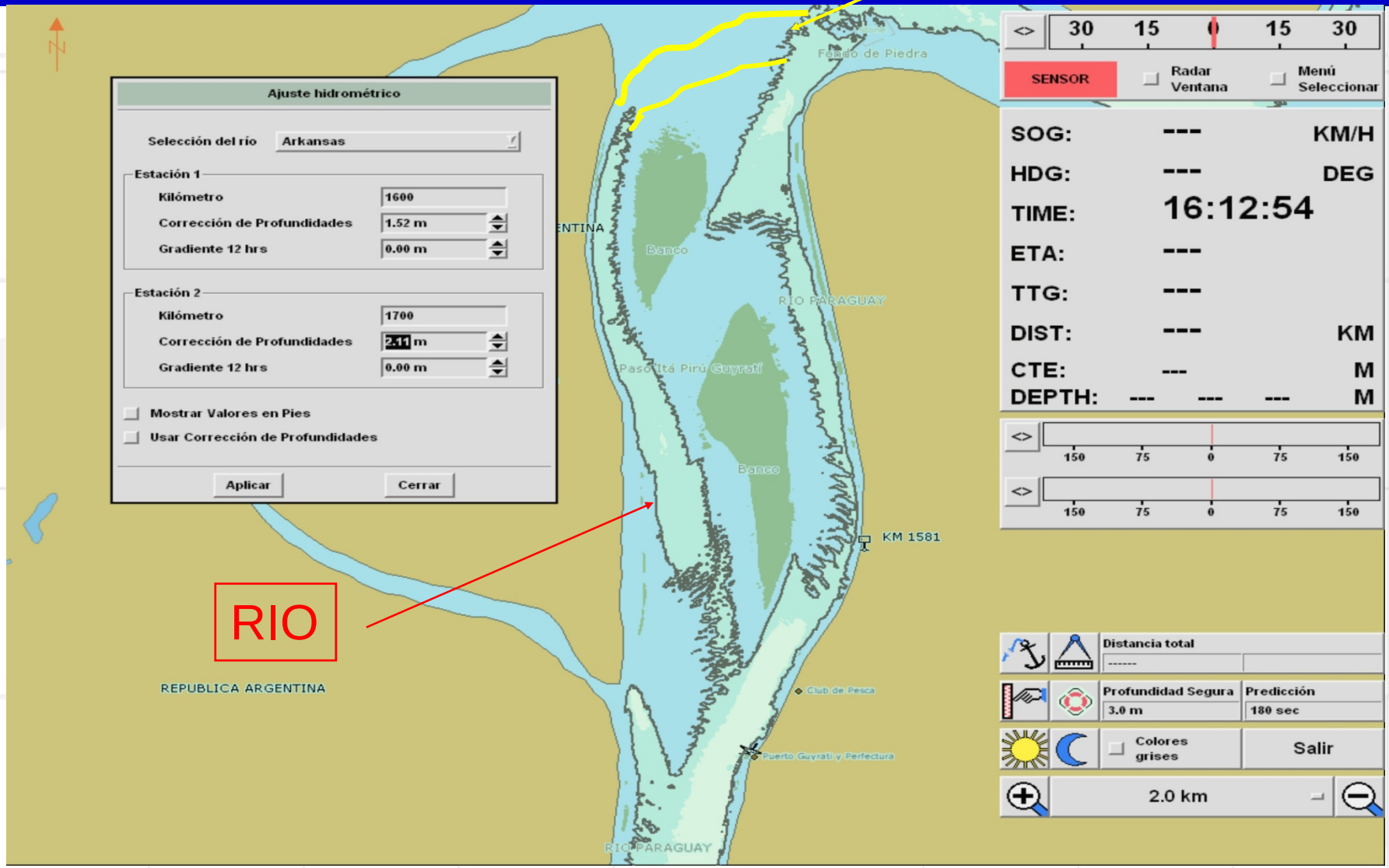
Source: Capt. Paul Amos, Columbia River Pilots Assoc.

River Information Overlay (RIO) on Aerial Photograph



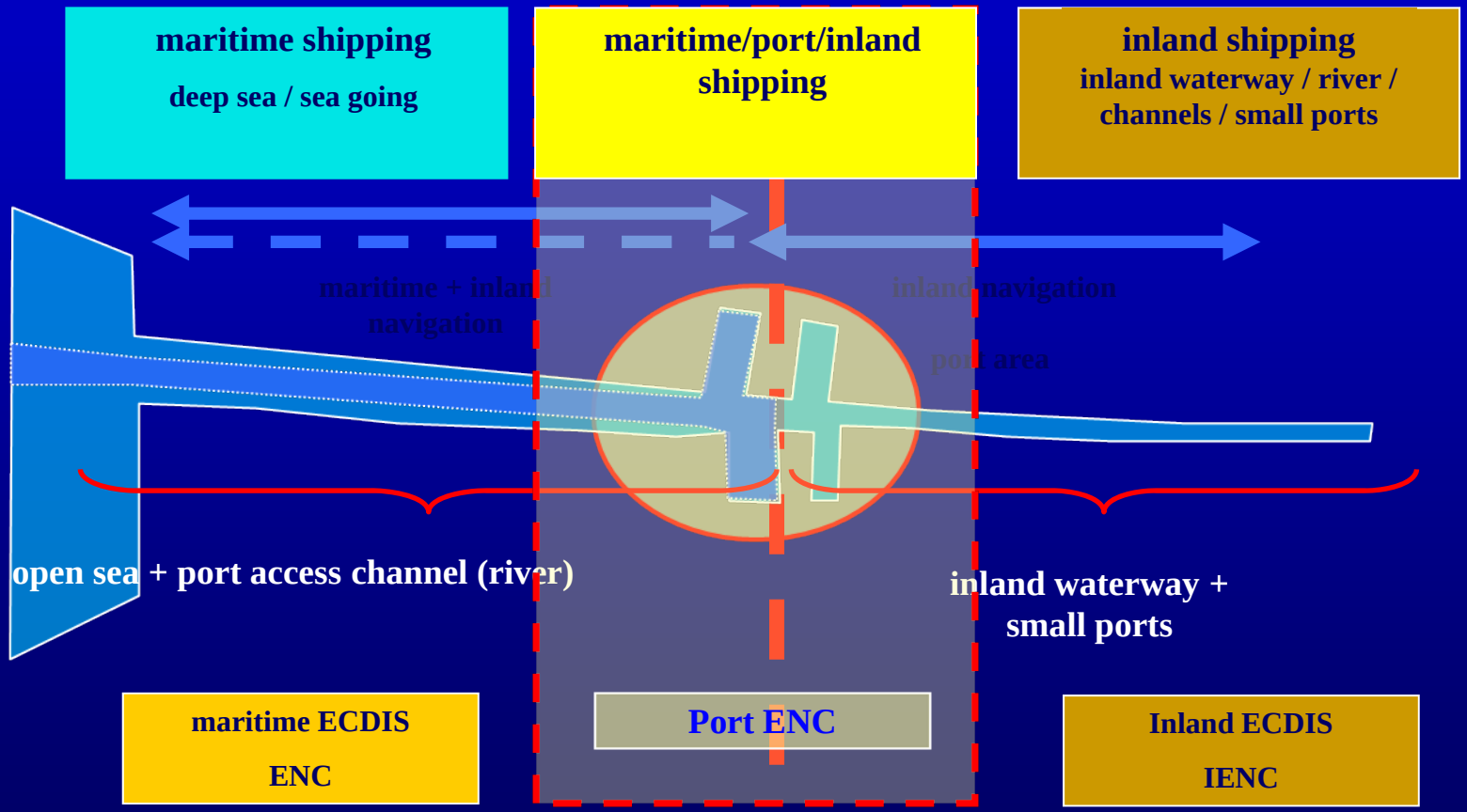
Source: Capt. Paul Amos, Columbia River Pilots Assoc.

River Information Overlay (RIO)

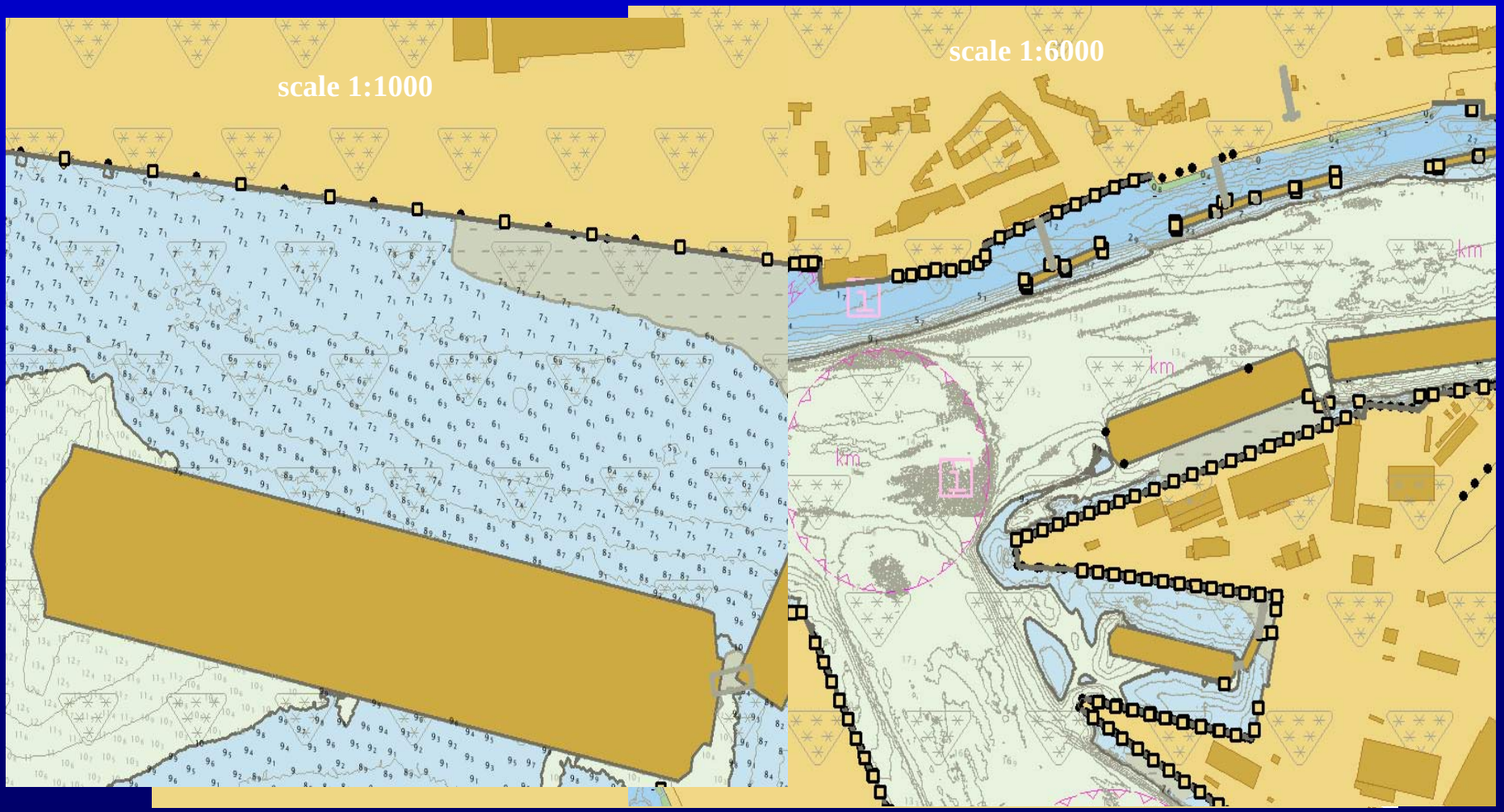


Source: Otto Duarte Volker, Cledir SA

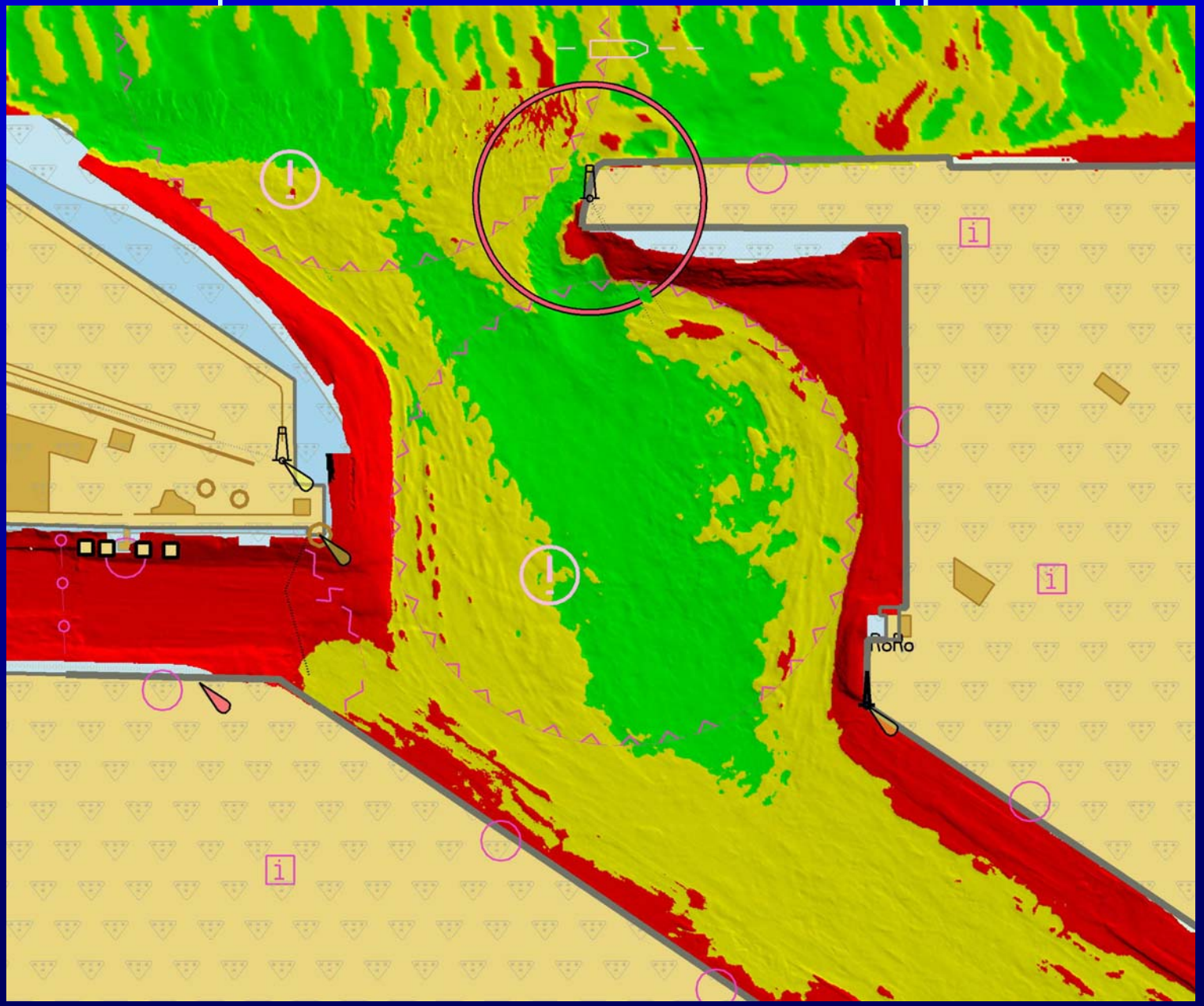
Maritime ← → Port ← → Inland



Port ENC – Port of Hamburg, Germany



Depth areas used for decision-support

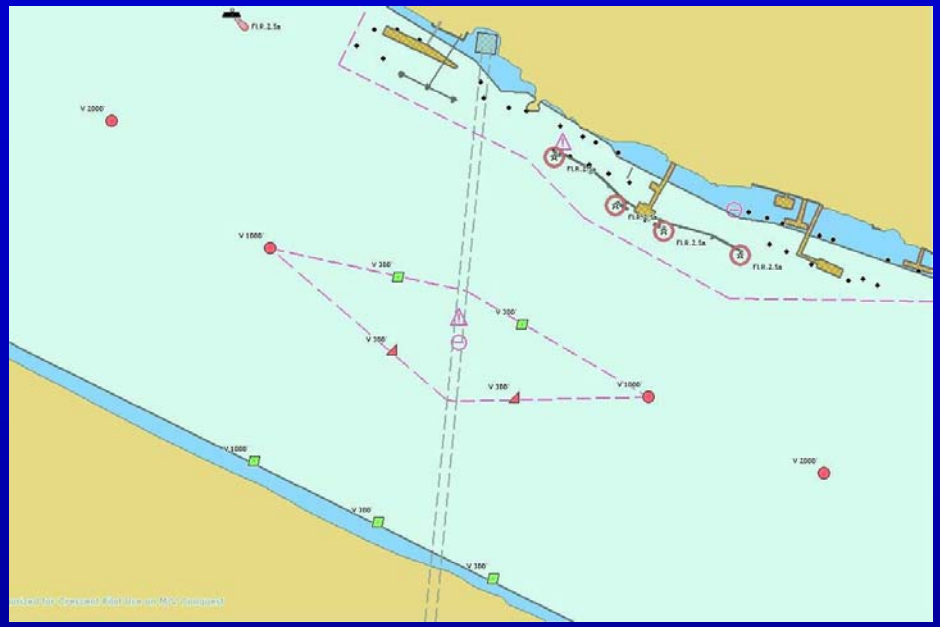


Special port requirements

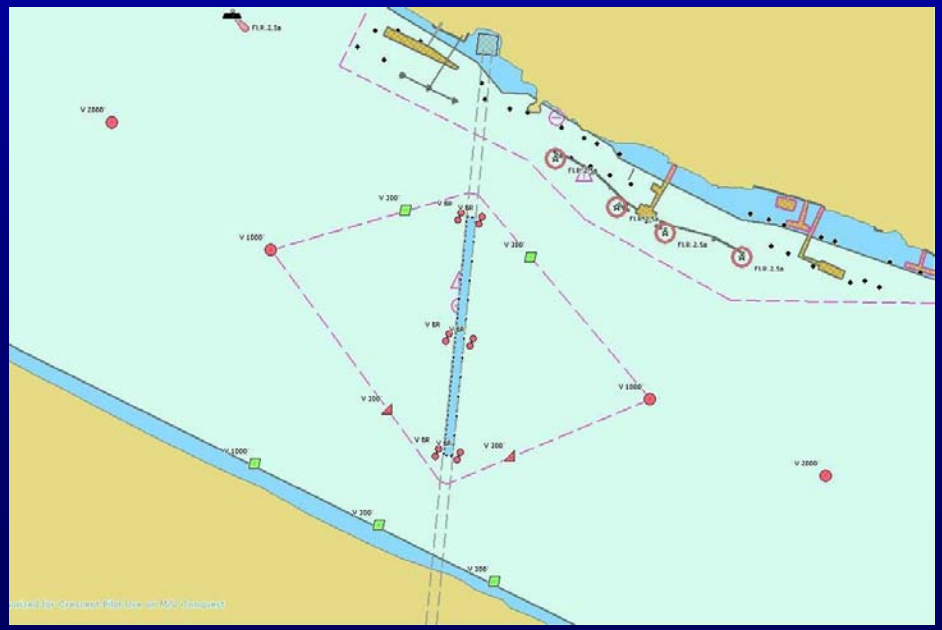
3-D bridge / lock passages information (air draft)

“Virtual AtoN”

Lower river stage
&/or
less powerline sag



Higher river stage
&/or
more powerline sag

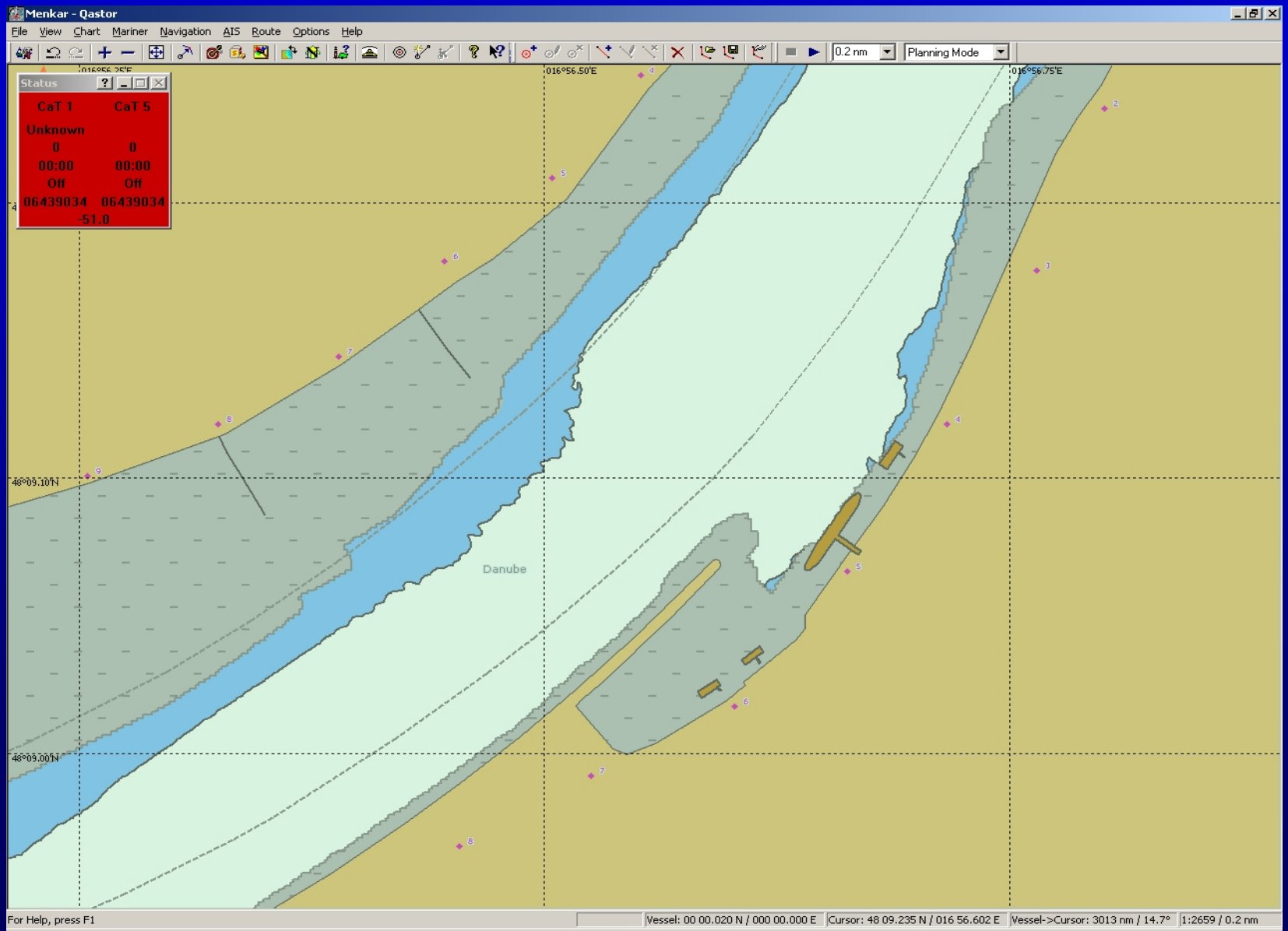


Source: Ralph Scheid, USACE New Orleans District

Water level models: Challenges and Opportunities

- A water level model has to describe the water level for various gauge levels.
- It is not possible to use the same water level model everywhere.
- Differences due to tidal influence, kind of dams, power stations, locks and water management.
- Some countries are already using water level models, which are not only used for inland navigation, but also for flood protection, energy management, etc.
- The different models should be used on shore, the results should be transmitted to the on board applications in a standardized way.

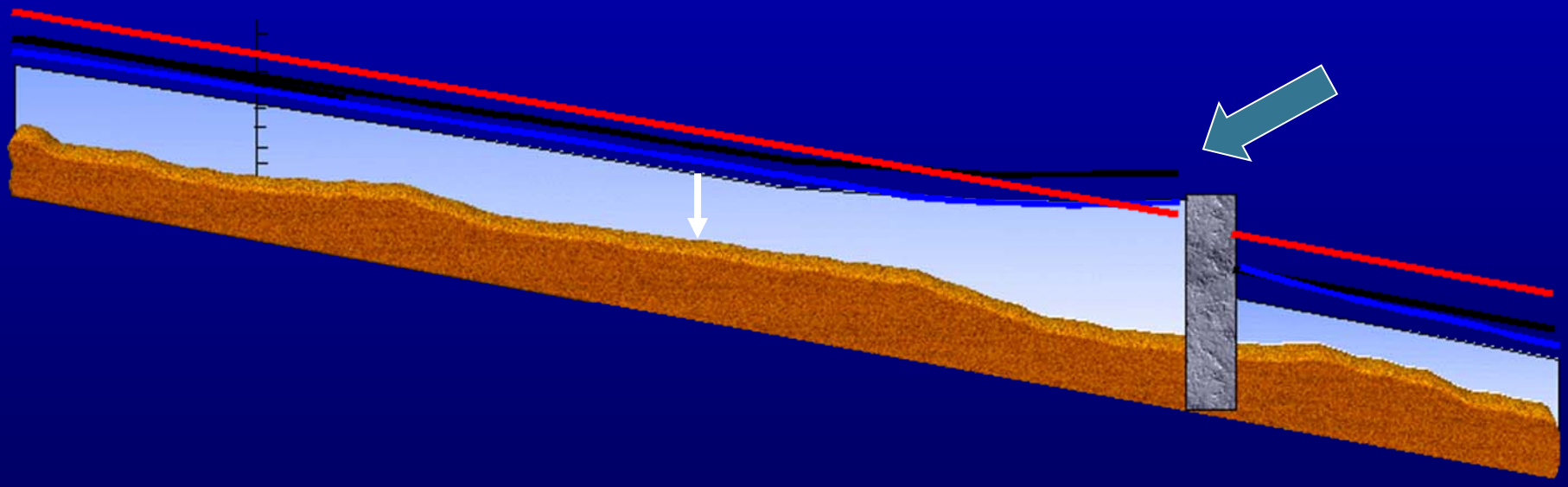
Depth information is referred to a reference water level.



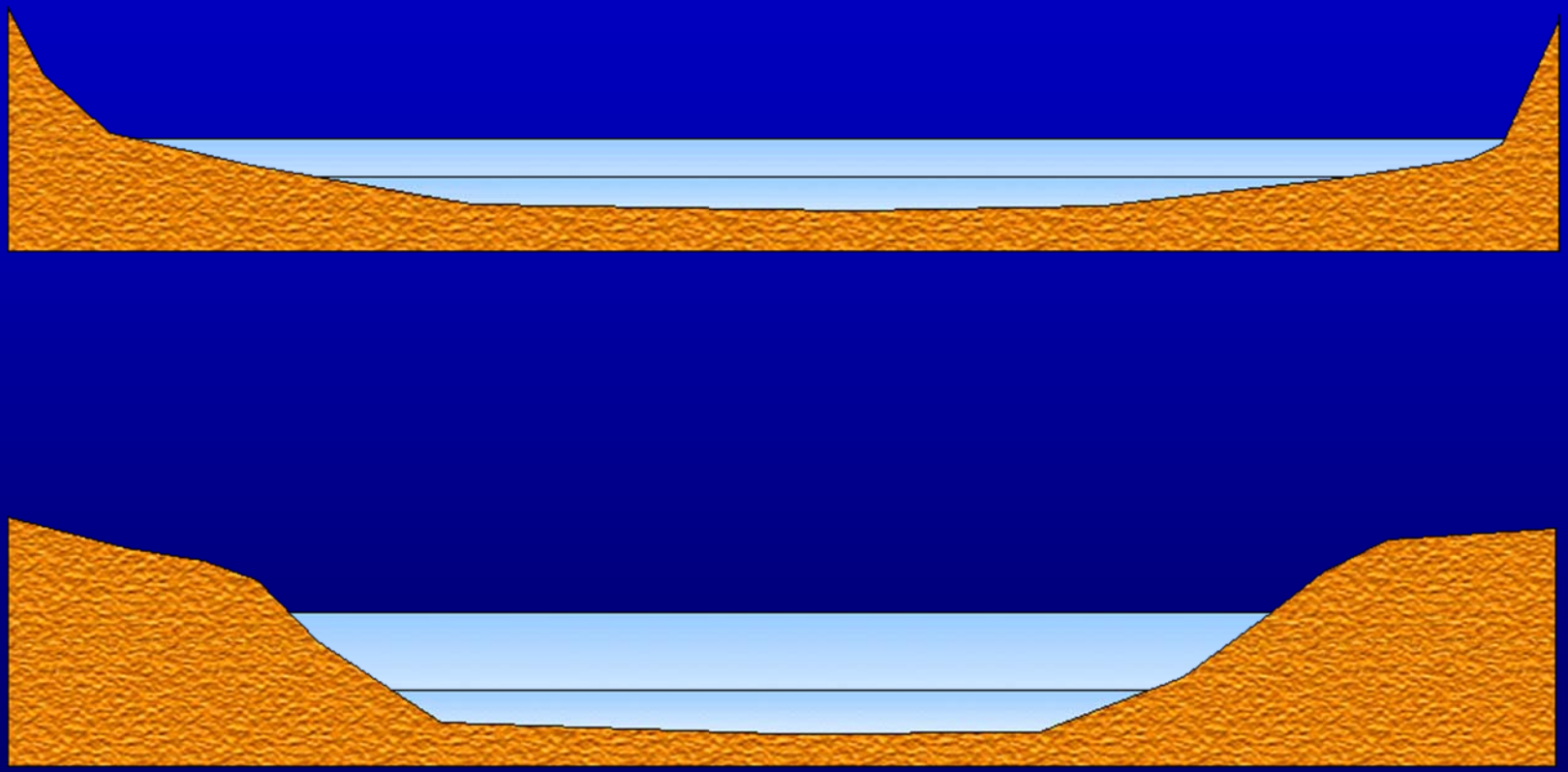
Depth information in Inland ENCs is referred to a reference water level, which is sloped and non-linear.

If the water level at the gauge is 1 m above the reference level, the skipper adds 1 m to all the depth values.

We need a **inland/river (fluvial) water level model**, because water levels are not parallel.



Inland/river (fluvial) water level models are also needed for free flowing sections due to different cross sections.



S-57 ENC Product Specification

- Used by HOs to produce ‘maritime’ ENC data for ECDIS
- Current version (3.1) recently updated (3.1.1) to meet new IMO requirements:

  Particularly Sensitive Sea Area (PSSA)

  Archipelagic Sea Lanes (ASL)
- Since MIOs (and RIOs) are used with ENCs, they should conform – as much as possible – to the ENC Product Specification.

MIO* - General Content Specification

Purpose: Produce all MIOs in conformance with a single, overall data content specification.

- Based on ENC Product Specification
- Is similar to Additional Military Layers (AMLs) specification developed/used by NATO.
- ENC software manufacturers will not have to develop new software tools to deal with MIOs.*
- Existing ECDIS/ECS can read MIOs in the same manner as ENCs and AMLs. **

* Applies to RIOs

* CARIS, ESRI, Jeppesen Marine/dKart, HYPACK & SevenCs
** Transas Marine & ICAN

Looking Ahead…

River Information Overlays (RIOs)

Goal: Regardless of what software tools or process is used is used to produce them, RIOs should be:

- consistent and uniform
- suitable for use in “standard” ECDIS and ECS

Two international groups involved:

- Harmonization Group in Marine Information Overlay (HGMIO)
- Inland ENC Harmonization Group (IEHG)