



HydrOffice QC Tools Manual

Release 4.1.0

2024, CCOM/JHC, UNH

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IN BRIEF

QC Tools assist in the review of various types of data occurring all throughout the ping-to-public process.

Accepted data inputs are bathymetric grids, feature files, sounding selections, and directory structures. The output is GIS-layers that alert to the user various parts of their data that might require more attention. Summary reports are also printed for the record and review.

The objectives are to improve data accuracy, while also reducing the overall time required for ping-to-chart.

USER MANUAL

2.1 Installation

Note: If you download the frozen application ([from the download page](#)), you don't need to care about installation and dependencies (so you may just skip this section).

2.1.1 Installation using the Pydro distribution

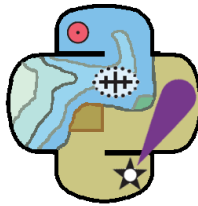


Fig. 2.1: The Pydro logo.

If you are on Windows, you can easily install QC Tools 4 as part of the [NOAA Office of Coast Survey Pydro](#) distribution.

Pydro is a suite of software tools used to support hydrography. It is (almost exclusively) built from open source components as well as public domain custom developed software. Pydro is maintained by the Hydrographic Systems and Technology Branch (HSTB) to support NOAA operations (aiding Office of Coast Survey fleet) and is made available for public use.

You can download the latest Pydro installer from [here](#).

2.2 Survey Validation

2.2.1 Overview

The **Survey Validation** tab will:

- Receive bathymetric grids and feature file inputs for analysis (see [Survey Inputs](#)).
- Scan grids for anomalous grid data “fliers” (see [Flier Finder](#)).
- Scan grids for empty grid nodes that meet 2024 version of the NOAA NOS Hydrographic Survey Specifications and Deliverables (HSSD) definitions of “holidays” (see [Holiday Finder](#)).

- Compute basic grid statistics to ensure compliance to uncertainty and density requirements prescribed in the 2024 NOAA HSSD (see [Grid QA](#)).
- Scan features to ensure proper attribution (see [Feature Scan](#)).
- Ensure surveyed features are properly accounted for in the gridded bathymetry (see [VALSOU checks](#)).

2.2.2 Survey Inputs

Receive bathymetric grids and feature files.

- Select the **Survey Validation** tab on the QC Tools interface.

In **Data Inputs**:

- Drag-and-drop any number of grids and/or features files, anywhere onto the interface. The "+" browse button may also be used.
- The directory and filename of accepted grid and feature files will populate in the respective locations of Data inputs.
- With the addition of a grid and features, the **Flier Finder**, **Holiday Finder**, **Grid QA**, **Feature Scan**, and **VAL-SOU Checks** tabs on the bottom of the interface are now available ([Fig. 2.2](#)).
- Note that any unaccepted file types will be rejected with a message to inform the user ([Fig. 2.3](#)).
- The **Clear data** button may be used to remove all data inputs.

In **Survey Requirements**:

- Set the desired requirements for **Uncertainty** and **Feature Detection**. These parameters are based on the 2024 NOAA HSSD.

These requirements are used by the tools to set parameters:

- **Flier Finder** uses **Uncertainty** when calculating the height threshold for fliers when using the Noisy Margins algorithm.
- **Holiday Finder** uses the **Feature Detection** to determine the size of hole or holiday in the gridded surface.
- **Grid QA** uses **Uncertainty** for the TVU calculation and **Feature Detection** to calculate the allowable resolution check for variable resolution surfaces.

In **Data Outputs**:

- The output **Formats** may be customized. The user has the option to suppress **Shapefile** and **KML** output.
- Output files location is controlled by the **Create project folder** and **Per-tool sub-folder** flags. The four available combinations are:
 - No flags set (see [Fig. 2.4](#), pane A). The outputs are stored directly under the default or user-defined location.
 - Only the **Per-tool sub-folders** flag set (see [Fig. 2.4](#), pane B). The outputs are stored in a tool-specific sub-folder (in the default or user defined-location).
 - Only the **Create project folder** flag set (see [Fig. 2.4](#), pane C). The outputs are stored in a survey folder (in the default or user defined-location). *This is the default setting.*
 - Both flags set (see [Fig. 2.4](#), pane D). The outputs are stored in tool-specific sub-folders in a survey folder (in the default or user defined-location).
- The default output **Folder** location is listed; however, this may be modified via drag-and-drop (or browse to) a user-specified output folder. To return to the default output folder location, click **Use default**.

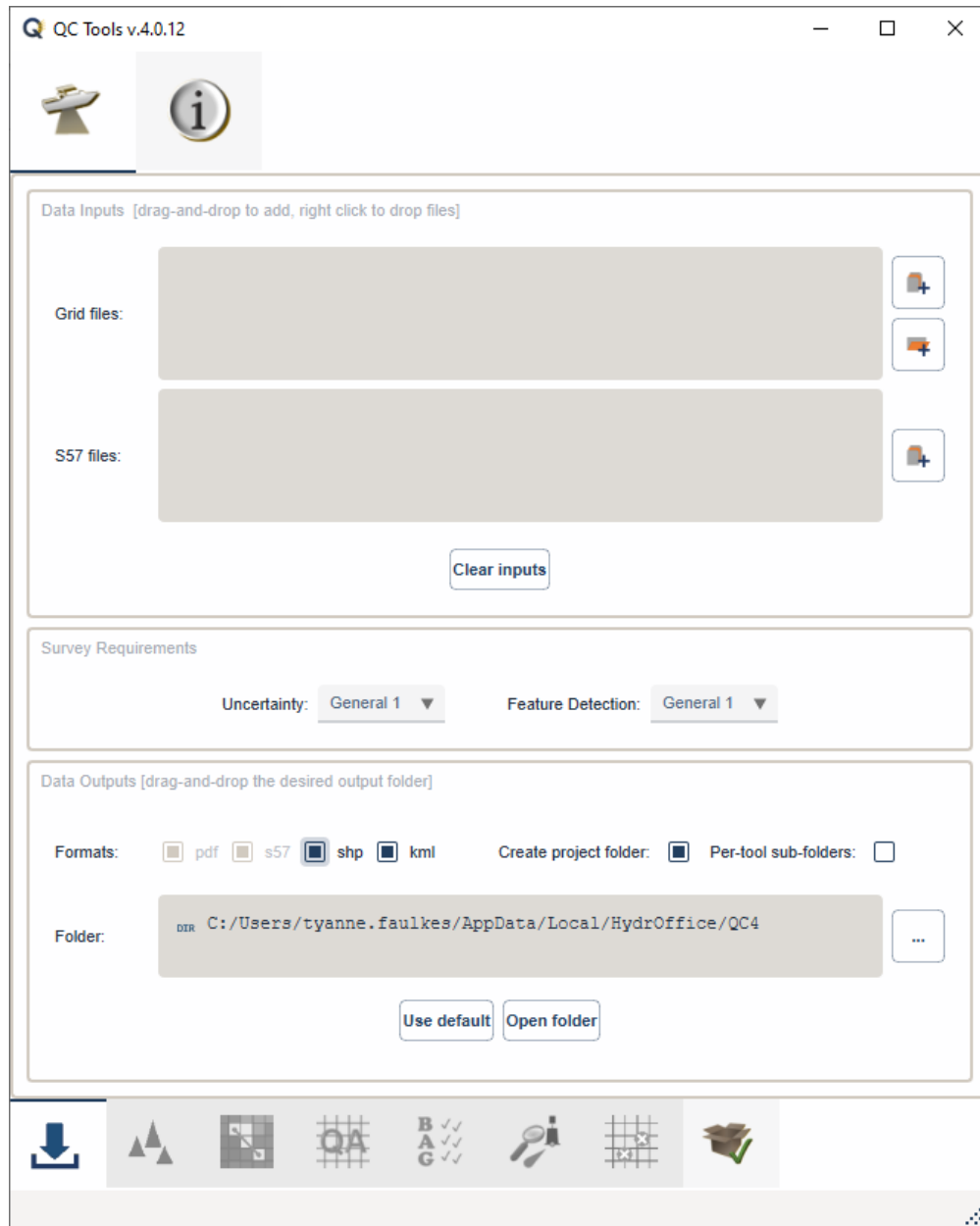
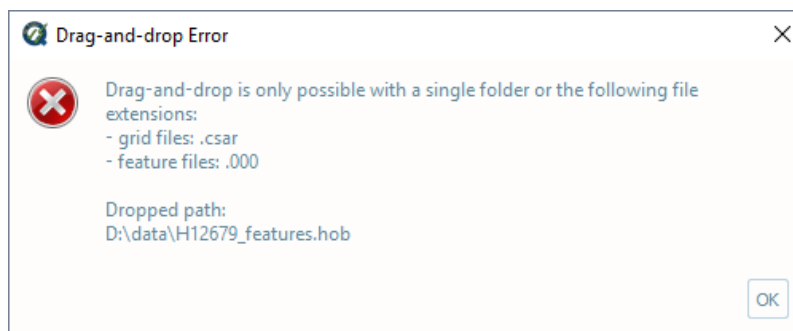
Fig. 2.2: Data inputs and outputs for the *Survey* tab.

Fig. 2.3: The error message for unsupported formats.

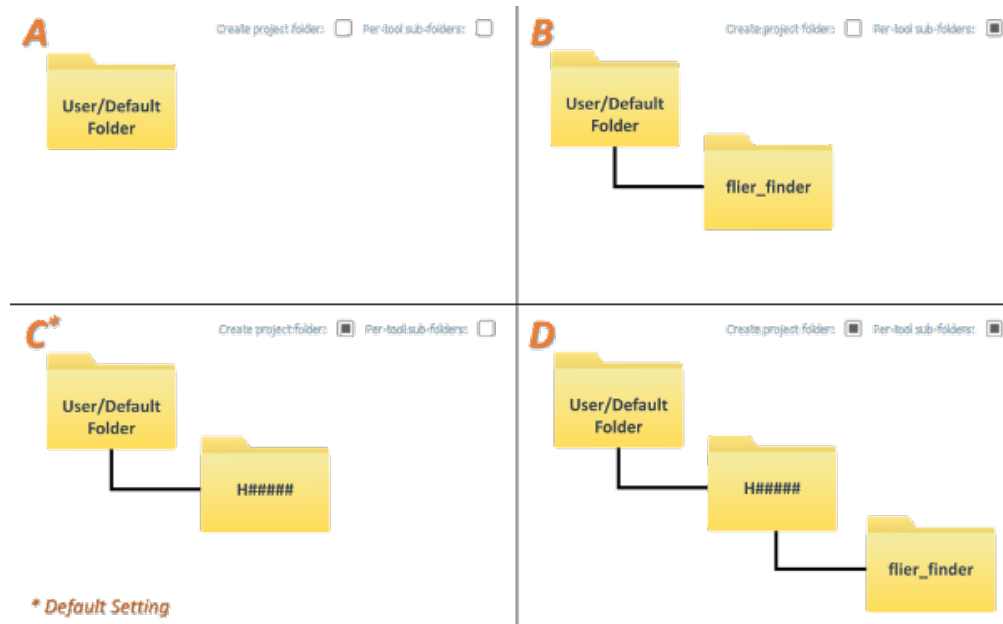


Fig. 2.4: The resulting folder structure based on the four available combinations of output flags.

- The ensuing functions will open the output folder automatically upon execution; however, if needed, the specified output folder may be accessed by clicking the **Open folder** button.

2.2.3 Flier Finder

..warning:: It is NOT guaranteed that the Flier Finder algorithm will identify all the fliers. As such, it is recommended to use Flier Finder in combination with other QC methods.

How To Use?

Scan grids for anomalous grid data “fliers”.

- Select the **Flier Finder** tab (Fig. 2.5) on the bottom of the QC Tools interface.
- For **Flier Finder v10**, first consider **Settings**:
 - The **Flier height** will be determined automatically by the program and does not need to be set, but the user may choose to do so in order to run a specific **Flier height**.
 - The automatic determination of **Flier height** is performed per tile, and is based on the **median** depth (characteristic depth), the **MAD** (variability in range), and the standard deviation of the **gaussian curvature** (roughness).
 - The selected **Checks** are enabled by default. You can enable or disable them in order to run custom analysis (see the “How Does It Work?” section below).
- To change the **Settings** for **Flier Finder v10**:
 - Click the **Unlock** button, and click **OK** to the dialogue.
 - If desired, enter a desired Flier search height in meters in the **Force flier heights** box.
 - * A single height may be entered to apply to all loaded grids, or multiple heights may be entered (separated by comma) to apply to each grid loaded.

- * These values, if entered, will override any **Estimated heights** determined by the program.
 - Enable or disable the specific **Checks** to run.
 - If desired, modify the filtering horizontal and vertical distances from the closest point feature or designated sounding.
 - Enable or disable the specific **Filters** to run.
 - In **Execution** for **Flier Finder v10**:
 - Click **Flier Finder**. After executing, the output window opens automatically (Fig. 2.6), and the results are shown:
 - An output window will open in File Explorer. From the output window, drag-and-drop the desired output file into the processing software to guide the review. Each candidate flier is labeled using the identifier of the algorithm that detected it (e.g., “2” for Gaussian Curvature).
-

How Does It Work?

Flier Finder v10:

Estimate height:

First, a base height from the median depth of the grid is assigned:

Depth Interval	Base height
if < 20	1.0
if < 40	2.0
if < 80	4.0
if < 160	6.0
if >= 160	8.0

Then, the base height is incrementally increased by the level of depth variability and roughness of the grid:

- Depth variability is estimated by proxy using the Normalized Median of Absolute Deviation (NMAD) of the grid, which is derived by dividing the absolute difference of depth mean and depth median by depth standard deviation.
 - The lower the NMAD, the more depth variability we estimate.
 - An increase in the Base height of the flier search height estimation is warranted if NMAD is less than 0.20 (1 increase) or less than 0.10 (2 increases).
- Roughness is estimated by the standard deviation of the Gaussian curvature (STD_CURV).
 - The Gaussian curvature is a measure of concavity at each node, whether concave up (shoal) or concave down (deep).
 - The higher the STD_CURV, the rougher the surface.

Fig. 2.5: The **Flier Finder** tab.

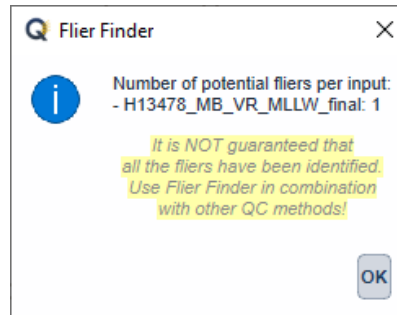


Fig. 2.6: The output message at the end of **Flier Finder** execution.

- An increase in the Base height of the flier search height estimation is warranted if STD_CURV is greater than 0.01 (1 increase) or greater than 0.10 (2 increases).

Increases are +2.0 meters, unless the Base height is 1.0 meter, then the increase is +1.0 meter. In this manner, Estimated flier heights are always on the interval scale of 1 (minimum), 2, 4, 6, 8, 10, 12, 14, 16 (maximum).

For example:

- If a surface has depth median = 12 m, NMAD = 0.15, and STD_CURV = 0.005, then the Estimated height = 2.0 m.
- If a surface has depth median = 75 m, NMAD = .04, and STD_CURV = 0.08, then the Estimated height = 10.0 m.

Checks:

Laplacian Operator

The Laplacian Operator is a measure of curvature at each node. It is equivalent to summing the depth gradients of the four nodes adjacent (north, south, east, and west) to each node. If the absolute value of the Laplacian Operator is greater than four times the flier search height, the node will be flagged.

In the example below, a 3 m flier search height would register 1 flag, while a 2 m flier search height would register 4 flags, and a 1m search height would register 7 flags.

Depth Layer				Laplace			
9	9	9	9	0	1	0	3
9	8	9	6	1	4	10	9
9	9	3	9	0	7	24	9
9	9	9	9	0	0	6	0

The algorithm is effective, but may be prone to excessive flags, as demonstrated in the above example. Testing showed that it generally did not reveal fliers not already revealed by the other algorithms. For these reasons, it is disabled by default, but is recommended as an additional check in those situations when the other algorithms return very few or no flags.

The example in Fig. 2.7 shows grid nodes (depths in meters) recommended for further examination by the Laplacian Operator (indicated by 1s) and a 6m estimated search height.

Gaussian Curvature

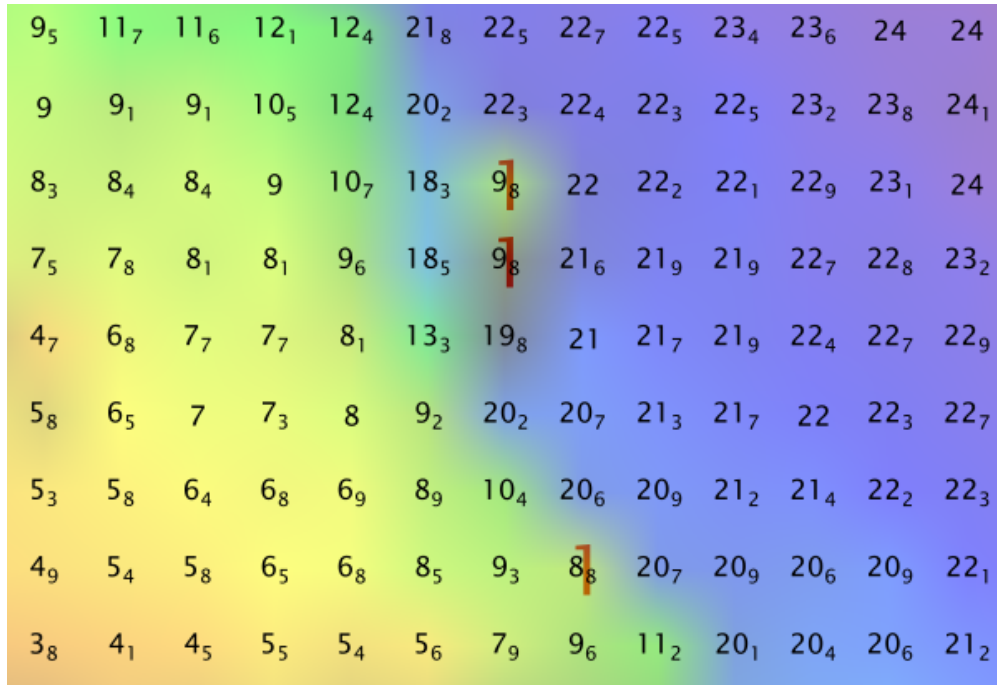


Fig. 2.7: Laplacian Operator.

The Gaussian Curvature is a measure of concavity at each node. The gradients are taken in the x and y directions to establish g_x and g_y , and repeated on each gradient again in the x and y direction to establish g_{xx} , g_{xy} , g_{yx} , and g_{yy} (note that $g_{xy} = g_{yx}$). The gaussian curvature at each node is then determined by:

$$(g_{xx} * g_{yy} - (g_{xy} * g_{yx})) / (1 + (g_x^2) + (g_y^2))^2$$

Note that this algorithm is dependent on the standard deviation of the tile's gaussian curvature.

In the example below, a single flier is found (regardless of flier height).

Depth Layer				Gaussian Curvature			
9	9	9	9	-1	0	-1	-.09
9	8	9	6	0	-2.3	0	-.14
9	9	3	9	-2.5	0	20	0
9	9	9	9	0	-9	0	-36

Testing showed that the algorithm on occasion offered unique value by flagging a flier not captured by other algorithms, while also it is not prone to excessive flags. For these reasons this algorithm is enabled by default.

The example in Fig. 2.8 shows grid nodes (depths in meters) and a deep flier found by the Gaussian Curvature (indicated by the red 2).

Adjacent Cells

This algorithm examines the nodes that are adjacent to a single node. There are a maximum of 8 adjacent nodes (N,NW,W,SW,S,SE,E,NE), but there could be less than 8 if the node resides on a grid edge.

The algorithm crawls across empty cells (2 nodes diagonally, and 3 nodes in the cardinal directions) in order to establish neighbors. For example, the image below shows that 6 neighbors were found for the flagged node; previous versions of Flier Finder would only have identified 4 (Fig. 2.9).



Fig. 2.8: Gaussian Curvature.

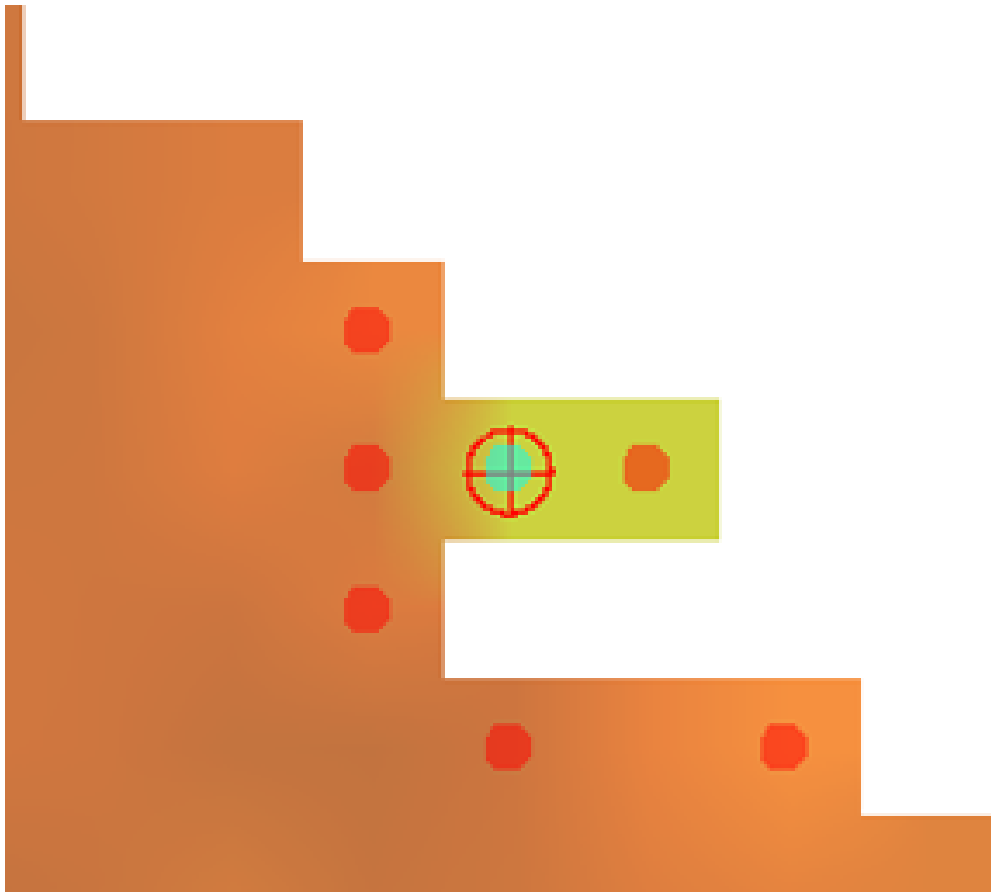


Fig. 2.9: Crawling example.

The depth is differenced with each adjacent cell identified, and the number of times the difference is greater in magnitude than the flier search height is tallied. If the ratio of this tally to the number of adjacent cells available is 0.8 or greater, then the node is flagged.¹

In the example below, a 3 m flier search height would register 2 flags, while a 2m search height would also register 2 flags, and a 1m search height would register 3 flags.

Depth Layer				Adjacent Cells(3m)			
9	9	9	9	0	0	.2	.33
9	8	9	6	0	.13	.25	1
9	9	3	9	0	0	1	.4
9	9	9	9	0	.2	.2	.33

Testing showed that the Adjacent Cells algorithm offers unique value by flagging fliers not captured by the other algorithms (especially those residing on grid edges), and is not as prone to excessive flagging as the Laplacian Operator. For these reasons, it is enabled by default.

The example in Fig. 2.10 shows grid nodes (depths in meters) and the type of flier that Adjacent Cells (indicated by the red 3) identifies with particular effectiveness, in this case with a 4m search height.

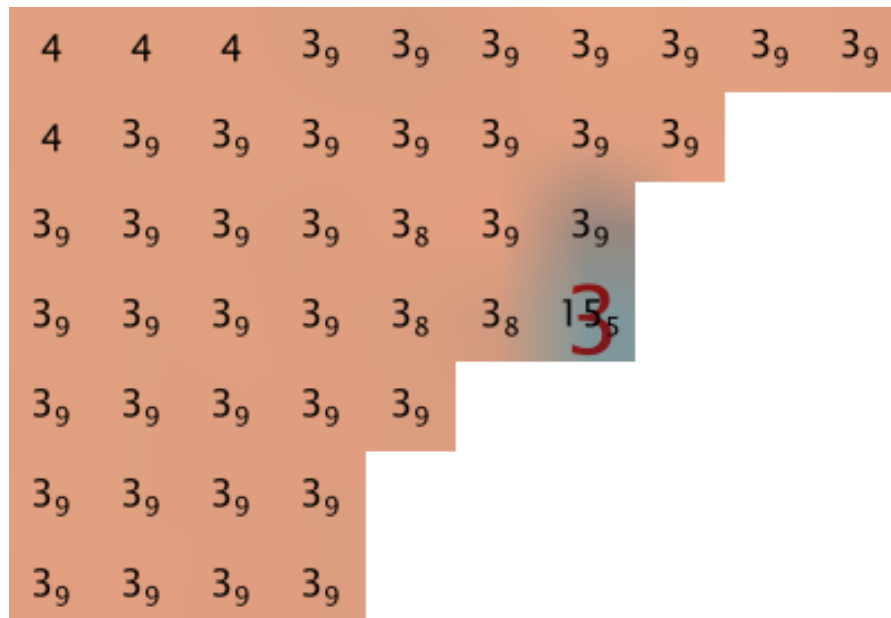


Fig. 2.10: Adjacent Cells.

Edge Slivers

The Edge Slivers algorithm identifies small groups of connected nodes (3 nodes or less) that are detached (but within 5 nodes) from the grid. If the depth difference between the nearest detached node and the valid connection to the grid is greater than half the flier search height, a flag is registered.

Testing showed that the algorithm offers unique value by identifying the quite common fliers that result in areas of sparse data density. For this reason, it is enabled by default.

The example in Fig. 2.11 shows grid nodes (depths in meters) and the type of detached nodes that Edge Slivers flags,

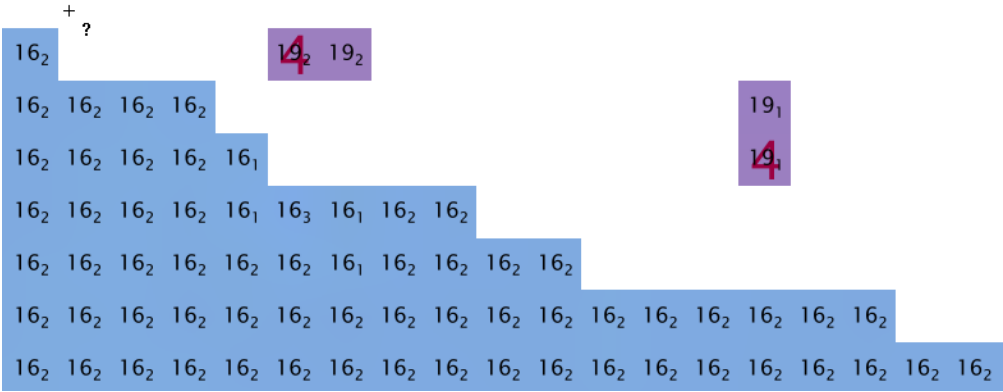


Fig. 2.11: Edge Slivers.

in this case with a 4m search height.

Isolated Nodes

The Isolated Nodes algorithm identifies small groups of connected nodes (3 nodes or less) that are detached (but outside of 5 nodes) of the grid. Effectively it is identifying the remaining isolated nodes not caught by Edge Slivers, however, it is independent of flier search height, meaning that all small groups of isolated nodes will be flagged.

Testing shows that the algorithm offers unique value by identifying nodes far detached from the grid that the reviewer may wish to exclude. Because it is identifying any detached nodes and not considering their associated depth, it is largely considered a separate tool to be used on an “as-needed” basis. Therefore, it is not enabled by default.

The example in Fig. 2.12 shows a grid node far detached from the main grid, found by Isolated Nodes (indicated by a red 5).



Fig. 2.12: Isolated Nodes.

Noisy Margins

The Noisy Margins is tailored to identify fliers along noisy swath edges.

¹ In the case that node has only 4 neighbors, and 3 of these have a difference greater than the search height, the ratio of 0.75 will trigger a flag on the node. This exception has been made because it has been observed so frequently during testing.

The algorithm crawls across empty cells (2 nodes diagonally, and 3 nodes in the cardinal directions) in order to establish a margin. A margin is identified when a node is missing two neighbors in the surrounding 8 directions (N, NW, W, SW, S, SE, E, and NE).

Once that a margin node is identified, the least depth and the maximum difference with its neighbors are calculated.

The least depth is used to calculate the local Total Vertical Uncertainty (TVU), which is used for the flagging threshold. The TVU is calculated per 2024 NOAA HSSD:

$$TVU = A + (B * Depth)$$

where $A = 0.15$, $B = 0.0075$ for Exceptional, $A = 0.25$, $B = 0.0075$ for Critical, $A = 0.5$, $B = 0.01$ for General 1, $A = 1.0$, $B = 0.02$ for General 2 and General 3, and $A = 2.0$, $B = 0.05$ for General 4.

The TVU is selected in the **Input tab** in the **Feature Detection** drop down.

A noisy margin is flagged when the maximum depth difference with its neighbors is greater than the flagging threshold. To prevent too many flags, the algorithm searches the nearest three nodes and if any of those nodes contain a flag, it will not be flagged. If a flag is not present in a three node area, the flier is flagged.

Fig. 2.13 shows an example of a flagged 4.5m edge node. Since the shallowest node in the neighborhood is 3.7m, the flagging threshold developed from TVU was 0.504m for General 1. The maximum difference between the node and its neighbors is 0.8m, therefore the margin node was flagged.

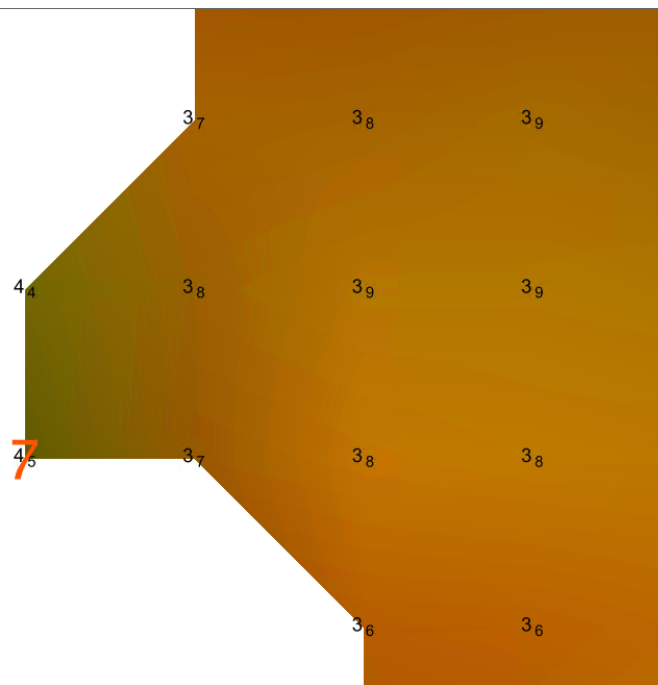


Fig. 2.13: Noisy margin.

Which Flier Finder Algorithm Should I Use?

For basic use:

- For standardized operation of this tool, the automatic estimated search height and the following checks are recommended:
 - Gaussian Curvature

- Adjacent Cells
- Edge Slivers

For advanced use:

- If the default options generate too few flags, and/or it is desired to perform a custom search, you may force a smaller flier height, and/or utilize the “Laplace Operator” algorithm.
- The “Isolated Nodes” algorithm is used to find nodes detached from the grid and is an independent check to be used on an as-needed basis.
- The “Noisy Edge” algorithm is used to identify fliers along survey edges. It is recommended for use with surveys that are utilizing corresponding side scan coverage.

A summary of the checks is shown in the table below, and also see the “How Does It Work?” section to understand how each check works.

	Lap #1	Gau #2	Adj #3	Edg #4	Iso #5	Nsy #6	Nsy #7
Flier height estimated	x		x	x			
Prone to excessive flags	x				x	x	x
Enabled by default		x	x	x	x		
Use on as-needed basis	x					x	x

Filters:

After the algorithm has completed identifying fliers, an optional final step compares those fliers against point features with a depth (when *Use Features from S57 File* is checked) and/or designated soundings (when *Use Designated (SR BAG only)* is checked).

Both filters work in a very similar way. By default, the filters remove a flier candidate when the distance of a designated sounding/point feature is:

- Horizontally, less than (or equal to) 1.0 times the resolution (e.g., 1m for 1-m grid).
- Vertically, less than (or equal to) 0.01 meters.

It is also possible to modify the above filtering criteria. And, if the user does not want to apply the filters, they may be turned off.

Note: The *Use designated* filter does not work with CSAR files because of the current CSAR SDK limitations, and the designated soundings are currently not written by CARIS applications in VR BAGs.

What do you get?

Upon completion of the execution of **Flier Finder** you will receive a pop-up verification if your surface contains potential fliers or not (Fig. 2.14).

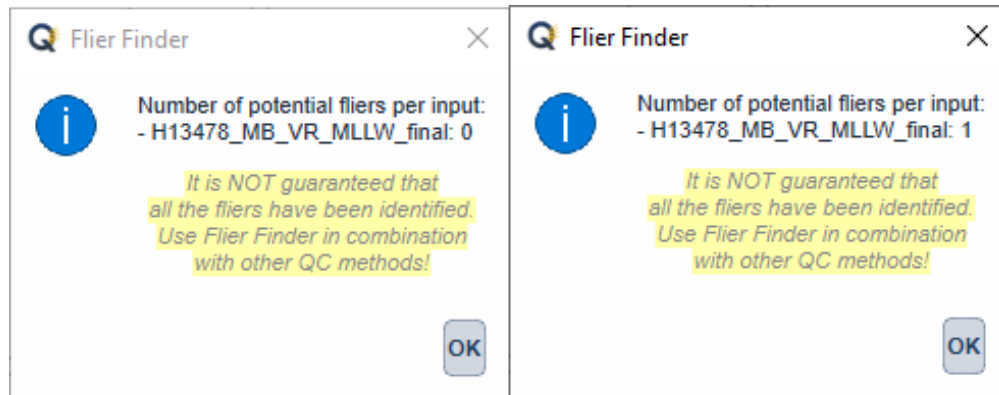


Fig. 2.14: The **Flier Finder** output message.

Flier Finder produces two .000 files containing the locations of potential fliers. These can be loaded into your GIS software of choice for further analysis.

One type of .000 file is called the “blue notes” which is a file containing \$CSYMB features (Fig. 2.15). The NINFOM field of the \$CSYMB features contains the algorithm detected (e.g., “2” for Gaussian Curvature).

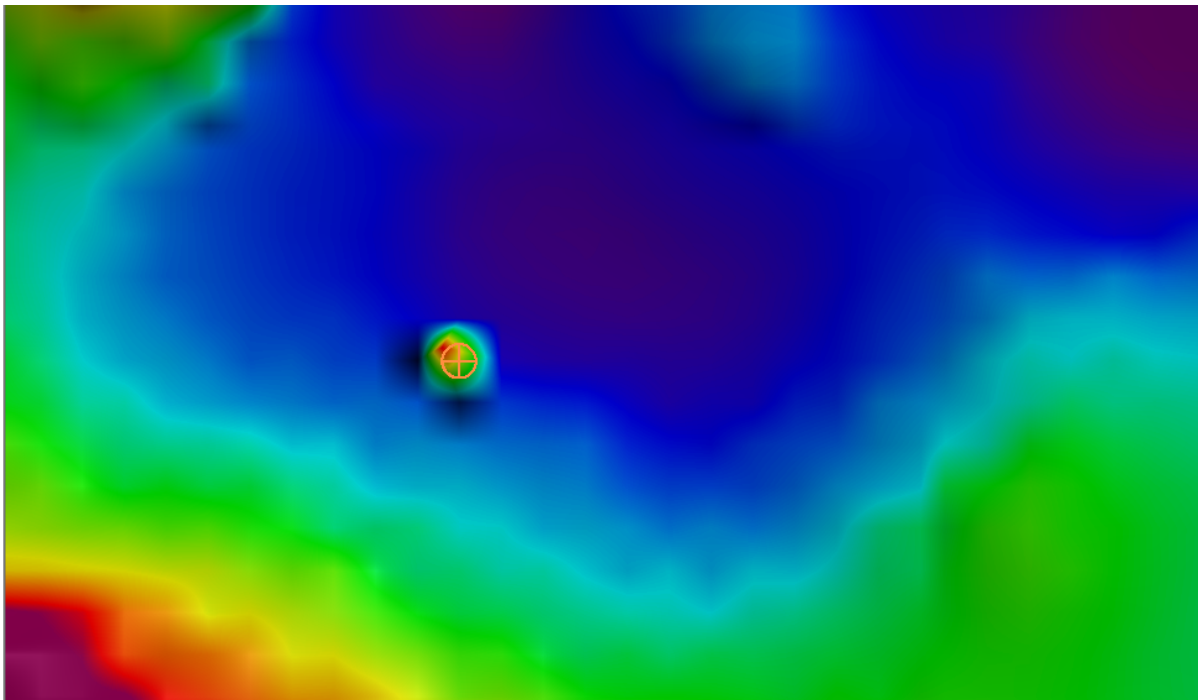


Fig. 2.15: An example of a potential flier identified with a blue note (\$CSYMB).

The other type of .000 file is a sounding file that contains SOUNDG features (Fig. 2.16). The depth of each SOUNDG feature identifies the algorithm that detected it (e.g., “3” for Adjacent Cells).

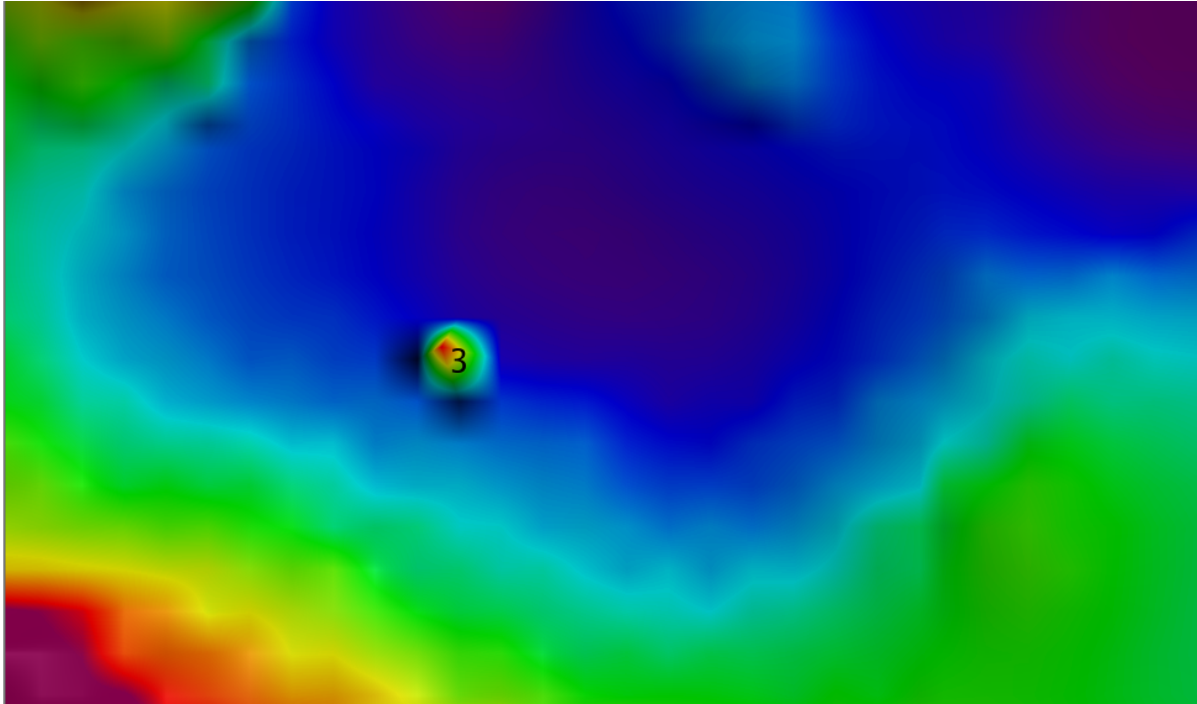


Fig. 2.16: An example of a potential flier identified with a sounding (SOUNDG).

The naming convention of the output files contains important information about the settings that were used to execute Flier Finder. Each setting is separated by a period in the naming convention. See Fig. 2.17.

[grid filename].FFv[version].[forced flier height].[check #][uncertainty requirement(only for Noisy Margins)].[filter #].[symbol type]

e.g., H13412_MB_VR_MLLW_Final.FFv10.h0_5.chk23457gen1.flt1.blunotes

Fig. 2.17: Example naming convention for a Flier Finder output. In this example the user selected a 0.5 meter manual flier height, ran checks #2, #3, #4, and #5, #7 with General 1 Uncertainty and selected filter #1.

2.2.4 Holiday Finder

How To Use?

Scan grids for unpopulated nodes (“holidays”).

- Select the **Holiday Finder** tab (Fig. 2.18) on the bottom of the QC Tools interface.
- To change the **Parameters** for **Holiday Finder v5**:
 - Click the **Unlock** button, and click **OK** to the dialogue.
 - Activating **Identify all gaps in the grid** will activate a special mode that will return all the holes, regardless of size, in the grid and will override the **Feature Detection** requirement chosen in the input window.
 - Set the **Upper holiday area limit (as multiple of minimum holiday size)**. Unpopulated parts of the grid larger than this setting will not be flagged as holidays.

- In **Execution**, click **Holiday Finder**.

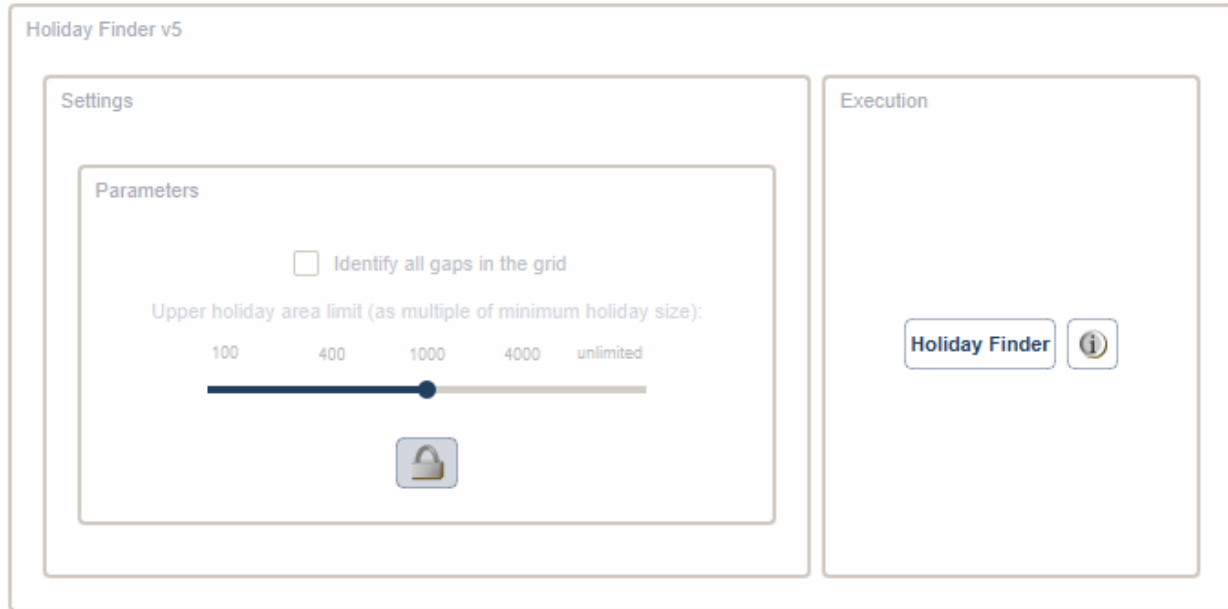


Fig. 2.18: The **Holiday Finder** tab.

- After computing, the output window opens automatically, and the results are shown (Fig. 2.19).

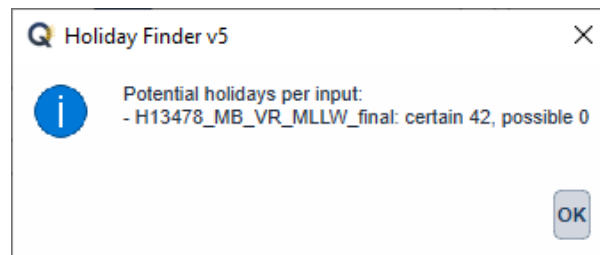


Fig. 2.19: The output message at the end of **Holiday Finder** execution.

- An output window will open in File Explorer. From the output window, drag-and-drop the desired output file into the processing software to guide the review.

Note: For proper visualization, the software adopted to analyze the S57 output of VALSOU Checks has to represent the sounding values in meters.

How Does It Work?

The grid is scanned, and any empty grid nodes (“holes”) surrounded by populated nodes are identified. These are flagged as holidays based on 2024 NOAA HSSD.

A holiday is defined as a box of unpopulated nodes.

The holiday size is calculated in number of nodes based on the minimum allowable resolution and the grid resolution, per this formula:

$\text{floor}((\text{minimum allowable resolution} \times 3) / \text{grid resolution})$

Only in the case of a variable resolution input, all the tiles are re-sampled to create a single resolution grid (selecting the highest resolution among all the grid tiles).

The minimum allowable resolution is determined based on the Tables of Minimum Required Grid Resolution in the 2024 NOAA HSSD. The user defines the **Feature Detection** requirement in the **Input Tab**. The median value of all the node depths surrounding the perimeter of the holiday is determined to then evaluate against the NOAA Specification.

Note: The output of Holiday Finder is a sounding, with a value of “1” for certain holidays, and “2” for possible holidays.

In the example in (Fig. 2.20), General 1 requirements identify the hole of 12 grid nodes, because there it contains an instance of 3x3 unpopulated grid nodes. The holes with 7 and 2 nodes do not.

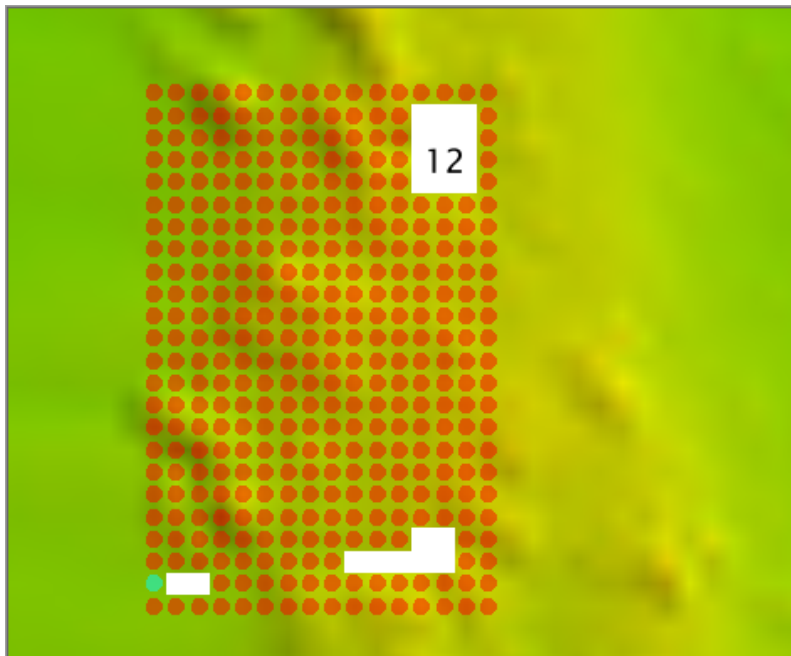


Fig. 2.20: Example for General 1.

A candidate hole is flagged with a “1” (if certain) or a “2” (possible holiday).

Note that the default **Upper holiday area limit (as multiple of minimum holiday size)** is set to 1000, meaning that an unpopulated part of the grid will be flagged only if smaller than 1000 times the minimum holiday size. This setting exists so the search can be refined at the user’s discretion.

For example:

- If desired to search for only the smallest of holidays, the **Upper holiday area limit** might be set at **100**.
 - If desired to flag all unpopulated parts of the grid, regardless of their size, the **Upper limit** would be set at **unlimited**.
 - Settings in between are used at the discretion of the user, to identify holidays, while also preventing undue clutter in the output.
-

What do you get?

Upon completion of the execution of **Holiday Finder** you will receive a pop-up verification if your surface contains potential holidays or not (Fig. 2.21).

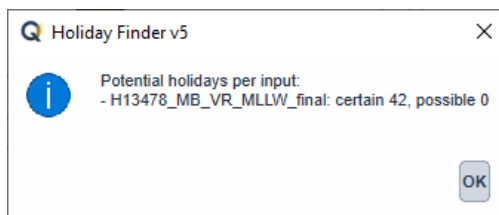


Fig. 2.21: The output message at the end of **Holiday Finder** execution.

Holiday Finder produces one .000 files containing the locations of potential holidays represented as soundings (Fig. 2.22). Certain holidays are represented with 1 and possible holidays are represented at 2.

The naming convention of the output files contains important information about the settings that were used to execute Holiday Finder. Each setting is separated by a period in the naming convention. See Fig. 2.23.

2.2.5 Grid QA

How To Use?

Computes grid statistics to ensure compliance with uncertainty, density, and resolution requirements. Users must ensure that the appropriate **Survey Requirements** have been selected in the **Input Tab** to ensure accurate calculations.

- Select the **Grid QA** tab (Fig. 2.24) on the bottom of the QC Tools interface.
- Check the boxes that correspond with the plots you wish to generate.
- In **Execution**, click **Grid QA v7**.
- After computing, the output window opens automatically, and the results are shown (Fig. 2.25).
- From the output window, view each plot to assess the grid compliance to uncertainty and density specifications.

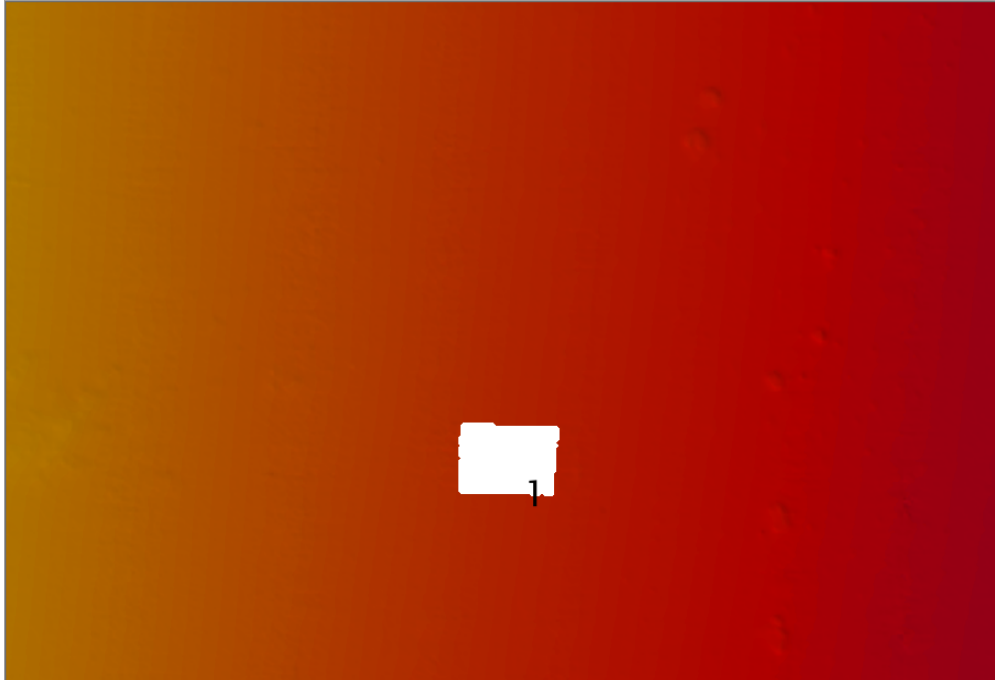
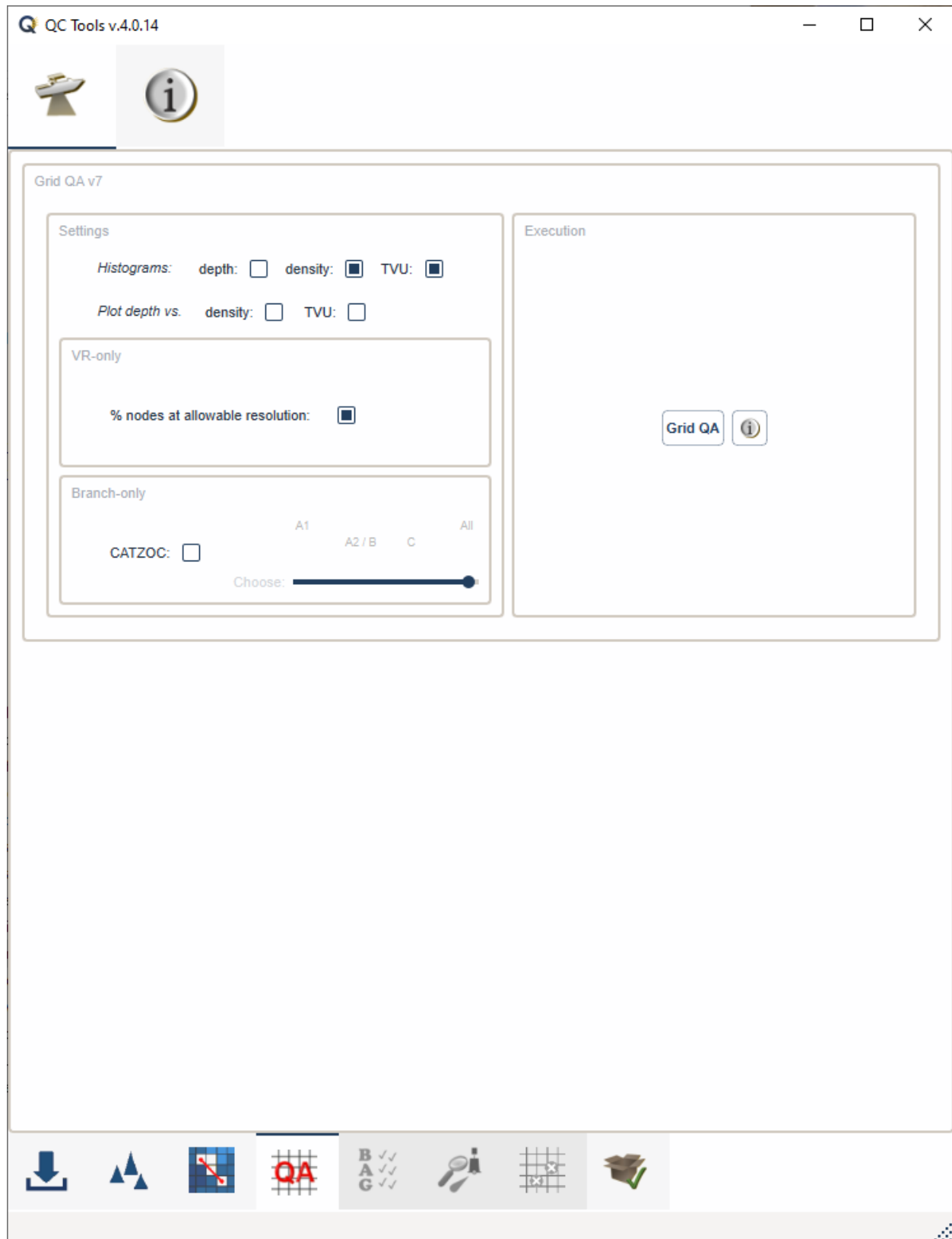


Fig. 2.22: An example of a certain holiday identified with a sounding.

[grid filename].HFv[version].[intended use].[upper holiday limit]

e.g., *H13412_MB_VR_MLLW_Final.HFv5.exc.1000*

Fig. 2.23: Example naming convention for a Holiday Finder output. In this example the user selected Exceptional as quality metric, with an upper holiday limit of 1000.

Fig. 2.24: The **Grid QA** tab.

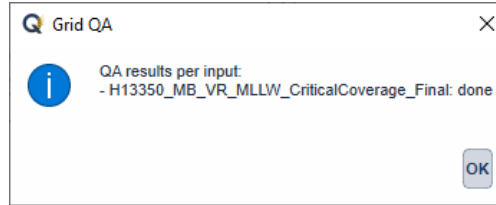


Fig. 2.25: The output message at the end of **Grid QA v7** execution.

Note: The **Plot depth vs. density** and **Plot depth vs. TVU QC** can potentially require a large amount of memory (i.e., when the input grid contains hundreds of millions of nodes). As such, both plots are unflagged by default. You can flag them if you need their output. If having both plots selected triggers a memory error, you may try to flag these plots once at a time.

How Does It Work?

The Depth, Uncertainty, Density (if available), and a computed Total Vertical Uncertainty (TVU) QC layer are used to compute particular statistics shown as a series of plots.

The following plots are the output of Grid QA:

- The Depth layer is plotted as a distribution (plot entitled “**Depth Distribution**”).
- The Density layer is plotted as a distribution (plot entitled “**Data Density**”).
 - Percentages of nodes less than 5 soundings per node fall in the red shaded region of the plot and together must be less than 5% of all nodes in order to “pass”.
- TVU is plotted as a distribution (plot entitled “**Uncertainty Standards - NOAA [OCS Quality Metric]**”).
 - Percentages of nodes with TVU QC greater than 1.0 (indicating that the allowable error has been exceeded) fall in the red shaded region of the plot, and together must be less than 5% of all nodes in order to “pass”.
- Density is plotted against the corresponding Depth of the node (plot entitled “**Node Depth vs. Sounding Density**”).
- TVU is plotted against the corresponding Depth of the node (plot entitled “**Node Depth vs. TVU QC**”).
- Only for Variable Resolution grids, a histogram with the percentage of nodes at the prescribed resolution is created. This histogram can be used to evaluate whether “[a]t least 95% of all grid nodes must have a resolution equal to or smaller than the minimum required resolution for the node depth/height.” (NOAA HSSD). The resolution is determined by the **Feature Detection** selection made in the the **Survey Requirements** section in the **Input Tab** window.
- TVU (CATZOC) [Branch] is plotted as a distribution (plot entitled “**Uncertainty Standards - CATZOC ...**”).

TVU QC Calculations

The TVU QC layer is calculated on-the-fly by the program. TVU QC based on OCS Quality Metrics for Uncertainty (as defined in the 2024 NOAA HSSD) and is determined by a ratio of uncertainty to allowable error. It is calculated as such:

$$TVU\ QC_{(OCS\ Quality\ Metrics)} = Uncertainty / A + (B * Depth)$$

where for: *Exceptional:* $A = 0.15, B = 0.0075$

Critical: $A = 0.25, B = 0.0075$

General 1: $A = 0.5, B = 0.01$

General 2/3: $A = 1.0, B = 0.02$

General 4: $A = 2.0, B = 0.05$

The OCS Quality Metric is selected in the **Survey Input Tab** in the **Survey Requirements** section under the **Uncertainty** drop down.

TVU QC based on IHO S-57 CATZOC is used by the hydrographic branch to evaluate the quality of bathymetry for surveys that are not subject to the HSSD. **This check should NOT be used by NOAA field units or contract field units.**

For TVU QC based on IHO S-57 CATZOC, TVU QC is calculated as such:

$$TVU\ QC_{(IHO\ S-57\ CATZOC)} = Uncertainty / (A + (B * Depth))$$

where for:

CATZOC A1: $A = 0.5, B = 0.01$

CATZOC A2 and CATZOC B: $A = 1.0, B = 0.02$

CATZOC C: $A = 2.0, B = 0.05$

What do you get?

Upon completion of the execution of **Grid QA** you will receive a pop-up verification if your statistics are complete (Fig. 2.26).

Grid QA produces images representing specific statistical analysis:

- Depth Distribution (Fig. 2.27).
- Data Density (Fig. 2.28).
- Uncertainty Standards - NOAA HSSD (Fig. 2.29) and CATZOC (Fig. 2.33).

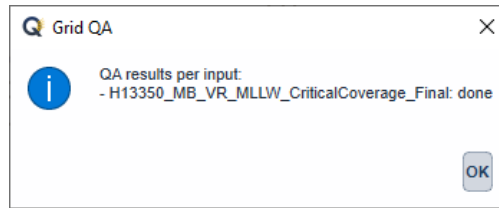


Fig. 2.26: The output message at the end of **Grid QA** execution.

- Resolution Requirements (*only for VR grids*) (Fig. 2.30).
- Node Depth vs. Sounding Density (Fig. 2.31).
- Node Depth vs. TVU (Fig. 2.32).

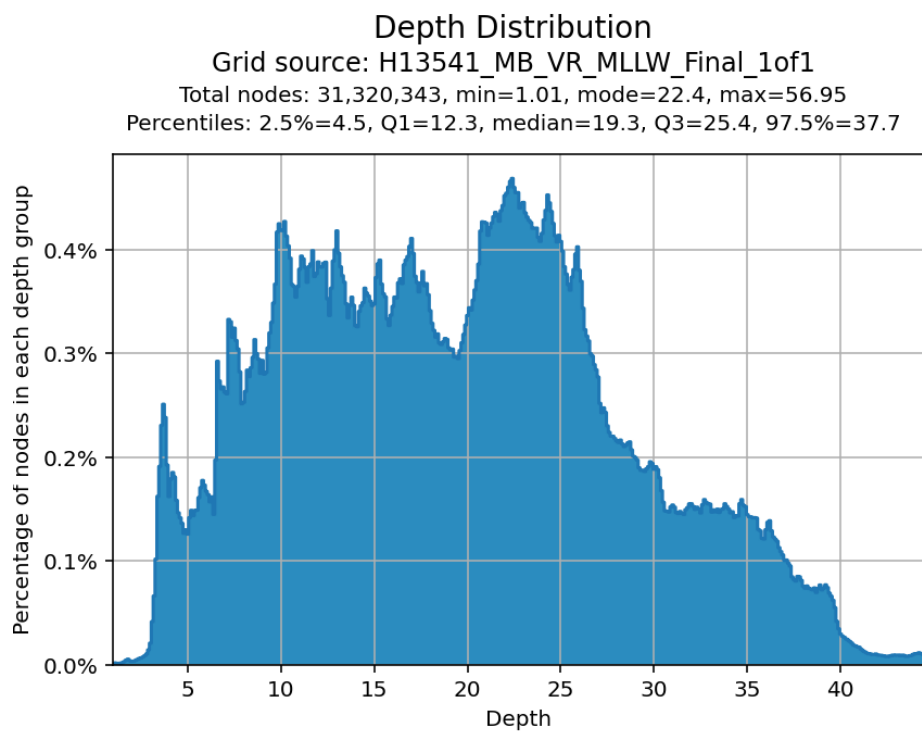


Fig. 2.27: A histogram of the percentage of total nodes at each depth represented in the surface.

The naming convention of the output files contains important information about the settings that were used to execute Grid QA. Each setting is separated by a period in the naming convention. See the example below.

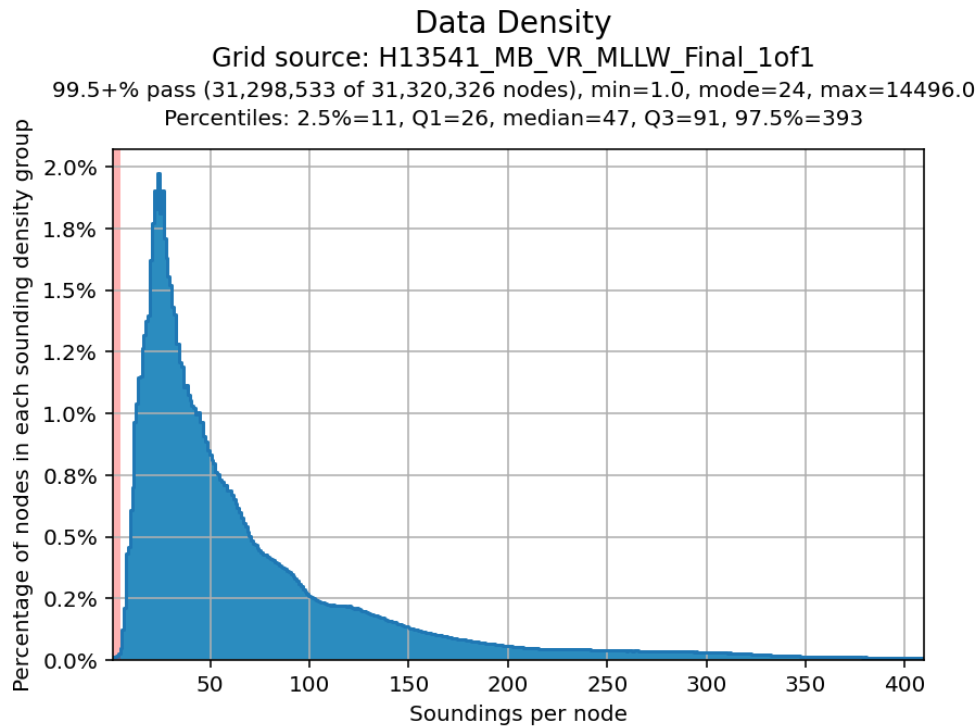


Fig. 2.28: A histogram of the percentage of total nodes that contain a specific sounding per node. To pass a node must have at least 5 soundings contributing to the population of that node.

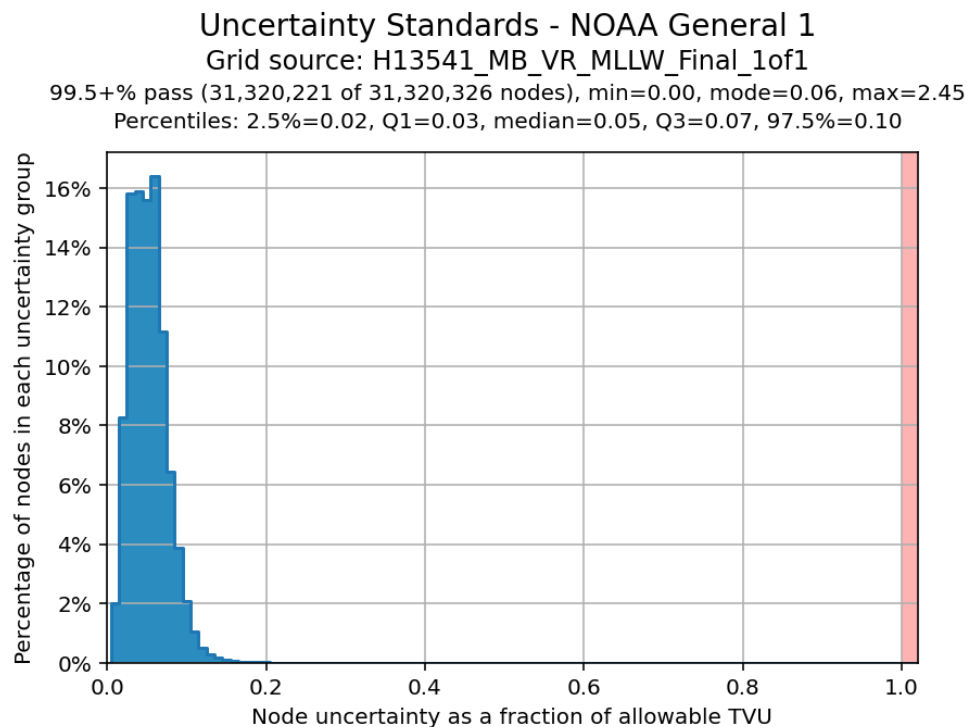


Fig. 2.29: A histogram of the percentage of total nodes that contain a node uncertainty as a fraction of the IHO TVU. Anything over 1.0 does not pass uncertainty requirements.

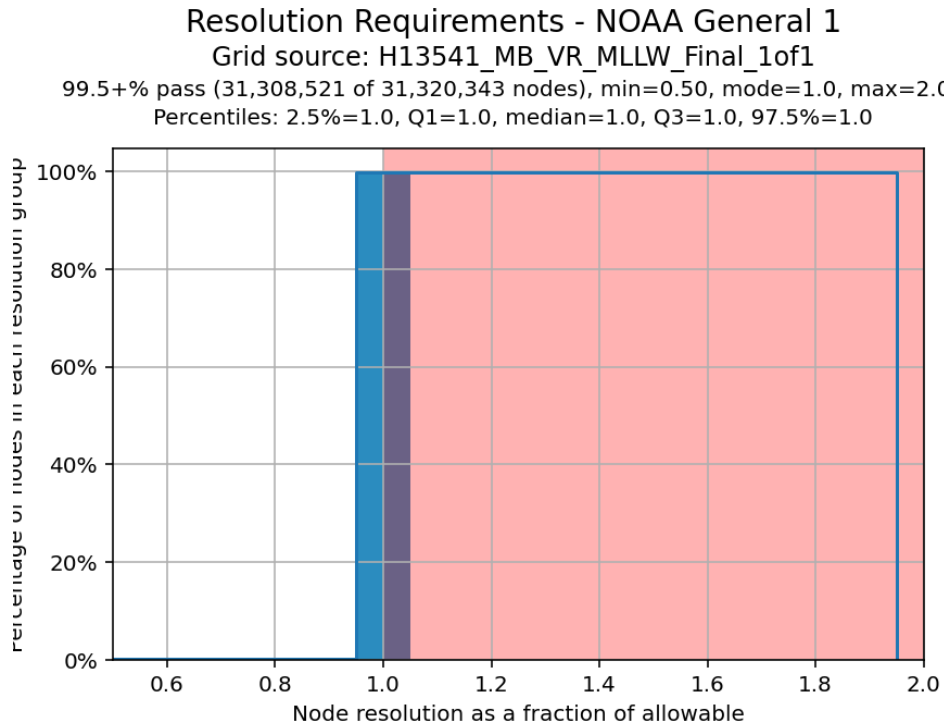


Fig. 2.30: A histogram, created only for VR surfaces, that shows the percentage of nodes that have a node resolution as a fraction of the allowable resolution at that depth. Anything over 1.0 does not pass uncertainty requirements.

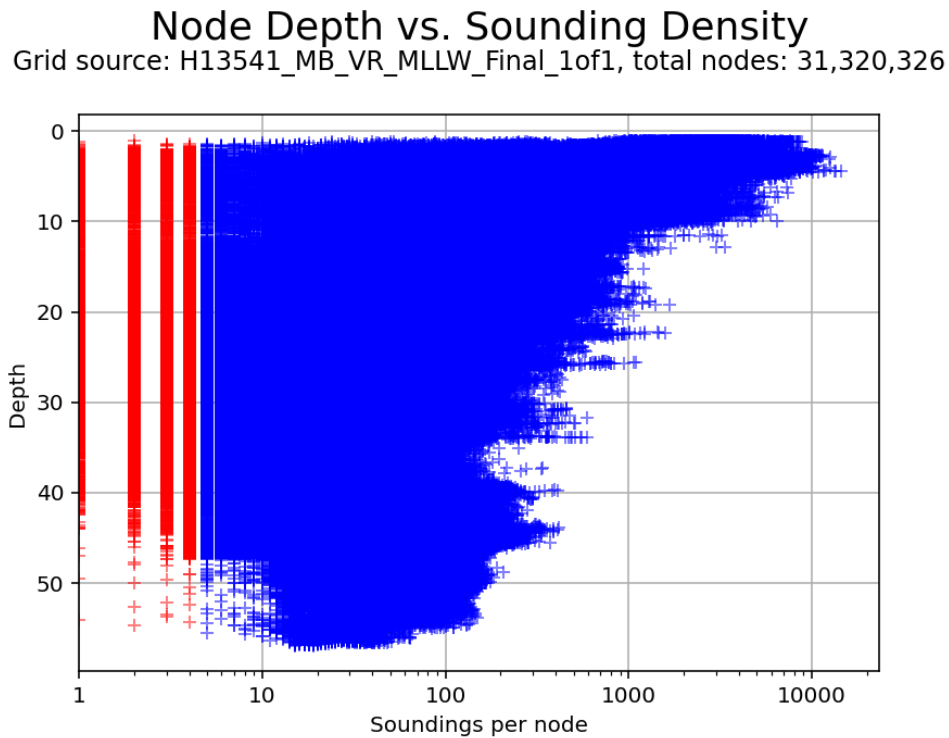


Fig. 2.31: A plot of every node represented in the surface in plotted as its depth on the y axis and its density on the x axis.

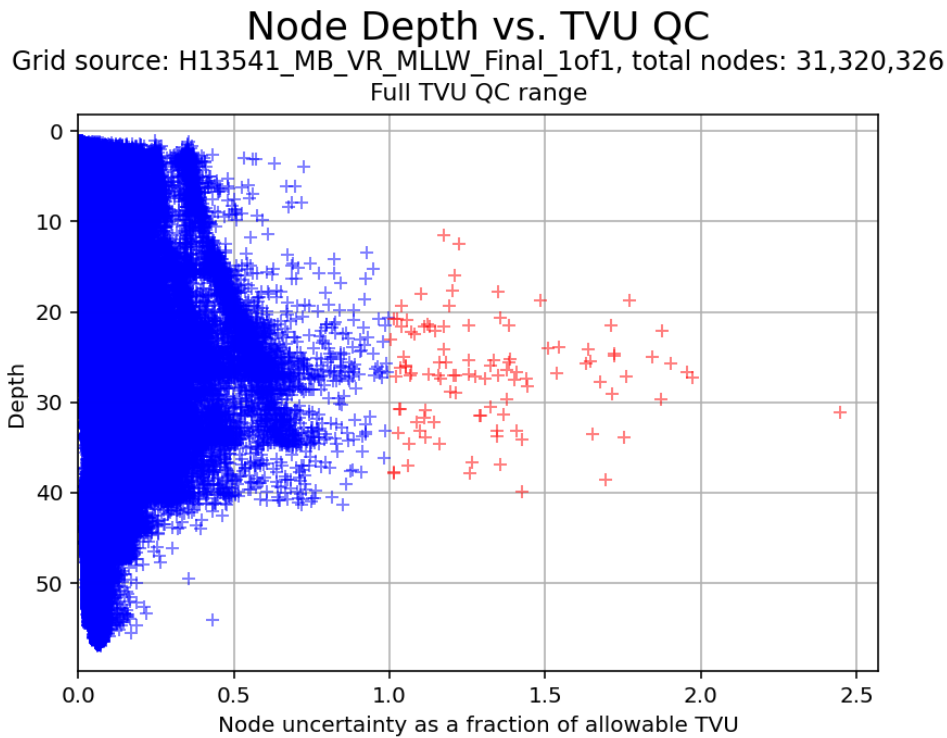


Fig. 2.32: A plot of every node represented in the surface in plotted as its depth on the y axis and its uncertainty as a fraction of the IHO TVU on the x axis.

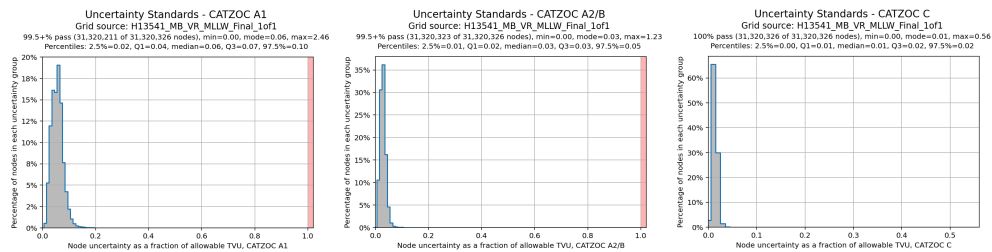


Fig. 2.33: Similar to the uncertainty plot, the CATZOC uncertainty shows a histogram of the percentage of total nodes that contain a node uncertainty as a fraction of the specific CATZOC TVU value. Anything over 1.0 does not pass the requirements.

`[grid filename].GQv[version].[plot type]`

e.g., `H13412_MB_VR_MLLW_Final.GQv7.tvu_qc`

Fig. 2.34: Example naming convention for a Grid QA output. In this example the of an output for the TVU QC analysis.

2.2.6 BAG Checks

How To Use?

Evaluates BAGs to ensure compliance with NOAA NBS and BAG specification requirements.

In order to access this tool, load in a BAG file into the **Data Inputs** tab.

- Select the **BAG Checks** tab (Fig. 2.35) on the bottom of the QC Tools interface.
- Check the boxes that correspond with the checks you wish to perform.
- In **Execution**, click **BAG Checks v2**.

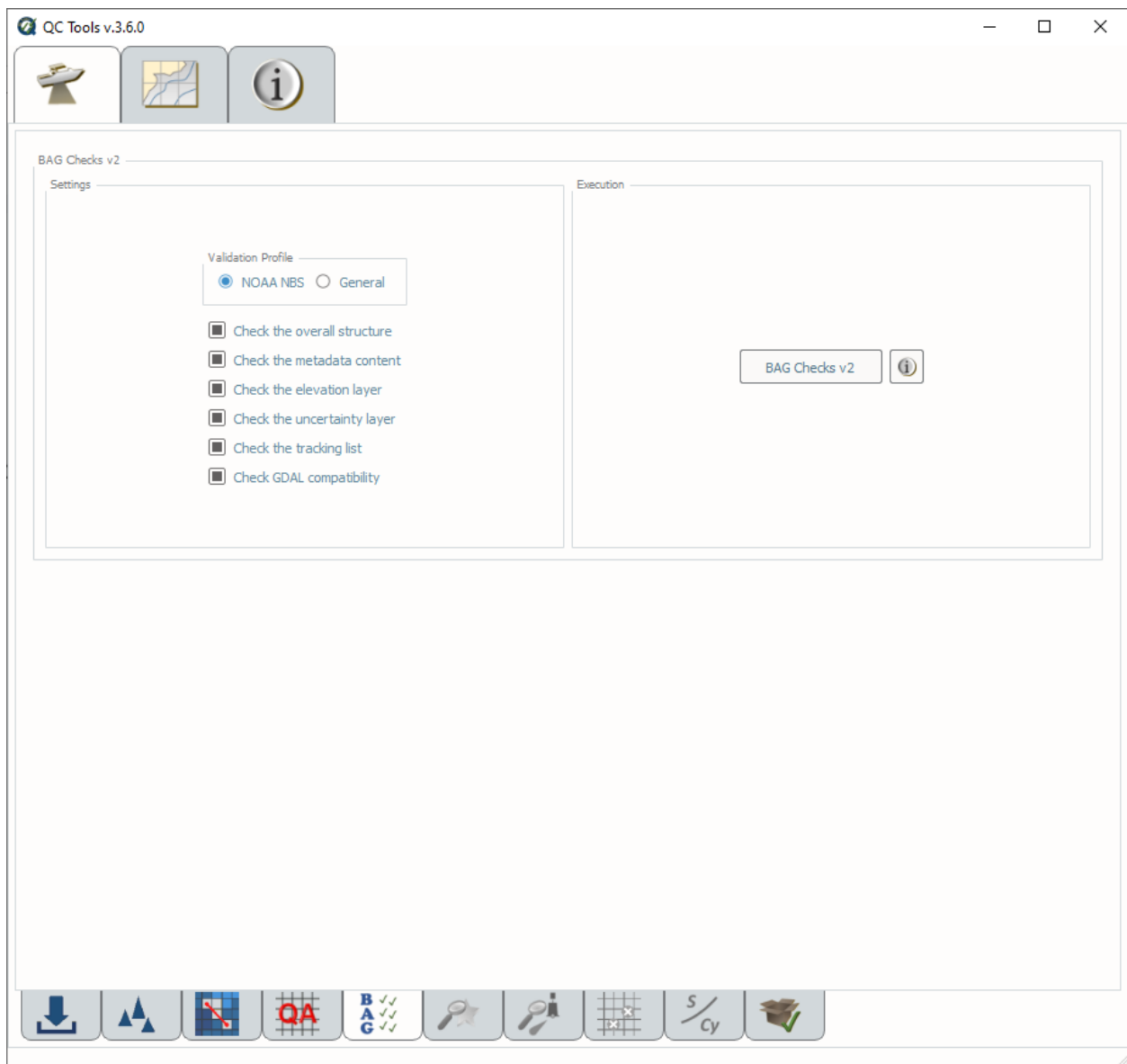


Fig. 2.35: The **BAG Checks** tab.

How Does It Work?

The BAG files are inspected to ensure compliance with NOAA NBS requirements and BAG Format Specification Documents:

- **Check the overall structure: Check that the critical components of BAG structure are present.**
 - BAG Root group
 - BAG Version attribute
 - Metadata dataset
 - Elevation dataset
 - Uncertainty dataset
 - Tracking List dataset
 - **For VR Surfaces:**
 - * VR Metadata dataset
 - * VR Refinements dataset
 - * VR Tracking List dataset
- **Check the metadata content: Checks to ensure that metadata associated with the BAG are appropriately attributed:**
 - Metadata dataset
 - VR Metadata dataset (VR only)
 - **For NOAA NBS Profile:**
 - * Resolution matches with filename (SR only).
 - * Spatial reference system is projected.
 - * Vertical datum is defined.
 - * Creation date.
 - * Survey start date.
 - * Survey end date.
 - * Product Uncertainty.
- **Check the elevation layer: Checks to ensure the validity of the elevation layer of BAG. Checks the following:**
 - For the presence of a Elevation dataset.
 - All depth values are not NaN.
 - VR Refinements (VR only).

- **Check the uncertainty layer:** Checks to ensure the validity of the uncertainty layer in the BAG. Checks the following:
 - For the presence of an Uncertainty dataset.
 - All values are not NaN.
 - Uncertainty values are only positive.
 - VR Refinements (VR only).
 - **For NOAA NBS Profile:**
 - * **Uncertainty values are not too high:**
 - The uncertainty threshold is based on the max depth: $UT = 4.0m + 0.1 * d_{max}$.
 - This check is skipped in case of ellipsoid depths (detected from the filename).
- **Check the tracking list:** Checks to ensure the validity of the tracking list. Checks the following:
 - For the presence of the Tracking List dataset and the VR Tracking List dataset (VR only).
 - Validity of the entries in the ‘row’ column.
 - Validity of the entries in the ‘col’ column.
- **Check GDAL Compatibility:** Checks to ensure that the surface is compatible with GDAL. Checks the following:
 - Checks that the grid does not have more than 10,000,000 refinement grids which will result in a GDAL error.

What do you get?

Upon completion of the execution of **BAG Checks** you will receive a pop-up verification “pass” if your surface passes all the checks, or “fail” if your surface fails any one check (Fig. 2.36).

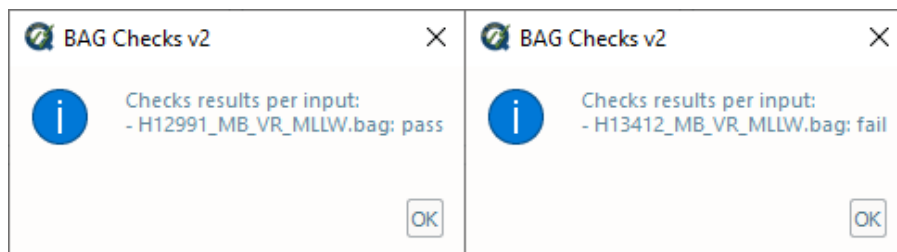


Fig. 2.36: The **BAG Checks** pop-up output.

BAG Checks produces a PDF report that indicates what checks were performed and the results of the checks (Fig. 2.37). At the end of the report a summary indicates how many warnings and errors were identified for the surface (Fig. 2.38).

B.2. Check that the spatial reference system is projected OK
B.3. Check the presence of the creation date OK
B.4. Check the presence of the survey start date [WARNING] Unable to retrieve the survey start date.
B.5. Check the presence of the survey end date [WARNING] Unable to retrieve the survey end date.
B.6. Check the selection of Product Uncertainty [WARNING] The Uncertainty layer does not contain Product Uncertainty: Unknown
C. Elevation
C.1. Check the presence of the Elevation dataset OK

Fig. 2.37: An example of a **BAG Checks** PDF report.

F. Summary
F.1. Structure - Errors: 0 - Warnings: 0
F.2. Metadata - Errors: 0 - Warnings: 3
F.3. Elevation - Errors: 0 - Warnings: 0
F.4. Uncertainty - Errors: 0 - Warnings: 0
F.5. Tracking List - Errors: 0 - Warnings: 0

Fig. 2.38: An example of the **BAG Checks** summary.

2.2.7 Feature Scan

How To Use?

Scan features to ensure proper attribution.

In order to access this tool, load an S-57 file into the **Data Inputs** tab.

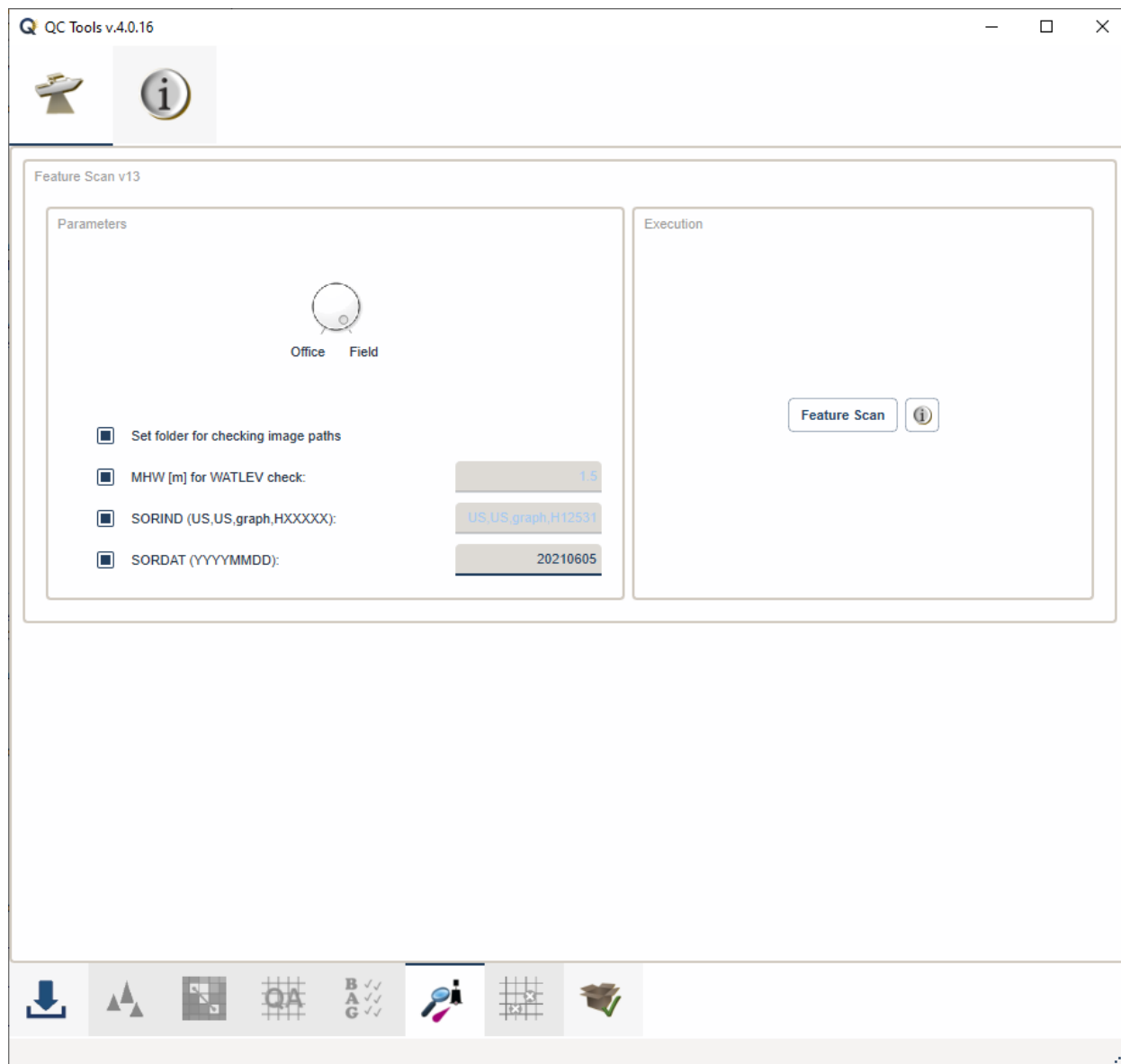
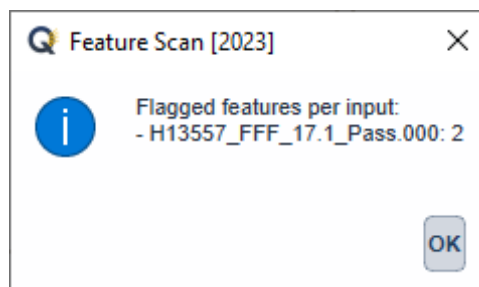
- Select the **Feature Scan** tab (Fig. 2.39) on the bottom of the QC Tools interface.
- In **Parameters**:
 1. Turn the knob to select either the **Office** or **Field** profile.
 2. When **Select the path to the images folder** is set, the user can navigate to their multimedia or images folder upon execution of the tool. When this is unchecked, Feature Scan will search in the relative path that the feature file is located.
 3. **MHW** value is required to check proper attribution of WATLEV per the HSSD. Enter MHW value as a positive number.
 4. When **SORIND** and **SORDAT** are set, the entered values are compared to the attribution of new and updated features.
- In **Execution**, click **Feature Scan v13**.
- After computing, the output window opens automatically, the results are shown (Fig. 2.40).
- From the output window, drag-and-drop the output file(s) into the processing software to guide the review.
- In addition, the results are printed to PDF for a documented summary.

How Does It Work?

The S-57 features are scanned to ensure proper attribution per the NOAA HSSD.

The logic for QC Tools 4 Feature Scan is shown below. This logic is consistent with the 2024 NOAA HSSD.

- Checks for feature file consistency:
 - Check to ensure no feature redundancy. Features that have the same position, acronym, and attribution are flagged.
 - Check to ensure no feature has NOAA discretionary attributes (**acqsts**, **cnthgt**, **keywrd**, **prkyid**, **prmsec**, and **userid**).
- Assigned features = all features with **asgnmt = 2**:
 - All Assigned features must have **descrip**.
- All new and updated features except **\$AREAS**, **\$LINES**, **\$CSYMB**, **\$COMPS**, and **\$TEXTS**:
 - Must have **SORIND** and **SORDAT** and that they are in the proper formats.

Fig. 2.39: The **Feature Scan** tab.Fig. 2.40: The output message at the end of **Feature Scan** execution.

- Check for agreement of **SORIND** and **SORDAT** values when entered in the Parameters.
- All features with **ELEVAT** are checked for valid value.
- All features with images:
 - Receive a warning if an image is used on multiple features.
- Sounding features = all **SOUNDG**.
 - All Sounding features must have **TECSOU** and **QUASOU**.
- DTONs = all features with **descrip = 1 or 2, sftype = 3**:
 - All DTONs must have **images**.
- Obstructions = all **OBSTRN** with **descrip = 1 or 2**:
 - All obstructions (excluding foul ground and foul areas) must have **images**.
 - Provide a warning for all obstructions (excluding foul ground and foul areas) that do not have **VALSOU** or **HEIGHT**.³
 - If obstruction has **VALSOU**:
 - * Obstruction must have **WATLEV**, **QUASOU**, and **TECSOU**.
 - * **WATLEV** is attributed appropriately per HSSD.¹
 - * **QUASOU** is attributed appropriately per HSSD.²
 - If obstruction has **HEIGHT**:
 - * Must have **WATLEV** = “Always Dry”
 - * **TECSOU** and **QUASOU** must be blank.
 - If obstruction does not have **VALSOU** or **HEIGHT**:
 - * **QUASOU** and **TECSOU** must be blank.
 - If obstruction is a foul area (**CATOBS = 6**):
 - * Must not have **VALSOU** populated.
 - * **QUASOU** and **TECSOU** must be blank.
 - If obstruction is foul ground (**CATOBS = 7**):
 - * Must have **WATLEV**.
 - * **VALSOU**, **QUASOU**, and **TECSOU** must be blank.
- Rocks = all **UWTROC** with **descrip = 1 or 2**:
 - Provide a warning for all rocks that do not have have a **VALSOU**.[?]
 - If Rock has **VALSOU**:
 - * Must have **WATLEV**, **QUASOU**, and **TECSOU**.
 - * **WATLEV** attributed appropriately per the HSSD.[?]
 - * **QUASOU** is attributed appropriately per HSSD.²
 - If Rock does not have **VALSOU**:

³ **VALSOU** is optional for rocks, wrecks, and obstructions if it is unsafe to obtain the least depth. If missing a warning flag is issued.

¹ Allowable combinations of **WATLEV** per **VALSOU** depending on location are shown below as stated in Appendix E in the 2022 Hydrographic Specifications and Deliverables.

² Allowable combinations of **TECSOU** and **QUASOU** are shown below.

- * Must have **QUASOU** and **TECSOU** of null/undefined.
- Wrecks = all **WRECKS** with **descrip = 1 or 2**:
 - All Wrecks must have **images** and **CATWRK**.[?]
 - Provide a warning for wrecks that do not have **VALSOU** or **HEIGHT**.
 - If Wreck has **VALSOU**:
 - * Must have **WATLEV**, **QUASOU**, and **TECSOU**.
 - * **WATLEV** attributed appropriately per the HSSD.[?]
 - * **QUASOU** is attributed appropriately per HSSD.^{Page 35, 2}
 - If Wreck has **HEIGHT**:
 - * Must have **WATLEV** = “Always Dry”
 - * **TECSOU** and **QUASOU** must be blank.
 - If Wreck does not have **VALSOU** or **HEIGHT**:
 - * **QUASOU** and **TECSOU** must be blank.
- Seabed areas:
 - Seabed area lines and areas = all **SBDARE** with **line** or **area** geometry.
 - * All Seabed area lines and areas must have **NATSUR** and **WATLEV**.
 - Seabed area points = all **SBDARE** with **point** geometry.
 - * All Seabed area points must have **NATSUR**.
 - * All Seabed area points must have as many **NATSUR** attributes as **NATQUA** and/or **COLOUR**.
 - * All Seabed area points must have an allowable combination of **NATSUR** and **NATQUA**.⁴
- Mooring Facilities
 - All **MORFAC** must have **CATMOR**.
- Coast lines and shorelines:
 - All **COALNE** must have **CATCOA**.
 - All **SLCONS** must have **CATSLC**.
- Land elevations:
 - All **LNDELV** must have **ELEVAT**.
- Metadata coverages:
 - All **M_COVR** must have **CATCOV**, **INFORM**, and **NINFOM**.
- Specific for the Field Profile:
 - **All features with images (Field Profile Only):**
 - * All **images** contain the correct naming convention and they have a corresponding image in the multimedia folder.
 - * Receive a warning if an image is used on multiple features.
- Specific for the Office Profile:

⁴ Allowable combinations of **NATSUR** and **NATQUA** are shown below.

- All features must have **onotes**.
- All features must have **hsdrec**.
- Checks for features that are permitted by MCD (**DRGARE, LOGPON, PIPARE, PIPOHD, PIPSOL, DMPGRD, CBLSUB, CBLARE, FAIRWY, CBLOHD, BCNSPP, BRIDGE, OBSTRN** with **CATOBS = 5**, and **MORFAC** with **CATMOR = 7**).
- Flags ATONS if they are found in the file. MCD defines ATONS as: **LIGHTS, BOYLAT, BOYSAW, BOYSPP, DAYMAR, FOGSIG, RTPBCN, BOYISD, BOYINB, BOYCAR, BCNSPP, BCNLAT, BCNSAW, BCNCAR, and BCNISD**
- All new/updated **M_QUAL** features must have **CATZOC, SURSTA, SUREND, and TECSOU**.
- All features must have **descrip**.
- No features with onotes text input field exceeding 250 characters.

Classification	Always Underwater	Awash	Covers & Uncovers	Always Dry
Elevation (VALSOU or HEIGHT)	> 0.1 m below chart datum (e.g., MLLW or LWD ⁺)	< 0.1 m above chart datum (e.g., MLLW) to 0.1 m below chart datum (e.g., MLLW)	0.1 m ≥ chart datum (e.g., MLLW) to 0.1 m SPOR (e.g., MHW)	> 0.1 m SPOR (e.g., MHW)
S-57 Object	UWTROC OBSTRN WRECKS	UWTROC OBSTRN WRECKS	UWTROC OBSTRN WRECKS	LNDARE & LNDELV* OBSTRN** WRECKS**
WATLEV Value	3	5	4	none
Vertical coordinate system is positive up for elevations and positive down for depths				

⁺In the Great Lakes, rocks, obstructions, and wrecks are defined in relation to Low Water Datum.

*A rock becomes an islet at 0.1 meters above SPOR (e.g. MHW). LNDARE point or area objects are used to characterize islets. Elevation for islets is encoded using the object LNDELV, with attribute ELEVAT, and are shown relative to the SPOR.

**When the depth of an obstruction or wreck is greater than 0.1 meters above MHW, HEIGHT attribution is required rather than VALSOU. As with ELEVAT, heights are shown relative to SPOR (e.g., MHW). In this situation, WATLEV and VALSOU are left null.

TECSOU	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Q	1	o	o				o					o		
U	2									o				
A	6			o	o		o					o		
S	7													
O	8													
U	9		o											
	NULL													

TECSOU: found by echosounder (1), found by side scan sonar (2), found by multibeam (3), found by diver (4), found by leadline (5), swept by wire-drag (6), found by laser (7), swept by vertical acoustic system (8), found by electromagnetic

sensor (9), photogrammetry (10), satellite imagery (11), found by levelling (12), swept by side-scan sonar (13), and computer generated (14).

QUASOU: depth known (1), depth or least depth “unknown” (2), least depth known (6), least depth “unknown”, safe clearance at value shown (7), value reported (not surveyed) (8), value reported (not confirmed) (9), and NULL (undefined/blank).

NATQUA		1	2	3	4	5	6	7	8	9	10
N	1					o	o	o	o	o	o
A	2					o	o	o			o
T	3					o	o	o			o
S	4	o	o	o			o		o	o	o
U	5								o	o	
R	6								o	o	
	7								o	o	
	8								o	o	
	9								o	o	
	11								o		
	14				o						
	17				o					o	
	18								o	o	

NATQUA: fine (1), medium (2), coarse(3), broken (4), sticky (5) soft (6), stiff (7), volcanic (8), calcareous (9), hard (10)

NATSUR: mud (1), clay (2), silt (3), sand (4), stone (5), gravel (6), pebbles (7), cobbles (8), rock (9), lava (11), coral (14), shells (17), boulder (18)

What do you get?

Upon completion of the execution of **Feature Scan** you will receive a pop-up verification if your surface contains potential fliers or not (Fig. 2.41).

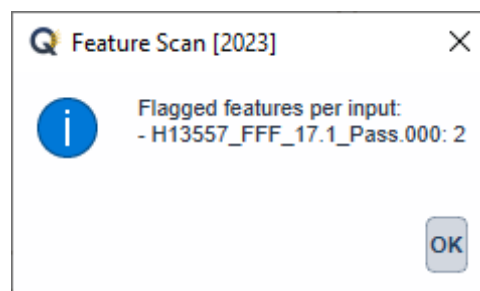


Fig. 2.41: The **Feature Scan** output message.

Feature Scan produces a .000 files containing “blue notes” which helps the user identify the locations flagged features. Each test that results in a flag will have a corresponding feature in the output file. The **NINFOM** field is used to describe the warning or error associated with the feature. The **INFORM** field contains the corresponding test number from the PDF Report (Fig. 2.43). These can be loaded into your GIS software of choice for further analysis.

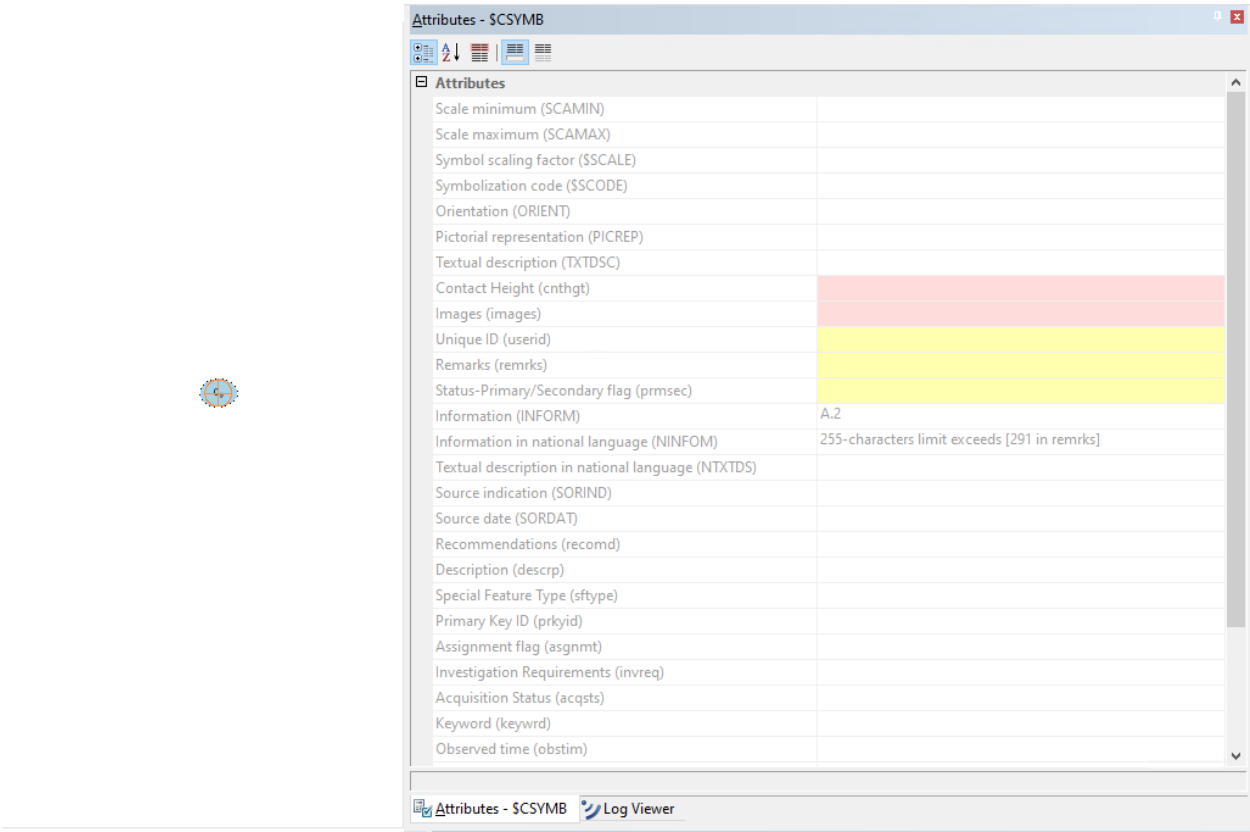


Fig. 2.42: An example of a warning associated with an obstruction identified with a blue note (\$CSYMB).



Information		Information in national language
J.8	invalid/prohibited value for TECSOU	
J.2	warning: missing VALSOU	
J.7	warning: missing attribute: WATLEV	
E.1	missing images folder	

Fig. 2.43: An example of one feature with multiple flags. The “Information” field shows the corresponding section from the PDF Report, the “Information in national language” field shows a description of the flag.

Feature Scan produces a PDF report that indicates what checks were performed and the results of the checks (Fig. 2.44). At the end of the report, a summary indicates how many warnings and errors were identified grouped by type (Fig. 2.45).

The naming convention of the output files contains important information about the settings that were used to execute Feature Scan. Each setting is separated by a period in the naming convention. See Fig. 2.46.

2.2.8 VALSOU checks

How To Use?

Ensure the least depth of features match the gridded bathymetry.

In order to access this tool, load a grid and an S-57 file into the **Data Inputs** tab.

- Select the **VALSOU Checks** tab (Fig. 2.47) on the bottom of the QC Tools interface.
- **In Parameters:**
 - The **Include TECSOU=laser** checkbox may be enabled (in the event of lidar bathymetry wherein we’d expect features to be represented in the grid), or disabled (as in the case of shoreline investigations where the VALSOUs are not derived from the surface).
- **In Execution**, click **VALSOU Checks**
- After computing, the output window opens automatically, and the results are shown (Fig. 2.48). Note, the check considers all combination of grids and features files loaded. If there is no overlap found between a grid and feature file, no output is generated, and the summary will report “no overlap”.

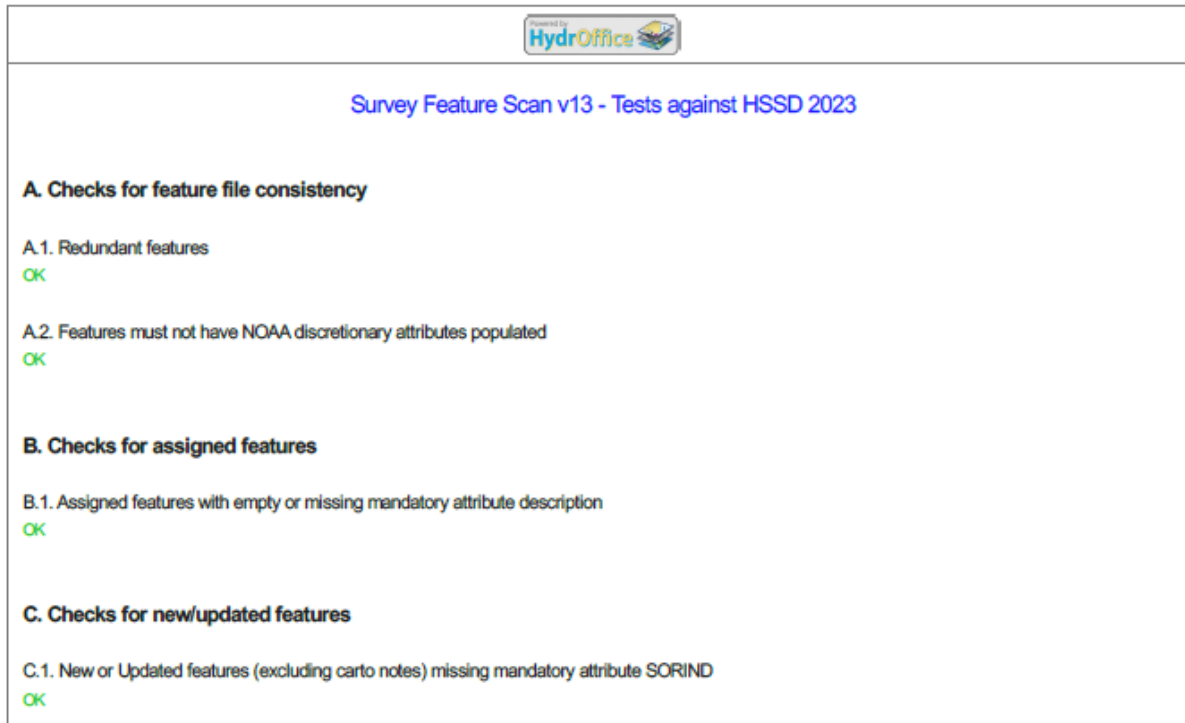


Fig. 2.44: An example of a **Feature Scan** PDF report.

- From the output window, drag-and-drop the output into the processing software to guide the review.

Note: VR CSAR: this tool may provide false positives due to current limitations in accessing designated soundings through the CARIS SDK.

Note: VR BAG: this tool may provide false positives because grids created with CARIS apps do not currently contain the location of designated soundings.

R. SUMMARY

R.1. Summary by section:

- Section A - Checks for feature file consistency: 0
- Section B - Checks for assigned features: 0
- Section C - Checks for new or updated features: 26
- Section D - Checks for new or deleted features: 0
- Section E - Checks for images: 0
- Section F - Checks for soundings: 0
- Section G - Checks for DTONs: 0
- Section H - Checks for wrecks: 0
- Section I - Checks for underwater rocks: 0
- Section J - Checks for obstructions: 0
- Section K - Checks for offshore platforms: 0
- Section L - Checks for seabed areas: 0
- Section M - Checks for mooring facilities: 0
- Section N - Checks for coastlines and shorelines: 0
- Section O - Checks for land elevations: 0
- Section P - Checks for meta coverages: 0
- Section Q - Checks ONLY for office: 0

Fig. 2.45: An example of the **Feature Scan** summary.

[s57 filename].FSv[version].[HSSD year]

e.g., H13412_FFF.FSv13.2023

Fig. 2.46: Example naming convention for a feature scan. In this example the 2023 specifications were used to analyze the data.

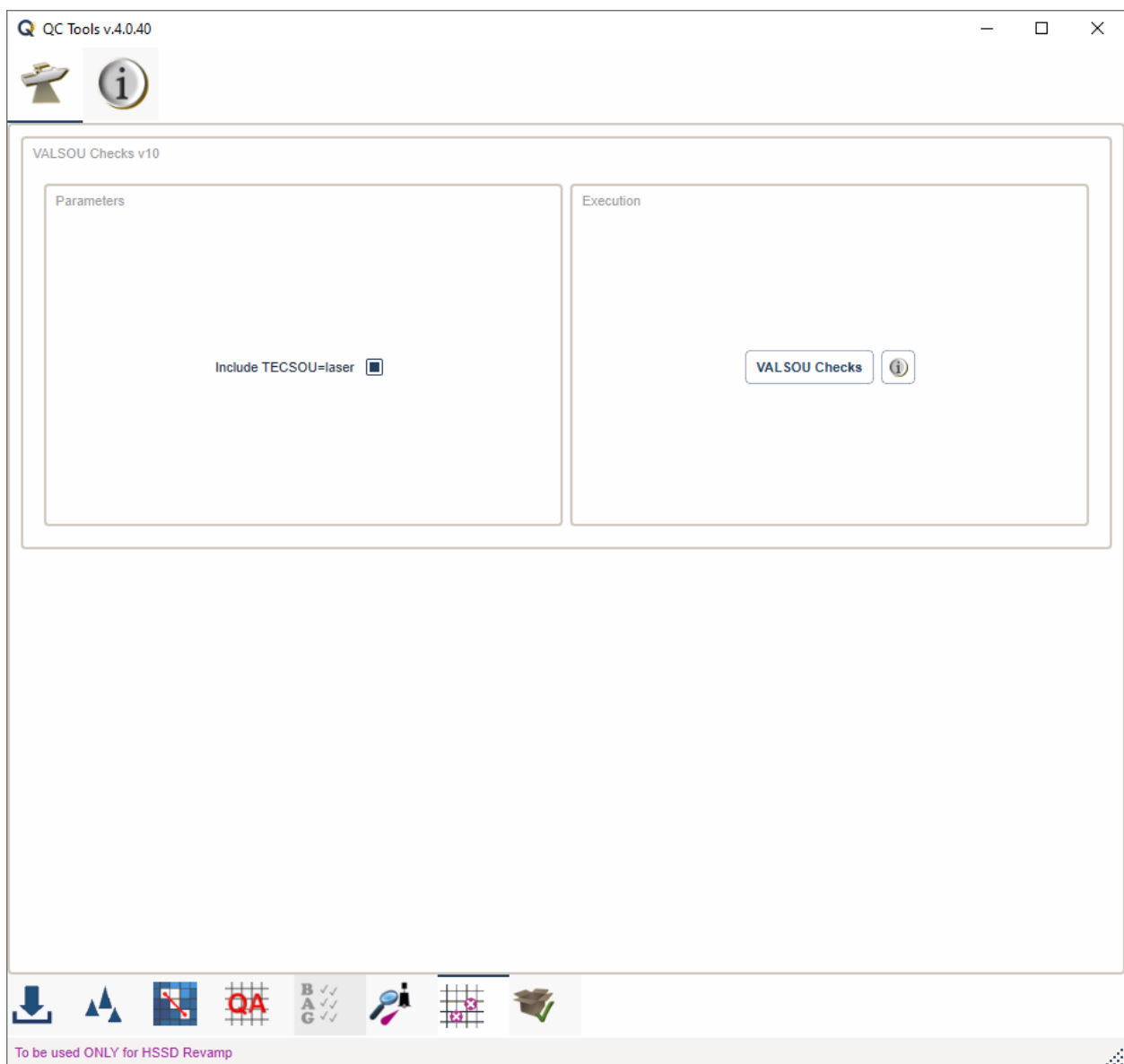


Fig. 2.47: The VALSOU Checks tab.



Fig. 2.48: The output message at the end of **VALSOU Checks** execution.

How Does It Work?

The grid is scanned for features expected to be represented in the grid as per specification. These features are new or updated wrecks, rocks, and obstructions, and a grid node should be found that agrees with the feature VALSOU.

For each feature, 9 grid node depths are selected: the grid node depth closest in position to the feature, and the 8 grid nodes surrounding it (Fig. 2.49). The minimum depth is selected from those 9 grid node depths, and that minimum depth must match the feature VALSOU (to centimeter precision). If not, a flag is raised. Note, this check not only ensures parity between feature VALSOUs and the grid, but it will also ensure the VALSOU entered is the most shoal depth among the 9 grid nodes atop the feature.

In cases involving multiple grids, once a feature registers a positive match on any given surface, it successfully passes the check. The tool continues to scrutinize all features, whether flagged due to discrepancies or those that have not yet been examined, until every input surface has undergone analysis.

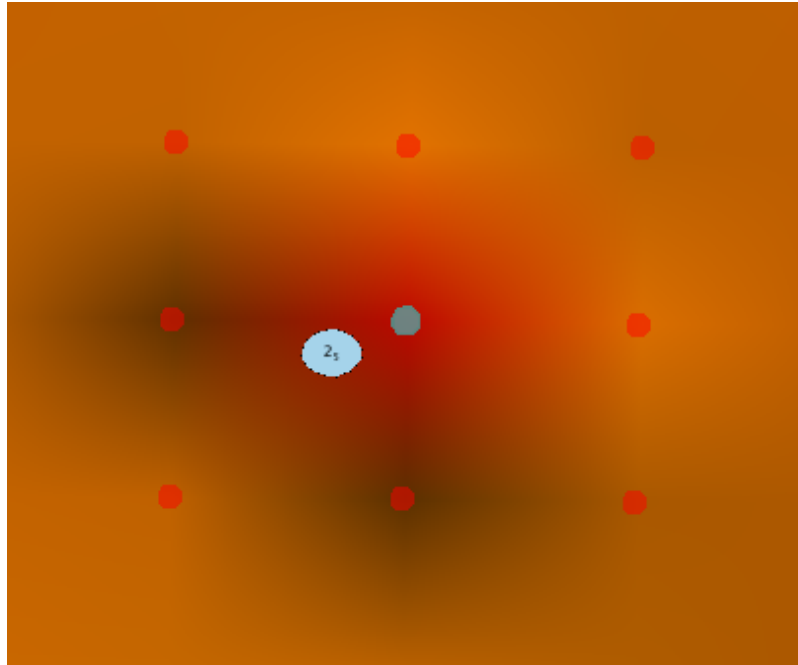


Fig. 2.49: The grid node closest in position to the feature and the 8 grid nodes surrounding it are included in the search. The minimum of these nodes must match the feature VALSOU.

What do you get?

Upon completion of the execution of **VALSOU Checks** you will receive a pop-up verification if your surface contains potential discrepancies with your S-57 VALSOUs, either a depth discrepancy (i.e. the VALSOU does not match the grid) or a not visited flag (i.e. there was no grid found underlying the S-57 VALSOU)(Fig. 2.50).



Fig. 2.50: The output message at the end of **VALSOU Checks** execution.

The output of this tool is a .000 file that contains \$CSYMB features which provides the location of the potential discrepancy. Drag and drop in your GIS of choice. The NINFOM field indicates the reason for the flagged object and the VALSOU vs. the least depth found in the grid.

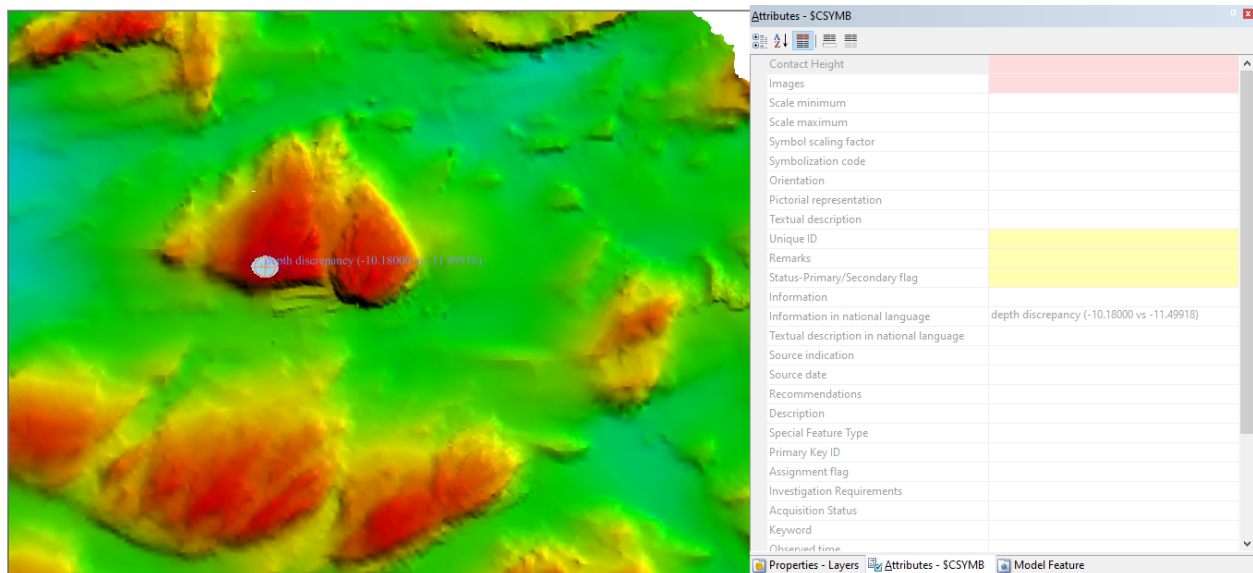


Fig. 2.51: Example of a flagged depth discrepancy found with VALSOU Checks. The orange symbol is the flag. The NINFOM field shows a depth discrepancy with the VALSOU of a value of -10.18000 vs. the least depth of the grid which is -11.49918.

The naming convention of the output files contains important information about the settings that were used to execute VALSOU Checks. Each setting is separated by a period in the naming convention. If multiple grids are used, the number of grids will be listed in place of the grid filename. See Fig. 2.52.

[s57 filename]_vs_[grid filename].VCv[version].[TECSOU=laser]

e.g., H13667_FFF_vs_H13667_MB_VR_MLLW_final.VCv10.las

Fig. 2.52: Example naming convention for a VALSOU Checks output. In this example the user selected a “include TECSOU = laser”.

If there are no flags found during the check, an empty file will be created with “empty” as the extension of the file.

2.3 Info Tab

The **Info** tab contains numerous helpful links and utilities (Fig. 2.53):

- The HydrOffice QC Tools website
- The Online User Manual
- The Offline User Manual (PDF)
- A User Bug Report Tool
- The HydrOffice Main Page
- The NOAA Nautical Charts Home Page
- The Center for Coastal and Ocean Mapping Main Page
- The University of New Hampshire Main Page
- Uncertainty Calculator
- The Rock or Islet oracle
- NOAA S-57 Support Files for CARIS
- License Information
- Contacts List
- QC Tools Software Information

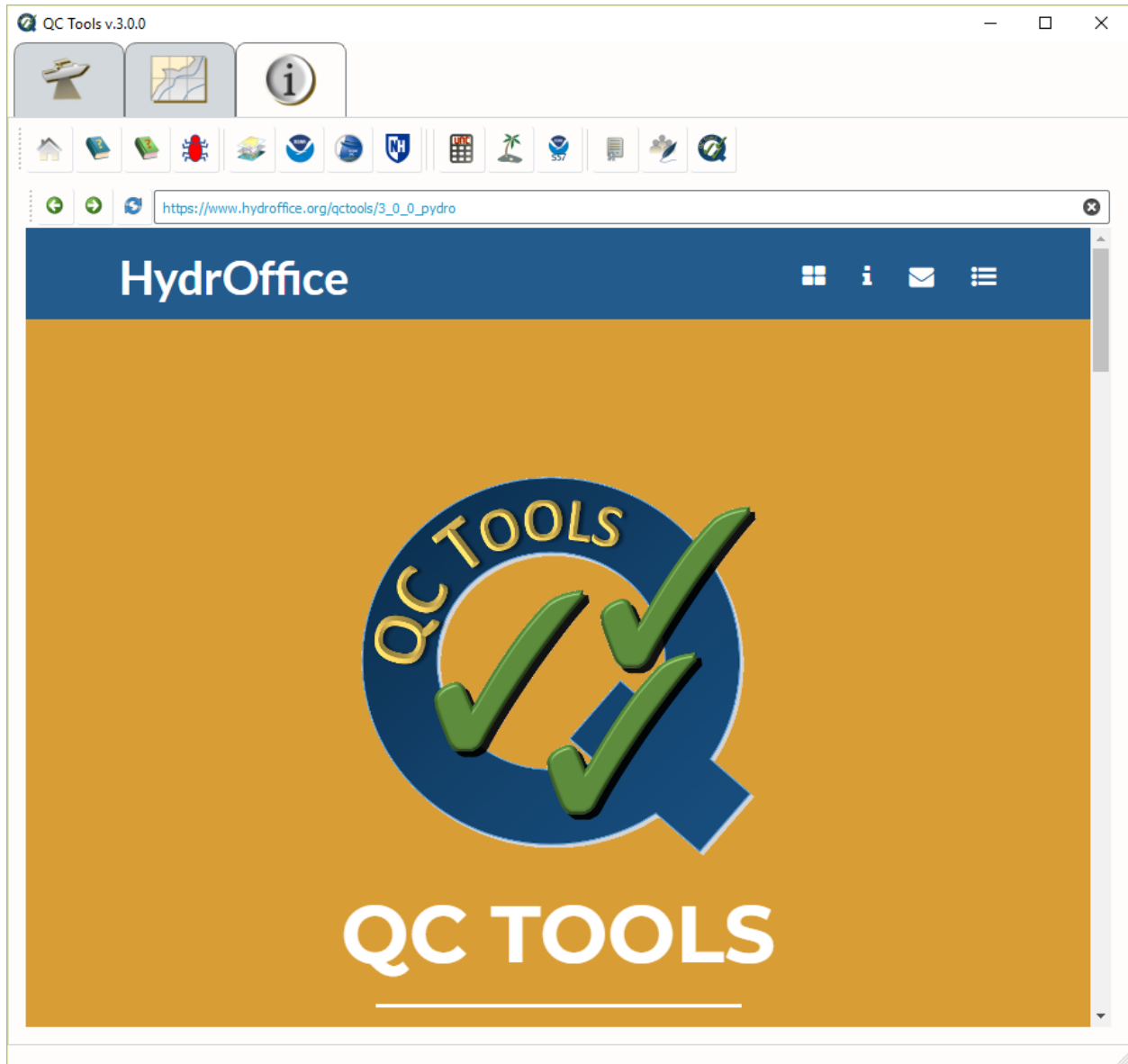


Fig. 2.53: The **Info** tab

2.3.1 RorI: Your Rock-or-Islet Oracle

How To Use?

RorI has been created as a tool to help hydrographers determine if their feature is a rock or an islet. **RorI** is a standalone tool that is launched from the button at the top of the Info tab (Fig. 2.54).

How Does It Work?

At the top of RorI, the Depth/Elevation toggle does not have an impact on how RorI is doing its calculations (Fig. 2.55). The toggle controls two visualizations. First, the boxes below which show you the limits that define the different WATLEV values. You can either view these values in an elevation (positive up) or depth (positive down). The boxes below show the limits behind of each WATLEV value which are derived from NOAA's Hydrographic Specifications and Deliverables.

Chart Datum is the water level reference on a nautical chart. Typically MLLW, except for the Great Lakes and connecting waterways, which use LWD.

SPOR is the shoreline plane of reference, the vertical datum accepted as the reference plane for shoreline, typically Mean High Water (MHW).

The user will then enter two very important pieces of information: the MHW value and the depth of the feature. The hydrographer will retrieve the MHW value from their tide note. The feature shall be tidally corrected and be referenced to MLLW. That means all depths above MLLW shall be negative! Note for the Great Lakes, all data is referenced to LWD, therefore there is no input needed by the user.

Next, RorI will crunch the numbers and tell you if your feature is a rock or islet (Fig. 2.56). If it is a rock, it will let you know its depth (VALSOU) and water level effect (WATLEV). If your feature is an islet, it will reference the elevation (ELEVAT) to MHW (LWD for the Great Lakes).

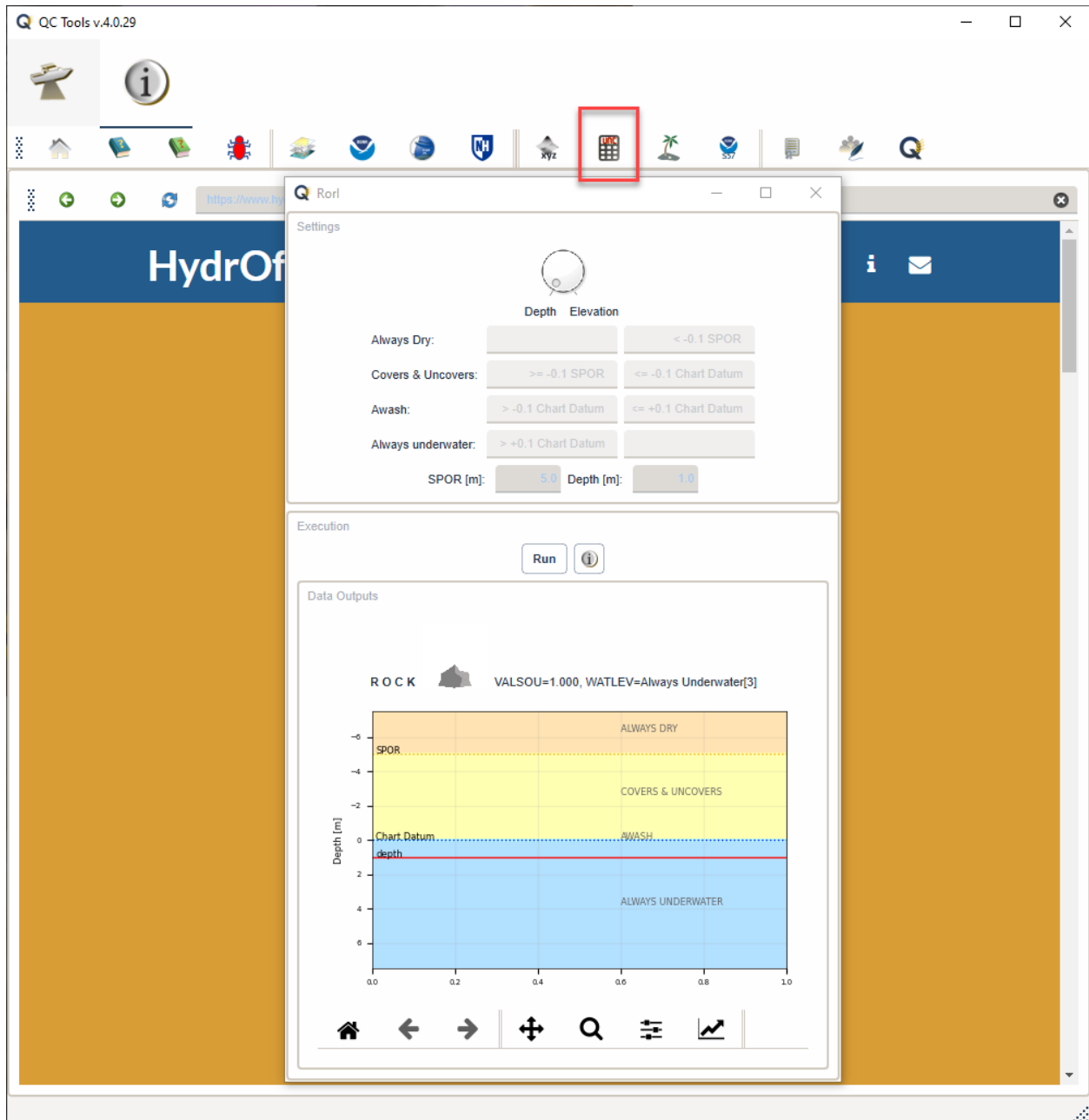


Fig. 2.54: The RorI interface.

Settings

Depth Elevation

Always Dry: < -0.1 SPOR

Covers & Uncovers: >= -0.1 SPOR <= -0.1 Chart Datum

Awash: > -0.1 Chart Datum <= +0.1 Chart Datum

Always underwater: > +0.1 Chart Datum

SPOR [m]: 3 Depth [m]: 2.3

Execution

Run

SPOR Input

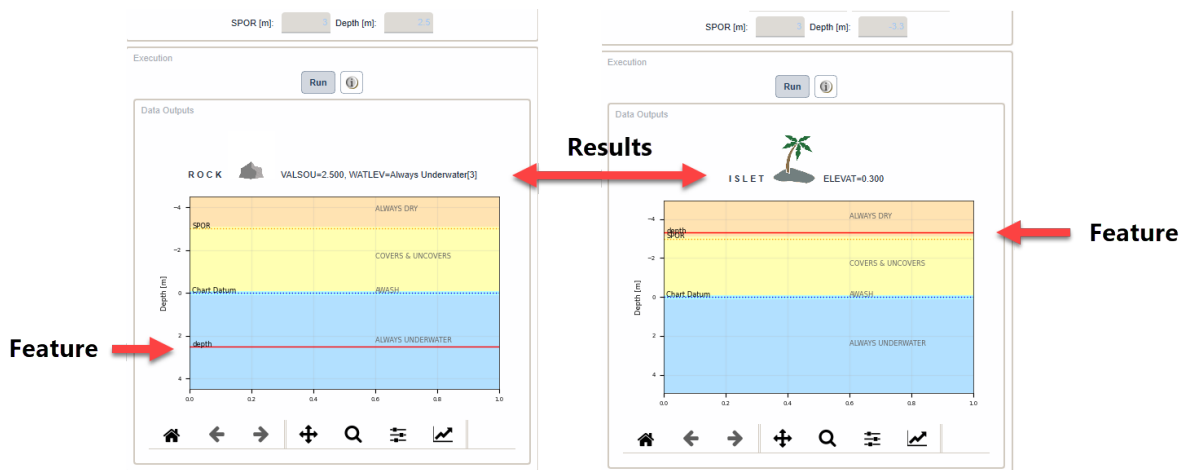
Depth Input

Execution

Fig. 2.55: The **RorI** settings and inputs.

RorI does not use magic to calculate the difference between a rock or an islet. What it does is some simple math. The tool compares the depth to the MHW value (or LWD for the Great Lakes) which are both entered by the user. If the rock is higher in elevation than 0.1 m, then it is an islet.

RorI is based on the following specifications:

Fig. 2.56: The **RorI** outputs.

RorI also helps the hydrographer visualize the difference between a rock and an islet for their survey using a graphic.

2.3.2 Uncertainty Calculator

How To Use?

Uncertainty Calculator is a standalone tool to help you calculate the total vertical uncertainty and total horizontal uncertainty of hydrographic data (Fig. 2.58).

To launch the tool, click the button at the top of the **Info** tab (Fig. 2.57).



Fig. 2.57: The **Uncertainty Calculator** button in the **Info** tab.

The user can select among different NOAA and IHO (S-44 and S-57) quality metrics. Optionally, the user can select a second quality metric for performing a direct comparison. Once that the user set the input depth and click on the Run button, the uncertainty requirements are displayed.

How Does It Work?

Uncertainty calculations are based on NOAA Quality Metric, S-44 Orders, and S-57 CATZOC uncertainties as described below:

NOAA HSSD

$$TVU\ QC = a + (b * depth)$$

where:

- $a = 0.15m$, $b = 0.0075$ for NOAA Exceptional

Fig. 2.58: The **Uncertainty Calculator** interface.

- $a = 0.25m, b = 0.0075$ for NOAA Critical
- $a = 0.5m, b = 0.01$ for NOAA General 1
- $a = 1.0m, b = 0.02$ for NOAA General 2
- $a = 1.0m, b = 0.02$ for NOAA General 3
- $a = 2.0m, b = 0.05$ for NOAA General 4

$$THU\ QC = k + p * depth$$

where:

- $k = 1m, p = 0pct$ for NOAA Exceptional
- $k = 2m, p = 0pct$ for NOAA Critical
- $k = 5m, p = 5pct$ for NOAA General 1
- $k = 20m, p = 10pct$ for NOAA General 2
- $k = 50m, p = 0pct$ for NOAA General 3
- $k = 500m, p = 0pct$ for NOAA General 4

IHO S-44

$$TVU\ QC = \sqrt{a^2 + (b * depth)^2}$$

where:

- $a = 0.15m, b = 0.0075$ for IHO Exclusive Order
- $a = 0.25m, b = 0.0075$ for IHO Special Order
- $a = 0.5m, b = 0.013$ for IHO Order 1a & 1b
- $a = 1.0m, b = 0.023$ for IHO Order 2

$$THU\ QC = k + p * depth$$

where:

- $k = 1m, p = 0pct$ for IHO Exclusive Order
- $k = 2m, p = 0pct$ for IHO Special Order
- $k = 5m, p = 5pct$ for IHO Order 1a & 1b
- $k = 20m, p = 10pct$ for IHO Order 2

IHO S-57 CATZOC

$$TVU\ QC = a + (b * depth)$$

where:

- $a = 0.5m, b = 0.01$ for CATZOC A1
- $a = 1.0m, b = 0.02$ for CATZOC A2
- $a = 1.0m, b = 0.02$ for CATZOC B
- $a = 2.0m, b = 0.05$ for CATZOC C

$$THU\ QC = k + p * depth$$

where:

- $k = 5m, p = 5pct$ for CATZOC A1
- $k = 20m, p = 0pct$ for CATZOC A2
- $k = 50m, p = 0pct$ for CATZOC B
- $k = 500m, p = 0pct$ for CATZOC C

The graph at the bottom of the tool is interactive and visually represents the total vertical and total horizontal uncertainties at that order. If the user wants to compare different uncertainty specifications, you can select a second quality metric in the “**Quality Metric #2**” and a second line will appear in blue.

2.3.3 BAG xyz

How To Use?

Export elevation values as a point cloud.

- Add 1 or more BAG files in **Inputs**.
- Choose the coordinate reference system that the user would like the file to be exported. The user may keep the **original coordinate reference system**, convert to **Geographic WGS84**, or convert to a specific **EPSG code** using the radio buttons.
- Choose the Z convention of either **Depth** (positive down) or **Elevation** (positive up).
- The user optionally can choose to truncate the depth after a specific decimal place.
- The user may also choose the output order of the latitude/northing, longitude/easting, and depth/elevation to suit their needs.
- In **Execution** (Fig. 2.59), click **Export as XYZ**.
- After computing, the output window opens automatically.

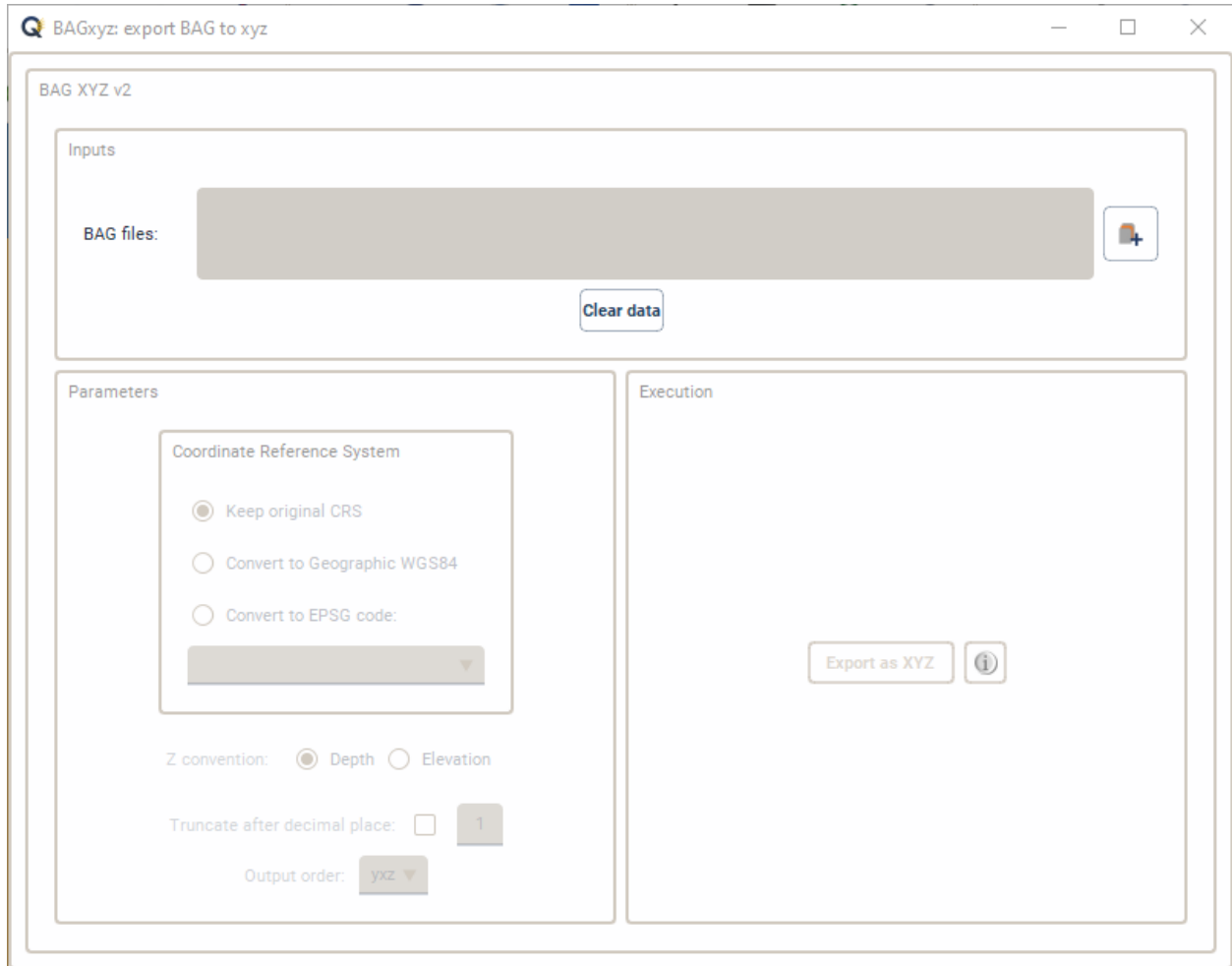


Fig. 2.59: BAG XYZ's interface.

How Does It Work?

A text file with three columns is created.

2.4 Supported Formats

Format	Read	Write
Bathymetric Attributed Grid (.bag)	X	
Caris CSAR (.csar)	X	
S-57 (.000)	X	X
Shapefile (.shp)		X
KML (.kml)		X

2.5 List of references

- Masetti, G.; Faulkes, T.; Wilson, M.; Wallace, J. *Effective Automated Procedures for Hydrographic Data Review*. *Geomatics* **2022**, 2(3), 338-354.

COMMAND LINE INTERFACE

3.1 General Commands

```
usage: QCTools [-h] [--version] {flier_finder,holiday_finder,grid_qa} ...
```

3.1.1 Named Arguments

--version show program's version number and exit

3.2 Flier Finder

```
usage: QCTools flier_finder [-h] [--enforce_height ENFORCE_HEIGHT] [-l CHECK_LAPLACIAN]
↪ [-c CHECK_CURV]
                                [-a CHECK_ADJACENT] [-i CHECK_ISOLATED] [-v CHECK_SLIVERS] [-
↪ m CHECK_MARGINS]
                                [--filter_fff FILTER_FFF]
                                [--quality-metric {Exceptional,Critical,General 1,General 2,
↪ General 3,General 4}]
                                [--filter_distance_multiplier FILTER_DISTANCE_MULTIPLIER]
                                [--filter_delta_z FILTER_DELTA_Z] [--s57_path S57_PATH] [-k
↪ ENABLE_KML_OUTPUT]
                                [-s ENABLE_SHP_OUTPUT]
                                input_dtm output_folder
```

3.2.1 Positional Arguments

input_dtm The input DTM file to be searched for potential fliers.
output_folder The output folder for the results of the search.

3.2.2 Named Arguments

- enforce_height** Pass a value in meters (e.g., 1.0) to enforce a specific height value. Otherwise, the height value will be automatically estimated.
- l, --check_laplacian** True to enable the Laplacian Operator Check.
Default: False
- c, --check_curv** True to enable the Gaussian Curvature Check.
Default: True
- a, --check_adjacent** True to enable the Adjacent Cell Check.
Default: True
- i, --check_isolated** True to enable the Isolated Nodes Check.
Default: True
- v, --check_slivers** True to enable the Edge Slivers Check.
Default: True
- m, --check_margins** True to enable the Noisy Margins Check.
Default: False
- filter_fff** True to enable filtering of S57 features.
Default: False
- quality-metric** Possible choices: Exceptional, Critical, General 1, General 2, General 3, General 4
The quality metric for estimating the uncertainty in Check Margins
Default: "General 1"
- filter_distance_multiplier** Remove flags at the passed distance from the FFF or designated features. Distance expressed as a multiple of the grid resolution.
Default: 1.0
- filter_delta_z** Remove flags within the passed delta Z from the FFF or designated features. The delta Z is expressed in meters.
Default: 0.01
- s57_path** Path to the S57 file used by '-filter_fff True'.
- k, --enable_kml_output** True to enable KML as an additional output format for the flags.
Default: False
- s, --enable_shp_output** True to enable Shapefile as an additional output format for the flags.
Default: False

3.3 Holiday Finder

```
usage: QCTools holiday_finder [-h] [--quality-metric {Exceptional,Critical,General 1,
↪General 2,General 3,General 4}]
                                [--max-size MAX_SIZE] [-k ENABLE_KML_OUTPUT] [-s ENABLE_
↪SHP_OUTPUT]
                                input_dtm output_folder
```

3.3.1 Positional Arguments

input_dtm The input DTM file to be searched for potential holidays.

output_folder The output folder for the results of the search.

3.3.2 Named Arguments

--quality-metric Possible choices: Exceptional, Critical, General 1, General 2, General 3, General 4
 The quality metric for estimating the holiday size
 Default: “General 1”

--max-size The maximum size of a detected holiday. Use 0 for infinite
 Default: 0

-k, --enable_kml_output True to enable KML as an additional output format for the flags.
 Default: False

-s, --enable_shp_output True to enable Shapefile as an additional output format for the flags.
 Default: False

DEVELOPER'S GUIDE

4.1 How to contribute

Every open source project lives from the generous help by contributors that sacrifice their time and this is no different. To make participation as pleasant as possible, this project adheres to the [Code of Conduct](#) by the Python Software Foundation.

Here are a few hints and rules to get you started:

- Add yourself to the [AUTHORS.txt](#) file in an alphabetical fashion. Every contribution is valuable and shall be credited.
- If your change is noteworthy, add an entry to the [changelog](#).
- No contribution is too small; please submit as many fixes for typos and grammar bloopers as you can!
- Don't *ever* break backward compatibility.
- *Always* add tests and docs for your code. This is a hard rule; patches with missing tests or documentation won't be merged. If a feature is not tested or documented, it does not exist.
- Obey [PEP 8](#) and [PEP 257](#).
- Write [good commit messages](#).
- Ideally, [collapse](#) your commits, i.e. make your pull requests just one commit.

Note: If you have something great but aren't sure whether it adheres – or even can adhere – to the rules above: **please submit a pull request anyway!** In the best case, we can mold it into something, in the worst case the pull request gets politely closed. There's absolutely nothing to fear.

Thank you for considering to contribute! If you have any question or concerns, feel free to reach out to us (see [Credits](#)).

4.2 How to build the documentation

4.2.1 Requirements

The documentation is built using `sphinx`, so you need to have it:

- `pip install sphinx sphinx-autobuild`

4.2.2 First-time creation of documentation template

Just once for each project, you can create the documentation template as follows:

- `mkdir docs`
- `cd docs`
- `sphinx-quickstart`

4.2.3 Generate the documentation

To create the html:

- `make html`

To create the pdf, you first need to install a latex distribution, then:

- `make latexpdf`

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Version 3, 29 June 2007

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CREDITS

QC Tools is based on an ongoing joint development between the NOAA's [Ocean of Coastal Survey](#) and UNH's [Center for Coastal and Ocean Mapping](#).

For bugs and feature requests: qctools@hydrooffice.org

NOAA bugs and feature requests: ocs.qctools@noaa.gov

Feel free to contact us for comments and suggestions:

- [Giuseppe Masetti](#)
- [Tyanne Faulkes](#)
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