QRev - Processing Software For Moving-Boat ADCP Streamflow Measurements

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Please Mute Your Phones
Overview

• QRev Goals
• QRev Processing Approach
• Recommended Workflow
• QRev’s Graphical User Interface
• QRev Features
• Recommended Workflow
• Requirements and Limitations
QRev Goals

• USGS standard processing algorithms
  • Apply same algorithms to data independent of manufacture of ADCP

• Use the best data available
  • Manufactures’ software often ignore usable data due to their approach to handling invalid data

• Use the best interpolation methods with available data to estimate values for invalid data
  • Manufacturers’ software use forward or backward propagation of data and not interpolation.

• Improve consistency and efficiency
  • Automate data quality evaluation
  • Automate data uncertainty estimation
QRev Processing Approach

Not using an ensemble ignores potentially good data

Holding a value constant is not the best estimate of the missing data

QRev linearly interpolates invalid data to allow use of valid data

- Discharge
  - Water velocity
  - Depth
  - Boat speed

- Water velocity
  - Depth
  - Boat speed

- Depth

- Boat speed
  - Bottom track
  - GPS
Workflow

- Collect data in field using manufacturer software
  - WinRiver II
  - RiverSurveyor Live
  - Use USGS procedures as before

- Postprocess data in field using QRev
  - For current versions of RSL you will need to reprocess the data in RSL to create the Matlab files.
  - Once data are loaded into QRev the manufactures software should not longer be used for processing.

- Load data into SV Mobile
  - *_QRev.xml

- Office checking and review must be done in QRev using saved QRev file
  - *_QRev.mat
QRev Main Window
Color coded buttons
Buttons on Main Window

- Arranged from top to bottom to lead user through steps loading, reviewing and finalizing a measurement.
- Button look helps guide the user
  - No quality checks done associated with button, but access to other functions or windows
  - Loaded measurement does not have data associated with feature
  - Date checks performed passed all quality checks
  - Data quality checks have identified potential issue but likely not critical. Message panel will contain any issues identified
  - Data quality checks identified an issue that could have significant impact on measurement or violates USGS policy. Message panel will contain any issues identified
Red and yellow buttons have associated messages
Measurement Details

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Measurement</th>
<th>PB-CBA 0.000</th>
<th>PB-CBA 0.000</th>
<th>PB-CBA 0.000</th>
<th>PB-CBA 0.000</th>
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</thead>
<tbody>
<tr>
<td><strong>Discharge</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Q (m³/s)</td>
<td>134.265</td>
<td>137.178</td>
<td>133.303</td>
<td>133.590</td>
<td>135.863</td>
</tr>
<tr>
<td>Top Q (m³/s)</td>
<td>34.122</td>
<td>34.665</td>
<td>33.665</td>
<td>33.590</td>
<td>33.439</td>
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<tr>
<td>Middle Q (m³/s)</td>
<td>91.299</td>
<td>90.562</td>
<td>91.121</td>
<td>90.457</td>
<td>92.717</td>
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<tr>
<td>Bottom Q (m³/s)</td>
<td>7.090</td>
<td>7.027</td>
<td>6.905</td>
<td>7.240</td>
<td>6.565</td>
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<tr>
<td>Left Q (m³/s)</td>
<td>1.633</td>
<td>1.817</td>
<td>1.288</td>
<td>1.417</td>
<td>1.224</td>
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<tr>
<td>Right Q (m³/s)</td>
<td>0.213</td>
<td>0.167</td>
<td>0.324</td>
<td>0.387</td>
<td>0.111</td>
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<td><strong>Time</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Duration (s)</td>
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<td>1719.1</td>
<td>1719.9</td>
<td>1552.7</td>
<td>1105</td>
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<td><strong>Reference</strong></td>
<td>Navigation Ref</td>
<td>BT</td>
<td>BT</td>
<td>BT</td>
<td>BT</td>
</tr>
<tr>
<td>Composite Tracks</td>
<td>Off</td>
<td>Off</td>
<td>Off</td>
<td>Off</td>
<td>Off</td>
</tr>
<tr>
<td>Depth Ref</td>
<td>BT</td>
<td>BT</td>
<td>BT</td>
<td>BT</td>
<td>BT</td>
</tr>
<tr>
<td><strong>Moving Bed</strong></td>
<td>Moving-bed</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Correction</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
</tbody>
</table>

**Errors**

- Transsects selected are not reciprocal transsects.
- SYSTEM TEST: All system test data have at least one test that failed.
- TEMPERATURE: Temperature range is 3.1 degrees C which is greater than 2 degrees.
- Temperature: No independent temperature reading.
- BT: Percentage of invalid ensembles in a transect exceeds 5%.
- BT: Interpolated discharge for invalid ensembles in a transect exceeds 25%.
- BT: Mean Value: The percentage of invalid ensembles in a transect exceeds 5%.
- BT: Mean Value: Interpolated discharge for invalid ensembles in a transect exceeds 25%.
- BT: Mean Value: The percentage of invalid ensembles in a transect exceeds 5%.

**Profile Extrapolation**

- Normalized Unit Q
- Extrapolation Distance from Streambed

**Measurement Quality Assessment**

- COV %: 2.59
- LeftRight Edge: 1.14 / 0.16
- Width: 9.69
- Invalid Cells: 1.45
- Area: 9.69
- Invalid Ens: 34.29
- Random Uncertainty: 2.6
- Invalid Data Uncertainty: 7.1
- Edge Q Uncertainty: 0.4
- Extrapolation Uncertainty: 1.1
- Moving-Bed Test Uncertainty: 1.6
- Systematic Uncertainty: 1.5
- Estimated 95% Uncertainty: 8.4 / 8.4

**User Rating**

- Not Rated
Quick Review of Extrapolation
Measurement Quality Assessment

Measurement Details (Units: English)

<table>
<thead>
<tr>
<th>PARAMETERS</th>
<th>MEASUREMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>DISCHARGE</td>
<td></td>
</tr>
<tr>
<td>Use</td>
<td></td>
</tr>
<tr>
<td>Total Q (ft³/s)</td>
<td>768.429</td>
</tr>
<tr>
<td>Top Q (ft³/s)</td>
<td>180.345</td>
</tr>
<tr>
<td>Middle Q (ft³/s)</td>
<td>487.750</td>
</tr>
<tr>
<td>Bottom Q (ft³/s)</td>
<td>94.206</td>
</tr>
<tr>
<td>Left Q (ft³/s)</td>
<td>3.451</td>
</tr>
<tr>
<td>Right Q (ft³/s)</td>
<td>2.668</td>
</tr>
<tr>
<td>TIME</td>
<td></td>
</tr>
<tr>
<td>Duration (s)</td>
<td>1273.0</td>
</tr>
<tr>
<td>Start Time</td>
<td>10:28:49</td>
</tr>
<tr>
<td>End Time</td>
<td>10:40:42</td>
</tr>
</tbody>
</table>

Reference

- Navigation Ref: BT
- Composite Tracks: Off
- Depth Ref: BT

Moving Bed

- Moving-bed: No
- Correction: No

System Test

- No system test
- Temperature: No independent temperature reading
- User Input: Station name not entered
- User Input: Station name not entered

Errors

- 8a: The percentage of invalid ensembles in a transect exceeds 5%
- GQA: The percentage of invalid ensembles in a transect exceeds 5%
- GQA: Interpolated discharge for consecutive invalid ensembles exceeds 5%
- GQA: Interpolated discharge for invalid ensembles in a transect exceeds 25%
- GQA: Original: The percentage of invalid ensembles in a transect exceeds 5%
- GQA: GQA: The percentage of invalid ensembles in a transect exceeds 5%

Profile Extrapolation

- Auto
- Selected

Measurement Quality Assessment

- Q: 3.03 Lab/Right Edge 0.45 / 0.36
- Width: 0.84 Invalid Cells: 0.06
- Area: 1.00 Invalid Ens: 3.77
- User Rating: Not Rated

Systematic Uncertainty: 1.5%
Estimated 95% Uncertainty: 4.7%
Common - Comment

Automatic

User
Comments cannot be deleted or edited. If you need to correct a comment do so with another comment.
Common Features in QRev Windows
Select Data

- **SonTek: Transect**
  - *mat files only
  - not the moving-bed tests
  - CompassCal folder in default location
  - SystemTest folder in default location

- **TRDI: *.mmt file**
  - Option for Checked Only

- **QRev: *.mat file saved by QRev**
QRev Processing

• User loads data
• QRev processes data
  • Use loaded boat velocity reference (BT, GGA, VTG) with composite tracks off
  • Use 4-beam average depths with composite depths on
  • Apply automated filters
  • Use automated extrapolation methods
  • Compute discharge
  • Complete quality assessment
  • Display data to user
• User reviews messages, makes necessary changes, and adds comments
• User saves data
Display Units

- Sets the units used for values displayed in Qrev
  - English (default)
  - SI
- Option chosen will continue to be used when QRev is restarted
- Internally all processing is in SI units.
To process like WR2 or RSL:
1) Select SonTek or TRDI
2) Click Original as Loaded

Note: QRev always uses the automated extrapolation method by default.
System Test

System Test QA
• System test completed
• All tests passed
Compass QA

- Compass required (Loop or GPS)
- Calibration completed
- Evaluation completed (for TRDI ADCPs)
Temperature QA

- Range during measurement
  - > 1 degrees C
- Difference from user’s measurement
  - > 2 degrees C
  - If no ADCP temperature entered, the mean for the whole measurement is used.
Moving-bed Test (Loop Test)
Moving-bed Test (Stationary Test)
Moving-bed Test Auto Selection for Multiple Tests

- Used to determine if there is a moving-bed
- Used to correct for a moving-bed if applicable

**Priority**

- Last loop test which does not have critical errors
- If not valid loop, all stationary tests that do not have critical errors

*QRev will not use a mix of loop and stationary tests*
Moving-Bed QA

- Moving-bed test(s) completed
- Moving-bed test(s) valid (no critical errors)
- If stationary tests, a moving-bed, no GPS data: are there 3 stationary tests?

Loop test QA
- Flow speed < 0.8 fps
- % invalid BT > 20%, > 5%
- Consecutive invalid BT > 10
- Flow direction and compass evaluation

Stationary test QA
- Duration < 300 seconds
- Equilibrium conditions reached
- Invalid BT > 50%, > 10%
Entries in the first row apply to all transects.
Use Input QA

- Draft = 0
- Draft consistent for all transects
- Magvar consistent for all transects
- If GPS, magvar = 0
- Station name and number provided
BT Filters – 3-Beam Solutions

• Auto
  • Default
  • Evaluates 3-beam solutions using neighboring data if within 50% uses as valid

• Allow - will use 3-beam solutions

• 4-Beam Only – requires all 4 beams to have valid velocity
BT Filters - Error Velocity

- **Auto**
  - Default
  - Use variance of error velocity data to automatically set threshold limits for each transect

- **Manual**
  - Users enter a value that is applied to all transects

- **Off**
  - No error velocity filter applied
BT Filters – Vertical Velocity

- **Auto**
  - Default
  - Use variance of vertical velocity data to automatically set threshold limits for each transect

- **Manual**
  - User enters value that is applied to all transects

- **Off**
  - No vertical velocity filter applied
BT Filters – Other Filters

- **Smooth**
  - LOWESS smooth filter with dynamic moving window applied to detect and remove spikes

- **Off**
  - Default
  - No spike detection filter applied
GPS Filters

The GPS Filters interface allows for the selection and configuration of various filters for GPS data processing. The interface includes options for selecting data, display units, and various processing settings. Specific features include GPS filter settings, discharge data, and ship track data, as well as options for selecting different filter types and adjusting parameters such as differential quality and HDOP (Horizontal Dilution of Position). The interface also includes tools for selecting reference data, applying filters, and analyzing the output data.
GPS - Minimum Diff Quality (GGA)

- Minimum quality of GPS GGA data required
  - 1 – Autonomous
  - 2 – Differential
  - Default
  - 4+ - RTK
- Does not affect VTG
GPS Filters – Altitude Change (GGA)

- **Auto**
  - Default
  - Set to 3 meters (9.84 ft)
- **Manual**
  - User specified
- **Off**
  - No Altitude Filter
GPS Filters - HDOP

- **Auto**
  - Default
  - Sets maximum HDOP to 2 and maximum change to 1
  - This may filter out data that is needed

- **Manual**
  - User selected
    - Maximum HDOP
    - Change in HDOP

- **Off**
  - No HDOP Filter

HDOP – Horizontal Dilution of Precision: Measure of possible error (GPS accuracy) due to the geometry of the satellites visible to the GPS receiver (lower is better, < 2 preferred)
GPS Filters - Other

- **Smooth**
  - LOWESS smooth filter with dynamic moving window applied to detect and remove spikes

- **Off**
  - Default
  - No spike detection filter applied
Depths
Depth Reference Options

• Comp 4-Beam Preferred
  • Default
  • Uses 4-beam average when available, if not uses depth sources

• 4-Beam Avg
  • Will only use the average of the 4-beam bottom track depths

• Vertical
  • Will only use vertical beam depths

• Comp Vertical Preferred
  • Uses vertical beam when available, if not uses other depth sources
Bottom Track Depth Averaging Options

- IDW – Inverse Depth weighted Average - default
- Simple – Simple average of beam depths
Depth Options to Filter out spikes

- **Smooth**: uses a LOWESS smooth filter
  - Default
  - Can have issues with large gaps
- **TRDI**: Filter out a beam depth in an ensemble if it is > 1.75 time other beam depth
- **Off**: No filtering of depth data
WT Filter – Excluded Distance

• Will exclude any data down to this distance below the ADCP

• For M9 defaults to .52 ft (to screen out water velocities possibly affected by flow disturbance)
WT Filters – 3-Beam Solutions

- **Auto**
  - Default
  - Evaluates 3-beam solutions using neighboring data

- **Allow** - will use 3-beam solutions

- **4-Beam Only** – requires all 4 beams to have valid velocity
WT Filters – Vertical Velocity

- **Auto**
  - **Default**
  - Use variance of vertical velocity data to automatically set threshold limits for each transect

- **Manual**
  - User enters value that is applied to all transects

- **Off**
  - No vertical velocity filter applied

- For water track, these are the vertical velocities in each depth cell
WT Filters – SNR Filter

• Currently can only be applied to SonTek Data

• Looks for differences between beam SNR in an attempt to filter out data that might be affected by air/bubbles in front of transducers

• Defaults on Auto with no Manual setting (SonTek Only)
WT Filters – “All Time Series” Graph
WT Filters – “Other” Graph

[Graph showing speed (m/s) vs. ensembles]
WT Filters – “Contour Showing Invalid” Graph

• Default view when entering WT Filters dialog
• Top graph shows contour with white space for invalid data
• Bottom graph is contour including interpolated velocities
QRev Checks: BT, GPS, Depths, WT

• Percent of ensembles with invalid (5%)
• Percent of discharge interpolated for consecutive ensembles (3%, 5%)
• Overall percent of discharge interpolated (25%)
Extrapolation
Edges

### Edge Settings

<table>
<thead>
<tr>
<th>Filename</th>
<th>Start Edge</th>
<th>Left Type</th>
<th>Left Coef</th>
<th>Left Distance (ft)</th>
<th>Left # En</th>
<th>Left # Val</th>
<th>Left Discharge (ft³/s)</th>
<th>Right Type</th>
<th>Right Coef</th>
<th>Right Distance (ft)</th>
<th>Right # En</th>
<th>Right # Val</th>
<th>Right Discharge (ft³/s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>20160115143643r.mat</td>
<td>Right</td>
<td>Triangular</td>
<td>0.3635</td>
<td>5.0</td>
<td>8</td>
<td>8</td>
<td>1.62</td>
<td>Triangular</td>
<td>0.3535</td>
<td>7.0</td>
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<td>1.66</td>
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<td>Triangular</td>
<td>0.3635</td>
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<td>10</td>
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<td>1.85</td>
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<td>2.37</td>
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<td>Triangular</td>
<td>0.3635</td>
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<td>7.0</td>
<td>4</td>
<td>4</td>
<td>2.42</td>
</tr>
</tbody>
</table>

#### Left Edge

- **Water Speed (ft/s)**
- **Depth (ft)**
- **Distance North (ft)**

#### Right Edge

- **Water Speed (ft/s)**
- **Depth (ft)**
- **Distance North (ft)**

[Image of Edge Settings window with data and graphs]
QRev Edges Check

- Sign of edge discharge consistent
- Consistent edge type for each edge
- Edge discharge > 5%
- Edge discharge = 0
Measurement Quality Assessment – Main Window

- Tables to assist in rating in quality and uncertainty of measurement
  - COV % of: total discharge, width, area
  - % discharge in: left/right edge, invalid cells, invalid ensembles
  - Automatic and any User estimated uncertainty of various aspects of the measurement.
    - User can enter estimates in right column
    - Last row = overall estimated uncertainty of measurement
QRev Measurement Quality Assessment Summed Up

- Random – uses the Q COV and # transects
- Invalid – 20% of the sum % discharge for invalid cells and ensembles
- Edge - 30% of total discharge in edges
- Extrapolation – % difference in Q from selected extrap to other extrap methods and average of best 4 options
- Moving-Bed –
  - Bottom track not reference = 0%
  - bottom track used
    - valid moving bed test with no moving bed = 1%
    - moving bed present and correction applied = 1.5%
    - moving bed test warnings, invalid, or not done = 3%
- Systematic – 1.5% (for biases in ADCPs and beam misalignment)
- User column for adjusting Automatic computed uncertainties
User Rating – Main Window

• Provides dropdown menu for user to rate the measurement

• Consider
  • Measurement Quality Assessment uncertainty value
  • Quality of stage measurement
  • Any other factors that might affect overall quality of measurement
Save

- Opens Save Dialog box for saving QRev Matlab file (*_QRev.mat) and QRev xml file (*_QRev.xml)
- If data are later reviewed or reprocessed the *_QRev.mat file should be loaded in QRev
- The *_QRev.xml summary file is for loading into SVMobile
- Defaults to folder where data was loaded
- The default QRev naming format which is YYYYMMDDHHMMSS_QRev.mat where date and time is current date and time
Close

- Exits QRev
- Any changes made that have not saved will be lost
- If you have imported a new measurement from WinRiver II or RSLive and not saved QRev will prompt
- No prompt while closing if
  - If you have already saved an imported Qm in QRev – even if changes made after save
  - If you open a QRev file – even if changes made without save
- Pressing the X button on the QRev main window also exits QRev
Workflow

- Collect data in field using manufacturer software
  - WinRiver II
  - RiverSurveyor Live
  - Use USGS procedures as before

- Postprocess data in field using QRev
  - For current versions of RSL you will need to reprocess the data in RSL to create the Matlab files.
  - Once data are loaded into QRev the manufactures software should not longer be used for processing.

- Load data into SV Mobile
  - *_QRev.xml

- Office checking and review must be done in QRev using saved QRev file
  - *_QRev.mat
Loading Acoustic Data

- Channel is “staged”; has documentation & notes, but no discharge.
- Import is used to load acoustic measurement data from file.
- Summarize is used to manually enter flow info. Generally not used.
Check/Edit Acoustic Info/Notes

Notes added to SVMobile from the notes made within WinRiver II, RiverSurveyor or QRev
Not currently reviewable in QRev

• Heading
• Pitch
• Roll
• Correlations
• Intensities
• SonTek: change in magnetic field
• Subsectioning

If these need to be reviewed, use the manufacture software to review these characteristics but continue to process the data in QRev.
?????? Questions ???????