Index-velocity Rating Tips Quick Sheet

Index velocity ratings relate the velocity measured by an instrument (Vi) to mean-channel velocity (Vm).

Discharge measurements are made while the index velocity meter measures velocity continuously. It is suggested that at sites with rapidly changing flow that the sampling and averaging interval for index-velocity measurement be set to 60 seconds and 60 seconds respectively.

When creating an index-velocity rating, **DO** compute Vm by dividing discharge (Q) by the standard area (A) from the **stage-area rating**. **DO NOT** compute Vm using the discharge measurement area (the measurements might be made in different places at different times).

Make a summary table to show your measurement data, including measurement number, date and start/end time, mean gage height, discharge, standard area from your stage-area rating, measured-mean channel velocity (Vm) and index velocity (Vi) for the measurement period, and any remarks. It is suggested that all velocity data be set up in the table (Vx, Vy, Vz, multi-cell Vx and Vy, etc). Use a spreadsheet so you can plot the data and do mathematical operations.

Make plots! Plot Vm (y-axis) versus Vi (x-axis) to visualize the index velocity relation (linear, for example). Plot Vm versus other velocity data and stage. Be consistent with plotting (Keep Vm on the Y-axis). Look for changes in slope or non-linear behavior (i.e. data doesn't plot in a straight line).

If the relation is linear, a linear regression equation can be used for the index-velocity rating as a way to compute the mean-channel velocity (Vm_comp):

$$Vm\_comp = a*Vi + C$$

Where:
Vm_comp = computed mean velocity
 "a"   = index velocity coefficient (multiplier)
 "C"   = y-axis intercept

Simple linear regression analysis should be used to assess the "fit" of the data. Many users choose to use the data analysis tool in Excel.

Assess the linear regression using:
- Standard Estimate of the Error (SEE or SE)—overall indicator of rating error—the lower the better
- Keep in mind the hydraulics of the site. The coefficients "a" and "C" in the above equation are indicative of site characteristics

- Residual plots— residuals are the difference between measured and estimated values plotted on the y-axis. The x-axis can be different data (initially measured-mean velocity (Vm), but time and stage are also a good idea to plot on the x-axis. Data should appear to be random, the data should **NOT** show a pattern, and outliers can be easily identified. Patterns may indicate another variable is affecting the relation to mean velocity. Outlier measurements should be carefully checked for measurement errors or irregularities in index-velocity data
- Number of observations
  (should be 10 to 20 for each variable in regression equation)
- R-squared: should be about 0.95 or better. If around 0.90 or lower, consider a multi-parameter index-velocity rating with Vi and stage (GH)

Multiple-linear regressions can be evaluated using measured-mean velocity as the dependent variable and index velocity and gage height as the independent variables.

Vm_comp = a*Vi + b*GH*Vi + C

Where:
Vm_comp = computed mean velocity
"a" = Vi coefficient
"b" = GH*Vi coefficient
 "C" = y-axis intercept

Assess the multiple-linear regression with the same tools as for a single variable equation.
It is recommended that you initially use Vi and GH instead of Vi and GH*Vi. If GH turns out to be a significant variable, then repeat the regression analysis using Vi and Vi*GH in place of GH so the rating can be implemented in ADAPS using a stage correction factor.

When the water breaks out of the channel, is it likely that the shape of the rating will change.
In this case a compound rating may be necessary (i.e. linear relation in channel, different linear relation with flow in overbanks). A table rating can be used to represent such a rating in ADAPS.

If the site experiences upstream and downstream flow, the measured-mean channel velocity at zero (0) velocity should be used as an initial break point to separate the positive and negative velocity. Regression analysis should then be performed separately on the positive and negative portions of the data.

All regression equations should make sense hydraulically.