Highlights from the New Index Velocity Techniques and Methods Report – New Policies and Procedures

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South Carolina WSC

WebEx Presentation August 16, 2011

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Index Velocity Techniques & Methods

- Standardize procedures
- Detailed guidance
  - Site selection
  - ADVM selection
  - ADVM orientation
  - ADVM configuration
  - Velocity data Quality Assurance
  - Rating development and verification
- No guidance for index velocity under ice
- Describes index rating development using Excel
- New index rating tools are coming!

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Techniques & Methods - Highlights

- Site selection
- ADVM location and alignment
- Configuring the ADVM
- ADVM data to transmit
- Discharge measurement procedures
- Routine field procedures
- Routine office procedures
- Stage-area rating creation and verification
- Index rating creation and verification
- Index Rating shifts

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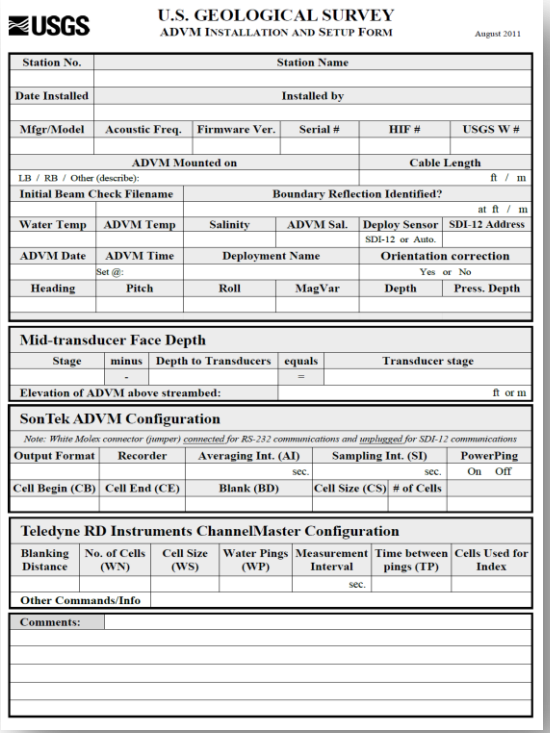
Techniques & Methods - Highlights

- **Increase in documentation**



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U.S. GEOLOGICAL SURVEY
ADVM INSTALLATION AND SETUP FORM
August 2011

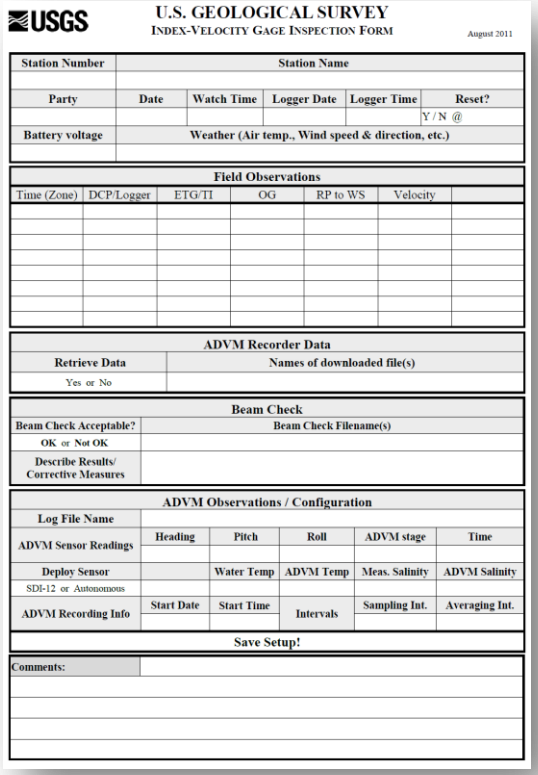
Station No.	Station Name				
Date Installed	Installed by				
Mfgr/Model	Acoustic Freq.	Firmware Ver.	Serial #	HIF #	USGS W #
ADVM Mounted on				Cable Length	
LB / RB / Other (describe):				ft / m	
Initial Beam Check Filename	Boundary Reflection Identified?				
				at ft / m	
Water Temp	ADVM Temp	Salinity	ADVM Sal.	Deploy Sensor	SDI-12 Address
				SDI-12 or Auto.	
ADVM Date	ADVM Time	Deployment Name		Orientation correction	
	Set @:			Yes or No	
Heading	Pitch	Roll	MagVar	Depth	Press. Depth

Mid-transducer Face Depth				
Stage	minus	Depth to Transducers	equals	Transducer stage
	-		=	
Elevation of ADVM above streambed:				ft or m

SonTek ADVM Configuration				
Note: White Molex connector (jumper) connected for RS-232 communications and unplugged for SDI-12 communications				
Output Format	Recorder	Averaging Int. (AI)	Sampling Int. (SI)	PowerPing
		sec.	sec.	On Off
Cell Begin (CB)	Cell End (CE)	Blank (BD)	Cell Size (CS)	# of Cells

Teledyne RD Instruments ChannelMaster Configuration						
Blanking Distance	No. of Cells (WN)	Cell Size (WS)	Water Pings (WP)	Measurement Interval	Time between pings (TP)	Cells Used for Index
				sec.		
Other Commands/Info						

Comments:



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U.S. GEOLOGICAL SURVEY
INDEX-VELOCITY GAGE INSPECTION FORM
August 2011

Station Number	Station Name				
Party	Date	Watch Time	Logger Date	Logger Time	Reset?
					Y / N @
Battery voltage	Weather (Air temp., Wind speed & direction, etc.)				

Field Observations						
Time (Zone)	DCP/Logger	ETG/TI	OG	RP to WS	Velocity	

ADVM Recorder Data	
Retrieve Data	Names of downloaded file(s)
Yes or No	

Beam Check	
Beam Check Acceptable?	Beam Check Filename(s)
OK or Not OK	
Describe Results/ Corrective Measures	

ADVM Observations / Configuration					
Log File Name					
ADVM Sensor Readings	Heading	Pitch	Roll	ADVM stage	Time
Deploy Sensor		Water Temp	ADVM Temp	Meas. Salinity	ADVM Salinity
SDI-12 or Autonomous					
ADVM Recording Info	Start Date	Start Time	Intervals	Sampling Int.	Averaging Int.
Save Setup!					

Comments:

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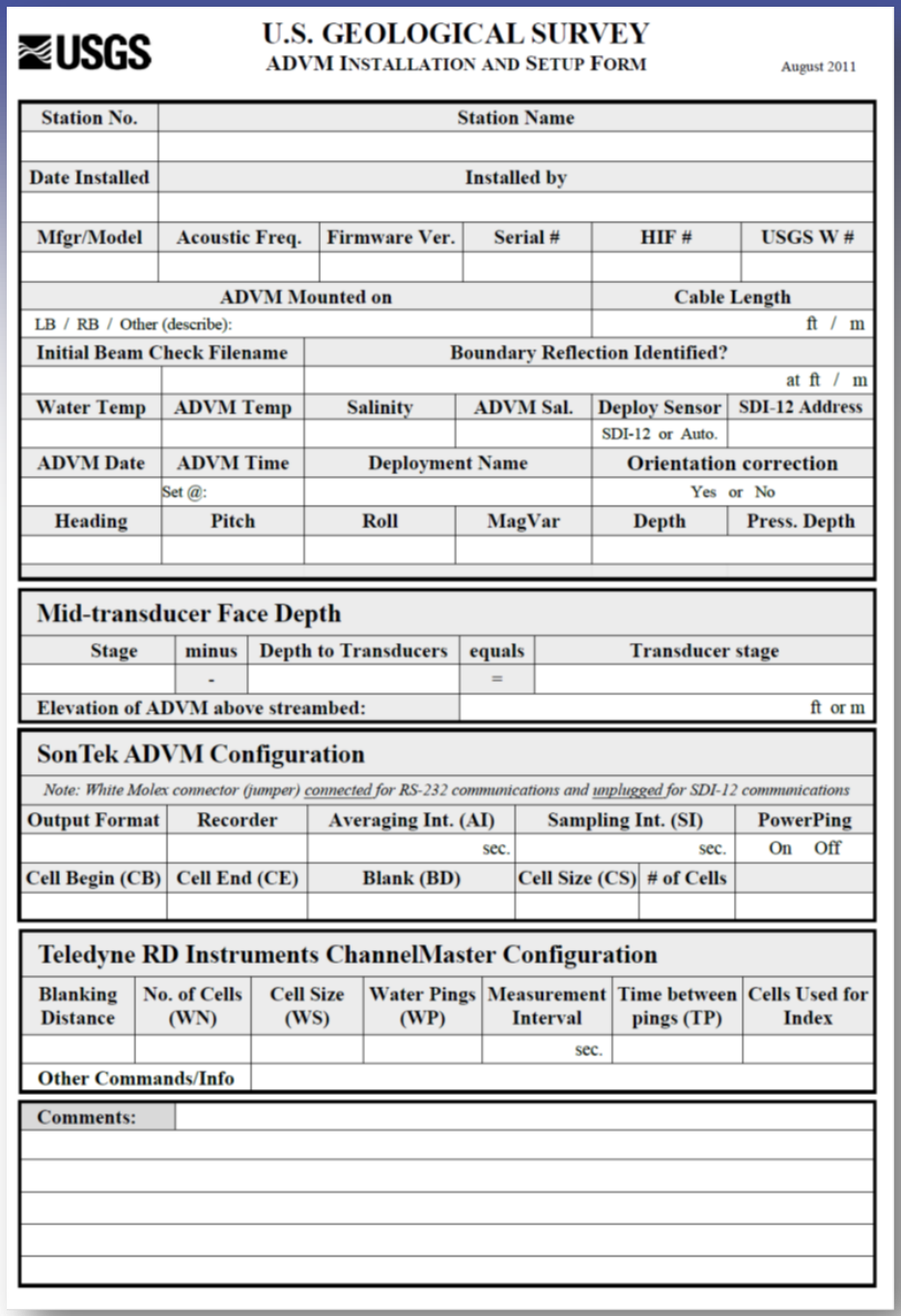

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ADVM INSTALLATION AND SETUP FORM

August 2011

Station No.	Station Name				
Date Installed	Installed by				
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ADVM Date	ADVM Time	Deployment Name		Orientation correction	
	Set @:			Yes or No	
Heading	Pitch	Roll	MagVar	Depth	Press. Depth

Mid-transducer Face Depth

Stage	minus	Depth to Transducers	equals	Transducer stage
	-		=	
Elevation of ADVM above streambed:				ft or m

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Teledyne RD Instruments ChannelMaster Configuration

Blanking Distance	No. of Cells (WN)	Cell Size (WS)	Water Pings (WP)	Measurement Interval	Time between pings (TP)	Cells Used for Index
				sec.		
Other Commands/Info						

Comments:	

ADVM Installation & Initial Setup Form

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INDEX-VELOCITY GAGE INSPECTION FORM

August 2011

Station Number	Station Name				
Party	Date	Watch Time	Logger Date	Logger Time	Reset?
					Y / N @
Battery voltage	Weather (Air temp., Wind speed & direction, etc.)				

Field Observations

Time (Zone)	DCP/Logger	ETG/TI	OG	RP to WS	Velocity	

ADVM Recorder Data

Retrieve Data	Names of downloaded file(s)
Yes or No	

Beam Check

Beam Check Acceptable?	Beam Check Filename(s)
OK or Not OK	
Describe Results/ Corrective Measures	

ADVM Observations / Configuration

Log File Name					
ADVM Sensor Readings	Heading	Pitch	Roll	ADVM stage	Time
Deploy Sensor		Water Temp	ADVM Temp	Meas. Salinity	ADVM Salinity
SDI-12 or Autonomous					
ADVM Recording Info	Start Date	Start Time	Intervals	Sampling Int.	Averaging Int.

Save Setup!

Comments:	

Routine Inspection Form

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Site Selection

- **Field and research observations**
- **Reconnaissance measurements**
- **Temporary ADVM installation**

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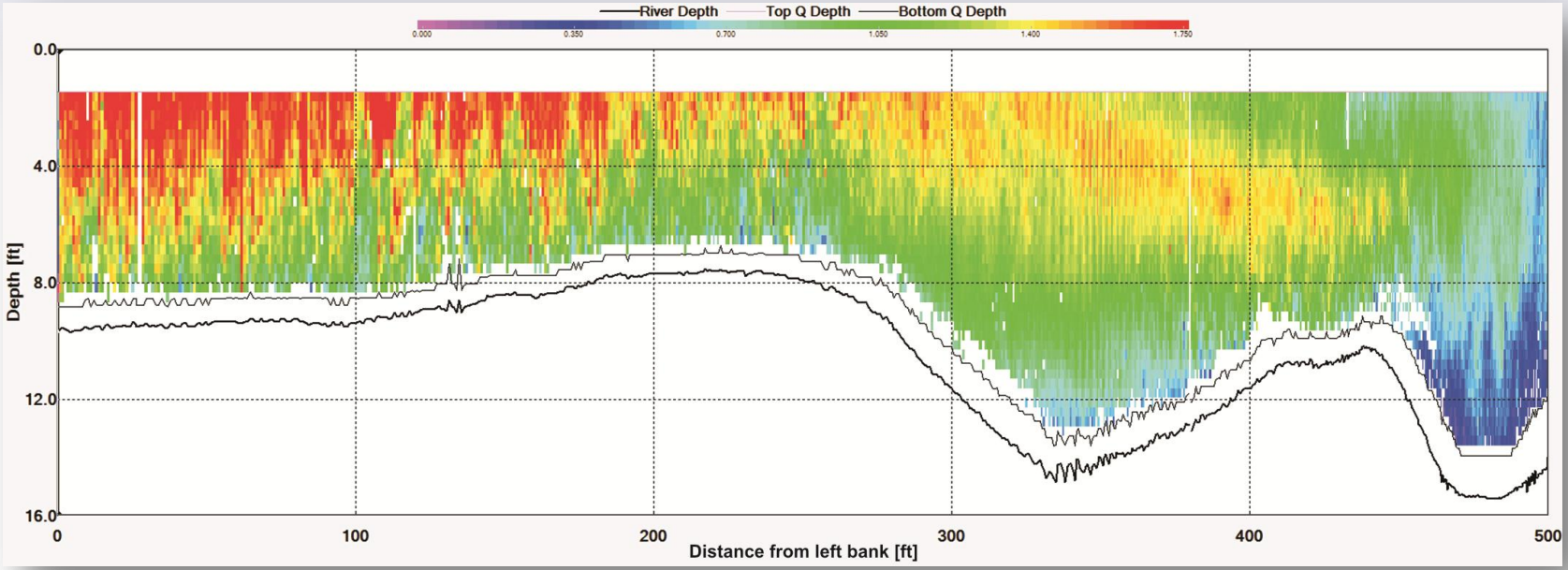
Look for Uniform Velocity Distribution



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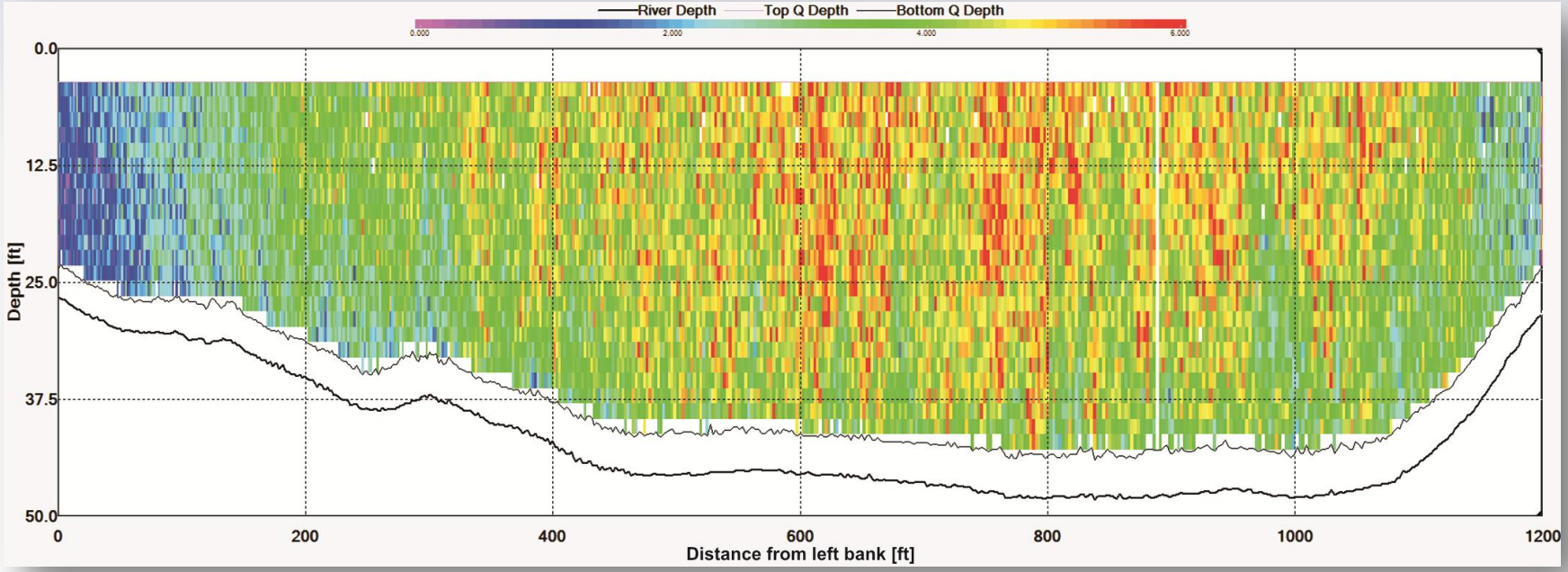
Look for Uniform Velocity Distribution



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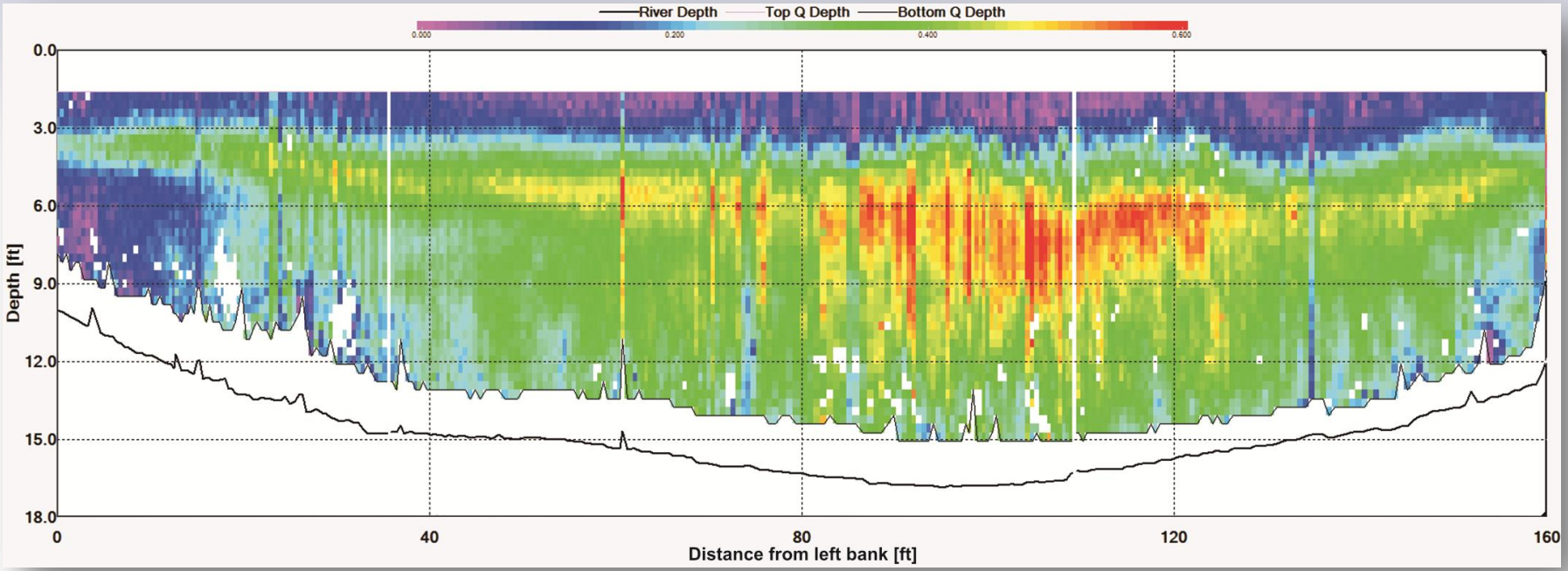
Be aware of Unusual Velocity Distributions



May affect choice of ADVM orientation and installation

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ADVM Location and Alignment

- **Identify optimum location at the chosen site**
  - **Clear of boundary effects**
  - **Clear of flow disturbances**
  - **Measurement volume near maximum velocity**
- **Optimum alignment of the ADVM**
  - **Sometimes overlooked**
  - **Critical for the best possible index rating**

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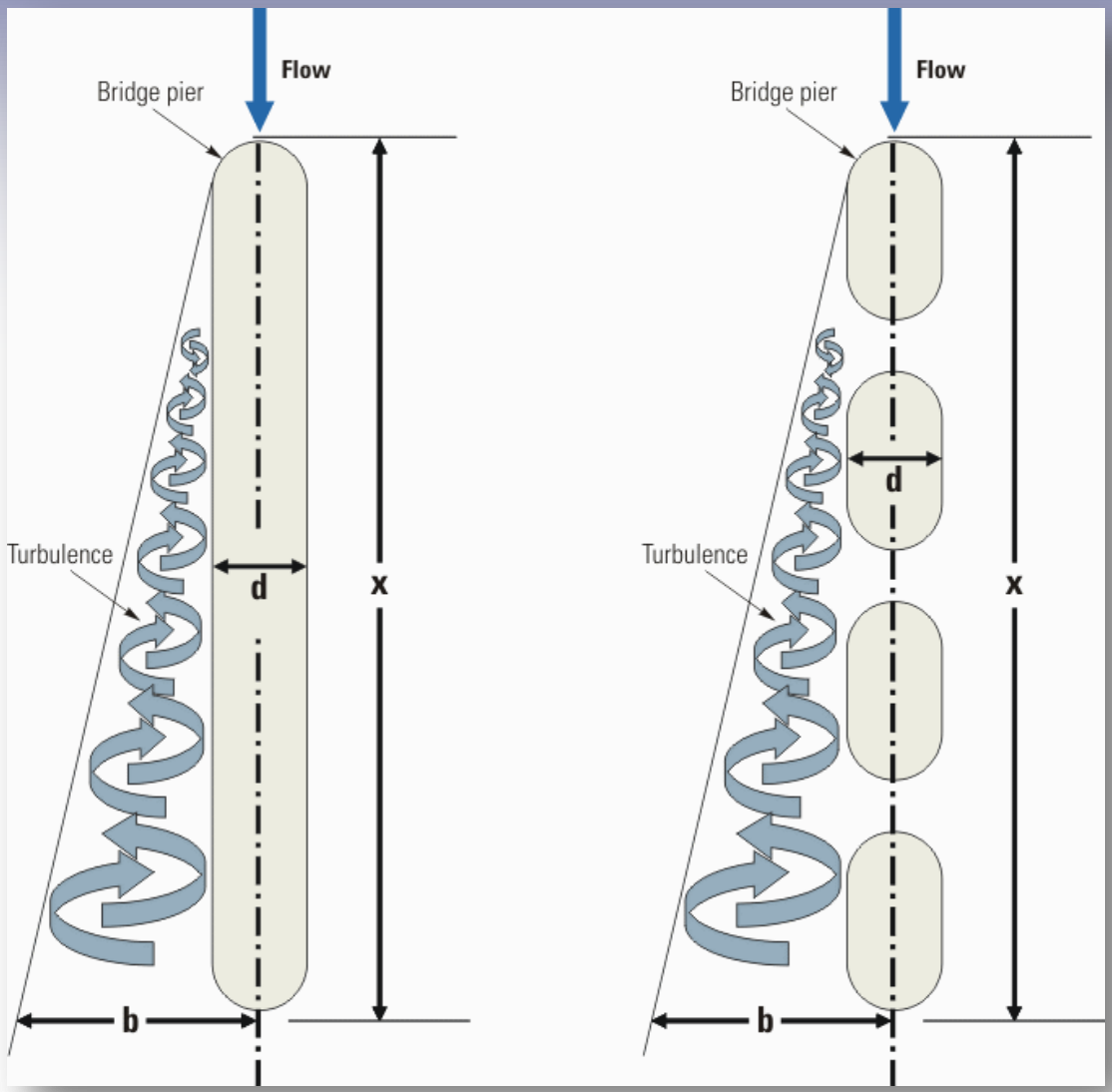
Wake Turbulence/Boundary Effects



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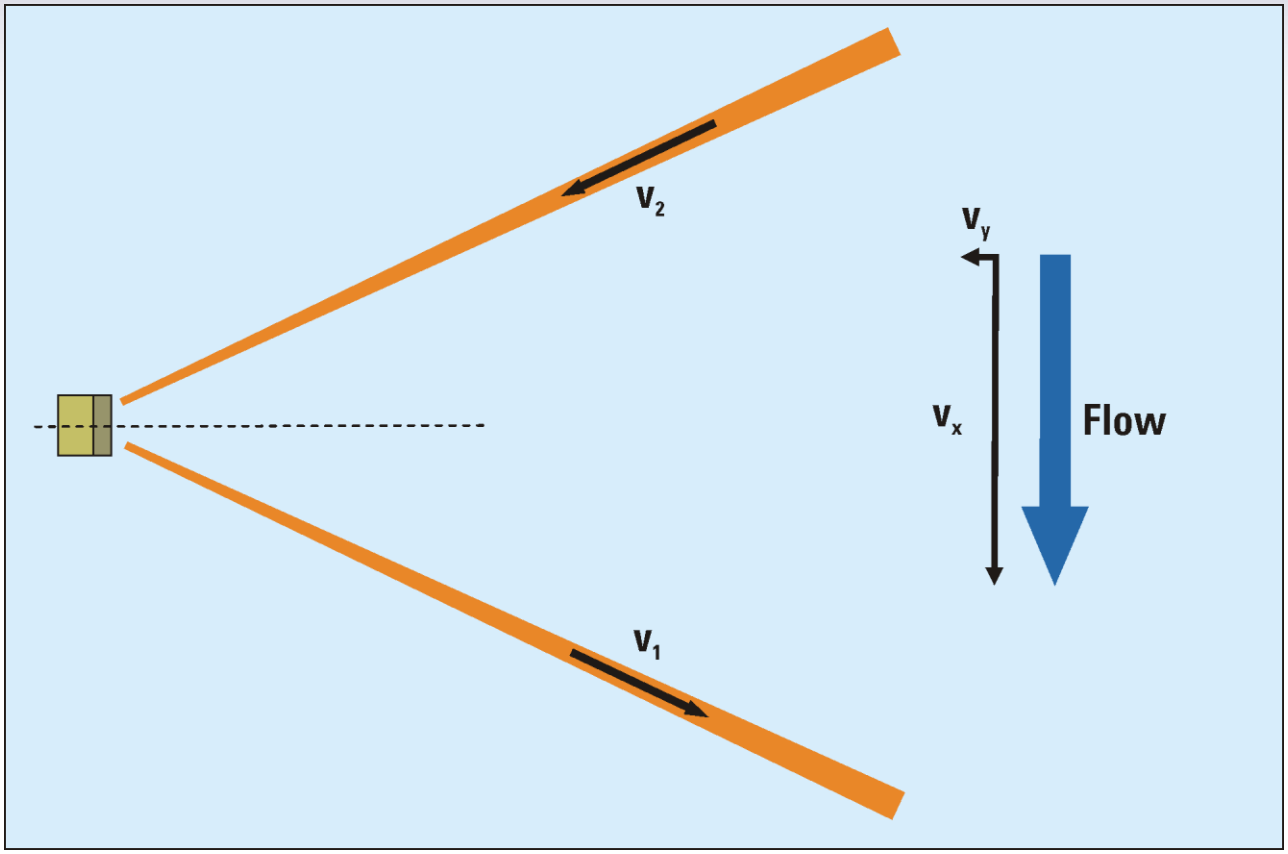
ADVM Alignment



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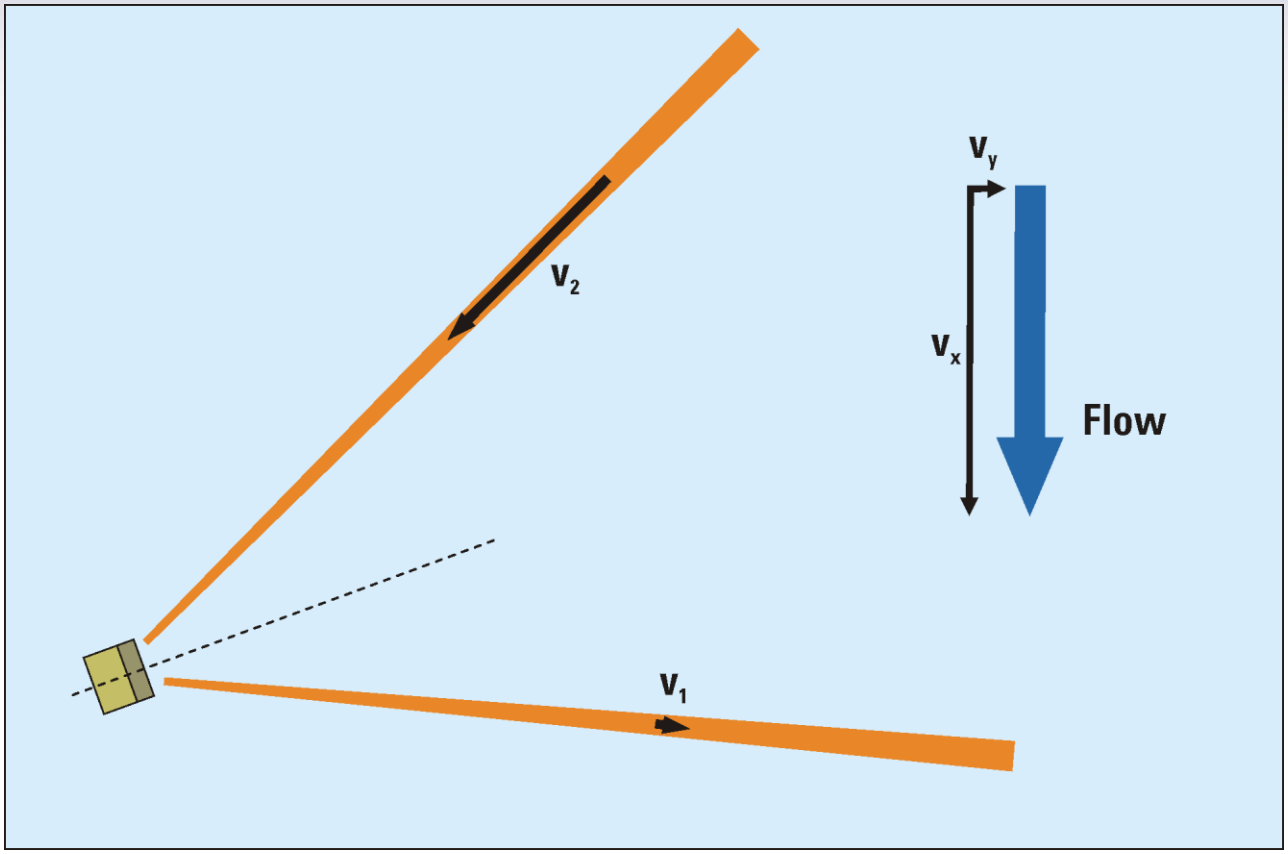
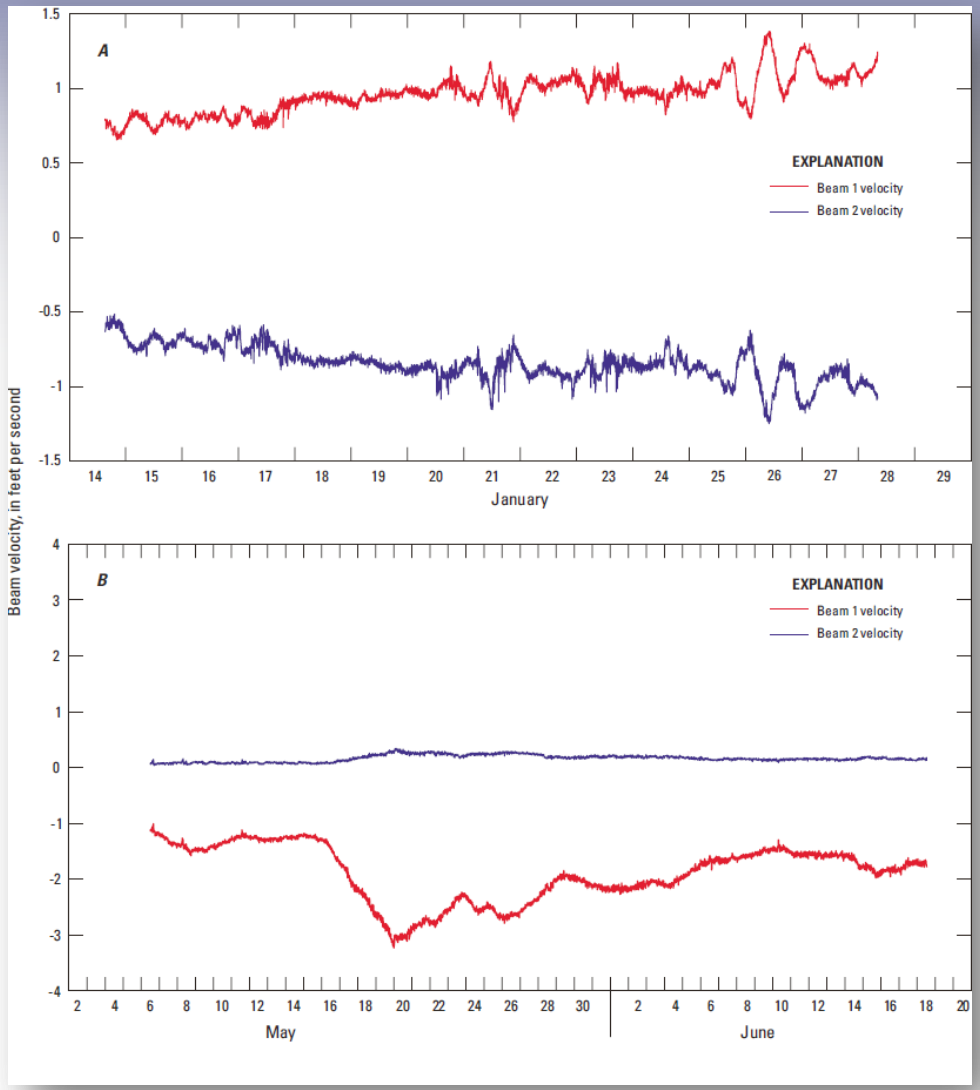
ADVM Alignment



ADVM Alignment

Beam Velocity



Beam Velocity

Properly aligned

Improperly aligned

Date/Time

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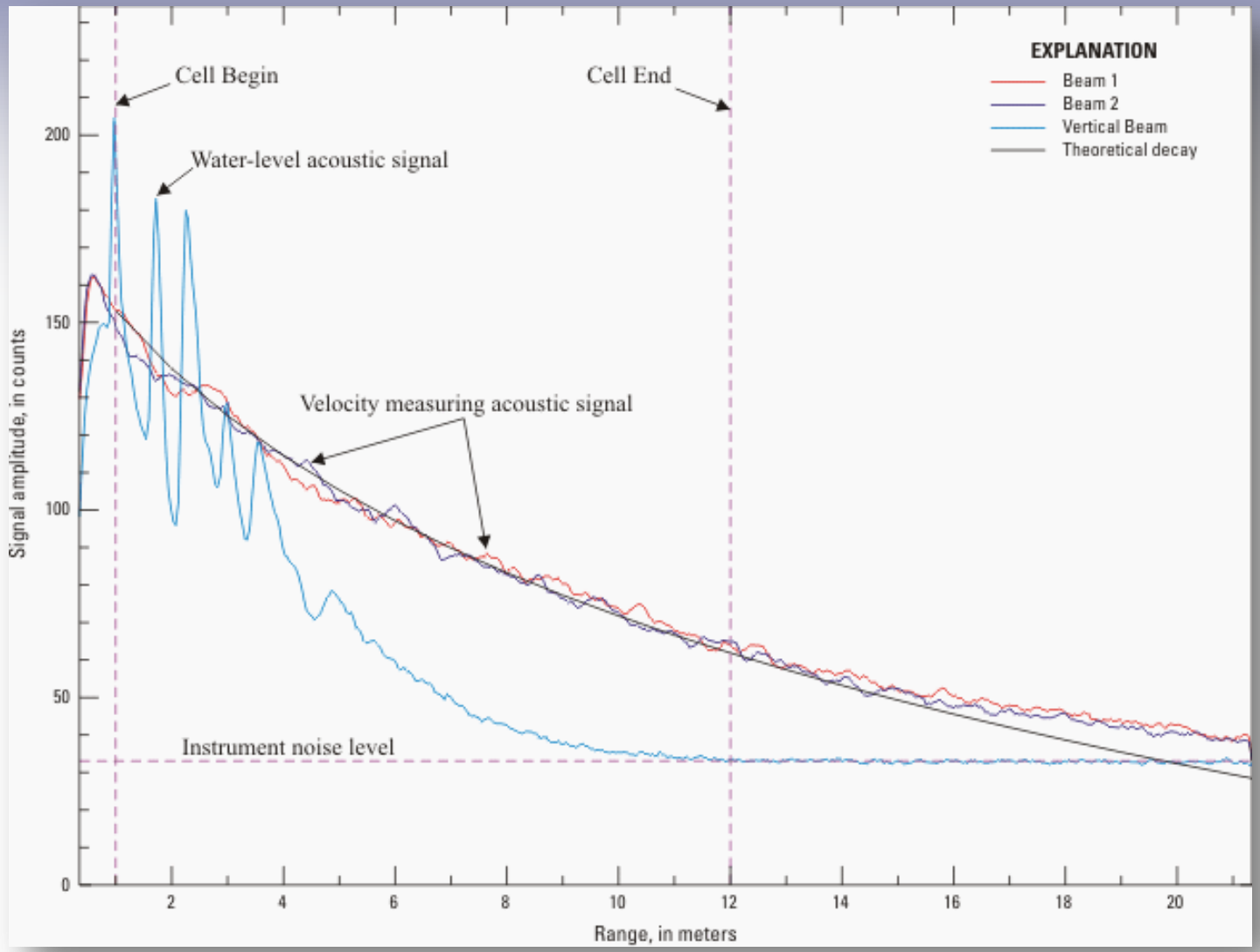
Configuring an ADVM

- **Choosing the best measurement volume**
  - **Signal strength analysis (beam checks)**
  - **Multiple-cell velocity data analysis**

Beam Signal Strength Analysis



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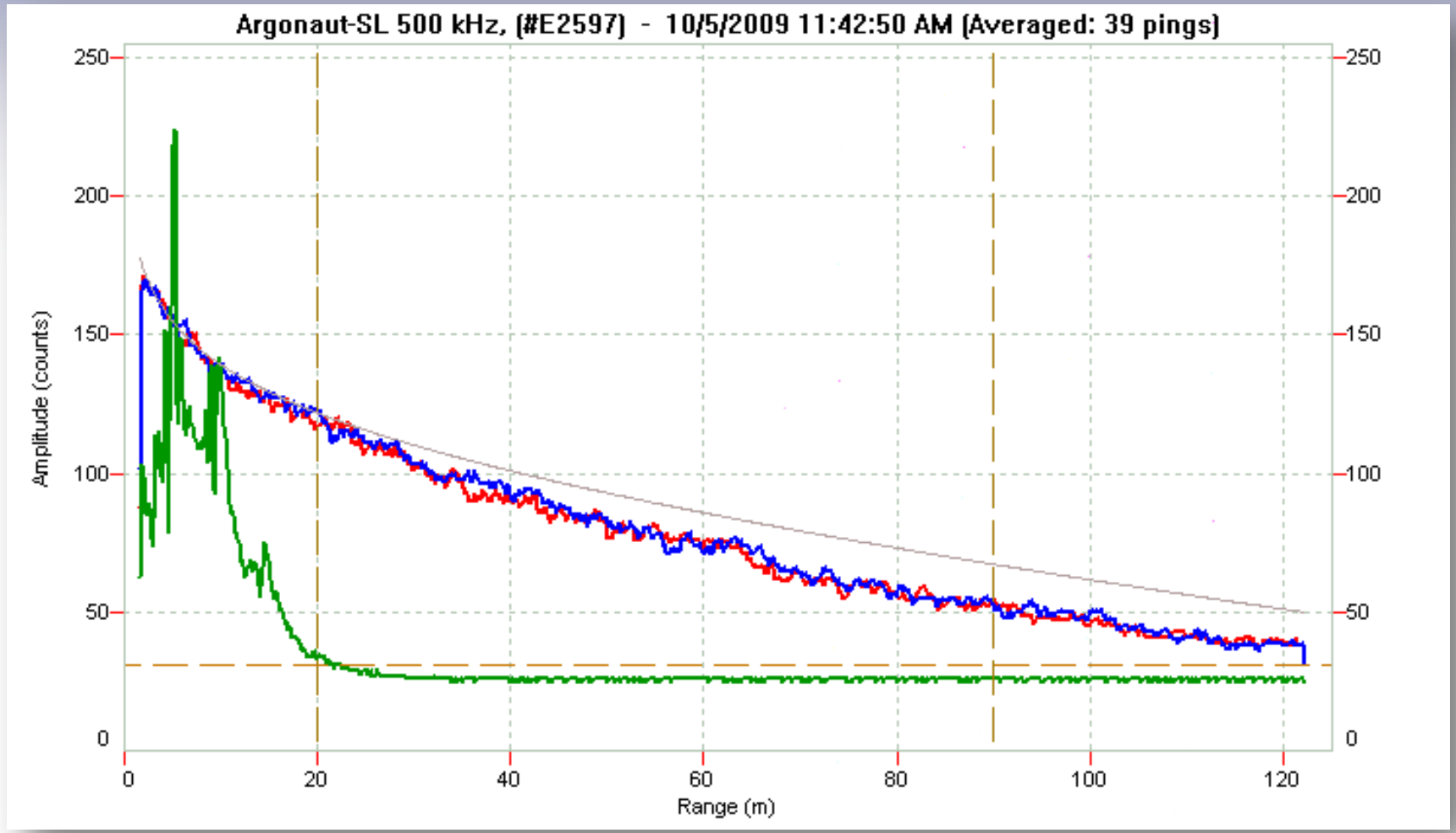
Beam Signal Strength Analysis



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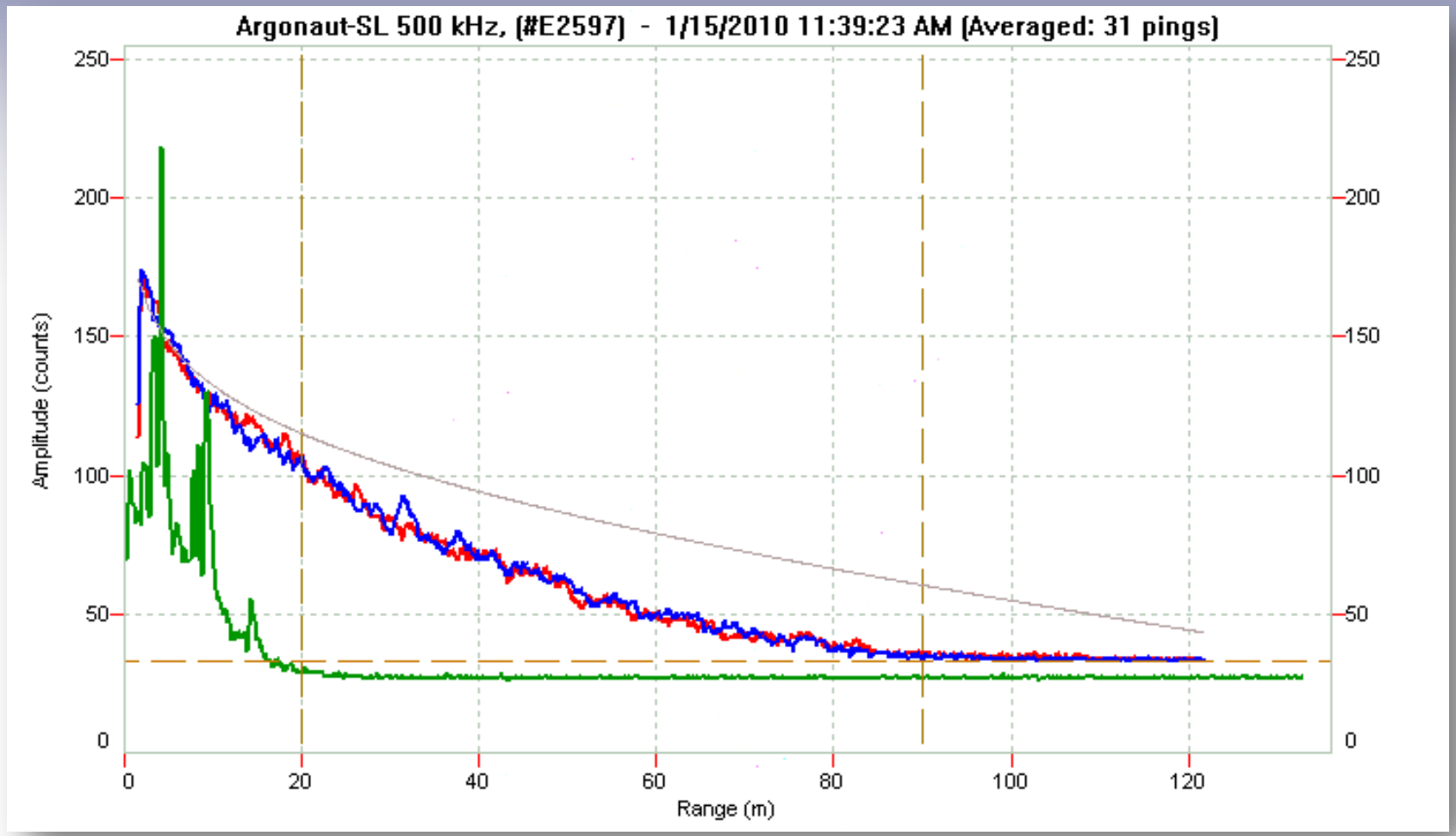
Beam Signal Strength Analysis



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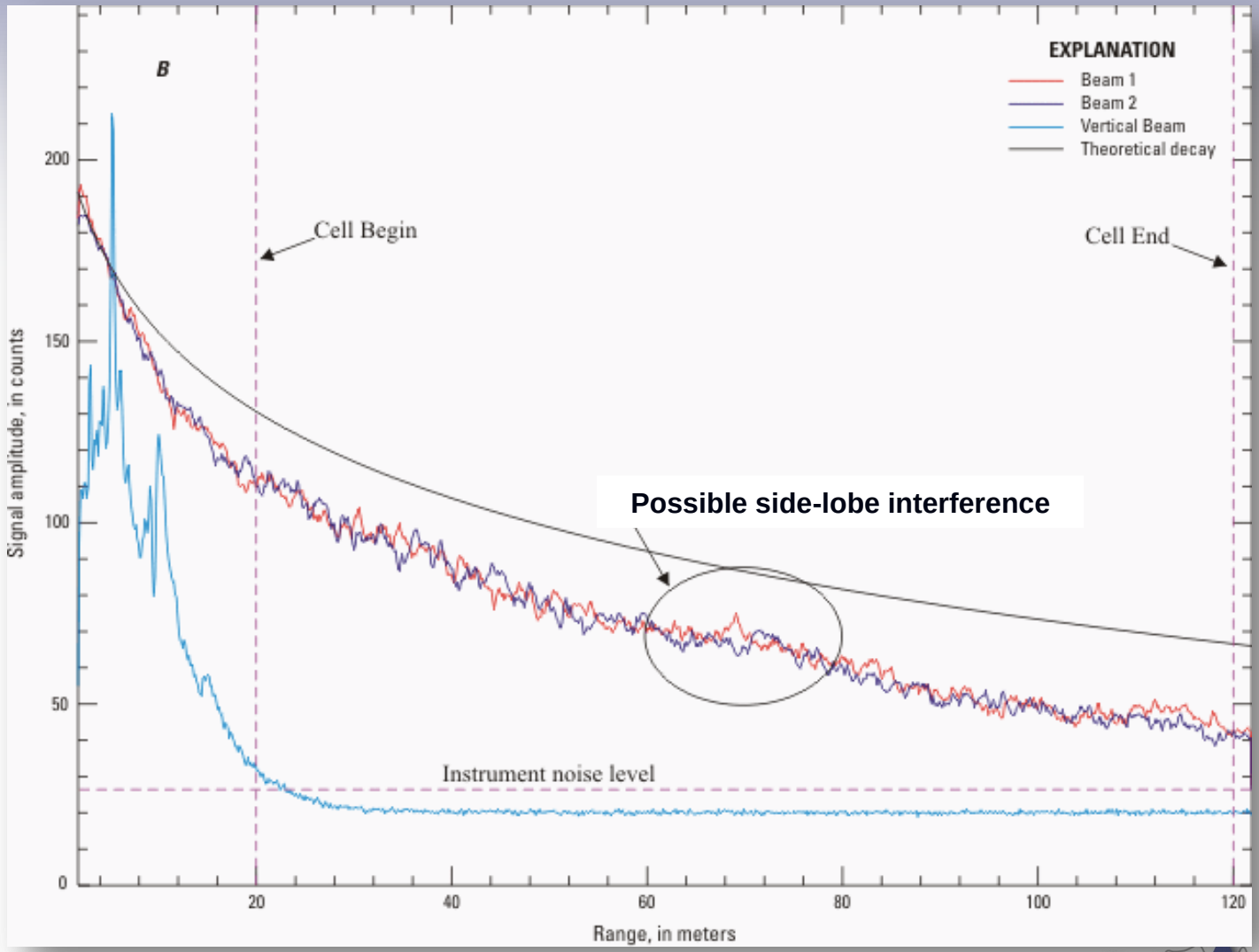
Beam Signal Strength Analysis
(50 pings averaged)



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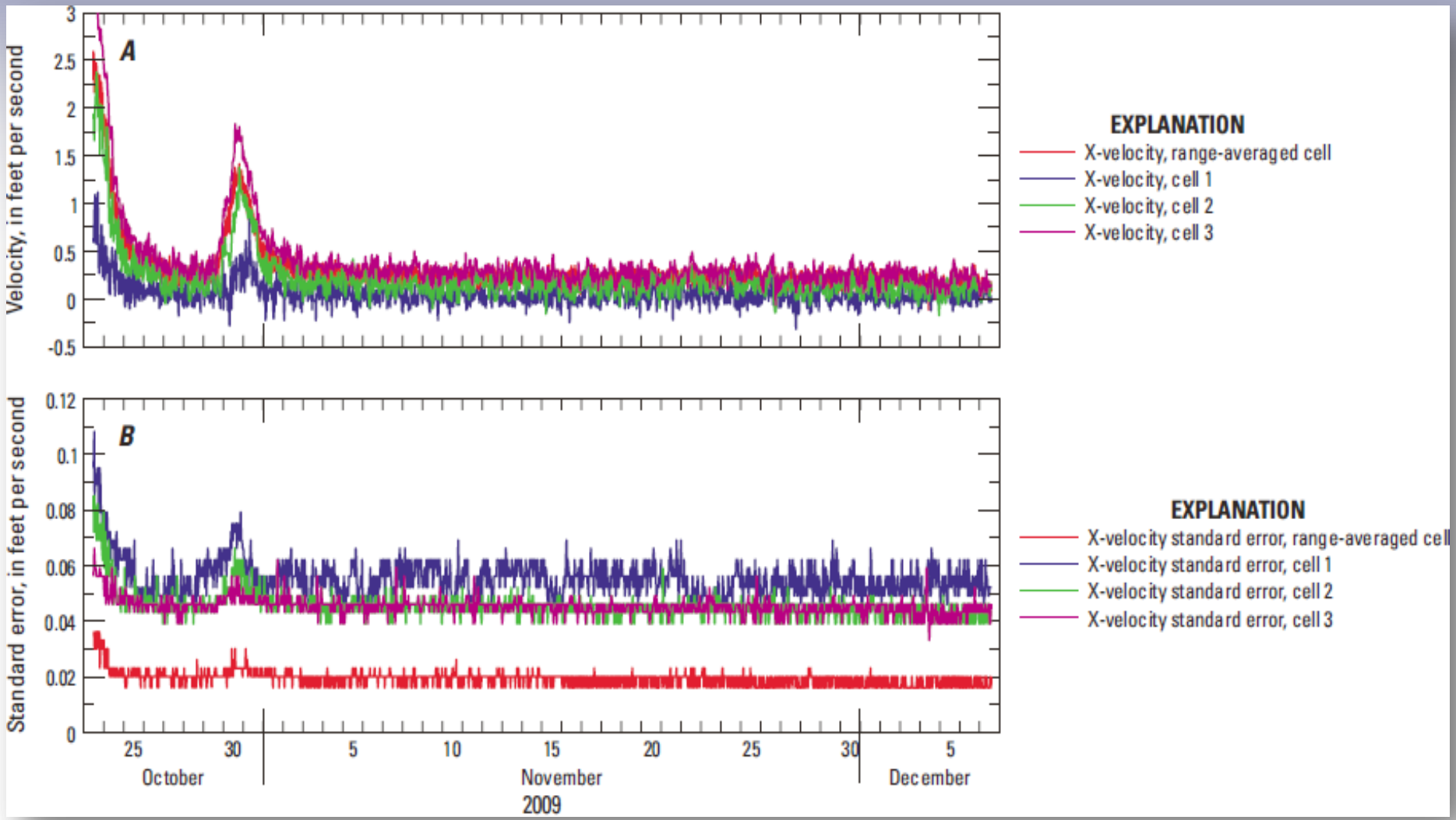
Multiple Cell Velocity Analysis



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Configuring an ADVM

- **Routine measurement interval**
  - **Site dependent**
    - **Start with 5 minute interval (evaluate the data and adjust as necessary)**
    - **Tidal sites can usually use 15-minute interval**
- **Routine averaging period**
  - **Site dependent**
    - **Maximize averaging based on measurement interval Example: 5-minute measurement interval and 4-minute averaging period**

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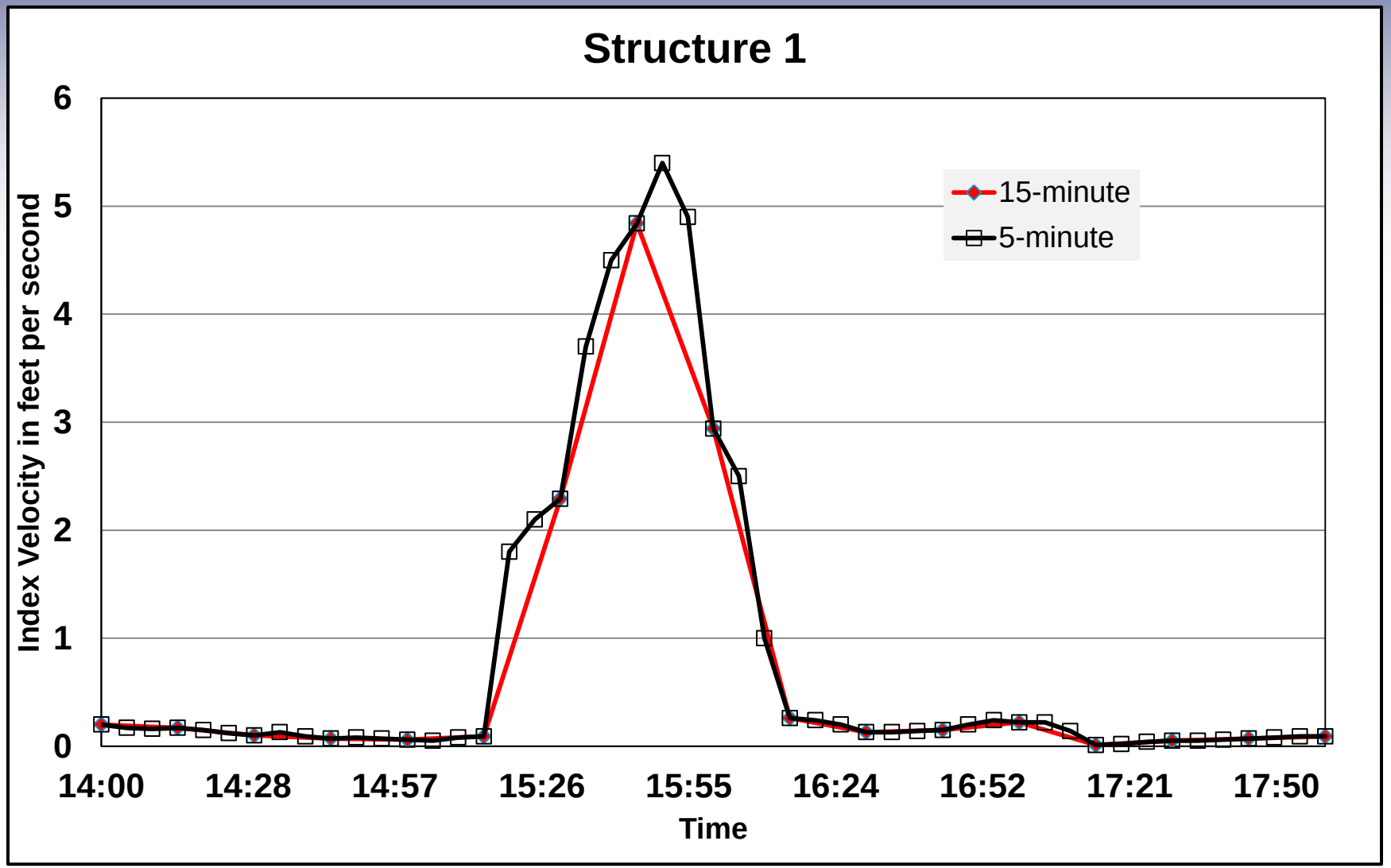
Routine Measurement Interval



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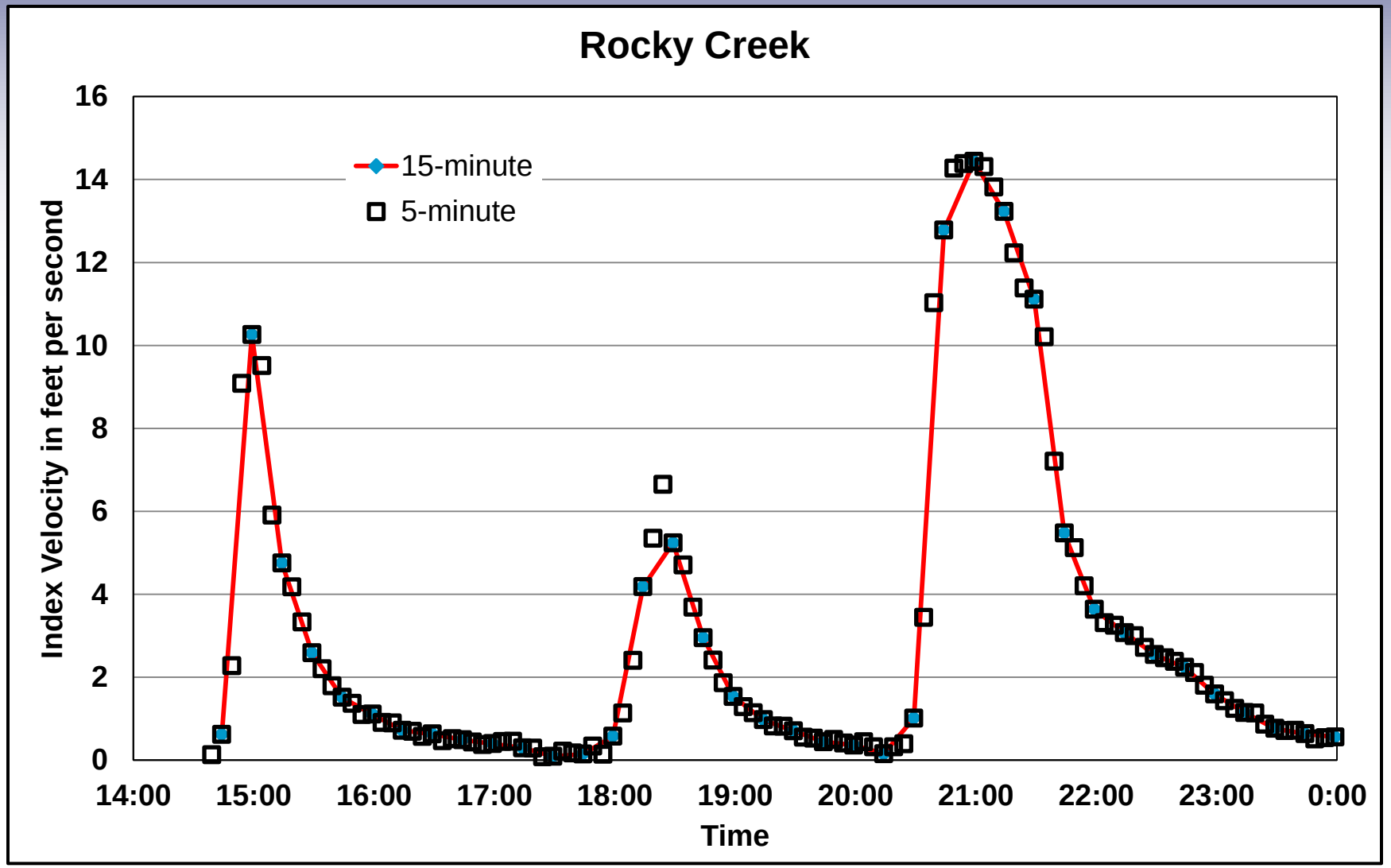
Measurement Interval



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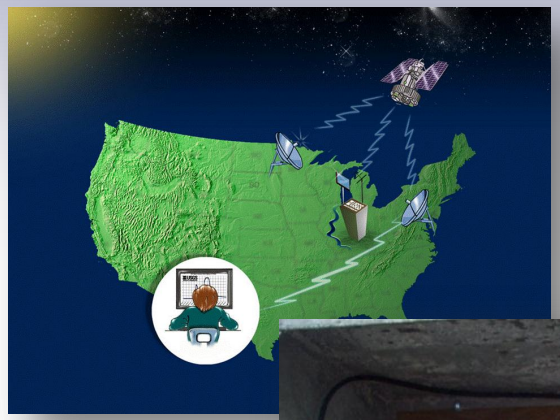
ADVM Data to Transmit to NWIS and Review



- X velocity
- Cell End
- ADVM temperature
- Y velocity
- Average SNR
- Consider transmitting multi-cell data if possible

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Discharge Measurement Procedures

- **Set ADVM Measurement Interval to 60 seconds**
- **Set ADVM Averaging Period to 60 seconds**
- **Record ADVM data internally**

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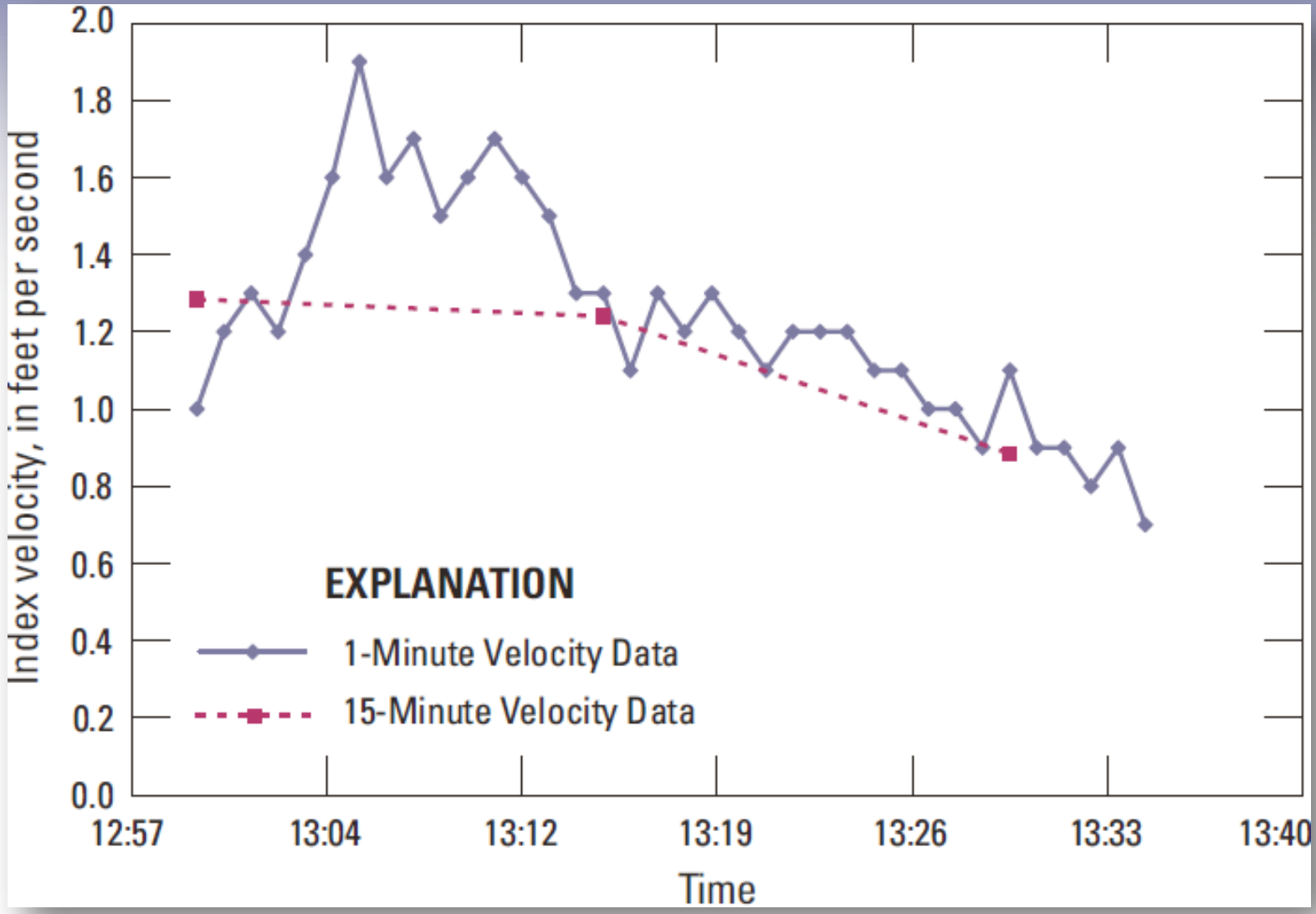
Discharge Measurement Procedures



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Routine Field Procedures

- Recover and review internal ADVM data
- Signal strength check (beam check)
- ADVM internal time check
- ADVM temperature check
- Clean ADVM
- Check alignment
- Record heading, pitch, and roll (if applicable)
- Field forms are provided
  - Installation
  - Routine inspection

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Routine Office Procedures

- **Review ADVM data – both Transmitted and Internally-Recorded Data**
- **Review the following internal recorder data:**
  - **Velocity (range-averaged and multi-cell)**
  - **Temperature**
  - **Cell end**
  - **Signal amplitudes and instrument noise**
  - **Internal diagnostic signal strength checks**
  - **Heading, pitch, and roll**
  - **Velocity standard deviations**

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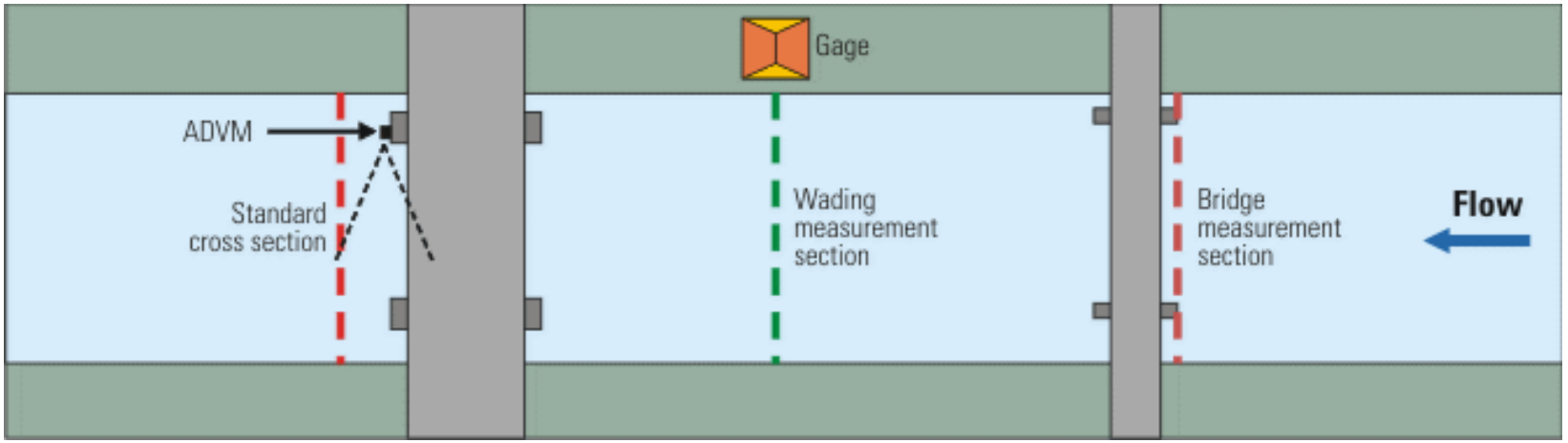
Stage-area Rating

- **Identify and document location of standard cross-section (should also be described in station description) and measuring sections**
- **Identify and document data used for survey**



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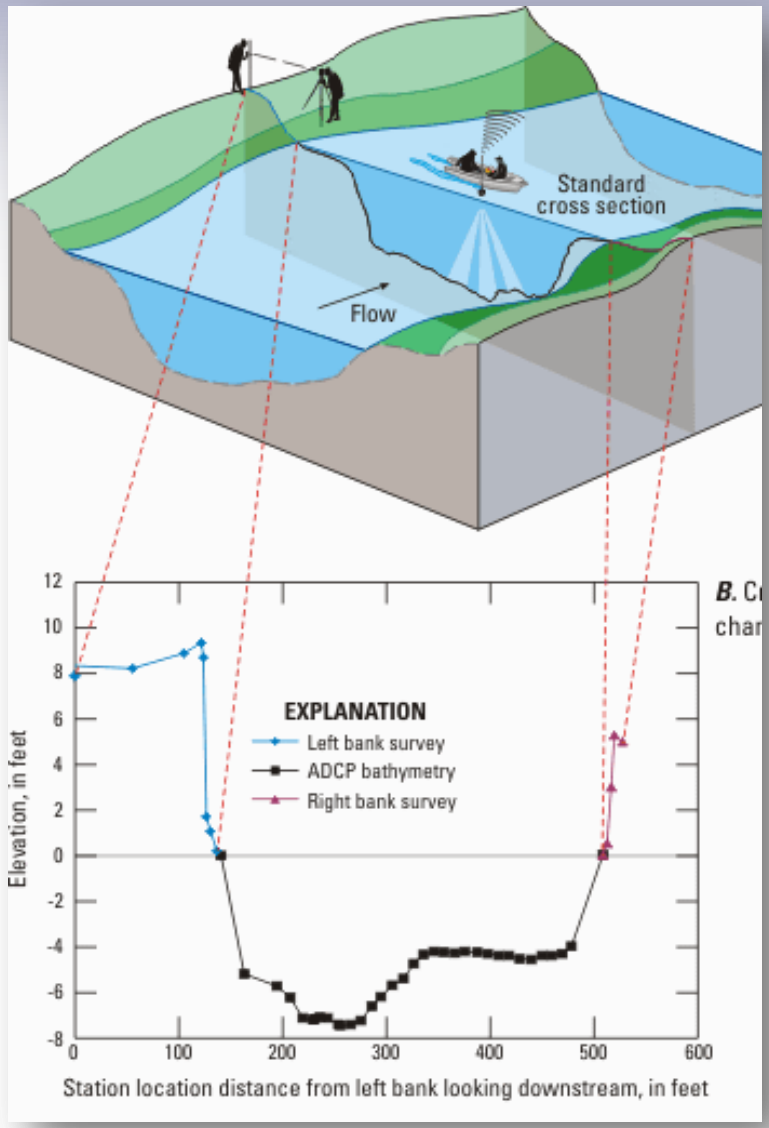
Example of Integrating an ADCP and Conventional Survey



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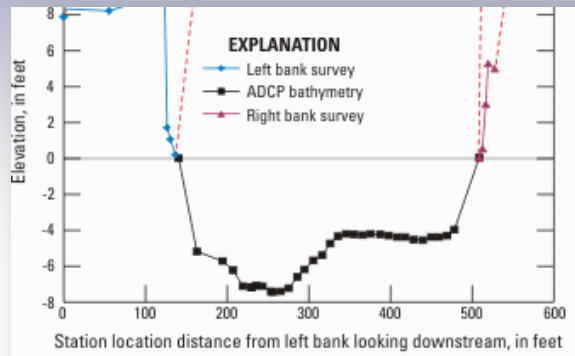

Table 4. Table showing channel bank survey data.

Station (feet)	Elevation (feet above gage datum)	Comment
		Left bank survey
0	0.00	Left edge of water (water surface)
4	0.20	
10	1.06	
14	1.71	
17	8.70	
19	9.33	
36	8.88	
85	8.21	
141	8.33	End of left bank survey
		Right bank survey
0	0.00	Right edge of water (water surface)
13	0.54	
17	3.01	
20	5.29	
28	5.00	Land surface extends nearly horizontal into forested wetland as far as you can see

Table 5. Table showing simp

Station (feet)	Elevation (feet above gage datum)	
141	0.00	R
163	-5.20	
195	-5.73	
208	-6.24	
220	-7.13	
230	-7.21	
231	-7.17	
236	-7.10	
244	-7.13	
254	-7.42	
256	-7.46	
266	-7.42	
276	-7.25	
286	-6.61	
295	-6.20	
306	-5.70	
317	-5.40	
327	-4.75	
336	-4.35	
346	-4.21	
356	-4.25	
366	-4.28	
376	-4.21	
388	-4.25	
398	-4.31	
409	-4.39	
419	-4.39	
429	-4.54	
440	-4.57	
450	-4.39	
460	-4.39	
470	-4.31	
479	-3.98	
509	0.00	

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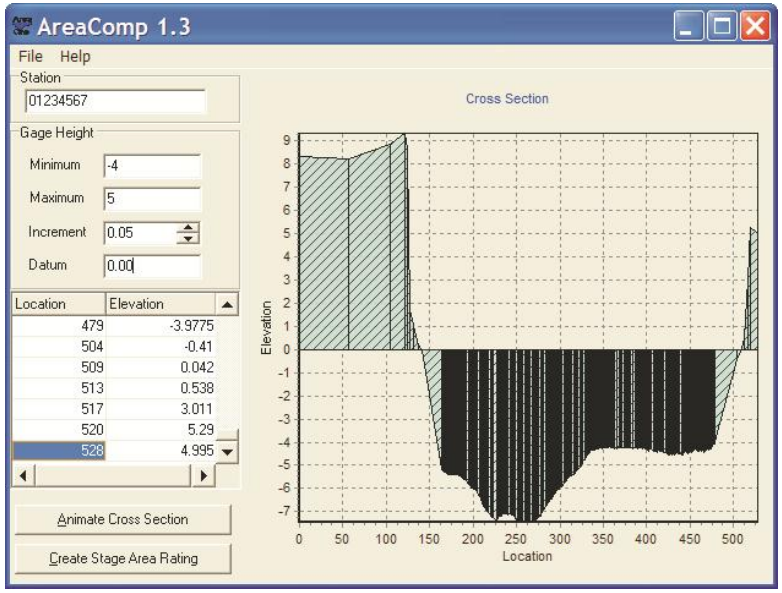
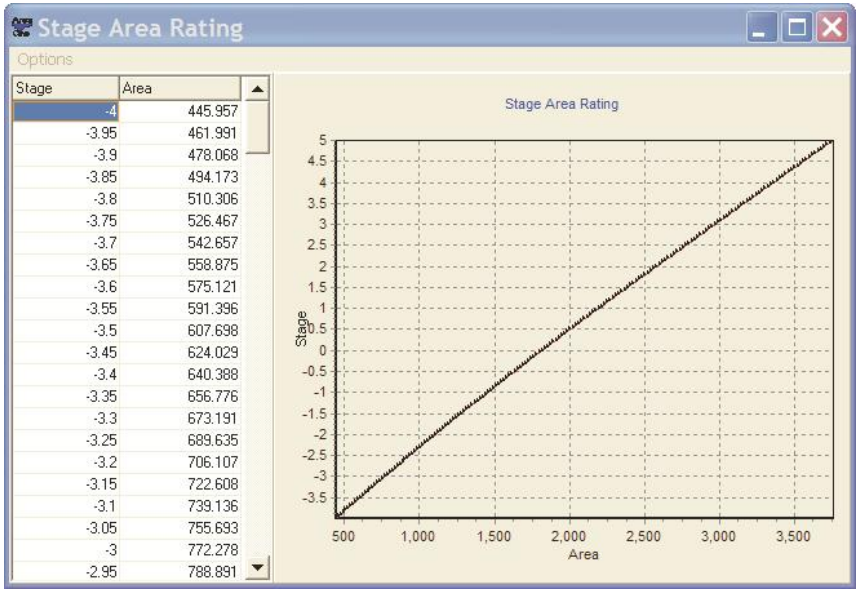
Stage-area Rating

- **Use AreaComp to compute the stage-area rating**
- **Archive all related data**





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Stage-area Rating Verification

- Re-survey every year for first three years
  - If S-A rating is stable – then every 3 years
  - If there is change – then ???????
- Re-survey if index rating shows outlier
- Re-survey after flow event

- Guidance provided for when stage-area rating changes should be made

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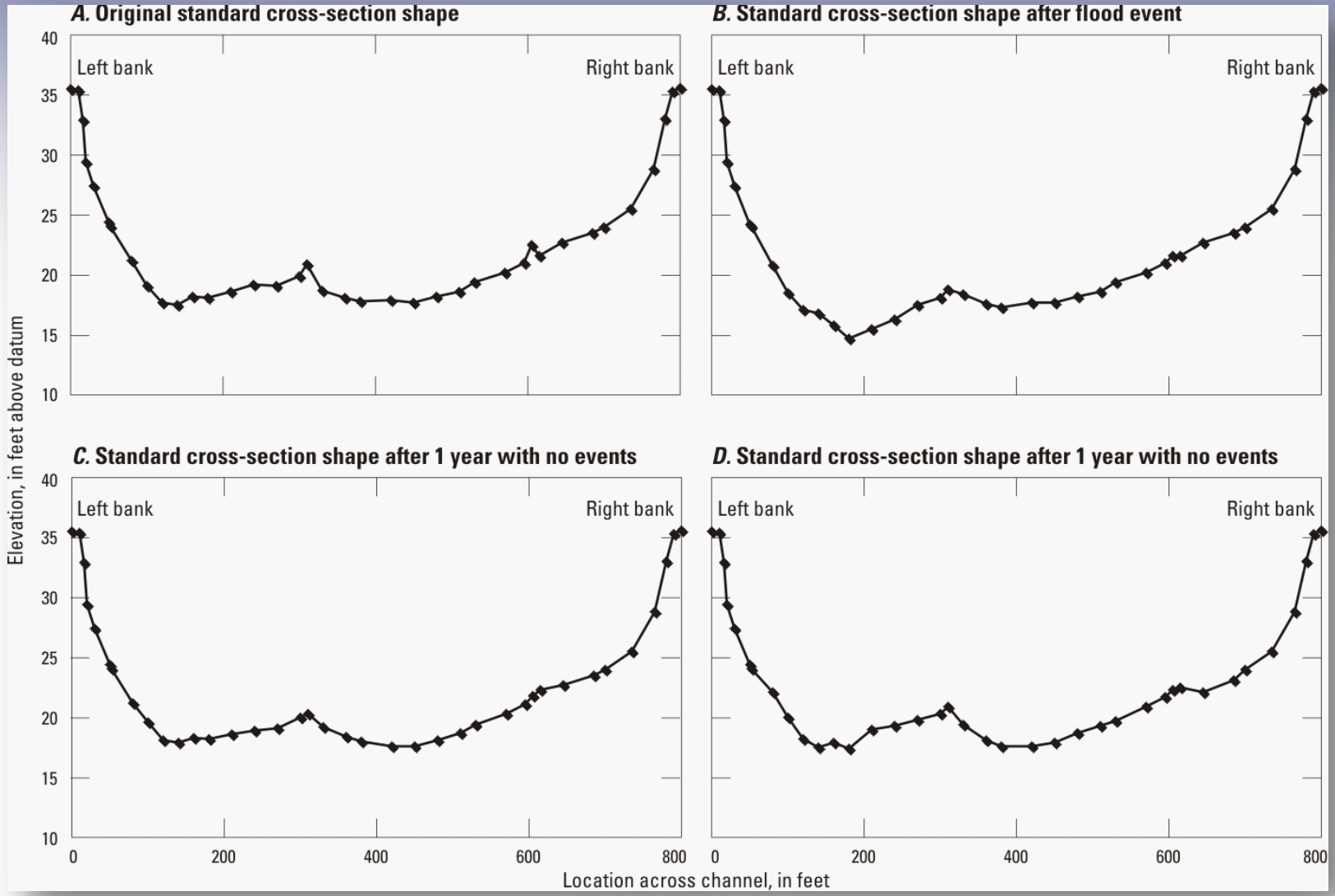
Evaluating Cross-section Change



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Stage-area Rating Verification

		Original Stage-area Rating[1] A	Stage-area rating[2], Example B		Stage-area rating[3], Example C		Stage-area rating[3], Example D	
Statistic	Stage (ft)	Rated Area (ft^2)	Rated Area (ft^2)	Percent Difference from (A)	Rated Area (ft^2)	Percent Difference from (A)	Rated Area (ft^2)	Percent Difference from (A)
Minimum	22.15	1,760	2,290	30	1,730	-1.7	1,620	-8.0
Maximum	31.98	8,640	9,170	6.1	8,610	-0.4	8,510	-1.5
Mean	25.42	3,830	4,360	14	3,790	-1.0	3,690	-3.6

[1]Original stage-area rating
[2]After flood event
[3]After 1 year and no flood events

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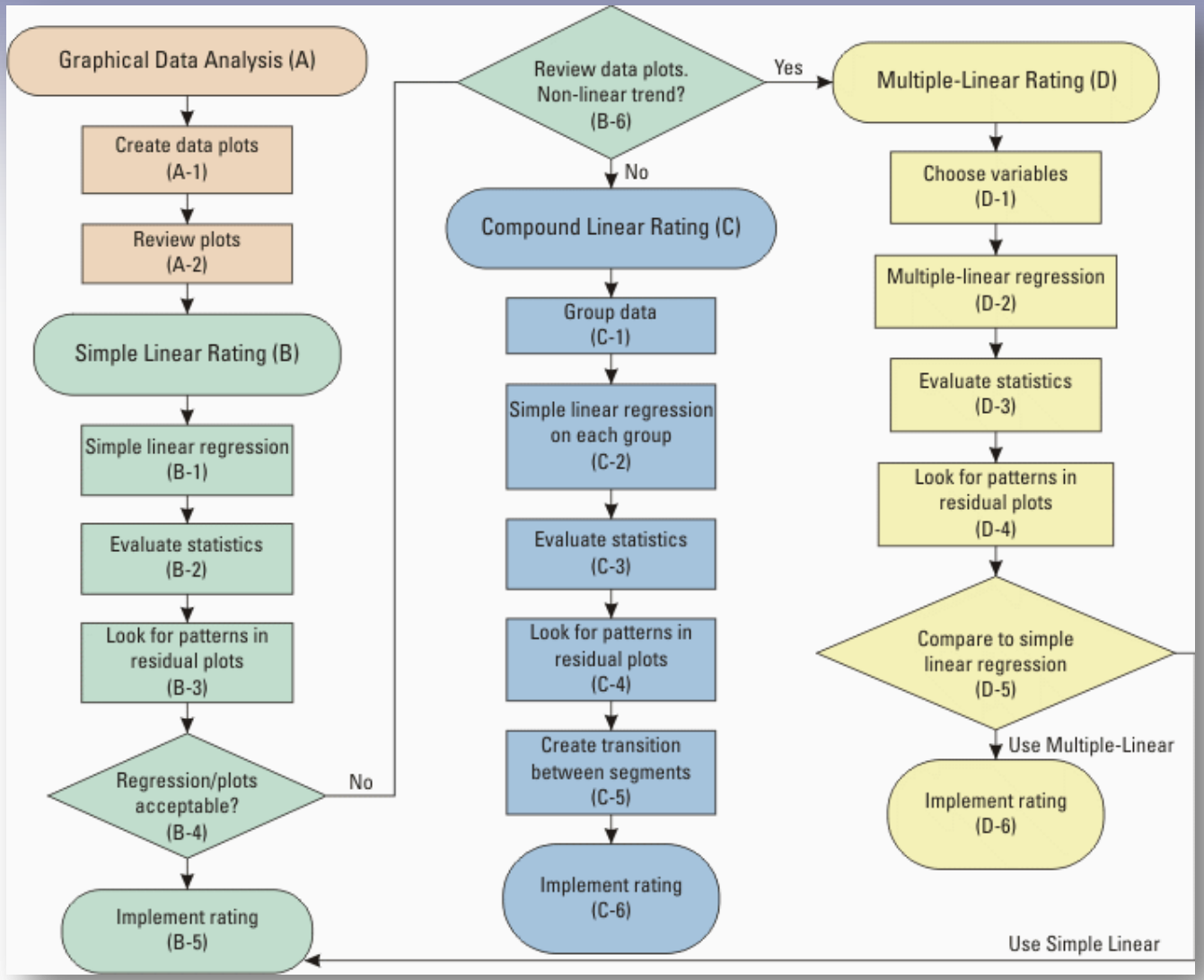
Flowchart for Rating Development



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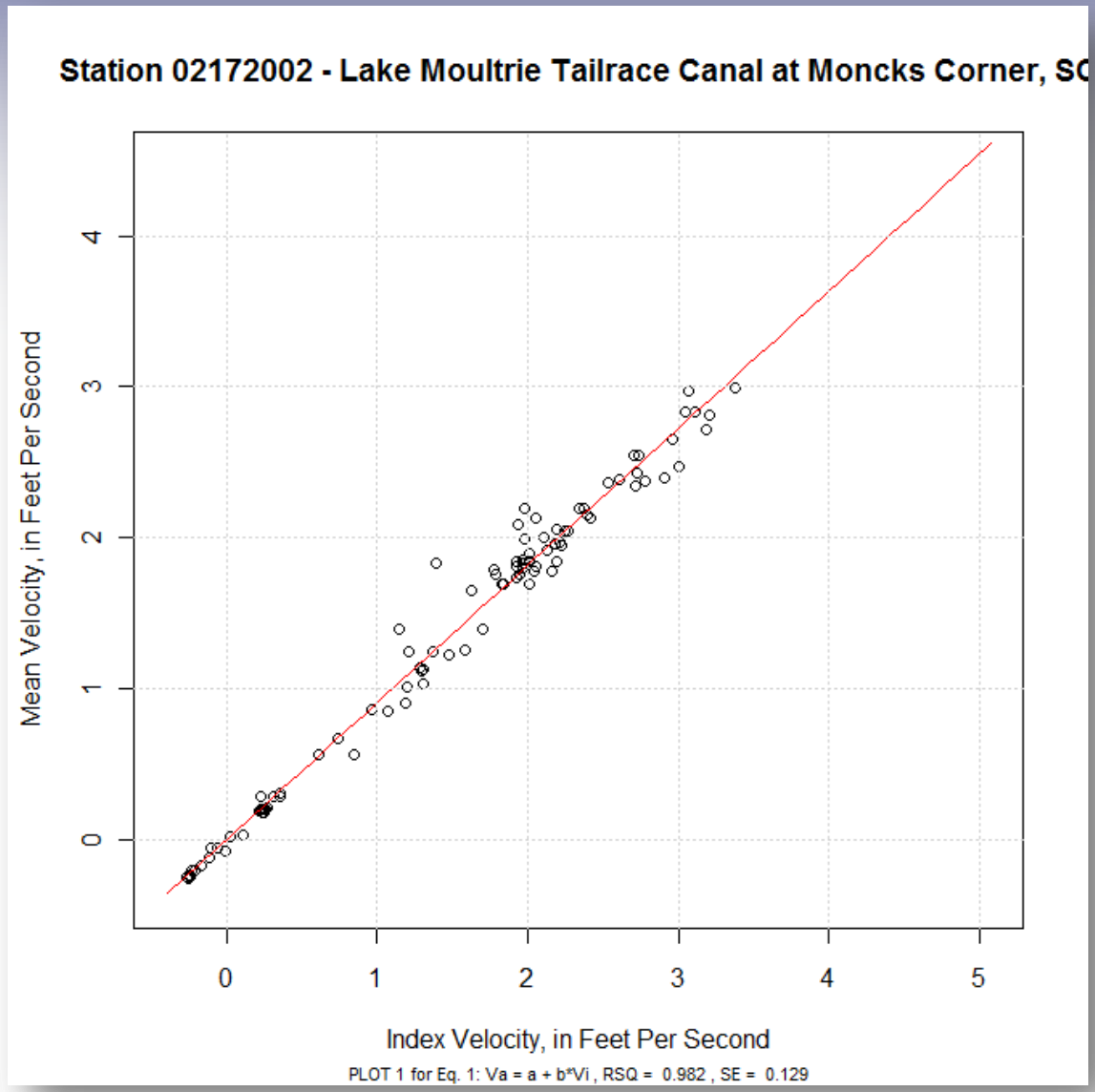
Simple Linear Regression



- **Use as the base line for comparing other regression alternatives**

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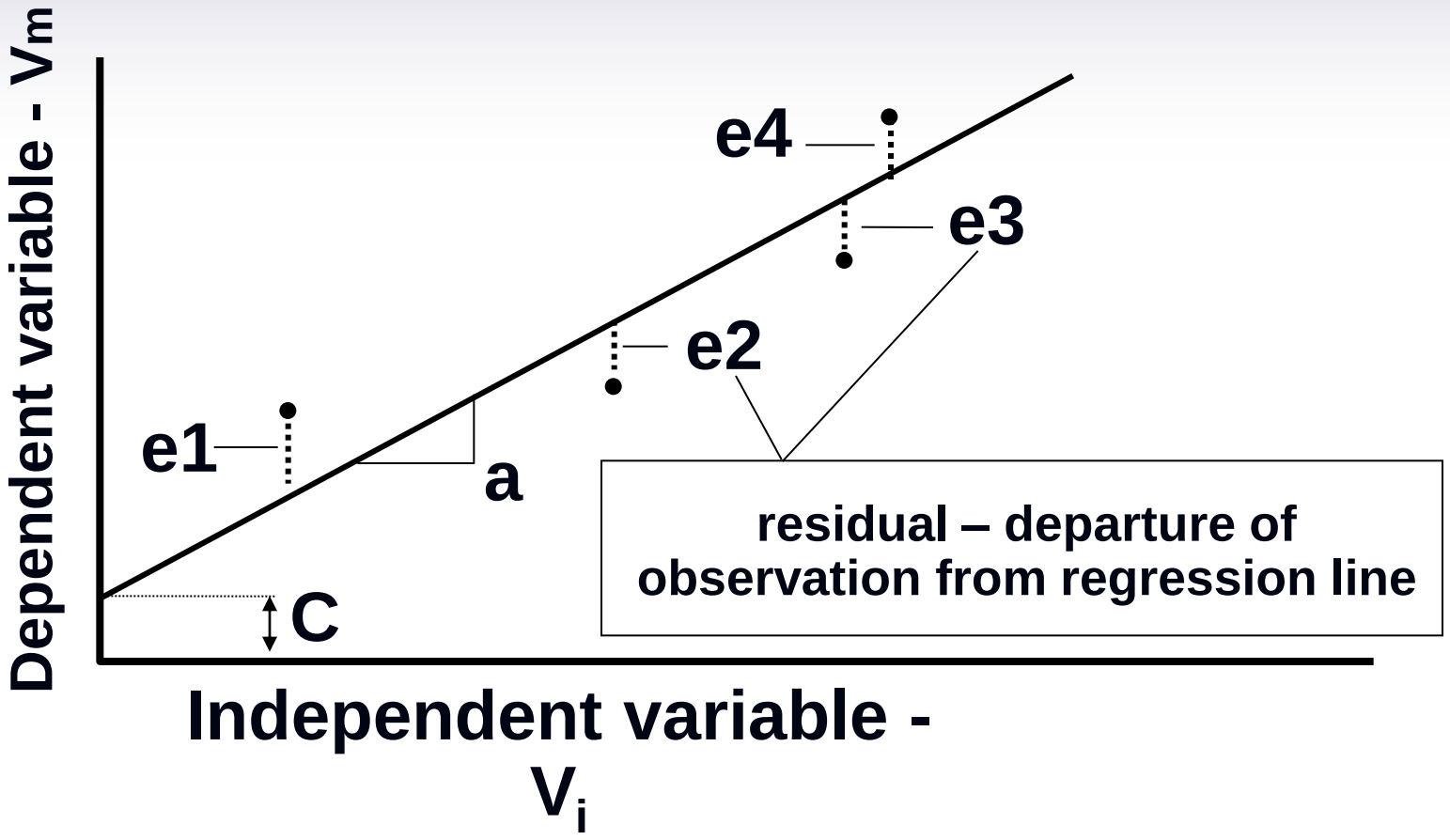
Evaluate Residuals
Righhhht…What are Residuals?



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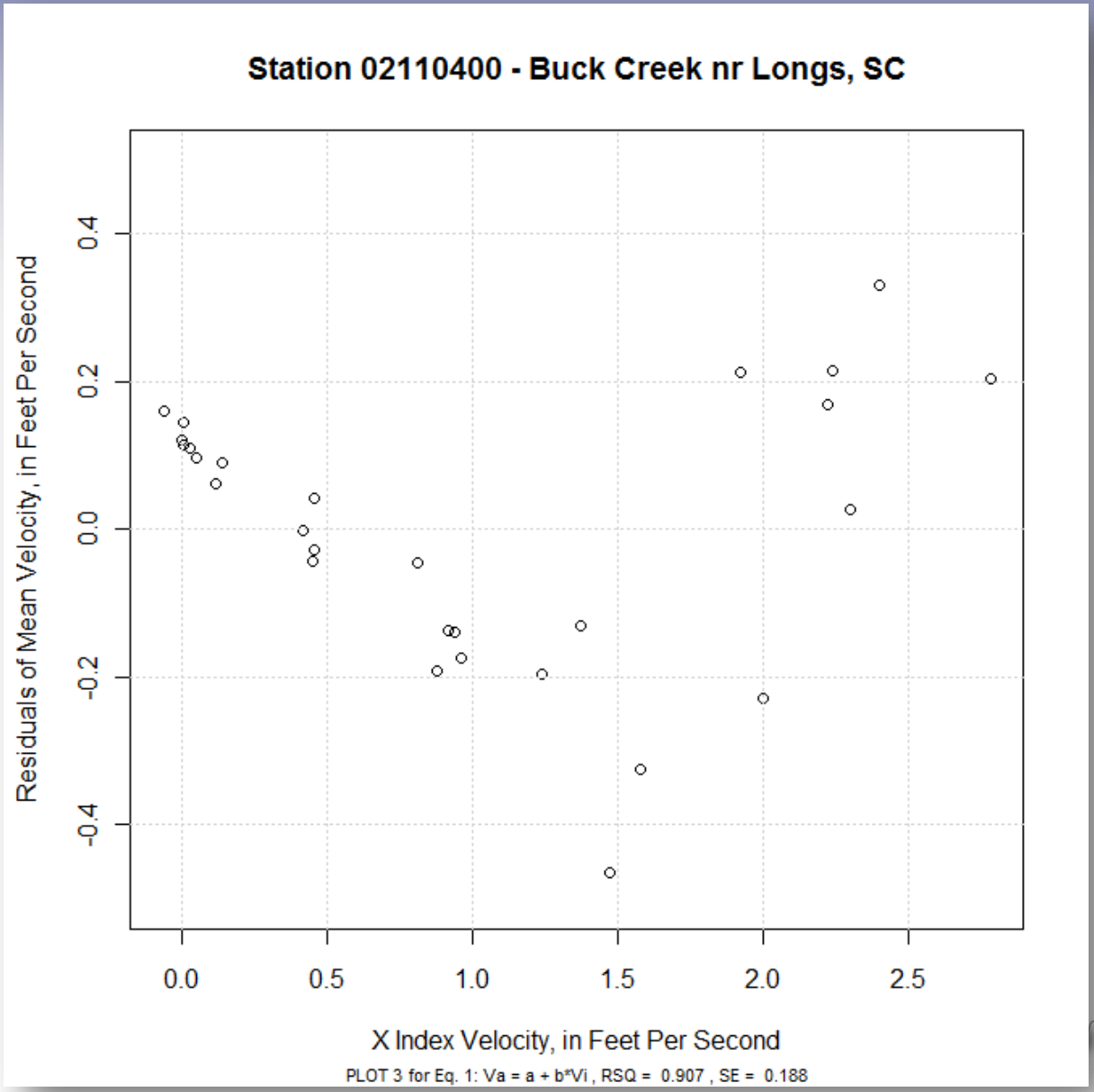
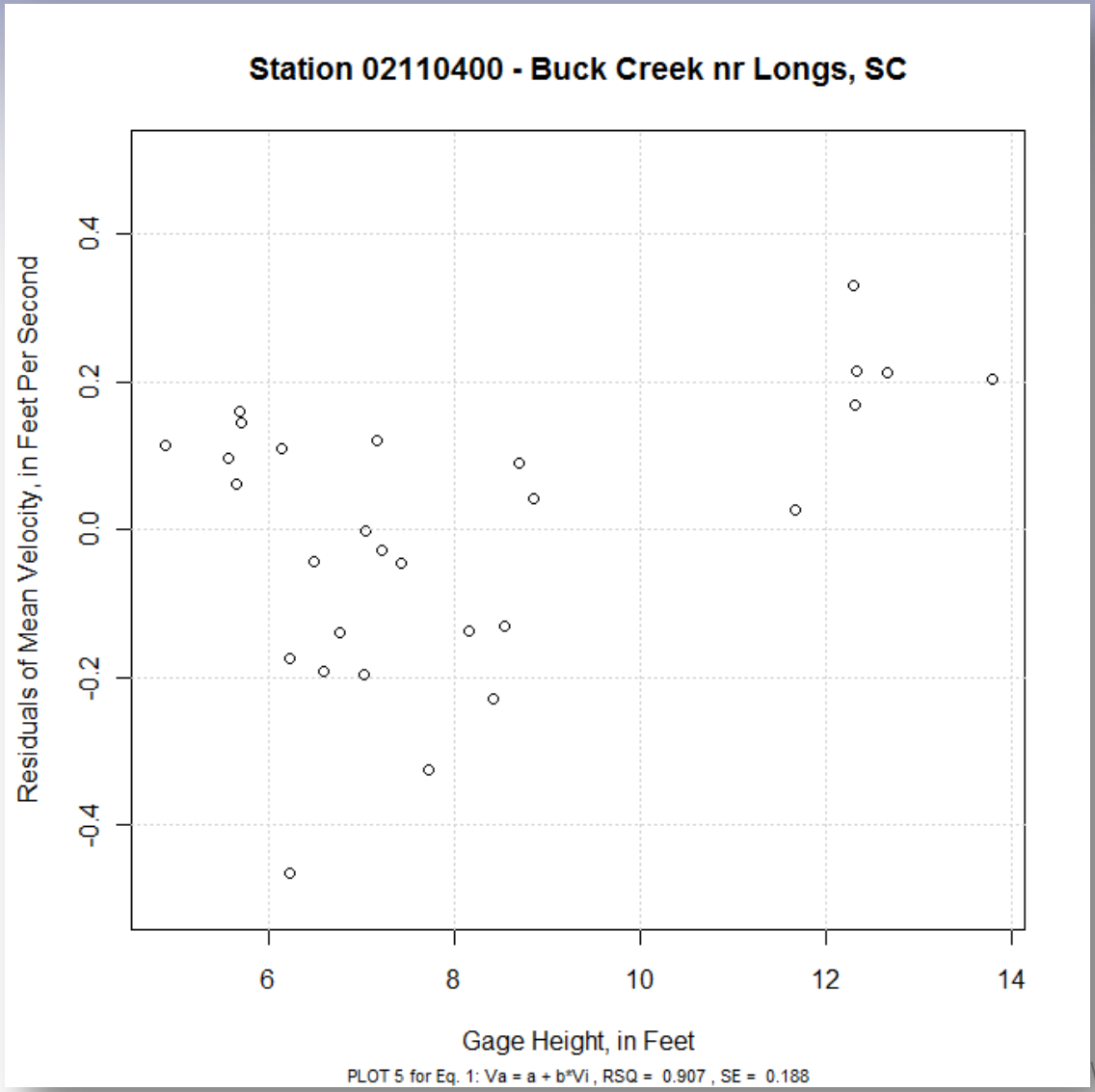
Residuals versus Index Velocity



Residuals versus Gage Height



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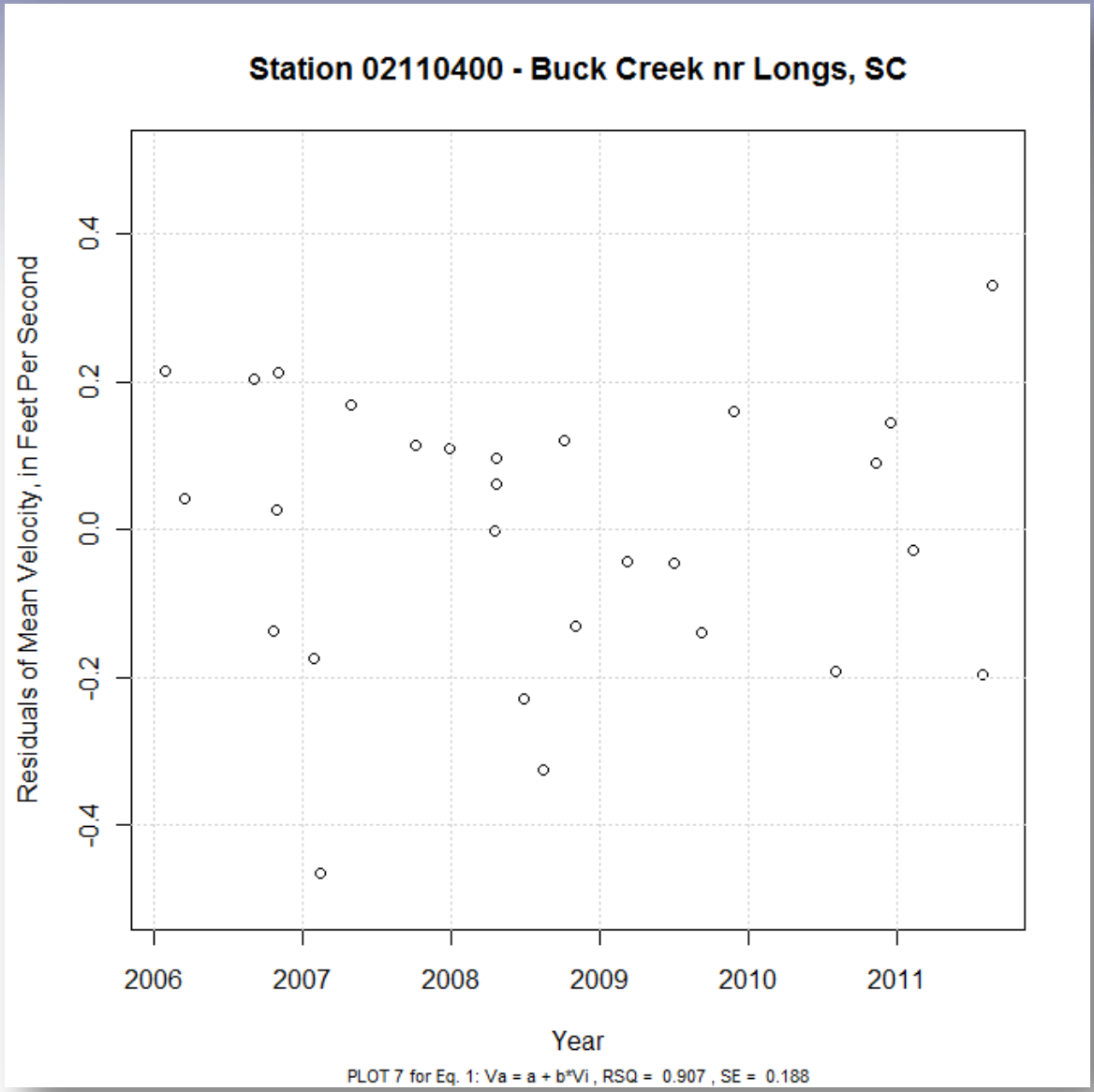
Residuals versus Time



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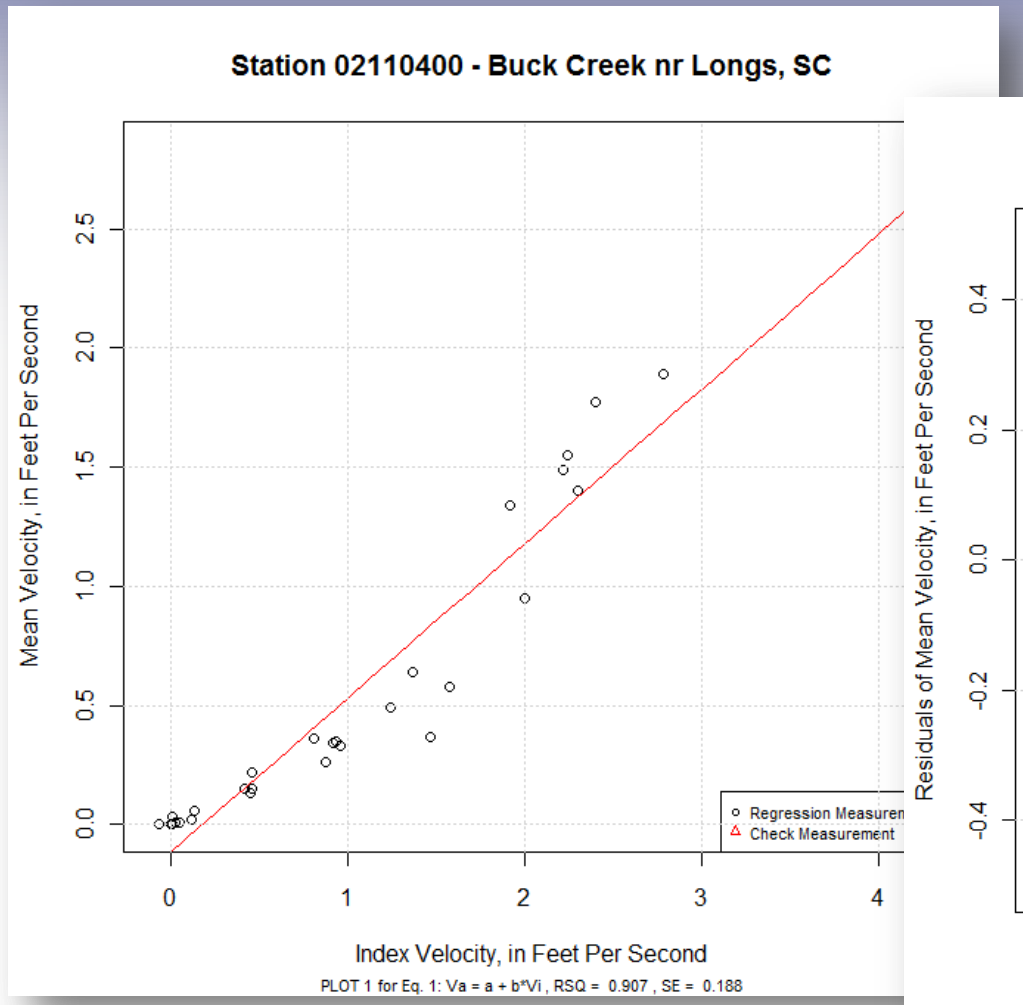
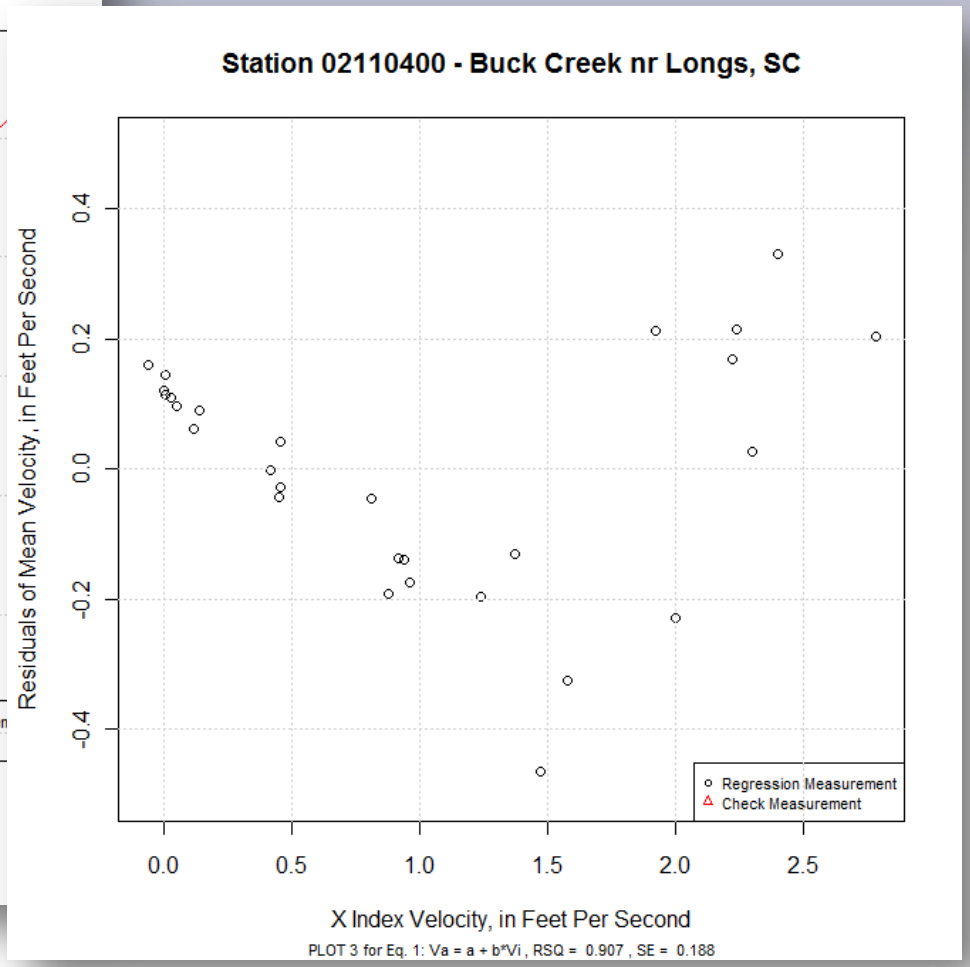
Does data indicate changes in slope?





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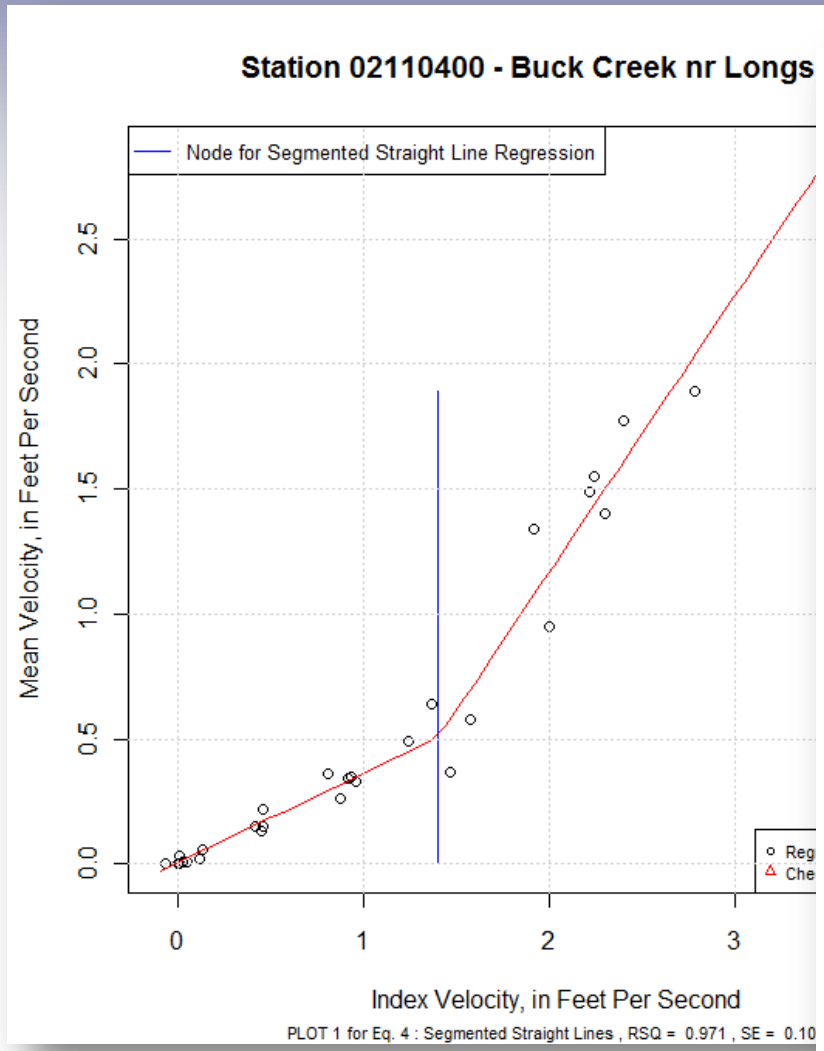
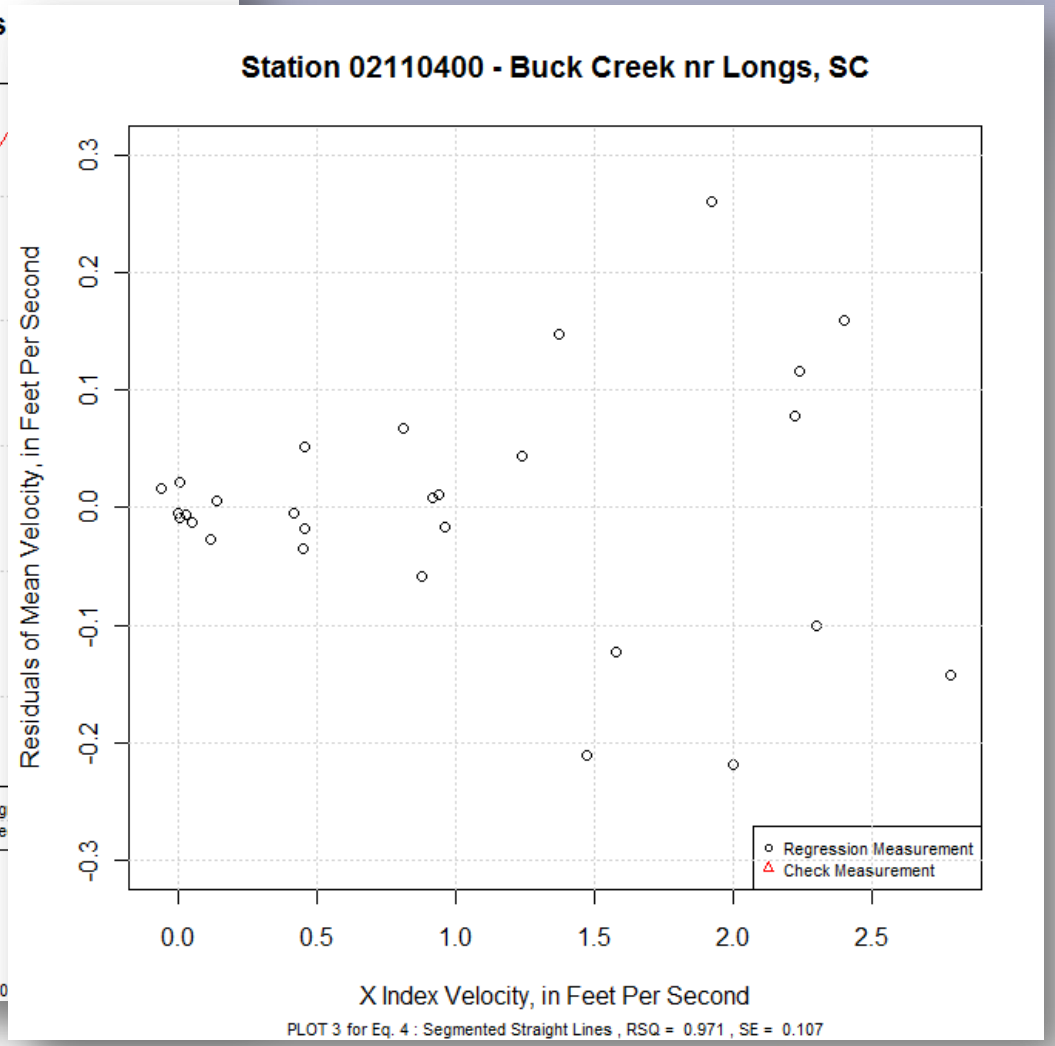
Compound Linear Ratings





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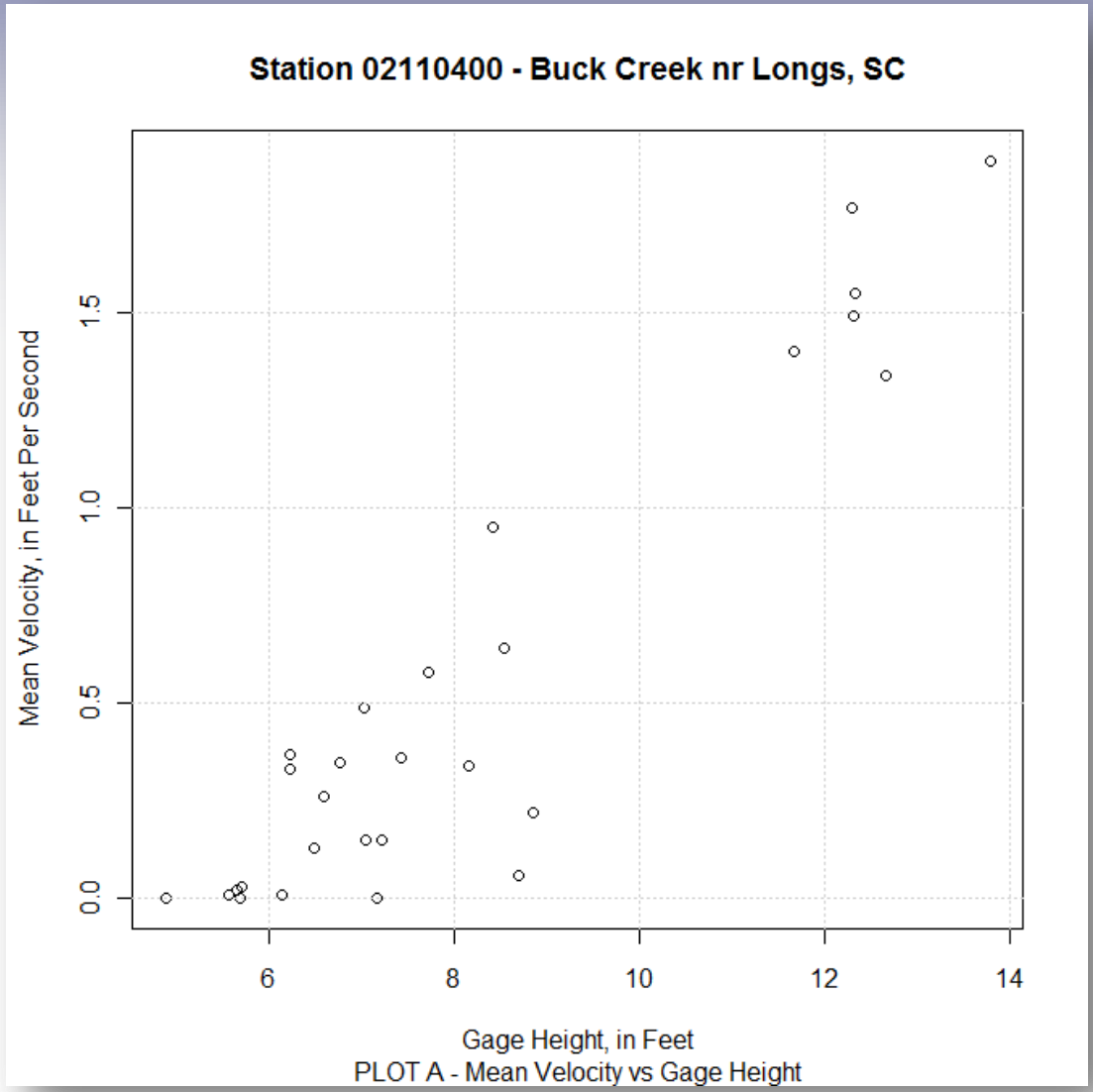
Should Stage Be a Variable?



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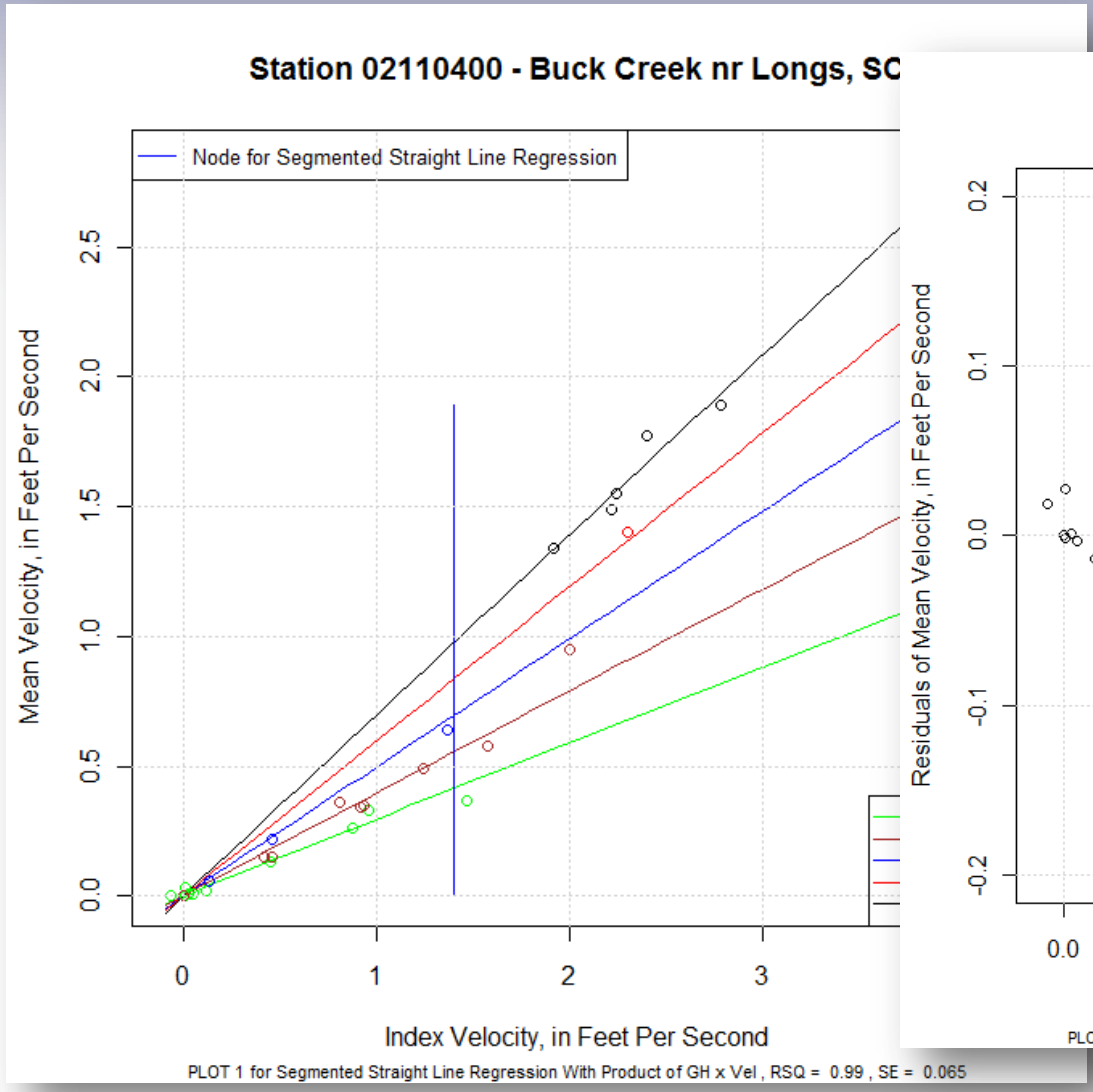
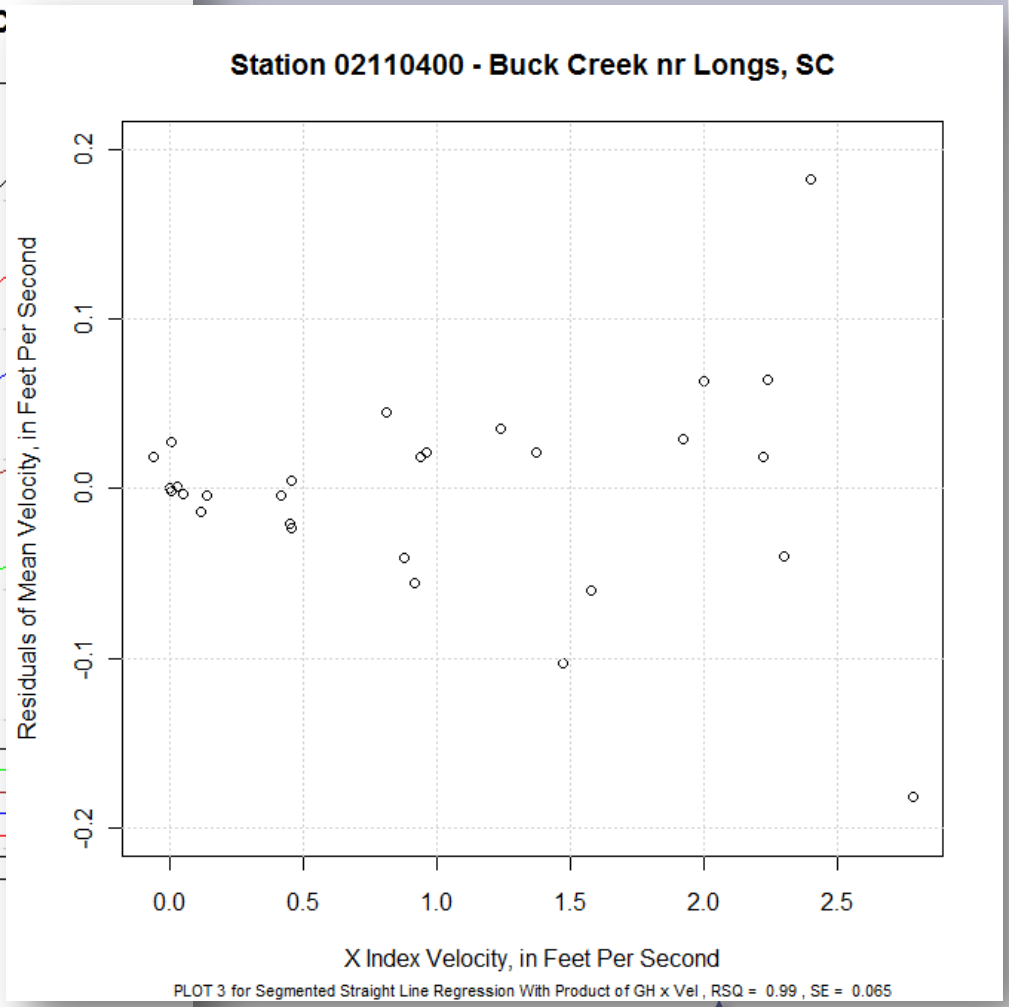
Should Stage Be a Variable?





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Index Rating Development Summary

- **Plot index velocity and mean velocity**

  (use as a baseline to compare other rating forms)

  - **Evaluate residuals plots versus**
    - **Index Velocity**
    - **Stage**
    - **Time or measurement number**
  - **Evaluate R^2, Standard Error (SE), number of observations, and p-values**
- **Evaluate separating the data into regions**
- **Evaluate including gage height as a variable**
  - **Typically use (gage height × index velocity)**

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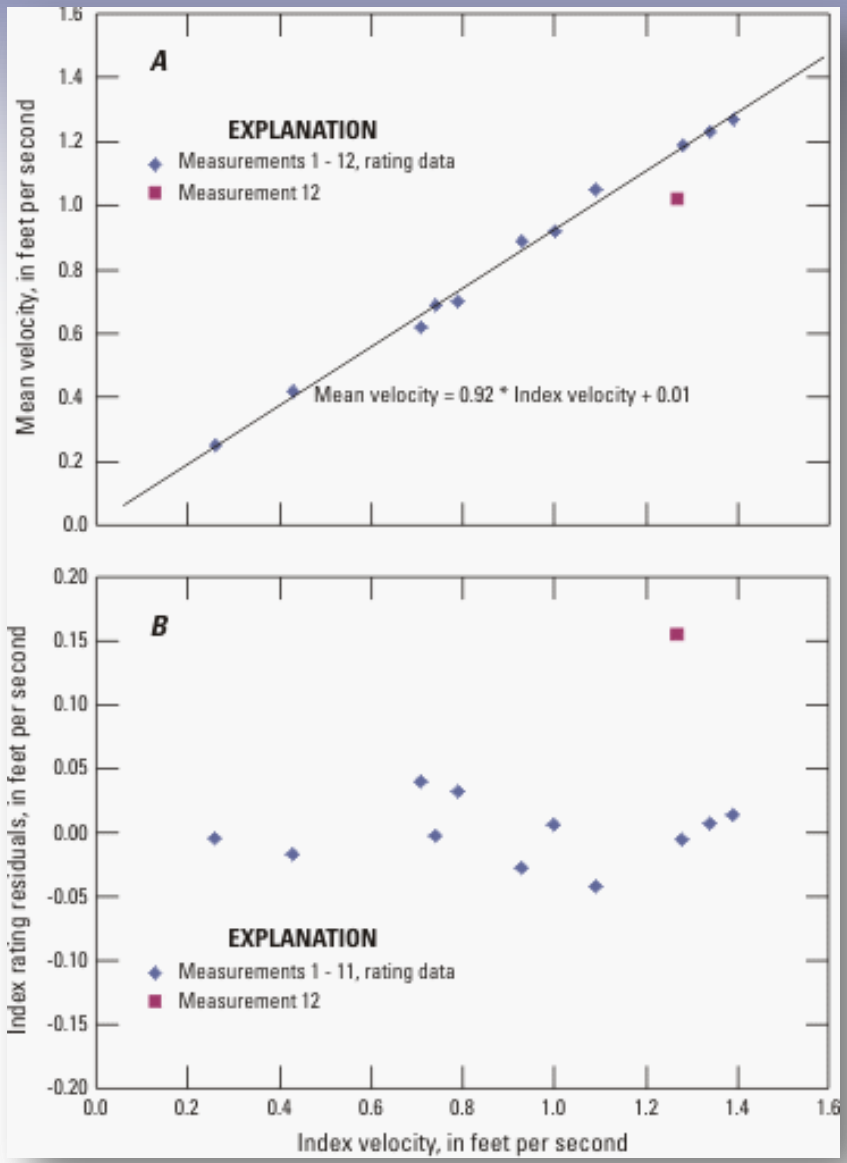
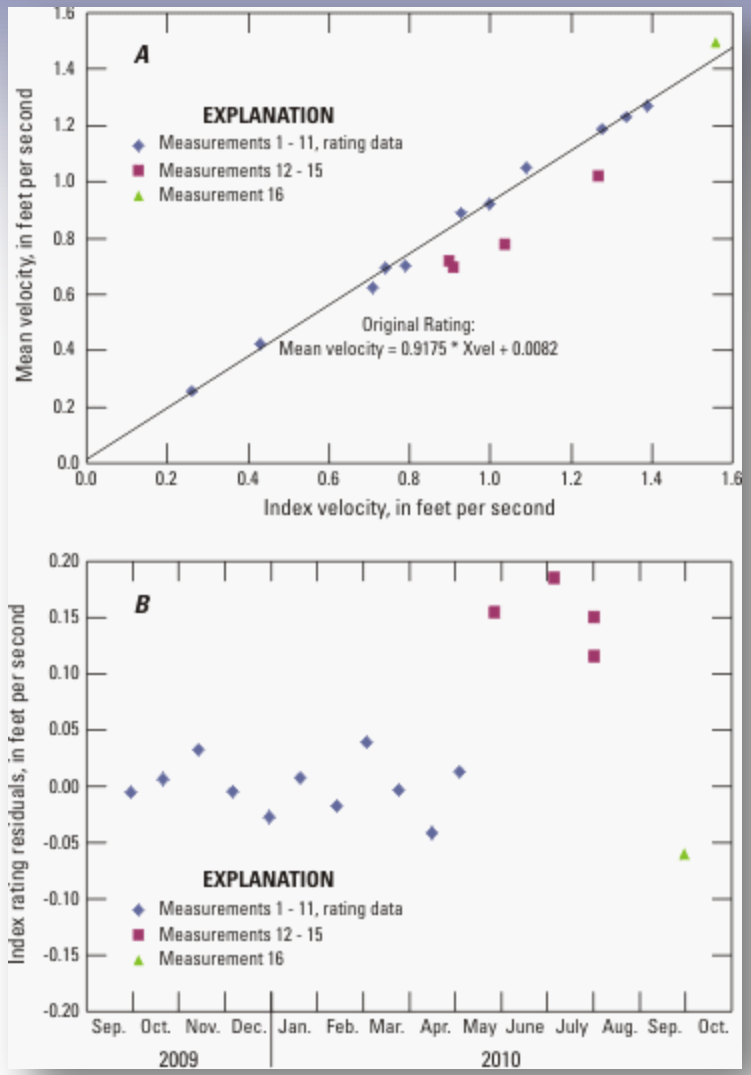
Index Rating Shifts

- **Evaluate possible shifts using residual plots and observed conditions**
  - **Trends in residuals over time**
  - **Trends in a specific range of values**
  - **Field observations**
  - **Where to transition the shift**
- **Accuracy of measurements**
  - **Consider errors in discharge measurements and/or index velocity data**
- **Accuracy of index rating**
  - **Consider error associated with the index rating**

Index Rating Shifts





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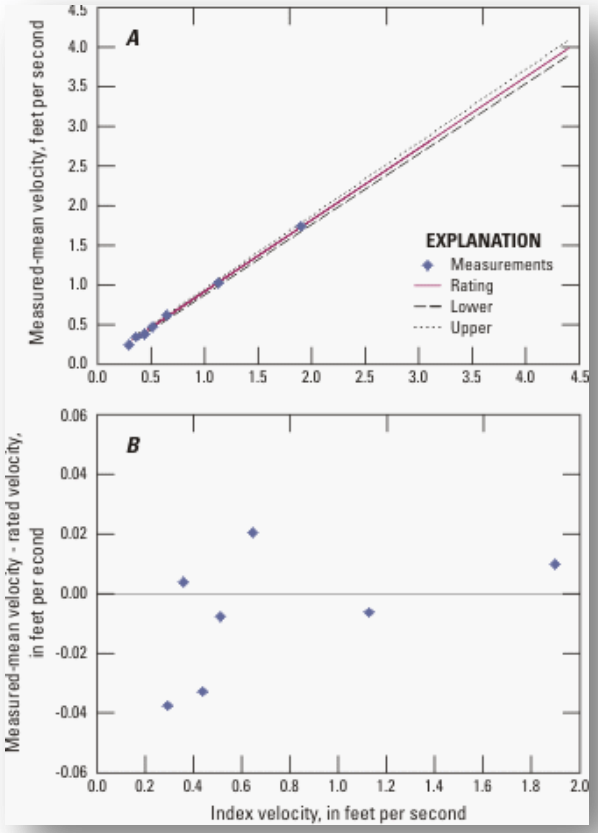
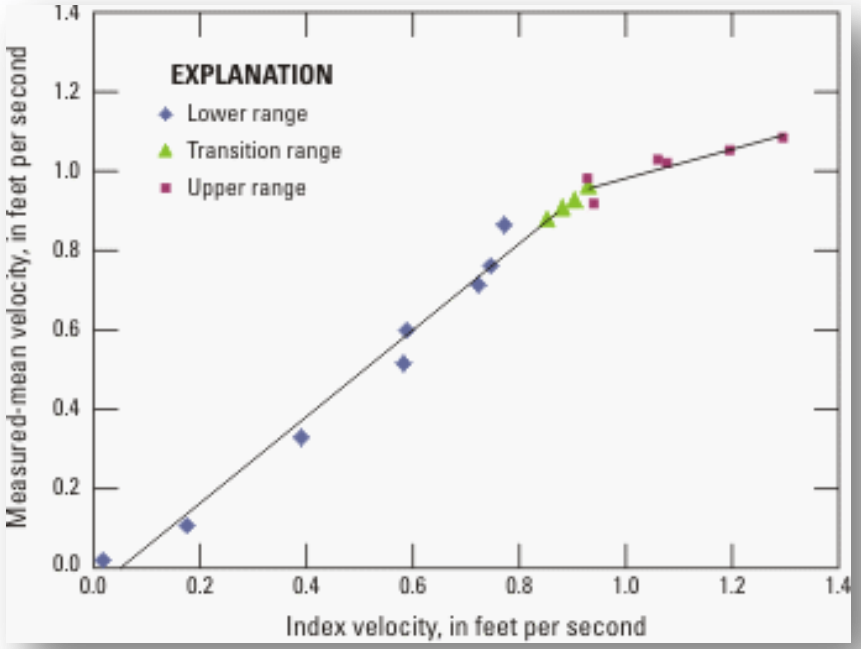
New Policies and Procedures

- **Guide book for using index velocity to compute continuous discharge**
- **Many examples are provided**





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Acknowledgements

Many people contributed to the report. Thanks to everyone who shared data, provided technical reviews, or took the time to discuss anything related to index velocity.

The report is currently at EPN for final editing and layout.

Computing Discharge using the Index-Velocity Method – Techniques and Methods 3-A23

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Questions???

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