United States Geological Survey
Kentucky Water Science Center

Cooperator Workshop

June 11, 2013
A. Thomas Ruby III

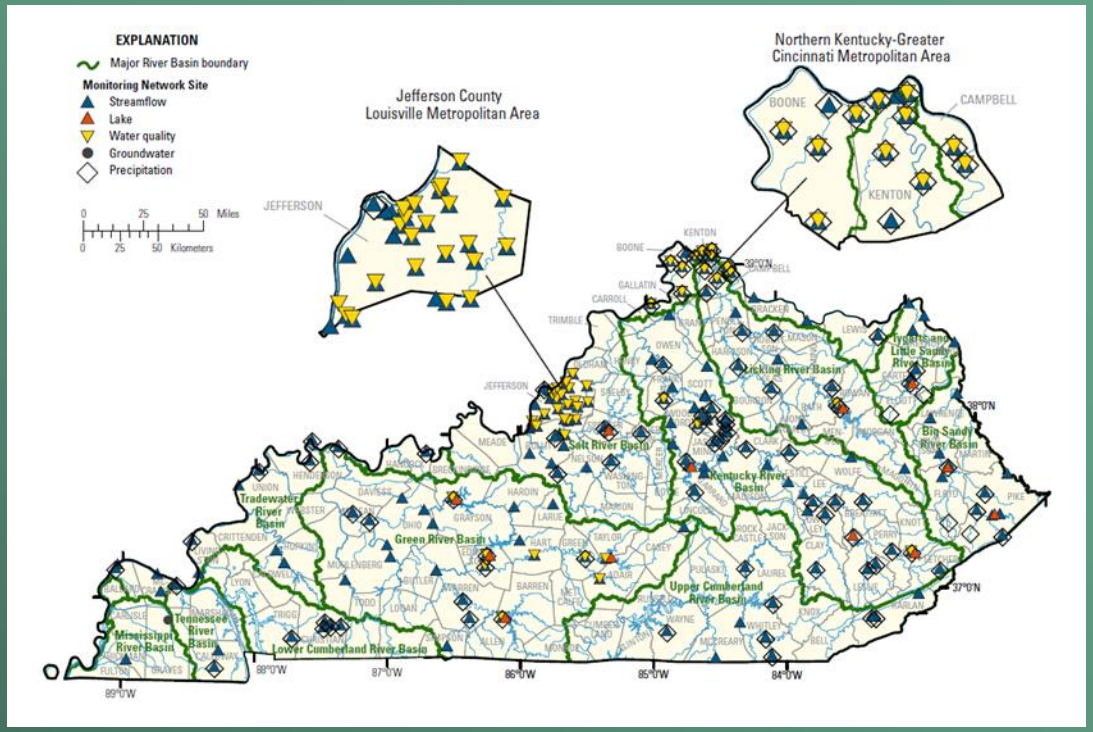
USGS

- Stream Gage Program
- Update on Streamgaging 101
- Levels at Gaging Stations
- Capabilities of USGS in Surface Water

USGS

Stream gage Program

- The gage network is growing.
- We installed many new gages in WY 2012
- There is 5 new gages scheduled to be installed in WY 2013



USGS

We can not do this without all of you

Thank you!!!

USGS

But there are always set backs

- Sequestration has hit the USGS

  - 03237255 Kinniconick Creek below Trace Creek at Tannery, KY
    - Discontinued on May 7, 2013
    - It was in cooperation with the National Streamflow Information Program (NSIP)
    - No further news on if it will return after next year

USGS

Century Gages

- The Kentucky Water Science Center has two gages that are over 100 years old!!
- The next few years we will have more century birthdays for the gages

USGS

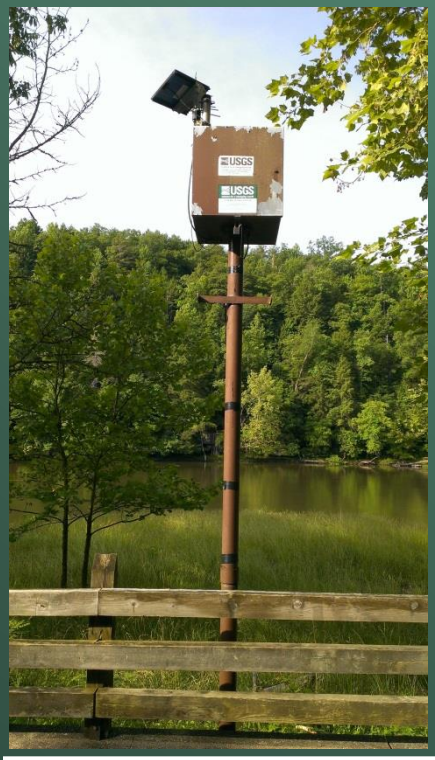
03284000 Kentucky River at Lock 10 near Winchester, KY

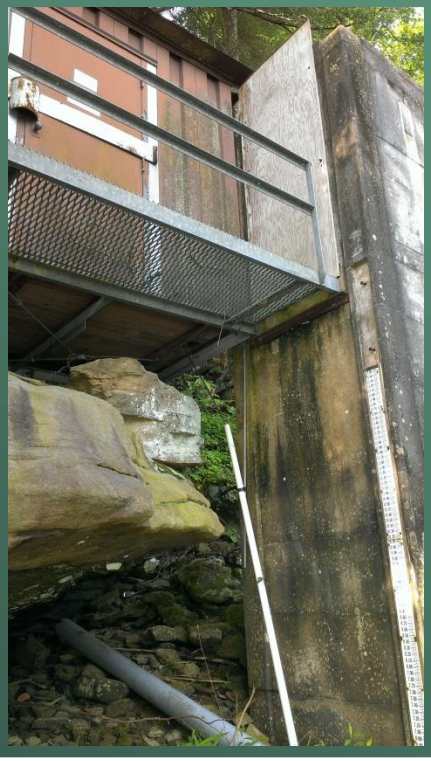
- The gage is almost 104 years in service.
- Daily discharge began in October 1909.

USGS

03404500 Cumberland River at Cumberland Falls, KY

- **The gage is almost 107 years in service.**





USGS

USGS
science for a changing world

Century Streamflow Gage

(Serving Kentucky for over 100 years)

Stream Monitoring Station

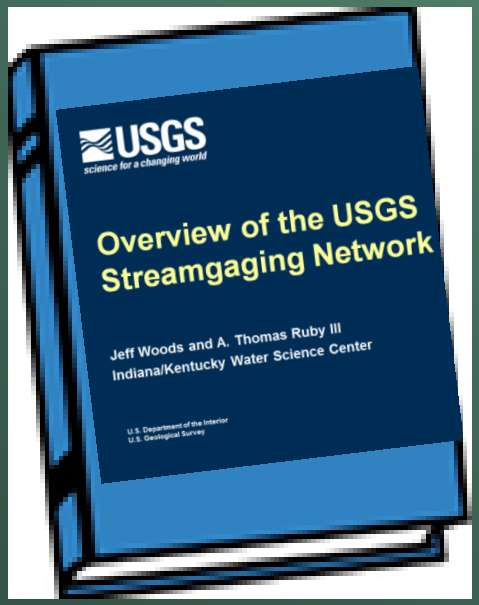
This station has been in operation for over 100 years as part of a national network for obtaining Water-Resources Information. The recorded water level and/or corresponding rate of flow are used for flood forecasting, reservoir operations, design of bridges and culverts, interstate and intrastate water-rights claims and many other projects.

For information contact:

Kentucky Water Science Center
502-493-1900
http://ky.water.usgs.gov

Streamgaging 101

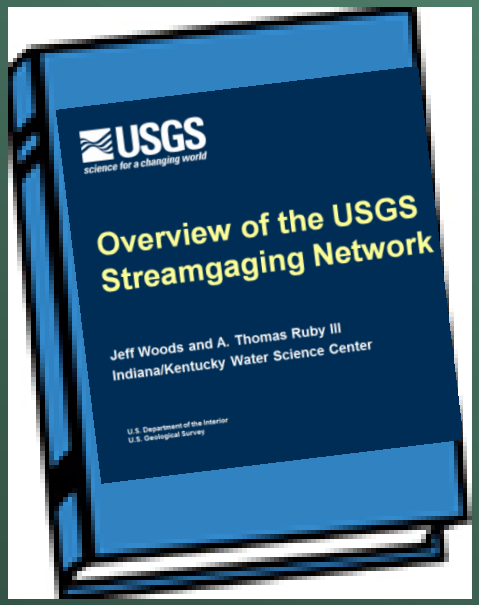
It's Finished!!



USGS

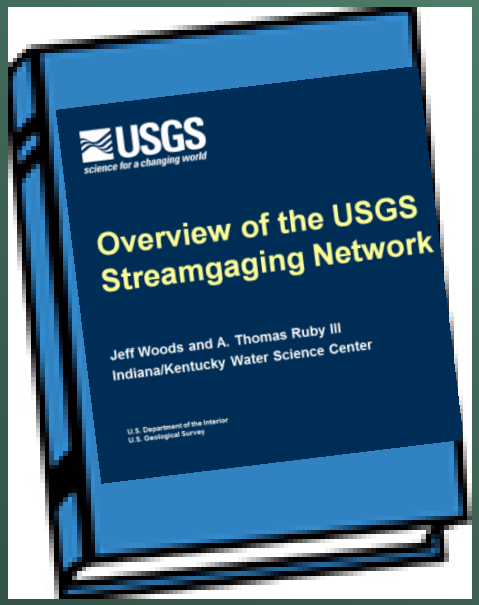
Streamgaging 101

Or maybe not?



USGS

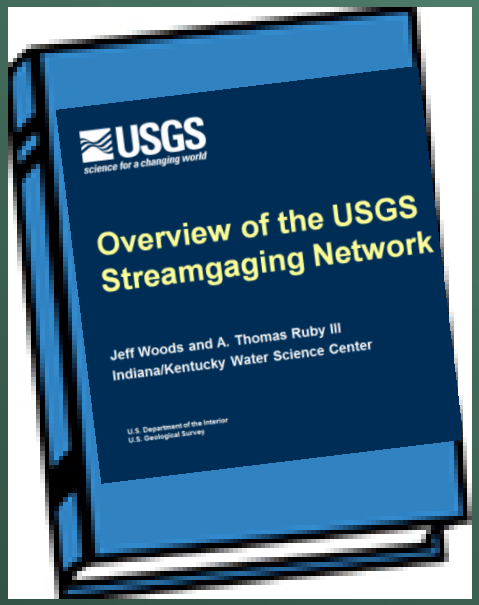
Streamgaging 101



It is a document that will be updated.

USGS

Streamgaging 101



Starting with this next section.

USGS

Levels at Gaging Stations

- What are levels and why are they needed?
- What is the USGS precision?
- How often are levels run?
- What equipment is needed?
- Where does levels start?
- How are levels run?

USGS

What are levels and why are they needed?

- Operational procedures at U.S. Geological Survey gaging stations include periodic leveling checks to ensure that gages are accurately set to the established gage datum.

- Differential leveling techniques are used to determine elevations for reference marks, reference points, all gages, and the water surface.

USGS

What are levels and why are they needed?

Basically,

So the equipment can be set from a reference gage and to make sure nothing has moved at the gaging station, due to settling, heaving, or other natural disturbances.

USGS

What is the USGS precision ?

Precision of gaging station levels:

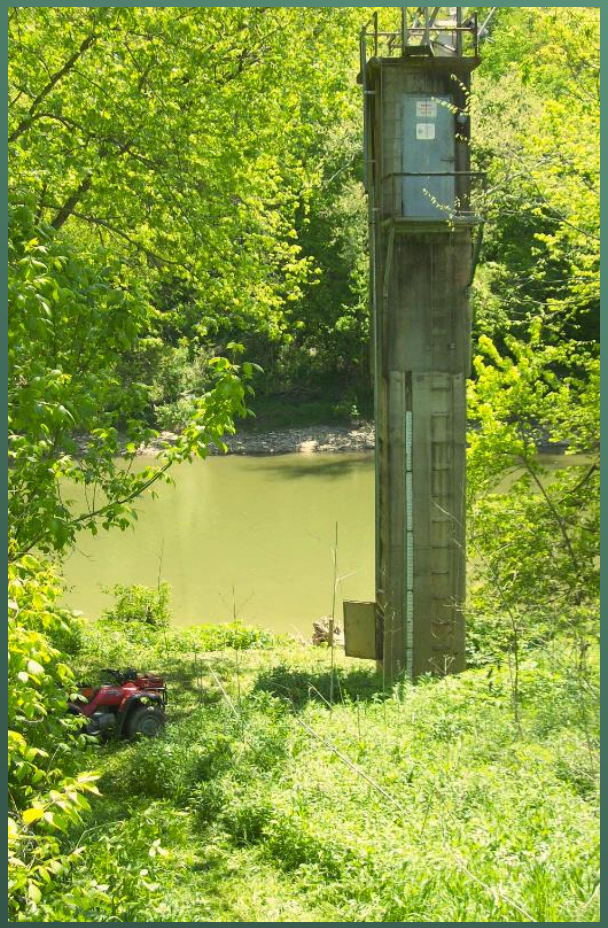
0.001 ft

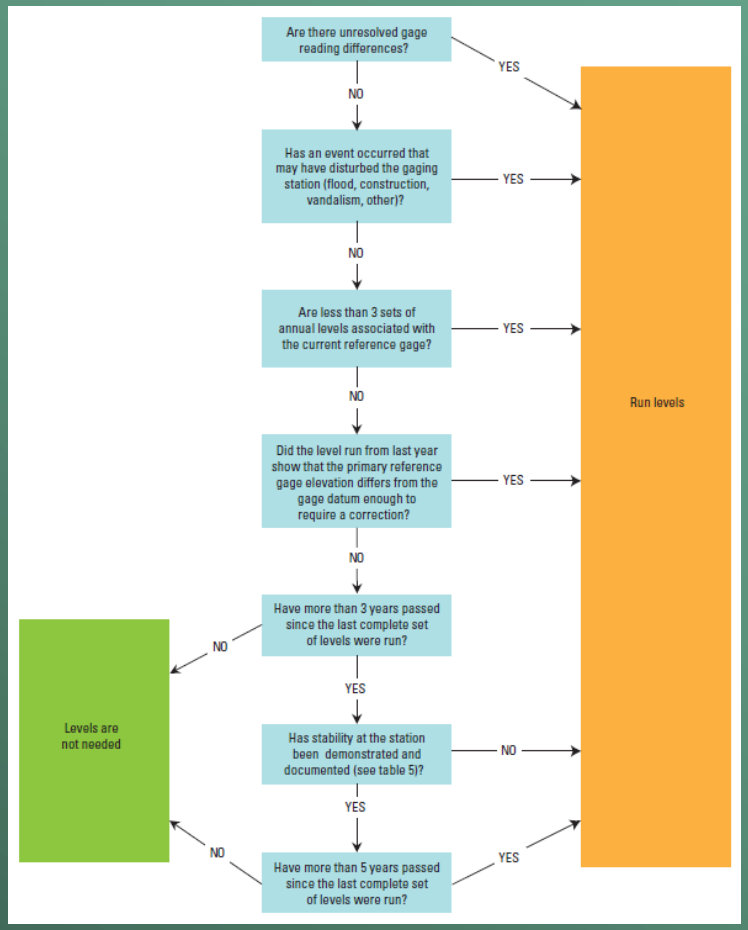
Accuracy of gaging station levels:

<0.01 ft

USGS

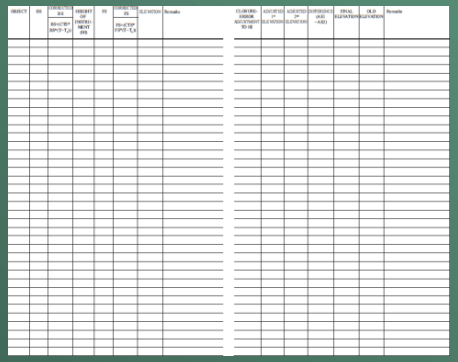
How often are levels run?





USGS

What equipment is needed?



USGS

Where does levels start?

- Reference marks are installed and elevations are determined in the gage datum when gaging stations are established. Stable and permanent reference marks facilitate maintaining that the gages at a station are set to the gage datum over the life of the station.
- Reference marks provide a means for recovering the gage datum if the gaging station is destroyed or is removed and reactivated sometime later.
- Gaging stations should have a minimum of three independent reference marks

USGS

How are levels run?

We’re going to show you!

USGS

How are levels run?

- The instrument should be placed upon a firmly set tripod in a stable location.
- The instrument should be properly leveled.
- The temperature of the leveling rod should be equilibrated to the air temperature. Rod-scale and air temperatures should be measured and noted.

USGS

How are levels run?

- Determine the order in which the reference marks, reference points, gages, water surface, and other objects are to be shot. The initial instrument height is determined from a backsight (BS) to the origin, as determined from historical levels at the station. The BS value, measured to the nearest 0.001 ft, should be corrected for expansion or contraction of the rod scale if needed and then added to the given elevation of the origin reference mark to obtain the instrument height.

USGS

U.S. DEPARTMENT OF THE INTERIOR

U.S. Geological Survey

Gaging Station Level Notes

Station Number:	98180000
Station Name	TEST at USGS Building
Date	June 11, 2013
Party	RWT (inst.) PJB (rod)

SUMMARY OF OBJECTIVE POINTS

Object	Adjusted 1st Elevation (AE1)	Adjusted 2nd Elevation (AE2)	Difference (AE1 −AE2)	Final Elevation ((AE1+ AE2)/2)

GAGE READINGS

Time	WS			Ref.
0950	2.58			2.58

INSTRUMENT

Make/Model: Laser/ -- inc

Serial Number: _____

Collimation (optical): _____

Collimation test date: _____

Collimation (digital): _____

Collimation test date: _____

ROD

Scale material: _____ CTE _____ 1/F° or 1/C°

CTE conversions: (1/°F * 1.8 = 1/°C) and ((1/°C)/1.8 = 1/°F)

Temperature (T): Rod:_____ °F or °C; Air:_____ °F or °C

Standard temp (T_o): 68°F or 20°C or other: _____

Given/Origin elevation: 12.345

Max elevation of objective point: _____

Min elevation of objective point: _____

Max elevation difference (L): _____

$C_t = CTE * L (T-T_o)$ C_t= _____

Other devices used as rod (list):

Rod taped (circle): (yes) no

Rod level used (circle): (yes) no

GAGE RESET

	Ref.			
Found	3.46			
Left				

WEATHER: Cool, Calm, almost like indoors with AC on.

NOTES: No temp correction needed.

Computed by: Checked by: Date:

OBJECT	BS	CORRECTED BS BS+(CTE* BS*(T−T_o))	HEIGHT OF INSTRU-MENT (HI)	FS	CORRECTED FS FS+(CTE* FS*(T−T_o))	ELEVATION	Remarks
RM 1						12.345	ORIGIN
RM 2							
RM 3							
WS							
staff							
TP							
staff							
WS							
RM 3							
RM 2							
RM 1							

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RM 1	3.456		15.801			12.345	ORIGIN
RM 2							
RM 3							
WS							
staff							
TP							
staff							
WS							
RM 3							
RM 2							
RM 1							

How are levels run?

- Foresights (FS) read to the nearest 0.001 ft should then be taken to the reference marks, reference points, gages, water surface, and other objects that were planned to be shot from the current instrument setup.
- The corrected FS values should be subtracted from the corresponding instrument height to obtain elevations in the gage datum. All gages and recorders should be read and noted with corresponding times just before or immediately after the FS on the water surface.

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CTE conversions: (1/°F * 1.8 = 1/°C) and ((1/°C)/1.8 = 1/°F)

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RM 2							
RM 3							
WS							
staff							
TP							
staff							
WS							
RM 3							
RM 2							
RM 1							

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RM 1	3.456		15.801			12.345	ORIGIN
RM 2				7.662		8.139	Lag in board
RM 3							
WS							
staff							
TP							
staff							
WS							
RM 3							
RM 2							
RM 1							

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Collimation test date: _____

ROD

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CTE conversions: (1/°F * 1.8 = 1/°C) and ((1/°C)/1.8 = 1/°F)

Temperature (T): Rod:_____ °F or °C; Air:_____ °F or °C

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RM 2				7.662		8.139	Lag in board
RM 3				8.235		7.566	bolt in board
WS							
staff							
TP							
staff							
WS							
RM 3							
RM 2							
RM 1							

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Temperature (T): Rod:_____ °F or °C; Air:_____ °F or °C

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Given/Origin elevation: 12.345

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Max elevation difference (L): _____

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RM 2				7.662		8.139	Lag in board
RM 3				8.235		7.566	bolt in board
WS				13.217		2.584	Water surface +/- .003
staff							
TP							
staff							
WS							
RM 3							
RM 2							
RM 1							

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WS				13.217		2.584	Water surface +/- .003
staff				12.341		3.459	Held on staff 3.46
TP							
staff							
WS							
RM 3							
RM 2							
RM 1							

How are levels run?

- After taking a FS on all objective points that were planned to be shot from the current instrument setup, a turning point should be established. The turning point should be a stable, independent object that is not an objective point of the level circuit. This point will be used to establish a new instrument height from which second elevations will be determined for the objects previously shot.

USGS

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NOTES: No temp correction needed.

Computed by: Checked by: Date:

OBJECT	BS	CORRECTED BS BS+(CTE* BS*(T−T_o))	HEIGHT OF INSTRU-MENT (HI)	FS	CORRECTED FS FS+(CTE* FS*(T−T_o))	ELEVATION	Remarks
RM 1	3.456		15.801			12.345	ORIGIN
RM 2				7.662		8.139	Lag in board
RM 3				8.235		7.566	bolt in board
WS				13.217		2.584	Water surface +/- .003
staff				12.341		3.459	Held on staff 3.46
TP				5.620		10.181	Turning Point 1
staff							
WS							
RM 3							
RM 2							
RM 1							

How are levels run?

- Take a BS to the turning point, and if required, correct for expansion or contraction of the rod scale and add it to the determined elevation of the turning point to determine a new instrument height.
- take FSs to the same objective points, correcting for expansion or contraction if conditions require it, and obtain second elevations for each.

USGS

U.S. DEPARTMENT OF THE INTERIOR

U.S. Geological Survey

Gaging Station Level Notes

Station Number:	Station Name	Date	Party			
98180000	TEST at USGS Building	June 11, 2013	RWT	(inst.)	PJB	(rod)

SUMMARY OF OBJECTIVE POINTS

Object	Adjusted 1st Elevation (AE1)	Adjusted 2nd Elevation (AE2)	Difference (AE1 −AE2)	Final Elevation ((AE1+ AE2)/2)

GAGE READINGS

Time	WS			Ref.
0950	2.58			2.58

INSTRUMENT

Make/Model: Laser/ -- inc

Serial Number: _____

Collimation (optical): _____

Collimation test date: _____

Collimation (digital): _____

Collimation test date: _____

ROD

Scale material: _____ CTE _____ 1/F° or 1/C°

CTE conversions: (1/°F * 1.8 = 1/°C) and ((1/°C)/1.8 = 1/°F)

Temperature (T): Rod:_____ °F or °C; Air:_____ °F or °C

Standard temp (T_o): 68°F or 20°C or other: _____

Given/Origin elevation: 12.345

Max elevation of objective point: _____

Min elevation of objective point: _____

Max elevation difference (L): _____

$C_t = CTE * L (T-T_o)$ C_t= _____

Other devices used as rod (list):

Rod taped (circle): (yes) no

Rod level used (circle): (yes) no

GAGE RESET

	Ref.			
Found	3.46			
Left				

WEATHER: Cool, Calm, almost like indoors with AC on.

NOTES: No temp correction needed.

Computed by: Checked by: Date:

OBJECT	BS	CORRECTED BS BS+(CTE* BS*(T−T_o))	HEIGHT OF INSTRU-MENT (HI)	FS	CORRECTED FS FS+(CTE* FS*(T−T_o))	ELEVATION	Remarks
RM 1	3.456		15.801			12.345	ORIGIN
RM 2				7.662		8.139	Lag in board
RM 3				8.235		7.566	bolt in board
WS				13.217		2.584	Water surface +/- .003
staff				12.341		3.459	Held on staff 3.46
TP				5.620		10.181	Turning Point 1
staff							
WS							
RM 3							
RM 2							
RM 1							

U.S. DEPARTMENT OF THE INTERIOR

U.S. Geological Survey

Gaging Station Level Notes

Station Number:	98180000
Station Name	TEST at USGS Building
Date	June 11, 2013
Party	RWT (inst.) PJB (rod)

SUMMARY OF OBJECTIVE POINTS

Object	Adjusted 1st Elevation (AE1)	Adjusted 2nd Elevation (AE2)	Difference (AE1 −AE2)	Final Elevation ((AE1+ AE2)/2)

GAGE READINGS

Time	WS			Ref.
0950	2.58			2.58

INSTRUMENT

Make/Model: Laser/ -- inc

Serial Number: _____

Collimation (optical): _____

Collimation test date: _____

Collimation (digital): _____

Collimation test date: _____

ROD

Scale material: _____ CTE _____ 1/F° or 1/C°

CTE conversions: (1/°F * 1.8 = 1/°C) and ((1/°C)/1.8 = 1/°F)

Temperature (T): Rod:_____ °F or °C; Air:_____ °F or °C

Standard temp (T_o): 68°F or 20°C or other: _____

Given/Origin elevation: 12.345

Max elevation of objective point: _____

Min elevation of objective point: _____

Max elevation difference (L): _____

$C_t = CTE * L (T-T_o)$ C_t= _____

Other devices used as rod (list):

Rod taped (circle): yes no

Rod level used (circle): yes no

GAGE RESET

	Ref.			
Found	3.46			
Left				

WEATHER: Cool, Calm, almost like indoors with AC on.

NOTES: No temp correction needed.

Computed by: Checked by: Date:

OBJECT	BS	CORRECTED BS BS+(CTE* BS*(T−T_o))	HEIGHT OF INSTRU-MENT (HI)	FS	CORRECTED FS FS+(CTE* FS*(T−T_o))	ELEVATION	Remarks
RM 1	3.456		15.801			12.345	ORIGIN
RM 2				7.662		8.139	Lag in board
RM 3				8.235		7.566	bolt in board
WS				13.217		2.584	Water surface +/- .003
staff				12.341		3.459	Held on staff 3.46
TP	4.525		14.433	5.620		10.181	Turning Point 1
staff							
WS							
RM 3							
RM 2							
RM 1							

U.S. DEPARTMENT OF THE INTERIOR

U.S. Geological Survey

Gaging Station Level Notes

Station Number:	Station Name	Date	Party			
98180000	TEST at USGS Building	June 11, 2013	RWT	(inst.)	PJB	(rod)

SUMMARY OF OBJECTIVE POINTS

Object	Adjusted 1st Elevation (AE1)	Adjusted 2nd Elevation (AE2)	Difference (AE1 −AE2)	Final Elevation ((AE1+ AE2)/2)

GAGE READINGS

Time	WS			Ref.
0950	2.58			2.58

INSTRUMENT

Make/Model: Laser/ -- inc

Serial Number: _____

Collimation (optical): _____

Collimation test date: _____

Collimation (digital): _____

Collimation test date: _____

ROD

Scale material: _____ CTE _____ 1/F° or 1/C°

CTE conversions: (1/°F * 1.8 = 1/°C) and ((1/°C)/1.8 = 1/°F)

Temperature (T): Rod:_____ °F or °C; Air:_____ °F or °C

Standard temp (T_o): 68°F or 20°C or other: _____

Given/Origin elevation: 12.345

Max elevation of objective point: _____

Min elevation of objective point: _____

Max elevation difference (L): _____

$C_t = CTE * L (T-T_o)$ C_t= _____

Other devices used as rod (list):

Rod taped (circle): (yes) no

Rod level used (circle): (yes) no

GAGE RESET

	Ref.			
Found	3.46			
Left				

WEATHER: Cool, Calm, almost like indoors with AC on.

NOTES: No temp correction needed.

Computed by: Checked by: Date:

OBJECT	BS	CORRECTED BS BS+(CTE* BS*(T−T_o))	HEIGHT OF INSTRU-MENT (HI)	FS	CORRECTED FS FS+(CTE* FS*(T−T_o))	ELEVATION	Remarks
RM 1	3.456		15.801			12.345	ORIGIN
RM 2				7.662		8.139	Lag in board
RM 3				8.235		7.566	bolt in board
WS				13.217		2.584	Water surface +/- .003
staff				12.341		3.459	Held on staff 3.46
TP	4.525		14.433	5.620		10.181	Turning Point 1
staff				10.972		3.461	
WS							
RM 3							
RM 2							
RM 1							

U.S. DEPARTMENT OF THE INTERIOR

U.S. Geological Survey

Gaging Station Level Notes

Station Number:	98180000
Station Name	TEST at USGS Building
Date	June 11, 2013
Party	RWT (inst.) PJB (rod)

SUMMARY OF OBJECTIVE POINTS

Object	Adjusted 1st Elevation (AE1)	Adjusted 2nd Elevation (AE2)	Difference (AE1 −AE2)	Final Elevation ((AE1+ AE2)/2)

GAGE READINGS

Time	WS			Ref.
0950	2.58			2.58

INSTRUMENT

Make/Model: Laser/ -- inc

Serial Number: _____

Collimation (optical): _____

Collimation test date: _____

Collimation (digital): _____

Collimation test date: _____

ROD

Scale material: _____ CTE _____ 1/F° or 1/C°

CTE conversions: (1/°F * 1.8 = 1/°C) and ((1/°C)/1.8 = 1/°F)

Temperature (T): Rod:_____ °F or °C; Air:_____ °F or °C

Standard temp (T_o): 68°F or 20°C or other: _____

Given/Origin elevation: 12.345

Max elevation of objective point: _____

Min elevation of objective point: _____

Max elevation difference (L): _____

$C_t = CTE * L (T-T_o)$ C_t= _____

Other devices used as rod (list):

Rod taped (circle): yes no

Rod level used (circle): yes no

GAGE RESET

	Ref.			
Found	3.46			
Left				

WEATHER: Cool, Calm, almost like indoors with AC on.

NOTES: No temp correction needed.

Computed by: Checked by: Date:

OBJECT	BS	CORRECTED BS BS+(CTE* BS*(T−T_o))	HEIGHT OF INSTRU-MENT (HI)	FS	CORRECTED FS FS+(CTE* FS*(T−T_o))	ELEVATION	Remarks
RM 1	3.456		15.801			12.345	ORIGIN
RM 2				7.662		8.139	Lag in board
RM 3				8.235		7.566	bolt in board
WS				13.217		2.584	Water surface +/- .003
staff				12.341		3.459	Held on staff 3.46
TP	4.525		14.433	5.620		10.181	Turning Point 1
staff				10.972		3.461	
WS				11.852		2.581	Water surface +/- .002
RM 3							
RM 2							
RM 1							

U.S. DEPARTMENT OF THE INTERIOR

U.S. Geological Survey

Gaging Station Level Notes

Station Number:	98180000
Station Name	TEST at USGS Building
Date	June 11, 2013
Party	RWT (inst.) PJB (rod)

SUMMARY OF OBJECTIVE POINTS

Object	Adjusted 1st Elevation (AE1)	Adjusted 2nd Elevation (AE2)	Difference (AE1 −AE2)	Final Elevation ((AE1+ AE2)/2)

GAGE READINGS

Time	WS			Ref.
0950	2.58			2.58

INSTRUMENT

Make/Model: Laser/ -- inc

Serial Number: _____

Collimation (optical): _____

Collimation test date: _____

Collimation (digital): _____

Collimation test date: _____

ROD

Scale material: _____ CTE _____ 1/F° or 1/C°

CTE conversions: (1/°F * 1.8 = 1/°C) and ((1/°C)/1.8 = 1/°F)

Temperature (T): Rod:_____ °F or °C; Air:_____ °F or °C

Standard temp (T_o): 68°F or 20°C or other: _____

Given/Origin elevation: 12.345

Max elevation of objective point: _____

Min elevation of objective point: _____

Max elevation difference (L): _____

$C_t = CTE * L (T-T_o)$ C_t= _____

Other devices used as rod (list):

Rod taped (circle): yes no

Rod level used (circle): yes no

GAGE RESET

	Ref.			
Found	3.46			
Left				

WEATHER: Cool, Calm, almost like indoors with AC on.

NOTES: No temp correction needed.

Computed by: Checked by: Date:

OBJECT	BS	CORRECTED BS BS+(CTE* BS*(T−T_o))	HEIGHT OF INSTRU-MENT (HI)	FS	CORRECTED FS FS+(CTE* FS*(T−T_o))	ELEVATION	Remarks
RM 1	3.456		15.801			12.345	ORIGIN
RM 2				7.662		8.139	Lag in board
RM 3				8.235		7.566	bolt in board
WS				13.217		2.584	Water surface +/- .003
staff				12.341		3.459	Held on staff 3.46
TP	4.525		14.433	5.620		10.181	Turning Point 1
staff				10.972		3.461	
WS				11.852		2.581	Water surface +/- .002
RM 3				6.867		7.566	
RM 2							
RM 1							

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Gaging Station Level Notes

Station Number:	98180000
Station Name	TEST at USGS Building
Date	June 11, 2013
Party	RWT (inst.) PJB (rod)

SUMMARY OF OBJECTIVE POINTS

Object	Adjusted 1st Elevation (AE1)	Adjusted 2nd Elevation (AE2)	Difference (AE1 −AE2)	Final Elevation ((AE1+ AE2)/2)

GAGE READINGS

Time	WS			Ref.
0950	2.58			2.58

INSTRUMENT

Make/Model: Laser/ -- inc

Serial Number: _____

Collimation (optical): _____

Collimation test date: _____

Collimation (digital): _____

Collimation test date: _____

ROD

Scale material: _____ CTE _____ 1/F° or 1/C°

CTE conversions: (1/°F * 1.8 = 1/°C) and ((1/°C)/1.8 = 1/°F)

Temperature (T): Rod:_____ °F or °C; Air:_____ °F or °C

Standard temp (T_o): 68°F or 20°C or other: _____

Given/Origin elevation: 12.345

Max elevation of objective point: _____

Min elevation of objective point: _____

Max elevation difference (L): _____

$C_t = CTE * L (T - T_o)$ C_t= _____

Other devices used as rod (list):

Rod taped (circle): yes no

Rod level used (circle): yes no

GAGE RESET

	Ref.			
Found	3.46			
Left				

WEATHER: Cool, Calm, almost like indoors with AC on.

NOTES: No temp correction needed.

Computed by: Checked by: Date:

OBJECT	BS	CORRECTED BS BS+(CTE* BS*(T−T_o))	HEIGHT OF INSTRU-MENT (HI)	FS	CORRECTED FS FS+(CTE* FS*(T−T_o))	ELEVATION	Remarks
RM 1	3.456		15.801			12.345	ORIGIN
RM 2				7.662		8.139	Lag in board
RM 3				8.235		7.566	bolt in board
WS				13.217		2.584	Water surface +/- .003
staff				12.341		3.459	Held on staff 3.46
TP	4.525		14.433	5.620		10.181	Turning Point 1
staff				10.972		3.461	
WS				11.852		2.581	Water surface +/- .002
RM 3				6.867		7.566	
RM 2				6.293		8.140	
RM 1							

How are levels run?

- To close the leveling circuit, the final shot should be a FS taken on the origin reference mark

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Gaging Station Level Notes

Station Number:	98180000
Station Name	TEST at USGS Building
Date	June 11, 2013
Party	RWT (inst.) PJB (rod)

SUMMARY OF OBJECTIVE POINTS

Object	Adjusted 1st Elevation (AE1)	Adjusted 2nd Elevation (AE2)	Difference (AE1 −AE2)	Final Elevation ((AE1+ AE2)/2)

GAGE READINGS

Time	WS			Ref.
0950	2.58			2.58

INSTRUMENT

Make/Model: Laser/ -- inc

Serial Number: _____

Collimation (optical): _____

Collimation test date: _____

Collimation (digital): _____

Collimation test date: _____

ROD

Scale material: _____ CTE _____ 1/F° or 1/C°

CTE conversions: (1/°F * 1.8 = 1/°C) and ((1/°C)/1.8 = 1/°F)

Temperature (T): Rod:_____ °F or °C; Air:_____ °F or °C

Standard temp (T_o): 68°F or 20°C or other: _____

Given/Origin elevation: 12.345

Max elevation of objective point: _____

Min elevation of objective point: _____

Max elevation difference (L): _____

$C_t = CTE * L (T - T_o)$ C_t= _____

Other devices used as rod (list):

Rod taped (circle): yes no

Rod level used (circle): yes no

GAGE RESET

	Ref.			
Found	3.46			
Left				

WEATHER: Cool, Calm, almost like indoors with AC on.

NOTES: No temp correction needed.

Computed by: Checked by: Date:

OBJECT	BS	CORRECTED BS BS+(CTE* BS*(T−T_o))	HEIGHT OF INSTRU-MENT (HI)	FS	CORRECTED FS FS+(CTE* FS*(T−T_o))	ELEVATION	Remarks
RM 1	3.456		15.801			12.345	ORIGIN
RM 2				7.662		8.139	Lag in board
RM 3				8.235		7.566	bolt in board
WS				13.217		2.584	Water surface +/- .003
staff				12.341		3.459	Held on staff 3.46
TP	4.525		14.433	5.620		10.181	Turning Point 1
staff				10.972		3.461	
WS				11.852		2.581	Water surface +/- .002
RM 3				6.867		7.566	
RM 2				6.293		8.140	
RM 1							

U.S. DEPARTMENT OF THE INTERIOR

U.S. Geological Survey

Gaging Station Level Notes

Station Number:	98180000
Station Name	TEST at USGS Building
Date	June 11, 2013
Party	RWT (inst.) PJB (rod)

SUMMARY OF OBJECTIVE POINTS

Object	Adjusted 1st Elevation (AE1)	Adjusted 2nd Elevation (AE2)	Difference (AE1 −AE2)	Final Elevation ((AE1+ AE2)/2)

GAGE READINGS

Time	WS			Ref.
0950	2.58			2.58

INSTRUMENT

Make/Model: Laser/ -- inc

Serial Number: _____

Collimation (optical): _____

Collimation test date: _____

Collimation (digital): _____

Collimation test date: _____

ROD

Scale material: _____ CTE _____ 1/F° or 1/C°

CTE conversions: (1/°F * 1.8 = 1/°C) and ((1/°C)/1.8 = 1/°F)

Temperature (T): Rod:_____ °F or °C; Air:_____ °F or °C

Standard temp (T_o): 68°F or 20°C or other: _____

Given/Origin elevation: 12.345

Max elevation of objective point: _____

Min elevation of objective point: _____

Max elevation difference (L): _____

$C_t = CTE * L (T - T_o)$ C_t= _____

Other devices used as rod (list):

Rod taped (circle): yes no

Rod level used (circle): yes no

GAGE RESET

	Ref.			
Found	3.46			
Left				

WEATHER: Cool, Calm, almost like indoors with AC on.

NOTES: No temp correction needed.

Computed by: Checked by: Date:

OBJECT	BS	CORRECTED BS BS+(CTE* BS*(T−T_o))	HEIGHT OF INSTRU-MENT (HI)	FS	CORRECTED FS FS+(CTE* FS*(T−T_o))	ELEVATION	Remarks
RM 1	3.456		15.801			12.345	ORIGIN
RM 2				7.662		8.139	Lag in board
RM 3				8.235		7.566	bolt in board
WS				13.217		2.584	Water surface +/- .003
staff				12.341		3.459	Held on staff 3.46
TP	4.525		14.433	5.620		10.181	Turning Point 1
staff				10.972		3.461	
WS				11.852		2.581	Water surface +/- .002
RM 3				6.867		7.566	
RM 2				6.293		8.140	
RM 1				2.088		12.345	

U.S. DEPARTMENT OF THE INTERIOR

U.S. Geological Survey

Gaging Station Level Notes

Station Number:	98180000
Station Name	TEST at USGS Building
Date	June 11, 2013
Party	RWT (inst.) PJB (rod)

SUMMARY OF OBJECTIVE POINTS

Object	Adjusted 1st Elevation (AE1)	Adjusted 2nd Elevation (AE2)	Difference (AE1 −AE2)	Final Elevation ((AE1+ AE2)/2)
RM 1	12.345	12.345	0.000	12.345
RM 2	8.139	8.140	0.001	8.139
RM 3	7.566	7.566	0.000	7.566
staff	3.459	3.461	0.002	3.460

INSTRUMENT

Make/Model: Laser/ -- inc

Serial Number: _____

Collimation (optical): _____

Collimation test date: _____

Collimation (digital): _____

Collimation test date: _____

ROD

Scale material: _____ CTE _____ 1/F° or 1/C°

CTE conversions: (1/°F * 1.8 = 1/°C) and ((1/°C)/1.8 = 1/°F)

Temperature (T): Rod:_____ °F or °C; Air:_____ °F or °C

Standard temp (T_o): 68°F or 20°C or other: _____

Given/Origin elevation: 12.345

Max elevation of objective point: _____

Min elevation of objective point: _____

Max elevation difference (L): _____

$C_t = CTE * L (T-T_o)$ C_t= _____

Other devices used as rod (list):

Rod taped (circle): (yes) no

Rod level used (circle): (yes) no

GAGE READINGS

Time	WS			Ref.
0950	2.58			2.58
0955	2.58			2.58

GAGE RESET

	Ref.			
Found	3.46			
Left	3.46			

WEATHER: Cool, Calm, almost like indoors with AC on.

NOTES: No temp correction needed.

Computed by: Checked by: Date:

OBJECT	BS	CORRECTED BS BS+(CTE* BS*(T−T_o))	HEIGHT OF INSTRU-MENT (HI)	FS	CORRECTED FS FS+(CTE* FS*(T−T_o))	ELEVATION	Remarks
RM 1	3.456		15.801			12.345	ORIGIN
RM 2				7.662		8.139	Lag in board
RM 3				8.235		7.566	bolt in board
WS				13.217		2.584	Water surface +/- .003
staff				12.341		3.459	Held on staff 3.46
TP	4.525		14.433	5.620		10.181	Turning Point 1
staff				10.972		3.461	
WS				11.852		2.581	Water surface +/- .002
RM 3				6.867		7.566	
RM 2				6.293		8.140	
RM 1				2.088		12.345	

U.S. DEPARTMENT OF THE INTERIOR

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Gaging Station Level Notes

Station Number:	98180000
Station Name	TEST at USGS Building
Date	June 11, 2013
Party	RWT (inst.) PJB (rod)

SUMMARY OF OBJECTIVE POINTS

Object	Adjusted 1st Elevation (AE1)	Adjusted 2nd Elevation (AE2)	Difference (AE1 −AE2)	Final Elevation ((AE1+ AE2)/2)
RM 1	12.345	12.345	0.000	12.345
RM 2	8.139	8.140	0.001	8.139
RM 3	7.566	7.566	0.000	7.566
staff	3.459	3.461	0.002	3.460

INSTRUMENT

Make/Model: Laser/ -- inc

Serial Number: _____

Collimation (optical): _____

Collimation test date: _____

Collimation (digital): _____

Collimation test date: _____

ROD

Scale material: _____ CTE _____ 1/F° or 1/C°

CTE conversions: (1/°F * 1.8 = 1/°C) and ((1/°C)/1.8 = 1/°F)

Temperature (T): Rod:_____ °F or °C; Air:_____ °F or °C

Standard temp (T_o): 68°F or 20°C or other: _____

Given/Origin elevation: 12.345

Max elevation of objective point: _____

Min elevation of objective point: _____

Max elevation difference (L): _____

C_t = CTE * L (T−T_o) C_t= _____

Other devices used as rod (list):

Rod taped (circle): yes no

Rod level used (circle): yes no

GAGE READINGS

Time	WS			Ref.
0950	2.58			2.58
0955	2.58			2.58

GAGE RESET

	Ref.			
Found	3.46			
Left	3.46			

WEATHER: Cool, Calm, almost like indoors with AC on.

NOTES: No temp correction needed.

Computed by: Checked by: Date:

OBJECT	BS	CORRECTED BS BS+(CTE* BS*(T−T_o))	HEIGHT OF INSTRU-MENT (HI)	FS	CORRECTED FS FS+(CTE* FS*(T−T_o))	ELEVATION	Remarks
RM 1	3.456		15.801			12.345	ORIGIN
RM 2				7.662		8.139	Lag in board
RM 3				8.235		7.566	bolt in board
WS				13.217		2.584	Water surface +/- .003
staff				12.341		3.459	Held on staff 3.46
TP	4.525		14.433	5.620		10.181	Turning Point 1
staff				10.972		3.461	
WS				11.852		2.581	Water surface +/- .002
RM 3				6.867		7.566	
RM 2				6.293		8.140	
RM 1				2.088		12.345	

U.S. DEPARTMENT OF THE INTERIOR

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Gaging Station Level Notes

Station Number:	98180000
Station Name	TEST at USGS Building
Date	June 11, 2013
Party	RWT (inst.) PJB (rod)

SUMMARY OF OBJECTIVE POINTS

Object	Adjusted 1st Elevation (AE1)	Adjusted 2nd Elevation (AE2)	Difference (AE1 −AE2)	Final Elevation ((AE1+ AE2)/2)
RM 1	12.345	12.345	0.000	12.345
RM 2	8.139	8.140	0.001	8.139
RM 3	7.566	7.566	0.000	7.566
staff	3.459	3.461	0.002	3.460

INSTRUMENT

Make/Model: Laser/ -- inc

Serial Number: _____

Collimation (optical): _____

Collimation test date: _____

Collimation (digital): _____

Collimation test date: _____

ROD

Scale material: _____ CTE _____ 1/F° or 1/C°

CTE conversions: (1/°F * 1.8 = 1/°C) and ((1/°C)/1.8 = 1/°F)

Temperature (T): Rod:_____ °F or °C; Air:_____ °F or °C

Standard temp (T_o): 68°F or 20°C or other: _____

Given/Origin elevation: 12.345

Max elevation of objective point: _____

Min elevation of objective point: _____

Max elevation difference (L): _____

C_t = CTE * L (T−T_o) C_t= _____

Other devices used as rod (list):

Rod taped (circle): (yes) no

Rod level used (circle): (yes) no

GAGE READINGS

Time	WS			Ref.
0950	2.58			2.58
0955	2.58			2.58

GAGE RESET

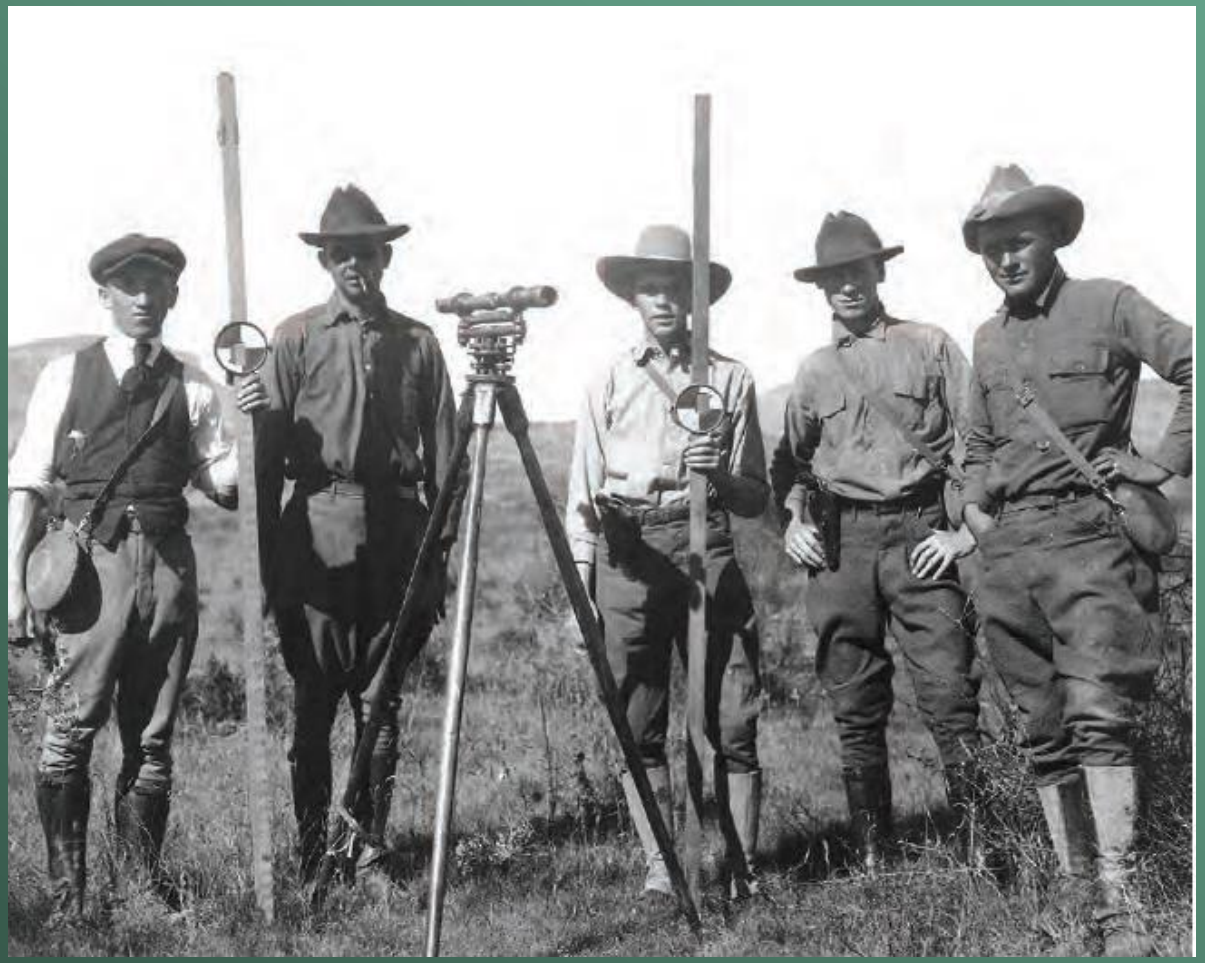
	Ref.			
Found	3.46			
Left	3.46			

WEATHER: Cool, Calm, almost like indoors with AC on.

NOTES: No temp correction needed. NO reset needed.

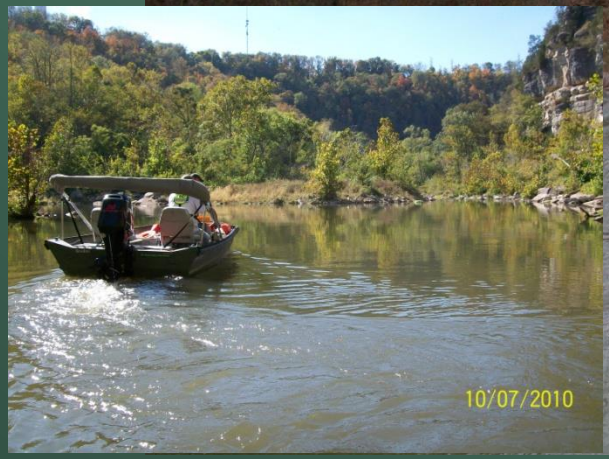
Computed by: Checked by: Date:

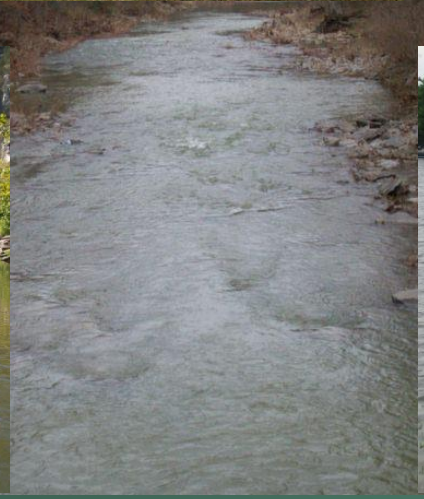
OBJECT	BS	CORRECTED BS BS+(CTE* BS*(T−T_o))	HEIGHT OF INSTRU-MENT (HI)	FS	CORRECTED FS FS+(CTE* FS*(T−T_o))	ELEVATION	Remarks
RM 1	3.456		15.801			12.345	ORIGIN
RM 2				7.662		8.139	Lag in board
RM 3				8.235		7.566	bolt in board
WS				13.217		2.584	Water surface +/- .003
staff				12.341		3.459	Held on staff 3.46
TP	4.525		14.433	5.620		10.181	Turning Point 1
staff				10.972		3.461	
WS				11.852		2.581	Water surface +/- .002
RM 3				6.867		7.566	
RM 2				6.293		8.140	
RM 1				2.088		12.345	



USGS

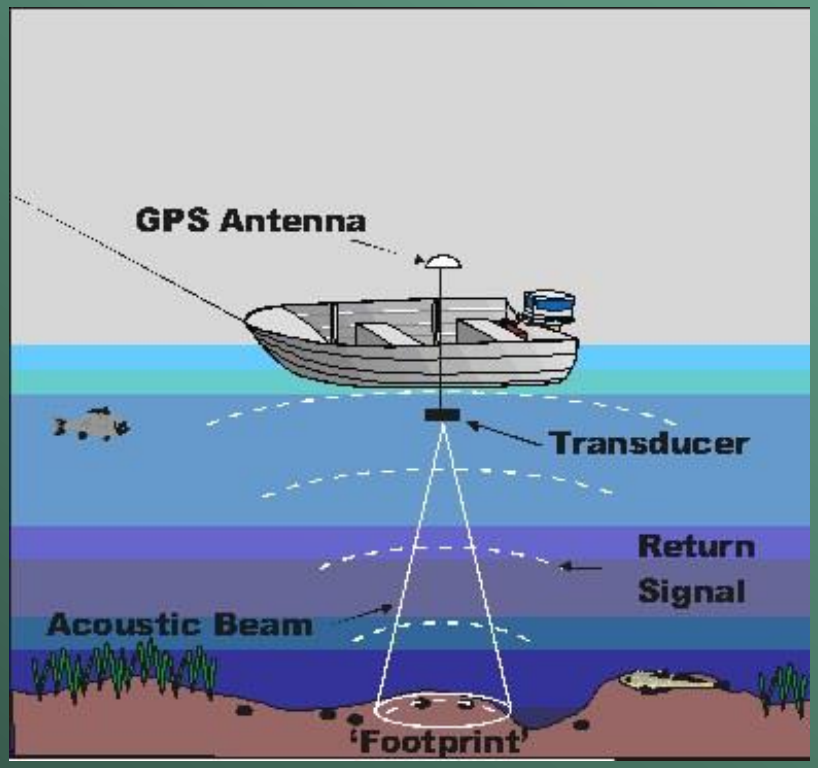
Hydrologic Surveillance Tools and Capabilities





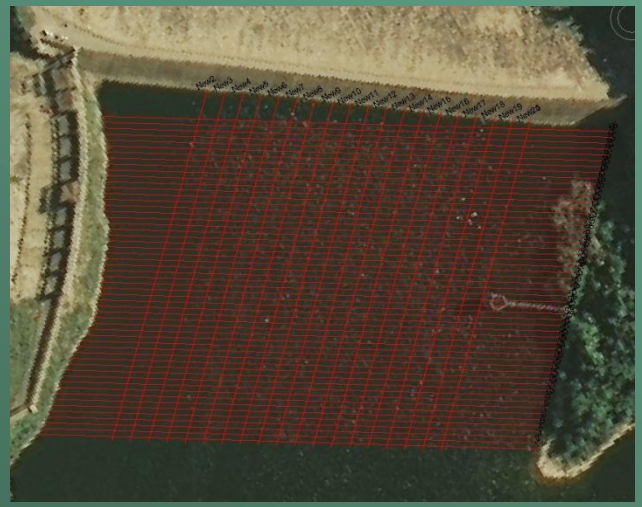
USGS

Single-beam bathymetry

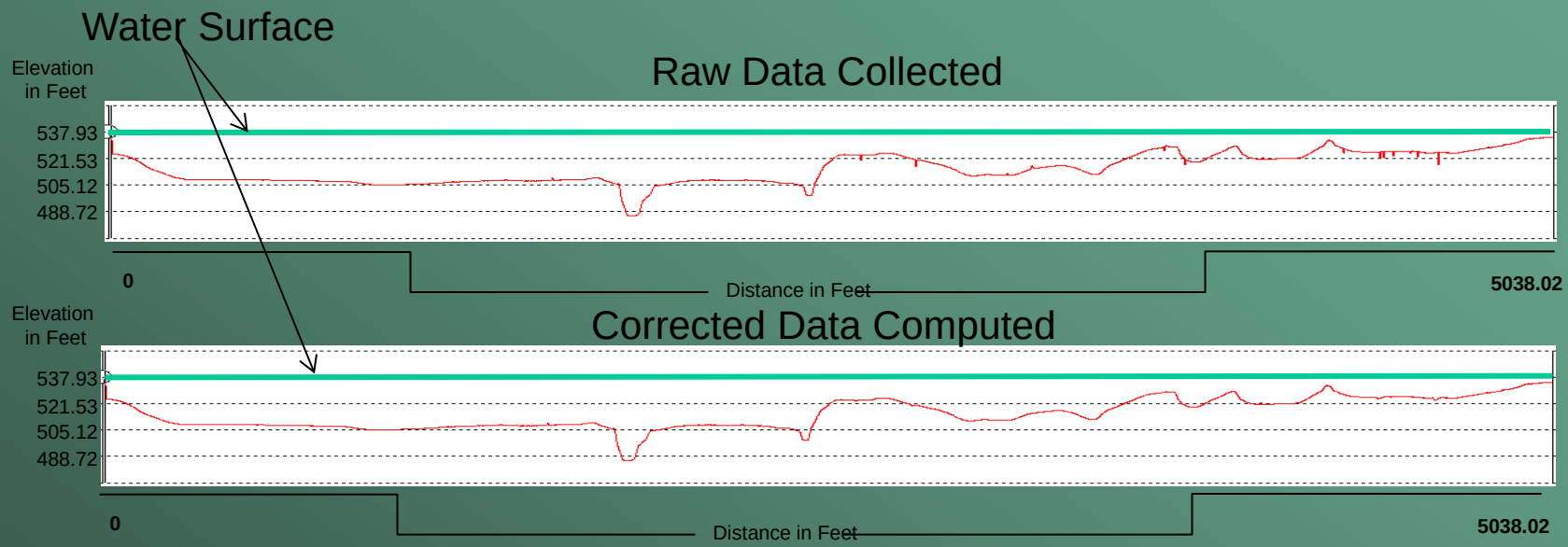


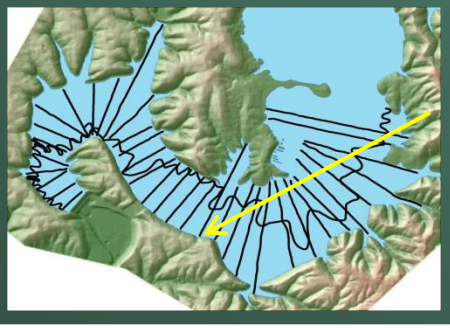
USGS

Single-beam bathymetry



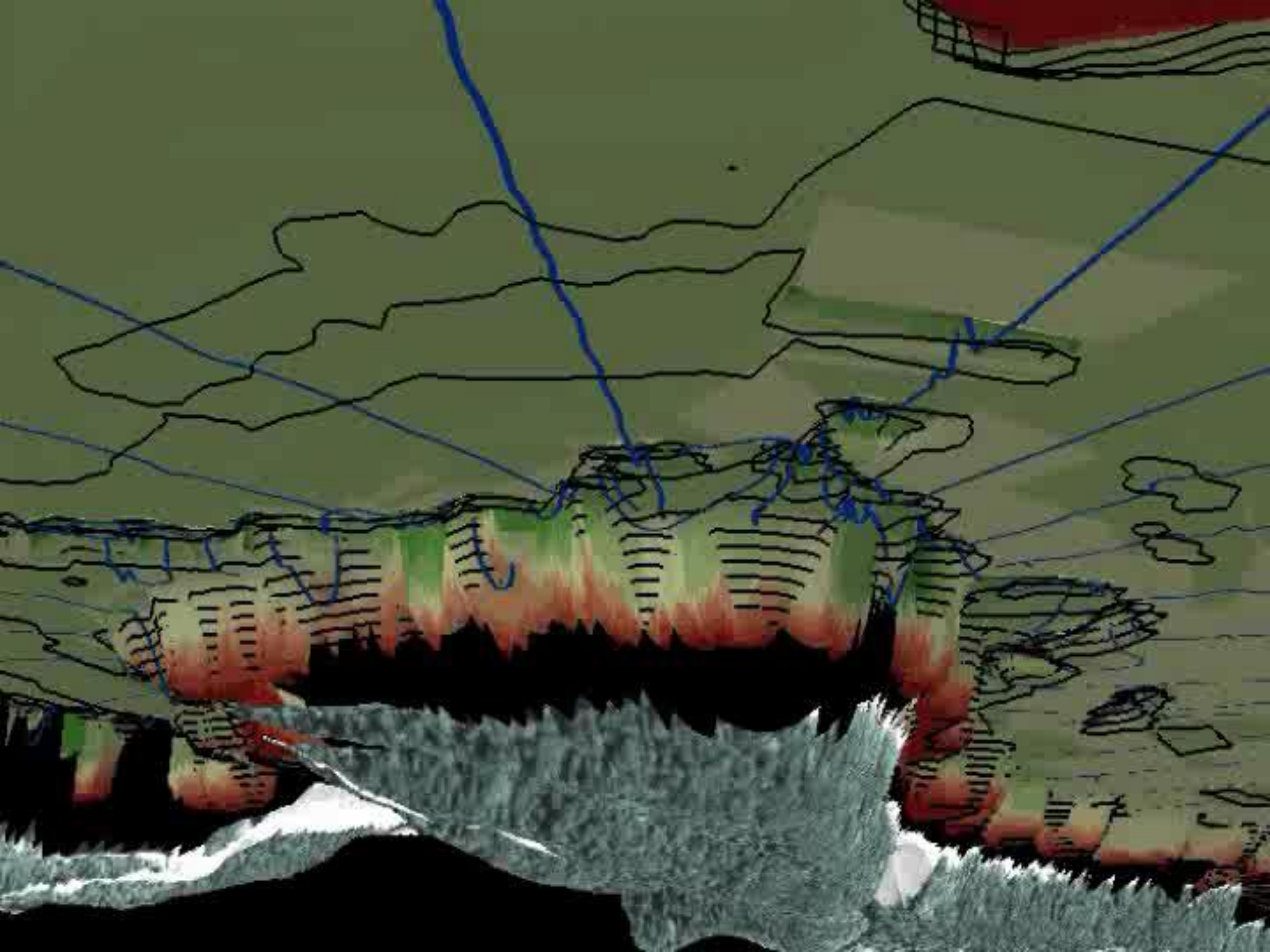
Example Single-beam bathymetry





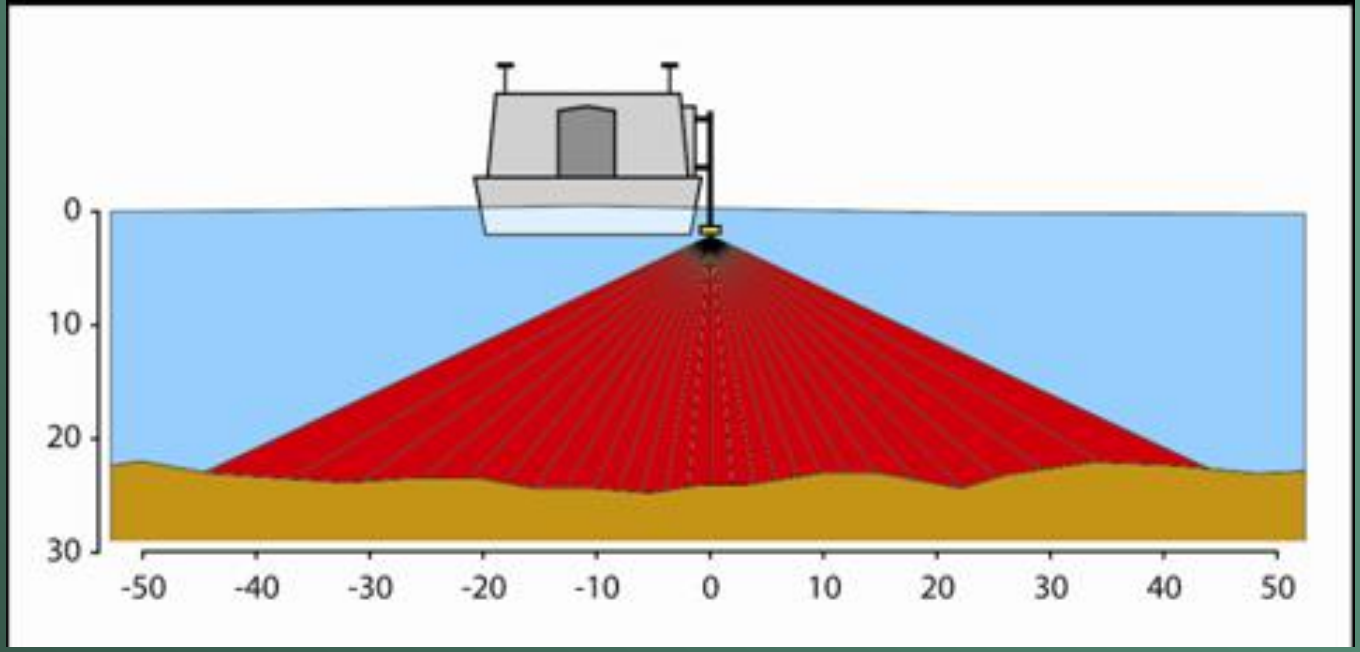
Bathymetry Transect 42

USGS



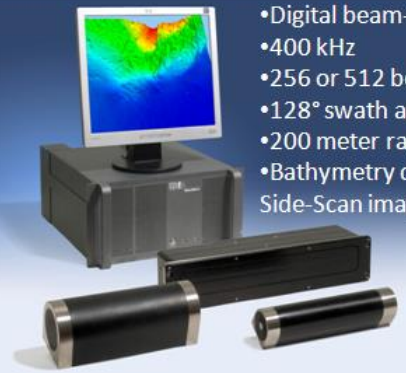
Multibeam Hydrographic Surveying

- Wide yet narrow swath perpendicular to the boat direction
- Multiple beams in just one ping
- ***SURVEYS the ENTIRE RIVER or LAKE BED***



USGS

RESON Seabat 7125
Multibeam Echosounder System

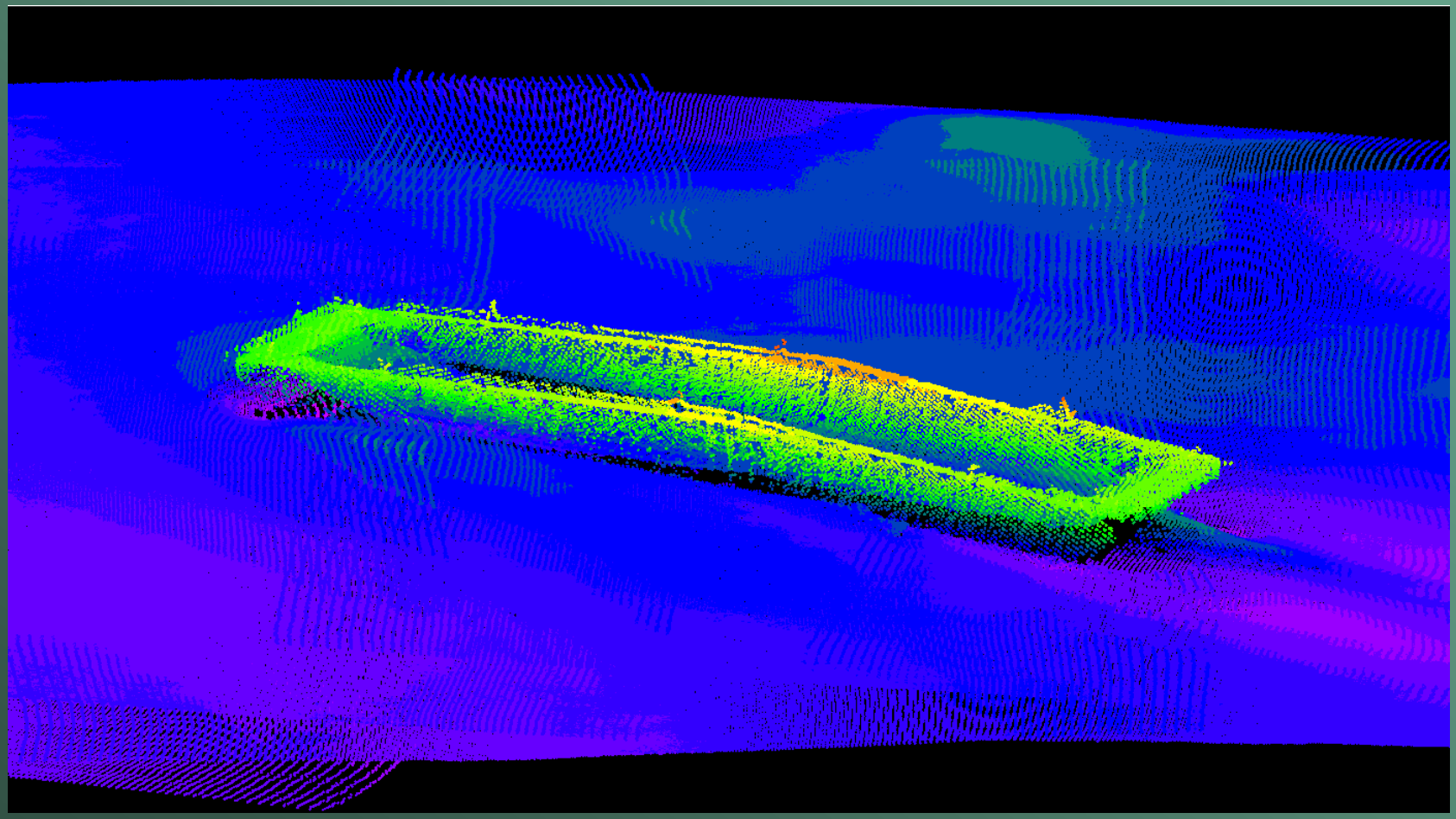


- Digital beam-former
- 400 kHz
- 256 or 512 beams
- 128° swath angle
- 200 meter range
- Bathymetry data and Side-Scan imagery

USGS

USGS
science for a changing world

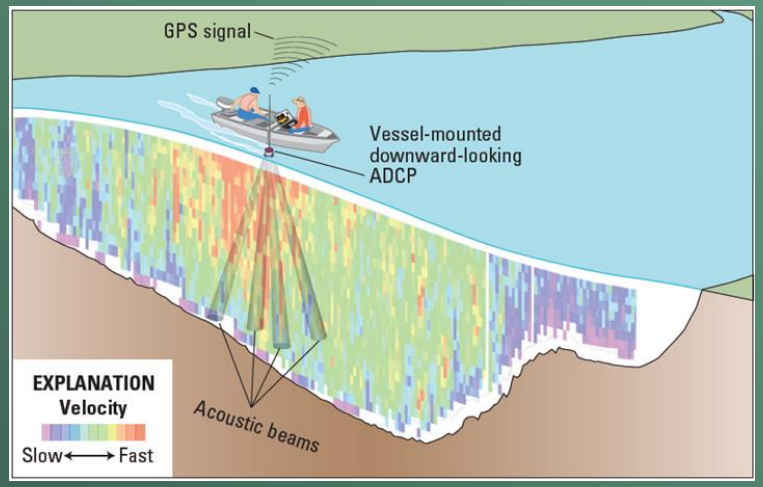
Sunken Barge using Multi-beam

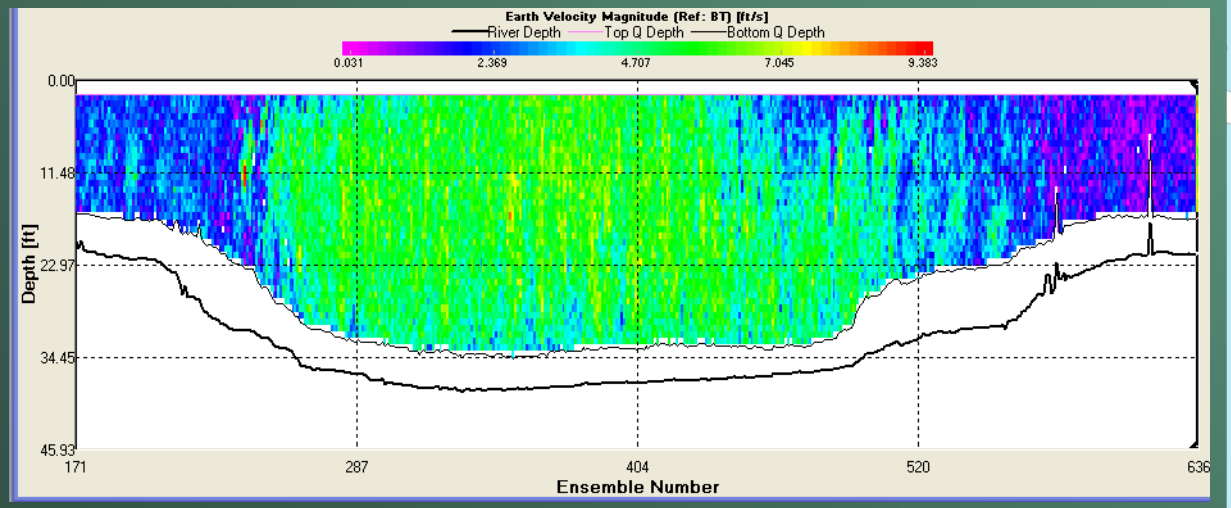


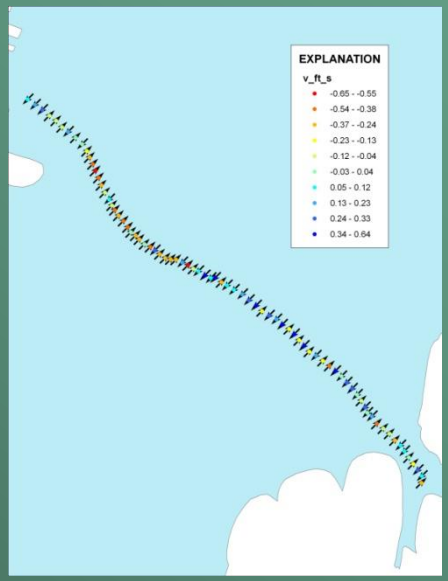
U.S. Department of the Interior
U.S. Geological Survey

Ohio River near Louisville Water intakes
found 8/24/2012

Acoustic Doppler Current Profiler (ADCP)





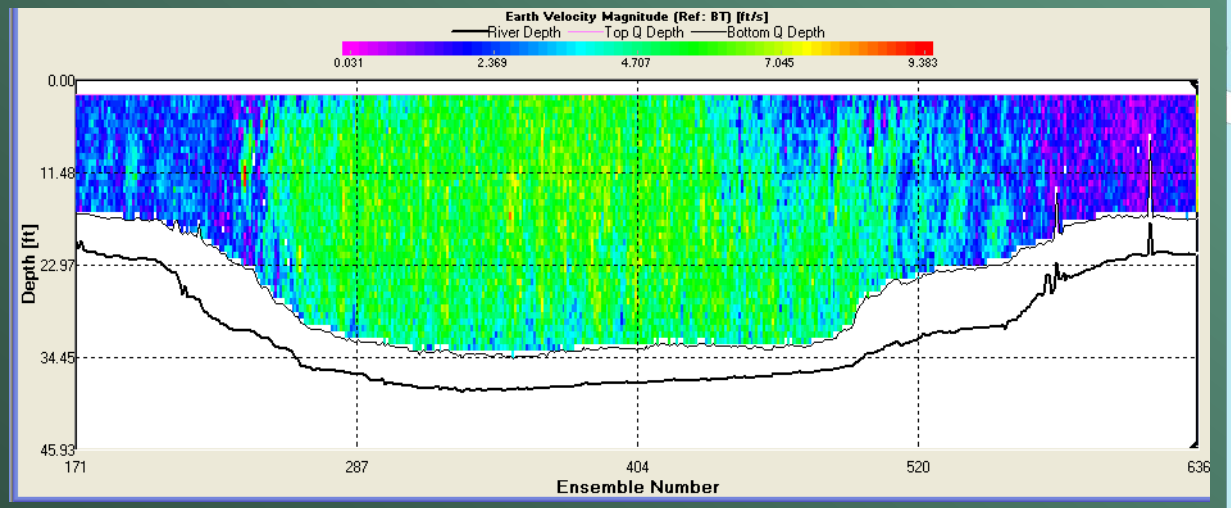


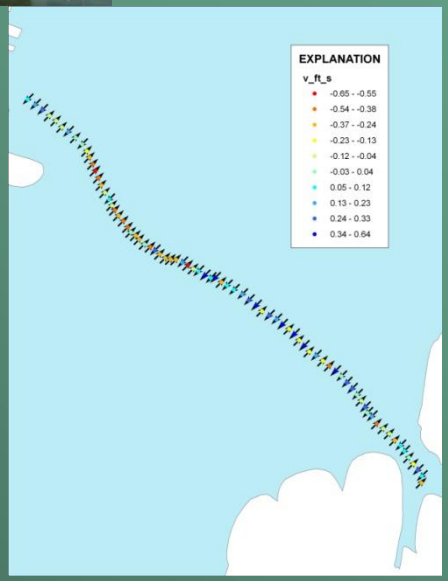
USGS

ADCP

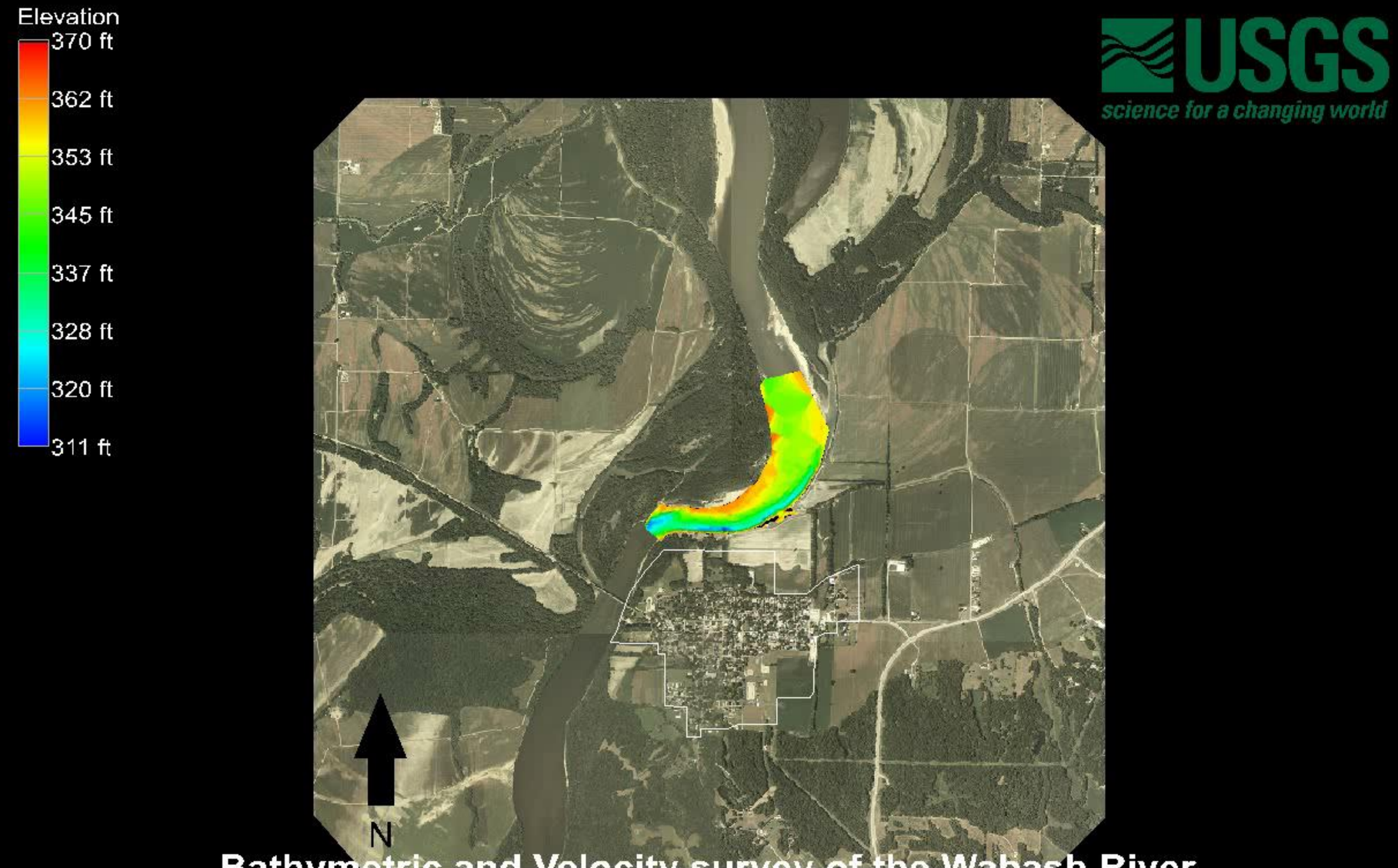

USGS
MERCURY


USGS


Earth Velocity Magnitude (Ref: BT) [ft/s]
River Depth
Top Q Depth
Bottom Q Depth
0.031
2.369
4.707
7.045
9.383
0.00
11.48
22.97
34.45
45.93
Depth [ft]
171
287
404
520
636
Ensemble Number


EXPLANATION
v_ft_s
-0.65 - -0.55
-0.54 - -0.38
-0.37 - -0.24
-0.23 - -0.13
-0.12 - -0.04
-0.03 - 0.04
0.05 - 0.12
0.13 - 0.23
0.24 - 0.33
0.34 - 0.64

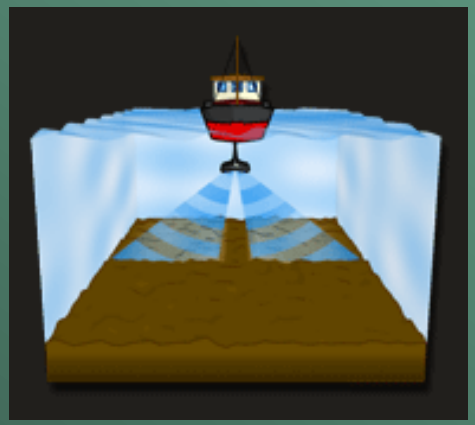
USGS

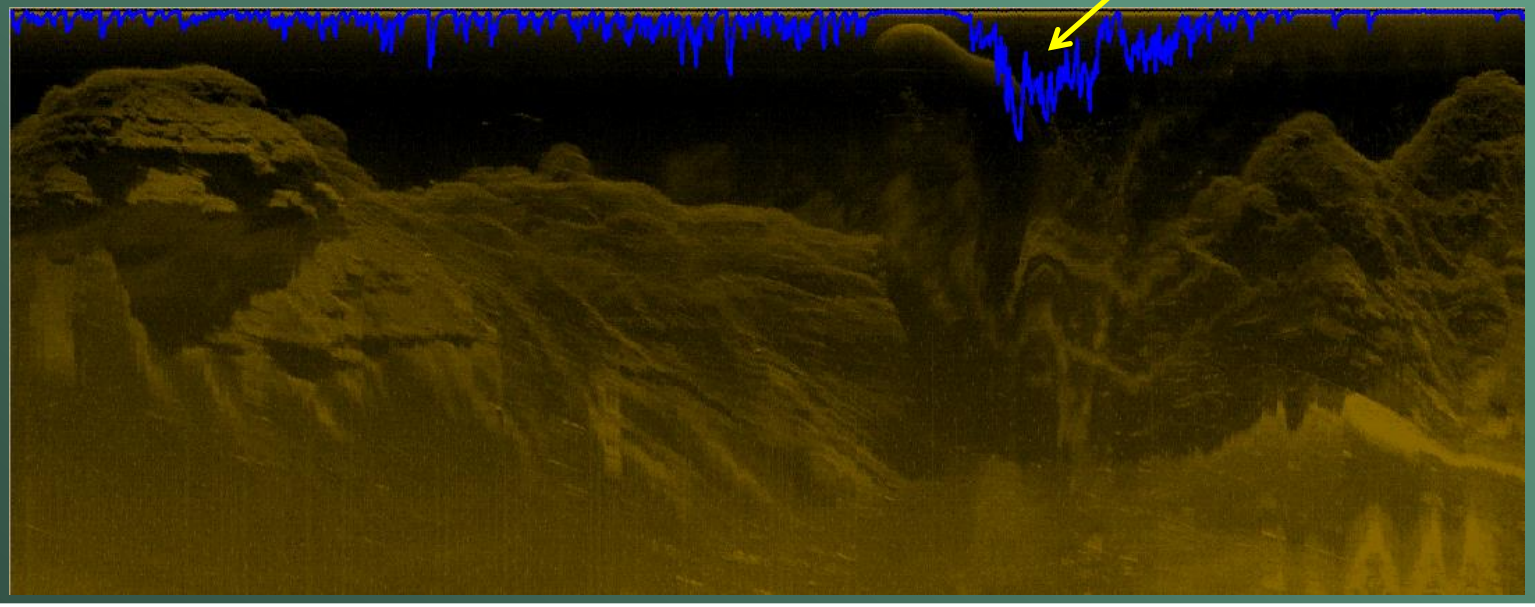


USGS
science for a changing world

Bathymetric and Velocity survey of the Wabash River near New Harmony, Indiana

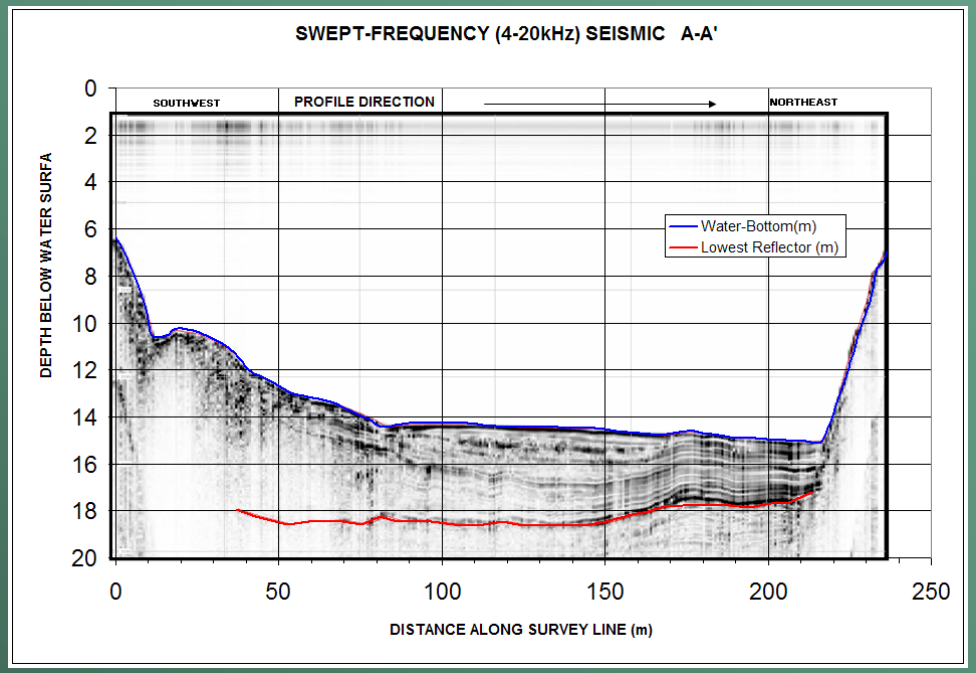
Side Scan Sonar





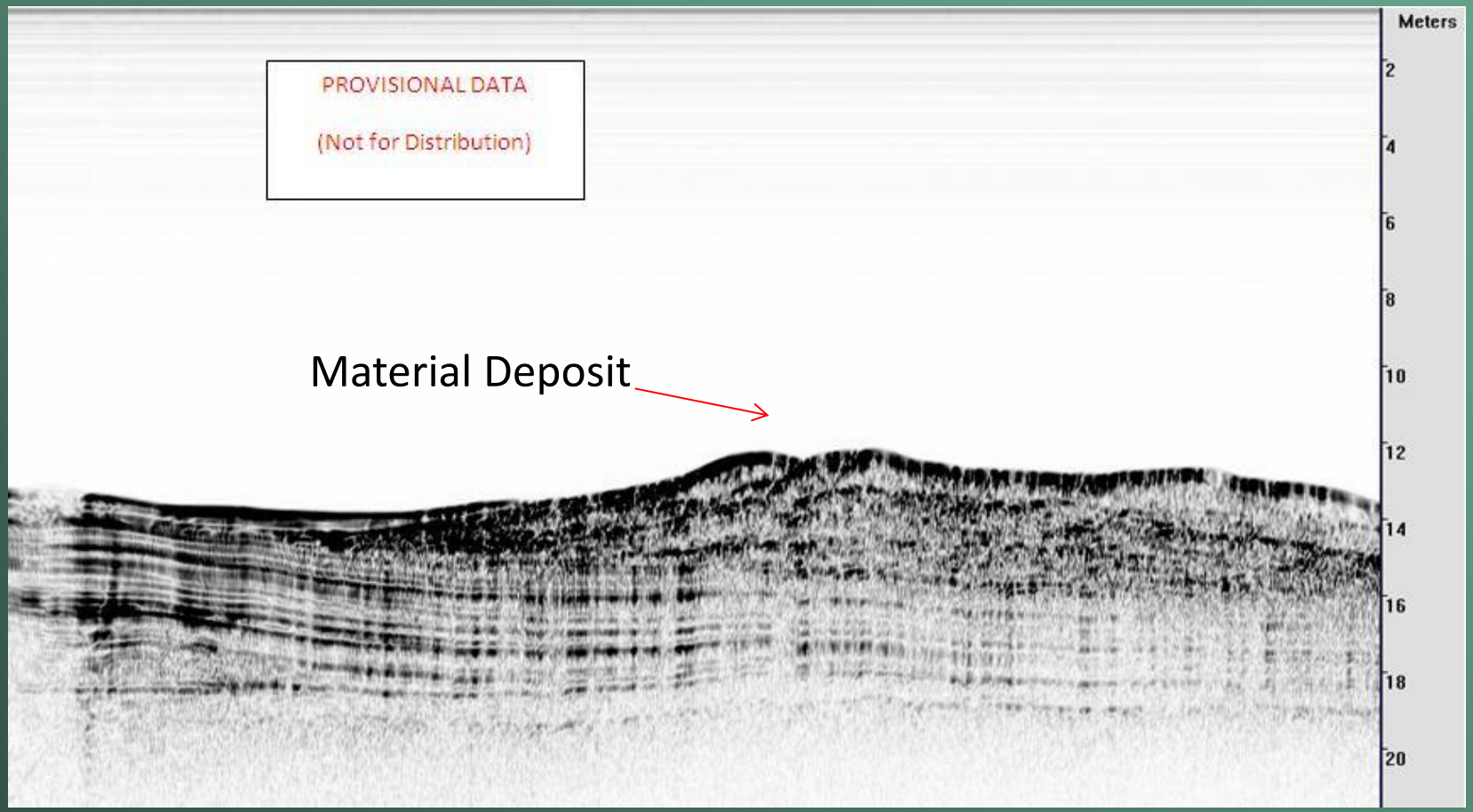
USGS

Swept-frequency acoustic sub-bottom profiler



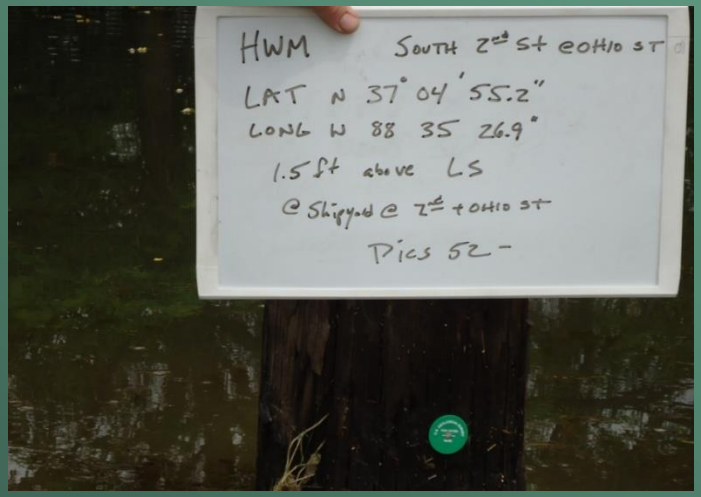
USGS

Swept-frequency acoustic sub-bottom profiler



USGS

High Water Mark Collection for Flood Inundation

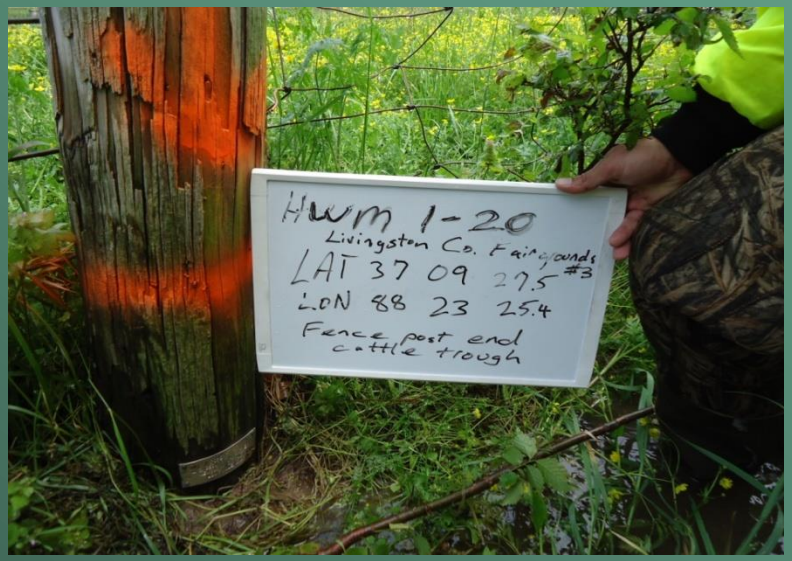


1 ½ weeks

69 total river miles

6 different streams

9 counties



USGS

Determining Elevation

4 crews of 2

222 marks surveyed

USGS

Determining Elevation

Used RTK system with Rover

Conventional levels were run

Checked survey over known points

USGS

Isn’t Everything Fun!!!

USGS