Discharge Measurement:
Mammoth Spring,
Silver Springs Group,
Marion County, Florida;
July 22, 2009

Prepared for:

St. Johns River Water Management District

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INTRODUCTION

The St. Johns River Water Management District (SJRWMD) contracted with Karst Environmental Services, Inc. (KES) to conduct a series of quarterly discharge measurement at Mammoth Spring of the Silver Springs Group in Marion County, Florida. This report documents the results of the measurement made at the site on July 22, 2009. A summary of the results and collected data for that measurement are presented in Table 1.

PURPOSE and SCOPE OF WORK

The purpose of this work was to obtain accurate discharge measurements of the Mammoth Spring, the headspring and major source of groundwater discharge into the Silver River. A quarterly discharge measurement was to be made at the vent of Mammoth Spring during July, 2009.

SITE DESCRIPTION

Mammoth Spring is the largest spring of the Silver Springs Group, and is the headspring of the Silver River. The spring lies within a spring pool surrounded by the Silver Springs theme park. Mammoth Spring's vent is a wide, oval-shaped opening about 69 feet across, with floor to ceiling heights that vary from under 2 to over 6 feet. The depth of this vent ranges between 24 and 34 feet deep. The rock that comprises the ceiling of this vent is solid and self-supported, with the floor beneath composed of a layer of boulders and rubble. See Figure 1.

A large cavern with a complex network of cave passages lies inside of this vent. These cave passages supply waters of varying characteristics to the cavern, where some mixing occurs before these waters exit the vent. The inside of the cavern is a complex structure of breakdown boulders, bedding planes, and small passageways. It was determined during prior investigations that discharge measurements of individual water sources within the cavern would be problematic, if not impossible. The outer edge of this spring vent provided the best location for an underwater discharge measurement with an appropriately adapted instrument.

PERSONNEL

Fieldwork for this discharge measurement was performed by KES personnel Peter Butt, Mark Long, Matt Hubner and Wayne Kinard. Data management and report preparation was performed by Peter Butt and Georgia Shemitz. Data processing using Surfer 8 contouring software was performed by W. Bruce Lafrenz, P.G., of Tetra Tech of Orlando, Florida.

METHODS

Instrumentation

The instruments used for this discharge measurement were Marsh-McBirney Model 2000 Flo-Mate electronic flowmeters, Serial Numbers 2002679 and 2006103, that have been adapted for fully submersible use. In order to operate and read the meter at depth, the unit has been placed within an underwater housing with a transparent lid. The sensor wire is routed through a sealing gland on the housing lid. There are two housing controls that allow for direct operation of the

flow meter. One operates the on/off/reset buttons, and the other operates the time interval selector buttons that control the measurement period.

The flowmeters used were factory calibrated while in their underwater housing in the method normally used for these units on April 7, 2008 and May 15, 2009. Copies of the Calibration Certificates are included with this report.

Field Operations

Velocity measurements were taken just inside the ceiling edge of the vent. At the measurement site, the floor of the vent was 34 feet deep, and the ceiling was 25 feet deep.

A positioning grid of telescoping aluminum poles with 0.1, 0.25, 0.5 and one-foot interval markings that provided support for the sensor was set up by Pete Butt on July 21, 2009. Butt also recorded measurements of the grid and surrounding walls. Seventeen poles (labeled A to Q) were positioned vertically to provide the primary positioning grid for velocity measurements. Eight horizontal poles were used as a spacing reference, and fastened to the vertical poles for support. Conduit dimensions around the grid were measured with a collapsible steel tape. As all sensor-support poles were positioned at roughly right angles to the main flow path, no angle coefficient corrections for velocity readings were made. The flowmeter sensor was attached to the poles with a low-profile metal spring clamp. Most measurement stations were set using one-foot intervals on the vertical poles. Velocity stations and boundary points are identified with alpha-numeric labels, based on the letter assigned to identify each vertical pole. See Figure 2.

Pete Butt and Mark Long positioned the sensors and recorded positional data. Matt Hubner and Wayne Kinard took the velocity readings after taking reset cues from Butt and Long, and also recorded positional data. During all measurements, the sensor handlers were able to move away from the measurement cross-section, and remove themselves from the cross section of the flow. The meter operators were also positioned downstream and away from the cross-section. This minimized or eliminated the possibility of interference with flow while the measurements were taken. The flowmeters were operated in the "Fixed Point Averaging" mode. Fixed Point Averaging is an average of velocities over a fixed period of time. Averaging periods of 60 seconds were used. The flowmeters were reset between each station. One-hundred and sixty-nine (169) station readings were made. Meter S/N 2002679 was operated from Pole A through Pole N, and meter S/N 2006103 was operated from Pole Q through Pole O.

Data Processing

Field measurements of the velocity measurement stations and measured vent boundary points were plotted on grid paper and assigned X- and Y-axis values. Boundary filler points were generated for the measured boundary points. See Figure 1. Values for the Z-axis were the point velocities, and zero values were assigned to the cross-section boundary points. See Table 3. The X, Y and Z data was processed using the Surfer v.8 (by Golden Software, Inc.) contouring program. The gridding method used was point Kriging with linear drift, an anisotropy ratio of 3 at an angle of 0°, and a variogram slope of 1.0. The anisotropy ratio used was selected due to the extremely elongated horizontal aspect of the measurement cross-section. The results of the contour processing are illustrated in Figures 3 and 4.

During this measurement, one negative velocity was measured. Negative velocity stations typically represent slight back eddies near walls. In order to incorporate these negative values, calculations were made using a Surfer 8 "blanking file" operation to define the measurement

cross-section boundary. The blanking file operation also assists in the elimination of artifacts present in the contouring process that would create inaccuracies in the flow calculations.

The total discharge is shown on Table 2 as the **Net Volume (Cut-Fill)**, and has been calculated as the Positive Volume (Cut) less that portion of the Negative Volume (Fill) lying within the measurement cross-section boundary walls that define the plane of measurement.

The software also calculates the total cross-sectional area of the measurement location within the passage, and is presented on page 1 of Table 2 as the **Operational Planar Area**. The Operational Planar Area is the sum of the Positive (Cut) and that portion of the Negative (Fill) Planar areas lying within the measurement cross-section boundary walls that define the plane of measurement.

RESULTS AND DISCUSSION

This measurement is the eighth one performed at Mammoth Spring applying the method and data processing used at other spring sites by KES. This measurement site also represents the largest cross-section and amount of discharge measured by KES. Based on KES' experience at other springs, the estimate of discharge for this measurement should be considered to be a minimum value. Due to the extremely elongated cross-section, a high anisotropy ratio setting was used to minimize a "bull's eye" or "curtain" effect that occurs in the contouring and has the unwanted effect of lowering the actual discharge value.

The estimated discharge of Mammoth Spring on July 22, 2008 was 247.39 CFS (cubic feet per second). This result is also expressed as 111036 GPM (gallons per minute) or 159.892 MGD (million gallons per day), see Table 1. One-hundred and sixty-nine (169) readings were made, see Figures 2, 3 and 4. The point velocity readings ranged from -0.02 to 1.15 feet per second (fps), with an overall average station reading of 0.78 fps. The total cross-sectional area was calculated as 309.6 square feet. Individual point velocity measurement periods of 60 seconds were used. The measurements commenced at about 11:48 hours and were completed by 14:41 hours.

KES supported SJRWMD water sampling activities at Mammoth Spring and Catfish Hotel Spring during the morning of July 21, 2009.

UNDERWATER DISCHARGE MEASUREMENT							
Location:	**MAMMOTH SPRING (Silver Springs Group)**				Marion County, Florida		
Personnel:	Peter Butt, Mark Long, Matt Hubner, Wayne Kinard						
Method:	Grid within irregular conduit/cross-section						
Instrument:	MMB2000 FLO-MATE in U/W case, sensor on support poles						
Analysis Method: Surfer 8 with kriging							
Mammoth Spring Total Discharge:			**Date:**	**July 22, 2009**			
CFS	**247.39**		Time Start:	11:48			
MGD	**159.892**		Time End:	14:41			
GPM	**111036**						
Total Cross-sectional Area:		309.60	square feet	Msmt. Periods:			
Avg. Station Point Velocity:		0.78	feet/second	60 seconds			
Cross-section Depth:		25-34	feet deep				
Velocity Reading by Station:		(All velocity readings in feet per second.)					

Station #	Point Velocity	Station #	Point Velocity	Station #	Point Velocity	Station #	Point Velocity
AH1	0.01	E3	0.9	I8	0.96	M6	0.98
AH2	0.34	E4	0.95	IJ1	1.03	M7	1.07
A1	0.31	E5	1.02	IJ2	1.01	M8	0.95
A2	0.25	E6	0.98	IJ3	0.96	MN1	1
A3	0.17	EF1	1.02	J1	0.13	MN2	0.99
A4	0.19	EF2	1.03	J2	0.74	MN3	0.99
A5	0.26	EF3	1.05	J3	1.02	N1	0.05
A6	0.3	F1	0.12	J4	1	N2	0.56
A7	0.44	F2	0.65	J5	1.11	N3	0.88
AB1	0.32	F3	1.08	J6	1.09	N4	0.91
AB2	0.46	F4	1.05	J7	1.13	N5	0.99
AB3	0.5	F5	0.96	J8	0.97	N6	1.07
B1	0.4	F6	0.39	JK1	0.93	N7	0.95
B2	0.64	FG1	1.07	JK2	0.92	NO1	0.93
B3	0.49	FG2	1.07	JK3	0.93	NO2	0.96
B4	0.46	FG3	1.04	K1	0.43	NO3	0.98
B5	0.93	G1	0.3	K2	0.96	O1	0.6
B6	0.44	G2	0.76	K3	0.98	O2	0.87
B7	-0.02	G3	0.96	K4	1	O3	0.99
BC1	0.63	G4	1.02	K5	1.1	O4	1.1
BC2	0.87	G5	0.82	K6	1.08	O5	0.91
BC3	0.92	G6	0.52	K7	1.14	OP1	0.95
C1	0.61	GH1	1	K8	0.87	OP2	0.9
C2	0.86	GH2	0.97	KL1	1.02	OP3	0.92
C3	0.91	GH3	0.93	KL2	1.03	P1	0.76
C4	1.01	H1	0.06	KL3	0.98	P2	0.85
C5	1.09	H2	0.61	L1	0.47	P3	0.83
C6	1.13	H3	0.87	L2	0.83	P4	0.83
C7	0.72	H4	1	L3	0.96	P5	0.77
CD1	0.99	H5	0.94	L4	1.04	P6	0.9
CD2	1.11	H6	0.94	L5	1.06	PQ1	0.49
CD3	1.04	H7	0.97	L6	1.09	PQ2	0.49
D1	0.48	HI1	0.82	L7	1.15	PQ3	0.47
D2	1.06	HI2	0.92	L8	1.04	Q1	0
D3	1.05	HI3	1.04	LM1	0.97	Q2	0.01
D4	1.11	I1	0.09	LM2	0.96	Q3	0.12
D5	1	I2	0.73	LM3	0.96	Q4	0.16
D6	0.31	I3	0.99	M1	0.14	Q5	0.3
DE1	1.12	I4	0.97	M2	0.66	Q6	0.35
DE2	1.1	I5	1	M3	0.87	Q7	0.18
DE3	0.95	I6	1.06	M4	0.96	QH2	0.38
E1	0.49	I7	1.04	M5	1.03	QH1	0.3
E2	0.9						

Table 1. Discharge of Mammoth Spring, Silver Springs Group, Marion County, Florida on July 22, 2009. Data record and calculation of discharge measurement.

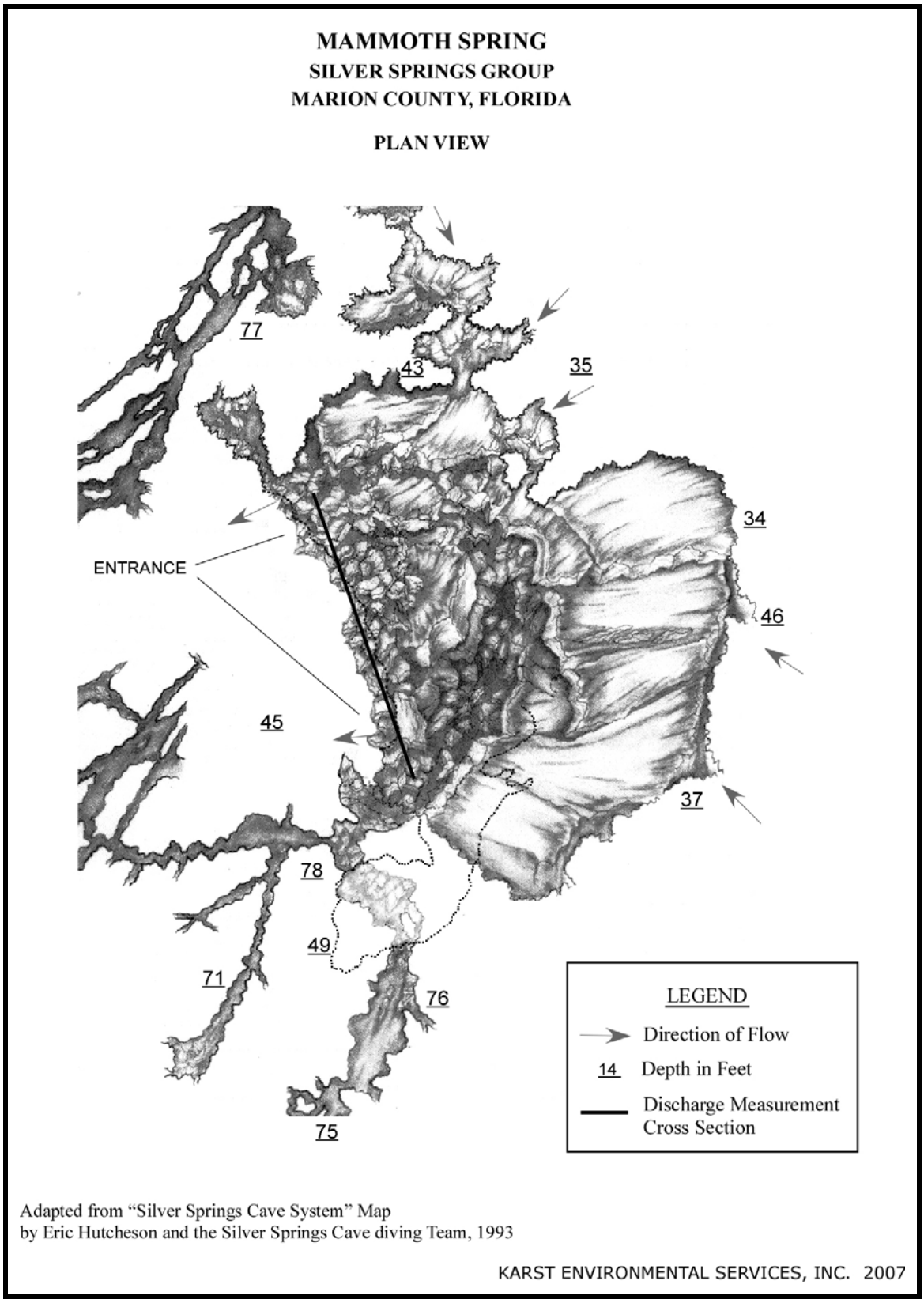

Figure 1. Map of Mammoth Spring, Silver Springs Group, Marion County, Florida.

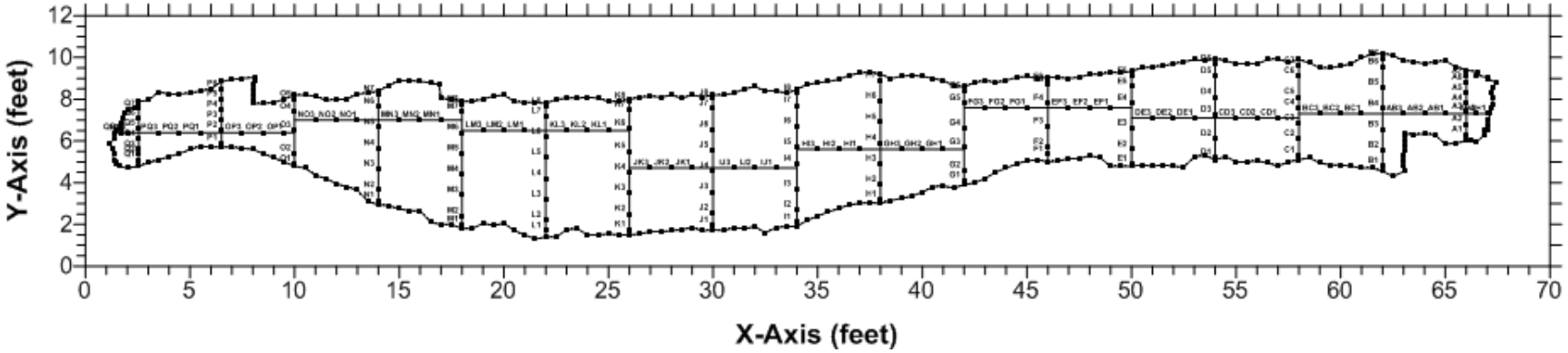

Figure 2. Discharge measurement cross-section; Mammoth Spring, Marion County, Florida, July 22, 2009 measurement. Cross-section is viewed to the upstream of observer, and is located between the 25- and 34-foot depth levels. Support poles are represented by dashed lines. Velocity measurement stations are shown as points along the support poles. See Table 1 for station velocities. Boundary wall of the cross section is shown as the perimeter ring of connected points. X- and Y-axis scales are shown in feet.

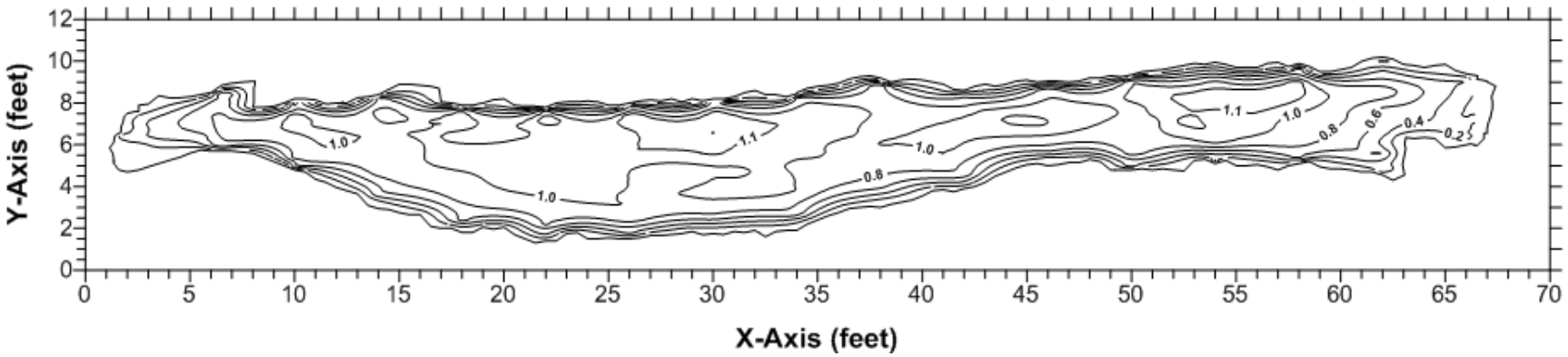

Figure 3. Discharge measurement cross-section; Mammoth Spring, Marion County, Florida, July 22, 2009 measurement. Flow contour velocities are shown in feet per second. Areas with negative velocities (reverse flow) are shaded and delineated by hatched lines. Outer boundary of cross section represents the zero-value contour. X- and Y-axis scales are shown in feet.

TABLE 2. MAMMOTH SPRING, JULY 22, 2009.
SURFER 8 GRID VOLUME COMPUTATIONS AND GRIDDING REPORT

UPPER SURFACE

Grid File Name:	G:\Hydro\KES\Mammoth\2009\Mammoth 07-22-09\Mammoth 7-22-09.bln.grd
Grid Size:	61 rows x 356 columns
X Minimum:	0
X Maximum:	71
X Spacing:	0.2
Y Minimum:	0
Y Maximum:	12
Y Spacing:	0.2
Z Minimum:	-0.012678437149366
Z Maximum:	1.1573684758076

LOWER SURFACE
Level Surface defined by Z = 0

VOLUMES
Z Scale Factor: 1
Total Volumes by:

Trapezoidal Rule:	247.39163971577
Simpson's Rule:	247.35250164494
Simpson's 3/8 Rule:	247.38999207724

CUT & FILL VOLUMES
Positive Volume [Cut]: 247.39221873556
Negative Volume [Fill]: 0.00057901979171666
Net Volume [Cut-Fill]: 247.39163971577<<<<<<Total Discharge in CFS
(The Net Volume value is used due to the presence of negative velocity values.
Positive Vol. Cut - Negative Vol. Fill = Net Volume. Please refer to report text.)

AREAS
Planar Areas
Operational Planar Area: 309.60 <<<<Total Cross-section Area in Square Feet
(Calculated using blanking file due to the presence of negative velocity values;
Operational Planar Area = [P.P.A.Cut + N.P.A.Fill] = [Total Planar Area - Blanked Planar Area].
Please refer to report text.)
Positive Planar Area [Cut]: 309.594937195
Negative Planar Area [Fill]: 0.0050628050016539
Blanked Planar Area: 542.4
Total Planar Area: 852

Surface Areas
Positive Surface Area [Cut]: 351.42534773021
Negative Surface Area [Fill]: 0.0060752875417456

GRIDDING REPORT

Data Source

Source Data File Name:	G:\Hydro\KES\Mammoth\2009\Mammoth 07-22-09\Mammoth 7-22-09SURFERXYZT3750PointsBLF.xlsx (sheet 'Silver Spring 7-22-09')
X Column:	A
Y Column:	B
Z Column:	C

Data Counts

Active Data:	750
Original Data:	750
Excluded Data:	0
Deleted Duplicates:	0
Retained Duplicates:	0
Artificial Data:	0
Superseded Data:	0

Univariate Statistics

	X	Y	Z
Minimum:	1.15	1.3	-0.02
25%-tile:	16.75	4.8	0
Median:	34	6.6	0
75%-tile:	51.75	8.4	0
Maximum:	67.4	10.2	1.15
Midrange:	34.275	5.75	0.565
Range:	66.25	8.9	1.17
Interquartile Range:	35	3.6	0
Median Abs. Deviation:	17.5	1.8	0
Mean:	34.0846112	6.3517703466667	0.17661333333333
Trim Mean (10%):	34.060811390533	6.4188280473373	0.13721893491124
Standard Deviation:	20.011631299244	2.4990231031515	0.36055993097157
Variance:	400.46538725688	6.245116470085	0.13000346382222
Coef. of Variation:			2.0415215780513
Coef. of Skewness:			1.7101674075608

Inter-Variable Correlation

	X	Y	Z
X:	1.000	0.203	-0.018
Y:		1.000	0.014
Z:			1.000

Inter-Variable Covariance

	X	Y	Z
X:	400.46538725688	10.148917053639	-0.12742879940267
Y:		6.245116470085	0.012741999840711
Z:			0.13000346382222

Planar Regression: Z = AX+BY+C

Fitted Parameters

	A	B	C
Parameter Value:	-0.00038579796956996	0.0026672731426436	0.17282120067397
Standard Error:	0.0006730203848378	0.0053894002745572	0.039411529251345

Inter-Parameter Correlations

	A	B	C
A:	1.000	0.203	-0.406
B:		1.000	0.750
C:			1.000

ANOVA Table

Source	df	Sum of Squares	Mean Square	F
Regression:	2	0.062361124524739	0.031180562262369	0.23904
Residual:	747	97.440236742141	0.13044208399216	
Total:	749	97.502597866666		

Coefficient of Multiple Determination (R^2): 0.00063958423559152

Nearest Neighbor Statistics

	Separation	|Delta Z|
Minimum:	0.05	0
25%-tile:	0.25	0
Median:	0.25495097567964	0
75%-tile:	0.26925824035673	0.01
Maximum:	1	1.04

Midrange:	0.525	0.52
Range:	0.95	1.04
Interquartile Range:	0.019258240356725	0.01
Median Abs. Deviation:	0.0060566870431249	0
Mean:	0.34084205665561	0.0756
Trim Mean (10%):	0.31755716489831	0.038594674556213
Standard Deviation:	0.24247753780307	0.20217312712953
Variance:	0.05879535633904	0.040873973333333
Coef. of Variation:	0.71140733095644	2.6742477133536
Coef. of Skewness:	2.0499819516444	3.1509862216439
Root Mean Square:	0.41829255781602	0.21584562384569
Mean Square:	0.17496866392427	0.046589333333333

Complete Spatial Randomness

Lambda:	1.2719949120204
Clark and Evans:	0.76882210207819
Skellam:	1048.785758477

Exclusion Filtering

Exclusion Filter String: Not In Use

Duplicate Filtering

Duplicate Points to Keep: First
X Duplicate Tolerance: 7.8E-006
Y Duplicate Tolerance: 1E-006
No duplicate data were found.

Breakline Filtering

Breakline Filtering: Not In Use

Gridding Rules

Gridding Method: Kriging
Kriging Type: Point
Polynomial Drift Order: 1
Kriging std. deviation grid: no

Semi-Variogram Model

Component Type: Linear
Anisotropy Angle: 0
Anisotropy Ratio: 3
Variogram Slope: 1

Search Parameters

No Search (use all data): true

Output Grid

Grid File Name:	G:\Hydro\KES\Mammoth\2009\Mammoth 07-22-09\Mammoth 7-22-09.grd
Grid Size:	61 rows x 356 columns
Total Nodes:	21716
Filled Nodes:	21716
Blanked Nodes:	0
Blank Value:	1.70141E+038

Grid Geometry

X Minimum:	0
X Maximum:	71
X Spacing:	0.2
Y Minimum:	0
Y Maximum:	12
Y Spacing:	0.2

Grid Statistics

Z Minimum:	-1.2120487902532
Z 25%-tile:	-0.57047269813482
Z Median:	-0.25691335696626
Z 75%-tile:	0.68699362166953
Z Maximum:	1.1573684758076
Z Midrange:	-0.027340157222801
Z Range:	2.3694172660607
Z Interquartile Range:	1.2574663198044
Z Median Abs. Deviation:	0.41091776666097
Z Mean:	-0.029959297613138
Z Trim Mean (10%):	-0.036188607067434
Z Standard Deviation:	0.67877963294119
Z Variance:	0.46074179009577
Z Coef. of Variation:	-1
Z Coef. of Skewness:	0.43533702976167
Z Root Mean Square:	0.67944046803914
Z Mean Square:	0.46163934960925

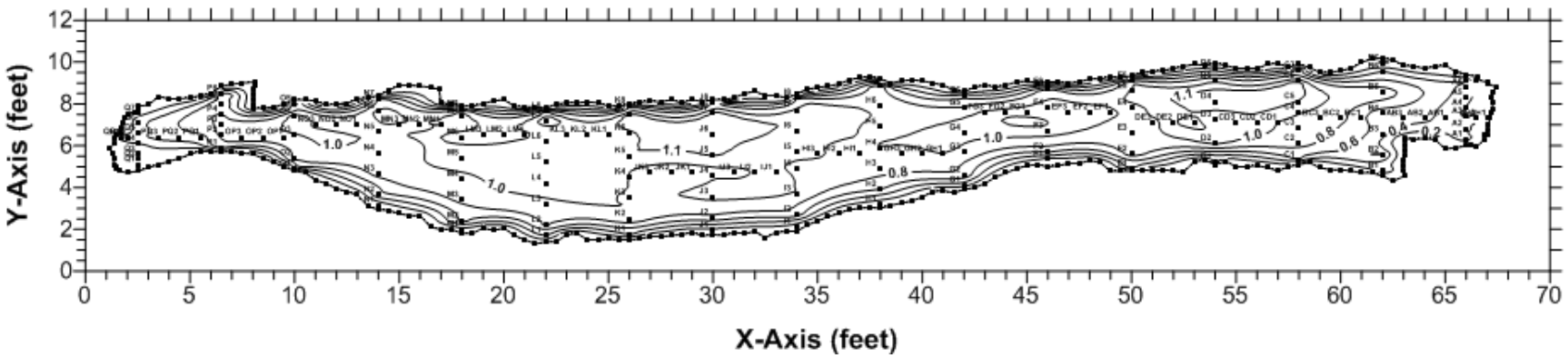

Figure 4. Discharge measurement cross-section; Mammoth Spring, Marion County, Florida, July 22, 2009 measurement. Relationship of flow contours (velocities shown in feet per second) and velocity measurement stations (labeled points) are shown. Areas with negative velocities (reverse flow) are shaded and delineated by hatched lines. See Table 1 for station velocities. Boundary wall of the cross section is shown as the perimeter ring of connected points. X- and Y-axis scales are shown in feet.

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Table 3. Silver Springs Main Spring XYZ Grid Data, July 22, 2009.					
X	Y	Z (Velocity)	Station Name	X Plot	Y Plot
67	7.3	0.01	AH1	670	73
66.5	7.3	0.34	AH2	665	73
66	6.3	0.31	A1	660	63
66	6.8	0.25	A2	660	68
66	7.4	0.17	A3	660	74
66	7.8	0.19	A4	660	78
66	8.3	0.26	A5	660	83
66	8.8	0.3	A6	660	88
66	9.1	0.44	A7	660	91
65	7.3	0.32	AB1	650	73
64	7.3	0.46	AB2	640	73
63	7.3	0.5	AB3	630	73
62	4.8	0.4	B1	620	48
62	5.55	0.64	B2	620	55.5
62	6.55	0.49	B3	620	65.5
62	7.55	0.46	B4	620	75.5
62	8.55	0.93	B5	620	85.5
62	9.55	0.44	B6	620	95.5
62	9.95	-0.02	B7	620	99.5
61	7.3	0.63	BC1	610	73
60	7.3	0.87	BC2	600	73
59	7.3	0.92	BC3	590	73
58	5.3	0.61	C1	580	53
58	6.1	0.86	C2	580	61
58	6.85	0.91	C3	580	68.5
58	7.6	1.01	C4	580	76
58	8.1	1.09	C5	580	81
58	9.1	1.13	C6	580	91
58	9.6	0.72	C7	580	96
57	7.1	0.99	CD1	570	71
56	7.1	1.11	CD2	560	71
55	7.1	1.04	CD3	550	71
54	5.2	0.48	D1	540	52
54	6.1	1.06	D2	540	61
54	7.25	1.05	D3	540	72.5
54	8.1	1.11	D4	540	81
54	9.1	1	D5	540	91
54	9.7	0.31	D6	540	97
53	7.1	1.12	DE1	530	71

X	Y	Z (Velocity)	Station Name	X Plot	Y Plot
52	7.1	1.1	DE2	520	71
51	7.1	0.95	DE3	510	71
50	4.9	0.49	E1	500	49
50	5.6	0.9	E2	500	56
50	6.6	0.9	E3	500	66
50	7.8	0.95	E4	500	78
50	8.6	1.02	E5	500	86
50	9.1	0.98	E6	500	91
49	7.6	1.02	EF1	490	76
48	7.6	1.03	EF2	480	76
47	7.6	1.05	EF3	470	76
46	5.35	0.12	F1	460	53.5
46	5.7	0.65	F2	460	57
46	6.7	1.08	F3	460	67
46	7.8	1.05	F4	460	78
46	8.7	0.96	F5	460	87
46	8.85	0.39	F6	460	88.5
45	7.6	1.07	FG1	450	76
44	7.6	1.07	FG2	440	76
43	7.6	1.04	FG3	430	76
42	4.1	0.3	G1	420	41
42	4.6	0.76	G2	420	46
42	5.7	0.96	G3	420	57
42	6.6	1.02	G4	420	66
42	7.8	0.82	G5	420	78
42	8.4	0.52	G6	420	84
41	5.6	1	GH1	410	56
40	5.6	0.97	GH2	400	56
39	5.6	0.93	GH3	390	56
38	3.2	0.06	H1	380	32
38	3.9	0.61	H2	380	39
38	4.9	0.87	H3	380	49
38	5.9	1	H4	380	59
38	6.9	0.94	H5	380	69
38	7.9	0.94	H6	380	79
38	8.9	0.97	H7	380	89
37	5.6	0.82	HI1	370	56
36	5.6	0.92	HI2	360	56
35	5.6	1.04	HI3	350	56
34	2.1	0.09	I1	340	21

X	Y	Z (Velocity)	Station Name	X Plot	Y Plot
34	2.7	0.73	I2	340	27
34	3.7	0.99	I3	340	37
34	4.9	0.97	I4	340	49
34	5.7	1	I5	340	57
34	6.7	1.06	I6	340	67
34	7.7	1.04	I7	340	77
34	8.3	0.96	I8	340	83
33	4.7	1.03	IJ1	330	47
32	4.7	1.01	IJ2	320	47
31	4.7	0.96	IJ3	310	47
30	1.95	0.13	J1	300	19.5
30	2.55	0.74	J2	300	25.5
30	3.55	1.02	J3	300	35.5
30	4.55	1	J4	300	45.5
30	5.55	1.11	J5	300	55.5
30	6.55	1.09	J6	300	65.5
30	7.55	1.13	J7	300	75.5
30	8.05	0.97	J8	300	80.5
29	4.7	0.93	JK1	290	47
28	4.7	0.92	JK2	280	47
27	4.7	0.93	JK3	270	47
26	1.75	0.43	K1	260	17.5
26	2.5	0.96	K2	260	25
26	3.5	0.98	K3	260	35
26	4.5	1	K4	260	45
26	5.5	1.1	K5	260	55
26	6.6	1.08	K6	260	66
26	7.5	1.14	K7	260	75
26	7.9	0.87	K8	260	79
25	6.5	1.02	KL1	250	65
24	6.5	1.03	KL2	240	65
23	6.5	0.98	KL3	230	65
22	1.7	0.47	L1	220	17
22	2.2	0.83	L2	220	22
22	3.2	0.96	L3	220	32
22	4.2	1.04	L4	220	42
22	5.2	1.06	L5	220	52
22	6.2	1.09	L6	220	62
22	7.2	1.15	L7	220	72
22	7.65	1.04	L8	220	76.5
21	6.5	0.97	LM1	210	65
20	6.5	0.96	LM2	200	65
19	6.5	0.96	LM3	190	65

X	Y	Z (Velocity)	Station Name	X Plot	Y Plot
18	2	0.14	M1	180	20
18	2.4	0.66	M2	180	24
18	3.4	0.87	M3	180	34
18	4.4	0.96	M4	180	44
18	5.4	1.03	M5	180	54
18	6.4	0.98	M6	180	64
18	7.4	1.07	M7	180	74
18	7.75	0.95	M8	180	77.5
17	7	1	MN1	170	70
16	7	0.99	MN2	160	70
15	7	0.99	MN3	150	70
14	3.15	0.05	N1	140	31.5
14	3.65	0.56	N2	140	36.5
14	4.65	0.88	N3	140	46.5
14	5.65	0.91	N4	140	56.5
14	6.65	0.99	N5	140	66.5
14	7.65	1.07	N6	140	76.5
14	8.25	0.95	N7	140	82.5
13	7	0.93	NO1	130	70
12	7	0.96	NO2	120	70
11	7	0.98	NO3	110	70
10	4.9	0.6	O1	100	49
10	5.4	0.87	O2	100	54
10	6.5	0.99	O3	100	65
10	7.4	1.1	O4	100	74
10	8	0.91	O5	100	80
	0				
9.5	6.4	0.95	OP1	95	64
8.5	6.4	0.9	OP2	85	64
7.5	6.4	0.92	OP3	75	64
6.5	5.9	0.76	P1	65	59
6.5	6.5	0.85	P2	65	65
6.5	7	0.83	P3	65	70
6.5	7.5	0.83	P4	65	75
6.5	8	0.77	P5	65	80
6.5	8.5	0.9	P6	65	85
5.5	6.4	0.49	PQ1	55	64
4.5	6.4	0.49	PQ2	45	64
3.5	6.4	0.47	PQ3	35	64
2.55	5.1	0	Q1	25.5	51
2.55	5.35	0.01	Q2	25.5	53.5

X	Y	Z (Velocity)	Station Name	X Plot	Y Plot
2.55	5.6	0.12	Q3	25.5	56
2.55	6.1	0.16	Q4	25.5	61
2.55	6.6	0.3	Q5	25.5	66
2.55	7.1	0.35	Q6	25.5	71
2.55	7.55	0.18	Q7	25.5	75.5
2	6.4	0.38	QH2	20	64
1.7	6.4	0.3	QH1	17	64
67.15	7.3	0	AE	671.5	73
66	9.4	0	AT	660	94
66	6	0	AS	660	60
62	10.2	0	BT	620	102
62	4.55	0	BS	620	45.5
58	9.9	0	CT	580	99
58	5.1	0	CS	580	51
54	9.95	0	DT	540	99.5
54	5.1	0	DS	540	51
50	9.35	0	ET	500	93.5
50	4.8	0	ES	500	48
46	9.05	0	FT	460	90.5
46	5	0	FS	460	50
42	8.6	0	GT	420	86
42	3.9	0	GS	420	39
38	9.2	0	HT	380	92
38	3	0	HS	380	30
34	8.5	0	IT	340	85
34	8.45	0	ITX	340	84.5
34	1.9	0	IS	340	19
30	8.2	0	JT	300	82
30	1.75	0	JS	300	17.5
26	8	0	KT	260	80
26	1.5	0	KS	260	15
22	7.8	0	LT	220	78
22	1.4	0	LS	220	14
18	7.9	0	MT	180	79
18	1.8	0	MS	180	18
14	8.4	0	NT	140	84
14	2.95	0	NS	140	29.5
10	8.2	0	OT	100	82
10	4.8	0	OS	100	48
6.5	8.85	0	PT	65	88.5
6.5	5.7	0	PS	65	57
2.55	7.9	0	QT	25.5	79
2.55	7.6	0	QTX	25.5	76
2.55	7.75	0	QTX1	25.5	77.5
2.55	4.8	0	QS	25.5	48
1.4	6.4	0	QE	14	64

X	Y	Z (Velocity)	Station Name	X Plot	Y Plot
67.2	7.55	0	AETA	672	75.5
67.25	7.75	0	AETB	672.5	77.5
67.25	8.05	0	AETC	672.5	80.5
67.2	8.3	0	AETD	672	83
67.3	8.55	0	AETE	673	85.5
67.4	8.8	0	AETF	674	88
67	9	0	AETG	670	90
67	9.05	0	AETH	670	90.5
66.5	9.15	0	AETI	665	91.5
66.55	9.3	0	AETJ	665.5	93
67.05	7.05	0	AESA	670.5	70.5
67	6.8	0	AESB	670	68
67	6.55	0	AESC	670	65.5
66.85	6.55	0	AESD	668.5	65.5
66.85	6.3	0	AESE	668.5	63
66.5	5.95	0	AESF	665	59.5
66.2	6.05	0	AESG	662	60.5
65.5	9.55	0	ATA	655	95.5
65	9.85	0	ATB	650	98.5
64.5	9.8	0	ATC	645	98
64	9.7	0	ATD	640	97
63.5	9.8	0	ATE	635	98
63	9.85	0	ATF	630	98.5
62.5	10.1	0	ATG	625	101
65.5	5.9	0	ASA	655	59
65	5.85	0	ASB	650	58.5
64.5	6.3	0	ASC	645	63
64	6.35	0	ASD	640	63.5
63.5	6.3	0	ASE	635	63
63.1	6.35	0	ASF	631	63.5
63.1	6.3	0	ASG	631	63
63.05	6.05	0	ASH	630.5	60.5
63.1	5.8	0	ASI	631	58
63.05	5.55	0	ASJ	630.5	55.5
63	5.3	0	ASK	630	53
62.95	5.05	0	ASL	629.5	50.5
63	4.8	0	ASM	630	48
63.05	4.55	0	ASN	630.5	45.5
62.5	4.3	0	ASO	625	43
61.5	10.15	0	BTA	615	101.5
61	10	0	BTB	610	100
60.5	9.7	0	BTC	605	97
60	9.6	0	BTD	600	96
59.5	9.5	0	BTE	595	95
59	9.5	0	BTF	590	95
58.5	9.75	0	BTG	585	97.5
61.5	4.7	0	BSA	615	47

X	Y	Z (Velocity)	Station Name	X Plot	Y Plot
61	4.7	0	BSB	610	47
60.5	4.8	0	BSC	605	48
60	4.85	0	BSD	600	48.5
59.5	4.85	0	BSE	595	48.5
59	4.95	0	BSF	590	49.5
58.5	5.2	0	BSG	585	52
57.5	9.75	0	CTA	575	97.5
57	9.95	0	CTB	570	99.5
56.5	9.9	0	CTC	565	99
56	9.7	0	CTD	560	97
55.5	9.7	0	CTE	555	97
55	9.7	0	CTF	550	97
54.5	9.85	0	CTG	545	98.5
57.5	5	0	CSA	575	50
57	4.8	0	CSB	570	48
56.5	4.95	0	CSC	565	49.5
56	5.05	0	CSD	560	50.5
55.5	5	0	CSE	555	50
55	5	0	CSF	550	50
54.5	5.25	0	CSG	545	52.5
53.5	9.85	0	DTA	535	98.5
53	9.9	0	DTB	530	99
52.5	9.8	0	DTC	525	98
52	9.7	0	DTD	520	97
51.5	9.6	0	DTE	515	96
51	9.55	0	DTF	510	95.5
50.5	9.5	0	DTG	505	95
53.5	5.3	0	DSA	535	53
53	5.25	0	DSB	530	52.5
52.5	4.75	0	DSC	525	47.5
52	4.8	0	DSD	520	48
51.5	4.85	0	DSE	515	48.5
51	4.8	0	DSF	510	48
50.5	4.85	0	DSG	505	48.5
49.5	9.25	0	ETA	495	92.5
49	9.3	0	ETB	490	93
48.5	9.2	0	ETC	485	92
48	9.2	0	ETD	480	92
47.5	9.05	0	ETE	475	90.5
47	9	0	ETF	470	90
46.5	9.05	0	ETG	465	90.5
49.5	4.8	0	ESA	495	48
49	4.8	0	ESB	490	48
48.5	5.2	0	ESC	485	52
48	5.3	0	ESD	480	53
47.5	5.15	0	ESE	475	51.5

X	Y	Z (Velocity)	Station Name	X Plot	Y Plot
47	5.15	0	ESF	470	51.5
46.5	5.05	0	ESG	465	50.5
45.5	9	0	FTA	455	90
45	9.1	0	FTB	450	91
44.5	9.05	0	FTC	445	90.5
44	8.9	0	FTD	440	89
43.5	8.8	0	FTE	435	88
43	8.9	0	FTF	430	89
42.5	8.8	0	FTG	425	88
45.5	5.1	0	FSA	455	51
45	5.05	0	FSB	450	50.5
44.5	4.9	0	FSC	445	49
44	4.7	0	FSD	440	47
43.5	4.5	0	FSE	435	45
43	4.2	0	FSF	430	42
42.5	4	0	FSG	425	40
41.5	8.65	0	GTA	415	86.5
41	8.9	0	GTB	410	89
40.5	9	0	GTC	405	90
40	9.1	0	GTD	400	91
39.5	9.15	0	GTE	395	91.5
39	9.1	0	GTF	390	91
38.5	9	0	GTG	385	90
41.5	3.75	0	GSA	415	37.5
41	3.85	0	GSB	410	38.5
40.5	3.8	0	GSC	405	38
40	3.55	0	GSD	400	35.5
39.5	3.35	0	GSE	395	33.5
39	3.25	0	GSF	390	32.5
38.5	3.15	0	GSG	385	31.5
37.5	9.3	0	HTA	375	93
37	9.25	0	HTB	370	92.5
36.5	9.15	0	HTC	365	91.5
36	8.95	0	HTD	360	89.5
35.5	8.85	0	HTE	355	88.5
35	8.8	0	HTF	350	88
34.5	8.7	0	HTG	345	87
37.5	3.05	0	HSA	375	30.5
37	3	0	HSB	370	30
36.5	2.95	0	HSC	365	29.5
36	2.75	0	HSD	360	27.5
35.5	2.6	0	HSE	355	26
35	2.4	0	HSF	350	24
34.5	2.2	0	HSG	345	22
33.5	8.3	0	ITA	335	83

X	Y	Z (Velocity)	Station Name	X Plot	Y Plot
33	8.4	0	ITB	330	84
32.5	8.4	0	ITC	325	84
32	8.6	0	ITD	320	86
31.5	8.5	0	ITE	315	85
31	8.3	0	ITF	310	83
30.5	8.2	0	ITG	305	82
33.5	1.9	0	ISA	335	19
33	1.85	0	ISB	330	18.5
32.5	1.6	0	ISC	325	16
32	1.9	0	ISD	320	19
31.5	1.8	0	ISE	315	18
31	1.85	0	ISF	310	18.5
30.5	1.7	0	ISG	305	17
29.5	8.1	0	JTA	295	81
29	8.2	0	JTB	290	82
28.5	8.05	0	JTC	285	80.5
28	8.2	0	JTD	280	82
27.5	8.1	0	JTE	275	81
27	8.15	0	JTF	270	81.5
26.5	8.1	0	JTG	265	81
29.5	1.7	0	JSA	295	17
29	1.85	0	JSB	290	18.5
28.5	1.75	0	JSC	285	17.5
28	1.7	0	JSD	280	17
27.5	1.65	0	JSE	275	16.5
27	1.65	0	JSF	270	16.5
26.5	1.55	0	JSG	265	15.5
25.5	7.9	0	KTA	255	79
25	7.9	0	KTB	250	79
24.5	8.05	0	KTC	245	80.5
24	8.1	0	KTD	240	81
23.5	8.05	0	KTE	235	80.5
23	8.05	0	KTF	230	80.5
22.5	8	0	KTG	225	80
25.5	1.5	0	KSA	255	15
25	1.55	0	KSB	250	15.5
24.5	1.5	0	KSC	245	15
24	1.5	0	KSD	240	15
23.5	1.8	0	KSE	235	18
23	1.75	0	KSF	230	17.5
22.5	1.4	0	KSG	225	14
21.5	7.85	0	LTA	215	78.5
21	7.85	0	LTB	210	78.5
20.5	7.9	0	LTC	205	79
20	8.2	0	LTD	200	82
19.5	8.15	0	LTE	195	81.5

X	Y	Z (Velocity)	Station Name	X Plot	Y Plot
19	8	0	LTF	190	80
18.5	7.9	0	LTG	185	79
21.5	1.3	0	LSA	215	13
21	1.5	0	LSB	210	15
20.5	1.7	0	LSC	205	17
20	2.05	0	LSD	200	20.5
19.5	1.95	0	LSE	195	19.5
19	2.05	0	LSF	190	20.5
18.5	1.8	0	LSG	185	18
17.5	8	0	MTA	175	80
17	8.05	0	MTB	170	80.5
16.9	8.7	0	MTBX	169	87
16.5	8.8	0	MTC	165	88
16	8.85	0	MTD	160	88.5
15.5	8.9	0	MTE	155	89
15	8.9	0	MTF	150	89
14.5	8.65	0	MTG	145	86.5
17.5	2	0	MSA	175	20
17	2	0	MSB	170	20
16.5	2.1	0	MSC	165	21
16	2.65	0	MSD	160	26.5
15.5	2.65	0	MSE	155	26.5
15	2.75	0	MSF	150	27.5
14.5	2.9	0	MSG	145	29
13.5	8.3	0	NTA	135	83
13	8.25	0	NTB	130	82.5
12.5	8	0	NTC	125	80
12	8	0	NTD	120	80
11.5	7.95	0	NTE	115	79.5
11	8.15	0	NTF	110	81.5
10.5	8.2	0	NTG	105	82
13.5	3.1	0	NSA	135	31
13	3.65	0	NSB	130	36.5
12.5	3.8	0	NSC	125	38
12	3.95	0	NSD	120	39.5
11.5	4.2	0	NSE	115	42
11	4.35	0	NSF	110	43.5
10.5	4.7	0	NSG	105	47
9.5	8	0	OTA	95	80
9	7.85	0	OTB	90	78.5
8.5	7.8	0	OTC	85	78
8.05	7.8	0	OTD	80.5	78
8	7.8	0	OTE	80	78
8.05	8	0	OTF	80.5	80
8.05	8.25	0	OTG	80.5	82.5
8.05	8.5	0	OTH	80.5	85

X	Y	Z (Velocity)	Station Name	X Plot	Y Plot
8.05	8.75	0	OTI	80.5	87.5
8.1	8.85	0	OTJ	81	88.5
8.1	9.05	0	OTK	81	90.5
7.5	9	0	OTL	75	90
7	8.95	0	OTM	70	89.5
9.5	5	0	OSA	95	50
9	5.2	0	OSB	90	52
8.5	5.4	0	OSC	85	54
8	5.6	0	OSD	80	56
7.5	5.65	0	OSE	75	56.5
7	5.7	0	OSF	70	57
6	8.5	0	PTA	60	85
5.5	8.4	0	PTB	55	84
5	8.3	0	PTC	50	83
4.5	8.25	0	PTD	45	82.5
4	8.25	0	PTE	40	82.5
3.5	8.35	0	PTF	35	83.5
3	7.95	0	PTG	30	79.5
6	5.7	0	PSA	60	57
5.5	5.75	0	PSB	55	57.5
5	5.6	0	PSC	50	56
4.5	5.4	0	PSD	45	54
4	5.25	0	PSE	40	52.5
3.5	5.1	0	PSF	35	51
3	4.95	0	PSG	30	49.5
1.5	6.5	0	QETA	15	65
1.7	6.6	0	QETB	17	66
1.7	6.85	0	QETC	17	68.5
1.8	7.1	0	QETD	18	71
1.85	7.35	0	QETE	18.5	73.5
2	7.5	0	QETF	20	75
2.4	7.6	0	QETG	24	76
1.35	6.1	0	QSEB	13.5	61
1.15	5.85	0	QSEC	11.5	58.5
1.3	5.6	0	QSED	13	56
1.35	5.35	0	QSEE	13.5	53.5
1.35	5.1	0	QSEF	13.5	51
1.45	5	0	QSEG	14.5	50
1.5	4.9	0	QSEH	15	49
1.6	4.8	0	QSEJ	16	48
2	4.7	0	QSEK	20	47
67.2	8.9	0	AETF1	672	89
66.75	9.1	0	AETH1	667.5	91
66.275	9.35	0	AETJ1	662.75	93.5

X	Y	Z (Velocity)	Station Name	X Plot	Y Plot
66.675	6.14	0	AESE1	666.75	61.4
65.75	9.475	0	AT1	657.5	94.75
65.25	9.7	0	ATA1	652.5	97
64.75	9.825	0	ATB1	647.5	98.25
64.25	9.75	0	ATC1	642.5	97.5
63.75	9.75	0	ATD1	637.5	97.5
63.25	9.825	0	ATE1	632.5	98.25
62.75	9.975	0	ATF1	627.5	99.75
62.25	10.15	0	ATG1	622.5	101.5
65.75	5.95	0	AS1	657.5	59.5
65.25	5.875	0	ASA1	652.5	58.75
64.8334	5.98328	0	ASB1	648.334	59.8328
64.6668	6.11656	0	ASB2	646.668	61.1656
64.25	6.325	0	ASC1	642.5	63.25
63.75	6.325	0	ASD1	637.5	63.25
63.3	6.325	0	ASE1	633	63.25
62.775	4.425	0	ASN1	627.75	44.25
62.25	4.425	0	ASO1	622.5	44.25
61.75	10.175	0	BT1	617.5	101.75
61.25	10.075	0	BTA1	612.5	100.75
60.75	9.85	0	BTB1	607.5	98.5
60.25	9.65	0	BTC1	602.5	96.5
59.75	9.55	0	BTD1	597.5	95.5
59.25	9.5	0	BTE1	592.5	95
58.75	9.625	0	BTF1	587.5	96.25
58.25	9.825	0	BTG1	582.5	98.25
61.75	4.625	0	BS1	617.5	46.25
61.25	4.7	0	BSA1	612.5	47
60.75	4.75	0	BSB1	607.5	47.5
60.25	4.825	0	BSC1	602.5	48.25
59.75	4.85	0	BSD1	597.5	48.5
59.25	4.9	0	BSE1	592.5	49
58.75	5.075	0	BSF1	587.5	50.75
58.25	5.15	0	BSG1	582.5	51.5
57.75	9.825	0	CT1	577.5	98.25
57.25	9.875	0	CTA1	572.5	98.75
56.75	9.925	0	CTB1	567.5	99.25
56.25	9.8	0	CTC1	562.5	98
55.75	9.7	0	CTD1	557.5	97
55.25	9.7	0	CTE1	552.5	97
54.75	9.775	0	CTF1	547.5	97.75
54.25	9.9	0	CTG1	542.5	99
57.75	5.05	0	CS1	577.5	50.5

X	Y	Z (Velocity)	Station Name	X Plot	Y Plot
57.25	4.9	0	CSA1	572.5	49
56.75	4.875	0	CSB1	567.5	48.75
56.25	5	0	CSC1	562.5	50
55.75	5.025	0	CSD1	557.5	50.25
55.25	5	0	CSE1	552.5	50
54.75	5.125	0	CSF1	547.5	51.25
54.25	5.175	0	CSG1	542.5	51.75
53.75	9.9	0	DT1	537.5	99
53.25	9.875	0	DTA1	532.5	98.75
52.75	9.85	0	DTB1	527.5	98.5
52.25	9.75	0	DTC1	522.5	97.5
51.75	9.65	0	DTD1	517.5	96.5
51.25	9.575	0	DTE1	512.5	95.75
50.75	9.525	0	DTF1	507.5	95.25
50.25	9.425	0	DTG1	502.5	94.25
53.75	5.2	0	DS1	537.5	52
53.25	5.275	0	DSA1	532.5	52.75
52.8332	5.0883	0	DSB1	528.332	50.883
52.6666	4.9166	0	DSB2	526.666	49.166
52.25	4.775	0	DSC1	522.5	47.75
51.75	4.825	0	DSD1	517.5	48.25
51.25	4.825	0	DSE1	512.5	48.25
50.75	4.825	0	DSF1	507.5	48.25
50.25	4.825	0	DSG1	502.5	48.25
49.75	9.3	0	ET1	497.5	93
49.25	9.275	0	ETA1	492.5	92.75
48.75	9.25	0	ETB1	487.5	92.5
48.25	9.2	0	ETC1	482.5	92
47.75	9.125	0	ETD1	477.5	91.25
47.25	9.025	0	ETE1	472.5	90.25
46.75	9.025	0	ETF1	467.5	90.25
46.25	9.05	0	ETG1	462.5	90.5
49.75	4.8	0	ES1	497.5	48
49.25	4.8	0	ESA1	492.5	48
48.8333	4.9333	0	ESB1	488.333	49.333
48.6666	5.0666	0	ESB2	486.666	50.666
48.25	5.25	0	ESC1	482.5	52.5
47.75	5.225	0	ESD1	477.5	52.25
47.25	5.15	0	ESE1	472.5	51.5
46.75	5.1	0	ESF1	467.5	51
46.25	5.025	0	ESG1	462.5	50.25
45.75	9.025	0	FT1	457.5	90.25
45.25	9.05	0	FTA1	452.5	90.5
44.75	9.075	0	FTB1	447.5	90.75

X	Y	Z (Velocity)	Station Name	X Plot	Y Plot
44.25	8.975	0	FTC1	442.5	89.75
43.75	8.85	0	FTD1	437.5	88.5
43.25	8.85	0	FTE1	432.5	88.5
42.75	8.85	0	FTF1	427.5	88.5
42.25	8.7	0	FTG1	422.5	87
45.75	5.05	0	FS1	457.5	50.5
45.25	5.075	0	FSA1	452.5	50.75
44.75	4.975	0	FSB1	447.5	49.75
44.25	4.8	0	FSC1	442.5	48
43.75	4.6	0	FSD1	437.5	46
43.25	4.35	0	FSE1	432.5	43.5
42.75	4.1	0	FSF1	427.5	41
42.25	3.95	0	FSG1	422.5	39.5
41.75	8.625	0	GT1	417.5	86.25
41.25	8.775	0	GTA1	412.5	87.75
40.75	8.95	0	GTB1	407.5	89.5
40.25	9.05	0	GTC1	402.5	90.5
39.75	9.125	0	GTD1	397.5	91.25
39.25	9.125	0	GTE1	392.5	91.25
38.75	9.05	0	GTF1	387.5	90.5
38.25	9.1	0	GTG1	382.5	91
41.75	3.825	0	GS1	417.5	38.25
41.25	3.8	0	GSA1	412.5	38
40.75	3.825	0	GSB1	407.5	38.25
40.25	3.675	0	GSC1	402.5	36.75
39.75	3.45	0	GSD1	397.5	34.5
39.25	3.3	0	GSE1	392.5	33
38.75	3.2	0	GSF1	387.5	32
38.25	3.075	0	GSG1	382.5	30.75
37.75	9.25	0	HT1	377.5	92.5
37.25	9.275	0	HTA1	372.5	92.75
36.75	9.2	0	HTB1	367.5	92
36.25	9.05	0	HTC1	362.5	90.5
35.75	8.9	0	HTD1	357.5	89
35.25	8.825	0	HTE1	352.5	88.25
34.75	8.75	0	HTF1	347.5	87.5
34.25	8.575	0	HTG1	342.5	85.75
37.75	3.025	0	HS1	377.5	30.25
37.25	3.025	0	HSA1	372.5	30.25
36.75	2.975	0	HSB1	367.5	29.75
36.25	2.85	0	HSC1	362.5	28.5
35.75	2.675	0	HSD1	357.5	26.75
35.25	2.5	0	HSE1	352.5	25
34.75	2.3	0	HSF1	347.5	23

X	Y	Z (Velocity)	Station Name	X Plot	Y Plot
34.25	2.05	0	HSG1	342.5	20.5
33.75	8.375	0	ITX1	337.5	83.75
33.25	8.35	0	ITA1	332.5	83.5
32.75	8.4	0	ITB1	327.5	84
32.25	8.5	0	ITC1	322.5	85
31.75	8.55	0	ITD1	317.5	85.5
31.25	8.4	0	ITE1	312.5	84
30.75	8.25	0	ITF1	307.5	82.5
30.25	8.2	0	ITG1	302.5	82
33.75	1.9	0	IS1	337.5	19
33.25	1.8755	0	ISA1	332.5	18.755
32.75	1.725	0	ISB1	327.5	17.25
32.25	1.75	0	ISC1	322.5	17.5
31.75	1.85	0	ISD1	317.5	18.5
31.25	1.825	0	ISE1	312.5	18.25
30.75	1.775	0	ISF1	307.5	17.75
30.25	1.725	0	ISG1	302.5	17.25
29.75	8.15	0	JT1	297.5	81.5
29.25	8.15	0	JTA1	292.5	81.5
28.75	8.125	0	JTB1	287.5	81.25
28.25	8.125	0	JTC1	282.5	81.25
27.75	8.15	0	JTD1	277.5	81.5
27.25	8.125	0	JTE1	272.5	81.25
26.75	8.125	0	JTF1	267.5	81.25
26.25	8.05	0	JTG1	262.5	80.5
29.75	1.725	0	JS1	297.5	17.25
29.25	1.775	0	JSA1	292.5	17.75
28.75	1.8	0	JSB1	287.5	18
28.25	1.725	0	JSC1	282.5	17.25
27.75	1.675	0	JSD1	277.5	16.75
27.25	1.65	0	JSE1	272.5	16.5
26.75	1.6	0	JSF1	267.5	16
26.25	1.525	0	JSG1	262.5	15.25
25.75	7.95	0	KT1	257.5	79.5
25.25	7.9	0	KTA1	252.5	79
24.75	7.975	0	KTB1	247.5	79.75
24.25	8.075	0	KTC1	242.5	80.75
23.75	8.075	0	KTD1	237.5	80.75
23.25	8.05	0	KTE1	232.5	80.5
22.75	8.025	0	KTF1	227.5	80.25
22.25	7.9	0	KTG1	222.5	79
25.75	1.5	0	KS1	257.5	15
25.25	1.525	0	KSA1	252.5	15.25

X	Y	Z (Velocity)	Station Name	X Plot	Y Plot
24.75	1.525	0	KSB1	247.5	15.25
24.25	1.5	0	KSC1	242.5	15
23.75	1.65	0	KSD1	237.5	16.5
23.25	1.775	0	KSE1	232.5	17.75
22.75	1.575	0	KSF1	227.5	15.75
22.25	1.4	0	KSG1	222.5	14
21.75	7.825	0	LT1	217.5	78.25
21.25	7.85	0	LTA1	212.5	78.5
20.75	7.875	0	LTB1	207.5	78.75
20.25	8.05	0	LTC1	202.5	80.5
19.75	8.175	0	LTD1	197.5	81.75
19.25	8.075	0	LTE1	192.5	80.75
18.75	7.95	0	LTF1	187.5	79.5
18.25	7.9	0	LTG1	182.5	79
21.75	1.35	0	LS1	217.5	13.5
21.25	1.4	0	LSA1	212.5	14
20.75	1.6	0	LSB1	207.5	16
20.25	1.875	0	LSC1	202.5	18.75
19.75	2	0	LSD1	197.5	20
19.25	2	0	LSE1	192.5	20
18.75	1.925	0	LSF1	187.5	19.25
18.25	1.8	0	LSG1	182.5	18
17.75	7.95	0	MT1	177.5	79.5
17.25	8.025	0	MTA1	172.5	80.25
16.9666	8.2666	0	MTB1	169.666	82.666
16.9333	8.48332	0	MTB2	169.333	84.8332
16.7	8.75	0	MTBX1	167	87.5
16.25	8.825	0	MTC1	162.5	88.25
15.75	8.875	0	MTD1	157.5	88.75
15.25	8.9	0	MTE1	152.5	89
14.75	8.775	0	MTF1	147.5	87.75
14.25	8.525	0	MTG1	142.5	85.25
17.75	1.9	0	MS1	177.5	19
17.25	2	0	MSA1	172.5	20
16.75	2.05	0	MSB1	167.5	20.5
16.3333	2.2833	0	MSC1	163.333	22.833
16.1668	2.4666		MSC2	161.668	24.666
15.75	2.65	0	MSD1	157.5	26.5
15.25	2.7	0	MSE1	152.5	27
14.75	2.825	0	MSF1	147.5	28.25
14.25	2.925	0	MSG1	142.5	29.25

X	Y	Z (Velocity)	Station Name	X Plot	Y Plot
13.75	8.35	0	NT1	137.5	83.5
13.25	8.275	0	NTA1	132.5	82.75
12.75	8.125	0	NTB1	127.5	81.25
12.25	8	0	NTC1	122.5	80
11.75	7.975	0	NTD1	117.5	79.75
11.25	8.05	0	NTE1	112.5	80.5
10.75	8.175	0	NTF1	107.5	81.75
10.25	8.2	0	NTG1	102.5	82
13.75	3.025	0	NS1	137.5	30.25
13.3334	3.2833	0	NSA1	133.334	32.833
13.1668	3.4666	0	NSA2	131.668	34.666
12.75	3.725	0	NSB1	127.5	37.25
12.25	3.875	0	NSC1	122.5	38.75
11.75	4.075	0	NSD1	117.5	40.75
11.25	4.275	0	NSE1	112.5	42.75
10.8334	4.4666	0	NSF1	108.334	44.666
10.6668	4.58332	0	NSF2	106.668	45.8332
10.25	4.75	0	NSG1	102.5	47.5
9.75	8.1	0	OT1	97.5	81
9.25	7.925	0	OTA1	92.5	79.25
8.75	7.825	0	OTB1	87.5	78.25
8.3	7.8	0	OTC1	83	78
7.8	9.025	0	OTK1	78	90.25
7.25	8.975	0	OTL1	72.5	89.75
6.75	8.9	0	OTM1	67.5	89
9.75	4.9	0	OS1	97.5	49
9.25	5.1	0	OSA1	92.5	51
8.75	5.3	0	OSB1	87.5	53
8.25	5.5	0	OSC1	82.5	55
7.75	5.625	0	OSD1	77.5	56.25
7.25	5.675	0	OSE1	72.5	56.75
6.75	5.7	0	OSF1	67.5	57
6.3334	8.7333	0	PT1	63.334	87.333
6.1668	8.61668	0	PT2	61.668	86.1668
5.75	8.45	0	PTA1	57.5	84.5
5.25	8.35	0	PTB1	52.5	83.5
4.75	8.275	0	PTC1	47.5	82.75
4.25	8.25	0	PTD1	42.5	82.5
3.75	8.3	0	PTE1	37.5	83
3.3332	8.2164	0	PTF1	33.332	82.164
3.1666	8.0832	0	PTF2	31.666	80.832
2.775	7.925	0	PTG1	27.75	79.25
6.25	5.7	0	PS1	62.5	57
5.75	5.725	0	PSA1	57.5	57.25

X	Y	Z (Velocity)	Station Name	X Plot	Y Plot
5.25	5.675	0	PSB1	52.5	56.75
4.75	5.5	0	PSC1	47.5	55
4.25	5.325	0	PSD1	42.5	53.25
3.75	5.175	0	PSE1	37.5	51.75
3.25	5.025	0	PSF1	32.5	50.25
2.775	4.875	0	PSG1	27.75	48.75
2.2	7.55	0	QETF1	22	75.5
1.8	4.75	0	QESJ1	18	47.5
2.1666	4.733	0	QESK1	21.666	47.33
2.3333	4.767	0	QESK2	23.333	47.67

CALIBRATION CERTIFICATE

Model: 2000 Serial Number: 2002679

Unit Gain Ratio: — Time Constant: —

Type of Reading

Velocity:
- ☒ FPS
- ☐ CMS
- ☐ _____

Level:
- ☐ IN
- ☐ CM
- ☒ N/A

	Static Velocity	Dynamic Velocity	Level
Standard:	Zero	2.00	X
Measured:	0.00	1.96	

☒ Factory Calibration

☐ Field Profile Calibration;
Site Coefficient or Velocity Multiplier: _____

Calibration Technician: Dan Gossner Date: 5/15/09

QA Technician: [signature] Date: 5/15/09

This document certifies that the described instrument has been calibrated. Verification is indicated by the measured results shown above. Velocity calibration is traceable to the National Institute of Standards and Technology, (NIST), Gaithersburg, MD. For product information, service, or calibration, please contact the Customer Service Department.

MARSH-McBIRNEY, INC.
4539 Metropolitan Ct., Frederick, MD 21704-8364
(301) 874-5599 * 800-368-2723 * FAX (301) 874-2172

P/N 101001301

Flowmeter Calibration Certificate.

OPEN CHANNEL
CALIBRATION CERTIFICATE

Model: 2000 Serial Number: 2006103

Sensor #: 201

Type of Reading

Velocity: FPS

Level:
- ☐ IN
- ☒ N/A

	Static Velocity	Dynamic Velocity	Level
Standard:	Zero	1.996	N/A
Measured:	0.00	1.998	N/A
Tolerance:	±0.05 FPS	±2%	±0.4 in.

Calibration Technician: [signature] Date: 4/7/08

Calibration is traceable to the National Institute of Standards and Technology (NIST), Gaithersburg, MD. For Product information, service, or calibration, please contact the Customer Service Department.

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Flowmeter Calibration Certificate.

SUMMARY OF DISCHARGE MEASUREMENT ACTIVITIES														
MAMMOTH SPRING (SILVER SPRINGS GROUP)			**Marion County, Florida**											
Performed by Karst Environmental Services, Inc., High Springs, Florida														
DATE	**DISCHARGE (CFS)**	**INSTR. USED**	**CALC. METHOD**	**NUMBER STATIONS**	**X-SECTION AREA** (sq.feet)	**Avg. Station Point Velocity** (fps)	**High Msmt.** (fps)	**Low Msmt.** (fps)	**TIME START:**	**TIME FINISH:**	**Depth** (feet)	**Neg. PV's**	**Blanking Used?**	**NOTES:**
3/24/2005	**300.29**	MMB 201	Grid Count	115	323.06	0.96	1.33	-0.14	14:00	17:50	25-34	3	yes	
9/19/2006	**240.07**	MMB 201	Grid Count	138	308.16	0.71	1.16	-0.39	13:40	17:50	26-32	8	yes	
9/10/2007	**207.78**	MMB 201	Grid Count	132	321.36	0.61	0.96	-0.06	12:50	16:42	26-34	2	yes	
7/16/2008	**199.68**	MMB 201	Grid Count	138	309.78	0.60	0.93	-0.06	11:44	13:48	25-33	1	yes	
10/17/2008	**315.77**	MMB 201	Grid Count	136	319.18	0.94	1.48	-0.19	11:28	13:31	25-33	1	yes	
1/14/2009	**247.87**	MMB 201	Grid Count	149	308.2	0.73	1.13	-0.15	12:40	14:43	25-33	4	yes	
4/15/2009	**193.26**	MMB 201	Grid Count	168	308.07	0.61	0.92	-0.1	12:40	15:02	24-32	2	yes	
7/22/2009	**247.39**	MMB 201	Grid Count	169	309.60	0.78	1.15	-0.02	11:48	14:41	25-34	1	yes	

Table 4. Summary of Discharge Measurement Activities; Mammoth Spring, Marion County, Florida.