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Gaging of the Gasconade River

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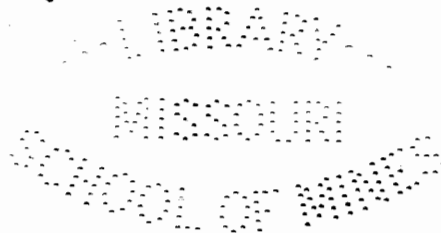
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GAGING OF THE GASCONADE RIVER.

- B Y -

Lawrence Collins

Sidney R. Hatch



A THESIS SUBMITTED TO THE FACULTY OF
THE SCHOOL OF MINES AND METALLURGY OF THE UNIVERSITY OF
MISSOURI IN PARTIAL FULFILLMENT OF THE WORK REQUIRED FOR
THE DEGREE OF BACHELOR OF SCIENCE IN CIVIL ENGINEERING AND
MINING ENGINEERING.

Rolla, Missouri,
1914.

Approved by:

Elmer Harris

Professor of Civil Engineering

18385

MSM
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SELECTION OF A GAGING STATION.

The work of establishing a gaging station was begun January 31st, 1914. Due to cold weather and lack of knowledge of the river it was very difficult to locate a suitable gaging station. The advantages offered by the bridge for putting in a gaging station on the lower side of the bridge was considered and tried.

A cross-section was taken about thirty feet down stream from the Frisco R.R. bridge near Jerome, Missouri. The distance between abutments of the bridge is four hundred and thirty two feet (432') This location was soon found to be impracticable on account of the speedy current caused by the rapid fall immediately below the bridge. The many cross currents and eddies that were encountered were also a detriment to accurate work with the current meter.

A record was kept of the stage at the bridge through the remainder of the year. The bench mark to which the stages were referred being on the bottom of the lower chord on the down stream side at the west end of the bridge.

After several unsuccessful attempts at stretching cables it was decided that another station should be selected. The river was investigated for two miles both above and below the bridge. Many soundings were taken at various places and the nature of the currents noted.

LOCATION OF NEW STATION.

The location of the new station decided upon is about three-quarters ($\frac{3}{4}$) of a mile above the Frisco R. R. bridge. The channel is straight and the cross-section nearly uniform for about five-hundred feet (500), both above and below the station. The bottom here is permanent, and fairly smooth.

The right bank rises at an angle of approximately 30° to a height of over one-hundred and fifty feet (150')

The left bank rises at an angle of about twenty-five degrees (25°) to a height of nearly twelve feet above the average stage of river.

The breadth of the river, is about two hundred and fifteen feet (215') at ordinary stage.

For a bench mark to refer stages of river, an iron peg was driven in a large sycamore tree standing on the left bank of river near the water, on down stream side.

All tables and one chart are referred to stages taken from this peg to surface of water, and are measured downward so that the larger figures indicate lower stages of the river.

METHOD OF PROCEDURE.

Two cables were stretched across the river at right angles to the channel and about four feet above the water.

A No.9 smooth wire was used as an anchor cable from which to hold the boat. About eight feet down stream from the anchor cable was stretched a smaller cable of twisted wire upon which was fastened tags at ten foot intervals.

One man sat in the bow of the boat and held the large cable, holding the boat so that the man in the stern would be directly under the station marked on the gaging cable. The soundings and velocities were taken in this way, at each of the stations along the cross-section.

Velocities were taken with a Price Current Meter. A stop-watch was used to record the time. The average velocity at each section was obtained by raising or lowering the meter in approximately the time taken to record ten clicks (there being ten revolutions to one click.) If the depth was too great or the current too swift the meter was held at approximately six tenth (.6) of the total depth below the surface.

This method of procedure proved to be very effective so was followed for the remainder of the season.

Due to much rafting on the river the cables were taken down after each gaging.

GAGING AT FLOOD STAGE.

During flood stage it was impossible to get to the gaging station so the old station below the rail-road bridge was resorted to.

The cross-section of the river at this had been obtained early in the season.

Stations were taken opposite each pannel point on the bridge (at twenty-four foot intervals.)

The boat from which the velocities were taken was held in place by a system of V shaped ropes held by two men stationed on the lower chord of the bridge.

Due to the high velocity (seven to eight feet pr second) it was very difficult to keep the boat from being drawn in to the piers and swamped.

The large amount of drift coming down the river also increased the difficulty of taking accurate velocities.

The velocities from abutment to abutment were found to be surprisingly constant.

Sta. Stage = 9.45'

February 28th, 1914.

Sta.	Dep.	Secs. for	Velocity	Between	Areas	Average	Quantity.
	ft.	100 rev.	ft./ sec.	Sta.'s	ft.	Vel.	ft./sec.
1	-1.5		0				
				1 - 2	.5	.2	.1
2	1.6	620	.41				
				2 - 3	23.5	.51	12.0
3	3.1	392	.61				
				3 - 4	35.0	.90	31.5
4	3.9	205	1.19				
				4 - 5	45.0	1.53	69.3
5	5.1	126	1.88				
				5 - 6	52.5	2.12	110.8
6	5.4	101	2.33				
				6 - 7	56.0	2.68	150.1
7	5.8	77	3.03				
				7 - 8	60.0	3.24	194.2
8	6.2	68	3.44				
				8 - 9	64.0	3.57	228.1
9	6.6	63	3.70				
				9 - 10	67.0	3.83	256.6
10	6.8	59	3.96				
				10 - 11	70.5	4.22	297.5
11	7.3	52	4.48				
				11 - 12	75.0	4.57	342.7
12	7.7	50	4.66				
				12 - 13	79.0	4.78	377.6
13	8.1	48	4.90				
				13 - 14	79.5	4.90	398.5
14	7.8	48	4.90				
				14 - 15	77.0	4.95	381.1
15	7.6	46	5.01				
				15 - 16	74.0	4.81	358.2
16	7.2	50	4.66				
				16 - 17	68.0	4.66	316.9
17	6.4	50	4.66				
				17 - 18	63.5	4.18	265.4
18	6.3	63	3.70				
				18 - 19	60.0	3.60	216.0
19	5.7	67	3.50				
				19 - 20	51.5	3.11	160.1
20	4.6	86	2.71				
				20 - 21	43.7	2.13	93.1
21	4.0	152	1.55				
				21-21-7.5	20.8	1.13	23.3
21-7.5	1.8	341	.7	Total	-----	-----	4283.1

Sta. Stage = 10.9'

March 7, 1914.

Sta. No.	Dep. ft.	Secs. for 100 rev.	Velocity ft./sec.	Between Sta's.	Areas ft.	Average vel.	Quantity ft./sec.
1	-3.0		0				
				1 - 2	0	0	
2	-1.0		0				
				2 - 3	8.5	.55	2.8
3	1.6	370	.66				
				3 - 4	20.0	.75	15.0
4	4.2	275	.84				
				4 - 5	30.0	1.07	32.1
5	3.6	183	1.30				
				5 - 6	37.5	1.49	55.9
6	3.9	141	1.67				
				6 - 7	41.0	1.67	68.5
7	4.3	141	1.67				
				7 - 8	45.0	1.89	85.5
8	4.7	112	2.12				
				8 - 9	49.0	2.38	116.6
9	5.1	89.0	2.63				
				9 - 10	52.0	2.66	138.3
10	5.3	87	2.69				
				10 - 11	55.5	2.76	153.1
11	5.8	82	2.83				
				11 - 12	60.0	2.91	175.2
12	6.2	78	3.00				
				12 - 13	64.0	3.07	197.1
13	6.6	74	3.15				
				13 - 14	64.5	3.21	206.4
14	6.3	71	3.26				
				14 - 15	62.0	3.26	202.1
15	6.1	71	3.26				
				15 - 16	59.0	3.16	186.4
16	5.7	76	3.06				
				16 - 17	53.0	3.03	160.6
17	4.9	78	3.00				
				17-18	48.5	2.70	130.9
18	4.8	98	2.39				
				18 - 19	45.0	2.19	98.5
19	4.2	118	1.99				
				19 - 20	36.5	1.81	66.1
20	3.1	146	1.63				
				20 - 21	28.0	1.29	36.1
21	2.5	250	.95				
				21- 21 1/2	7.5	10.7	7.7
21 1/2	7.5	.3	540				
			.48				
Total --							2134.9

Sta. Stage = 11.3'

March 14th, 1914.

Sta. No.	Dep. ft.	Secs. for 100 rev.	Velocity ft./sec.	Area Sta's. ft.	Average Vel.	Quantity ft./sec.
1	3.4					
1 - 2						
2	.3					
2 - 3						
3	1.2	510	.49	4.5	.25	1.1
3 - 4						
4	2.0	330	.72	16.0	.61	9.6
4 - 5						
5	3.2	210	1.12	26.	.92	23.9
5 - 6						
6	3.5	180	1.31	33.5	1.27	40.7
6 - 7						
7	3.9	145	1.66	37.0	1.48	54.9
7 - 8						
8	4.3	114	2.07	41.0	1.87	76.4
8 - 9						
9	4.7	107	2.20	45.0	2.14	96.0
9 - 10						
10	4.9	100	2.34	48.0	2.27	109.0
10 - 11						
11	5.4	93	2.51	51.5	2.42	124.0
11 - 12						
12	5.8	90	2.60	56.0	2.56	143.1
12 - 13						
13	6.2	88	2.67	60.0	2.64	158.1
13 - 14						
14	5.9	82	2.84	60.5	2.76	166.6
14 - 15						
15	5.7	84	2.78	58.0	2.81	163.0
15 - 16						
16	5.3	87	2.69	55.0	2.74	150.4
16 - 17						
17	4.5	91	2.57	49.0	2.63	128.9
17 - 18						
18	4.4	111	2.11	44.5	2.34	104.1
18 - 19						
19	3.8	146	1.63	41.0	1.87	76.7
19 - 20						
20	2.7	173	1.39	32.5	1.51	49.1
20 - 21						
21	2.1	220	1.08	24.0	1.24	29.6
21-21-7.5						
21-7.5	.2			7.5	8.6	4.1
					Total	1710.2

Sta. Stage = 12.0

March 20th, 1914.

Sta.	Dep.	Secs. for	Velocity	Between	Areas	Average	Quantity
	ft.	100 rev.	ft./sec.	Sta's.	ft.	Vel.	ft./sec.
1	-4.1						
				1 - 2	0	0	0
2	-1.0						
				2 - 3			
3	.5						
				3 - 4	9.0	.28	3.6
4	1.3	450.0	.55				
				4 - 5	19.0	.78	14.0
5	2.5	260.0	.91				
				5 - 6	25.5	1.00	25.5
6	2.8	220.0	1.09				
				6 - 7	30.0	1.28	38.1
7	3.2	160.0	1.47				
				7 - 8	34.0	1.64	56.1
8	3.6	150.0	1.81				
				8 - 9	38.0	1.81	69.2
9	4.0	130.0	1.81				
				9 - 10	41.0	1.88	77.5
10	4.2	120.0	1.95				
				10 - 11	45.0	2.04	91.8
11	4.7	110.0	2.13				
				11 - 12	49.0	2.04	100.0
12	5.1	120.0	1.95				
				12 - 13	53.0	2.04	103.4
13	5.5	110.0	2.13				
				13 - 14	53.5	2.24	109.1
14	5.2	100.0	2.34				
				14 - 15	51.0	2.47	118.8
15	5.0	90.0	2.60				
				15 - 16	48.0	2.47	116.7
16	4.6	100.0	2.34				
				16 - 17	42.0	2.15	90.3
17	3.8	120.0	1.95				
				17 - 18	37.5	1.88	70.5
18	3.7	130.0	1.81				
				18 - 19	34.0	1.58	51.7
19	3.1	180.0	1.35				
				19 - 20	25.5	1.24	30.1
20	2.0	210.0	1.12				
				20 - 21	17.0	1.06	18.0
21	1.4	240.0	.99				
				21-21-7.5	4.5	1.00	4.5
21-7.5	.5			Total	-----	-----	1189.9

March 27, 1914.

Sta. Stage = 10.9

Sta.	Depth.	Time.	Vel.:	Bet.Sta.	Area.	Average.	Quantity.	
1	3.0			1 - 2				
2	4.1			2 - 3	8.5	.47	4.0	
3	1.6	360	.68	3 - 4	20.0	.82	16.4	
4	2.4	250	.95	4 - 5	30.0	1.14	33.9	
5	3.6	180	1.32	5 - 6	37.5	1.44	54.4	
6	3.9	150	1.57	6 - 7	41.0	1.62	66.8	
7	4.3	140	1.68	7 - 8	45.0	2.00	90.0	
8	4.7	101	2.33	8 - 9	49.0	2.50	122.5	
9	5.1	88	2.66	9 - 10	52.0	2.71	140.4	
10	5.3	85	2.75	10 - 11	55.5	2.80	155.4	
11	5.8	82	2.84	11 - 12	60.0	2.92	175.2	
12	6.2	79	3.00	12 - 13	64.0	3.08	197.1	
13	6.6	74	3.15	13-14	64.5	3.24	208.3	
14	6.3	70	3.32	14 - 15	62.0	3.27	202.7	
15	6.1	72	3.22	15 - 16	59.0	3.13	184.1	
16	5.7	77	3.03	16 - 17	53.0	2.98	157.4	
17	4.9	80	2.92	17 - 18	48.5	2.67	129.0	
18	4.8	97	2.41	18 - 19	45.0	2.24	100.8	
19	4.2	113	2.07	19 - 20	36.5	1.88	68.6	
20	3.1	140	1.69	20 - 21	28.0	1.30	36.4	
21	2.5	260	.91	21-21	17.5	10.7	.67	7.2
21-7.5	.3					Total	----	2150.6

Sta. Stage = 9.04'

March 30th, 1914.

Sta. No.	Dep. ft.	Secs. for 100 rev.	Velocity ft. /sec.	Between Stais	Areas ft.	Average vel.	Quantity ft. /sec.
1	1.1						⁶ 1.2
2	2.0	480	.52	1 - 2	4.5	.27	1.2
3	3.5	350	.68	2 - 3	27.5	.60	16.5
4	4.3	159	1.49	3 - 4	39.0	1.09	81.1
5	5.5	93	2.51	4 - 5	49.0	2.00	98.0
6	5.8	75	3.11	5 - 6	56.5	2.81	158.7
7	6.2	65	3.61	6 - 7	60.0	3.36	204.6
8	6.6	61	3.85	7 - 8	64.0	3.73	338.7
9	7.0	57	4.08	8 - 9	68.0	3.96	269.3
10	7.2	52	4.48	9 - 10	71.0	4.28	313.9
11	7.7	51	4.54	10 - 11	74.5	4.51	336.0
12	8.1	50	4.66	11 - 12	79.0	4.60	363.4
13	8.5	47.5	4.93	12 - 13	83.0	4.79	398.0
14	8.2	46.0	5.01	13 - 14	83.5	4.97	415.0
15	8.0	43.0	5.35	14 - 15	81.0	5.18	419.6
16	7.6	48.0	4.90	15 - 16	78.0	5.12	399.7
17	6.8	52	4.48	16 - 17	72.0	4.69	337.7
18	6.7	58	4.02	17 - 18	67.5	4.25	286.9
19	6.1	61.5	3.79	18 - 19	64.0	3.91	249.6
20	5.0	79.0	2.95	19 - 20	55.5	3.37	187.0
21	4.4	121.0	1.94	20 - 21	47.0	2.44	114.9
				21-21-7.5	24.6	1.45	36.9
21-25	2.2	252.0	.95				
				Total	-----4926.7		

Sta. Stage- 8.'

April 3rd, 1914.

Sta. No.	Dep. ft.	Secs. for 100 rev.	Velocity ft./sec.	Between Sta's. ft.	Average vel.	Quantity. ft. /sec.
1	.1					
				1 - 2	15.0	5.0
2	3.0	364.0	.66			
				2 - 3	37.5	36.5
3	4.5	185.0	1.29			
				3 - 4	49.0	78.6
4	5.3	122.0	1.92			
				4 - 5	59.0	152.8
5	6.5	71.0	3.26			
				5 - 6	66.5	244.1
6	6.8	57.0	4.08			
				6 - 7	70.0	301.7
7	7.2	51.0	4.54			
				7 - 8	74.0	357.4
8	7.6	45.0	5.12			
				8 - 9	78.0	417.3
9	8.0	42.0	5.58			
				9 - 10	81.0	461.7
10	8.2	40.0	5.82			
				10 - 11	84.5	496.8
11	8.7	39.0	5.94			
				11 - 12	89.0	543.8
12	9.1	37.0	6.28			
				12 - 13	93.0	594.3
13	9.5	36.0	6.51			
				13 - 14	93.5	608.7
14	9.2	36.0	6.51			
				14 - 15	91.0	592.4
15	9.0	36.0	6.51			
				15 - 16	88.0	562.3
16	8.6	37.0	6.28			
				16 - 17	82.0	524.0
17	7.8	36.0	6.51			
				17 - 18	77.5	459.6
18	7.7	43.0	5.35			
				18 - 19	74.0	379.6
19	7.1	48.0	4.90			
				19 - 20	65.5	294.1
20	6.0	57.0	4.08			
				20 - 21	57.0	196.1
21	5.4	83.0	2.80			
				21-21-7.5	27.0	42.7
21-7.5	1.8	74.0	.36			

Total -----7349.5

Sta. Stage - 10.4'

April 22nd, 1914.

Sta. No.	Dep. ft.	Secs. for 100 rev.	Velocity ft./sec.	Between Sta's.	Area ft.	Average vel.	Quantity ft./sec.
1	2.5						
				1 - 2	.5	.25	.1
2	1.6	480	.53				
				2 - 3	13.5	.72	9.7
3	2.1	260	.92				
				3 - 4	25.0	1.19	29.8
4	2.9	162	1.46				
				4 - 5	35.0	1.70	59.5
5	4.1	122	1.94				
				5 - 6	42.5	2.05	87.3
6	4.4	108	2.16				
				6 - 7	46.0	2.38	109.5
7	4.8	90	2.59				
				7 - 8	50.0	2.83	141.5
8	5.2	76	3.06				
				8 - 9	54.0	3.16	170.7
9	5.6	71	3.26				
				9 - 10	57.0	3.35	191.0
10	5.8	68	3.44				
				10 - 11	60.5	3.53	213.7
11	6.3	65	3.61				
				11 - 12	65.0	3.76	244.2
12	6.7	60	3.91				
				12 - 13	69.0	3.96	273.5
13	7.1	58	4.02				
				13 - 14	69.5	3.99	277.5
14	6.8	59	3.96				
				14 - 15	67.0	3.88	260.0
15	6.6	615	3.79				
				15 - 16	64.0	3.65	233.8
16	6.2	67	3.50				
				16 - 17	58.0	3.37	189.8
17	5.4	72	3.24				
				17 - 18	53.5	3.08	164.8
18	5.3	80	2.92				
				18 - 19	50.0	2.66	133.0
19	4.7	98	2.39				
				19 - 20	41.5	2.31	95.8
20	3.6	104	2.24				
				20 - 21	34.0	1.96	67.6
21	3.2	141	1.68				
				21-21-7.5	15.0	1.27	19.0
21-7.5	.8	280	.85	Total			2971.8

Sta. Stage = 9.85'

May 7, 1914.

Sta.	Depth.	Time.	Vel.	Bet.Sta.	Area.	Average.	Quantity.	
1	1.9							
				1 - 2	2.4	.5	1.2	
2	1.2	480	.52					
				2 - 3	19.5	.85	16.6	
3	2.7	200	1.18					
				3 - 4	31.0	1.53	47.4	
4	3.5	125	1.88					
				4 - 5	41.0	2.08	85.3	
5	4.7	102	2.29					
				5 - 6	48.5	2.39	115.9	
6	5.0	94	2.49					
				6 - 7	52.0	3.82	146.6	
7	5.4.	74	3.15					
				7 - 8	56.0	3.42	191.5	
8	5.8	63	3.69					
				8 - 9	60.0	3.83	229.8	
9	6.2	59	3.96					
				9-10	64.0	4.08	261.1	
10	6.4	56	4.20					
				10 - 11	66.5	4.26	282.6	
11	6.9	54	4.31					
				11 - 12	71.0	4.40	312.4	
12	7.3	52	4.48					
				12 - 13	75.0	4.84	325.5	
13	7.7	56	4.20					
				13 - 14	75.5	4.44	334.5	
14	7.4	50	4.66					
				14 - 15	73.0	4.54	332.1	
15	7.2	53	4.43					
				15 - 16	70.0	4.28	296.1	
16	6.8	58	4.02					
				16 - 17	64.0	4.02	257.3	
17	6.0	58	4.02					
				17 - 18	59.5	3.81	227.3	
18	5.9	65	3.61					
				18 - 19	55.0	3.44	192.1	
19	5.3	71	3.26					
				19 - 20	47.5	2.87	136.8	
20	4.2	94	2.49					
				20 - 21	39.0	2.35	91.6	
21	3.6	106	2.20					
21				21 - 22	7.5	20.0	2.00	40.0
21-7.5	1.7	132	1.79					
					Total	-----	3923.7	

April 8th, 1914.

Sta. at Bridge, Bridge stage 15.0' 24' Sections.

Sta. No.	Dep. ft.	Secs. for 100 rev.	Velocity ft. /sec.	Between Sta's.	Areas ft.	Average vel.	Quantity ft. /sec.
1	4.1	61	3.85	1 - 2	116.4	4.71	548.25
2	5.6	42	5.58	2 - 3	145.2	5.93	861.04
3	6.5	37	6.28	3 - 4	168.0	6.51	1093.68
4	7.5	34	6.74	4 - 5	194.4	6.74	1310.25
5	8.7	34	6.74	5 - 6	225.6	6.86	1487.61
6	10.1	33	6.98	6 - 7	249.6	6.80	1697.28
7	10.7	35	6.63	7 - 8	278.4	6.80	1893.12
8	12.5	33	6.98	8 - 9	297.6	7.09	2109.98
9	12.3	32	7.21	9 - 10	290.4	7.21	2093.78
10	11.9	32	7.21	10 - 11	283.2	7.32	2073.02
11	11.7	31	7.44	11 - 12	273.6	7.44	2035.58
12	11.1	31	7.44	12 - 13	262.8	7.09	1863.25
13	10.8	34	6.74	13 - 14	262.8	6.97	1831.71
14	11.1	32	7.21	14 - 15	268.8	7.09	1905.80
15	11.3	33	6.98	15 - 16	274.8	7.09	1948.33
16	11.6	32	7.21	16 - 17	280.8	6.92	1943.14
17	11.8	35	6.63	17 - 18	282.0	6.22	1754.04
18	11.7	40	5.82	18 - 19	278.4	5.01	1394.78
19	11.5	56	4.20				
Total -----							29044.64

~~29044.64~~