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The utilization of the Gasconade River for power purposes

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Department: Mining Engineering

THESIS

FOR THE

Degree of Bachelor of Science

IN

MINE ENGINEERING.

SUBJECT:

"The Utilization of the Gasconade River for Power Purposes."

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W. H. POWELL.

MAY, 1901.

THE UTILIZATION OF THE GASCONADE RIVER

FOR POWER PURPOSES.

This subject was suggested by Professor Elmo G. Harris.

Location.

The site of the proposed developmnet is near the town of Arlington, Missouri.

The Gasconade River is a rapid stream, subject to very sudden fluctuations in regard to rise and fall.

The river rises in the Ozark Mountains and empties into the Missuri River. It is fed by numerous streams of its own nature, the principle one being Big Piney.

The country drained is very rough, and generally of a limestone formation. The hills are steep and wooded. The soil is thin and in places absent, making the amount of rainfall held back by these agents small compared with the total. Everything in like manner tends to cause freshets. In times of drouth, the river is fed by springs and at such times is exceedingly clear and very suitable as a water supply.

The highest water recorded by United States Government Gauge was in 1897. At that time, being twenty-four feet above low water mark on the gauge but as this mark is about two feet above real low water mark, the rise must have been twenty-eight feet.

Object.

At the point where our survey begins, near Arlington, the river follows close to the bluffs on the west side. On the opposite side is farming land, probably one-fourth of a mile in width, which is flooded in seasons of high water. The river hugs these bluffs for probably two miles asd then crosses its valley and in striking the opposite bluffs is deflected northward.

About midway below this point,the Little Piney River enters it and just below the junction of these two rivers the Gasconade is crossed by the Frisco Railroad.

A short distance below the bridge,it again turns and flows to the north-west.

Two miles west of Arlington a narrow valley breaks in and up this the Frisco Railroad climbs. The head of this valley is only a short distance from the point where our survey was begun. A proposed tunnel was calculated to join the river and this valley,thus connecting two points of the river having a difference of elevation of twelve and six hundred and eighty-seven thousand feet. The tunnel need not be lined as the limestone is massive and the sand stone penetrated would be abundantly safe if the tunnel be given a proper arched form.

A weir and pipe line was also calculated to join these two points on the river in order to utilize its power.

Twenty-three hundred HP. can be developed by this fall with the water at disposal.

Field Work.

We first walked over the above mentioned territory and saw the lay of the country. Then a place in the river was selected where the cross-section was almost constant. Here the measurements of the current and cross-section were taken.

A stationary water gauge was placed here,so the height of the river could be read at any time.

A transit was run to such points that were necessary in plotting and then a lever to the same point in order to obtain their respective elevations.

Method of Taking Cross-section of River.

We selected of water between a ripple and an eddy, near our water gauge. Then a cord divided into ten feet was stretched across the river at this point.

At each division a rod was emersed, so that the zero of the rod was level with the water bottom. This rod was read and reading noted

Method Used in Getting Current.

At each division of the above mentioned cord an accurate current meter was placed and the average velocity found at that point. From this we obtained the volumme of water passing through each section. Length of tunnel 7460 feet.

Instruments.

One Transit

One level

Two stadia poles

One Price Acoustic Current Meter.

One water gauge, graduated into hundreths

Two cords

Boat, tape, hatchet, stakes, etc.

Transit Notes

Stations	Deflections	Distance
Bridge		
	0°00'	800'
1		
	232°52'	660'
2		
	227°57'	470'
3		
	213°26'	435'
4		
	210°35'	490'
5		
River (a)	305°30'	150'

Stations.	Deflection	Distance	Vertical Angle
	209° 24'	418'	
6			
River (a)	280° 41'	190'	
	202° 45'	500'	
7			
	196° 30'	285'	
8			
	190° 52'	549'	
9			
River (a)	246° 30'	1000'	
	183° 00'	554'	
10			
	170° 1'	440'	
11			
	165° 44'	420'	
12			
	165° 30'	505'	
13			
	155° 52'	520'	
14			
	162° 11'	470'	
15			
	151° 50'	380'	
16			
	159° 31'	475'	
17			
	161° 5'	410'	
18			
	157° 10'	290'	
19			
	125° 28'	361'	
20			
	86° 44'	698'	
Point of Hill	122° 30'	600'	
21			
	86° 57'	803'	
22			
	88° 2'	629'	
23			
	98° 45'	562'	
24			
	71° 4'	311'	
25			
	59° 59'	525'	
26			
	89° 41'	470'	
27			
	105° 12'	248'	
28			
	127° 45'	238'	
29			
	129° 38'	228'	
a			
	106° 39'	312'	7° 20'

Station	Deflection	Distance	Vertical Angle
b			
	34° 17	259'	
c			
	70° 48'	285'	30° 11'
gap			
29			
	179° 51'	672'	
30			
	188° 36'	461'	
31			
	138° 20'	307'	
33			
	77° 39'	341'	
34			
	126° 40'	274'	
35			
	97° 49'	283'	12° 33'
36			
	45° 41'	410'	13° 55'
37			
	28° 54'	46'	4° 36'
38			
	55° 8'	286'	30° 2'
39 ( )			
	67° 53'	390'	25° 28'
River (a)	225°	20'	
River (b)	129° 43'	350'	
Bluff (c)	45°	150'	
40			
	312° 48'	388'	
41			
	316° 2'	368'	
42			
	323° 49'	436'	
43			
	323° 1'	350'	
gap	142° 22'	220'	
44			
	322° 23'	600'	
45			
	331° 1'	310'	
46			
	323° 9'	300	
47			
	326°	213'	
48			
	330° 36'	278'	
River (a)	47°	25'	
Bluff (b)	246°	60'	31° 0'
49			
	329° 8'	380'	
50			
	331°	205'	

Station	Deflection	Distance	Vertical Angle.
51			
	319°23'	328'	
River (a)	55°	12	
Blubb (b)	226°30'	160'	32°14'
52			
	331°33'	345'	
53			
	334°24'	246'	
54			
	325°2'	206'	
55			
	532°2'	145'	
56			
	328°4'	200'	
57			
	339°8'	190'	
58			
	349°41'	171'	
59			
	349°47'	170'	
60			
	355°4'	158'	
61			
	336°36'	155	
62			
	3°19'	141'	
63			
	346°9'	154'	
64			
	1°31'	261'	
65			
	7°10'	292'	
66			
	354°22'	244'	
67			
	355°	292'	
68			
	4°11'	390'	
69			
	551°32'	270'	
70			
	351°	242'	
River (a)	133°40'	460'	
Bluff (b)	271°30'	110'	
72			
	331°28'	298'	
Slough (a)	271°37'	55'	
Bluff (b)	271°30'	169'	
73			
	2°11'	933'	
74			
	306°15'	626'	
Sough (a)	69°	25'	

s

Station	Deflection	Distance	Vertical Angle.
Mouth of Slough (b)	335°	225'	
75			
	276°16'	651'	
River (a)	5°	5'	
Hill (b)	198°	1000'	
76			
	250°25'	602'	
77			
	239° 4'	522'	
River (a)	302°10'	150'	
Bridge	252° 25'	450'	
78			
	189° 45	700'	
No.1			
	2°11'	800'	
Bridge			

Height of Instrument (HI) 4.58'

Station	B.S.	F.S.	Elevation
Bridge	4.43		21.42
No.1	5.45	3.39	22.46
2	2.305	3.60	24.31
3	3.98	2.68	23.935
5	4.72	2.88	25.035
6	4.48	4.48	25.275
8	2.11	5.06	24.695
9	2.48	8.18	18.625
10	7.69	8.275	12.83
Sub Stake	9.77	1.45	19.07
14	2.03	8.83	20.01
16	3.18	9.12	12.92
18	10.98	3.02	13.08
Sub Stake	8.15	1.71	22.35
21	9.62	1.05	29.45
22	9.02	1.23	37.84
Sub Stake	10.75	1.11	45.78
24	9.04	3.565	52.965
Sub stake	10.75	1.11	45.78
24	9.04	3.565	52.965
Sub stake	11.35	0.58	61.425
26	0.555	0.555	72.22
Sub stake	11.65	0.02	72.755
27	7.29	6.02	78.385
28	7.49	5.80	79.875
Sub Stake (a)	10.89	0.67	86.695
Sub Stake (b)	11.285	1.055	96.53
Sub Stake (c)	11.75	0.77	106.985
Sub stake (d)	11.76	0.395	118.34
30 (gap)	9.37	9.37	120.73
Sub stake	11.89	0.22	129.88

Station	B.S.	F.S.	Elevation.
Rock on top of Pine Bluff		0.25	141.52
28	7.47		79.875
Sub stake	10.92	0.90	87.445
31	1.74	0.69	97.675
Sub stake (a)	0.95	11.79	87.625
Sub stake (b)	2.56	11.29	77.285
32	3.87	3.87	75.975
Sub stake	7.71	0.10	79.745
34		4.31	83.145
21	0.92	0.	29.45
Sub stake (a)	1.75	11/13	19.24
Sub stake (b)	1.07	11.40	9.59
Sub stake (c)	4.00	7.04	3.62
Sub stake (d)	5.54	3.47	4.15
Sub stake (e)	4.302	3.56	6.03
Sub stake (f)	0.053	11.262	-.93
Sub stake (g)		10.81	-12.687
River	6.00		0.00
Sub stake (a)	10.67	3.27	2.73
Sub stake (b)	3.59	1.79	11.61
Sub stake (c)	7.95	2.49	12.71
Sub stake (a)	4.81	8.13	12.53
43	4.19	4.19	13.15
Pine Bluff Gap	5.00	5.00	12.34
44	4.67	6.09	11.25
45	4.39	3.95	11.97
46	4.68	4.68	11.48
47	7.16	4.75	11.61
48	5.52	5.52	13.25
49	2.63	5.95	12.82
51	7.22	5.66	9.79
52	6.56	3.87	13.14
54	8.83	10.46	9.24
55	7.19	7.19	10.88
56	3.54	0.82	17.25
58	2.49	6.97	13.82
59	3.95	3.95	12.36
Sub stake	5.73	5.30	11.01
60	4.51	4.51	12.23
Sub stake	5.78	5.76	10.98
62	8.58	8.58	10.18
Sub stake	7.28	11.10	7.66
64	3.04	3.04	11.90
65	2.65	3.15	11.79
Sub stake	8.53	8.33	6.11
67	4.77	4.77	9.87
Sub stake	3.345	3.02	11.62
68	5.69	5.69	9.275
Sub stake	2.25	11.19	3.875
69	1.825	1.99	4.13
Sub stake	10.295	10.295	-4.335
70	11.045	5.55	.41
72	6.895	7.39	4.065
Sub stake (a)	11.61	0.10	10.86

Staion	B.S.	F.S.	Elevation.
Sub stake (b)	1.03	1.885	20.585
Sub stake (c)	7.34	7.03	14.585
74	7.04	7.04	14.885
75	3.44	1.92	20.005
76	0.89	6.72	16.725
77	5.27	5.27	12.345
Sub stake	9.385	0.18	17.435
Bridge		5.40	21.42
78	4.15	5.17	20.40
72	3.63		4.065
Sub stake (a)	5.065	0.33	7.365
Sub stake (b)	5.37	4.72	7.71
Sub stake (c)	1.11	2.57	10.51
Sub stake (d)	2.095	9.84	1.78
Water Level	9.02	9.02	-5.145
Zero on water gauge		10.825	-6.95
31	0.672		141.52
Sub stake (a)	3.75	11.78	130.412
Sub stake (b)	0.812	11.76	122.402
Sub stake (c)	0.67	11.21	112.004
Sub stake (d)	0.29	11.69	100.984
Sub stake (e)	0.12	11.315	89.959
Sub stake (f)	0.905	11.32	78.759
Sub stake (g)	0.525	11.735	67.929
Sub stake (h)	1.101	11.57	56.884
Sub stake (j)	0.482	11.43	46.555
Sub stake (k)	1.20	11.00	36.037
Sub stake (l)	0.27	11.31	25.927
Sub stake (n)	3.29	11.42	14.777
Pine Bluff gap		5.477	12.59

Checked with former record 12.34'
Difference --.25 foot

Height of River.

Date	Gov. Gauge feet	Our Gauge feet	Difference of gauges in feet
1901			
Feb.16		0.8	1.47
April 8	1.3		
11	0.33	1.8	
12	0.08		
19	7.7		
20	6.2		
21	4.3		
22	2.5		
23	2.00		
24	1.4		
25	1.2		
26	1.1		
27	0.5		
28	0.2		
29	0.1		
May 15	-1.05		
24	-1.5		

Reading taken May 15th.1901 by W.H.Powell. Gov. Gauge reading -1.05

Dist from Bank	Depth ft	Time of of 100 Revols.	Section	Area sq.ft	Aver. vel	Vol. cu.ft.
10	1.9	418	1	9.5	.617	5.682
20	4.1	415	2	30.	.616	18.510
30	4.75	380.2	3	44.25	.668	29.559
40	5.6	159	4	51.75	1.461	72.502
50	6.	132.2	5	58	1.859	108.122
60	5.9	136.	6	54.5	1.806	98.472
70	5.8	103.6	7	58.5	2.363	138.258
80	6.8	103.2	8	63	2.363	148.869
90	5.65	128	9	62.25	1.917	119.333
100	4.5	128.6	10	50.75	1.910	96.933
110	3.1	139.4	11	38	1.760	66.880
120	1.92	186	12	25.1	1.335	33.509
130	1.45	338	13	16.85	..747	12.385
140	.9	420	14	11.75	.682	7.544
					Total	957.68

Reading taken May 24th., 1901 by Charles A. Fach. Gov. Gauge Reading -1.5 feet.

Station	Distance to Previous station	Time of 100 revols.	Depth in feet	Time of 100 rev in sec.	Vel in feet per sec	Volumne cubic feet
1	6	12'14.6"	1.6	734	0.359	8.616
2	11	4' 6.4"	5.	246	1.019	41.477
3	11	2'46.6"	5.98	166	1.485	75.746
4	11.1	2' 6.8"	5.95	126	1.947	112.585
5	10.8	2'0.6"	5.85	121	2.023	128.826
6	10.9	2'10"	6.45	130	1.887	130.985
7	10.9	2'45.4"	6.2	165	1.494	116.513
8	10.8	3'58.6"	6.	238	1.052	83.667
9	10.8	6'21.6"	5.8	381	0.668	54.799
10	10.7	11'21.6"	5.15	681	0.389	30.904
11	10.75	16'13.2"	4.7	973	0.271	17.487
12	11.1	19'12.8"	2.95	1152	0.228	10.683
13	9		0.00			1.539
					Total	816.827

Computation of Volumne. Used formula $= \left(\frac{v_1 + v_1'}{2}\right)\left(\frac{\text{Depth} + \text{depth}'}{2}\right)$ width

(0 to 1) $\frac{.359 + 0}{2} = \left(\frac{6 \times 1.6}{2}\right) = 8.616$ Cu feet

(1 to 2) $\frac{.359 + 1.019}{2}\left(\frac{.5 + 5.98}{2}\right)11 = 41.4778$ "

(2 to 3) $\frac{5 + 5.98}{2}\left(\frac{1.019 + 1.485}{2}\right)11 = 75.7460$ "

(3 to 4) $\frac{5.98 + 5.95}{2}\left(\frac{1.485 + 1.947}{2}\right)11 = 112.58534$ "

(4 to 5) $\frac{5.95 + 5.85}{2}\left(\frac{1.947 + 2.023}{2}\right)11 = 128.8265$ "

(5 to 6) $\frac{5.85 + 6.45}{2}\left(\frac{2.023 + 1.887}{2}\right)10.9 = 130.985$ Cu feet

(6 to 7) $\frac{6.45 + 6.2}{2}\left(\frac{1.887 + 1.494}{2}\right)10.9 = 116.5128$ " "

(7 to 8) $\frac{6.2 + 6}{2}\left(\frac{1.494 + 1.052}{2}\right)10.8 = 83.6676$ " "

(8 to 9) $\frac{6. + 5.8}{2}\left(\frac{1.052 + 0.668}{2}\right)10.8 = 54.7992$ " "

(9 to 10) $\frac{5.8 + 5.15}{2}\left(\frac{0.668 + .0.389}{2}\right)10.7 = 30.90384$ " "

(10 to 11) $\frac{5.15 + 4.7}{2}\left(\frac{0.389 + 0.271}{2}\right)10.75 = 17.48670$ " "

(11 to 12) $\frac{4.7 + 3.0}{2}\left(\frac{0.271 + 0.228}{2}\right)11.1 = 10.68375$ " "

(12 to 13) $\frac{3.0 + 0}{2}\left(\frac{.228 + 0}{2}\right)9.0 = 1.53900$ " "

Total 816.827 Cu. Feet

Horse Power Obtained.

All of the readins were taken at very low water and for six months of each year the flow would be 3200 cubic feet and above

(1) At 817 cu. ft. per second.

$$\frac{62.5 \times 817 \times 12.68}{550} = 1177 \text{ Horse Power}$$

(2) At 958 cu ft. per second.

$$\frac{62.5 \times 958 \times 12.68}{550} = 1378 \text{ H.P.}$$

(3) At 16000 cu. ft. per second.

$$\frac{62.5 \times 1600 \times 12.68}{550} = 2300 \text{ H.P.}$$

(4) For six months we can get 3200 cubic feet per second.

May 4th. Gauge -0.42 Discharge 1600 cubic feet.

Walbridge H. Powell

Charles A. Rich