

DESIGN OF  
RESERVOIR AND DAM ON HINSON CREEK  
FOR  
COLUMBIA, MO., WATER SUPPLY

by  
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W. W. Southwell 1888  
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A THESIS  
for the  
DEGREE OF BACHELOR OF SCIENCE  
IN CIVIL ENGINEERING

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UNIVERSITY OF MISSOURI  
DEPARTMENT OF CIVIL ENGINEERING

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## INTRODUCTION

The proposed reservoir and dam lies on Hinkson Creek between Ashland Road and the Quarry Road about  $\frac{3}{4}$  of a mile S. E. of Columbia, Mo. in Sec. 19 of R. 15 W. Twp. 48 N.

A topographic survey of the site was made with transit and stadia and a cross section of the valley was taken by the same method. No soundings for bed rock were necessary as it was easily estimated as to the slope for such a short distance.

The required data as to the water supply for said reservoir was taken from the daily gage readings of H. G. Hunter and C. F. Phillips for 1909; a copy of which can be found in their thesis for 1909; and the daily gage readings of H. Horan and R. Hodson for 1911. These gage readings were taken on both the Hinkson and Grindstone Creeks and by the combined results obtained from the two sets the discharge of the Hinkson at the dam site was determined.

Incorporated in this investigation is the topographic map of the reservoir site, hydrographs and rating curves of both creeks and sections and



elevations of a rough masonry dam 900 ft. long and  
35 ft. high. Following this are the estimates and  
costs tabulated.

# DAILY GAGE READINGS OF GRINDSTONE

-1910-

DAY	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.
1	1.70	1.20	1.30	1.20	1.20	1.20	1.30	1.00	0.90	0.90	0.80	0.80
2	1.30	1.55	1.45	1.20	1.80		1.30	1.00	0.90	0.90	0.80	0.80
3	1.20	1.50	1.50	1.20	1.60	1.30	1.30	5.45	0.90	0.90	0.80	0.80
4	1.20	1.50	1.40	1.20	1.45	1.30	1.30	1.70	4.80	0.85	0.90	0.80
5	1.15	1.40	1.40	2.05	2.90	1.50	1.30	1.50	3.00	0.85	0.80	0.75
6	1.10	1.30	1.30	1.60	2.00		1.60	1.00	1.40	0.85	0.80	0.75
7	1.10	1.30	1.30	1.35	3.00		1.60	1.00	1.40	0.85	0.80	0.75
8	1.05	1.25	1.30	1.35	1.60	7.50	1.50	0.90	1.40	0.85	0.80	0.75
9	1.00	1.20	1.30	1.35	1.60	2.00	1.40	0.90	1.10	0.80	0.80	0.75
10	1.00	1.25	1.30	1.25	1.70	1.60	1.30	0.90	1.00	0.80	0.80	0.75
11	1.00	1.30	1.30	1.25	1.60	1.40	1.30	0.90	1.00	0.80	0.80	0.75
12	4.70	1.35	1.20	1.20	1.60	1.30	1.30	0.90	0.90	0.80	0.80	0.75
13	2.10	1.15	1.20	1.20	1.60	1.30	1.30	0.85	0.90	0.80	0.80	0.75
14	1.50	1.20	1.20	1.20	1.60	1.25	1.60	0.80	0.90	0.80	0.80	0.75
15	1.60	1.35	1.20	1.40	1.60	1.25	3.30	0.80	0.80	0.80	0.80	0.75
16	1.35	1.15	1.20	1.20	1.60	1.25	2.00	0.80	0.80	0.80	0.80	0.75
17	2.40	1.30	1.20	1.20	1.60	1.20	2.80	0.80	0.80	0.80	0.80	0.75
18	1.50	1.20	1.20	1.20	1.55	1.20	2.00	0.80	0.80	0.80	0.80	0.75
19	1.50	1.20	1.20	1.20	1.50	1.20	1.70	0.75	0.80	0.80	0.80	0.75
20	1.40	1.10	1.20	1.20	1.50	1.20	1.30	0.75	0.80	0.80	0.80	0.75
21	1.40	1.00	1.20	1.20	1.50	1.15	1.15	0.75	0.80	0.90	0.80	0.75
22	1.40	0.95	1.20	1.20	6.90	1.10	1.15	0.75	0.75	0.90	0.80	0.75
23	1.30	0.90	1.20	1.20	2.00	1.10	1.10	0.75	5.10	0.90	0.80	0.75
24	1.20	0.55	1.20	1.20	1.50	1.10	1.10	0.75	1.20	0.90	0.80	0.75
25	1.90	0.90	1.20	1.20	1.35	4.80	1.10	0.70	1.10	0.90	0.80	0.75
26	1.40	0.90	1.20	1.20	1.30	1.60	1.10	0.70	1.10	0.90	0.80	0.75
27	1.40	1.35	1.20	1.20	1.30	1.50	1.10	0.70	1.10	0.90	0.80	0.75
28	1.35	1.30	1.20	1.20	1.30	1.30	1.10	0.90	1.10	0.80	0.80	0.75
29	1.30		1.20	1.20	1.30	1.30	1.10	0.90	1.10	0.80	0.80	0.75
30	1.25		1.20	1.20	1.30	1.30	1.00	0.90	1.00	0.80	0.80	0.75
31	1.20		1.20		1.30		1.00	0.90		0.80		0.90



# DAILY GAGE READINGS OF HINKSON

~1910~

DAY	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.
1	1.00	0.53	0.63	0.35	0.40	0.40	0.30	0.20	0.10	0.50	0.40	0.50
2	1.00	0.78	0.73	0.40	1.60		0.20	0.20	0.10	0.40	0.40	0.50
3	1.00	0.73	0.97	0.40	1.01	0.40	0.20	0.20	0.10	0.40	0.40	0.50
4	0.90	0.83	0.78	0.80	0.70	0.40	0.20	0.20	8.20	0.40	0.50	0.45
5	0.60	0.83	0.90	3.65	0.65	0.70	0.20	0.20	3.00	0.40	0.50	0.45
6	0.50	0.53	0.90	1.80	1.90		0.50	0.20	1.20	0.30	0.40	0.45
7	0.50	0.53	0.80	1.00	5.00		0.40	0.20	1.20	0.30	0.40	0.45
8	0.50	0.58	0.70	0.80	1.80	5.50	0.30	0.20	1.20	0.30	0.40	0.45
9	0.40	0.58	0.55	0.70	1.55	1.45	0.30	0.20	3.20	0.30	0.40	0.45
10	0.40	0.53	0.55	0.70	0.80	1.00	0.30	0.20	1.00	0.30	0.40	0.45
11	0.40	0.53	0.50	0.65	0.70	0.70	0.30	0.20	0.90	0.20	0.40	0.45
12	5.80	0.48	0.50	0.60	0.65	0.60	0.30	0.20	0.90	0.20	0.40	0.45
13	2.60	0.53	0.45	0.60	0.60	0.50	0.30	0.20	0.80	0.20	0.40	0.45
14	1.11	0.43	0.45	0.60	0.50	0.45	0.30	0.15	0.70	0.20	0.40	0.45
15	1.23	0.43	0.40	0.80	0.50	0.40	5.30	0.10	0.60	0.20	0.50	0.45
16	0.88	0.38	0.40	0.80	0.50	0.35	1.00	0.10	0.50	0.20	0.50	0.40
17	2.13	0.33	0.40	0.70	0.50	0.30	4.60	0.40	0.40	0.20	0.50	0.40
18	1.23	0.38	0.40	0.60	0.50	0.30	1.00	0.30	0.40	0.20	0.50	0.40
19	1.13	0.43	0.40	0.60	0.40	0.30	0.90	0.30	0.40	0.20	0.50	0.40
20	1.13	0.43	0.40	0.60	0.40	0.30	0.60	0.20	0.30	0.20	0.50	0.40
21	0.88	0.33	0.40	0.55	0.40	0.25	0.30	0.20	0.30	0.40	0.50	0.40
22	0.73	0.38	0.40	0.50	0.40	0.25	0.30	0.20	0.25	0.30	0.50	0.40
23	0.63	0.23	0.40	0.50	1.45	0.20	0.20	0.20	5.60	0.30	0.50	0.40
24	0.53	0.23	0.40	0.50	0.80	0.20	0.20	0.20	1.00	0.30	0.50	0.40
25	0.73	0.23	0.40	0.50	0.70	5.00	0.20	0.10	0.90	0.40	0.50	0.40
26	0.73	0.33	0.40	0.50	0.60	1.50	0.70	0.10	0.80	0.40	0.50	0.40
27	0.83	0.87	0.40	0.50	0.55	1.00	0.50	0.10	0.80	0.40	0.50	0.40
28	0.63	0.77	0.35	0.45	0.50	0.60	0.40	0.10	0.70	0.40	0.50	0.40
29	0.73		0.35	0.45	0.40	0.50	0.30	0.10	0.70	0.40	0.50	0.50
30	0.63		0.35	0.40	0.40	0.40	0.20	0.10	0.70	0.40	0.50	0.50
31	0.58		0.35		0.40		0.20	0.10		0.40		0.40



# GAGE READINGS <sup>50'</sup> 1911

## GRINDSTONE

DAY	JAN	FEB
1	0.90	0.90
2	0.90	0.90
3	0.90	0.90
4	0.90	0.90
5	0.90	0.90
6	0.80	0.90
7	0.80	0.90
8	0.80	0.90
9	0.80	0.90
10	0.80	0.90
11	0.90	0.90
12	0.90	0.90
13	0.90	0.85
14	0.90	0.90
15	0.90	0.90
16	0.90	0.90
17	0.90	0.90
18	0.90	2.30
19	0.90	1.70
20	0.90	1.60
21	0.90	1.50
22	0.90	1.50
23	0.90	1.40
24	0.90	1.40
25	0.90	1.36
26	0.90	2.90
27	1.00	1.80
28	1.00	1.50
29	1.00	
30	0.90	
31	0.90	

## HINKSON

DAY	JAN	FEB
1	0.40	0.40
2	0.40	0.40
3	0.40	0.40
4	0.35	0.40
5	0.30	0.40
6	0.30	0.40
7	0.30	0.40
8	0.30	0.40
9	0.35	0.40
10	0.40	0.40
11	0.40	0.40
12	0.40	0.40
13	0.40	0.33
14	0.40	0.40
15	0.40	0.40
16	0.40	0.40
17	0.40	0.40
18	0.40	1.85
19	0.40	1.40
20	0.40	1.30
21	0.40	1.20
22	0.40	1.00
23	0.40	1.00
24	0.40	0.90
25	0.40	0.80
26	0.40	3.80
27	0.70	1.75
28	0.60	1.10
29	0.50	
30	0.40	
31	0.40	



# DAILY DISCHARGE OF GRINDSTONE

~1910~

DAY	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.
1	29	7	10	7	7	7	10	2	1	1	1	1
2	10	21	16	7	35	* 6	10	2	1	1	1	1
3	7	18	18	7	23	10	10	976	1	1	1	1
4	7	18	14	7	16	10	10	29	785	1	1	1
5	5	14	14	59	230	18	10	18	258	1	1	1
6	4	10	10	23	54	* 12	23	2	14	1	1	1
7	4	10	10	12	258	* 12	23	2	14	1	1	1
8	3	8	10	12	23	1578	18	1	14	1	1	1
9	2	7	10	12	23	54	14	1	4	1	1	1
10	2	8	10	7	29	23	10	1	2	1	1	1
11	2	10	10	7	23	14	10	1	2	1	1	1
12	755	12	7	7	23	10	10	1	1	1	1	1
13	64	5	7	7	23	10	10	1	1	1	1	1
14	18	7	7	7	23	8	23	1	1	1	1	1
15	23	12	7	14	23	8	346	1	1	1	1	1
16	12	5	7	7	23	8	54	1	1	1	1	1
17	102	10	7	7	23	7	200	1	1	1	1	1
18	18	7	7	7	21	7	54	1	1	1	1	1
19	18	7	7	7	18	7	29	1	1	1	1	1
20	14	4	7	7	18	7	10	1	1	1	1	1
21	14	2	7	7	18	5	5	1	1	1	1	1
22	14	2	7	7	1400	4	5	1	1	1	1	1
23	10	1	7	7	54	4	4	1	875	1	1	1
24	7	0	7	7	18	4	4	1	7	1	1	1
25	44	1	7	7	12	758	4	1	4	1	1	1
26	14	1	7	7	10	23	4	1	4	1	1	1
27	14	12	7	7	10	18	4	1	4	1	1	1
28	12	10	7	7	10	10	4	1	4	1	1	1
29	10		7	7	10	10	4	1	4	1	1	1
30	8		7	7	10	10	2	1	2	1	1	1
31	7		7		10		2	1		1		1



# DAILY DISCHARGE OF HINKSON ~1910~

DAY	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.
1	63	16	22	4	7	7	1	1	1	14	7	14
2	63	34	30	7	165	* 7	1	1	1	7	7	14
3	63	30	60	7	63	7	1	1	1	7	7	14
4	48	39	34	36	27	7	1	1	3625	7	14	11
5	21	39	48	1150	24	27	1	1	790	7	14	11
6	14	16	48	220	250	* 27	14	1	93	1	7	11
7	14	16	36	63	1900	* 27	7	1	93	1	7	11
8	14	20	27	36	220	2175	1	1	93	1	7	11
9	7	20	17	27	154	133	1	1	895	1	7	11
10	7	16	17	27	36	63	1	1	63	1	7	11
11	7	16	14	24	27	27	1	1	48	1	7	11
12	2340	12	14	21	24	21	1	1	48	1	7	11
13	580	16	11	21	21	14	1	1	36	1	7	11
14	79	9	11	21	14	11	1	1	27	1	14	11
15	95	9	7	36	14	7	2065	1	21	1	14	11
16	46	6	7	36	14	4	63	1	14	1	14	7
17	325	3	7	27	14	1	1675	7	7	1	14	7
18	95	6	7	21	14	1	63	1	7	1	14	7
19	80	9	7	21	7	1	48	1	7	1	14	7
20	80	9	7	21	7	1	21	1	1	1	14	7
21	46	3	7	18	7	1	1	1	1	7	14	7
22	30	6	7	14	7	1	1	1	1	1	14	7
23	22	1	7	14	133	1	1	1	2230	1	14	7
24	16	1	7	14	36	1	1	1	63	1	14	7
25	30	1	7	14	27	1900	1	1	48	7	14	7
26	30	3	7	14	21	525	27	1	36	7	14	7
27	39	38	7	14	18	63	14	1	36	7	14	7
28	22	35	4	11	14	21	7	1	27	7	14	7
29	30		4	11	7	14	1	1	27	7	14	14
30	22		4	7	7	7	1	1	27	7	14	14
31	20		4		7		1	1		7		7



# DAILY DISCHARGE OF HINKSON & GRINDSTONE - 1910 -

DAY	JAN.	FEB.	MAR	APR	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.
1	92	23	32	11	14	14	11	3	2	15	8	15
2	73	55	46	14	200	13	11	3	2	8	8	15
3	70	48	78	14	86	17	11	977	2	8	8	15
4	55	57	48	43	43	17	11	30	4410	8	15	12
5	26	53	62	1209	254	45	11	19	1048	8	15	12
6	18	26	58	243	304	39	37	3	107	2	8	12
7	18	26	46	75	2158	39	30	3	107	2	8	12
8	17	28	37	48	243	3758	19	2	107	2	8	12
9	9	27	27	39	177	187	15	2	899	2	8	12
10	9	24	27	34	65	86	11	2	65	2	8	12
11	9	26	24	31	50	41	11	2	50	2	8	12
12	3095	24	21	28	47	31	11	2	49	2	8	12
13	644	21	18	28	44	24	11	2	37	2	8	12
14	97	16	18	28	37	19	24	2	28	2	15	12
15	118	21	14	50	37	15	2441	2	22	2	15	12
16	58	11	14	43	37	12	117	2	15	2	15	8
17	427	13	14	34	37	8	1875	8	8	2	15	8
18	113	13	14	28	35	8	117	2	8	2	15	8
19	98	16	14	28	25	8	67	2	8	2	15	8
20	94	13	14	28	25	8	31	2	2	2	15	8
21	60	5	14	21	25	6	6	2	2	8	15	8
22	44	8	14	21	1407	5	6	2	2	2	15	8
23	32	2	14	21	187	5	5	2	3105	2	15	8
24	23	1	14	21	54	5	5	2	70	2	15	8
25	74	2	14	21	39	2658	5	2	52	8	15	8
26	44	4	14	21	31	548	31	2	40	8	15	8
27	53	50	14	21	28	81	18	2	40	8	15	8
28	34	45	11	18	24	31	11	2	31	8	15	8
29	40		11	18	17	24	5	2	31	8	15	15
30	30		11	14	17	17	3	2	29	8	15	15
31	27		11		17		3	2		8		8



# DAILY DISCHARGE for 1911

GRINDSTONE

HINKSON

GRINDSTONE  
& HINKSON

DAY	JAN	FEB	JAN	FEB	JAN	FEB
1	1	1	7	7	8	8
2	1	1	7	7	8	8
3	1	1	7	7	8	8
4	1	1	4	7	5	8
5	1	1	1	7	2	8
6	1	1	1	7	2	8
7	1	1	1	7	2	8
8	1	1	1	7	2	8
9	1	1	4	7	5	8
10	1	1	7	7	8	8
11	1	1	7	7	8	8
12	1	1	7	7	8	8
13	1	1	7	3	8	4
14	1	1	7	7	8	8
15	1	1	7	7	8	8
16	1	1	7	7	8	8
17	1	1	7	7	8	8
18	1	86	7	235	8	321
19	1	29	7	123	8	152
20	1	23	7	109	8	132
21	1	18	7	93	8	111
22	1	18	7	63	8	81
23	1	14	7	63	8	77
24	1	14	7	48	8	62
25	1	12	7	56	8	48
26	1	250	7	1250	8	1460
27	2	55	27	205	29	240
28	2	18	21	78	23	96
29	2		14		16	
30	1		7		8	
31	1		7		8	



PLATE I



200

10x



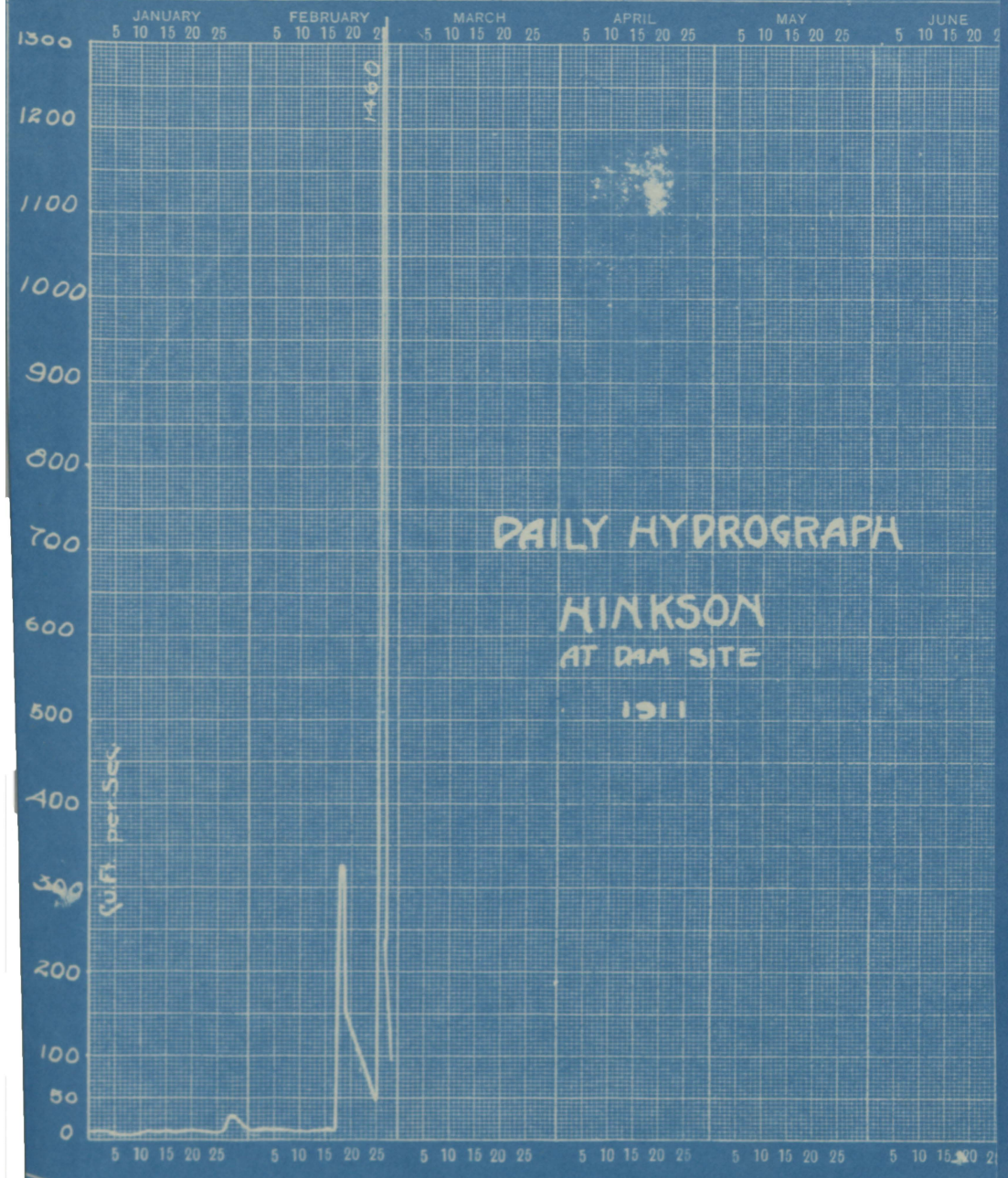




PLATE III.

20

18

16

14

12

10

0.8

Gage Height in Ft.

1900

2000

SECTION PAPER. 10 X



PLATE IV.



PLATE VI.

(11)

PLATE V.



PLATE VI.

(11)







# RATING TABLES

HINKSON 1910-11

	0	1	2	3	4	5	6	7	8
.0	0	63	283	790	1340	1900	2455	3008	
.1	1	78	320	845	1400	1950	2510	3068	
.2	1	93	362	895	1450	2008	2565	3122	3625
.3	1	109	412	950	1506	2065	2620	3180	
.4	7	123	482	1005	1565	2128	2680	3235	
.5	14	142	525	1065	1628	2175	2730	3295	
.6	21	165	580	1125	1675	2230	2792	3350	
.7	27	190	630	1175	1730	2287	2848	3405	
.8	36	220	680	1230	1788	2340	2900	3460	
.9	48	250	740	1285	1840	2400	2955	3515	

GRINDSTONE 1910-11

	0	1	2	3	4	5	6	7	8
.0	0	2	54	258	550	845	1134	1430	1725
.1	0	4	64	288	580	875	1163	1460	
.2	0	7	74	317	610	904	1192	1490	
.3	0	10	86	346	640	933	1221	1519	
.4	0	14	102	376	668	962	1250	1549	
.5	0	18	120	405	697	990	1280	1578	
.6	0	23	140	435	725	1018	1310	1608	
.7	1	29	170	464	755	1047	1340	1637	
.8	1	35	200	493	785	1076	1370	1666	
.9	1	44	230	521	815	1104	1400	1695	



RESERVOIR CAPACITY

Contour	Acres	Acre Feet
<u>605</u>	_____	-----
610	2.617	4.36
615	22.846	67.515
620	55.800	264.130
625	92.681	645.355
630	126.166	1266.165

Total capacity is 1266.165 A.Ft.

Available Quantity

On account of the large amount of sediment carried by the two streams at flood times, a rough estimate should be made of the amount the reservoir will be filled. Such estimate will be taken at about 2/5 of its original capacity in 10 years time. Then by filling in Ashland Road near the bridge over the Hinkson (see map); the maximum storage obtainable will be about 600 A. Ft. From the mass curve this will afford a daily quantity of about 30 A.ft. per day for the entire year.

Assuming the daily consumption of 80 gal. per capita, this quantity will supply approximately 80,000 people; which number will, judging from past growth, be greatly in excess of the population of Columbia within the next 25 years.

DESIGN OF DAM

The design of dam is taken from Wegman's Practical Profile No.1 for masonry dams.

The dam is to be made of rough limestone masonry thru out and laid up in cement mortar.

The cement shall be of any good portland brand provided it satisfactorily meet the requirements of the Amer. Soc. of Testing Materials.

Sand must be clean and sharp.

Proportions 1:2 for mortar

Bed Rock	Contour	
Flow Line	604	26. ft.
Flood Line	632.5	250ft.
Over-topping	639.0	6.5 "
	Totalheight,	<u>35.0 ft.</u>

Foundation to be 5 ft. below surface of bed  
(rock.

Spillway.

The maximum flood increased 50% for which the spillway must be designed is 6600 sec. ft.

On account of the bridge on Ashland Road being low, we can allow a head of only 3 ft. on the spillway.

The type of crest used is Type "K" taken from the Eng. News for Jan. 12 1911, and designed by Gardner S. Williams. The coefficient for this crest is 1.163

$Q/\text{coeff. equals } Lh^{3/2}$

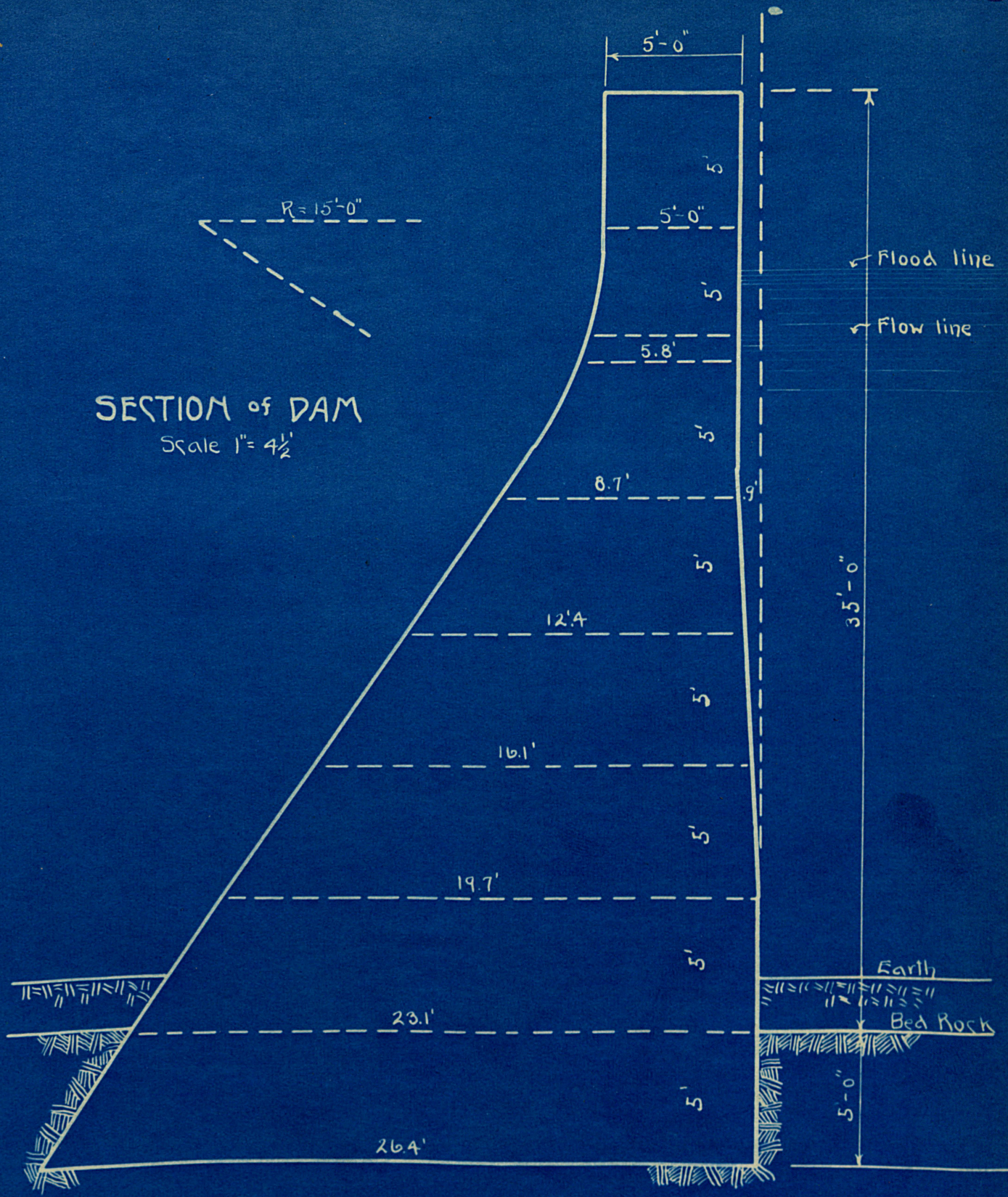
$6600/1.163 \text{ equals } 3.33L^{3/2}$

L is hence 329.0 ft. (the required length of spillway).



# SECTION of DAM

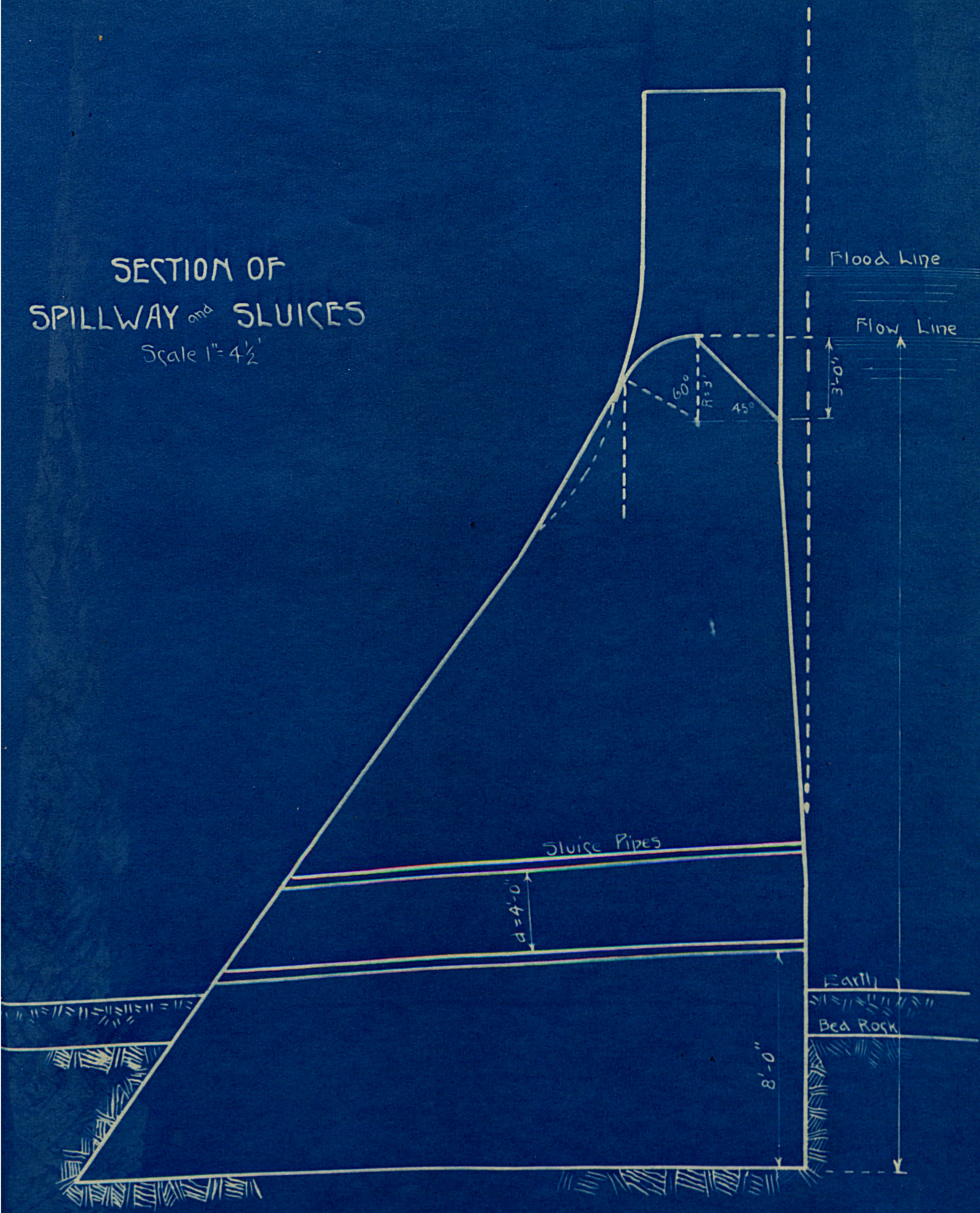
Scale 1" = 4 1/2'





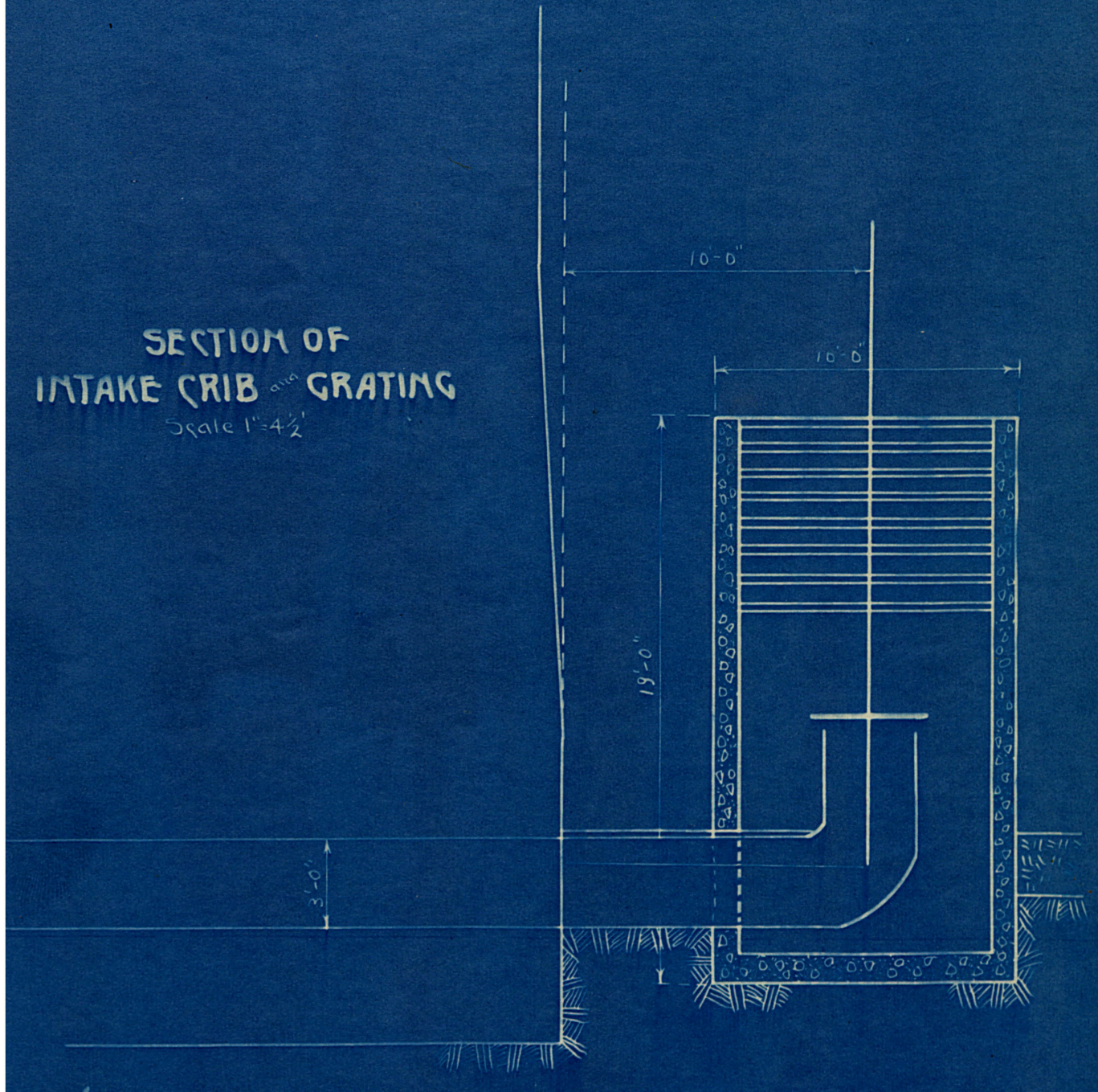
# SECTION OF SPILLWAY and SLUICES

Scale 1" = 4 1/2'

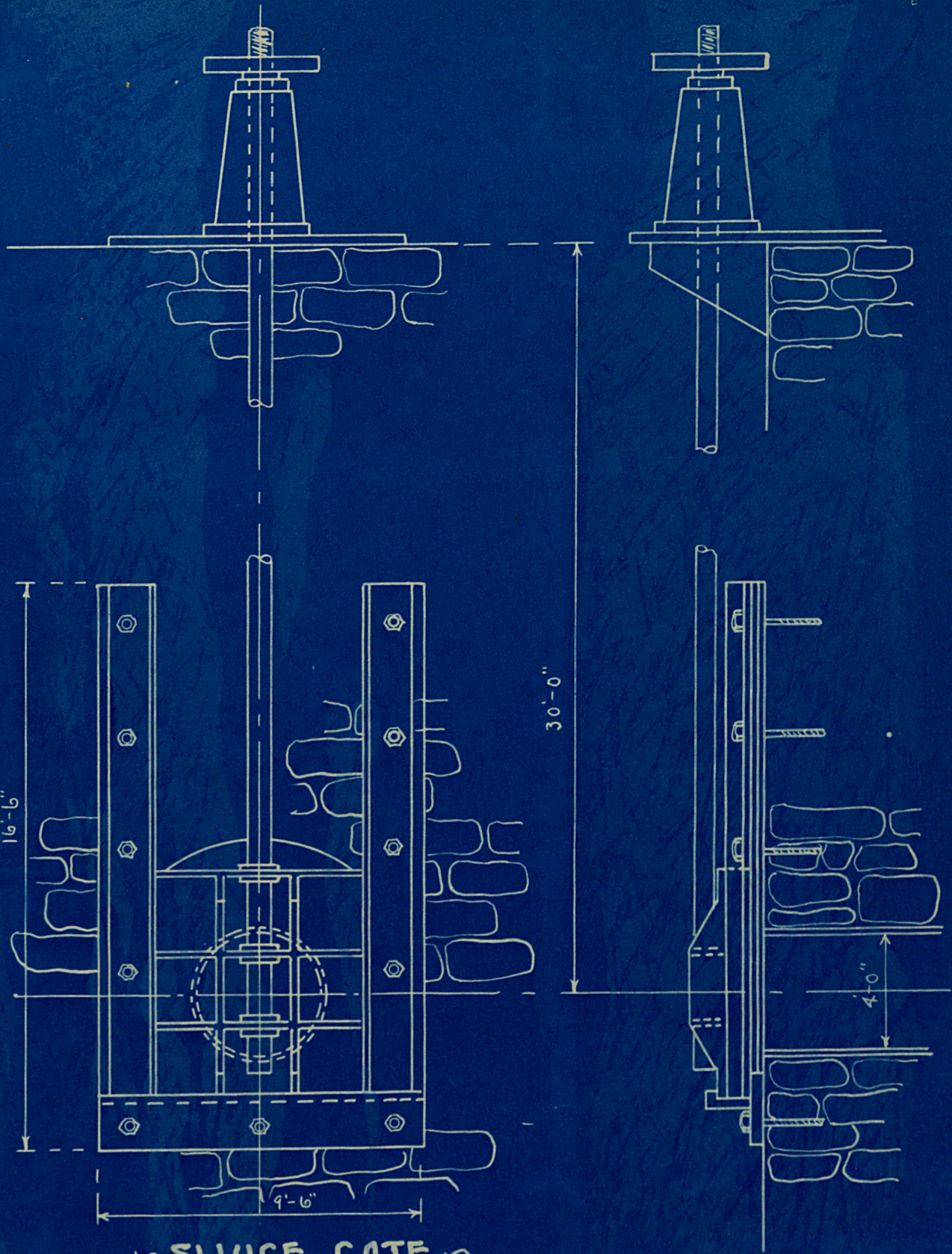




SECTION OF  
INTAKE CRIB AND GRATING  
Scale 1" = 4 1/2'







~ SLUICE GATE ~  
 Scale 1" = 4"



ESTIMATE OF COST

DAM

Excavation -----4800 cy.  
 Rough Limestone Masonry -----4650 "

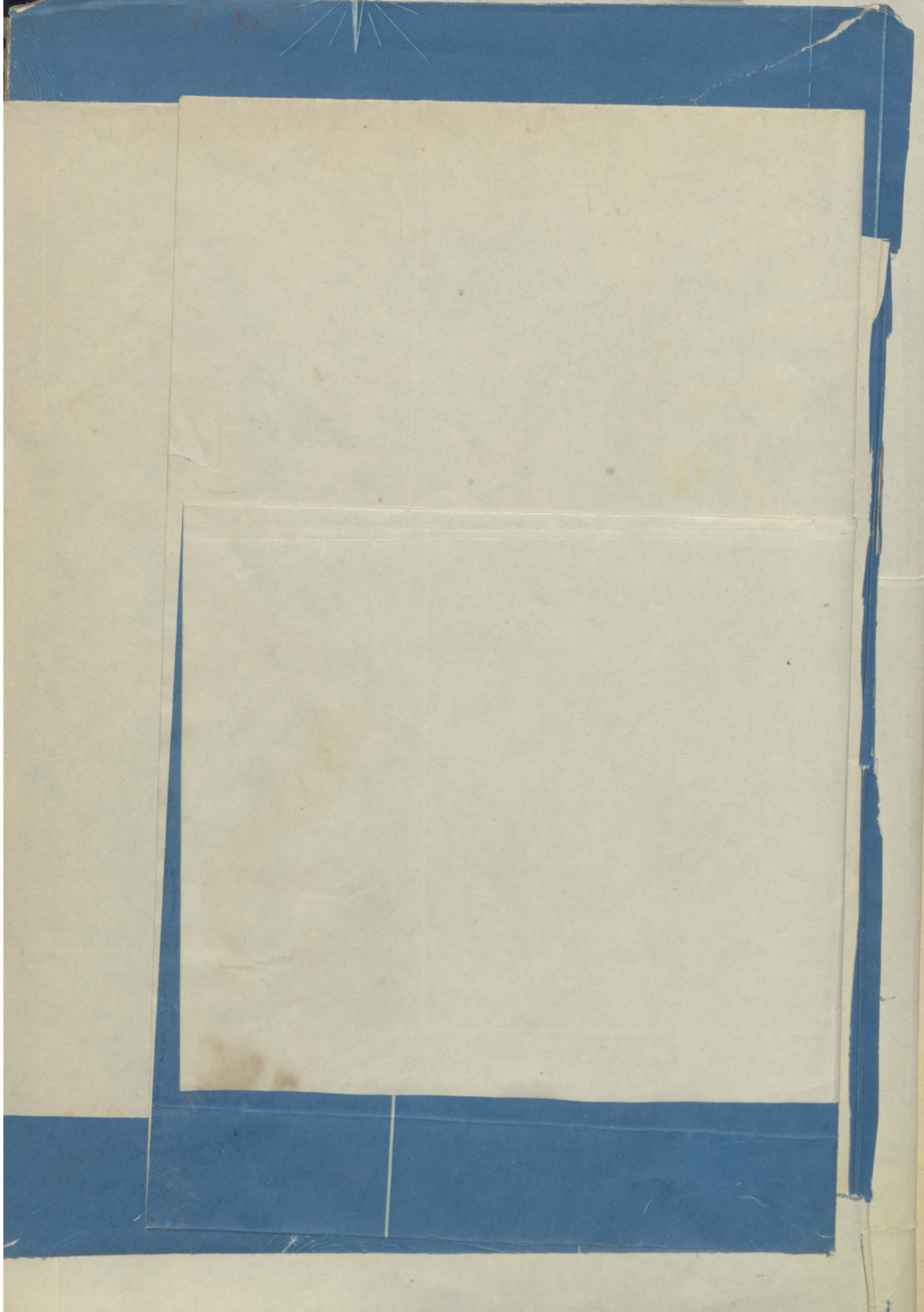
Excavation at \$1.00 per cy.  
 Masonry at \$14.00 per cy.

Cost of excav.-----\$4800.00  
 " " masonry -----65100.00  
 Estimated cost of intake -----1000.00  
 " " " sluices -----500.00  
 " " " sluice gates -----700.00  
 Total cost of dam---72100.00

Filling on Ashland Road---2000 cy.  
 (at 20 cts. per cy-\$400.00  
 Land--- 150 A. at \$150 per A.----- 22500.00  
 Total cost of dam and reservoir---\$95,000.00

6CONCLUSION

The estimates made as to the filling of reservoir with sediment and as to the probable growth of the city of Columbia are necessarily very rough, but the aim has been to make all estimates on the safe side. As a final conclusion we are pretty safe in saying that if the reservoir is constructed as herein designed, the water supply will be ample for about 25 or 30 years in the future, and that the project is a practical and a paying one.



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