R E P O R T

on the

CARROLL RESERVOIR

and

SYSTEM OF WORKS UNDER THE SAME

MADE BY

H. CLAY KELLOGG, CONSULTING ENGINEER.

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REPORT ON THE WATER SUPPLY FURNISHED BY THE CARROLL RESERVOIR. THE CONSTRUCTION OF A DAM AT THE SITE PROPOSED FOR SAID RESERVOIR. THE CONSTRUCTION OF A MAIN CANAL TO A SUPPLEMENTARY RESERVOIR FOR DISTRIBUTION PURPOSES ON THE SAN DIEGUITO RANCH,

and

THE MAIN DISTRIBUTARIES FROM SAID SUPPLEMENTARY RESERVOIR TO THE LANDS THAT CAN BE IRRIGATED BY SAID WATER SUPPLY UPON THE SAN DIEGUITO RANCH, LOCKWOOD MESA AnD OTHER LANDS REQUIRING IRRIGATION.

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1st. HOW MUCH WATER IS AVAILABLE FOR SALE AND USE.

2nd. HOW MUCH LAND CAN BE IRRIGATED BY SAID WATER, AND DETAILED AMOUNT REQUIRED FOR EACH DISTRICT IRRIGATED.

3rd. WHAT WILL BE THE COST OF THE CONSTRUCTION OF SAID WATER SYSTEM.

4th. THE COST OF THE WATER WHICH SHALL INCLUDE THE COST PER MINERS INCH AND THE COST PER ACRE AND THE VALUE OF THE LAND IN ITS PRESENT STATE AND ITS VALUE WITH A WATER SUPPLY.

This report is addressed to W. E. Hodges, Vice President of the Atchison, Topeka and Santa Fe Railway System, and will give the conclusions under each heading from the facts which have been obtainable from the different sources from which they could be secured, and the reasons for said conclusions under the different headings will be elaborately set forth in the form of an Appendix to these reports and Exhibits which are indexed in regular order from A to N and will accompany the several divisions of said report.

W A T E R S U P P L Y .

The Water Supply is primarily the water shed of the San Dieguito River, which is designated on account of the different basins through which it passes, as the San Dieguito at the San Dieguito Ranch and the Bernardo in "Carroll Reservoir Water Shed", and the Santa Isabel on its upper reaches above the Pamo Dam, which is the dividing factor between the Bernardo Basin and the Pamo Reservoir, and the water supply of the Carroll Reservoir is assumed to be the 196 square miles of water shed tributary to it and the Bernardo Basin plus whatever water may be allowed to pass over the crest of the Pamo Dam.

The average rainfall on this water shed is 1.1' in depth per annum. By estimating this in acre feet per second and assuming the government statistics to be correct for the percentage, this would furnish an average of 27,600 acre feet per annum. Checking this by comparison with Table #3 of the water supply, which is compiled for a period of years extending from 1905-06 to 1914-15, an average period of ten years, we get 26,570 acre feet, which is a very close check, being about one-half of what I term a complete cycle of seasons for Southern California; therefore, I have concluded that it is safe to assume that the average supply for storage is that amount with the surplus from Pamo Dam added which Table #3 shows to be about 50% of the above quantity for one-half the period of ten years. This would be a very valuable addition with a higher dam which would conserve about 60% of this increment from the waste over the Pamo Dam.

For a more elaborate discussion of examination into this

subject you are referred to Table #2 of run-off at Bernardo Bridge at Carroll dam, and Table #3 showing the water supply in acre feet, and Table #4 of the use and waste at the Carroll Reservoir; and for a more extensive study you are referred to Appendix A of this report.

Another feature which adds an additional supply to the Carroll Reservoir is the 6600 acre feet, which by mutual agreement is to be delivered from the Pamo Reservoir to the San Pasqual irrigators. This water is to be delivered in two irrigating ditches irrigating about 1200 acres of land. About 40% of this water percolates into the Carroll Reservoir adding 2460 acre feet to its storage as a permanent addition.

If in the earlier part of the season additional waters were used upon these lands it would have a tendency to further increase the storage supply into the Carroll Reservoir in the drier periods.

Additional water can also be developed by pumping water from the gravel beds around the upper rim of the Bernardo Basin near the flood line of the reservoir. This increment can be made to give a permanent additional water supply for the drier periods for what is known as the dry seasons, of at least 300".

For detailed study of this situation you are referred to Appendix A, and the Tables hereinbefore mentioned as it is from all of these investigations that I have concluded that the available water supply after deducting for seepage and evaporation at the dam would be 2000" for a period of 200 days. This would be dependable with the additions of the waters which could be pumped from the gravels heretofore referred to excepting for a possibility which has occurred during the last seven years of the twenty-

one year cycle referred to in Appendix A when all irrigating systems of Southern California were compelled to reduce their supply from one to three years during this cycle. In figuring the available water supply it will be necessary to figure on a deduction for evaporation and seepage in the canals and a loss in the distribution. This has been found by actual experience to be from 6 to 12% in the canal systems, and from 15 to 25% in deliveries; therefore, I would consider that the safe available supply for sale and use would be 1400 Miners Inches, to which might be added the amount of water that can be pumped from the wells in the basin of the San Dieguito on the San Dieguito Ranch, which can be safely estimated at 250" in addition to the reservations made by the San Dieguito Ranch for their bottom lands, making a total when fully developed, of 1650" of water, for which water rights could be sold.

D U T Y O F W A T E R.

A careful study of this whole question has been made, as set forth as Appendix B, accompanying this report.

After considering all of the data at hand and the arguments presented by different authorities, and including my personal observations, I have concluded that 1" to 7 acres for all of the lands which I have classed as #1, in comparison with all of the lands in the several tracts under a gravity system, is the safest estimate of the quantity required, and the system of works has been planned to furnish a sufficient capacity for all of the lands that can be irrigated by gravity water. If in the development of the several tracts of land it is found desirable to irrigate a larger amount of land with the same amount of water, the

opportunity can at once be furnished for doing so by pumping water upon the lands which adjoin and lie above the main trunk lines or distributaries.

S Y S T E M O F W O R K S .

1st. DAM FOR CARROLL RESERVOIR

This has been carefully treated under Divisions A, B and C of Appendix C, to which you are referred for a consideration of the different divisions of the subject.

Two types of dam have been taken under consideration.

One is the MULTIPLE ARCH Type Design, by Mr. J. S. Eastwood, and the other the SINGLE ARCH design by Mr. L. Jorgensen.

Both of these plans have been carefully considered together with a study of the Dam Site with reference to the advantages that might be obtained by the construction of either class of dam.

A structure which would be entirely satisfactory can be made with either plan as the conditions are favorable for both.

The main things to be considered are both carefully made in the design of either dam, which is as follows:

1st. A careful uniting of the structure of the underlying bed rock.

2nd. A large and elaborate Spillway sufficient to pass in safety the maximum floods.

3rd. A proper construction of large sluice ways for clearing the reservoir.

The estimates of cost in my opinion provide a sufficient sum to meet these special requirements. In my judgment, one of the most important features is the provision for elaborate sluiceways of the proper dimensions to remove the immense amount

of debris which accumulates in torrential floods in streams of this character. This feature has been sadly overlooked in the construction of all the modern reservoirs in Southern California, as has also a proper provision for passing the flood waters over the dam.

Both of these designs specifically provide for an adequate spillway, and I would recommend that careful provision be made for the sluice ways.

The additional items of cost under this heqding in the Jorgensen Dam provide $10,000.00 for these outlet sluices. This is independent of the cost for the canal intake.

Mr. Eastwood's type of dam is peculiarly adapted for the economical construction of a sluiceway, and this can be constructed for the sum he has set aside for that purpose.

In the single Arch type dam suggested by Mr. Jorgensen it would be necessary to enlarge the cross section of the dam to provide for an increase in hhight, I have decided that an increase in height of at least 20' should be provided for and have therefore enlarged the section of his dam so that it can be raised the additional 20' without any addition to the structure as built. This will increase the cost of construction up to the 350' contour, $44,000.00, and would make the cost of his dam $315,000.00.

In the Eastwood type of dam it will only be necessary to increase the depth of the girders on the exterior slope of the dam to raise the dam 20' above the 315' contour, and as I have stated in the appendix C, this can be done at the time it is proposed to raise the dam, at a cost of about $30,000.00, and

the interest on the $30,000.00 of investment can be saved until the time has arrived to raise the dam. This will make the present cost of the Eastwood type of dam, $280,000.00.

I would recommend that in the providing of the funds necessary for reservoir construction, $315,000.00 be set aside for that purpose.

For a further discussion of the subject, see Appendix C of this report and the tables showing capacity of reservoir and Summary of cost, and for the location of the reservoir, see Map Exhibit A; and for location and elevation of Dam Sites, see Exhibits B and C, which are contour maps of the Dam Site and Spillway; and Exhibit D which is a Profile of Dam Site C; and for a general idea of the comparative elevations of the water level at reservoir, the intake of the canal and the relative elevation of the high and low water levels in San Dieguito Reservoir and outlet of San Dieguito Reservoir, see Exhibit E.

Also Exhibit A, Jones Report showing the relative capacities for each 10' in height of Carroll Reservoir.

(Exhibit A)
(Jones Report)

DAMSITE C --- CARROLL RESERVOIR.

Survey October 1916

Depth	Contour	Area	Capacity	
			Acre Feet	Million Gallons
0	205	.1	.0	0
10	215	3.7	20	6.5
20	225	10.5	91	29.7
30	235	25.6	271	88.3
40	245	56.1	679	221.3
50	255	115.0	1,535	500.2
60	265	233.7	3,279	1,068.5
70	275	350.9	6,202	2,020.9
80	285	535.5	10,634	3,465.1
90	295	751.0	17,066	5,561.0
100	305	1,029.2	25,967	8,461.4
110	315	1,317.1	37,699	12,284.3

DAMSITE A is 1200 feet up stream from DAMSITE C.

M A I N C A N A L

This extends from the Carroll Reservoir to the San Dieguito Ranch, a distance of 26,100', and has a grade of .5 per 1000'. Exhibit E, graphically illustrates the grade line of this canal and its relation to the two reservoirs.

The Canal will run along the Northerly side of the San Dieguito River and will run for a considerable portion along a steep side hill, which in places has a slope of only about one-half to one. It is proposed to cut a bench into the solid formation and make a flat bottom conduit; that is, a concrete pipe reinforced at the bottom with additional concrete so as to form a flat surface on the bottom a little more than the width of the pipe. This will form a solid structure. The benching on the upper side will be sufficient so that the slope of the hill will extend over the top of the pipe. This concrete pipe will be 48" in diameter and across the ravines or draws where it is not practical to follow the contour of the hill, reinforced concrete pipe will be used. On the section where the canal reaches the Mesa lands it will be an open canal lined with concrete, excepting for a section of 1800' where it will be necessary to put in an inverted syphon. This will be 52" in diameter and 1800' in length. The lined section of canal will have an average width of 4' and a depth of 5'.

The Appendix D for the Main Canal together with the Tables and Summary attached thereto give the details and cost of said canal, the total construction cost being $79,786.00

Overhead and Administration Expense 18% 14,361.00

Making the total cost of the Canal 94,147.00

Exhibits F and G show the alignment and Profile of the Main Canal.

S A N D I E G U I T O R E S E R V O I R

This Reservoir serves the purpose of an equalizer of the flow of the main distributaries and also has some storage capacity.

A copy of Exhibit B, Jones Report hereto attached shows the depth, elevation, area and capacity in acre feet of this reservoir.

I have planned to build this dam of earth as described in the Summary of Cost hereto attached, the cost of construction being $14,698.20.

Exhibit H shows the plan of the Reservoir and Exhibit K shows the Profile of the Dam site.

M A I N D I S T R I B U T A R I E S .

These are indicated as follows:

UPPER PORTION ON THE SAN DIEGUITO RANCH, Exhibit L

LOWER PORTION, Exhibit M

CONTOUR MAP, showing the lower Portion Exhibit N

CONTOUR MAP, showing Main Lines and Districts in Irrigation System, Exhibit O

which is a plat showing the main lines and districts irrigated. This map made on a small scale shows the location of the canals and their numbers; also the portion of the districts in which the water is to be used, and the number of acres in each district. The acreages which are marked with only the number of acres are the lands irrigated by Gravity and the acreages which are marked with a P appended, thereto, indicate the lands that are above the gravity line to which water would have to be pumped.

The additional l

The additional lands irrigated are on distributing lines running from San Dieguito Reservoir to the lands irrigated.

The Canals are numbered 1, 2, 3 and 4.

The designation and capacity of line and the number of acres dependent upon them are indicated Alphabetically as follows:

The Summary showing that 1382 Miners Inches of water

(Exhibit B)
(Jones Report)

UPPER SAN DIEGUITO RESERVOIR AREA

AND

CAPACITY TABLE

Depth	Contour	Area	Capacity	
			Acre Feet	Million Galls
0	200	0	0	0
5	205	.2	.5	0.2
10	210	1.6	5.0	1.6
15	215	4.3	20.0	6.5
20	220	8.2	51.0	16.6
25	225	14.1	107.0	34.9
30	230	24.1	202.5	66.0
35	235	38.2	358.5	116.8
40	240	53.2	587.0	191.3
45	245	72.2	900.5	293.4
50	250	90.0	1,306.0	425.6

Volcan Land & Water Company.

Accompanying Map 652 A-T 2

DAM FOR SAN DIEGUITO RESERVOIR

The estimate for this Dam is for an Earth Dam with a Core Wall running down to bed rock in the center.

This Core Wall up to a height of 25' to be of concrete 4' in thickness, and the Puddle Trench will be 6' in thickness.

An Outlet Pipe will be placed on each side of the Dam and is included in the estimate, and a Spillway will be placed on the North side of the Dam 10' in width and lined with concrete.

The following estimate includes all these items.

CORE WALL (Excavation for Concrete 87.4 Yds.).....	$	43.00
(Concrete).....		1904.00
PUDDLE TRENCH ..... Excavation		100.00
" in "		115.00
MAIN FILL .....39,930 yds at 25¢ ...		9982.00
2 OUTLET PIPES, N. SIDE & S. SIDE		1143.70
WEIR BOX & CONNECTIONS		378.00
WINDLASS & FLAP VALVES		780.00
SPILLWAY (excavation 198 yds = $ 49.30 (Concrete Lining 508 Cu. Ft. = 203.20		252.50
Total		14698.20

will be required on gravity lands and for domestic water, is indicated in the above Tables.

The following Tables give the number of the MAINS, GRADE, CAPACITY, LENGTH, SIZE OF PIPE, KIND OF PIPE, and the TOTAL COST of each Line.

In the discussion under Appendix G for the "Classification of Lands", I have decided not to recommend Line #4 described as Green Valley Lines.

The following Table of Comparison of Distributaries shows that the lands in District #6 can be supplied with water for $55,389.00 less than they could by the construction of the Green Valley Line, and if in the future the development of the water system or the desire of the owners of the lands on the Green Valley Line make it an inducement to construct such line, it can then be taken up, as in that event the additional water provided for in Line #3 could be utilized by pumping to higher elevations; therefore, I have recommended the construction of Lines #1, #2 and #3 and the addition to #3 of the necessary lines to irrigate District #8.

No. 1 - A	is capacity of Line and Acregge dependent on it.
No. 2 - B	is ditto from Junction to Azuna Division.
No. 2 - C	is ditto from Azuna Division to W. Line S.D.Ranch
No. 2 - D	W Line S. D. Ranch to Del Mar Reservoir.
No. 2 - F	is ditto Del Mar Reservoir to Junction with Coast Division.
No. 2 - G	is Junction with Coast Division to Junction with Line No. 3.
No. 2 - E	is Del Mar Reservoir to Del Mar.
No. 3 - B	from Junction of Line No. 2 & 3 with 1 to West Line of San Dieguito Ranch.
No. 3 - C	from West Line S. D. Ro to Junction at Coast with Line No. 2.
No. 3 - D	from Junction of Lines 2 & 3 along Coast Line to N. Line of Jones District No. 6.

No. 3 - E	From N. Line of Jones District No. 6 to N line of Jones District No. 7 (Batiquitos Lagoon).
Note	"Mains" refer to the main distributing lines through the several tracts. The lateral lines for the delivery of water is not estimated or described.

(3)

LANDS & SIZE OF PIPE

KELLOGG NUMBERS ACREAGE CAPACITY AND NUMBERS	NO. OF MAIN	GRAVITY LANDS OPPOSITE SECTION.	NO. OF M.I. FOR GRAVITY LAND	PUMPING LANDS ADJACENT.	REMARKS
1 - A	1	0	0		
2 - B		140	14		
2-C		460	46	500	
2 - D		250	35	480	
2 - E		400	50		
2 - F		250	35		
2 - G		450	64		
3 - B		600	85		
3 - C		150	20		
3 - D		1095	157	969	
3 - E	7	1127	161	800	
To tal		5922	667	2169	
No. 8 DISTRICT		2564	366		
		8486	1003		

12-b

3 (a)

GRAVITY LANDS NOT UNDER PRINCIPAL MAINS.

San Dieguito Rancho -	Walnut Orchard	590 acres
" " "	San Elijo	330 "
District No. 12	Olivenheim	792 "
	Assign 250 M.I. to	1712 "

S U M M A R Y

Provided on Principal Mains	667 M. I.
District No. 8	366 M. I.
Outside of Principal mains	250 M.I.
Total of Gravity Water	1283 M.I.
Domestic water for lands along coast	100 M.I.
Total water used	1382 M.I

12-c

NO.OF MAIN	GRADE PER 1000'	CAPACITY	LENGTH	SIZE	EXCAVATION COST PER FOOT	KIND OF PIPE	COST OF PIPE	COST OF LAYING	COST OF GATES	TOTAL COST PER FOOT	TOTAL COST
1-A	1.2	1003"	7,200	40"	48½¢	Cement P.	$1.35	20¢	.01¢	$2.06	$14830.00
1-A	1.2	"	2,000	40"	48½¢	Reinf.C.P.	1.90	1.00	.01¢	3.41	6820.00
											21650.00
2-B	0.8	244"	1,950	24"	26¢	Cement P.	.70¢	.20	.02	1.18	2350.00
2-C	0.8	230"	12,350	22"	24¢	Cement P.	.60¢	.20¢	.03	1.07	13210.00
2-C	0.8	230"	1,500	22"	24¢	Reinf.C.P.	1.26	70¢	.03	2.23	3345.00
2-D	0.8	184"	12,600	20"	21¢	Cement P.	.50	15¢	.02	.88	11090.00
2-D	"	"	1,000	20"	21¢	Reinf.Con.	.90	30¢	.02	1.43	1430.00
2-D	"	"	1,400	20"	2.50	Tunnel	.90	80¢		4.20	5875.00
2-E	1.0	50"	10,000	12"	.14	Steel Pipe	1.30½	10¢	.03	1.57½	15750.00
2-F	0.8	99"	9,600	18"	.19	Cement P.	.40	15¢	.03	.77	7390.00
2-F	"	"	1,400		.19	Reinf.C.P.	.54	24¢	.03	1.00	1400.00
2-G	"	64"	2,200	14"	.15	Cement P.	.25	10¢	.03	.53	1165.00
											63005.00
											15750
											47255

NO. OF MAIN	GRADE PER 1000'	CAPACITY	LENGTH	SIZE	EXCAVATION COST PER FOOT	KIND OF PIPE	COST OF PIPE	COST OF LAYING	COST OF GATES	TOTAL COST PER FOOT	TOTAL COST
3-B	1.2	789"	10,300	36"	.42	Cement P.	1.15	20¢	.03	1.80	18550.00
3-B	1.2		400	"	.42	Reinf.C.P.	1.60	1.00	.03	3.05	1220.00
3-B	1.2		1,900	32"	.36	Steel Pipe	3.23	.20	.03	3.80	7225.00
3-C	1.2	704"	9,800	34"	.39	Cement P.	1.05	.20	.02	1.66	16250.00
3-C	1.2		1,900	32"	.36	Steel Pipe	3.23	.25	.02	3.96	7525.00
3-D	1.0	684"	4,000	32"	.39	Steel Pipe	3.23	.20	.03	3.85	15400.00
3-D	1.0		14,500	34"	.39	Cement P. (or casing)	1.20	.20	.03	1.82	26434.00
3-E	1.0	527"	1,300	32"	.36	Reinf.C.P.	1.38	1.00	.03	2.77	3600.00
3-E	1.0		16,000	32"	.36	Cement P.	1.10	.20	.03	1.69	27120.00
3-F	1.2	366"	4,000	24"	.30	Steel P.	2.52	.20		3.02	12080.00
											135404.00
District No. 8.											
3-G	1.2	366"	10,300	24"	.26	C. P.	.65	.15	.03	1.09	11230.00
3-H	1.2	150"	1,800	18"	.19	Steel P.	1.95	.15	.03	2.32	4175.00
3-K	1.2	125"	4,900	18"	.19	C. P.	.40	.15	.03	.87	4260.00
						Total of District No. 8					19665.00

GREEN VALLEY LINE 600" CAPACITY

NO.OF MAIN	GRADE PER 1000'	CAPACITY	LENGTH	SIZE	EXCAVATION COST PER FOOT	KIND OF PIPE	COST OF PIPE	COST OF LAYING	COST OF GATES	TOTAL COST PER "FOOT	TOTAL COST
4 - A	1.0	600"	9050	32"	.35	C.P.	$1.00	$0.20	.007 .01 65.00	$1.56	$14118.
4-B	1.0	500"	12900	30"	"	C.P.	.90	.15	.01	1.41	18125
"	"	"	3300	"	"	Reif.P.	1.26	.99	.01	2.61	8597
"	"	"	3600	28"	"	Steel P.	2.85	.20	.01	3.41	12260
"	"	"	400	"	2.50	Tunnel	.90	.80	.006 1.25	4.20	1680
4-C	1.0	366"	9300	26"	.30	C. P.	.75	.15	.03	1.23	11440
"	"	"	600	"	"	Reinf.P.	1.20	0.80	.03	2.33	1398
"	"	"	13900	.02	"	Steel P.	2.52	.20	.03	3.05	42400
											110018.

LINES 1 & 3 FIGURED WITHOUT 366" M. I. FOR DISTRICT NO. 8.

NO.OF MAIN	GRADE PER 1000'	CAPACITY	LENGTH	SIZE	EXCAVATION COST PER FOOT	KIND OF PIPE	COST OF PIPE	COST OF LAYING	COST OF GATES	TOTAL COST PER FOOT	TOTAL COST
1-A	1.2	637"	7,200	30"	35¢	C.P.	0.90	.15	.01	$1.41	$10150.00
1-A	1.2	"	2,000	30"	35¢	Reinf.C.P.	1.26	.99	.01	2.61	5220.00
											15370.00
3-B	1.2	423"	10,300	28"	30¢	C.P.	.66	.15	.02	1.13	11630.00
3-B	"	"	400	28"	"	Reinf.C.P.	1.20	.98	.02	2.50	1000.00
3-B	"	"	1,900	26"	"	Steel P.	2.66	.20	.02	3.18	6045.00
3-C	1.2	338"	9,800	24"	"	C.P.	.65	.15	.02	1.12	10980.00
3-C	"		1,900	24"	"	Steel P.	2.52	.20	.02	3.04	5775.00
3-D	1.0	318"	4,000	24"	"	Steel P.	2.52	.20	.02	3.04	12160.00
3-D	1.0	318"	14,500	26"	"	C.P.	.75	.15	.02	1.22	17700.00
3-E	1.0	141"	1,300	18"	25¢	Reinf.C.P.	.54	.24	.02	1.05	1365.00
3-E	1.0	"	16,000	18"	"	C.P.	.40	.15	.02	.82	13110.00
3-F	1.2	100"	4,000	15"	25¢	Steel P.	1.43	.15		1.83	7320.00
											87085.00

A. Recommended Construction. Distributaries.

Line No. 1	Capacity 1003"	21,650.00	
" No. 2	" 244" to 64"	63,005.00	
" No. 3	" 789" to 366"	135,404.00	
District No. 8	" 366" to 125"	19,665.00	239,724.00

Comparison of Distributaries

Lines 1 & 3 with District No. 8

No. 1 Capacity 1003"	$21,650.00	
" 3 " 789" to 366" to Junction with No. 4 line	135,404.00	157,054.00

Lines 1 & 3 without District No. 8.

No. 1. Capacity 637"	15,370.00	
No. 3 " 423" to 100" to Junction with No. 4 line	87,055.00	102,425.00
Extra Cost to serve District No. 8 by means of lines 1 and 3		54,629.00

Line No. 4. Green Valley Line.

From San Dieguito Reservoir to Junction with Line No. 3.	110,018.00	
Extra cost to serve District No. 8 by lines No. 1 and 3	54,629.00	
Excess of Green Valley Line		$55,389.00

SUMMARY.

Summary of Cost.

Carroll Dam Crest Elevation	Const. Cost.	Overhead expense	Total
315 above sea. Spillway elev.			
310 above sea.			
With Eastwood Dam	270,000	10,000	280,000
With Jorgensen Dam built with section raising to 335 above sea	288,000	27,000	315,000
Main canal capacity 1550 Miners inches 5 miles long	79,786	14,361	94,147
San Dieguito Reservoir	14,698	2,205	16,903
Main Distributaries			
No. 1	21,650	4,330	25,980
No. 2	63,005	12,601	75,606
No. 3	135,404	27,080	162,484
Line in District No. 8	19,665	3,933	23,598
Total			398,718
Auxilliary Reservoirs	Const. Cost	Overhead 15%	Total
	9,200	1,580	10,580
Total all Structures, excepting Carroll Dam			411,335
Recommended Capital Provisions.			
Carroll Dam			315,000
All other Structures			411,335
Total			726,335

The above Summary of cost includes everything but the Pumping Plants and Force Mains to pump the 250" of water into the system of works.

I have not made any revision of my former estimates, but as they were carefully made at the time I investigated the underground waters of the San Dieguito Ranch and the conditions of water supply carefully studied, I think it is safe to make the same recommendations for the development of the water that I made at that time, which in effect is that a plant be built about 9000 feet above the present plant and a pipe line built down to the South-west corner of the Aguna place where the water from two plants could become interchangeable, and a booster plant be put in at that place to elevate the water required by the Mutual Water Company to their system of works, and that this joint system be paid for by the Santa Fe R. R. Company and the Mutual Water Company; that is, the portion in which they are both equally interested, the improvement of the old plant and the new plant and connecting pipe line be paid for jointly, and the necessary booster plant be paid for by the Mutual Water Company.

The following is the estimate of cost for the work completed as a whole after deducting the amount to be paid by the Santa Fe Ranch for their part of the construction and including the booster plant and force main is, $15000.00

The construction of a separate system of works would cost equally as much and would not prove as satisfactory.

With this addition the total cost of the system of works as contemplated by the Mutual Company will be, $746000.00

COST OF WATER FOR SYSTEM OF WORKS AS LAID OUT.

Per Miners inch		$520.00
Estimating the water at the rate of 1 inch to 7 acres, The water would cost	70.00	
Estimated value of the land without water	30.00	
Total		100.00
The cost where the water has to be pumped above the gravity line, would be		150.00 per A.

TABLE OF ELEMENTAL VALUES PER AcRE.

Class of land.	Cost of Water per acre	Land without water	Land with water	Value of water right per acre	Remarks
Coast lands	$70.00	$50.00	$350.00	$230.00	To pay interest on additional cost and maintenance pumped water will cost $70.00 per acre more.
1st class lands	70.00	30.00	250.00	150.00	
2nd class lands	70.00	30.00	200.00	100.00	

TOTAL VALUES OF WATER TO DAND.

Coast Lands	4,000	$920,000.00	
1st Class	3,000	450,000.00	
2nd Class	3,200	320,000.00	
Total		1,690,000.00	After deducting cost of land and system of works.

The above values I consider conservative as they are based on comparative values in unimproved territory. The class of products that may be grown upon these lands should pay a good income upon the investment.

I believe this report covers all the points which have been under discussion.

This last subject is one upon which many of you are comparatively well posted.

In conclusion, will say that in the discussion of any of the different points on divisions of the report, I refer you to the appendices for more elaborate discussion.

In regard to the location in detail of the Distributaries they may have to be modified in detail as they are not located from actual surveys upon the ground and the estimates for the same do not include the smaller laterals for delivering the water upon the different subdivisions of the land.

Respectfully submitted,

H. Clay Kellogg

Civil and Hydraulic Engineer.

INDEX TO APPENDICES.

INDEX TO EXHIBITS.

Digest of Mr. Post's Report to W. E. Hodges, Oct. 13,1916, as to the available water supply of Carroll Reservoir.

I have checked up the computation of the water shed from the contour maps and Government report. From my computations on the contour maps and Government reports, I make the area 186 sq. miles, but Mr. Post's more detailed information will possibly add the other ten miles which he estimates, making the water sheds 196 sq. miles for the Carroll Reservoir, independent of any surface flow from the Pamo Dam.

In regard to the cycle of years between high and low periods of water supply, will take that up under a separate head, for the purpose of determining by comparison the ratio between the same.

ESCONDIDO CREEK: This creek is in itself a local water shed, reaching about to rim of the San Luis Rey River, a distance of about 14 miles above Escondido, and the San Luis Rey River runs in behind said creek. In addition to this the water shed is cut off by the Escondido Reservoir, which is more than ample to store the waters from the water shed above the dam during ordinary periods of rainfall, therefore, I do not consider the residue of the water shed which Mr. Post estimates at 48 sq. miles, will justify the construction of the reservoir.

On the future increase of heights of Carroll Dam, to the heights of 140 ft. This is an economic feature that should be considered as a reinforcement to future requirements when the lands are developed.

In regard to the development of water from pumping in the gravel beds of the Bernardo basin. I took up the investigation of this basin very thoroughly, in my report of the underground waters of the San Dieguito river, I formed the conclusion at that time that there are no subterranean waters passing through the bed of the river between the Bernardo basin and the San

the San Dieguito basin and this opinion is verified by the investigations for the dam site of the Carroll Reservoir, therefore, it is safe to assume that the stored waters in the gravels of the Bernardo basin which would be available for pumping. The San Pasqual valley lies in the upper end of the Bernardo basin, where a settlement has appropriated the surface flow of the stream, and irrigate about twelve hundred acres by two ditches running along each side of the valley. The Government reports indicate that the water is running all the year around in the canyon above this valley and it is stipulated by the parties interested, that in case the Pamo Dam is constructed, the amount delivered to the San Pasqual irrigators shall be 6600 acre ft. during irrigating season. This would be more of an advantage to Carroll Reservoir than a detriment, because 40% would be returned to the reservoir basin as percolating water, adding 2460 acres ft. to the storage in the reservoir, as a permanent addition. If additional water is used in these ditches, it will have a beneficial effect in times of low water, by joining the waters of the reservoir at the lower levels or increasing the pumping supply.

Citrus orchards are being planted in portions of the Escondido district, their water supply being taken from the water shed of the San Luis Rey River and the return water will be into the Carroll Reservoir. This is variously estimated at from 27% to 35% of the water used in soils of this class. In time this will prove a valuable increment and will reinforce the low water supply in dry periods when it is most required.

In seasons like 1912-13 the river is dry for two or three months in the summer, this is led to the boring of wells and the construction of pumping plants at several points in the valley. These wells show that at the upper end the debris cone has a depth of 96 feet to bed rock and at the lower end of the valley they are from 40 feet to 25 feet to bed rock, immediately above the high water line. In 1913 they were probably pumping all together 200 miners inches of water, these developments indicate that there is quite a large area of gravel basin round the upper border of the Carroll reservoir and the indications are that this debris cone has been deposited by the river and side canyons upon the original floor of the basin and I believe that a flow of 300 inches of water could be developed by a system of wells around the upper edge of the reservoir, these wells could be located near enough to the high water line to be above the danger of flooding and the water could be economically piped down through the reservoir to the canal intake at the dam. In my opinion this should be considered as an emergency supply for the low cycle of years, which has been mentioned by Mr. Post. It is a well known fact by those who have been familiar with the conditions here in Southern California for a period of more than twenty years that there times when the water supply cannot be maintained at the ordinary standard fixed for the mean supply. All of the water systems have felt this deficiency. During the last cycle of low water, pumping plants were placed in the bed of the Bear Valley reservoir, which is recognized as the most dependable supply in Southern California, and Redlands, which receives water from this system, had to build pumping plants in the Yucaipe valley to sustain the orchards during this periods. A number of illustrations could be given, but this illustrates the point that all possible care must be taken to carry the system over this period and it also illustrates the

fact that with the best system a shortage can be expected by the irrigators at this time.

CYCLE OF YEARS. The best historical record that I can obtain shows the complete cycle to be from 21 to 22 years, the best natural barometer determining the cycle is Lake Elsinore. In 1883 I surveyed out the town and colony of Elsinore. At the time the lake was practically dry, there being only about 1200 acres of land covered with water, out of the 6000 acres the maximum depth being 3-9/10 feet. Juan Machado, a Spaniard over 60 years old whose family originally owned the lake had lived there all his life and informed me that in 1839-40 the lake was dry and also in 1859-61 it was dry and grass was growing over the major portion of it, and that it was filled by a flood in 1841 and 1862, it was also filled by the flood of 1884. Following up the study more closely of this cycle, from my individual observation dating from 1868, I find the lake also over-flows a second time about seven years after the first over-flow and also by keeping a record of the seasons by the growth of crops, the rainfall and the shortage of water in irrigation system, I find that each 21 years is approximately divided into three divisions and that these divisions run about as follows, taking the nomenclature of the farmer, the first seven years run two years above the normal and one about normal, with the seventh year below normal. The second seven years about one above normal and one below, the third seven years one above normal and two below with the last two years dry. Owing to disturbing elements, namely the irrigation of the Perris valley and Hemet system and the construction of the Hemet reservoir, the last cycle in Lake Elsinore has been disturbed so that the low water mark was two feet higher than in 1883 and the high water mark, namely the over-flow, was not quite reached in 1905-6. Also the second over-flow in the cycle should have been reached in 1914-15 instead of 1915-16 as occurred. The uniformity of these

conditions are not absolutely exact, but they are sufficiently accurate to form a guide and they prove that there is only one dangerous period of draught and that is in the last seven years of the cycle. The other dry periods are so short that they do not produce any bad effects excepting on temporary crops.

By carefully husbanding this extra supply and the underground water of the San Dieguito basin, the irrigators under this system of works can be carried over this period.

San Dieguito basin and underground water supply. It is not necessary for me to go into details in regard to the water that may be secured from this basin, suffice it to say that I regard the 250 inches of water to be obtained from this source as dependable and that the subject is exhaustively treated in my report of 1913. As intimated by Mr. Jones the construction of the Carroll Reservoir has cut off the most of the available water for storing the gravels of this basin, but the amount of water on the 29 sq. miles of water shed tributary to the basin and the ancient river channel referred to in my report will furnish the water. There is no way of absolutely determining the velocity of the water in this old ancient channel, but there would be a possibility of an over-draught if the pumping was continued over too long a period of time. However, I still maintain that the storage basin outlined in my former report, will be necessary for the maintenance of the quantity of water required for the irrigation of the bottom lands and to furnish the 250 inches to the Carroll system.

Regarding the bottom lands in the San Dieguito river bottom, between San Dieguito Ranch and the ocean, I seriously doubt whether they will ever require any considerable amount of water, but as they are directly riparian through the stream they will have to be considered, by this I mean that they can demand the water they require at the same rate as that charged to the

Mutual Water Company, however, I do not consider it necessary to provide a pipe line and system of works for these lands, as such pipe lines can be more economically built in conjunction with the pipe system for the San Dieguito Ranch on the bottom lands and if it was required the water could be turned into the said system of works from the upper system by the construction of a short pipe line near the Asuna Place or immediately above the ranch line.

TABLE NO. 2.

RUNOFF AT BERNARDO BRIDGE NEAR CARROLL DAM

U. S. GEOLOGICAL SURVEY MEASUREMENTS

IN

CO-OPERATION WITH V.L.& W.CO. IN ACRE FEET.

MONTH	1911-12	1912-13	1913-14	1914-15	1915-16
Oct.	0	0	0	0	0
Nov.	0	12	0	0	0
Dec.	0	12	2	0	334
Jan.	0	12	4,390	6,270	257,513
Feb.	0	310	12,700	25,000	25,527
Mar.	(a)1,400	1,390	2,400	9,410	16,207
Apl.	(a)4,400	320	1,210	8,270	6,801
May	1,990	8	695	19,800	3,370
June	33	3	24	1,760	1,332
July	6	0	0	54	252
Aug.	0	0	0	53	0
Sept.	0	0	0	0	2
Total	7,830	2,070	21,420	70,620	311,340

(a) Estimated.

TABLE NO. 4

COMPUTATION OF USE AND WASTES

CARROLL RESERVOIR IN ACRE FEET

SEASON (OCT. 1 TO OCT. 1)	RUNOFF (SUPPLY) MOSTLY RCD.BETWEEN NOV.1 & APR. 1	WASTED OVER CARROLL DAM DURING RAINY PERIOD.	RESERVOIR CONTENTS APR.1st (END OF RAINY PERIOD.)	(a)IRRIGATION WATER USED (b)PLUS EVAPORATION LOSS DURING ENSUING SUMMER.	RESERVOIR CONTENTS NOV. 1 - END OF DRY PERIOD.
1905-06	49,660	12,660	37,000	15,600	21,400
1906-07	38,920	23,320	37,000	15,600	21,400
1907-08	5,310	0	26,710	15,600	11,110
1908-09	53,960	28,070	37,000	15,600	21,400
1909-10	36,340	20,740	37,000	15,600	21,400
1910-11	12,980	0	34,380	15,600	18,780
1911-12	5,560	0	24,350	(a) 12,000	12,350
1912-13	2,070	0	14,420	(a) 12,000	2,420
1913-14	10,840	0	13,260	(a) 12,000	1,260
1914-15	50,060	14,320	37,000	15,600	21,400
1915-16	306,090	290,490	37,000	15,600	21,400
AcREAGE EXCLUDING 1915-16	26,570	9,910			

(a) Irrigation Water used taken at 12,200 Acre Feet per year
(b) Evaporation from Reservoir Surface at 3,400 Acre Feet per year.
(c) Evaporation Loss of the Reservoir is small during this period. (because of lessened area and so-called "make up" or seepage from banks during a lowering reservoir), and would not amount to over 1000 Acre feet per year. Pumping from gravels 1000 Acre Feet per year would therefore compensate this, and give a uniform annual Irrigation use of 12,000 Acre Feet.

To pump 10,000 Acre Feet requires pumping 250 Miners Inches for 100 days in the year.

TABLE NO. 3

TABLE OF WATER SUPPLY IN ACRE FEET.

	RUNOFF TOTAL DRAINAGE AREA LT CARROLL DAM	RUNOFF OF PAMO LESS 6600 Acre FEET REQUIREMENT OF SAN PASQUAL VALLEY	DIFFERENCE: BEING RUNOFF OF DRAINAGE AREA EXCLUDING PAMO	ADD 40% RETURN WATERS	ADD WASTE FROM PAMO	Total AVAILABLE FOR CARROLL PROJECT
1905-06	94,000	56,380	37,620	2,640	9,400	49,660
1906-07	47,500	29,120	18,380	2,640	17,900	38,920
1907-08	7,300	4,630	2,670	2,640		5,310
1908-09	66,000	40,640	25,540	2,640	25,780	53,960
1909-10	44,800	27,300	17,500	2,640	16,200	36,340
1910-11	21,400	13,160	8,240	2,640	2,100	12,980
1911-12	7,830	4,910	2,920	2,640		5,560
1912-13	2,070	0	2,070	0		2,070
1913-14	21,420	13,220	8,200	2,640		10,840
1914-15	70,620	43,200	27,420	2,640	20,000	50,060
1915-16	311,340	151,290	160,050	2,640	143,400	306,090
Average 10 years (exclding 1915-16)						26,570

DUTY OF WATER.

This becomes a very important question in all cases where the land is to be irrigated exceeds the water supply and that is the condition which confronts us here, and the lands to be irrigated can be considered from several different angles, such as the character of soil, advantage in location and cost of delivering the water. In my study of the situation, I have endeavored to consider these different points without considering the ownership of land. And to show the scope over which my investigations have been made, I will under this head introduce some investigations that have been made by other parties, at the same time taking into account their point of view and in this connection I will introduce the following quotations, made from my report to W. E. Hodges on the water supply of the San Dieguito Ranch.

The variation in the amount of water used in different localities is caused by the character of soil, the economy of delivery, and the cost of water.

In the majority of cases the quantity of water actually used is far less than estimated. In those localities where all the economical conditions have been studied, and the best results obtained, 2 acre feet, equal to 24" depth on the land, has produced the most satisfactory results. With a complete system of piping on the hill lands, 1" to 7 acres equal to 2.08 acre feet will be sufficient, as the runs will necessarily be short, and deliveries made at close intervals. At Corona and Highgrove, 3" in depth is considered the best for each irrigation. I have therefore figured at 2.08 acre feet as a basis to be adopted for the hill lands on this tract, divided as follows,-
7 irrigations of .26 each, extending over a 7 months period termed the irrigating season, subject of course to the modifying conditions of

seasons, and one irrigation through the winter months. More water can be used if required, by increasing the length of the period of irrigation, without increasing the capacity of the plant.

The system of furrow irrigation is the only available method for placing the water upon these lands, which are very irregular, being on the sides of the hills. In the planting of the trees it will be found of great advantage to place them upon grade contours, the rows following the contour of the hill, with a grade that will permit the water to move slowly along the furrows. This grade has, by those most experienced with conditions similar to those existing on this tract, been found to be about one inch and a half to each tree, - that is, if the trees are set at distances of 20' or 25', each tree will be 1½" lower than the last one, along the direction in which the water is to flow.

The water on these slopes will necessarily have to be delivered in small quantities. A 25" stream will be found the most economical and satisfactory upon this slope.

EQUATION OF WATER FOR IRRIGATION.

3-1/8" depth at each irrigation = .26 x 7/8 = 1.82 sec. ft. to be used in 7 months. The remainder to be used in the winter months.
25" = ½ sec. ft. = 30 cu. ft. per minute = 1800 cu. ft. per hour.

$\frac{.26 \times 43560}{1800}$ = 6.3 hours to irrigate one acre.

The San Fernando Valley system to be irrigated by the Los Angeles aqueduct can be considered in a measure as similar to the San Dieguito territory and Mr. Mulholland on the duty of water estimates this quantity required as 1 inch constant flow to 7½ acres. This is concurred in by the board appointed to investigate the report.

The Government selected Gage Canal System as being about the best example of the economic use of water and the following is from their report.

The Government Report Irrigation Investigation Bulletin 119, 1911, gives the results of three years' observation on the duty of water in this district, and a table giving the data in concise form is included herewith.

Duty of Water Under Gage Canal. 1898-1901.

District and year.	Area	Water used	Depth of Irrigation	Depth of irrigation & rainfall.
District No. 1	Acres	Acre-feet.	Feet	Feet.
1898-1899	3,595	8,330.46	2.32	2.79
1899-1900	3,614	8,779.64	2.43	2.87
1900-1901	3,614	7,478.78	2.07	2.74
District No. 2				
1898-1899	2,871	6,407.80	2.23	2.71
1899-1900	3,237.84	6,855.71	2.12	2.56
1900-1901	3,237.84	6,584.44	2.03	2.70
District No. 3				
1898-1899	530	943.55	1.78	2.26
1899-1900	650	1,059.89	1.63	2.07
1900-1901	650	904.31	1.39	2.06
Canal as a whole.				
1898-1899	6,996	15,681.84	2.24	2.72
1899-1900	7,501.84	16,695.24	2.23	2.67
1900-1901	7,501.84	14,967.53	2.00	2.67

Making the average for the three years in the three Districts 2.02 - depth

The following is taken from the Cuyamaca Water Company, which parallels the San Dieguito territory to some extent.

CUYAMACA WATER COMPANY.

Crop	Character of Irrigation		Area Irrigated in Acres. High Service	Low Service	Flume	Total
Olives	Periodical Irrigation		198.5	3.2	152.7	354.40
Deciduous	"	"	55.62	21.73	158.0	215.35
Grapes	"	"	0.78	0	603.7	604.48
Total	"	"	254.90	24.95	894.4	1174.23
Domestic	Continuous irrigation during irrigation season		20.96	20.25	37.9	79.11
Citrus	"	"	926.03	195.85	1091.9	2213.78
Vegetables	"	"	81.69	52.20	71.1	204.99
Alfalfa	"	"	12.4	0.20	40.0	52.60
Total	"	"	1041.08	268.50	1240.9	2550.48
GRAND TOTAL			1295.98	293.43	2135.3	3734.71
			Total amount of water delivered in full service year - thousand cu.ft.			
			49,203.8	12,244.2	78,532.6	139,980.5
			Depth of water applied - ac. ft. per acre.			
			0.87	0.96	0.85	0.86#

Note: # = Equivalent to 1 Miners Inch to 12.6 acres for 9 months Irrigation Season.

Sweetwater System Coast soil or acre ft. per acre .93

or M. I. per acre 1 to 11 acres.

The following table shows use of water for a number of years.

- SWEETWATER WATER COMPANY -

SUMMARY OF MONTHLY USE OF WATER - ACRE FEET.

Month	A 1910	1911	1912	1913	1914	Monthly Averages	Monthly Per cent
Jan.	10	24	20	119	33	41	0.98
Feb.	47	15	231	47	32	74	1.77
March	151	16	171	83	99	104	2.49
April	325	441	26	284	297	275	6.58
May	589	627	193	614	404	486	11.63
June	608	594	668	485	570	585	14.02
July	593	594	607	525	602	584	14.01
Aug.	598	679	686	581	620	633	15.17
Sept.	581	598	588	550	577	579	13.82
Oct.	250	451	444	428	320	379	9.08
Nov.	160	320	402	198	202	256	6.13
Dec.	231	184	347	81	57	180	4.32
Total	4143	4543	4383	3995	3813	4176	100.00

1/25/15

T

About 4500 acres.

APPENDIX "C" - SECTION "A"

DETAILS OF CARROLL DAM.

December 7th, 1916

I have made a careful examination of the Dam Site as located at Dam Site "C", and have made a careful observation of the comparative merits of Dam Site "C" and Dam Site "A"; also a study of the Profile and Contour Survey of the locations made by Mr. Post.

This personal examination was made on the 25th and 26th of November, 1916. A reconnoissance was also made of the same site in 1913 and during the dry period when the conditions of underflow and seepage could be observed above and below the dam site.

My report made at that time on the San Dieguito Ranch indicates my favorable impression of the dam site. I refer to that study of the situation as to how these conclusions were arrived at at that time.

The heavy floods have displaced most of the loose materials above the bed rock so that it appears upon the surface almost entirely across the cross section. The pits excavated up the sides of the mountain on either side show that this bed rock is almost at the surface and all the examinations and investigations made establish the fact of a perfect bed rock entirely across the dam site.

The location survey made for the line of an arch dam across the canon intersects the bed of the stream at what I consider the best point to build a dam. In estimating a right line through the axis of the dam my judgment would be to bring the end of the

dam on the Southerly side of the stream a few feet further up stream, but this is more of a matter of opinion than of necessity. In my judgment all of the conditions are exceptionably good for the construction of a permanent dam at this point regardless of the type of dam used. If properly constructed it cannot be other than successful.

In the study of the types of dam suggested I shall refer to them as "EASTWOOD MULTIPLE ARCH DAM" and the "JORGENSEN SINGLE ARCH DAM".

Both plans have been submitted together with specifications and estimates of cost and will consider the two separately and introduce the plans and estimates as furnished mass a part of these Appendices.

1st. "THE EASTWOOD MULTIPLE ARCH DAM".

There are many features of this Dam that appeal to me; the principal feature being that for this particular place its economy of material and construction together with the fact that the rock is rather hard for the purposes of quarrying, it looks like it should be the most economical structure. There are several other advantages in this form of structure, one of which is that it at all times furnishes an opportunity for the inspection of the interior of the dam. It also furnishes at a moderate expense an ideal opportunity of building a large sluice at the base of the dam at a very moderate cost, which can at all times be inspected throughout its length except directly at the gateway which only occupies a small section at the toe of the dam. It also affords advantages in the construction of a spill-

way as by the construction of a concrete deck or curtain wall the water can be passed over the crest of the dam and down the back slope on a curtain wall over which the water will pass smoothly without creating any jar upon the dam and this curtain wall without increasing the initial cost to any great extent becomes an additional brace for the stability of the dam and the expense for the construction of expensive spillways on the sides of the dam can be in a great measure obviated. In the preliminary plan which Mr. Eastwood has submitted he suggests a spillway the entire length of the dam, which I think is correct inasmuch as the extreme floods as shown by the gaugings demand a very wide spillway, and as I have already shown it does not require any large additional expense. However, I do not consider that it is necessary to build an additional waste way on both sides of the dam. The natural configuration of the ground makes it very simple and economical to construct a spillway on the North side of the dam while the South side presents a uniform section of rock formation on the wall which would require considerable expense in constructing a waste way, therefore I would make the South end of the dam with a stone pier at the end without any waste way and construct a waste way on the North end; have estimated the cost of such a waste way 50' in width to be $4660.00. See estimate of spillway in the Appendix of this report.

As this cost for spillway will not exceed the cost of spillways on the plan furnished by Mr. Eastwood it will not be considered as an additional cost in the construction of the dam.

The question of the raising of the dam which has been rec-

commended both by myself and Mr. Post is one that has to be considered in connection with the construction of the dam.

The buttresses which form the main stay of the dam in the Eastwood type are planned to be 36' apart from center to center. When it is considered necessary to raise the dam additional struts or beams could be built on the edge of these buttresses on their outer slope of the necessary width or thickness to sustain the additional stress on the dam and it would be done with very slight additional expense over what would be the cost to build them at the present time, as the only expense would be the scabbling off of the face of the wall and roughening it so as to secure unit or bond with the concrete in place. I have made no estimate of the cost of this extra construction for raising the dam to an additional height of 20', but it is safe to say that it would not exceed $30,000.00

The effect of the dam after it was raised is that there would be ribbon walls on the back slope of the dam, which I consider would be an advantage as it would divide up the water curtain into divisions. I find that Mr. Eastwood inclines to the opinion that there is an advantage in a continuous ribbon of water. My experience is that in wide sheets of water the action of the wind would have a tendency to unequally distribute the stream which would be prevented by this divided ribbons which I have put in on wooden crests where they were of considerable width. However, the question is not very vital in this case as the width of the wier and the depth of the water do not make such provisions a necessity.

I hereto attach the plans, specifications and estimates of cost which Mr. Eastwood has sent me.

2nd. "THE JORGENSEN SINGLE ARCH DAM."

I believe that this would be an entirely safe structure and it is an economical type of construction for this site and would no doubt give satisfaction.

In his construction he designs a spillway on either side of the dam of sufficient dimensions to take care of the flood waters, therefore a continuous overflow of the dam would not be required. Mr. Jorgensen has furnished a plan and complete specifications for the construction of his dam up to the height at present required.

As I believe that provisions should be made for the raising of the dam to at least 20' higher I have made an estimate of the additional cost for making the structure sufficiently strong in its cross section so that it can be easily raised to an additional height above the crest of 20'. This will add $44,000.00 to the construction of the dam at this time, but as it would cost a great deal more to add the additional thickness necessary at a later date I would consider it advisable to provide for this raise in the beginning.

The only advantage that I can see in the construction of The Eastwood type of dam from an economic standpcint would be the saving of the interest on the money necessary for raising it to the additional height at some time in the future.

An estimate of the cost of the Jorgensen Dam and also the additional amount necessary to provide for the raising of the additional 20' is attached to and forms a part of this appendix.

CArrOLL DAM SPILLWAY.

Station	End Area	Av. end. Area.	Length	Cu. ft.
0x00	450			
		437	100'	43.700
1x00	425			
		425	50'	21.250
1x50	425			
		392	50'	19.600
2x00	360			
		280	100'	28.000
3x00	200			
		133	100'	13.300
4x00	66			
				125.850

Excavation Solid Rock

4660 Cu. Yds. at .85

Concrete Wall - 5' x 1 x 400' $3961.

2000 Cu. ft. at .35 700

Total Construction cost $4661.

NOTE--The following Specifications refer to preliminary Estimate Dam site "C" to 306 Elevation. The revised Estimate. For elevation 315, contour is $270900 as shown by the following telegram: "Copy".

San Francisco, Calif Dec 5 1916

H. Clay Kellogg

Spurgeon Bld Santa Ana Calif

Quantities in multiple arched dam up to crest elevation three hundred fifteen is eighteen thousand and sixty cubic yards concrete at fifteen dollars per cubic yard or two hundred and seventy thousand nine hundred dollars

john s eastwood

745p

DESCRIPTION AND OUTLINE SPECIFICATIONS

of the

CARROLL RESERVOIR OVERFLOW DAM,

being the

DECKED TYPE OF EASTWOOD MULTIPLE-ARCHED DAM.

December 2nd. 1916.

GENERAL SPECIFICATIONS.

LOCATION.

The structure is to be located on the profile site for Carroll Dam known as the site "C" as provided by Mr. W. S. Post Nov. 25th, 1915.

GENERAL DESCRIPTION OF DAM.

The dam is to be a structural dam of a type known as the Eastwood Multiple-arched Dam, to be decked to provide a continuous spillway for the discharge without distnrbance or injury of at least 80,000 cubic feet of water per second, to be all in compression, and to have a minimum safety factor of ten in compression under full service, the factors of safety in all other essentials exceeding ten. It is to have a crest length for spillway of 504 feet in the clear, the crown of the crest rollway to be at elevation 306, making a structure having a maximum height of 112 feet at the middle.

It is to consist of 14 buttresses, spaced 36 feet from center to center, these to be joined by arches on both the water face and the downstream deck, as shown on the drawings.

A rollway of heavy section is provided as a crest over which the water is to be carried on the long sweeping curve so that it will slide down the deck in a smooth and unruffled sheet to the curved toe and there discharged into the streambed in a horizontal direction. As the rear deck is also arched the sheed of water will follow down over the buttresses in the shallow trough thus created and will relieve the load on the arched deck. The arched deck will also be a stiff strut-tie for the downstream edges of the buttresses.

A strut-tie foot walk is to run through the middle of the buttresses and serve as a foot walk and inspection gallery as well, and also as a bridge through which to cross under any flood at any stage. This foot walk will also connect with the platform for operating the outlet gates and sluice ways. Arched openings are to be left in all buttresses of a height less than the foot walk, leading to protected openings in the wings at the ends. This arrangement will enable the attendants to reach any part of the structure at any stage of water.

EXCAVATIONS FOR FOUNDATIONS.

Great care is to be exercised in the preparation of the bedrock for the foundations. The rock is to be prepared for the buttress foundations by cleaning off all soft or decomposed portions, leveling it up across the pits and leaving it with jagged saw tooth shapes as shown on the drawings.

The cutoff wall at the toes of the water face arches is to be carefully excavated to sound unseamed or tight rock the shooting to be done by means of light shots, and all loose spalls of any kind are to be removed from the foundations and the rock thoroughly scrubbed with water under good pressure and again when concrete is to be laid.

CONCRETE.

The concrete to be used in this structure is to the best concrete the materials obtainable at the site will furnish, that for the buttress walls to be the equivalent of 1-21/2-5, mix, and that for the arched decks and beams to be of 1-2-4 mix, the exact proportions to be determined by trials in the field as to that mix will give the best and densest and strongest concrete of approximately these mixtures.

If the aggregate available at the site will not make a good and first class concrete without screening and washing it must be screened, or screened and washed as the case may be as determined by the engineer on the ground.

All cement used shall pass the specifications of the American Society for Testing Materials, shall be tested at the mill and only such cement as passes these requirements are to be allowed to be used in this work.

Field tests of the cement furnished and of the concrete made from it are to be made from time to time as required by the engineer in charge for the company.

REINFORCEMENT. All parts of the structure are to be reinforced as is shown on the detail sheet for reinforcement, the reinforcement to consist of deformed bars and Clinton Electric Welded mesh, all properly tied in place.

The Estimate of cost is as follows:-

Total concrete structure will be 14510 cu. yds.

This I have estimated at our overall cost of $15.00 per cu.yds. or $217650.00 for the concrete outlet works for the same placed $2750.00

Total cost of Dam complete $220400.00

The copy of Specifications for Multiple Arch Reinforced Concrete Dam Type III are typical of Specifications for the work, but are not complete, inasmuch as they do not contain any special features that refer to Dam site "C" of Carroll Reservoir.

S P E C I F I C A T I O N S .

FOR

MULTIPLE-ARCH REINFORCED CONCRETE DAM.

TYPE III

GENERAL DESCRIPTION OF THE STRUCTURE.

SECTION 17. This dam is to be a structural dam of the type known as the Eastwood Multiple-arched Type, in which design, ardhes are used for the water face deck and buttresses are used for the support of the same, designed especially to meet the conditions prevailing at this site, and so designed as to be completed to an eventful height of 150 feet, or 40 feet above its present crest line, to contour elevation of 5530. This base for the final dam is to be built to a crest line at contour elevation 5490, practically a 110 foot base for a 150 ft. dam when completed. It will consist of 11 arches supported by 11 buttresses. The structure is to be founded on a solid rock foundation, the cut-off wall at the front edges of the arch-ring foundations to be cut into sound rock for a tight cut-off and the buttress foundations to be sound rock, roughened and notched. The spillway, of ample section is to be located on the right hand end, as shown on the plans, the outlet gates to be located as near the present creek channel as possible, and at the elevation shown for the solid arched dam.

GENERAL DIMENSIONS

2. The general dimensions of the proposed 110 foot base for the 150 foot dam are as follows:

Slope of crown line of arches, 1 to 1, 45 degrees
Slope of back edges of buttresses, ¾ to 1, stepped for the extension.
Spans, 35 feet from center to center of buttresses.
Arc of extrados, angle of arch, 133 degrees to 34'
Radius of intrados of arches, varied with thickness.
Arch rings are three-hinged, the hinges being located at the spring lines and at the crown line of the arches.

3. The buttresses are supported and tied together by the use of reinforced strut-tie beams, built as part of the buttress the reinforcement being continuous from end to end and run into the bed rock at the ends. STRUT-TIE MEMBERS

4. The spillway as shown on the draws is located at the right hand end and is provided with a paved or concreted apron or floor, the crest being at elevation 5486 for partial height and 5526 for full height, the channel of the spillway to be extended to a point far enough to pass the waste water to the rear of the buttress walls. SPILLWAY

5. The excavation of the overburden to reach the foundations are to be so made as to enable good sound supporting bedrock to be reached for the buttress foundations and to permit the cut to be made for the cut-off walls of the arch ring walls into sound and tight bedrock. In rock excavation for the foundations, only small and light shots shall be used where blasting is necessary, the shots being so placed as to disturb as little as possible the surrounding ground. The bed rock must be cleaned of all spalls or loose fragments before placing concrete. EXCAVATIONS FOR FOUNDATIONS

The arch ring foundations can be excavated as a trench in all parts where the trench does not exceed about 8 or 10 feet, and as an open cut having the general outline of the eliptic plan of the arch rings where deeper than this, giving the cut such slopes as the materials will lay on as an angle of repose. The excavations for the buttresses are best made as trenches for all depths, open cut for shallow cuts and timbered for the deeper cuts, the cuts being wide enough to permit erecting forms inside of them.

6. As the structure is somewhat unusual in its shapes, the forms are sidigned as a part of the dam to give the contractor FORMS FOR CONCRETE

the advantage of past experience in their construction, and to remove all uncertainty as to the best forms to adopt. The forms are of wood, those for the buttresses being of panels made to reset and use over and over, all so designed as to fit in any part as well as of such sizes as to give a complete cover for the wall in the handiest units and shapes. The forms for the undersides of the arch rings are made up as a frame work of liners, giving the exact shape for the arch, these being made into a frame upon which is bent to shape lapped ½x6 inch boards, making a foundation from which to space the panels used for the outside forms of the arches. The use of these forms is not arbitrary but they are the results of actual experience in building and will, if used, make the form work as simple as for a straight wall.

7. It is the purpose of these general specifications to cover in a general wall all such matters relating to the construction of the structure as will lead to greater economy and better work in the structure, but there is no intent to make them rigid or arbitrary. The detail specifications to follow will contain the requirements for the work to be done. Full supplementary instruction and field drawings of details and methods to advance the work to the best advantage will be furnished, as well as plans for plant layout and methods of procedure. INTENTION OF GENERAL SPECIFICATIONS

8. The outlet gates are shown to consist of a pair of 24" valve gates, set in front of a pair of 24" butterfly gates, connected to a short piece of lap-welded tubing, provided with a flange to which to bolt the butterfly gates, the valve gates being bolted to the flange of the butterfly gates, and a short length of choker pipe, flanged to be bolted to the valve gate, all of standard make. All of these to be of a standard make for the required pressure, OUTLET WORKS

and built in place in the dam. The pipes through the dam can be set at the time the arch face is built and concreted in, the gates set after the dam is completed and the by-pass closure is to be closed.

UNWATERING

9. The unwatering of the site and the by-passing of the natural flow of the stream is to be provided in general by a low coffer dam upstream from the site, supplemented by a similar coffer dam at the downstream side, each far enough removed to not interfere with the work of excavation, the water being passed in a flume over the workings, the seepage being pumped into the flume. When the walls are up to the level of the stream bed a flap gate is to be put into one of the arches to close an opening to be left to pass the water temporarily, this flap gate being so arranged as to shut off the water, when it can be passed through the permanent gates till the space behind the flap gate is filled with concrete, making the permanent closure.

UNIT STRESSES IN THE STRUCTURE

SECTION 18. In the designs of this dam the following unit stresses have been considered as the maximum allowable and all parts are so designed and constructed that these limits cannot be exceeded when the structure is finally completed to the contour at elevation 5530, and is full water to that level. The stresses in the base structure are all proportionately less than the above amount in proportion to the depths of water stored.

Loading on foundations, less than 12 tons per square foot -

Buttresses in compression, 300# per sq. inch.
Arched deck in direct compression, 300# per sq. inch.
Foundation bases in direct shear, 100# per sq. inch.
Steel reinforcement, 14,000# per sq. inch.
There is no bending, no beam shear, or tension in the structure and none of the steel is stressed at all under normal conditions of temperature, the steel being needed for temperature change stresses only.

All of the above named stresses are the maximum in the final completed structure.

2. In all buttresses steel is inserted to connect the unfinished base with the additional wall needed to complete this structure, also through the corbels at the upstream ends of the buttresses, also to distribute the stresses that may be set up by the strut-tie beams. This steel and its dimensions is shown on the Reinforced Sheet.

Steel for reinforcement shall be in shape and sizes called for in the specifications and shall be of deformed bars, preferably corrugated bars.

The reinforcement for the arch ribs is to be of Clinton electric welded mesh or the equivalent, as shown on the Reinforcement Sheet. At the bases of the arches there should be inserted steel bars to join the arch rings to the cut-off walls and also to reinforce the front in a longitudinal line at this point.

The steel shall show the following physical and chemical proportions -

Ultimate tensile strength,	not less	than	80,000	lbs. per sq. inch.
Yield point	"	"	50,000	" " " "
Elongation in 8 inches	"	"	10	per cent
Phosphorous	"	more "	0.06	" "
Sulphur	"	" "	0.06	" "
Manganese	"	less "	0.04	" "

All bars must be free from seams flaws and cracks and have a workmanlike finish, and before being used in concrete it shall be cleaned free from all scale, dirt, paint and oil.

All secondary reinforcement such as netting, wire or ties shall be of the best quality obtainable.

REINFORCED CONCRETE

PROPORTIONING AND MIXING

SECTION 19. In all buttresses and floors a concrete having a mix of 1:3:6 Class "C" shall be used.

2. In the arch rings and all strut-tie beams and the gate

settings a 1:2:4 Class "A" mix shall be used.

3. Before beginning work of placing concrete, volumetric measurements shall be made to determine the exact proportions required of each to meet these results and from time to time should there be any change in the quality of the aggregation, volumetric measurements should be made to meet the changes necessary to keep the quality of the concrete to the required standard. VOLUMETRIC MEASUREMENTS

4. In general these mixtures shall be substantially based on gravel with 40% of voids and a barrel of 3.8 cu. ft. or 380 lbs. of Portland cement. QUANTITIES OF MATERIALS

Mixture	Cement	Sand	Rock	Concrete
1:3:6	1 Bbl.	11.4 c.f.	22.8 c.f.	25.6 c.f.
1:2:4	1 "	7.6 "	15.2 "	18.00 "

Sand and stone shall be measured when packed not more closely than by throwing it in the usual way into boxes.

5. The concrete shall be mixed in machine mixers and MIXING machines shall be so arranged that the materials, including the water, can be precisely and regularly proportioned in batches, which will produce a concrete of uniform consistency and color with the stones and water thoroughly mixed and incorporated with the mortar.

6. The cement, sand and stone ballast, all being perfectly clean shall be placed in the machine in the specified proportions, and be thoroughly mixed. Clean water shall then be added and the mixing continued until the mass is uniform throughout. All materials must be accurately weighed or measured and the quantities used in each batch carefully checked throughout the entire progress of the work.

7. The resulting concrete mixture shall be of such consistency as to move freely and be sloppy and soft when deposited. It shall be in every

instande what is generally known as "wet concrete". However, care must be exercised to not add an excess of water and thereby cause separation of cement from the aggregate. Each batch must be deposited in place as quickly as possible after mixing and the entire mass must have primary set within twenty-four hours. Concrete which has commenced to set before being deposited will not be permitted to remain in the work.

8. All concrete shall be deposited wet and sloppy and shall be thoroughly spaded and puddled to remove air and until all the interstices between the stones are thoroughly filled with mortar. When deficiency of moisture is indicated it shall be supplied by sprinkling. Each batch must be puddled and properly in place before another batch is deposited in the forms. All exposed surfaces of finished and unfinished work shall be kept moist by sprinkling with water under pressure at short intervals. No walking or handling of materials on concrete is to be permitted until it has thoroughly and completely hardened, and all finished work shall be protected as may be necessary by canvas or plank. Layers shall be formed with square ends and not sloped or tapered.

9. The concrete shall be placed by skilled workmen and all stones shall be worked well back from the face of form by spading so as to produce a smooth surface so that no stone shall approach the face of the work. FINISHING

10. When new work is joined to old work or to concrete already set, the joints shall be scarified and all loose material on the surface flushed out of the forms with water under pressure, the surface then slushed with grout of neat cement, or if still wet from the washing with neat cement dusted on the wet surface. The surface must not be grouted or dusted unless concrete is to be immediately laid on GROUTING

it, the grouting in all cases to immediately precede the laying of concrete.

11. Concrete shall be laid continuously in so far as possible and each layer incorporated with the one previously laid. Wherever it becomes necessary to place fresh concrete upon old concrete surface, the old surface shall be cleaned of all dirt, scum and laitance and thoroughly wetted and flushed before depositing the grout and fresh concrete. LAYING

12. The construction must be nearly monolithic as possible, but if it is necessary to place the concrete in sections, key blocks in the form of an inverted truncated pyramid for each of removal without disturbing the surrounding concrete, of proper size and arrangement shall be embedded in the concrete where the work is stopped so that the joining work may later be properly connected to it. Vertical joints shall not be permitted in buttress walls or arch ring walls except as shown on the plans. The vertical joints in the buttresses where they are to be later joined to the new work for the completed structure shall be provided with the joining reinforcement as shown on the plans and shall also be provided with key blocks fastened to the vertical forms and embedded in the horizontal portions of the steps to key the parts of the walls together. JOINTS

13. The buttresses and all walls are tapered unfformly from top to bottom to give the required thickness, and the wall is to be carried up with such lifts as are convenient, but in all cases must be left when ceasing work on a buttress wall so that the rear or downstream end of the wall is higher than the front by means of temporary boards placed across the forms to create steps or keys, each rising higher as the rear of the buttress is approached. CONSTRUCTION OF BUTTRESSES

14. The buttresses and their hinge joints shall be built first or kept at least a good distance ahead of the arch ring ARCH RING CONSTRUCTION

construction, preferably completed to the full height after which the arch rings are built in place. The forms for the under side can be carried up to a considerable distance above the place where the work is being done or completed to the top of the completed buttresses, the walls then being placed by using panel forms for the outside forms, braced to the inside forms. The steel for reinforcing the arch rings should be put in place before erecting the outside panels where the walls are thin. The outside panel forms must be properly spaced from the inside forms to give the required thickness of arch walls at the various levels. All of these dimensions will be given in field drawings.

15. Forms shall not be removed before the concrete is SUFFICIENTLY SET. Forms shall in no case be removed while the concrete is taking its set, and in not less than 24 hours after placing for buttress forms, not less than 12 hours for outside panel forms of arches and not less than 7 days for inside arch forms. REMOVAL OF FORMS

Reinforcing bars or net must not be jarred or moved while the concrete is taking its set.

16. All concrete masonry shall be built in place in wooden forms of sufficient strength, properly tied and braced together so as to be practically unyielding. The forms must have close joints and for outside walls of lumber dressed on the side exposed to the concrete so as to produce a smooth surface on all showing faces. The forms shall be coated with a heavy oil before using, and where used over, as in the case of panels, must be cleaned of adhering concrete before re-use. All forms shall be thoroughly wet before placing concrete against them. All concrete is to be dense and have a smooth FORMS

exterior surface and any cracks or spalling shall be repaired.

17. All exposed surfaces of concrete in the superstructure or that portion above the natural surface of the ground and exposed to view, shall be given special attention in laying in order to produce smooth surfaces in true plans uniform in structure and appearance. The corners of all finished edges as that of the strut-tie beams are to be clipped by inserting a fillet in the corners of all form for such parts of the work. EXPOSED SURFACES

18. All exposed reinforcement, left protruding from the buttress walls must be coated with a grout of cement after the work is completed and before leaving the work, to prevent rusting by exposure to the elements. EXPOSED REINFORCE-MENT

CONSTRUCTION.

SECTION 19. Buttresses are to be built of 1:3:6 concrete reinforced longitudinally with 1" square deformed rods as shown on the plans, all laps to be 30"; and for the partial height the ends of rods will be left projecting 24 inches at the ends of the buttresses. They shall be built with such lifts as are most convenient but at the termination of the pouring for any day the rear or downstream end is to be left higher than the front and proper keys provided in the wall at the point of cessation of work. The foundations shall be prepared by removing all spalls, fragments, chips, shavings or any foreign matter of any kind from the bedrock, washing it clean with a hose under pressure, dusting the surface with dry cement or slushing it with cement grout as may be directed, and placing the concrete immediately on this prepared surface. The forms for the buttress bases at the foundation should be of a frame work of studs nailed to a plate to bring the top to a level to BUTTRESSES

begin the use of the panel buttress forms, leaving the boards of the forms off at the bottom to permit the spread of the concrete to form the proper footing for the buttresses. At the end of each pouring beveled wooden blocks of convenient size are to be imbedded in the fresh concrete by pressing down into it until they are flush with the top, which are to be removed before beginning work on the surface, the surface roughened and all loose material of any kind washed out of the forms, till the surface is clean, then grouted or dusted and pouring immediately commenced. Holes in the rear forms for making the steps must be provided and the reinforcement placed as the concrete is laid, care being taken not to disturb the reinforcement after it is once in place. The steel rods used for reinforcing the corbel are to be wired to the corbel forms before the concrete is placed. The strut-tie beam forms shall be built at the same time as the buttress forms, and all steel shown on the detail drawings wired in place in them before pouring them. These forms must be braced firmly to the buttress forms to prevent sagging.

2. The deck of water-face of the dam shall be built of 1:2:4 concrete very wet and very carefully placed. The cut-off wall is to be placed carefully in a trench of such depth as will place all of it in sound rock that is free from seams, the trench being perfectly clean before concrete is laid in it and the reinforcing bars shown on the reinforcement sheet, placed in it, bent to an angle to fit the slope of the arch ring wall at the point placed. The concrete in the cut-off wall is to be continued up and constitute the base of the arch ring and is a part of it. The arch rings shall be cast in longitudinal lifts of about 6 feet, alternately on each side of the crown hinge form, the wall being so provided with key blocks as to be continuous and have no longitudinal joints.

3. The inside forms are to be supported on liners cut to the required radius for the point placed, all of which are given in the field drawings, these liners resting on the projecting ledge of the buttress. These liners are spaced 7' 11" apart to make use of even length studs of 16 feet cut to fit between the liners, making a frame of studs upon which the 1x6" boards are bent and nailed. Collar braces to stiffen the liners are put on at the time of erection, the liners being assembled to fit the required radius on a plat form in the carpenter yard. The Clinton mesh or other reinforcement acceptable to the engineer, is placed on the inside forms and spparated from it by means of briquettes of mortar of such dimensions as to space it properly from the forms and in the proper place in the walls. This reinforcement will be cut just short of the length of the half arch.

4. The outside forms are to consist of panels as shown on the detail sheet showing arch forms and details. These panels are to be held in place by means of dowel pins and over all a cable of light weight provided with turnbuckles and hooks at the ends to hold the row of panels in place, the ends of the cable fastening to wire loops placed in the filler of the buttress when the buttresses are poured. This arrangement obviates the tying of the outside form to the inside by means of wires left in the wall, which are objectionable as they cause weeping leaks where the water follows them.

STRUT-TIE BEAMS AND FOOT WALK

5. All strut-tie beams including the one used for a foot walk are to be continuous from end to end of the structure till they terminate in the bedrock at the ends into which the reinforcing rods are to be run and concreted in place.

6. The strut-tie beams are to be reinforced with rods running continuously through the buttress walls, from end to end and all of these are to be tied to the cross reinforcement placed in the buttresses

at the junction forming roots to distribute the stresses in the buttresses. The beams are so spaced as to give the structure absolute rigidity, and owing to the hinge construction, one is placed at the spring line of the arches. The strut beams are to be built at the same time and as a part of the buttresses.

FIELD JOINTS

7. Field joints in the arch rings shall be thoroughly roughened by picking and the feather edges of the top and bottom of the walls broken away and cleaned out before continuing the concreting. Great care must be taken to secure a tight joint between both inside and outside forms and old concrete at the top of lifts in order that no leakage of cement may take place at this joint, as it is essential that all surfaces, both inside and outside be as nearly perfect as it is possible to make them.

HINGE JOINTS

8. Before pouring the arch rings the surfaces of the hinge joints, which are cast with forms rolled true to make the hinge socket in the buttresses head or corbel, shall be trued up and made smooth and all pits filled even with cement mortar and troweled smooth with the remaining surface, and when dry, the surface coated with an asphaltum of low melting point, and ironed off smooth by means of a hot hand roller till the surface is true and smooth with a thin and even surface of asphaltum. The crown hinge socket is treated in a similar manner, the different halves of the arch ring being built up alternately so that the hinge lines are kept straight and are not permitted to become unbalanced. The metal part of the forms used on the corbel hinge sockets are again used for the crown hinges, being aligned by a line indicating the crown placed on the inside forms. The spring line hinges begin at the top of the cut-off wall while that at the crown line begins at a point normal on the arch to it.

9. A metal strip of ingot iron galvanized is to be fastened to the under side of the hinge socket forms, bent at 90 degrees so that the free edge can be bent out, coated with asphaltum and cast in the opposite side of the hinge, forming a flexible film to cut off any seppage passing through the hinge joints. These sheets are to be of light weight metal, bent and dipped before placing in the concrete, the strips to butt and be joined by means of a fold at the ends.

FINISHING SURFACES

10. All surfaces in the interior of the dam, such as the under side, deck, sides of buttresses shall be made as smooth as possible by the use of close, well made forms, but no special finishing is required after forms are removed except that any rough or porous spots shall be thoroughly cleaned and filled with a mortar to match the concrete in color and texture and be floated over with a wooden float to resemble the remainder of the walls. The outside surface of the deck shall be cleaned and painted with neat cement wash as soon as possible after the outside forms are removed.

FOOT WALK RAILING

11. A wrought iron pipe railing is to be set in the foot walk provided by the widening of one of the strut-tie beams, one side to have posts set in the top of the walk and on the other ~~side~~ the rail to be set into the side of the beam and run through the edge of the buttresses. The railing is to be painted to the satisfaction of the engineer.

OUTLET WORKS

12. The outlet works are to consist of a trash screen made of light railroad rails set into the block of concrete constituting the bell mouth of the outlet pipes set on the arch in the reservoir, the rack being vertical to make it self-clearing. The outlet pipes are to be of 24 inch lap-welded tubing, peaned at the upstream

end and flanged to fit a standard butterfly gate on the downstream end. These pipes should be dipped in asphaltum, and repainted when in place in the structure. The butterfly gates to be of standard make for the required pressure, to have bronze vanes and flange ~~faced~~ bored to fit the flange on outlet pipe, the other side to be bored to fit the standard 24" valve gate to be placed in front of it. The valve gate to be provided with a short piece of pipe bent to form a choker, unless the pipe is connected to a main, in which case it is not needed. The type of valve shall conform to Section 6 of the Salt Lake City Watermain Specifications.

CLEANING UP

13. After the work is finished, all materials, rubbish and debris shall be removed from the site, and the site cleaned up satisfactory to the engineer.

FIELD SERVICE

14. Field drawings of all parts of the works in such detail as to make all parts of the work plain, as well as instructions as to best and most economical methods will be furnished the contractor as required.

APPROXIMATE QUANTITIES OF REINFORCEMENT & FORM LUMBER.

PARTIAL HEIGHT

Steel Reinforcement;

For arch ring reinforcement, 78,155 sq. ft. Clinton Mesh #3/#8 x 2" x 8" black longitudinal wires.

28162	ft. of	3/4"	deformed bars,	26.95 tons.
8290	" of	1/2"	" "	3.55 "
31200	" of	1"	" "	53.00 "

Lumber Summary:

Buttress forms, about	16800	ft. B. M.
Arch forms	83500	" B. M.
Strut-tie beam forms	3600	" B. M.
Scaffolding & sundry	16100	" B. M.
Total	120000	ft. B. M.

FULL HEIGHT

Reinforcing steel:

Arched deck, 160000 square ft. Clinton Mesh or the equivalent, #3/#8 - 2" x 18" black wire.
58,800 ft. of 1" deformed bars - 100.0 tons
3/4" deformed bars.
Strut beams, 55,000 ft. 3/4" bars, 34' lengths.
Strut junctions, 2,600 ft. 3/4" bars, 10' lengths.
Copes on arches ,3,600 " " " odd lengths.
Arch ring bases, 4,200 " " " 10' lengths.

Total 3/4" bars, 65400' = 49.25 tons.

Corbel reinforcing	20500'	1/2"	deformed bars	
Cope "	2000	1/2"	" "	
Total 1/2" bars	22500	1/2"	" "	7.5 tons

PRELIMINARY REPORT ON THE CARROLL DAM POSSIBILITY

BY L. JORGENSEN, JUNE 3, 1916

THE CONSTANT ANGLE ARCH AT SITE "C".

On drawing C-55 are shown the details of the proposed dam. It is seen that the arch starts out from tangents at both abutments. This cheapens both the arch and the spillway. The normal water level is taken at elevation 316. The dam crest is at elevation 320. The bottom is at elevation 196 and the spillway floor at elevation 310.

The arch itself is designed for overflow to the extent of 5 feet passing over the crest. This is with the water at elevation 325. The discharge corresponding to a 325 ft. water level would in this case be 96,000 second feet. About 78,000 sec. ft. passing through the two spillways and about 18,000 sec. ft. passing over the crest of the main dam. This is a monolithic structure and is easily capable of withstanding such an overflow. With the water standing at the crest of the dam (elevation 320) the spillways will discharge 42,000 second feet of water.

The stresses given in a column on drawing C-55 are those due to the maximum water load with water at elevation 325 and 5 ft. of water flowing over the crest. They are seen to be conservative, the max. stress being 25.5 tons per square foot.

In this connection it may be of interest to note that the maximum arch stress in the "UPPER OTAY" dam is 61 tons per sq. ft. with water at the crest of the dam. This dam has recently withstood about 3 ft. of overflow.

SPILLWAY

Both "horns" of the arch are adapted for spillways, the left looking upstream (in this report called the South abutment) is the best, and a spillway length of 250 ft. can be constructed here for the greater part consisting of the gravity tangents against which the arch butts. At the right abutment a spillway length of 150 ft. can be economically constructed making a total spillway length of 400 ft. The spillway crest is as already mentioned chosen at elevation 310. With 6 ft. flashboards or automatic gates, (not included in the estimate as they are not absolutely necessary), the normal water level is fixed at elevation 316.

ESTIMATE OF COST.

The estimate given below is contractors price and does not include engineering or overhead charges, neither does it include outlet tower or any pipes or valves connected with it. It is assumed that a yard of concrete requires 1.25 barrels of cement at $3.00 per barrel at the site.

30,000 Yards of concrete, at $8.00	$240,000
Excavation and concreting for spillway (additional)	10,000
Excavation for arch	5,000
plastering upstream face with cement gun	5,000
	260,000

If the dam is built during the hot season contraction joints will be necessary or in their place some steel. This will add about ~~$5000~~ $5000 to the cost.

I strongly recommend to construct as much as possible of the arch during cool weather.

Estimate of Constant Angle Dam at Carroll.

Crest Elev. 316 Spillway elevation 310.

Jorgensen's Estimate with revised yardage and prices.

Complete for Dam, gates and Spillway, but not for flashboards.

29,000 cu. yds. at 6.50	188.500
Excavation & concrete Spillway (additional)	10,000
Excavation for arch	5,000
Plastering Upstream face cement gun	5,000
Steel or expansion joints	5,000
Construction Cost	213,500

To complete the Works require.

Outlet Water Tower with gates	6,000	
4 sluice gates, at various levels for regulation	15,000	
Consulting Engineers fee to Jorgensen if "constant angle" dam adopted 4%	10,000	
		31,000
Construction cost with Engineering gates included		244,500
General overhead % 10		24,450
Total including overhead		268,950

Estimate of Yardage.

Main Canal.

These estimates are based on Maps #553, Profile #554 - map #605A. and special cross sections taken between stations 46x50 and 85x75. Grade .5 per 1000;

Between Station 0 to 85x75 the line is figured as a pipe line 48" diameter, and the remainder as cement lined canal. Outlet Elevation Grade Carroll Canal is 254 ft. Inlet to San Dieguito is 241 feet. Length of Main Canal is 26100 feet.

New station	Length	Cut on upper side 8' bench	End Section Sq.Ft.	Average end section	Cu.ft.
0x00		4.3	17		
	205			16	3280
2x05		3.6	14		
Trestle 45'					
2x50		4.0	16		
	150			16	2400
4x00		4.0	16		
	450			17	7650
7x50		4.5	18		
Trestle 90'					
8x40		4.5	18		
	760			19	14440
16x00		5.0	20		
Trestle 80'					
16x80		4.5	18		
	610			18	10980
22x90		4.5	18		
Trestle 30'					
23x20		5.0	20		
	60			20	1200
23x80		5.0	20		
Trestle 20'					
24x00		5.0	20		
	110			22	2420
25x10		6.0	24		
Trestle 90'					
26x00		4.6	18		
	500			19	9500
31x00		5.0	20		
Trestle 120'					
32x20		4.5	18		
	730			18	13140
39x50		4.5	18		
Trestle 100'					
41x50		5.5	22		
	800			21	16800
46x50		5.0	20		
			Total		81730

Rock	1215	cu.yds.
Earth	1813	"
Total	3028	"

Trestles Max. Hgt 20 ft. 575 lin.ft.

Station	Dist. in feet.	Mean cut for 8 ft. bench	End Area	Mean end Area sq. ft.	Cu.ft.	Carroll pipe line cu. yds.
46x50		2.0	16.0			
	120.0			18.0	2160	80.0
47x70		2.5	20.0			
	43.0			22.0	946	350
48x13		3.0	24.0			
	105.0			22.0	2310	85.6
49x18		2.5	20.0			
	62.0			20.0	1240	45.9
49x80		2.5	20.0			
Trestle	25'				Trestle	
50x05		2.5	20.0			
	123.			16.0	1968	72.9
51x28		1.5	12.0			
	75.			16.0	1020	37.8
52x03		1.5	12.0			
Trestle	27.				Trestle	
52x30		4.5	36.0			
	83.			28.0	2324.	86.1
53x13		2.5	20.0			
	75.			18.0	1350	50.0
53x88		2.0	16.0			
	88			15.0	1320	48.9
54x76		1.7	13.6			
	70			12.0	840	31.1
55x46		1.3	10.4			
Trestle	50				Trestle	
55x96		1.3	10.4			
	197.0			17.2	3388	125.4
57x93		3.0	24.0			
Trestle	27				Trestle	
58x20		3.0	24.0			
	168			20.0	3360	124.4
59x88		2.0	16.0			
	145			20.0	2900	107.4
61x33		3.0	24.0			
	143			20.0	2860	105.9

Station	Dist. in feet	Mean cut for 8 ft. bench	End Area	Mean end Area sq. ft.	Cu.ft.	Carroll pipe line Cu.yds.
62x76		2.0	16.0			
Trestle	40					
63x16		2.5	20.0			
	92			26.	2392	88.6
64x08		4.0	320			
	106			26.	2756	102.1
65x14		2.5	20.0			
	162			26.	4212	156.0
66x76		4.0	32.0			
	122			26.	3172	117.5
67x98		2.5	20.0			
Trestle	72					
68x70		5.0	40.0			
	137			28	3836	142.1
70x07		2.0	16.0			
	83			16	1328	49.2
70x90		2.0	16.0			
Trestle	22					
71x12		2.0	16.0			
	62			28	1736	64.2
71x74		5.0	40.0			
Trestle around cliff	63					
72x37		4.0	32.0			
	166			32	5312	196.7
74x03		4.0	32.0			
						19528

Carroll Pipe Line Continued.

Station	Dist. in feet	Mean cut for 8 ft. bench	End Area	Mean end Area sq. ft.	Cu.ft.	Carroll pipe line cu.yds.
				Forward -------		1952.8
74x03	120.0	4.0	32.0	32.0	3840	142.2
75x23	162	4.0	32.0	24.0	3888	144.0
76x85	198	2.0	16.0	16.0	3168	117.3
78x83	117	2.0	16.0	14.0	1638	60.6
80x00	80	1.5	12.0			
80x80						
Trestle for syphon	70					
81x50						
82x15	65	1.5	12.0	16.0	1328	49.1
82x98	83	2.5	20.0	18.0	1620	60.0
83x88	90	2.0	16.0	16.0	800	29.6
84x38	50	2.0	16.0	10.8	3996	148.0
85x75	137	0.7	5.6			

--Syphon 215'-

Total 2703.6 cu yd

Rock-1324.1 cu.yds.

Earth-1379.5 "

Note.

Sta 46x50 of Projected line - Approx. 60x00 of Original Survey.

" 85x75 " " " - " 99x00 " " "

Trestles for Carroll Pipe Line.

Station	Length ft.	Maximum Height.ft.	
49x80 to 50x05	25.0	7.0	
52x03 to 52x30	27.0	5.0	
55x46 to 55x96	50.0	5.0	
57x93 to 58x20	27.0	8.0	
62x76 to 63x16	40.0	5.0	
67x98 to 68x70	72.0	6.0	
70x90 to 71x12	22.0	5.0	
71x74 to 72x37	63.0	20.0	
80x80 to 81x50	70.0	35.0	To support Syphon

SYPHON

Station	Length ft.	Head ft.
80x00 to 82x15	215.0	30.0

C A N A L S E C T I O N.

STATION	LENGTH	AVERAGE END SECTION	CU.FEET	
86 + 00	30	36	1080	
86 + 30				
TRESTLE 40'				
86 + 60				
88 + 50	190	30	5700	
TRESTLE 30'				
88 + 80				
90 + 00	120	30	3600	
TRESTLE 40'				
90 + 40				
91 + 80	140	32	4480	
TRESTLE 50'				
92 + 30				
95 + 70	340	33	11220	
TRESTLE 50'				
96 + 20				
99 + 40	320	40	12800	
TRESTLE 30'				
99 + 70				
101 + 30	160	37	5920	
TRESTLE 40'				
101 + 70				
105 + 10	340	30	10200	
TRESTLE 70'				
105 + 80				
111 + 80	600	39	23400	
TRESTLE 70'				
112 + 50	750	42	31500	
120 + 00				
TRESTLE 100'				
121 + 00				
126 + 00	500	44	22000	
TRESTLE 100'				
127 + 00				
150 + 50	350	30	10500	
			142400	

50% Rock

40% Rock

STATION	LENGTH	AVERAGE END SECTION	CU.FEET	
			142400	
TRESTLE 30'				
150 + 80				
190 + 00	4820	22	106040	
205 + 00	400	26	10400	
208 + 00	300	22	6600	
222 + 00	1400	30	42000	
SYPHON 1350'				
235 + 50				
247 + 00	1250	24	30000	
255 + 00	700	150	105000	
251 + 50	550	150	82500	
			524940	

20% Rock

10% Rock

SOLID ROCK	4440	Cu.yds.
EARTH	15000	"
TOTAL	19440	"
TRESTLES	450	Lin.ft.
SYPHON	1350	"

Summary Main Canal.

Section	Length Lin.ft.	Solid Rock C.Yds.	Earth Cu.Yds.	48" Closed Conduit in Trench Lin.ft.	Lined Canal Lin.ft.	48"Reinf. Cement Pipe Lin.ft.	52" Reinf. Cement pipe Lin.Ft.
0to46x50	4650	1215	1813	4075		575	
46x50to85x75	3925	1.324	1380	3384		541	
85x75to261x00	17525	4440	15000		15.725		1800
	26,100	6.979	18.193	7459	15.725	1116	1800

Estimate.

Solid Rock	6979	Cu. yds.	at .85	5932
Earth	18193	Cu. yds.	at .35	6368
48" Concrete Pipe	7459	lin.ft.	at $4.50	33565
48" Reinforced Concrete pipe	1116	"	at 5.50	6138
52" Reinforced Concrete	1800	"	at 6.00	10800
Lining Canal Section	15725	"	at 1.08	16983
Total Construction Cost				79786
Overhead & Administration 18%				14361
Total Cost including overhead				94,147

Appendix G.

Classification of Lands.

Mr. Jones has classified the land and gave a list of acres which I find to be quite accurate, as far as the Henshaw or Lockwood Mesa and the San Dieguito ranch are concerned, the gravity land and the lands to which water can pumped which are arable and waste land check up with the previous classification which I have made. There may be some differences in regard to the land further down, but it is immaterial, as there is more than enough land for the water supply. In addition to this classification, I think they should be classified with the reference to the character of the soil and their relative location, so far as their water supply and value is concerned.

The lands known as Walnut Canyon on the San Dieguito Ranch are more valuable than the other land on the said ranch, also some portions of the Lockwood Mesa are more valuable on account of the character of the soil than other portions of the land because they contain less clay and are more aluvial in their nature. I also consider the lands along near the coast more valuable by reason of their location, but they are also more valuable because they are more even and smooth and the soil contains more decomposed material and is more aluvial in character. Therefore, a higher value should be attached to them than the lands further inland. Also the lands to which water may be pumped are much more valuable near the coast as their soil is deeper and it contains a much smaller per centage of indurated clay. Mr. Jones has outlined the lands that can be reached by this system of works in Districts No. 1 to 12, a copy of which I shall include in this report, as it clearly represents the possibilities of the system and the Districts as outlined will aid me in my classifica-

tion of the lands and the location of the water upon the same. On account of the classification of soil on the basis I have outlined, I would for the present leave out District No. 1, District No. 2, all the pump lands on the San Dieguito ranch, which is designated as District No. 13 and also all that part of the San Dieguito ranch on the southeast of the San Dieguito river. Some of this soil, in what is known as Dutch flat, is comparatively good, but the area is not sufficient to justify carrying a pipe line across the San Dieguito river. I do not consider the character of the soil along what is termed Canal No. 4, or Green Valley line is good or as well adapted to irrigation as other lands that are more accessible. I have therefore, omitted them from the present consideration of the lands to be supplied with water, excepting the lands under the gravity line in District No. 12 known as the Olivenheim Valley which is a choice section already under cultivation. The bottom lands below the San Dieguito ranch designated District No. 4, are very close to the tide level and it is doubtful whether they will care to irrigate the same. They are only valuable for growing beans and sugar beets, however, as they are directly riparian to the stream they are in a position to demand water, but in case that they do require water, the land can be easily reached by supplementing pipe lines under the mains as laid out. 400 acres of land in District No. 3, which includes Del Mar have been included. About 150 acres of this is very desirable land and the other 250 acres, which includes the Del Mar town site, will likely require the water as the territory is already more or less developed. I believe that the territory under main distributaries which I have outlined will be sufficient to use all the water available, especially

as there are 2000 acres of good land to which water may be pumped at small expense immediately above these principal lines, and there is also a possibility that the bottom lands of District 4 may require some water, for this reason I also leave out District No. 9 and all the lands on the Green Valley line, excepting the Olivenheim District down to the junction of said line with line No. 5.

A D D E N D A .

Revised estimates from both Mr. Jorgensen and Mr. Eastwood were presented after my report came in, and there were one or two other matters which I will include in order to bring my report down to date.

Jorgensen Single Arch Dam "Constant Angle"

Revised estimate of cost	$221,200.00
Fee to Jorgensen	10,000.00
10% for supervision	22,120.00
Total of revised estimate	253,320.00

Eastwood Multiple Arch Dam

Revised estimate of cost, Contract price $226,600.00 being $44,300.00 less than former estimate.

Former estimate	$280,000.00
Deducting	44,300.00
Leaving total of revised estimate	235,700.00

The above figures show that at least $61,680.00 may be deducted from my former estimate of cost of dam, and the same amount from the system of works under the Carroll Dam, making the revised total $664,655.00

STEEL PIPE.

There is a strong probability that it will be at least ten years before more than one-half of the full water supply will be required upon Line #3, which supplies the Northerly

districts along the coast, and I find that there is 11,800 feet of steel pipe in the inverted syphons in this line, and it is not likely that at the end of this period that steel pipe will be as high as at the present time owing to the war conditions and the possibility of revised and additional developments of the steel manufacturing industry, therefore, it might prove to be a good plan and economy to reduce the size of the pipe to one-half their maximum capacity. By doing so, at least $20,000.00 could be taken from the estimated cost; also the Del Mar Line which is marked "2-E" in the table of Distributing Lines (See Table 9-e) is a side line independent of the main system and they have just put in a small steel pipe line that will supply their immediate wants which will be good for at least four years, therefore the cost of this line, which is $15,750.00 may be eliminated from the present cost of construction, making a further deduction from the total estimated cost of $35,750.00.

There are other factors upon which a present economy might be effected without in any way effecting the original plan as these pipes can be replaced at the end of ten or twelve years by new pipe lines of the calculated capacity for a completed system which would seem to be justified by the interest on the money at present deducted. However, this would not apply to any of the concrete pipe as the difference between the large pipe and a small pipe is not very great, and a small steel pipe would cost as much money as the larger concrete pipe.

PROPERTY RIGHTS.

The property and water rights to be included in this system are not included in the report. This amounts to $500,000.00.

I also learn that the cash amount to be invested was to be $600,000.00, which would make the outlay agreed upon, $1,100,000.00

I have also been requested to give my estimate of a conservative commercial value of the lands and system of works when completed.

My table of elemental values does not include any factors relative to the commercial value of this territory due to its location and environment. These include Railroad facilities, Highways and the desirability by reason of climate and scenic conditions for homes. These values I could only establish by comparison and would necessarily be conservative.

My opinion is that taking the classification as given in elemental values and adding the increment due to the above conditions that the following would be a conservative estimate of the commercial value.

COAST LANDS.

4000 acres - - - - - - - - -	at $650.00 per acre =	$2,600,000.00
Inland 1st Class Lands 3000 acres - - - - - - - - -	at $400.00 " " =	1,200,000.00
Inland 2nd class lands - - 3200 acres - - - - - - - - -	at $300.00 " " =	960,000.00
	Total - - - - - - -	4,760,000.00
Less amount set aside for water rights and works		1,100,000.00
Leaves a net profit of - - - - - - - - - - - - - -		3,660,000.00

The increase in the value due to the development should be more than sufficient to pay the interest on the money invested and the water rights.

Respectfully submitted,

H. Clay Kellogg

Civil & Hydraulic Engineer.

- C O P Y -

Santa Ana, Cal. December 11, 1916

Mr. E. O. Faulkner, Mgr.,
Tie & Timber Department,
Los Angeles, California.

Dear Sir:-

I am forwarding Addenda to Report, made necessary by the fact of the revised estimates of both Jorgensen and Eastwood, which should arrive this afternoon.

I am not taking any special pains on the revision for the reason that I believe there will be other revisions made before the final letting of the contract.

These revisions do not apply to form of construction but to the cost. From the prices given by Mr. Eastwood, I am confident that they are still susceptible to reduction, but there are some elements of cost which do not appear in the estimate.

After again carefully going over and studying the matter, of the elemental values given in my report, I am better satisfied than ever with the conclusions given, and I find by referring to my notes that the different factors were carefully considered.

The definition of elementary is "the first or primary principles of rudiments"; that is, this would be the rudiment of cost and value and not the commercial value, which could be arrived at, as shown in the following table:

	COST VALUE PER ACRE	COST WATER RIGHT PER ACRE	COMMERCIAL VALUE PER ACRE	TOTAL VALUE PER ACRE
Coast Lands	$120.00	$230.00	$300.00	$650.00
First Class	100.00	150.00	150.00	400.00
Second Class	100.00	100.00	100.00	300.00

The above table would give the following:

COAST LANDS 1st Class) Inland)	4,000 acres 3,000 "	at $650.00 at 400.00	-	$2,600,000.00 1,200,000.00
2nd Class) Inland)	3,200 acres	at $300.00	-	960,000.00
			Total	4,760,000.00
	Water rights & works -			1,100,000.00
	Net Profit as a whole -			$3,660,000.00

The increase in value due to the development should be more than sufficient to pay interest on the money invested.

In my report I will not include the table as tables do not seem to be clear to Mr. Henshaw or Mr. Fletcher.

I include a bill of expense and my own time up to December 1st.

Yours truly,

(Sgd) F. Clay Kellogg,

Hyd. & Civil Engineer.

Memorandum
(By Hodges - Dec. 20, 1916)

Mr. Kellogg in his report pages 3 and 4 states, that the available water supply after deducting for seepage and evaporation from the dam will be 2,000 inches for a period of 200 irrigation days and then goes on to deduct 30% for loss between the dam and the delivery of the water to irrigators. He has since stated that this 30% deduction is in error and stated that at least 200 inches could be added to the estimate making total of 1600 inches available at the dam and then in addition 250 inches from the San Dieguito bottom lands, making total of 1850 inches available. Get him to confirm this or correct his statement in writing.

The question was raised as to the amount of water to be sold per acre; whether the basis be 7 acres to the inch or ten acres to the inch. It was thought probable that this matter should be left to the purchaser of water, with the understanding that he purchase just what he believes he will need and it is up to the purchaser as to whether he will in the future require more.

In Mr. Kellogg's report Page 6, he recommends that either type of dam be so constructed as to enable the raising thereof to an additional 20 ft. The expense of this, approximately $30,000.00. Mr. Post insists that this can be eliminated and that the same result obtained by much cheaper construction. This is a point to be considered in the construction

QUESTION: Can the Mutual Water Company increase its stock sufficiently to take care of this construction? Get Legal opinion and incorporate in By-Laws if necessary.

On Page 8 Mr. Kellogg recommends an earth dam with concrete core at a cost of something over $14,000.00. A complete concrete dam could be built for approximately $20,000.00. It is the opinion that the concrete dam should be built.

Incorporate in the two agreements a complete general specification of the work to be completed in the general scheme of the Mutual Water Company, that is,

1st - The Carroll Dam and its Reservoir.

2nd - The main canal from the Carroll Dam to the San Dieguito Reservoir.

3d - The San Dieguito Dam and Reservoir.

4th - The canal and pipe line from the San Dieguito Reservoir to the junction with Lines No. 2 and No. 3, specified in Kellogg's report as line No. 1

5th - Line No. 2. Commence at the end of line No. 1 along the south side of the San Dieguito Ranch to Lockwood Mesa and Del Mar, known as line No. 2.

6th - The canal and pipe line from the Junction of lines No. 1 and No. 2 along the north side of the San Dieguito Ranch to Lacosta, known as Line No. 3.

7th - From Lacosta to Carl, shown in Kellogg's report as District No. 8.

8th - The necessary pumping plant, booster, canal and pipe lines to develop the 250 miner's inches of water from the San Dieguito bottoms' sands to the San Dieguito Reservoir.

9th - The proposed development of Escondido Creek, including the

dam reservoir site and necessary distributing system.

Provide in the agreements that should the loan to the San Dieguito Mutual Water Company be paid off prior to the completion of any portion of the work covered by the specifications, provision shall be made that there shall be left in the Treasury of the Mutual Water Company, a sufficient amount of stock for sale by it to provide for the cost of such development not then completed.

Ed Fletcher Papers

1870-1955

MSS.81

Box: 38 Folder: 13

Business Records - Reports - Kellogg, H.C - "Report on the Carroll Reservoir and System of Works Under the Same"