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COMPARISON BETWEEN 1891 AND 1905, AS AFFECTING THE RESPONSIBILITY OF THE CALIFORNIA DEVELOPMENT COMPANY FOR DAMAGE INCURRED.

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James D. Schuyler,

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James D. Schuyler,

Consulting Engineer.

C. R. Rockwood, C. E.,

Consulting Engineer, California Development Co.,

Los Angeles, Calif.

Dear Sir:

In compliance with your request, I have made a study of all available data for the purpose of determining approximately the volume of water which overflowed the banks of the Colorado river in Mexico, a portion of which reached the Salton Basin in the year 1891, prior to the construction of the Imperial Canal or the existence of any works of diversion from the river, as compared with the volume of water which, in the year 1905, probably would have overflowed the banks and flooded the Salton Basin had there been no artificial works in existence, and no break in the banks.

Following is a general summary of my conclusions in the matter:

PREMISES.

In making my computations of overflow, I accept your statement of conditions as having been established and agreed upon as facts, to wit:

1. That in 1891 the stage of the river at which overflow began was when the gage at Yuma indicated a height of 122 feet above sea level (22 feet on the gage).

2. That in 1905, owing to the deposit of silt upon the banks subsequent to 1891, the stage of the river at which a general overflow of the right bank began, was when the gage at Yuma indicated a height of 123 feet.

3. That Salton Basin filled in 1891 to a depth of 4.03 ft.

THE FLOOD OF 1891.

The Southern Pacific gage record kept at Yuma from 1878 to 1891 shows that with the exception of six days in March, 1884, during which the water rose above the stage of overflow, the high stage period when overflow could be anticipated was confined to a few weeks in May and June, or June and July. The remainder of the year the river was always confined to its normal bed. The exceptions to this general average condition appear to have been caused almost invariably by unseasonal and unusual storms on the watershed of the Gila river, bringing down extraordinary floods. When these came in conjunction with floods in the Colorado above the mouth of the Gila, the resultant rise was generally followed by a more or less prolonged

overflow of the banks of the river in Mexican territory. The extreme high water in 1891 began February 23d and ended March 1st. In these seven days the total discharge of the river was approximately as follows:

Date.	Gage.	Mean sec.ft.	Acre-feet.
Feb. 23, '91.	128.5	77,800	155,600
" 24	125.0	45,750	91,500
" 25	125.5	50,050	100,100
" 26	127.2	65,300	130,600
" 27	133.2	101,000	202,000
" 28	128.1	73,900	147,800
Mar. 1	123.9	36,400	72,800
Total - - - -			900,400

The normal flow of the stream at the gage height of 122 was approximately 19,000 cubic feet per second. I assume that this amount was constantly passing down the channel below the overflow during the period of "slop-over." This discharge past the overflow section could not well have been more than the normal flow at that gage-height and might have been somewhat less, due to the well known tendency of rivers to drop their load of sediment in the main channel and thus reduce its cross-section immediately below a crevasse, or a section of the stream where extended overflow occurs. The distance in which the overflow occurs is from five to eight miles, as I understand the situation, and while the depth in the channel at the upper end of this overflow section was naturally much higher than the normal (i.e., with Yuma gage at 122) when the overflow reached any considerable amount, at the lower end,

where the overflow ceased, the height could not at maximum flood have been much if any in excess of the normal before any water was overflowing. If this reasoning is correct, the amount passing down the channel below the overflow passage during the seven days was approximately 266,000 acre-feet. This deducted from the total discharge of the river in this period leaves a total of 634,000 acre-feet as the volume of water that left the river and passed down toward Salton basin.

The evidence is that this water did not make its appearance ir the Salton basin until June, but was impounded in natural basins or ponds along the Old Alamo river channel, formed by sand dunes that had blown into and across the channel, creating dams of sufficient height to hold the water temporarily in lakes of considerable size. When the subsequent rise in May occurred, the water rose in these ponds until finally the sand dams gave way, letting the water flow down into Salton basin.

In 1891 the record of the Yuma gage showed that the river was above the 122 ft. mark for 58 days in all. During that period the estimated total discharge of the river was 3,946,000 acre-feet, of which I estimate that the discharge passing down to the Gulf was approximately 38,000 acre-feet per day, or a total of 2,204,000 acre-feet. This deducted from the total discharge of the river, leaves 1,702,000 acre-feet as the probable total quantity of overflow.

I have been informed that the Salton basin was filled to a depth of 4.03 feet in 1891. The area at bottom is approximately 150 square miles, and at a height of 5.8 feet above bottom, or elev-275, the area is approximately 160 square miles. From these areas I compute the volume of the basin

to the depth of 4.03 feet at 395,800 acre-feet. To fill up the dry soil of the lake bed would have required at least six inches of depth, and possibly a foot or more. Adding six inches of absorbed water to the apparent filling of the basin, would make the total discharge into the basin that season about 443,000 acre-feet. This amount deducted from the total overflow as computed above, would indicate a loss in transit from the river to the Salton sink of 1,260,000 acre-feet, which is represented by the evaporation and soakage in the channels, sloughs and ponds during the season, Much of this must have been absorbed in the sand-dunes along the Alamo.

THE FLOODS OF 1905.

The total discharge of the Colorado past Yuma in 1905 was 19,710,000 acre-feet, as reported by the United States Geological Survey (Water Supply and Irrigation Paper No.177.) The normal discharge of the river is about 9,000,000 acre-feet per annum. The year 1905, therefore, gave a discharge more than double the normal. During this year the river was above the overflow stage during 129 days, as follows:

Month.	No. of days Overflow.	Total acre-feet Discharge.
January	1	55,000
February	11	1,013,900
March	27	2,944,720
April	14	1,430,460
May	31	2,593,000
June	30	4,550,000
July	10	884,140
November	2	330,400
December	3	309,440
	129	14,111,000

The discharge of the Colorado with the Yuma gage at elev+123 (the point where overflow began) fluctuated in 1905 between 30,000 and 32,000 sec. ft. I assume that during the 129 days of overflow the volume passing down to the Gulf had there been no break in the bank, and conditions remained normal, as they were in 1891, with the exception of the silt that had been deposited on the land adjacent to the river, would have been an average of 32,000 cubic feet per second, making a total of 8,256,000 acre-feet passing to the Gulf, and 5,855,000 acre-feet overflowing the west bank and passing downward toward the Salton basin.

Inasmuch as this water would have had a freer and less obstructed passage through to Salton sink than in 1891, as there were no sand dams across the Alamo channel in that year to create retarding ponds, the loss in transit would have been less than that in 1891, which I estimated at 1,260,000 acre-feet. It would probably be conservative to estimate this loss at 350,000 acre-feet, considering the fact that the rains of 1905 saturated the land more or less, and less water would have been absorbed, and the absence of ponds that existed in 1891. This 350,000 acre feet deducted from the total overflow of 5,855,000 acre-feet would leave a balance of about 5,500,000 acre-feet as the quantity which in all probability would have found its way to the Salton Basin in 1905.

From the fact that there were unusually heavy rains over all that region in 1905, the land forming the floor of the basin was well soaked up, and would have absorbed but little if any of this discharge, although during the period

of overflow there would have been a constant loss by evaporation to lessen the probable depth which the water would have reached. Without taking this evaporation loss into account the depth of water in Salton sea by the end of 1905 would have been approximately 35.8 feet. The evaporation may have been sufficient to have kept this depth to about 30 feet (elev-250.8 ft.) or possibly somewhat below.

ACTUAL FILLING OF SALTON BASIN IN 1905.

The record of the rise of water in Salton Basin in 1905, as kept by the Southern Pacific R. R. recorder, shows a rise of 7.17 feet up to June 1st from elev-280.8 to -273.63. At this level I compute the capacity of the basin at 605,350 acre-feet. Between June 1, 1905, and January 4th, 1906, the rise was but 16.63 feet, to elev-257, at which stage the contents of the basin were 3,045,000 acre-feet.

The effect of the levee along the Imperial Canal was to actually protect the valley from the heaviest part of the overflow, up to about July 1st, as the actual filling of the basin up to that date was only about 932,000 acre-feet, notwithstanding the fact that the computed volume of overflow up to that time which would have reached the basin in large part without the existence of these levees, was 5,291,000 acre-feet. Until the crevasse widened and the entire river was turned into the basin, the volume of filling in the basin was comparatively small, only about 9.8 feet in depth, where it would have been over thirty feet deep by July 1, 1905, had the levees and canal not been in existence.

In the summer of 1904 the California Development Company was seriously considering the building of several gates in the levee along the canal, at points some miles below Intake No.3, for the purpose of drawing water into the canal for irrigation supply, from the overflow which was standing several feet deep against the levee. This was when Intakes Nos. 1 and 2 were practically choked with silt, and the problem of getting water to the valley for necessary irrigation was a very serious one.

In confirmation of my estimate of the capacity of the Salton Sea basin in acre-feet, I find that the total discharge of streams flowing into the basin as measured by the United States Geological Survey (W. S. & I. Paper No.177, page 39) June 1st, 1905, to January 1, 1906, was 3,368,633 acre feet, whereas my estimate of the volume actually in the basin January 4, 1906, was 2,440,000 acre feet. If to the latter figure is added the evaporation over a mean area of 140,000 acres during seven months time, plus soakage in the margins, amounting in all to about 700,000 acre feet, the total would be 3,140,000 acre-feet, or only 6.8% less than the United States Geological Survey measurements of inflow. This seems to prove that my estimate of areas used in making computation of capacity were conservative.

Respectfully submitted,

Jas. D. Schuyler

Consulting Engineer.

Los Angeles, Calif.,

March 20, 1907.