[BROWN, WALTER H4]

The Kenilworth,
Bush and Powell Sts.,
San Francisco, Jan. 24, 1913.

Mr. Harry Chickering,
Mills Building,
San Francisco.

Dear Sir:

Referring to conversation with you yesterday regarding the run-off of the water-shed tributary to the Warner reservoir site and your request for further comment on the same subject.

On pages 53, 54, 55 of Vol. 75, (Dec. 1912), Transactions of the American Society of Civil Engineers, appears a statement by Geo. F. Maddock, Esq., Engineer for the H. M. Byllesby Co., which is contributed as a discussion to a paper on the "Morena Rock Fill Dam", by M. M. O'Shaughnessy, Member of the Am. Soc. C. E., and engineer for the Southern California Mountain Water Co.

Mr. O'Shaughnessy's paper deals with the construction of the Morena dam and refers briefly to the hydrological data relative to the water-shed tributary to the Morena reservoir, on Cottonwood Creek, which lies about 45 miles, in an air line, in a southerly direction from the Warner reservoir site, and is south of the Sweetwater water-shed.

The letter of Mr. Maddock's, as you have noted, does not discuss, nor contribute to, the paper presented by Mr. O'Shaughnessy, but appears to be a criticism of a water-shed

not elsewhere mentioned in the paper nor in the contributed discussions, and it is to correct some of the statements which Mr. Maddock probably does not understand, that this letter is addressed to you.

On page 55 of the volume referred to is Table #7, purporting to give the annual run-off of the Warner Water Shed, and following this table is a statement that, with proper storage provided "only 20 cubic feet per second were available for power during the long periods of drought which occur in this locality." The paragraph closes by stating that his analysis shows the run-off from the Warner water-shed to be "slightly less than 0,1 cubic feet per second per square mile of water-shed which agrees remarkably well with the Government's observations of this stream (San Luis Rey River) at Pala."

With this figure of one-tenth of a cubic foot per second per square mile in mind, I have turned to the U.S.G.S. records of stream-gaugings at Pala and find that the observations there were begun October 8, 1903, and that by neglecting the stream flow for the first eight days of that month, the mean discharge from a territory of 318 square miles, has been a mean of 0.232 cubic feet per second per square mile up to and including the seasonal year 1909-10, - period of seven successive seasons.

If the discharge of less than 0.1 of a second foot per square mile agrees remarkably well with a supply of 0.232 sec. ft. per square mile it seems needless to attempt or to continue engineering investigations of stream flow insomuch as the difference between the quantity arrived at by Mr. Maddock

and the actual measurements made by the U. S. Geological Survey would amount to approximately 27.72 sec. ft. constant flow throughout the year which amount is lost entirely by Mr. Maddock in his analysis and which is 138% of the amount he credits to the water-shed. The actual measure total flow as determined by the U.S.G.S. at Pala is over 232% of that asserted by Mr. Maddock in his letter.

A glance at Table 7, which expresses Mr. Maddock's idea of the run-off of the Warner water-shed shows he has used a rather light rate of run-off from the 9.5 square miles of water-shed subject to a rain-fall of 42.5 inches. This territory, by reference to Table 5, seems to be at an elevation of 5,300 feet above sea. He computes the run-off from this small section of the water-shed area at 18.8% of the rainfall, or 8 inches, making a seasonal run-off from the 9.5 sq. miles 4.054 acre feet. To a hydraulic engineer the statement would appear ridiculous when applied to the high mountain regions of the Coast Range. Had he calculated that the soakage and other losses would have been about 50%, resulting in a run-off of approximately 10,000 acre feet, he would have been nearer correct. While this amount of 10,000 acre feet, representing a 50% run-off is not to be here accepted as the proper rate for the 9.5 sq. miles in question, it is proper to state that there are regions in the Coast Range mountains of equal area where much higher ratios would easily apply. The Snow Mountain water-shed, on the South Fork of Eel River, with a considerably larger water-shed, (268 sq. miles) has shown annual run-off of from 75.5% to 76.2% of rain-fall of 73 inches and 60.7 inches respectively,

and 60% run-off with 46 inches precipitation. These ratios apply to the entire area of 268 sq. miles and are of use here only in indicating that Mr. Maddock's assumption of an 8 inch run-off for a mean of 42.5" precipitation on a high and small water-shed, is in great error.

Mr. Maddock states that his analysis of the Warner water-shed is based on the run-off records of the Cottonwood water-shed above Barrett and quotes, from Table 6, data from that region for the years 1906, -07, -08, -09, -10, neglecting the facilities offered in the publications of the U. S. Geological Survey on the stream-flow, at Pala, of the San Luis Rey River, (since 1903), the stream he was directly interested in and attempting to analyse.

In connection with the U. S. G. S. gaugings at Pala it is interesting to note the descriptions of the streams and gauging conditions as published in Water Supply Papers #213 and #300 and #271.

From Water Supply and Irrigation Paper #213, I quote:

"At a point below what is known as Warner's ranch reservoir site the river flows through a deep, narrow canyon with a heavy grade for a distance of about 10 miles, Below this point the grade is light, and the discharge is over a sandy and gravelly bed, where the water soon disappears, again rising in small quantities near the town of Pala, where the gauging station is located. Below the station it flows for a distance of about 25 miles on a light grade to the Pacific Ocean. There is a good soil covering throughout this basin, with a considerable growth of brush and grass, and with small areas of timber on the extreme higher elevations. The water is diverted at several points for irrigation, a considerable quantity being taken from the canyon above the gauging station and used in the vicinity of Escondido, which lies in an

Note

entirely separate drainage basin. The stream is torrential in character, the discharge being very light except during the winter season, in times of heavy rainfall."

From U.S.G.S. Water Supply Paper #300, now in press, I quote:

"No tributaries enter the river near the gauging station. Water is diverted from the river during the winter and spring months at a point in the rough canyon about 11 miles above the station to a storage reservoir and is used during the summer period for irrigation and municipal supply at Escondido and the surrounding country."

"* * * One mile above the station a small amount is diverted for use on the Sickler ranch.* * * * * Conditions for obtaining accurate discharge data are poor. The channel is wide, is composed of sand, gravel and boulders and is subject to constant change. The current is swift at flood stages."

"The estimates of discharge were prepared from rating curves covering short periods of time and by interpolation on the days when the gage was not read. The record may be considered as good."

From U.S.G.S. Water Supply Paper #271, I quote:

"* * * The river, (San Luis Rey) is formed by many small streams which have their sources in the higher elevations of the Coast Range and come together at the lower or west end of what is known as Warner's Valley. Below this point the river flows for a distance of ten miles through a deep, narrow canyon with a heavy grade, then over a sandy and gravelly bed with light grade for some forty miles, finally discharging into the Pacific Ocean at

Oceanside."

"Altitudes within this basin range from 50 to 500 feet in the foothills in the vicinity of Oceanside and from 500 to 6,000 feet on the mountains. Palomar Mountain, the highest peak in the basin, has an elevation of 6,126 feet above sea level. The upper portion of the basin is more or less rolling, and several of the valleys are under cultivation and are used extensively for stock raising; the middle part, occupied by the river in its canyon, is rough; on the lower reaches the surface becomes less rugged, merging into the foothills, which extend to the coast. The rocks are granitic."

"* * * The mean annual precipitation in this basin probably ranges from 10 to 40 inches, gradually increasing with altitude. * * *"

Consideration of the gauging conditions described in the foregoing excerpts and a study of the U.S.G.S. Topographical sheet for that region show that there is about 10 miles of canyon immediately below the Warner dam site and that then the river-bed begins to flatten out and then runs through some 12 miles of sand to the Pala gauging station. For some distance the water disappears, to partly reappear at the Pala station where it is gauged. There is undoubtedly an unmeasured quantity passing Pala station in the sub-flow.

Allowance should also be made for the evaporation loss as the water is held in check and percolates through the 12 miles of sand bed immediately above the gauging station. The loss here from capillary action and evaporation through the vast sand stretches

is of consequence, but with present data and time at the disposal of the writer, it is not possible to more than mention that there is a loss which should be studied in connection with the Pala gaugings; the loss is of sufficient magnitude to warrant evaluation, but, for the present, must be dismissed with the following citation of records of stream flow quoted by Mr. Hawwood:

Jan. 1906. Measured discharge at Warner's exceeded the total discharge at Pala by 34.2%.

Feb. 1906. Measured discharge at Warner's exceeded the total discharge at Pala by 34.2%.

Another account which should be considered is the amounts diverted to Escondido, and the quantity used on the Sickler ranch.

If the foregoing items of loss and of diversion were duly considered, there would undoubtedly be shown that a greater amount than 0.232 sec.ft. per sq.mile is contributed by the water-shed as against the "less than 0.1 cu.ft. per sec. per sq. mile" as stated by Mr. Maddock.

The total run-off of the San Luis Rey River water-shed above Pala gauging station, 318 sq.miles, without any allowance for the losses previously mentioned, as determined by the U.S.G.S. records, is as follows:

RUN-OFF AT PALA GAUGING STATION, U.S.G.S. WATER SUPPLY DATA

SEASONAL YEAR	ACRE FEET
*1903-04	7,680.
1904-05	42,000.
1905-06	108,000.
1906-07	83,000.
1907-08	24,900.
1908-09	48,600.
§1909-10	46,100
	360,280.

Mean for the above seven year period, 51,470 acre feet.

* The first eight days in October, 1903, no records were made.

§ July, August and September of this year were not measured and the stream flow for these months is not included in the total run-off. The time period, however, has been included in striking the mean for seven years.

Using the above mean of 51,470 acre feet, as from 318 square miles; reducing the value to one square mile, and raising the latter to correspond with the Warner water-shed area of 210 square miles, thereby neglecting entirely the higher rate of run-off due to the Warner high altitudes as well as the other losses mentioned in this letter, it would appear that the total run-off for the seven year period for the 210 square miles (Warner) would have been 237,930 acre feet, an annual mean of 33,990 acre feet.

In order to bring the total run-off down to the 19,840 acre feet, as claimed by Mr. Maddock, it would be necessary to add seven consecutive "dry" seasons, making a total of eight successive years of drought similar to the abovd season of 1903-04, antedating the above years, in order to reduce the mean run-off to 19,532 acre feet.

The rainfall during the season of 1903-04 was, according to Mr. Hawgood's data, 51% normal, and the climatological history of California does not show that any such dondition ever existed for a period of eight consecutive years. This may represent, however, the long period of drought referred to in the first part of this letter.

Records of precipitation on the Sweetwater water-shed, covering a period of 23 years, show that there were seven consecutive years of extremely light rainfall, on that shed, immediately preceding the season 1904-05, but all of these years were not as low as 1903-04 and also, the extreme conditions existing on the territory of the Sweetwater water-shed, can not be hurriedly taken as representing the conditions on a water-shed lying in a more favorable position, - to the <u>north</u> of it.

In working out the isohyetose zones there appear discrepancies between the data submitted by Mr. Maddock and by Mr. Hawgood. The tabulations and chart made by the latter I have examined and they appear to be worked up in greater detail than those by the former as is indicated by the following:

HAWGOOD.		MADDOCK.	
Rainfall inches per season.	Square Miles.	Rainfall inches per season.	Square Miles.
40 - - - -	1.2	40 to 45 - - - - - - - -	9.5
35 - 40 - - -	8.5	30 to 40 - - - - - - - -	14.4
30 - 35 - - -	6.2	25 to 30 - - - - - - - -	18.0
25 - 30 - - -	10.7	20 to 25 - - - - - - - -	25.2
20 - 25 - - -	22.4	15 to 20 - - - - - - - -	87.0
18 - 20 - - -	57.4	10 to 15 - - - - - - - -	55.9
16 - 18 - - -	81.8		
Under 16 - - -	21.8		
	210.0		210.0

Reconciling the fractional zones as given by Mr. Hawgood the comparison is as follows:

Rainfall inches per season.	SQUARE MILES. Hawgood	Maddock.
40 - 45 - - - -	1.2 - - - -	9.5
30 - 40 - - - -	14.7 - - - -	14.4
25 - 30 - - - -	10.7 - - - -	18.0
20 - 25 - - - -	22.4 - - - -	25.2
15 - 20 - - - -	139.2 - - - -	87.0
10 - 15 - - - -	21.8 - - - -	55.9
	210.0	210.0

By employing several methods in his analysis of the available data Mr. Hawgood arrives at the conclusion that there is available from the water-shed above Warner dam site, with an allowance for evaporation losses of 11.5%, a run-off sufficient to provide, with storage, a flow of 43.3 second feet.

It is not the writer's intention to discuss in this letter Mr. Hawgood's method of analysis. The report is long and elaborate and to attempt to check his computations and points of view would require more time and study than can at present be given to the subject. The amount of water he estimates as available is quickly checked, however, in a rough way, by a few computations from the data in the U.S.G.S. publications relating to the stream flow at Pala station.

This station is some 20 miles below Warner dam site and naturally includes drainage territory at a much lower altitude than the Warner water-shed and which would be less productive of run-off, because of the lighter rain-fall, than the higher mountain regions above the Warner reservoir site.

The Pala records show the following:

1903-04 - - - -	0.033	Sec.	Ft.	per	Sq.Mile
1904-05 - - - -	0.184	"	"	"	"
1905-06 - - - -	0.463	"	"	"	"
1906-07 - - - -	0.359	"	"	"	"
1907-08 - - - -	0.110	"	"	"	"
1908-09 - - - -	0.216	"	"	"	"
1909-10 - - - -	0.260	"	"	"	"
	1.625				

Mean for the period of seven seasonal years, 0.232 Sec.Ft. per Sq.Mi.

Accepting this mean of 0.232 Sec.Ft. per Sq.mile, for the sake of convenience, as the capacity of the higher water-shed, the stream flow in Sec.Ft. from the 210 square miles in the drainage area tributary to the Warner reservoir, would be:

0.232 x 210 = 48.72,

and with the evaporation loss which Mr. Hawgood accepts, the net available flow in cubic feet per second from the Warner reservoir would be 48.72 less 11.5% = 43.12, which considering the unsatisfactory gauging conditions at the station, makes the Government observations at Pala agree remarkably well with the independent calculations made by Mr. Hawgood.

Respectfully,

(Sgd) Walter Hy Brown.

File Eng. V.H.W.Co.

Development along the route surveyed by Mr. Post and estimated upon by Mr. Hawgood, eliminating the items of Pamo dam and the Sutherland developments but with a conduit large enough to deliver 112 M.G.D into San Clemente reservoir from the combined watersheds of the system, (174 second-feet), would cost $1,915,300., or $678,000 more than the estimate made by Mr. Post for conducting Warner water to San Clemente via the Escondido pipe line.

Development along the Hawgood route, (eliminating, for the time being, the Pamo dam and Sutherland developments) from Warner reservoir to San Clemente reservoir with a covered conduit of 43 M.G.D. (67 second-feet), capacity deliverable into San Clemente reservoir, would cost approximately $1,602,500., (page 4), being $216,000. (see page 8) in excess of the estimate made by Mr. Post on the cost of the Escondido-San Clemente pipe-line route.

The upper route, along the survey estimated upon by Mr. Hawgood, would permit power plant installations capable of generating an average output of 4,000 K.W. which, at 4 mills per K.W.H., would return a revenue of $140,000 annually. (Pages 8 and 9).

Your attention is called to the variety of estimates made for the construction of Warner dam, given below. All of the designs are similar.

Lippincott-O'Shaughnessy,	dam	105	ft.	high,	costs $499,850.
Post,	"	100	"	"	" 347,000.
Harroun,	"	90	"	"	" 325,000.
Hawgood,	"	100	"	"	" 237,768.

The required storage at San Clemente reservoir is estimated,in the various reports,as follows:

REPORT.	STORAGE CAPACITY. AC.FT.	M.G.	HEIGHT OF STRUCTURE. Feet.	ESTIMATED COST.
Lippincott-C'Shaughnessy,	8574.	2790	90	$691,000.
Hawgood,	4500.	1454	65	275,625.
Post,	3250.	1050	65	227,700.

Harroun, No details are given in the Harroun report.

The wide divergence in storage requirements,construction costs and items at San Clemente,as estimated above as well as the costs of Warner dam,indicate the need of a more thorough sifting and study along the lines of economic design than has been confirmed by a reading of the reports. If economic studies have been made discussion or analysis of the same has not been entered intc in the reports. Some one of those who have reported upon the Project may be right but I am unable,with the data available,to designate any particular design or estimate I feel you should follow. There is evident need of a concentrated study being undertaken with the one view of settling upon the economic design,location and form of development programme. There are no discussions in the reports to show that this has been done and in the remarks I am submitting to you herewith there has been little else done than the construction of a composit which, because of the wide discrepencies in costs and yardage,-and designs,must,of necessity,contain errors which should not, properly,be considered. With the data in hand I have constructed an estimate which I feel to be as conservative as may be made without further research and field investigation.

The revenue,(net),to be obtained from electrical energy developed on the upper (Hawgood)conduit route would justify the expenditure of $2,800,000. more than on the Escondido-San Clemente Pipe Line project and it is possible that the cost involved incident to power development would not exceed one-half that amount. This latter statement is ventured and is based only upon cursory examination of incomplete maps and data submitted in the reports. A greater part of the additional investment required would be chargable to hydraulic development on the Santa Ysabel River rather than to power-plant construction.

All of the foregoing subjects are gone into in further detail in the accompanying report.

Respectfully,

Walter H. Bowen

Ed Fletcher Papers

1870-1955

MSS.81

Box: 35 Folder: 33

Business Records - Reports - Brown, Walter H.Y - Report to Harry Chickering re: Warner Reservoir site