

SAN DIEGO RIVER

MISSION GORGE DAMISTE NO. 3,

REPORT BY

FRANCIS L. SELLEW. APR. 24, 1923

[w covering letters
CPT T. CRAVEN,
NAS, NORTH ISLAND
from BF]
CSM

April
Twenty-six
1923

Captain T. T. Craven,
Commanding Officer,
Naval Air Station,
North Island, California.

My dear Captain Craven:

A citizens' committee, consisting of E. B. Gould, Wm. Kettner and G. A. Davidson, suggested that I employ a competent engineer to make a report on the feasibility of building a dam on the San Diego River at Mission Gorge, and particularly the possibilities of furnishing water to the Government on some equitable basis. I tried to secure the services of F. E. Weymouth, Chief Construction Engineer of the U. S. Reclamation Service, but he was not available, so I secured the services of a former government engineer of note, Mr. Francis L. Sellow, who for five years was with the Reclamation Service and had charge of the construction of a large government project at Yuma, known as the Laguna project.

Attached hereto is copy of his report.

Mr. Sellow has tentatively recommended a single arch type of dam at Mission Gorge Site No. 3, known as the "Jorgenson type". My personal preference is either a multiple arch type or radial cone type of dam rather than a single arch dam, providing the Hydraulic Division of the State Railroad Commission of California officially approves this type of dam. The reasons for my preference, as above stated, are as follows:

It will save nearly a half million dollars in construction. It can be built in one-half or two-thirds the time. I am of the belief that the factors of safety are greater.

The State of California has complete jurisdiction as to what type of dam would be built at Site No. 3, and I assume the government is satisfied with any type that the State of California approves.

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Mr. Sellow did not have time to go into the net safe yield of the entire San Diego River and has not touched on the question of net safe yield with Mission Gorge #3 and the Fletcher dams both completed, however, both Mr. Sellow and I have assumed that the only question at issue was a sufficiency of water for the U. S. Government's needs, up to three million gallons a day, and that question being answered in the affirmative to your satisfaction there was no necessity of going into the question of net safe yield further.

I submit the following tentative propositions:

First: That the government finance, thru the issuance of forty-year bonds on a 4½ percent basis, the construction of the Mission Gorge dam and the pipe line to the north line of the Marine Base, having the damsite, reservoir site and all the completed work as security for the loan.

In consideration of the above the government is to buy water at 10 cents a hundred cubic feet, delivered at the North line of the Marine Base, and the Government to have the first right to any and all water in this system up to a maximum of three million gallons daily, we reserving the right to sell excess water to outsiders at any price we see fit, the City of San Diego to have the first option to buy said surplus water at rates mutually agreed upon or at a price set by the state authorities of California.

Second: We to finance the construction of Mission Gorge dam, the government to build its own pipe line, size to be mutually agreed upon, from the North line of the Marine Base to a connection with the Mission Gorge dam. We to have the free use of the pipe line and to maintain same at our own expense, the government to have the right to any amount of water up to three million gallons daily in perpetuity, the price to be 10 cents per hundred cubic feet, delivered at the North line of the Marine Base, and an equitable arrangement be made to reimburse the government for the cost of the pipe line, and we own same when completely paid for.

Third: We to build the Mission Gorge dam and pipe line to the North line of the Marine Base at our own expense, and to furnish water at 10 cents a hundred cubic feet at the North

line of the Marine Base, in consideration of which the Government is to make a twenty-year contract for the purchase of water, whether it uses it or not, commencing two years hence, taking two million gallons a day the first year, two and one-half million gallons a day the second year and three million gallons a day thereafter during the life of the contract. We must have a certain specified revenue and a contract in advance that will help us to finance the project.

Fourth: The Government to build a small pipe line, whatever size it desires, connecting up with Murray Dam of the Cuyamaca System, and taking what it wants at any time it wants water, the price to be 10 cents a thousand gallons at the reservoir. I am manager of the Cuyamaca Company and will recommend the last proposition to the new owners if you think this is the best proposition for the government.

Murray Dam is at an elevation of 550 feet above sea level when full, and a very small pipe line would take care of the government's needs. Please note that the distance to Murray Dam by actual survey is only 1,000 feet longer than to Mission Gorge No. 3.

It is understood that the water delivered under any of these propositions is to be chlorinated and of a quality approved by the State Board of Health of California.

I would be glad to have you seriously consider these propositions, and if deemed advisable by you, and for the best interests of the government, that you send thru channels your recommendations thereto.

Yours very truly,

ED FLETCHER

EF:KLM

San Diego, California
March 14, 1923

C O P Y

Colonel Ed Fletcher,
920 Eighth Street,
San Diego, California.

Dear Sir:

The United States Government is interested in securing an independent supply of water, and we ask you if you will please employ a competent engineer and secure the necessary details that we may submit to the Government relative to their acquiring their needs through the construction of Mission Gorge Dam No. 3.

Your earliest attention of this matter would be appreciated.

Yours very truly,

(Signed) E. B. Gould

William Kettner

G. A. Davidson

San Diego, California
April 24, 1925

Col. Ed Fletcher,
San Diego, California.

Colonel:

Acting under your instructions, initiated by a request from a Citizens Committee as contained in the annexed letter, the writer has considered a project for the further development of the San Diego River for domestic uses with reference to storage in Mission Gorge.

As a permanent and stable demand for water is essential to the success of such an enterprise attention will first be given to the possibilities of its sale in quantities which will justify the investment.

THE MARKET.

The existence of a market, near at hand, must be based upon the presumption that the City of San Diego is unable to serve from its municipal system the demands which will naturally be made upon it, consequently attention will first be given to the ability of that system to meet the requirements which may be logically anticipated.

The importance of the City as a port, as a Naval Base and an important link in the chain of national defence will depend mainly upon an adequate supply of pure water at reasonable rates so a clear understanding of the situation is necessary at the outset of this investigation.

On Plate I attached, the areas which are topographically and economically situated to furnish a domestic supply to the City, are surrounded by the broad red tint embracing the San Dieguito down to Lake Hodges Dam, the San Diego to Mission Valley, the Sweetwater, the Otay and portions of the Cottonwood comprising a total area of 1240 square miles with a safe dependable yield approximating 50,000,000 gallons daily.

This water was in the not very distant past available to San Diego and reasonable foresight would have dedicated it to Municipal use but the City today draws its supply from but 28% of the area, as indicated by the yellow tint on Plate I. Furthermore the City system lies in the district of lighter precipitation as shown by the rainfall curves on Plate I, resulting in a net safe yield of 9 million gallons daily which is only 17% of Nature's original allotment.

The Almighty provided well for San Diego but because of failure to grasp opportunities a city which had at its doors a supply sufficient for a half million people is now with less than 100,000 within its gates forced to buy water and draw upon its dry year reserve.

According to published statements of the Board of Water Commissioners the consumption in 1922 was 11½ m.g.d. or 28% in excess of the net safe yield: that estimated for 1925 is 13 m.g.d., an excess of 45% and in 1925 a use of 16 m.g.d. is anticipated which is nearly 80% more than the works as now constituted can produce. The past history of the City system, its present capacity and the expected demands in the near future, to meet which there appears no

adequate programme show that water from some outside source will be necessary if the growth of the community is to continue without interruption.

Among the demands which can be economically met by the Mission Gorge development are those of the local Naval and Military establishments of the United States. The estimates for the Naval Base alone made by one of its officers being one million gallons per day a year hence, two million gallons in 1925 with a ultimate demand of three million gallons within five years.

Add to this the requirements of the Army Bases and the probability that the City itself will be in the market for water, temporarily at least, and the desirability of the Mission Gorge project becomes apparent, it in fact amounts to a demand for immediate development.

NET SAFE YIELD

The quantity of water which may safely be drawn continuously from the San Diego River will depend largely upon the use to be made of it and the development programme, in so far as it affects the capacity and location of storage reservoirs. In domestic use, such as here contemplated the flow must be undiminished even in years of least run-off, and such is the supply here considered.

The development assumed limits the storage to the present Cuyamaca system and one reservoir in Mission

Gorge, a narrow rocky defile through which the river flows for about two and one quarter miles of its course, the lower end being some eleven and one half miles above Mission Bay.

Run-off and safe yield studies made under direction of T. H. King, your Chief Engineer, to which the writer has had access, appear very complete and are accepted for the purposes of this report.

These studies are based upon hydrographic data collected and assembled by F. E. Green who co-operates with the Water Resources Branch of the U. S. Geological Survey and his determinations are accepted and printed in Government publications.

I have also had access to the report of W. C. Earle, Consulting Engineer of the City of San Diego, on the water development of the San Diego River, said report having been filed May 11th, 1922, with the City Council, document No. 142575, said report having been made at the request of and addressed to the Mayor and Common Council of the City of San Diego. I find his report fully coincides with that of Messrs. King and Green as to net safe yield.

The aid and information supplied by Messrs. King, Green, and Earle have been of much value in the preparation of this section of the report.

A study of these records indicates that a dam 250 ft. high, at Mission Site No. 5, some 1500 feet above the lower end of the Gorge, having a reservoir capacity of 44,000 acre feet will give a net safe yield of 8,300,000 gallons daily.

Such a basin having a maximum area of some 1400 acres, will receive the run-off from about 363 square miles shown on Plate I in grey tint, embracing the entire San Diego River drainage area minus the Cuyamaca.

Mass curve studies based upon the records above referred to, indicate that the run-off in excess of the capacity of this reservoir is just about sufficient to supply the San Diego City Pumping Plant, representing an investment of over \$ 50,000, and the riparian owners in Mission Valley, below the damsite, who either are irrigating or can irrigate about 2500 acres by pumping from the underflow.

The crops are principally alfalfa requiring about three acre feet annually, of which probably one half returns to the underflow making a yearly loss from plants and evaporation of one and one half acre feet per acre equal to a total of 5750 acre feet for the entire area.

While the legality of these riparian rights may be questioned, they have been established by beneficial use of water extending over many years and litigation will probably result if they are ignored.

There is, however, no reason for violating them for if the dam were raised to prevent all waste the abnormal increase in the spread of the reservoir would result in an evaporation loss greater than the spillway waste under the present plan.

As evaporation is an absolute loss, passing the run-off into the atmosphere where it can be of no benefit, it is unquestionably the better plan and one in harmony with the laws of conservation to add the excess to the underflow below the dam where somebody may use it.

The safe yield estimated for No. 3 is so much less than that claimed by the Hydraulic Engineer for the City of San Diego for No. 2 about two miles further up the Gorge, that some analysis of the latter seems in order.

Site No. 2 is about a half mile below the head of the Gorge at which point a dam 166 ft. high flooding 6580 acres and providing storage for 285,000 acre feet, is proposed, the net safe yield being given as 12,500,000 gallons per day.

As the reservoir at Site No. 2 will be fed by a drainage area 5 square miles less in extent than that at No. 3, it is interesting to examine this difference of 50% in the net safe yield.

The figure of 12,500,000 gallons was reached by constructing a mass curve of the run-off assuming a full reservoir at the beginning of the critical period. That is at the start of the driest known period of years there was supposed to be 285,000 acre feet on hand to carry the system into the wet cycle.

The accepted records show the mean annual run-off at the Gorge to be about 25,000 acre feet, which means that the filling of the basin will require the total flow of the stream without draft or evaporation loss for twelve consecutive average years.

Allowing for the evaporation of four feet in depth annually and assuming that the exposed lake surface averages 2000 acres, which is less than one third the area of the high water spread of the reservoir, the yearly loss into the atmosphere would be 8000 acre ft. reducing the average annual addition to storage to 17,000 acre ft. At this rate 17 consecutive average years will be required to fill the basin.

Such continued run-off is shown by the records to be so unusual and occurring at such widely separated intervals, that there appears little justification for assuming a full reservoir at the start of the calculations.

If a volume of storage, in harmony with precipitation returns is assumed at the commencement of the dry period, the net safe yield will be about 10 m.g.d. and if a further reduction of 3750 acre ft. equal to about 3 m.g.d. be made to satisfy the riparian owners in Mission Valley, the dependable supply from Site No. 2 is seen to be 7 m.g.d. which is about 85% of that estimated for No. 3.

In considering the allowance for riparian rights below the dam it should be remembered that they are entrenched behind prior diversions and continued application from which position it will be extremely hard to dislodge them. If on the ground of higher use, domestic users are given the preference, those taking the water will pay the price.

The City seems, in its estimate, to have ignored these rights and therefore its figures should be penalized either in water or in money. If in water the result will be as above.

No allowance is here made for the Mission Valley Pumps which while not interfered with by the development at No. 3 would be in distress if the entire flow was stored as proposed at No. 2. Probably the City is the best judge as to whether or not this plant should be wiped out.

The conclusions from this study are that so far as safe yield is concerned a small deep storage in the Gorge is more efficient than a large shallow one on the comparatively flat lands above and that in this respect Site No. 3 is superior to No. 2.

LOCATION OF DAM

Mission Gorge contains three damsites. At No. 1 near the head of the defile may be seen the ruins of a diversion dam built many years since, to supply a canal leading to the Old Mission San Diego about five miles below.

While this site has a foundation which is apparently favorable, its extreme length, the rather indifferent abutments and the large evaporation loss incident to the comparatively shallow storage in the valley above eliminate it from further consideration.

Site No. 2 about 2500 feet below No. 1 is the location recommended by H. N. Savage, the Hydraulic Engineer for the City of San Diego, after extended investigation. As a damsite it has much merit: bedrock of good quality is within easy reach, the abutments are good, and the outcrops show the existence near at hand of sufficient rock for construction, at an elevation which will allow a gravity run from the mixers.

Its disadvantages are an average width of gorge unfavorable to a curved dam, excessive evaporation due to the extreme area of the lake which it will create, and the large outlay involved in the purchase of the reservoir site covering 7400 acres, much of it being good farming land with extensive improvements including one or two towns, together with several miles of railroad and paved highway.

The drawbacks, coupled with the fact that better results may be obtained elsewhere for less money prevent the approval of this site.

The location near the lower end of the Gorge, known as Site No. 3 has been examined, the borings and test pits showing excellent foundation and abutments which may be uncovered by a reasonable amount of excavation: its length permits the curved type of structure and sufficient rock for building purposes is within economic reach.

The reservoir will cover a maximum area of 1425 acres, which is but 20% of that at No. 2. Much of the storage is in the Gorge, flooding little land or improvements of value and greatly reducing losses from evaporation.

This site which seems to possess all the merits of No. 2 with none of its drawbacks will give a greater net safe yield than either of the others and at less cost. It is also some two miles nearer the market, reducing by that amount the length of conduit necessary to reach the delivery point.

To sum up, there exists at No. 3 a natural damsite of much merit, ideally located for economic development, equal in all features and superior in many to any location available on the San Diego River. In recommending site No. 3, I am only concurring in the opinion heretofore expressed by Messrs. O'Shaughnessy, King, and Earle.

TYPE OF DAM

The Gorge at Site No. 3 is favorable for the construction of dams of various types, prominent among them being the masonry dam of straight gravity section, the curved masonry dam with allowance for arch action, and the rockfill. Such structures may be considered as standard, conforming to the principles of good practice.

The determination of the design best adapted to the location, involves complete plans for each type with stress analysis, requiring more time than can now be given to it.

In addition to these standard types you have a proposition from Mr. Jorgenson for a structure composed of three single arches which on its face possesses much merit and it is believed that analysis and further study will show its employment to be proper and economical. As the matter now stands the Jorgenson plan promises best.

Mr. Eastwood has presented two plans, one for a Multiple Arch and one for a Radial Multiple Arch. While the contemplated height seems rather extreme for this type any opinion of value on the merits of the Eastwood design should be predicated upon complete analysis for which neither the time nor the details are now available. However this proposition should be carefully considered before final conclusions are reached.

For purposes of preliminary estimate the construction of the Jorgenson Three Arch type is assumed, without prejudice to any other design, the selection being influenced by the fact that the quantities involved are known and their use will save

time.

The masonry in this structure is estimated by its designer as 115,500 cu. yds; and steel 50 tons. Allowing an overburden of 15 ft. average depth, the excavation involved will be: earth 25,000 cu. yards; loose rock 5000 cu. yds., solid rock 2000 cu. yards.

THE PIPE LINE

The outlet is assumed to leave the dam 100 feet above the stream bed or at elevation 200 ft. above sea level, which allows a favorable location along the side of the Gorge and also leaves a reservoir volume below the outlet sufficient for the sediment accumulations of many years. At the present time 80% of the water supply of San Diego is consumed below the 200 level so the pipe line could serve the City should such use ever be desirable.

The lower end of the pipe line, 54,500 ft. below the dam is assumed at 50 ft. above sea level, although it will probably be lower than this, which gives a total fall of 150 ft. equivalent to 2.75 ft. per 1000.

While the safe continuous draft is estimated as 8,500,000 gallons daily the varying demand will make necessary short time deliveries much greater than this, the peak at times being nearly twice the average. The maximum demand has been assumed at the rate of 15,500,000 gallons per day which will pass through a 30" redwood pipe with a fall of 2.5 ft. per 1000, being well within the available slope.

Below the Gorge the pipe will lie in streets and roads with possibly two short detours in private land, and the ground is such that a fairly even profile may be obtained.

Plate II attached, shows a survey covering the entire length of the conduit.

A cover of two feet is assumed. An average depth of excavation of five feet and width of five feet giving one yard of excavation per lineal foot.

The estimated cost per lineal foot is:-

Excav. 1 cu. yd.	\$ 0.75
Redwood pipe in place	5.00
Hauling and distributing25
Total	\$ 6.00

LANDS AND RIGHTS OF WAY

It is understood that much of the land required for the various purposes has been secured and negotiations for the balance are in favorable shape so this feature will not be considered further.

ESTIMATE OF COST

Dam

Earth excav.	25,000 cu.yds. at 50¢	\$12,500
Loose rock ex.	5,000 " " " \$1.25	6,250
Solid " "	2,000 " " " 3.50	<u>7,000</u>
Total excav.	- - - - -	\$25,750

Main Structure Etc.

Concrete	115,500 cu.yds. at \$9.00	1,039,500
Steel - 50 tons at \$100		5,000
Outlets, valves, warehouses, living quarters for keeper, etc.		<u>25,000</u>
Total	- - - - -	<u>1,069,500</u>
Total for dam	- - - - -	\$ 1,095,250

Pipe Line

54,500 lineal ft. at \$6.00	327,000
Extra for heavy work in Gorge	<u>10,000</u>
Total pipe line	<u>337,000</u>
Total	\$ 1,432,250
Engineering and Contingencies 15%	<u>215,000</u>
Interest during construction period of 2 years, assumed as 6% of entire amt. for 1 year	<u>1,647,250</u>
Total	\$ 1,754,250

Assuming the bonds are marketed at 97 an issue of 1,800,000 will be required.

COMPARISON WITH DEVELOPMENT AT SITE NO. 2 AS PROPOSED BY H. H. SAVAGE, HYDRAULIC ENGINEER FOR CITY OF SAN DIEGO

The cost of the work embraced in the No. 2 development, including land, dam, pipe line and filtration plant with all features appertaining thereto is estimated by Mr. Savage in his report of Nov. 27, 1922, to the Mayor, Common Council and Board of Water Commissioners of the City as \$5,309,000 of which \$2,400,000 or 45% is for 7400 acres of land in the reservoir site with such improvements as towns, highways, and railroads. The estimate also includes \$117,000 for filters. Deducting these two amounts from the total estimate there remains for the dam and pipe line \$2,792,000 which is one and one half times that estimated for similar construction to develop 15% more water at Site No. 3.

Such comparison, however is decidedly unfair to No. 3 which floods very little land and wipes out no towns, communities, railroads, or highways. Should a fair amount be added for cost of reservoir lands and a comparison made of total estimates it is probable that the cost of No. 3 would be less than half that at No. 2.

When two engineers, starting with the same drainage area, the same river gorge, the same rainfall and run-off records and having in mind the same objective, which is the development of the most water at least cost, arrive at such widely different conclusions "a decent respect for the opinions of mankind requires that they shall state the causes which impel them" by such divergent paths.

An examination of the Hydraulic Engineer's report of Nov. 27, 1922 shows that the wide variation in conclusions

is due to a fundamental difference of opinion.

Mr. Savage considers it necessary to prevent any fresh water from reaching the ocean. To accomplish this the riparian rights in Mission Valley and the needs of the City Pumping Station there, are ignored and a dam proposed which will impound 285,000 acre feet with a lake area at highwater of 6580 acres.

The evaporation from such a basin will be enormous. When full it will amount to 26,000 acre ft. or slightly in excess of the average annual run-off as determined from a long term of years. With the lake area reduced to 3000 acres this loss will be 12,000 ac. ft. or 1/2 the average yearly run-off.

Having assumed the existence of this basin a mass curve is constructed which shows a net safe yield of 12½ m.g.d. To reach this amount the lake is considered as full at the beginning of the dry period, notwithstanding the records show that it might have filled about 1884-85, again in 1916 and if history repeats itself again in 1948.

Such figures, relating to a storage which can fill but once in 30 or 40 years exist mainly on paper.

However, let us assume that the basin is now full and delivering to San Diego the estimated 12½ m.g.d. which is about the present consumption in the City.

The total delivery the first year would be about 14,000 acre ft. and the reservoir being full, the evaporation loss would be some 26,000 ac. ft. or nearly double the beneficial use.

When the lake surface has reduced to 3650 acres the evaporation will about equal the annual draft.

It would be interesting to pursue this matter further

and show by tables and diagrams how much of the proposed expenditure at Site No. 2 will create actual value and what proportion will be dedicated to the construction of an immense evaporation pan, the land for which is estimated to cost \$2,400,000 or nearly one half the entire expense of the development. However, such exhibits are unnecessary for the fallacy of the proposed large storage is apparent.

A more rational solution of the problem appears to be a storage which reduces evaporation losses to a minimum and passes excess water to the lower gravels where it may be recovered if needed instead of drying it up and such is the ruling feature in the development herein suggested for Site No. 3.

A comparison of the costs of the two plans, together with the net safe yields available having due regard to the probability of filling the storage basin and a recognition of riparian rights, shows the latter plan to be decidedly better and not more than one half as expensive.

CONCLUSIONS

The conclusions from this study are:

- (1) That Site No. 3 in Mission Gorge on the San Diego River is a favorable location for a dam 250 ft. high, impounding 44,000 acre ft.
- (2) That 44,000 acre ft. is the economic volume for stream control, having due consideration for evaporation losses and the riparian uses in Mission Valley.
- (3) That the above control will give a dependable safe yield of 8,300,000 gallons per day, equal to about 9300 acre ft. annually.

(4) That the cost of the development, exclusive of land and including a pipe line for delivery to the Marine Base will not exceed \$1,800,000.

(5) That considering the entire river below the intake of the Cuyamaca system, Mission Gorge Site No. 5 is the most logical and economic location for works of stream control.

Respectfully submitted,

Francis L. Selver
Consulting Engineer.

Ed Fletcher Papers

1870-1955

MSS.81

Box: 42 Folder: 7

**Business Records - Reports - Sellew,
Francis [and Post, W.S.] - "Report: San
Diego River-Mission Gorge Damsite No.3"**



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