

California Railroad Commission - Engineering Department

DISCUSSION OF THE DEVELOPMENT
OF THE WATERS
of the
SAN DIEGO RIVER
and
SANTA YSABEL CREEK

San Francisco, California,
August 31, 1923.

F. M. Faude,
Hydraulic Engineer.

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SCOPE OF DISCUSSION

This discussion will embody an analysis of all the studies of safe yield of the San Diego River and Santa Ysabel Creeks, made by engineers of the United States Reclamation Service, the City of San Diego, the Cuyamaca Water Company and others, with a view of determining a logical method of conserving the flood waters of these streams, which are now to a large extent wasted into the ocean, and of developing these flood waters for use as a municipal supply for the City of San Diego, or for irrigation and domestic use on lands in the agricultural areas tributary to the City.

Whether these flood waters are developed by the City of San Diego or by private capital will not vitally affect the results of the analysis nor change the general scheme of development.

The detail of the computations used in determining safe yield of the various reservoir sites or costs of structures will of necessity be omitted.

The endeavor throughout the present investigation has been to determine by the most careful and conservative analysis the amount of water which can be developed by the various sources of supply, and is based upon the demands of domestic use of wa-

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ter. These limitations have necessarily compelled very careful consideration of the effect of the great drought which occurred between 1899 and 1905 and the possibility of a recurrence of such drastic conditions.

The estimated costs of dams for the various locations are reasonable costs for masonry structures of a type which has been thoroughly tested by actual construction and use under adverse conditions. There are several examples of this type of dam in San Diego County, where their use has proven the structures to be both safe and economical.

DESCRIPTION OF SAN DIEGO RIVER AND PRESENT
DEVELOPMENT OF THE WATERS OF THAT STREAM

The San Diego River rises in the mountains east of the City of San Diego and near the divide between the coast and the desert in the eastern part of the County. Like all streams in this vicinity the runoff is extremely erratic and ranges from extreme drought to extreme flood conditions. Storage of flood waters is absolutely essential in order to provide a supply of water for domestic and irrigation use. Reservoirs must be of such a capacity as to provide storage for at least three years of drought and some engineers have advocated an even larger storage capacity. Storage of extremely large capacity is however greatly influenced by excessive evaporation and the economic limits of storage are such that it is impracticable to conserve all the runoff of the watershed in years of extreme flood.

A considerable amount of water is pumped from underground

reservoirs in the valleys of the river, most of the pumping being done by private plants for irrigation purposes. Aside from these privately owned plants the Cuyamaca Water Company has constructed a pumping plant in the valley east of the town of Lakeside and has at times pumped large quantities of water. The City of San Diego has also constructed a pumping plant in the Mission Valley east of Old Town but operation of the plant has not been carried on to any great extent.

In 1888 the San Diego Flume Company finished construction of a water system for the irrigation of lands in the El Cajon Valley and the area lying east of the limits of the City of San Diego. In 1910 this system was sold to James A. Murray and Ed Fletcher and the plant has since been operated under the name and style of Cuyamaca Water Company. The present system consists of Cuyamaca Reservoir, of 11500 acre feet capacity, diverting dams on the San Diego River and South Fork Creeks; a flume 33 miles long; the Murray Reservoir of 6000 acre feet capacity; several small reservoirs; and a distribution system comprising more than 55 miles of pipe lines. Approximately 4000 acres are irrigated with water supplied by this system and there are about 1500 services connected thereto. The total population served is in excess of 30000.

DESCRIPTION OF SANTA YSABEL CREEK AND POSSIBLE DEVELOPMENT OF ITS WATERS

The Santa Ysabel Creek rises in the mountains northeast of the City of San Diego and is one of the tributaries of the San

Diequito River, whose course is generally parallel to and distant approximately twenty miles north of the San Diego River.

On the Santa Ysabel Creek is located the Sutherland Reservoir Site, where by the construction of a dam the runoff of a very prolific watershed may be impounded. On account of the large quantity of water which can be developed by this reservoir, and its location with respect to San Diego and tributary country, it is exceptionally attractive as a possible source of supply.

PLANS FOR CONSERVATION OF FLOOD WATERS OF SAN DIEGO RIVER

In order to conserve and develop the waters of the San Diego River to the greatest possible advantage the construction of additional reservoirs is not only desirable but imperative, and the following list indicates those reservoirs which have been recommended:

Fletcher Reservoir
South Fork Reservoir
El Capitan Reservoir
Mission Gorge Reservoir

These reservoirs will now be discussed under separate headings and, as the Fletcher and South Fork Reservoirs are naturally a part of Cuyamaca Water Company's system, a discussion of the safe yield of that system is also included.

SAFE YIELD OF CUYAMACA WATER COMPANY'S PRESENT SYSTEM

The safe yield of Cuyamaca Water Company's present system is at least 3500 acre feet per annum, or approximately 3.12

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million gallons per day. To furnish this amount of water, pumping from the sands of the San Diego River valley at the company's El Monte Pumping Plant would have been required as follows:

Year	Pumping Requirements	
	Acre Feet per Year	Million
		Gallons per Day
1899	1000	0.89
1900	3200	2.86
1903	200	0.18
1904	1900	1.69

These quantities of water could be pumped with the present equipment at the El Monte Plant, and in no other year than 1900 would the plant have been operated to full capacity.

In addition to a safe yield of 3.12 million gallons per day from the present gravity system the El Monte Plant could have furnished an additional supply of water in each year except 1900. The probable safe yield of the El Monte Plant with the present equipment is not less than 2 million gallons per day, and this yield could be materially increased by the installation of adequate equipment.

The present requirements of consumers of the Guyamaca system amount to approximately 3 million gallons per day.

Attention is called to the fact that since 1913 consumers have been furnished all the water they desired, the only interruptions to service being for very short periods during the progress of repair work on the flume or other facilities.

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SAFE YIELD OF PROPOSED FLETCHER AND SOUTH FORK
RESERVOIRS, WITH A DISCUSSION OF INCREASED
YIELD AT EL MONTE PUMPING PLANT

By the construction of a reservoir of 17,000 acre feet or 5½ billion gallons capacity at the Fletcher site, at or near the present Guyamaca diverting dam, and the construction of a reservoir on South Fork Creek of 3,000 acre feet or one billion gallons capacity, a safe yield of 4100 acre feet per year or 3.66 million gallons per day would be obtained. A dam at the Fletcher site could be constructed at a cost of approximately \$600,000. The South Fork Dam would cost about \$100,000.

These reservoirs would increase the yield of the present Guyamaca system to a total of 7,600 acre feet per year or approximately 6.8 million gallons daily.

To furnish this amount of water, pumping at El Monte Pumping Plant would have been required as follows:

Year	Pumping Requirements	
	Acre Feet per Year	Million
		Gallons per Day
1900	3200	2.86
1901	1300	1.16
1903	1500	1.34
1904	4300	3.84

In order to care for these drafts upon the underground reservoir at El Monte new wells and equipment should be installed so that heavy draft could be sustained and the water in the deeper

gravels made available. The cost of the rebuilding of this equipment would be comparatively inexpensive, the total depending entirely upon the amount of money spent for architectural or artistic effects in no way connected with efficient performance. Two pumping units of a capacity of 3 million gallons daily each could be installed for a total cost of from \$35,000 to \$50,000.

After the installation of new wells and equipment at the El Monte Plant a yield of from 3 to 4 million gallons per day can be depended upon.

EL CAPITAN RESERVOIR

This proposed reservoir is located on the San Diego River, the dam site being about six miles east of the town of Lakeside.

The construction of a dam 160 feet high will form a reservoir of 71,000 acre feet or 23 billion gallons capacity, will give a safe yield of 5,700 acre feet per year or 5.09 million gallons per day, and is based upon a full release of water to care for riparian lands below the dam.

Careful analysis of this project can result only in the conclusion that its merits are few and its drawbacks are many. The principal objection is its excessive cost, which results in an exorbitant price per thousand gallons for the water developed. This cost is far more expensive than for water developed at other projected reservoir sites, and serious consideration of this reservoir is therefore abandoned.

SAFE YIELD OF RESERVOIR AT MISSION GORGE SITE NO. 3

A dam creating a reservoir of 44,000 acre feet or 14 billion gallons capacity could be constructed for from \$600,000 to \$750,000. This dam is at the so-called Site No. 3 located a short distance above the westerly end of the gorge of the San Diego River below the town of Santee.

This reservoir would have a safe yield of 4,500 acre feet per year or four million gallons per day.

The outlet of this dam is at sufficient elevation to supply a large portion of the water use on the lower levels of the City of San Diego, and a pipe line to the City of a capacity of not less than ten million gallons per day could be built for \$350,000.

SAFE YIELD OF SUTHERLAND RESERVOIR

This reservoir site is located on the Santa Ysabel Creek, at the lower end of a very productive watershed. A reservoir of 60,000 acre feet or 19½ billion gallons capacity will assure a safe yield of 8 million gallons per day or 9,000 acre feet per year.

The water developed at Sutherland Reservoir can be most economically transported to the City of San Diego by means of a pipe line 15½ miles long from the reservoir to the Guyamaca flume at or near the diverting dam and thence by means of the flume and the company's pipe lines to University Heights Reservoir.

Arrangements can be made with the Guyamaca Company for the

transportation of the water developed in Sutherland Reservoir on a basis which will result in very economical transmission.

The cost of the Sutherland development will depend largely upon the price which must be paid the present owners for the reservoir lands, water rights and riparian rights below the proposed dam. If the property can be purchased for \$1,000,000, the entire Sutherland development can be effected at costs not to exceed the following amounts;

Reservoir Lands, Water Rights and Riparian Rights.	\$1,000,000
Dam	1,000,000
Pipe Line to Cuyamaca Flume	500,000
Total	\$2,500,000

RECONSTRUCTION OF CUYAMACA FLUME

So much criticism has been made from time to time of the condition of the present Cuyamaca flume that this discussion would not be complete without comment thereon.

Except for a six-mile section of the flume which can be advantageously replaced within the next few years no general reconstruction of the flume is necessary or economically advisable.

The section which should be rebuilt comprises the portion between Monte and Lankershim tunnels and includes practically all the high trestles remaining on the flume. This is the section on which a very large portion of the present maintenance cost is expended.

A relocation and reconstruction of this stretch of flume will reduce the length by approximately three miles and very materially reduce maintenance and operation expense.

The remainder of the flume can be kept in service for many years at a cost considerably less than the carrying charges on any type of permanent conduit that can be devised.

It is therefore recommended that the portion of the flume between Monte and Lankershim tunnels be relocated and rebuilt in the reasonably immediate future and that the remainder of the present flume be maintained as long as possible with timber salvaged from the reconstruction of that section.

Relocation and reconstruction of the six-mile section mentioned above, comprising approximately three miles of actual construction, will cost not to exceed \$100,000.

LOGICAL AND ECONOMICAL DEVELOPMENT OF THE WATERS OF THE SAN DIEGO RIVER

As a result of the present investigation it is evident that the logical and most economical development of the waters of the San Diego River is by means of the following program:

- Build Fletcher Dam.
- Build South Fork Dam.
- Acquire Sutherland Reservoir site, water and riparian rights, and construct Sutherland Dam and a pipe line to Cuyamaca flume.
- Build a dam at Mission Gorge Site No.3.
- Reconstruct the portion of Cuyamaca flume between Monte and Lankershim tunnels.
- Reconstruct the equipment at El Monte Pumping Plant so as to permit heavy draft and make available the waters in the deeper gravels.

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The cost of the development outlined above, together with the safe yield of the various reservoirs, would be as follows:

	Estimated Cost	Approximate Safe Yield	
		Acre Feet Per Year	Million Gallons Per Day
Fletcher Reservoir South Fork Reservoir	\$600,000) 100,000)	4,100	3.66
Sutherland Reservoir and Pipe Line	2,500,000	9,000	8.00
Mission Gorge Reservoir and Pipe Line	1,100,000	4,500	4.00
Reconstruct El Monte Pumping Plant	50,000	3,400 to 4,500	3.0 to 4.0
Reconstruct portion of present Cuyamaca Flume	100,000	3,500	3.12
Totals	\$4,450,000	24500 to 25600	21.78 to 22.78

It should be noted that the safe yield of the El Monte Pumping Plant as shown by the foregoing tabulation is not entirely correct as in four years out of thirty-five part of the safe yield would be required to make up deficiencies in the gravity supply, and in one year of the thirty-five year period practically the entire yield of the pumping plant would be required for that purpose.

As has been stated before, present consumers of Cuyamaca system use approximately three million gallons per day and the yield of the development outlined above which would be available

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for distribution to consumers other than those now served by the Cuyamaca system would be three million gallons less than the totals shown in the foregoing tabulation.

This program for development and conservation of the waters of the San Diego River assumes the use of the present system of Cuyamaca Water Company as a frame work upon which to build. The necessity for such use of the present system is so readily apparent to all who are acquainted with the facts, and who have given the matter intelligent consideration, that a detailed statement of the reasons for such a conclusion is unnecessary.

A map showing location of the various reservoirs and other features treated in this discussion is attached.

F. M. Faude,

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