REPORT OF

J. B. LIPPINCOTT

TO

THE SAN DIEGO IMPROVEMENT CLUBS

ON

PROPOSED WATER SUPPLY FOR THE CITY

OF

SAN DIEGO.

To the Special Committee

Of The San Diego Improvement Clubs.

Gentlemen:-

OBJECT OF REPORT.

I have been requested by you to report on the adequacy of a domestic water supply for the City of San Diego to be obtained from the bottom lands of the San Diego River in El Cajon Valley. In compiance therewith I submit to you the following statement.

REQUISITES OF CITY.

The population of the City of San Diego in the year 1900 is said to have been 17,000 persons; in the year 1904, the population is estimated at 25,000 people. The amount of water required per capita in the cities of Southern California where the supply is adequate to meet the demand, both for domestic uses proper and for the beautification of yards and of the city in general, is in excess of that used in any other portions of the United States.

The greatest rate of water consumption of any town in Southern California is that of Pasadena, where over 300 gallons per capita are used daily. The City of Los Angeles, during the Summer season, is using fully 200 gallons. The City of Long Beach is using 186 gallons. In the City of San Diego where the yards are large and the occasion offers for the consumption of a relatively large amount of water. It is desirable to use this water with the greatest possible economy, but where people pride themselves on the beautifying of their grounds, as they naturally do in San Diego, the consumption would be approximately 200

gallons per day per capita. In addition, a material portion, which has been estimated at 20 per cent of the water of your city is used for irrigation purposes. The area within your city boundaries is 42,000 acres. With your present population of 25,000 people, the normal summer consumption would probably be about 5,000,000 gallons. Of this amount 2,000,000 gallons daily is obtained from the Mission Valley, leaving a deficiency of 3,000,000 gallons, which has to be obtained in part from the San Diego flume. It is reasonable to suppose that within a period, say of fifteen years, you may have a population of 50,000 people requiring 10,000,000 gallons daily and involving a deficiency of 8,000,000 gallons above the amount which you now obtain from you present source in the Mission Valley. It would be advisable for you to obtain promptly, a new supply of 4,000,000 gallons daily, and an additional supply, say within fifteen years, aggregating 8,000,000 gallons in addition to that which you now have. The water of the San Diego flume could naturally be used along its line on the numerous orchards that require it. The province of the city should be to foster this district rather than be a party to its depletion by taking this water supply.

SAN DIEGO RIVER DRAINAGE BASIN.

The San Diego River drains an area of 316 square miles above a point called River View, which is at the head of El Cajon Valley. The culmination of the basin is at Cuyamaca Peak, the elevation of which is 6515 feet. The elevation of the lower end of the Cajon Valley in the river bottom is 310 feet, and the mean elevation of the basin is fully 2000 feet. This area is

rough and mountainous, and but sparsely occupied. The formation is largely of granitic rocks which yields a water supply of relative purity. A large portion of the basin above River View is covered by brush, and on the crests of the hills grow large pine timber.

The rainfall has been measured at a number of points on this mountain range. The following table is taken from a report of the United States Geological Survey, entitled "California Hydrography":-

PLACE	ELEVATION	YEARS	RAINFALL.
Campo	2660	1876-7 to 1901-2	19.54
Cuyamaca	4800	1887-8 to 1901-2	37.76
Descanso	3500	1895-6 to 1901-2	20.29
Julian	4500	1879-80 to 1895-6	33.55
Laguna	5440	1884-5 to 1901-2	19.30
Hellie	5240	1901-2	42.51
San Diego	69	1849-50 to 1901-2	9.50

From numerous observations taken along the western side of the Coast Range in Southern California, it has been observed that the rainfall increases with rise in elevation at the rate of six tenths of an inch in depth annually for each 100 foot rise in elevation. This is a general statement which has to be modified frequently for local conditions. Assuming the rainfall at the town of San Diego as a base, and the mean elevation of

our drainage basin at 2000 feet, we would obtain a computed mean rainfall in this basin of 21.5 inches. This computation, taken in connection with the observed rain at the stations given above, is believed to justify an estimate of 22 inches of rain on an average for the portion of the drainage basin of the San Diego River above River View.

The amount of stream flow that may be expected from a drainage basin is much more difficult of computation than the determination of the probable rainfall. In this instance we are guided by the observed stream discharge at two points in your county on the western side of the mountains. The Sweetwater River, above the dam, drains 186 square miles of country. The period of record at this point, as is so well known, has been of late one of unusual drouth. The long rain-fall record of San Diego indicates that these periods of drouth may again occur, and emphasizes the necessity of preparing for their repitition. The character of the lower portion of the drainage of the Sweetwater basin is such as to be unfavorable to a large amount of run off. This Sweetwater record, therefore, is probably below normal conditions above River View, and it is believed that larger floods occur on the San Diego River above River View. The discharge of the Sweetwater dam, for the seasons 1887-8 to 1901-2, has been at the rate of .09 cubic feet per second per square mile of drainage basin.* A record is also vaailable for a period of eight years for the discharge of the partion of the drainage basin of the San Diego River above the Cuyamaca reservoir. The area of this basin in but 11 square miles. It is quite a

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* U. S. Geological survey water supply paper-California Hydrography.

mountainous character. During this period the mean stream flow above the Cuyamaca dam was at the rate of .74 cubic feet per second per square mile.

A great number of observations have been taken throughout California showing the ratio between the rainfall in a given drainage basin and the resulting stream flow. This is subject to a wide fluctuation due to the character of the drainage basin as well as that of the storms. A table has been prepared, however, showing this ratio, and for 22 inches of rainfall the estimated run-off is .20 cubic feet per second per square mile of drainage basin. This table has been compiled from measurements mostly, made by the U. S. Geological Survey, during the period of drouth which we have recently been passing through.

As previously stated, the drainage area of the San Diego River above River view is 316 square miles, from which, however, should be deducted the 11 square miles of drainage area above the Cuyamaca Reservoir, leaving a net area of 305 square miles. The mean annual discharge of this basin, if a stream flow of .2 of a second foot per square mile is accepted for normal years, would be 61 cubic feet per second, which is equal to 39,000,000 gallons daily. From numerous observations made on the streams of Southern California, it is known that these basins yield spasmodic floods followed by periods of drouth. These flood discharges yield ordinarily from 75 to 85 per cent of the total annual flow of the river. They occur in the winter time when the demand for water both for irrigation and domestic uses is at a minimum. We therefore have to deal with a stream which, during the summer time is usually dry, and during the winter time is

discharging in flood waves, rushing down through the mountain canyons, carrying sands and gravels, and spreading itself over the flat valleys which it fills with the debris.

These computations are not given as exact determinations, but are merely presented as a reasonable argument indicating that we may expect a material volume of water to be offered for absorption to the gravel beds in Cajon Valley. A portion of this water would be diverted by the San Diego Flume and another part would pass on to the Sea but there would be available a large amount under normal conditions to recharge the gravels each year.

GRAVEL BEDS.

Above El Cajon Valley the bed of the San Diego River is mostly in narrow canyons which offer little opportunity for agriculture or the developement of underground water supplies. From River View to the lower end of the Cajon Valley, the river bed is approximately four miles in length. It is here a broad sandy wash or valley that has been filled with the coarse debris from the granitic mountains above. At its lower end, it is contracted. It has a grade of 16 feet to the mile through this flat protion. The bare sandy bed of the river itself is from 100 to 200 feet in width, and its flood plane, in many places is fully 1000 feet wide. El Cajon Valley proper is distinct from this sandy wash. It will not yield any material permanent amount of water to these gravels, and the drainage area tributary to Cajon Valley from the south, is excluded entirely from these estimates.

Parties representing the City of San Diego have obtained

options on the lands described in the table below. The second column in the table indicates the total area in each tract of land in question, and the third column the number of acres in the sandy wash of the river. The fourth column indicates the price for which the lands can be bought. In the Fanita Tract, the portion of the river bed above the Sycamore Canyon road is considered as water bearing land. That below the Sycamore Canyon Road is not so valuable for the purpose of producing water, as it is as a protection against the possible encroachment on the part of other persons. The Ferry Tract is situated above River View and in the small valley between that place and Lakeside. This is of importance to the city and should be obtained in the future.

SAN DIEGO RIVER

Areas of Bottom Land.

Tract.	Total Area.	Sandy Bottom		
Winchester	226	100		Option held
Williamson, H.D.	933	750	$45,000	" "
Gillen, J.R.	203	203	10,000	" "
Fanita water bearing land	700			" "
Fanita above Syc. Can.Rd. and H. line Lots 1-5-6	(408)	320	20,000*	" "
	2062	1373		
Ferry Tract	1000	450		No option
Luce & Sloane reserv. & R.O.W.	71¾			

* $20,000 buys any amount of bottom land in the ranch, 320 acres taken as water bearing and 380 water protection land.

It will be observed that the City has obtained options on 1373 acres of this bottom land. During the inspection that was made of this situation, 26 wells were visited between the Monte Tunnel and the Old Mission Dam on the San Diego River. The samples of the sands and gravels obtained from all these wells that were located in the river bottoms were of a very coarse and perous nature. The sands were remarkably free from silt or dirt, were sharp and angular, and were ideal for purposes of rapidly absorbing or yielding water. They are also of remarkable uniformity in character, as is also the slope of the water plane. Wells that were located away from the river bottom usually penetrate denser and more impervious soils, and the water is not so good. These sands and gravels compare very favorably with the best water producing gravels of Southern California.

Mr. C. S. Alverson, your Engineer, has collected samples from twelve test wells that he has put down, all of which show this character of sand, and which samples may be seen at the City Clerk's office in San Diego. The depth of these sands and gravels are not known. No well was found in the bottom of the river that had reached bed rock. One cased well was sounded to a depth of 87 feet without reaching bottom. This was the limit of the length of the chain. Four wells, owned by the San Diego Flume Co. that were sunk above Lakeside, near the Monte Tunnel, 250 feet apart, are each to a total depth of 70 feet. Two wells have been put down in the narrows of the river at the head of Cajon Valley, at the eastern end of the Williamson Tract, to depths of about one hundred feet. Mr. Alverson has fully described most of these

wells in his report to the Special Committee of the Common Council of the City of San Diego, and it would be needless to describe them further here, except to confirm what Mr. Alverson has previously stated.

Special reference, however, might be made to the pumping plant of the San Diego Flume Company which is located 1-1/2 miles above Lakeside. At this point, four circular shafts have been sunk in the sandy bottom of the river twenty feet, and four 8-inch galvanized iron casings have been put down in the bottoms of these shafts to an additional depth of 50 feet. At this point, the water level is standing 26 feet below the surface of the ground when the pumps are not running, and 36 feet below the surface when the pumps are running. Their location is in a narrow part of the canyon where the area of the gravel wash is not favorable to extensive storage capacity. The water is lifted from these four shafts by means of centrifugal pumps and gasoline engines, and is delivered to a steam pumping station, from which point it is lifted 300 feet into the Company's flume. On December 19, 1904, this plant was lifting about 2,000,000 gallons. It is stated that during the summer season, 4,000,000 gallons daily are frequently pumped from these four shafts, and that the plant has been running all summer. This is a good illustration of the amount of water that can be otained from these saturated gravels. It is believed that their capacity to yield water is very great, and with a given well and pumping plant the water output on a trial run is rather the measure of the capacity of the pumping plant than of the gravels. However, the one essential feature of these underground developements is the volume and the permanence

of the supply. The true question is, what is the amount of water afforded for the recharge of the gravels.

In the bottoms of the Cajon Valley, the water stands from six to eight feet beneath the surface of the ground, except in the lower portion of the valley, at the narrows where it stands at the surface of the ground, and where it is proposed to erect the pumping plant for the City of San Diego. Lagoons of surface water occur at River View and at the river bottoms constitute a great underground and covered storage reservoir from which evaporation is eliminated.

The City controls 1373 acres of this sandy river bottom. The voids in these gravels, which are filled with water, are probably 33 per cent of the mass, and we can safely say that 25 per cent of the entire volume consists of water which may be extracted by pumping. One foot in depth of these saturated gravels, of an area of 1373 acres, should therefore yield 112,000,000 gallons of water, or sufficient to give a flow of 306,000 gallons per day for one year of time. If 4,000,000 gallons daily is extracted for a year and no additional water was added thereto from the surrounding country or from the discharge of the stream over their surface, a lowering of the water plane of 13 feet would occur; or, if 8,000,000 gallons is extracted daily for a year, their surface would be lowered 26 feet.

During the past six years of drouth, there has been but two years when the river failed to flow over the length of this gravel bed. It would be entirely possible to pump these gravels down to a depth of 100 feet beneath the surface, but it is to be hoped that this will never be necessary. However, the extent to which

the lowering of this water plane may be expected, is the justification for the purchase of a large area of ground. The most common mistake that has been made with the pumping plants of Southern California, has been that the area of water bearing land from which the pump must draw has been insufficient. A given pumping plant makes a demonstration of the possibility of producing a water supply from a given gravel bed, and neighboring land owners, observing the benefits to be drived by such a process, follow suit, constructing other pumping plants, and the combined withdrawals rapidly lower the water plane beyond the limit where water can be commercially extracted to advantage.

It is desirable for the City not only to obtain an area sufficiently large to yield the necessary storage capacity, but also sufficiently large to prevent the encroachment on the part of other persons who may seek also to divert water from this source and to prevent adverse litigation under late court rulings. For this reason, a policy should be adopted of extending the area owned by the City so as to cover all the gravels along this river, above the Cajon Valley. This is particularly true in view of the certain fact that the City of San Diego, with its future growth, will demand all the available water supplies tributary to it.

As has been previously stated, the true question involved in passing upon one of these underground water supplies is, <u>will the available water supply offered for the recharging of the gravel beds each year be sufficient to counterbalance the withdrawals made therefrom.</u> In this instance, it is believed that a withdrawal of fully 4,000,000 gallons daily may be continuously made, and there is a strong probability that this may be increased to 8,000,000 gallons daily. When pumping is begun, careful observation should be kept of the fluctuations of the water level and the

withdrawals so gauged as to harmonize with the rise and fall of the water plane.

STRATEGIC LOCATION.

The strategic location of these lands is particularly favorable. We have a precipitous mountainous drainage basin, discharging through narrow canyons on to a sandy plane, which plane is contracted at its lower end by a dike of impervious material which holds back the underground flow. The grades of the entire plane focus towards this outlet, near which the main pumping plant should be established. Small subsidiary pumping plants will have to be distributed over this area to deliver water to the main plant, which, in turn, will lift it to gravity pipe line, which will command your city.

QUALITY OF THE WATER.

Nine tests were made of the quality of the underground water in El Cajon Valley by means of an electrlytic bridge. This apparatus shows the total salt contents of the water, but does not classify the salts.

It was found that all of the water examined in five wells located in the bottoms of the river bed had a close resemblance as to its quality. This uniformity indicates the common origin of this supply. The water in all these five wells contains about fifty grains to the gallon of mineral matter, which is usually considered as just within the reasonable limit for quality of domestics water supply. It is somewhat better than the water which is now being used by the City of San Diego. In fact, a test made of the water in the pipes of your city shows a slightly greater amount of saline matter.

The underground water, however, in the Cajon Valley or that which is approaching the river bottom from the Cajon Valley, is distinctly of a different type, and contains a much higher percentage of mineral matter. Therfore, the water development for your city should be confined to the sands and gravels of the lower river bottoms.

OTHER GRAVEL BEDS OF SOUTHERN CALIFORNIA.

The gravel beds in the Cajon Valley resemble in character those of the San Bernardino Valley above Colton, of the Lower San Gabriel Valley near Monte, and of the San Fernando Valley above Los Angeles; although the Cajon Valley is not so large in area of gravel bed but is relatively large in area of tributary drainage basin. In the San Bernardino Valley above Colton, a continuous flow of 82 cubic feet per second of water was being developed from wells in September 1902. This is equal to 4084 miner's inches. This is after a term of drought during which withdrawals have been continuous. Many detailed measurements of the flow from these San Bernardino Valley gravels may be obtained in a publication of the United States Geological Survey, called "California Hydrography", page 224. In the Lower San Gabriel Valley from 60 to 70 cubic feet per second of water rises near El Monte; and in the San Fernando Valley from 40 to 50 cubic feet per second are obtained above the City of Los Angeles. In Southern California, during the low summer stages, the total output of all the mountain streams south of the Tehachapai, is about 250 cubic feet per second, while the total amount of developed waters is approximately 500 cubic feet per second. It must be remembered, however, in this connection, that the flood water

discharged from the Sierra Madre and San Bernardino Mountains is much larger than those from the mountains of San Diego County.

DIVERSION WORKS.

The water should be gathered from these gravel beds by means of wells, distributed over the saturated area, particularly at the lower end of the valley. A system should be adopted which would permit of the operation of these wells from the central pumping station. This could be done by sinking 10 to 12 inch well casings and extracting the water therefrom by compressed air, which is delivered from the central station. The water could then be conveyed from the wells to a sump, at the main pump, where it should be sufficiently settled to drop all the sand that may come with it and thus save the cylinders of the main pump from cutting. It is recognized that the efficiency of an air lift pump is relatively low, but the water probably will not have to be lifted over 10 to 20 feet, at least at first, and the amount of work thus performed will be slight. If the water plane falls this will not interfere with the proper operation of an air lifting pumping device. The particular advantage of this system is its flexibility, both horizontally or vertically.

The main pumping engine should undoubtedly be of a high duty steam plunger pump type. The lift from the bottom of the sump to reservoir at the head of the force main, will be 152-1/2 feet, which is entirely feasible. The length of this forcemain would be 2-3/4 miles. It would discharge into a receiving reservoir of approximately 12,000,000 gallon capacity. Mr. Alverson has selected an admirable point for such a reservoir, taking advantage

of natural opportunities. From this receiving reservoir, the water could be taken in a gravity pipe line a distance of 9-1/4 miles to the University Reservoir. The elevation of the bottom of the sump is 307 feet, and the bottom of the University Reservoir 373 feet. The material long the line of proposed conduits is mostly earth and cobbles and the construction will not be difficult. It is both commercially and physically feasible to collect and deliver this water to the University Reservoir. The detailed estimates as to the cost and the plans for the work have not yet been prepared; neither was it understood to have been the purpose of this report to pass thereon, yet no hesitancy is felt in making the statement that the entire project is feasible.

RELATION OF CITY TO PROPOSE STORAGE RESERVOIRS.

While it is entirely desirable for the City to use every effort to promptly secure an additional water supply, and to place itself in an independent position for the delivery of water to the citizens of the town at cost; nevertheless, it is important to encourage the operations of the Southern California Mountain Water Company in its efforts to construct extensive storge reservoirs in your county. The city has a contract still in force to accept water from this corporation at a rate of 4 cents a thousand gallons, delivered at the University Heights Reservoir. The area of your city is great, and the rate of growth during the past few years has been such as to warrant the belief that it will be desirable to obtain large quantities of water from this Water Company in the not distant future. Moreover,

the price at which this water is offered to the city by them, is of such a reasonable character as to probably justify its purchase. The city, however, cannot afford to wait for the construction of such an extensive plant, and certainly all the water possible of development can be utilized in and around your town.

RECOMMENDATIONS.

It is recommended that the city purchase the lands along the San Diego River upon which it now has options, and that it should extend its holdings to cover other gravel beds along that river as your system is developed. The plant should be built as promptly as possible. Even if energetic action is taken, it is scarcely possible to hold your election, sell you bonds and build your plant within nine months. It is particularly recommended that if this construction is attempted, it should be carried on in a business manner, by business men, acting on the same lines and with the same methods and economy that they would use in the conduct of their own affairs; otherwise, no amount of skillful engineering will make a success of the project.

I wish to particularly commend the careful and conservative report that has been made on this subject of the available water supply by Mr. C. S. Alverson, Civil Engineer of your city. I have found nothing in his work to which I care to take exception.

Respectfully submitted,

J. B. Lippincott.

Ed Fletcher Papers

1870-1955

MSS.81

Box: 39 Folder: 13

Business Records - Reports - Lippincott, J.B - "Preliminary Report on Investigations of Possible Development of Water Resources controlled by Volcan Land and Water Co., San Diego Country, California"