The Riparian Situation

CUYAMACA WATER COMPANY INVESTIGATIO[N]

M.S. Bost

EFFECT OF INCREASED DEVELOPEMENT OF WATER BY THE CUYAMACA WATER COMPANY

upon the

WATER SUPPLY OBTAINABLE FROM RIPARIAN BOTTOM LANDS ALONG SAN DIEGO RIVER.

CHAS H. LEE.

Sept. 1912.

SAN DIEGO RIVER RIPARIAN PROBLEM

resulting from

INCREASING THE SUPPLY OF CUYAMACA WATER CO.

Report to

John M. Eshelman, Chairman California State Railroad Commission.

By

Charles H. Lee, Hydraulic Engineer.

September 16, 1912.

LIST OF TABLES -- RIPARIAN STUDY.

LIST OF DIAGRAMS.

THE SAN DIEGO RIVER RIPARIAN PROBLEM

resulting from

INCREASING THE SUPPLY OF CUYAMACA WATER CO.

This report presents to the Commission a complete statement regarding the water supply beneath riparian bottom lands along San Diego River and the effect upon this supply of increased development of water by the Cuyamaca Water Co. The conditions have been examined in the field personally, part of the time in company with some of the riparian owners. The conclusions are based on an impartial study of all reliable data obtainable in the time at my disposal.

The definite problems considered are:

1. What will be the effect upon present water supply pumped from riparian bottom lands if the Cuyamaca Water Company should develop sufficient water from the San Diego River drainage area to deliver each and every year a full supply of 3992 Ac. Ft. to its present consumers including 290 Ac. Ft. for the Indians.

2. What are the possibilities of increased development of water from riparian lands in excess of that now developed, after the Cuyamaca Water Company has perfected its supply.

The facts leading up to conclusions will be presented in the following order: 1. physical conditions: 2. rainfall and run-off; 3. Cuyamaca Water Company supply; 4. The riparian situation. 5. Suggestions for improvement.

1. PHYSICAL CONDITIONS.

The San Diego River heads in a plateau lying at an elevation of about 4,000 feet between the Volcan and Cuyamaca Mts. It receives the drainage from the plateau, the Cuyamaca Mts., and a zone of mountainous and hilly country about 12 miles in width extending in a southwesterly direction toward the Pacific Ocean. The upper portion of the drainage area, particularly the slopes of Cuyamaca Mt. is the most productive of run-off. The lower tributaries are less productive.

The river channel occupies the bottom of a deep canyon cut into granite from its upper reaches to Lakeside. Here the granite begins to dip beneath alluvial formations and the channel is in open valleys to Old Mission Dam Below here the river has cut a deep gorge through an obstructing range of hills, beyond which is the Mission Valley excavated from the alluvium. The granite is of fine texture and is non-water bearing except where disintegrated or fissured. The alluvium of the mesa extending from El Cajon Valley to the coast is a cemented conglomerate with strata of marl and is non-water bearing and practically impervious to the passage of water. Hence, generally speaking the river channel is underlaid by impervious formations from its source to the ocean.

In its past history, however, the river has cut into the underlying impervious frometion to a greater depth than at present. This deeper channel has been filled in modern geologic times with the gravel, sand and silt carried by the stream and a new grade established to suit altered conditions. These modern deposits are porous and not only contain water but allow a slow movement downstream.

The river in cutting the granite encountered rock of varying hardness. Where the rock was soft a wide channel was formed which, ~~ih~~ with the aid of tributaries became a small valley. The dykes of hard rock however, resisted the side cutting and permitted only a narrow gorge. The modern alluvial filling therefore, is not continuous in cross-section, but widens out in the old valley and contracts in the narrows. The water bearing formations along the San Diego River thus are a series of basins filled with porous material and connected by narrow necks at the bed rock contractions. They can be thought of as a series of underground reservoirs connected one with the other. Riparian bottom lands are those froming the surface of the reservoir, while the adjacent mesa and hill lands are the surface of the surrounding water tight formation.

The source of supply of these reservoirs is percolation from direct precipitation, percolation from the San Diego River and its tributaries, seepage from surrounding porous formations such as cones of side streams and disintegrated bed-rock in place, and underflow from the basin above. The movement of water is very slow through this material because of its fineness and the light grade of the ground-water surface. The most important sources of supply are therefore percolation from surface streams and precipitation. The rainy months are Dec. to March inclusive, but stream flow in the river continues in normal years until the end of June. Hence the bulk of the supply is received from December first to June thirtieth of each year. In ~~dys~~ dry years the river dries up in May and in excessive drought there may be no stream flow beyond the upper basins. From 50 to 75% of the

rainfall joins the ground-water supply. The amount absorbed from the streams depends upon the depth of the general water plane, the character of material surrounding the stream channel and the length of time during which the stream flows. The most favorable conditions for rapid absorption are coarse sands depleted of water.

The outlet from the reservoirs is by underflow to the next lower basin, by overflow into the river channel and by evaporation. The underflow through contractions is small and need be considered only in the upper basins where the material is coarse and the grade steep. In no case along the San Diego River does it exceed 70 M.I. and in most cases it is much less than this. The overflow into the river channel can be observed in the river bed at contractions in the canyon walls. These streams flow for a short distance and disappear again into the sands of the next lower basin. They are caused by the crowding of water from a basin into the contraction at its lower end. Another outlet afforded just above the contraction is by evaporation. A characteristic feature of every reservoir is a cieniega or area of moist soil supporting water grasses, rushes and water loving trees. The evaporation from such vegetation is enormous. Experiments indicate that it exceeds that from the same area of open water surface, in some cases by 100%. Evaporation is the most important natural draft upon the ground-water reservoirs. The months of greatest evaporation are May to September inclusive, during which 50% of the annual evaporation occurs. (See table 2[illegible]) . During May and June of the normal year the river is still flowing so that months of greatest natural depletion of ground-water are July, August and September

Considered as an average, inflow and outflow must be equal if the ground-water level does not change from year to year. Therefore, if the ground-water level continues to lower from year to year the draft on the reservoir is greater than the supply. The movement of water toward the lower or outlet end of the reservoirs is so slow that they withstood the period of seven years draught,1897-8 without material lowering of the water levels except where artificial draft occured.

Artificial draft upon ground-water reservoirs is made by pumping, This should be carried on so as not to exceed the supply else ground-water levels will be lowered permanently. The ideal method of operating ground-water reservoirs is to pump so as to lower the water plane beneath the evaporating area to such a level that evaporation ceases, (between 5 and 10 feet below the surface). Then the water which formerly evaporated becomes the pumped supply and as long as the amount pumped does not exceed the former evaporation no further lowering of water level occurs. This is a practical method of water conservation, and has been unknowingly accomplished in several of the large ground-water basins of Southern California. This can be accomplished in basins above Lakeside. In reservoirs where the evaporating area is small, as the basin below Lakeside, the only method of operation is to draw upon the storage during the pumping season and depend upon the river and rainfall to recharge the sands in the winter time. The usefulness of these reservoirs is limited by their capacity to hold enough water to tide over years of drought when the flood waters of the river are of short duration or absent entirely.

2. RAINFALL AND RUN-OFF.

The rainfall upon the drainage area tributary to San Diego River is best shown by the map A-15,Exhibit X,Cuyamaca Water Co. This was prepared by careful study of all existing rainfall records throughout the region (See Table 1,Exhibit XI),and shows the positions of lines of equal average annual precipitation. The amount varies from about 10 ins.near the sea coast to 45 ins, at the summit of Cuyamaca Mt. Table I of this report shows the variation of rainfall from year to year at San Diego and Cuyamaca, and Table 2 the monthly variation at typical stations. Annual variations are characterized by extremes of drought and plenty. Periods of three and four years considerable below normal are common. Seventy-three percent of the seasonal precipitation occurs between Dec. 1 and March 31.

Run-off increases in amount with precipitation and the per cent running into streams increases with the depth of precipitation. Map A-15 Exhibit X, shows the various sub-divisions of the drainage area, These are as follows: above Cuyamaca Dam 12 square miles: above Diverting Dam, not including Cuyamaca, 92 square miles; between Diverting Dam and U.S.G.S. Gaging Station at Lakeside, 104 square miles; between the latter point and Old Mission Dam 168 square miles, of which 71 square miles is in San Vicente Cr. and 16 square miles, Los Coches Cr; below Old Mission Dam 55 square miles. Table 3 gives the run-off as observed by the Flume Company at Cuyamaca Dam. Tables 4 to 8 give the run-off by months at Diverting Dam as observed by the Flume Company and Table 9 annual summary. Table 10 gives the run-off at Diverting Dam during the seasons 1905-6 to 1911-12 and Table 11 the same data at

The Government Gaging Station at Lakeside, includein the flume at Los Coches. Table 12 is the Computation of the run-off derived from the drainage area of 104 square miles between these two gaging stations. It will be noted that during the period of record this was 47% above normal according to the 19 year record at Cuyamaca Dam, and the run-off has been corrected accordingly to obtain normal conditions. The data indicates an average run-off fro Cuyamaca of 354 ac. ft. per square mile; for Diverting Dam, exclusive of Cuyamaca, of 137 ac. ft per square mile; and between Diverting Dam and Lakeside 80 ac. ft. per square mile.

The relation of average precipitation and average run-off is shown in Table 13. Values of precipitation were obtained from Map A-15, Exhibit X by planimeter measurement of the areas included between lines of equal rainfall. The per cent of runpoff for Cuyamaca is 19, for Diverting Dam exclusive of Cuyamaca 9.8, between Diverting Dam and Lakeside 7.6. Gagings have been made at Old Mission Dam and Murray Canyon since May 1912, but they do not cover the flood flow period December to April. (See Table 14). The runpoff factors for these lower areas and for san Vicente and Los Coches Crs. have been assumed after study of the contralling factors. Table 13 gives these, and the run-off computed from the average mean precipitation.

The critical periods are the years of drought. Then the percentage of run-off is less than average as well as the rainfall. Diagram I has been prepared from the data of Tables 1,3,9 and 13 showing the run-off in ac. ft. per square mile for varying character of rainfall years. It will be noted that the observations are scattered. This is due to the annual holdover effect, of extreme rainfall conditions upon

run-off. In general it can be said that there will be no run-off from Cuyamaca drainage if precipitation is 35% of normal or less. This condition has never occured at Cuyamaca, the nearest approach being 1893-4 when the rainfall was 37% of normal and run-off 60% of normal, The preceeding years were all normal or above, so that the run-off conditions were favorable. Run-off from the area above Diverting Dam is practically zero for rainfall years which are 50% of normal or less. Nine such seasons have occured at San Diego in 62 years, includeing in the count years a few per cent above 50% which follow dry years. Run-off above Diverting Dam would not be of any material assistance in re-charging the lower ground-water reservoirs unless the rainfall was greater than 60% of normal. In 62 years there have been 15 years with 60% or less. Therefore one year in four the run-off from above Diverting Dam is negligable as a source of ground-water supply below Monte contraction.

Run-off from the area between Diverting Dam and Lakeside is zero for rainfall years, 55% of normal or less. Eleven such years occured in 62 years of record at San Diego. The run-off would be too small to be effective unless the rainfall year was better than 60% of normal. Hence one year in four the run-off from this area is negligable as a ground-water supply below Riverview contraction. The run-off from San Vicente Cr. is zero for 60% rainfall or less and is negligable for years up to 65%, 19 of which occured in 62 years, or one in three. The dry years do not occur at regular intervals, there having been periods of eight years of plenty, (1904-5 to date),but when they do come they are often consecutive. There have occured in the last 62 years one series of four consecutive years which can be considered as below 60% in rainfall, two series of three years, and three series of two years. The four year series is too remote a possibility to draw conclusions from. It can be said however, that every thirty years a series of three consecutive years with rainfall below 60% can be expected, and every twenty years a series of two such consecutive years. Hence the ground-water supply of basins below the contraction at the Government Gaging Station at Lakeside is limited to the amount which the basins can supply during a period of three consecutive years without being recharged from any source but direct rainfall and seepage from the adjacent hillsides and mesa land.

3. CUYAMACA WATER COMPANY SUPPLY.

The supply delivered at meter which will meet all demands of present consumers is 256 M. I. continuous flow or 3702 ac. ft.per annum. (See Exhibit XI Page 12). With present distribution system in good condition, transmission and distribution losses represent 25% of the amount diverted at the head of the flume. With a system constructed on modern lines the total losses might be reduced as low as 10%, ~~##~~ but 15% will be assumed here. To supply 3702 ac. ft. per annum with 25% loss requires 4040 ac. ft. at Diverting Dam, and with 15% loss requires 4355 ac. ft. In addition the Indians require about 290 ac. ft. per year from which there is practically no loss.

The yield of the existing system at the Diverting Dam in years of ordinary drought such as 1901-2 when run-off was 36% of normal is 3700 ac. ft. Therefore to perfect the supply an amount equivalent to the transmission and distribution losses plus the Indian consumption is needed, namely 1530 ac. ft. per annum with the present system in first class repair or 945 ac. ft. with concrete conduct and new distribution system.

The waste of flood water at Diverting Dam during the last 14 years is shown on Tables 4 to 6 and was 79% of the total run-off exclusive of Cuyamaca. It amounted to 10,200 ac. ft. per annum during the whole 14 year period and in both 1905-6 and 1906-7 was over 28,000 ac. ft. During three years of the period it was practically zero.

By reference to the Cuyamaca and Diverting Dam mass curves(Index Nos. 1.014 B and 1.026 Exhibit X) it will be seen that there is a period of seven years drought 1897-8 to 1903-4 inclusive. The safe net yield of San Diego River at Diverting Dam not including losses in storage would have been 4100 ac. ft. per annum with 9200 ac. ft. storage capacity and full reservoirs to start with in 1897 and the storage of every drop of water during the whole period. Additional storage capacity of 9200 ac. ft. above Diverting Dam would therefore carry the flume though the drought provided there was no reservoir loss by evaporation. This loss is so great in Southern California that it is impossible to ~~dsyy~~ carry hold-over storage for more than three or four years. The waste during the period was 10,200 ac. ft. or about two years supply. It can be said that with from 10 to 15,000 ac.ft. storage capacity above Diverting Dam, full reservoirs in 1897, and so located as to catch all run-off, that the existing flume could have delivered a full supply to all its present consumers during five years out of the seven. With modern conduit and distribution system, allowing 15% loss in transit, 10,000 ac. ft. storage would have tided over the drought. There is 10,000 [ac.] ft. storage capacity above the flume which can be developed at a reasonable cost.

During the whole seven year period however, there would not have been any flood water passing Diverting Dam. Furthermore in only two years of the period, 1900-1 and 1902-3 would any flood waters have originated in the areas below Diverting Dam. The extent to which these flood waters would have recharged the sands if they had been depleted by pumping during the preceeding years is unknown, but they certainly would not have brought ground-water levels completely back to normal. Hence surface storage for the purpose of perfecting the flume supply would make possible a period of seven years, during five of which there would be no flood waters to recharge the ground-water basins below U.S. Gaging Station, and during two of which there would be partial recharging

4. THE RIPARIAN SUPPLY.

There are possibly six ground-water reservoirs along the San Diego River, four of which are above Mission Dam. (See accompanying map, Plate I) The first one extends from Cape Horn Point, 10.5 miles below Diverting Dam, to the Monte contraction, a distance of 3.35 miles; the next from Monte contraction to U.S.G.S. Gaging Station at Lakeside a distance of 1.27 miles; the third from Lakeside to Riverview contraction, 2.75 miles; the fourth from Riverview contraction to Old Mission Dam. 5.75 miles. The other basins are in Missio n Valley.

The average depth of water bearing material in each is as follows: above Monte contraction 125 feet; between Monte and U. S. Gaging Station 100 feet; Varies from 90 feet just below U. S. Gaging Station to 50 feet at Riverview contraction; below Riverview contraction decreases to about 22 feet at Scripps No. 2 Pumping Plant. The material filling the basins above Lakeside is coarse and yields water readily. The material in

basins below Lakeside has a tendency toward fineness away from the river channel. Silts, although they hold just as much water as the coarse material do not yield it as readily. They, however, constitute an important body of storage material which in a period of drought would yield a steady moderate supply.

The riparian owners in each basin along the river, the area irrigated by each, the additional area they propose to irrigate, (some of which is already under pipe lines), and the amount of water pumped are shown on Table 15. The area irrigated in 1912 was 1033 acres, the additional area planned 4158 acres and the amount of water pumped 5138 ac. ft. Similiar quantities along San Vicente and Los Coches Crs. are presented in Table 16. In Table 17 the data regarding areas is summarized together with the total area of bottom land and irrigable area of bottom and low mesa land. A portion of the Lakeside Farms lies on the slope above the river bottom and this area cannot be classed as bottom land. The ultimate plans for irrigation in the El Cajon basin also contemplate irrigation of considerable mesa land, principally the Scripps property. The total area of irrigable bottom land along the river from Monte contraction to Old Mission Dam is 3460 acres or three times the total area already irrigated. Of this total 61% is in El Cajon Valley.

In San Vicente basin 207 acres are irrigated, and 512 ac. ft. of water is being pumped in 1912. It is proposed to irrigate 365 acres additional. Los Coches basin has 115 ac. irrigated which covers most of the basin. These basins receive their supply from their respective creeks however, and not from the river. Their only relation to the problem in hand is that if depleted they will absorb more from their creek floods and thus reduce slightly the volume of flood waters below Lakeside.

In almost every case the irrigated bottom lands are planted to alfalfa. Table 18 gives data regarding the use of water on various farms. It wil be noted that where large pumping plants are installed much more water is used per acre than for the smaller plants. Thus Johnson's use is 9 ac. ft. per year; Ballentine's 8.70 ac. ft. per year; Gay's 9.50 ac. ft. per year, etc. Although some of this alfalfa is young and requires more water than it will two or three years hence, yet there is always a tendency to use water wastefully when it is cheap and plentiful as under the larger plants. under the smaller plants values runfrom 4 down to 2.15 ac. ft. per annum. Tables 19 and 20 present data regarding the use of water on well established alfalfa in Southern California, under best irrigation practice. The amount necessary where the rainfall is 12 inches, as at Lakeside, does not exceed 2.3 ac. ft. and large yields are obtained. Estimating liberally. 3 ac. ft. per annum per ac. is sufficient water for alfalfa after it has become fully established, on the river bottom lands along San Diego. River. Other crops require less water. Hence the area at present under irrigation along the river will soon require not more than 3099 ac. ft. per annum instead of the 5138 now pumped. The total area of irrigable bottom land will require 10,380 ac. ft. per annum.

The grades of the river bed in the various basins are given in Table 21. Underflow estimates presented in Table 22 are based on the latest results of experiments bySLICHTER and others and give very

reasonalbe results. The average movement of ground-water down stream above and at the Monte contraction is about 2-½ feet per day; at the U.S.G.S. Station about 1 ft. per day; and at Riverview contraction ½ ft. per day. The total underflow at Monte contraction is 904 ac.ft. per annum; at U.S.G.S. Station 405 ac.ft; and at Riverview 50 ac.ft. Hence ground-water levels in any particular basin arepractically independent of levels in any other basin and excessive pumping could be carried on for several years in an upper basin without lowering the gourn-water place in a lower basin. This was actually demonstrated in 1904 when, after five years of pumping, the Monte Pumping Plant lowered the water level so that trees died along the river channel as far as the Governemnt Gagin Station, but not beyond this point.

The evaporation from natural vegetation and moist soil occurs from the trees and shrub growth along the river channed and from cieniegas. The great losses from this cause have been realized only in recent years. The experimints by King,Clements and other American investigators, the German experiments and more particularly the Los Angeles Aqueduct experiments have been cousulted in arriving at proper rates of evaporation along the San Diego River bottom lands. It will be noted (Tabel 24) that the total natural evaporation loss along the river bottom is 3737 ac.ft. per annum of which 2175 ac.ft. or 58 % occurs above the Monte contraction. Most of the latter can be conserved by properly located pumping plants. The evaporation in lower basins is difficult to prevent except by keeping all vegetation cleared from along the river bottom, a procedure which would not be justified. The evaporation and transpiration from pubped water is at present about

50% with the low duty of water that prevails. With a more careful use of water a greater percent would pass out through the vegetation. For a duty of 3 ac. ft. per annum possibly 60% would be lost, and 40% return to the sands.

The volume of ground-water stored in the sands of each basin and available for pumping is rather difficult of estimating without actual test. An attempt has been made however, based on superficial area of porous material, reasonable porosity, a depth of complete depletion of 30 ft. which would mean a depth of water in wells of 40 to 50 ft. when pumping, and a factor of availability to cover the uncertainties of the yield from fine silts, shoaling of impervious formations around the rim, etc. (Table 25). The total volume of available storage in the Monte, Lakeside and El Cajon Valley is 17,450 ac. ft. This is not all within reach of the present pumping plant equipment however.

The ability of the ground-water reservoirs to withstand drought can be measured by comparing total annual losses with the storage capacity. For those basins where pumping plants are well distributed and the depth of porous material at least 50 ft. a large proportion of the storage capacity should be available, as for example in Monte and Lakeside Valleys. A much smaller proportion is available in El Cajon Valley, however, unless the existing pumping plants are moved from year to year. If several years passed without flood water to recharge the sands, and pumping went on, the natural evaporation and underflow from the basins would become less and less and finally cease. With these ideas in mind, Tables 26 and 27 were prepared for the condition that the sands were not recharged from year to year. For the present pumping draft, Monte and Lakeside basins carry a three years supply and

El Cajon Valley two years. For a reasonable duty of water on all lands now irrigated, Monte basin carries a six year supply, and Lakeside and El Cajon three years supply. The supply available to the existing pumping equipment, however, would last only about three years in Monte Valley and two years in Lakeside and El Cajon Valleys. Hence all of the basins are now being pumped more heavily than they can supply during the three year period of drought which occurs once in thirty years even if pumps were lowered so as to draw from a working level of 50 feet. With a reasonable duty of water, the present pump equipment would carry all three basins through a two years drought and by lowering pumps in Lakeside and Monte Valleys and moving the plants to areas of non depleted sands in El Cajon Valley the supply would last three years.

The construction of surface storage reservoirs for the sole use of the Cuyamaca Water Company consumers would increase the period during which no flood waters pass Diverting Dam from three to seven years. The assistance which Diverting Dam flood waste might bring to lower reparian interests in four years out of the seven would be lost. To this extent such reservoirs would injure riparian interests.

5. SUGGESTIONS FOR IMPROVEMENT.

The Cuyamaca Water Company needs an additional supply of not more than 1530 ac. ft. per annum. The riparian interests above Mission Dam require not more than 5,000 ac. ft. per annum for the present irrigated area, which area is slightly in excess of what it should be with the present water-supply conditions. The average annual waste of flood water past Diverting Dam alone, not to consider that originating lower down, is 10,200 ac. ft. An evaporation loss of 2175 ac.ft. per annum occurs above Monte contraction which can be conserved for beneficial use. The total needs are less than 6500 ac. ft. per annum and the total waste much in excess of 12,400 ac. ft. Therefore the water which now wastes is more than twice what is needed by both interests.

Conservation of evaporation. - The logical source of increased supply for the Cuyamaca Water Company is by pumping above the Monte contraction so as to conserve the evaporation loss that occurs there. This loss is 2175 ac. ft. per annum and the additional supply needed by the Company is on the average, 1530 ac. ft. per annum. To operate this ground-water reservoir with the greatest benefit to all interests, the flood waters in years of plenty should be diverted from the river at or near Cape Horn Point and spread all over the floor of the basin on either side of the river channel so as to fill up the sands to maximum level. The level can be six feet higher than the river bed near the channel and possibly fifteen feet higher on the higher ground away from the channel. With this storage reserve and no recharging of the sands for a period of two years the Company could make up all deficiency in gravity supply by pumping above Monte contraction without permanently lowering ground-water levels below normal in the river channel either above or below Monte contraction. Small floods during this period would pass on down to lower riparian basins without loss. If a third consecutive year of drought followed, water levels above Monte contraction would begin to recede below the river bed. If a fourth year of drought occured during which no flood waters originated below Monte contraction (such has occured once in the last 52 years) then a portion of the flood waters originating above Monte would be absorbed in passing through the basin. If the fourth year was a year of plenty, as is most . . . .

probable, there would be enough water to fill up all the depleted ground-water reservoirs.

The only injury that could result to lower riparian interests by the Cuyamaca Water Company developing water above the Monte contraction by pumping would be the possible absorption of small floods in the third and fourth years of drought. This could be entirely eliminated by the construction of a by-pass from Cape Horn Point to Monte contraction of capacity sufficient to carry a flow of water just large enough for lower riparian lands to absorb without waste to the ocean. Such a by-pass could be constructed of concrete at an expense within reason and entirely protect all riparian interests.

Conservation of flood water.- The difficultyof putting waste flood water to beneficial use lies in the fact that the annual run-off is subject to great extremes. Over-year storage is necessary for periods of seven years. The limit of effective over-year surface storage in California and particularly Southern California is three years. Ground-water storage however, is practical for an indefinite peroid. Hence if there is a solution it lies in utilizing ground-water reservoirs

The greatest difficulty in operating ground-water reservoirs is to fill them. Water travels through sand and soil very slowly, and muddy water tends to seal up the surface voids with slime. Hence part of the necessary equipment needed in utilizing groun-water storage on San Diego

River is temporary surface storage which will hold bach a large proportion of ordinary floods fro a few weeks. Silt would settle in such a reservoir and from it water could be liberated in such quantities that maximum recharging of the ground-water basins would result. The dam for such a reservoir need not be water tight, the only requisite would be stability under full head of water. In connection with such storage, provision should be made to spread all flood water over the surface of every basin to the greatest extent possible. This could be done by diverting and spreading river water on waste land, by winter adn spring irrigations with river water, by winter and spring pump irrigating and other methods. Since water moves slowly in the soil it is possible to fill up the land near the rims of the basins to a higher level than the river channel. Such water will gradually move toward the channel and be available for pumping later in the season and during following seasons. With 10,000 ac. ft. or more surface storage the present ground-water storage capacity could be greatly increased in the manner indicated.

The following definite suggestions are made as a basis for an adjustment of conflicting interests of the riparian owners and the Cuyamaca Water Company

1. Cuyamaca Water Company install a pumping plant so located as to conserve the greatest possible amount of the natural evaporation occuring above the Monte contraction.

2. A thorough scientific study be made of the behavior of this basin under pumping and of the per cent of flood waters lost for various stages of ground-water depletion. From such data a level of minimum

depletion be determined for which flood water losses into the basin from the river channel are negligable. If it be found that this level is so shallow that Cuyamaca Water Company could not take advantage of the ground-water storage above Monte contraction, the Company construct a by-pass for flood waters from Cape Horn Point to Monte contraction with a capacity sufficient to carry a volume of water just large enough for lower riparian lands to absorb without waste to the ocean.

3. Construct reservoirs on San Diego River and its tributaries for the purpose of holding glood waters so that they can be let down slowly to fill the ground-water basins. There are several possible sited on San Diego River and its tributaries above Cape Horn Point and at least one on San Vicente Cr. The necessity for such reservoirs is the insufficiency of the present riparian supply and has no connection with the Cuyamaca Water Company situation. The Cuyamaca Water Company would be benefited only to the extent that surfact storage water might be diverted for water spreading purposes above the Monte contraction.

4. Riparian owners and Cuyamaca Water Company study their respective basins, formulated definite plans for storing the maximum possible volume of flood water by water spreading or other means, and provide permanent organization and equipment to accomplish it.

By such means the Cuyamaca Water Company could perfect its supply, the riparian lands now irrigated would have a permanent supply and neither party need injure the other.

Respectfully submitted,

Charles H. Lee

Hydraulic Engineer.

Table 1.

SEASONAL PRECIPITATION -- CUYAMACA & SAN DIEGO.

Authority U. S. Weather Bureau.

Season July 1 to June 30	San Diego		Cuyamaca		Avg of Percentages.
	Inches.	% of Normal.	Inches	% of Normal.	
1850-51	8.41	87			
1-52	9.48	98			
2-53	11.03	114			
3-54	9.77	101			
4-55	13.56	139			
5-56	9.89	102			
6-57	4.76	49			
7-58	7.54	78			
8-59	6.61	68			
9-60	6.58	68			
1860-61	7.90	82			
1-62	15.64	162			
2-63	3.87	40			
3-64	5.14	53			
4-65	8.45	87			
5-66	12.82	132			
6-67	13.73	142			
7-68	11.33	117			
8-69	11.68	121			
9-70	5.48	57			
1870.71	5.17	53			
1-72	7.18	74			
2-73	6.50	67			
3-74	16.83	174			
4-75	5.73	59			
5-76	10.11	104			
6-77	3.75	39			
7-78	16.10	166			
8-79	7.88	81			
9-80	14.36	148			
1880-81	9.66	100			
1-82	9.51	98			
2-83	4.92	51			
3-84	25.97	268			
4-85	8.67	90			
5-86	16.96	172			
6-87	8.32	86			
7-88	9.82	101			
8-89	11.02	114	52.83	135	125
9-90	15.02	155	61.51	157	156

(Continued)

Table 1.

(Continued)

SEASONAL PRECIPITATION -- CUYAMACA & SAN DIEGO

Authority, U. S. Weather Bureau.

Season July 1 to June 30.	San Diego		Cuyamaca		Avg. of Percentages.
	Inches	% of Normal.	Inches	% of Normal	
1890-91	10.47	108	63.84	163	135
1-92	8.70	90	39.61	101	96
2-93	9.26	96	39.21	100	98
3-94	4.97	51	15.05	37	44
4-95	11.90	123	54.78	140	132
5-96	6.21	64	23.38	60	62
6-97	11.78	121	38.96	99	110
7-98	4.99	52	27.69	65	58
8-99	5.24	53	23.35	55	54
9-1900	5.97	62	27.70	65	64
1900-01	10.45	108	42.81	109	108
1-02	6.17	64	36.00	92	78
2-03	11.16	120	37.60	96	108
3-04	4.40	45	23.37	60	52
4-05	14.32	148	57.89	148	148
5-06	14.68	152	56.24	143	147
6-07	10.62	110	44.91	115	112
7-08	8.55	88	30.35	78	83
8-09	10.23	106	45.66	116	111
9-10	9.79	101	33.44	85	93
1910-11	11.99	124	32.15	82	103
11-12	10.75	111	32.02	82	96
Mean	9.68	100	39.18	100	100

Table 2.

PERCENTAGE OF MEAN SEASONAL PRECIPITATIONS OCCURING EACH MONTH FOR TYPICAL SAN DIEGO CO. STATIONS.

Month	San Diego	Cuyamaca	Julian	Escondido	Oceanside	Fallbrook	Poway	Average
July	.6	.7	1.7	0	.2	.2	.3	.5
Aug	1.2	1.6	.2	0	.6	.2	.2	.6
Sept	.8	1.5	.5	.8	.6	.6	.6	.8
Oct	3.6	4.5	3.3	3.7	4.3	4.2	3.6	3.9
Nov	10.0	8.5	8.0	9.5	9.8	8.6	8.7	9.0
Dec	13.1	12.9	7.1	17.9	14.5	16.9	13.5	14.6
Jan	18.4	17.8	20.4	20.6	26.7	19.9	22.8	20.9
Feb	20.5	20.1	17.9	18.2	14.3	19.9	18.9	18.5
Mar	15.5	20.3	23.5	17.9	20.7	17.5	19.0	19.1
Apr	6.4	5.9	10.2	7.6	6.0	7.8	8.1	7.4
May	3.5	5.6	6.9	3.0	2.2	3.6	3.9	4.1
June	.6	.6	.3	.5	0	.6	.5	.4
Total	100	100	100	100	100	100	100	
Pct. of Months	9.56	39.26	26.30	15.76	10.72	17.03	13.97	
Seasons	54-09	87-09	80-09	75-11	92-12	77-03	78-09	

Table 3.

YIELD OF CUYAMACA RESERVOIR AND RUN-OFF FROM TRIBUTARY DRAINAGE AREA,

(12 sq. Mi.) Values are in Acre Ft. and were computed from original records at Cuyamaca Reservoir.

Season Jul 1, to June 30th	Draft and *waste from Reservoir	Volume Water in reservoir July 1	Reservoir Accumulation or Depletion	Evaporation & Percolation Loss	Total run off	Run off per Sq. Mi.	Percent each seasons run-off bears to 19 year mean.
93-94	2438	6110	-3614	3683	2563	214	60
94-95	2565	2496	+5359	3973	11279	941	266
95-96	2984	8855	-5828	4891	2152	179	51
96-97	2023	3027	- 362	2531	4216	351	99
97-98	1741	2665	-2544	1627	834	69	20
98-99	335	121	- 121	258	472	39	11
99-00	55	0	0	78	260	22	6
1900-01	492	0	+1549	971	3031	253	72
01-02	1403	1549	- 470	1401	2351	196	55
02-03	1081	1079	+ 207	1172	2516	209	59
03-04	1257	1286	-1268	462	492	41	12
04-05	45	18	+5449	1337	6831	568	160
05-06	3329	5467	+5905	3536	12780	1065	301
06-07	4742	11372	- 159	4569	9259	772	218
07-08	2033	11213	-3562	4610	3201	267	75
08-09	3157	7351	+ 550	3469	7172	598	169
09-10	4210	8181	-2441	3316	5154	428	121
1910-11	4031	5740	-3008	1800	2765	231	65
11-12	1486	1852	+ 684	1496	3520	293	83
12-13	--	2468	--	--	--	--	--
Period	2110	--	- 243	2381	4250	354	100

19 year average run-off - 3.9 sec. Ft. - 0.49 M. F. per sq. Mi.
19 " " draft and waste - 2.9 sec. Ft.
19 " " loss - 3.3 sec. Ft.

Loss in storage 56% of run-off. * Total waste in 19 years - 5687 Ac. Ft., 1610 Ac. Ft. in Jan 1895, 769 Ac. Ft. in Apr to June 1906., and 3248 Ac. Ft. Mar to May 1907. This is 7% of the total 19 year run-off.

Table 4.

MONTHLY DISCHARGE SAN DIEGO RIVER AT DIVERTING DAM.

Including Cuyamaca Draft at Mouth Boulder Cr.
Observations by Flume Company.

Month	FLUME Sec. Ft.	FLUME Ac. Ft.	WASTE Sec. Ft.	WASTE Ac. Ft.	TOTAL DISCHARGE Sec. Ft.	TOTAL DISCHARGE Ac. Ft.
Season 1898-1899						
July	(0.4)	(24)	0	0	(0.4)	(24)
Aug	0	0	0	0	0	0
Sept	0	0	0	0	0	0
Oct	0	0	0	0	0	0
Nov	0	0	0	0	0	0
Dec	0	0	0	0	0	0
Jan	(0)	(0)	0	0	(0)	(0)
Feb	1.7	94	0	0	1.7	94
Mar	8.2	503	0	0	8.2	503
Apr	6.72	400	0	0	6.72	400
May	2.27	140	0	0	2.27	140
June	.96	57	0	0	.96	57
Season	1.69	122	0	0	1.69	122
Season 1899-1900.						
July	0	0	0	0	0	0
Aug	0	0	0	0	0	0
Sept	0	0	0	0	0	0
Oct	0	0	0	0	0	0
Nov	0	0	0	0	0	0
Dec	0	0	0	0	0	0
Jan	1.88	116	0	0	1.88	116
Feb	0.58	32	0	0	0.58	32
Mar	0.84	51	0	0	0.84	51
Apr	3.05	181	0	0	3.05	181
May	4.63	284	0	0	4.63	284
June	0.003	0.2	0	0	0.003	0.2
Season	0.92	665	0	0	0.92	665
Season 1900-1901.						
July	0	0	0	0	0	0
Aug	0	0	0	0	0	0
Sept	0	0	0	0	0	0
Oct	0	0	0	0	0	0
Nov	0.55	33	0	0	0.55	33
Dec	0.22	13	0	0	0.22	13
Jan	2.98	182	0	0	2.98	182
Feb	11.40	633	32.4	1799	43.80	2432
Mar	10.50	645	0.66	41	11.16	686
Apr	6.67	396	.21	13	6.88	409
May	5.60	344	1.22	75	6.82	419
June	5.68	337	0	0	5.68	337
Season	3.6	2504	2.9	1928	6.5	4513

Table 5.

MONTHLY DISCHARGE SAN DIEGO RIVER AT DIVERTING DAM.

Including Cuyamaca Draft at Mouth Boulder Cr.
Observations by Flume Company.

Month	FLUME Sec. Ft.	FLUME Ac. Ft.	WASTE Sec. Ft.	WASTE Ac. Ft.	TOTAL DISCHARGE Sec. Ft.	TOTAL DISCHARGE Ac. Ft.
Season 1901-1902.						
July	7.20	442	0	0	7.20	442
Aug	8.44	519	0	0	8.44	519
Sept	.01	0	0	0	.01	0
Oct	0	0	0	0	0	0
Nov	0	0	0	0	0	0
Dec	0	0	0	0	0	0
Jan	0.33	20	0	0	.33	20
Feb	1.91	106	2.89	160	4.80	266
Mar	10.80	660	33.40	2050	44.20	2710
Apr	9.42	558	4.75	281	14.17	839
May	5.24	322	0	0	5.24	322
June	5.66	337	0	0	5.66	337
Season	4.1	2964	3.4	2492	7.5	5456
Season 1902-1903						
July	5.88	362	0	0	5.88	362
Aug	2.78	171	0	0	2.76	171
Sept	0	0	0	0	0	0
Oct	0	0	0	0	0	0
Nov	0	0	0	0	0	0
Dec	2.2	14	0	0	2.2	14
Jan	0.9	58	0.1	6	1.0	64
Feb	12.6	702	12.0	664	24.6	1365
Mar	12.3	753	31.4	1930	43.7	2683
Apr	12.5	744	47.4	2618	59.9	3362
May	10.4	638	0.5	32	10.9	669
June	7.0	413	0	0	7.0	413
Season	5.5	3854	7.6	5450	13.1	9304
Season 1903-1904						
July	7.2	430	0	0	7.2	439
Aug	5.0	304	0	0	5.0	304
Sept	0	0	0	0	0	0
Oct	0	0	0	0	0	0
Nov	0	0	0	0	0	0
Dec	0	0	0	0	0	0
Jan	0	0	0	0	0	0
Feb	0	0	0	0	0	0
Mar	3.1	188	5.5	358	8.6	526
Apr	5.8	346	0	0	5.8	346
May	0.9	57	0	0	0.9	56
June	0	0	0	0	0	0
Season	1.8	1354	5.5	358	2.3	1672

Table 6.

MONTHLY DISCHARGE SAN DIEGO RIVER AT DIVERTING DAM

Including Cuyamaca Draft at Mouth Boulder Cr.
Observations by Flume Company.

Month	Flume Sec. Ft.	Flume Ac. Ft.	Waste Sec. Ft.	Waste Ac. Ft.	Total Discharge Sec. Ft.	Total Discharge Ac. Ft.
			Season 1904-1905			
July	0	0	0	0	0	0
Aug	0	0	0	0	0	0
Sept	0	0	0	0	0	0
Oct	0	0	0	0	0	0
Nov	0	0	0	0	0	0
Dec	0	0	0	0	0	0
Jan	1.0	61	0.2	12	1.2	73
Feb	11.1	613	62.6	3473	73.7	4086
Mar	5.2	318	173.1	10970	178.3	11289
Apr	10.5	626	34.2	2029	44.7	2655
May	9.5	585	39.2	2408	40.7	2989
June	10.2	606	6.4	383	16.6	989
Season	3.9	2809	26.3	19273	36.3	22081
			Season 1905-1906			
July	8.9	548	0	0	8.9	548
Aug	9.0	550	0	0	9.0	550
Sept	10.9	649	0	0	10.9	649
Oct	8.4	518	0	0	8.4	518
Nov	2.1	125	61.9	3678	63.8	3802
Dec	3.1	192	.8	48	3.9	240
Jan	8.4	515	5.6	347	14.0	860
Feb	8.8	489	38.3	2125	47.1	2614
Mar	10.0	611	288.3	17669	298.3	18280
Apr	11.3	672	72.7	4321	84.0	4993
May	9.2	568	20.7	1270	29.9	1837
June	11.9	706	11.4	676	23.3	1382
Season	8.5	5141	41.6	30144	50.1	35275
			Season 1906-1907			
July	11.80	723	.72	44	12.52	767
Aug	11.10	682	4.52	277	15.62	959
Sept	10.50	623	0.33	19	10.83	642
Oct	9.97	613	.05	3	10.02	616
Nov	8.35	495	.34	20	8.69	515
Dec	3.98	245	18.65	1145	22.63	1390
Jan	3.21	197	103.0	6320	106.21	6517
Feb	3.22	179	50.2	2780	53.42	2959
Mar	4.55	279	135.5	8300	140.05	8579
Apr	7.34	437	108.30	6440	115.64	6877
May	8.45	519	28.70	1764	37.15	2283
June	10.30	613	26.90	1597	37.2	2210
Season	7.7	5606	39.7	28709	47.4	34315

Table 7.

MONTHLY DISCHARGE SAN DIEGO RIVER AT DIVERTING DAM

Including Cuyamaca Draft at Mouth Boulder Cr.
Observations by Flume Company.

MONTH	Flume Sec.Ft.	Flume Ac.Ft.	Waste Sec.Ft.	Waste Ac.Ft.	Total Discharge Sec.Ft.	Total Discharge Ac.Ft.
			Season 1907-1908			
July	11.3	696	0.01	1	11.31	696
Aug.	11.4	701	0	0	11.4	701
Sept.	11.1	660	0	0	11.1	660
Oct.	9.59	588	4.3	264	13.89	852
Nov.	6.18	366	6.56	389	12.74	755
Dec.	7.87	483	13.52	830	21.39	1313
Jan.	8.2	503	8.8	542	17.0	1045
Feb.	7.6	436	53.3	3063	60.9	3499
Mar.	7.5	458	21.0	1295	28.5	1753
Apr.	11.2	664	9.1	545	20.3	1209
May	10.8	663	4.5	274	15.3	937
June	11.8	703	0.02	1	11.82	704
Season	9.5	6920	10.0	7205	19.5	14124
			Season 1908-1909			
July	12.20	748	0.26	16	12.46	764
Aug.	10.9	672	0.44	27	11.34	699
Sept.	10.3	611	0.04	3	10.34	614
Oct.	9.8	604	0.17	10	9.97	614
Nov.	8.6	511	0.05	3	8.65	514
Dec.	4.7	291	0.17	10	4.87	301
Jan.	7.7	476	42.2	2587	49.90	3063
Feb.	1.4	77	134.2	7440	135.60	7517
Mar.	3.4	208	55.5	3405	58.90	3613
Apr.	5.7	337	35.7	2120	41.40	2457
May	11.3	692	18.5	1132	29.80	1824
June	10.0	595	0.27	16	10.27	611
Season	8.0	5822	24.0	16770	32.0	22592
			Season 1909-1910			
July	10.3	630	0.37	23	10.67	653
Aug.	8.4	517	0.8	48	9.2	565
Sept.	8.6	512	0.16	6	8.76	518
Oct.	8.2	502	0	0	8.2	502
Nov.	6.5	388	1.57	94	8.07	481
Dec.	9.9	481	24.1	1478	32.0	1964
Jan.	2.1	130	93.9	5760	96.01	5890
Feb.	5.3	295	20.3	1127	25.60	1422
Mar.	8.1	497	23.9	1468	32.001	1965
Apr.	9.3	553	18.3	1087	27.60	1640
May	10.6	649	0.98	60	11.58	709
Jun.	11.0	654	0	0	11.00	654
Season	8.0	5812	15.4	11181	23.4	16993

Table 8.

MONTHLY DISCHARGE SAN DIEGO RIVER AT DIVERTING DAM

Including Cuyamaca Draft at South Boulder Cr.
Observations by Flume Company.

Month	Flume Sec. Ft.	Flume Ac. Ft.	Waste Sec. Ft.	Waste Ac. Ft.	Total Discharge Sec. Ft.	Total Discharge Ac. Ft.
Season 1910-1911						
July	11.8	727	0.02	12	11.82	739
Aug.	12.4	763	0.03	2	12.43	764
Sept.	12.2	727	0.4	24	12.6	751
Oct.	9.8	600	0.15	10	9.95	610
Nov.	7.3	435	0.08	5	7.38	440
Dec.	7.1	438	0.05	3	7.15	441
Jan.	8.1	495	7.1	438	15.2	933
Feb.	7.7	426	48.9	2715	56.6	3141
Mar.	3.8	238	27.9	1873	31.7	2111
Apr.	8.1	483	13.6	804	21.6	1287
May	9.1	559	0.15	11	9.28	570
June	5.7	337	0	0	5.7	337
Season	8.6	6228	8.2	5896	16.8	12124
Season 1911-1912						
July	5.0	306	0	0	5.0	306
Aug.	5.5	396	0	0	6.5	395
Sept.	4.8	286	0	0	4.8	286
Oct.	0.14	9	0	0	0.14	8
Nov.	0.0	0	0.01	1	0.01	1
Dec.	0.19	12	0	0	0.19	12
Jan.	1.28	78	0	0	1.28	78
Feb.	1.78	102	0	0	1.78	102
Mar.	10.1	622	50.29	3090	60.39	3712
Apr.	10.7	638	158.80	9439	169.47	10077
May	8.8	540	21.72	1334	30.52	1874
June	9.15	545	.08	5	9.23	550
Season	4.9	3544	19.2	13868	24.1	17412

Table 9.

SEASONAL DISCHARGE SAN DIEGO RIVER AT DIVERTING DAM

Exclusive of Cuyamaca Run Off Area of
Drainage — 92 Sq. Mi.

Season Jul. 1 to Jun. 30	Observed Run Off San Diego River at Diverting Dam: Ac. Ft. per Sq. Mi.	Observed Run Off San Diego River at Diverting Dam: Percent of 13 yr mean	Percentage Observed Seasonal run off to 19 yr mean at Cuyamaca Dam	Computed Run Off San Diego River at Diverting Dam: Ac.Ft. per Sq. Mi.	Percent of 19 yr Mean	Aggregate Run Off Per Sq. Mi. for Mass Curve
1893-1894	-	-	60	82	60	82
1894-1895	-	-	266	366	264	448
1895-1896	-	-	51	70	51	518
1896-1897	-	-	99	136	99	654
1897-1898	-	-	20	38	20	692
1898-1899	11	8	11	-	-	703
1899-1900	7	5	6	-	-	710
1900-1901	47	35	72	-	-	757
1901-1902	50	36	55	-	-	807
1902-1903	91	66	59	-	-	898
1903-1904	8	6	12	-	-	906
1904-1905	240	174	150	-	-	1146
1905-1906	363	264	301	-	-	1509
1906-1907	324	248	218	-	-	1833
1907-1908	137	100	75	-	-	1970
1908-1909	225	164	169	-	-	2195
1909-1910	148	108	121	-	-	2343
1910-1911	91	66	88	-	-	2434
1911-1912	176#	130	92	-	-	2610
Total	-		*			
Mean	°137°		100			

* The 14 year observed mean at Cuyamaca for seasons 1898 to 1911-12 equals that for the 19 season period 1893-94 to 1911-12. Hence assumed same relations at Diverting Dam.

° 137 Ac. Ft. per Sq. Mi. = 0.19 S.F. per Sq. Mi., Average total Yield = 17.8 S. F.

\# The accuracy of this value is questioned. The April floods were allowed to pass through the waste gates of the dam and were observed and reported upon by an inexperienced gate tender. His estimates vary from 1500 to 15000 M.I. during the month the latter exceeding the capacity of the Gates.

Table 10.

DISCHARGE OF SAN DIEGO RIVER AT DIVERTING DAM

Including Cuyamaca Draft at Mouth Boulder Cr.

Gage reading by Flume Co., rating by U.S.G.S. Values in Acre-Feet.

Month	SEASON						
	1905-06	1906-07	1907-08	1908-09	1909-10	1910-11	1911-12
July	548	768	696	764	683	739	506
Aug	550	960	701	699	565	765	596
Sept	649	642	660	614	518	751	286
Oct	518	616	882	614	502	610	9
Nov	3802	515	755	514	481	440	1
Dec	241	1390	1312	301	1964	441	12
Jan	860	6517	1045	3064	5890	933	78
Feb	2614	2959	5499	7517	1422	3141	108
Mar	18280	8579	1753	3613	1965	2111	3712
Apr	4993	6877	1209	2457	1640	1287	10076
May	1838	2283	937	1624	709	570	1874
June	1382	2210	704	611	654	337	550
Total Ac. Ft.	36275	34313	14124	22592	16965	12124	17412
Mean Sec. Ft.	50.1	47.4	19.5	31.2	23.4	16.8	24.1

Table 11.

DISCHARGE OF SAN DIEGO RIVER AT LAKESIDE

Including San Diego Flume at Los Coches

Measurements by U.S.G.S. -- Values in Acre-Feet.

Month	SEASON						
	1905-06	1906-07	1907-08	1908-09	1909-10	1910-11	1911-12
July	(495)	580	627	405	640	495	215
Aug.	(443)	509	546	443	1450	409	319
Sept.	(446)	482	347	446	440	506	101
Oct.	(416)	388	408	416	360	447	5
Nov.	(1060)	225	200	311	280	287	0
Dec.	(1120)	649	209	163	1930	307	8
Jan.	1309	11584	1345	9530	9752	621	43
Feb.	2644	5030	4090	15800	2845	5200	52
Mar.	42180	18104	2920	7620	2831	4970	4722
Apr.	17018	9804	1242	4970	2374	2100	6612
May	4722	3502	673	1000	470	569	2060
June	1374	1455	437	375	517	249	383
Total Ac. Ft.	73317	49615	14057	42040	24079	16231	15602
Mean Sec. Ft.	101.3	68.7	19.4	59.4	33.3	22.4	21.6

Table 12.

COMPUTATION OF RUN-OFF FROM DRAINAGE AREA TRIBUTARY TO SAN DIEGO RIVER BETWEEN DIVERTING DAM AND LAKESIDE.

Season	Discharge San Diego R. at Div. Dam incl. Cuyamaca Draft		Discharge San Diego R. at Lakeside incl. San Diego flume.		Discharge of San Diego R. at Lake-Side derived from 104 Sq.mi. below Div Dam.		% of each years run-off at Cuyamaca to 19 yr. mean.
	Sec. Ft	Ac.Ft.	Sec.Ft	Ac.Ft	Sec.Ft.	Ac. Ft.	
1905-6	50.1	36275	101.3	73317	51.3	37042	301
1906-7	47.4	34313	68.7	49615	21.3	13302	218
1907-8	19.5	14124	19.4	14057	0	0	75
1908-9	32.0	23160	59.4	42949	27.4	19781	169
1901-10	23.4	16963	33.3	24079	9.9	7116	121
1910-11	16.8	12124	22.4	16221	5.6	4097	65
1911-12	#24.1	#17412	21.6	15602	2.5	1792	83
Period	29.8	21540	46.6	33691	16.7	12163	147
Computed 19 year normal	----	-----	31.7	22950	11.3	8270	100
Normal Run-off per sq.mi.	0.19	137	0.152	110	0.109	79.5	

The accurracy of this value is questioned, 19.1 s.f.-13810 ac.ft. was used in this table. C.H.L.

Table 13.

AVERAGE PRECIPITATION AND RUN-OFF for DRAINAGE AREAS TRIBUTARY TO SAN DIEGO RIVER.

Drainage Basin	Elevation of Outlet Feet.	Area in Aq.Mi.	Average Mean Annual Precipitation from ischyetose Map. Inches	Ac.Ft.	Mean Annual Run-off for period 1893-4 to 1911-12 Ac.Ft.	Ac.Ft. per sq.mi.	Percent Run-off to Rainfall.
Above Cuyamaca Dam	4600	12	35	22,400	4250	#354	19.0
Above Diverting Dam exclusive of Cuyamaca	800	92	26.2	128,400	12.630	"137	9.8
Between Diverting Dam & U.S.G.S. Gaging Sta. at Lakeside	408	104	19.5	108,000	8.270	' 80	7.6
Between U.S.G.S. Gaging Sta. & Old Mission Dam	275	168	12.5	121,000	6,320	38	(5.2)
Between Old Mission DAM & Murray Canyon	25	55	10.0	29.300	879	16	(3.0)
San Vicente Cr.	400	71	15.6	59.100	4,020	57	(6.8)
Los Coches Cr.	400	16	13.8	10,900	660	43	(6.0)

Sec.Table No.3.
" " " No.9.
' " " No.12.
Values in parenthesis estimated.

Table 14. 1911-12

DISCHARGE AND RUN OFF IN SEC. FT. SAN DIEGO RIVER AT FOUR STATIONS.

SEASONS 1911-12	Diverting Dam: Flume	Diverting Dam: Surplus River Flow	Lakeside: Surplus River Flow		Near Santee: River Flow	Near Santee: Diff with Lakes Surp	Near San Diego: River flow into Ocean	Diff with Santee
July	5.0	0	0		0*	0*	0*	0*
Aug.	6.5	0	0		0*	0*	0*	0*
Sept.	4.8	0	0		0*	0*	0*	0*
Oct.	0.1	0	0		0*	0*	0*	0*
Nov.	0	0	0		0*	0*	0*	0*
Dec.	0.2	0	0		0*	0*	0*	0*
Jan.	1.3	0	0		0*	0*	0*	0*
Feb.	1.8	*0	0*		0*	0*	0*	0*
Mar.	10.1	50.3	77.5	r-674	7[illegible].3*	+0.8*	81.5*	+3.2*
Apr.	10.7	158.8	121.5	r-2.80	121.0*	-0.5*	135*	+14.0*
May	8.8*	22.0	35.0		39.0	+4.0	41	+2
June	9.2	0.1	0.5		3	+2.5	0	-3
Mean Sec.Ft.	4.87	19.21	19.5		20.1	-.566	21.41	+1.35
Total Ac.Ft.	3,640	13,900	14,150		14,660	-410	15,520	960

Note: Values marked * are interpolated by proportion from Diverting Dam and Lakeside discharges. - r = ration between months of known discharge.

a (23.5 from Cuyamace W Co - gal daily reduced to sec ft
(Kutters formula
(30.6 U.S. Rating table and gage heights
(S.S. Cuyamace W. Co. Rating table and Gage Heights.

Cuyamaca Water Co
514 Am Natl Bk

Table 15.

APPROXIMATE DATE REGARDING RIPARIAN LANDS

ALONG SAN DIEGO RIVER

Obtained from Alverson report July 1912 and personal examination by C. H. Lee, Sept. 1912.

Owner	Area Irrigated Acres	Additional Acres Expect to Irrigate Acres	Amount of Water Pumped 1912 Ac. Ft. per Annum
MONTE VALLEY			
Monte Ranch	15		---
John Gay	55	70	704
J. H. Birch	0	12	0
Ira Philbrook	0	42	0
Ireys	0	150	0
Total	70	274	704
LAKESIDE VALLEY			
G. G. Nelson	0	39	0
Grover Philbrook	20	0	(50)
Melville "	28	12	70
Jas. Williams	10	0	22
A. H. DeGaston	0	5	0
L. Kirckpatrick	4	5	(10)
J. C. Brockway	6	0	(15)
McClain	10	30	(25)
Whittaker & Langton	107	22	(25)
Griffin & Thompson	18	450	(45)
Thum Bros.	40	60	136
T. L. Barnes	75	0	126
H. W. Chase	7.5	7.5	30
Lakeside Farms	380	330	1082
J. Johnston	100	225	900
Total	708	1185	2536
EL CAJON VALLEY			
James Ballantine	35	165	312
Kinney	50	250	360
H. D. Williamson	85	369	476
E. W. Scripps	85	1915	750
Total	255	2699	1898
Grand Total	1033	4158	5138

Values in parenthesis estimated amount of water used per ac. assumed 2.5 ac. ft.

Table 16.

APPROXIMATE DATA REGARDING RIPARIAN LAND

ON SAN VICENTES AND LOS COCHES CRS.

Obtained from personal examination by C.H.Lee, Sept. 1912.

Owner	Area Irrigated Acres	Additional Area Expect to Irrigateacres	Amount of Water* Pumped 1912 Ac. Ft. per annum
SAN VICENTES			
Starriet	(10)	---	25
D. W. Ehlers	6	12	15
C. F. Bresee	0	26	10
E. W. Taylor	6	2	15
Schuyler	0	12	0
Percy DeGaston	7	8*	18
Ott	22	20*	55
J. F. Lamond	4	3	10
D. N. Downing	30	3	75
Wm. Kuhner	6	6	15
Paul Schultz	0	8	0
Stedman	18	0	45
Vertrees	2	100	0
Laws & Griffith	0	175	0
Foster	1	15	2
Above Foster's	20	60	50
EL CAJON VALLEY Company	0	---	0
Lucas	0	45	0
Tibbetts	5	10	12
Ostrich Farm	30	30	75
White	40	20*	100
Mrs. Melville	0	10	0
Total	207	565	512
LOS COCHES Below Gays P.Pl.	115	---	(200)

*Hill and mesa land

*Values estimated by assuming amount of water used per ac. in San Vicente basin 2.5 Ac.ft and in Los Coches 1,75 ac.ft.

Table 17.

APPROXIMATE AREA OF BOTTOM AND MESA LAND

IRRIGABLE FROM GROUND-WATER BASINS IN

THE VALLEY OF THE SAN DIEGO RIVER

Values in Acres.

Ground Water Basin	Total Area Bottom Lands	Area Irrigable Bottom Lands	Area Irrigable Los Mesa Lands	Area Irrigated in 1912	Non-irrigated Lands to be Irrigated in Near future
Cape Horn Point to Monte Contraction	880	750	0	15	------
Monte Contraction to U.S.G.S.Gaging Station.	425	360	-	55	274
U.S.G.S.Gaging Station to Riverview Contraction	1150	975	(850)	708	1185
Riverview Contraction to Old Mission Dam	(2500)	(2125)	(1500)	255	2699
San Vicente	704	650	---	197	565
Los Coches	128	115	---	115	---

Table 18.

VOLUME OF WATER USED PER ACRE PER ANNUM FOR

IRRIGATION BOTTON LANDS ALONG SAN DIEGO RIVER.

Pumping Plant	Crops	Area Irrigated Acres	Volume of Water pumped per annum Ac. Ft.	Amount of Water used per acre per annum Depth	Ac. Ft.
E. W. Scripps No.1	Alfalfa	40	150	3.75	3.75
H.D.Williamson	Alfalfa & Corn	85	476	5.60	5.60
Kinney & Chelsy	Alfalfa	50	300	6.00	6.00
James Ballantine	Alfalfa	35	312	8.70	8.70
J. Johnston	Alfalfa	100	900	9.00	9.00
Hugo Thum	Alfalfa	136	40	3.40	3.40
John H. Gay	Alfalfa	55	526	9.50	9.50
H. W. Chase	Alfalfa	7.5	30	4.00	4.00
G. E. Philbrook	Alfalfa	25	54	2.15	2.15
M. Philbrook	Alfalfa	28	70	2250	2.50
Jas. Williams	Alfalfa	10	22	2.20	2.20
Lakeside Farms	Alfalfa vege-tables,ect.	150 250	1082	2.85	2.85

The data for this table was obtained from Report of C. S. Alverson, C.E., July 1912 to Railroad Commission regarding ground-water supply along San Diego River.

Examination of Tables 19 and 20 show that with best irrigation pratcice alfalfa in So. Calif. is receiving between 2 and 2.5 ac.ft per ac. per year where the annual precipitation is 12 ins. at Lakeside.

Table 19.

AMOUNT OF WATER REQUIRED BY ALFALFA

Copied from Farmers. Bu. 373 U.S. Dept. Agriculture.

"Irrigation of Alfalfa" by Samuel Fortier

---0---

Alfalfa requires more water than most crops. This is readily accounted for by the character of the plant, the rapidity with which it grows, the number of crops produced in one season, and the heavy tonnage obtained.

As a result of careless practice there is a lack of uniformity in the quantity of water used, the volumes applied frequently being far in excess of the needs of the crop. The majority of the records collected and published by this office show a yearly duty of water for alfalfa ranging from 2.5 to 4.5 feet in depth over the surface, while in quite a large number of cases the volume applied would have covered the area irrigated to depths of 6 to 15 feet.

From the large number of measurements made on the duty of water it is possible to select some that possess great value, since they indicate what can be accomplished with a given quantity of water.

During the session of 1904 careful measurements were made by C. E. Tait of this Office, of the amount of water used on alfalfa fields in the vicinity of Pomona, Cal. The rainfall at Pomona for the winter of 1903-4 was much below the normal and amounted to about 9.1 inches. The quantity of irrigation water applied by pumping averaged 2.3 feet in depth and the yield of cured hay averaged from 1 to 1.5 tons per acre per crop, five or six crops being common. These figures are corroborated by many others collected in Southern California. Perhaps in no other locality of the arid region is a greater tonnage of alfalfa obtained, yet in a climate of scanty rainfall having a long, dry, hot summer only a comparatively small amount of water is used. About a third of the 9,000 acres irrigated by the Riverside Water Company is in alfalfa, and for the past seven years the average depth applied has been 2.31 feet, while the depth of rainfall and irrigation water combined has averaged 3.16 feet..

The best practice of southern California may be assumed up by stating that in localities having an annual rainfall of about 12 inches remarkably heavy yields of alfalfa may be obtained from the use of 24 to 30 inches of irrigation water, providing it is properly applied.

"U.S.Dept. Agr., Weather Bureau, Climate and Crop Service, California. Ann. Sums., 1903 and 1904.

Table 20.

DUTY OF WATER DETERMINATIONS FOR ALFALFA

Copied from Circular 108, Office of Experiment Stations, U. S. Dep't of Agriculture.

"Second Progress Report of Co-operative Irrigation Investigations in California" by Frank Adams.

----0----

The most data collected have referred to alfalfa, measurements having been made on 7,202 acres, not including the experiments at Davis, A summary of these measurements follows:-

Summary of measurements of duty of water on alfalfa, 1899-1910.

Location	Source of Water Supply	Yr.	Acreage		Depth of water applied
Turlock	Turlock Canal, average 10 farms	1909	909	Ft.	3.76
Modesto	Modesto Canal, average 7 farms	1910	521	"	1.90
Fresno	S.W. Uridge farm, pump	1910	60	"	5110
Madera	O.L.Sayre farm, pump	1910	500	"	4.74
Turlock	Turlock Canal	1904	2625	"	7.69
Modesto	Modesto Canal	1904	626	"	5.76
DO	Modesto Canal, Perley Ditch	1909	275	"	8.60
DO	Modesto Canal	1909	80	"	1180
Turlock	Turlock Canal, Hickman	1909	909	"	4.70
Pomona	Pumping, 8 farms	1905	192	"	1.40
DO	Pumping, 7 farms	1905	267	"	2.30
DO	Pumping, 6 farms	1908	218	"	2.40
	Total and average		7208	"	4.18

The largest amount found to have been used was a depth over the surface of 8.60 feet on 275 acres under the Perley ditch at Modesto. This land was largely newly seeded. On another small tract of 80 acres under the same ditch a duty of 1.80 feet in depth was found. The highest duty found was a depth of 1.40 feet, which was the average of measurements made on 8 farms at Pomona by Mr. C. E. Tait. The highest duty found in San Joaquin Valley over a considerable area was a depth of 1.90 feet, which was the average of measurements made by Mr. R.D.Robertson on 7 farms near Modesto, covering 521 acres. The average depth found on the entire 7,202 acres was 4.18 feet, but as this included measurements made at the heads of ditches as well as at the points of use, thus including some seepage losses, and as they also included both wasteful and economical use, it is not a true indication of the water requirements of this crop in California. It is believed that an average of the amounts used on the 17 farms in Modesto and Turlock districts covered by measurements in 1909 and 1910, viz. a depth 2.83 feet, more nearly represents reasonable use in such localities as San Joaquin Valley, and that an average of the measurements on the 21 farms at Pomona, viz. a depth, of 2.03 feet, fairly represents the best practice in southern California.

Table 21.

APPROXIMATE GRADE OF BED OF SAN DIEGO RIVER

Obtained from El Cajon Quadrangle - U.S.G.S.

Location	Elevation River Bed Feet-	Difference of Elevation Feet.	Distance Miles	Grade of River Bed Ft. per Mi.
Diverting Dam Mouth S. Fork	800			
		165	6.5	25.4
Cape Horn Point	625	110	4.0	27.5
		85	3.35	25.4
Monte Contraction	440			
		32	1.27	25.2
Lakeside U.S.G.S. Gaging Sta.	408			
		43	2.75	15.6
Riverview Construction	368			
		90	5.75	15.6
Old Mission Dam	275			

Table 22.

ESTIMATES OF UNDERFLOW AT CONTRACTIONS

IN SAN DIEGO RIVER VALLEY

Contraction	Gross sectional area porour material--Sq.Ft.	Hydraulic Grade Ft.per Mi.	Assumed average Diameter of soil Grain* Millimeters	Assumed Porosity* Per Cent	Volume of Under flow* Ac..Ft. per Annum	Veolcity of Water Mi. per yr.
Monte	125,000	25.1	0.50	35	904	0.17
U.S.G.S. Gaging Station	168,000	20.4	0.40	30	405	0.07
Riverview	33,700	15.5	0.40	30	50	0.04

* Determined from occular examination of material excavated from pits and drilled wells.

* See U.S. Geological Sruvey Water Supply Paper 140, Plate II.

Table 23.

DEPTH OF EVAPORATION FROM WATER SURFACE

AT SWEETWATER RESERVOIR NEAR SAN DIEGO

Month	Total in Inches	Rate in Inches per 24 hrs.	% of Total
Jan.	2.432	0.078	4
Feb.	2.074	0.074	4
Mar.	3.202	0.102	5
Apr.	4.658	0.155	8
May	5.559	0.179	10
June	6.653	0.222	11
July	7.522	0.243	13
Aug.	8.176	0.264	14
Sept.	6.566	0.219	11
Oct.	5.198	0.168	9
Nov.	4.800	0.160	8
Dec.	1.864	0.061	3
	58.074	0.160	100

The above record was made by observing fluctuations in a pan floating on surface of Sweetwater Reservoir. (See Water Supply Paper No. 81, P 344.) It is the average of a four year record 1889-92 inclusive. The record can be applied to the Lakeside region.

C. H. Lee

Table 24.

NATURAL EVAPORATION LOSSES FROM GROUND-WATTER BASINS

ALONG SAN DIEGO RIVER.

Basin	Natural Evaporating area. Character	Acres	Depth of water evaporated* Ins.per year	Natural Evaporation Loss Ac.Ft.per year
Cape Horn Pt. to Monte Contraction.	River channel and cieniega	450	58	2175
Monte Valley	River channel	105	45	400
Lakeside Valley	(River channel	100	45	562
	(Cienga	25	90	
El Cajon Valley	River channel	160	45	600
San Vicente	Creek Channel	30	45	110
Los Coches	" "	10	45	40

* Based on Sweetwater water evaporation record and knowledge of relative water evaporation and combined soil evaporation and transpiration derived from actual experiments in other localities.

* Based on actual examination and classification of bottom lands.

Table 25.

STORAGE CAPACITY OF GROUND-WATER BASINS

ALONG SAN DIEGO RIVER.

Basin	Area of Porous Material Ac.	Porosity or Material Percent	Depth of complete Depletion Ft.	Availability Factor* Percent	Volume of Available Water Ac.Ft.
Monte Valley	425	33	30	66	2770
Lakeside Valley	1150	30	30	50	5180
El Cajon "	(2500)	30	20	30	4500
Total					12450

*includes shoaling bedrock or conglomerate around rim of basis, non-availability of water held by silt, etc.

Table 26

COMPARISON PRESENT ACTUAL DRAFT

AND

AVAILABLE GROUND-WATER STORAGE

Basin	Area Irrigated Ac.	Amount of Water pumped 1912, Ac.Ft.	Annual loss from pumped water 50% Ac.Ft.	Natural evap' Loss Ac.Ft.	Under flow from Basin Ac.Ft.	Total annual Loss Ac.Ft.	Available groundwater Storage Ac.Ft.	Years
Monte Valley	70	704	353	400	405	1157	2770	3.5-
Lakeside Valley	708	2536	1297	562	50	1909	5180	3.1-
El Cajon Valley	255	1898	949	600	0	1549	4500	2.0*
Total	1033	5138	2598	1562	455	4613	12450	-----

- Assumed 50% natural evaportaion and underflow loss second year and 25% less third year.

* Assumed existing pumping plants in their present positions could have access to 66% of the available storage.

Table 27.

COMPARISON PRESENT REASONABLE DRAFT AND

AVAILABLE GROUND WATER STORAGE

Basin	Area irrigated Ac.Ft.	Amount of water pumped Annually Ac.Ft.	Annual loss from pumped water 60% Ac. Ft.	Natural evap. Loss Ac.Ft.	Underflow from basin Ac.Ft.	Total annual Loss Ac.Ft.	Available ground water storage Ac. Ft.	Years
Monte Valley	70	210	126	400	405	931	2770	6.0-
Lakeside Valley	708	2124	1274	562	50	1886	5180	3.2-
El Cajon Valley	255	765	459	600	0	1059	4500	2.8*
Total	1033	3099	2654	1562	455	3876	124500	---

* Based on 3 ac. ft. per annum duty of water

* Assumed 50% natural evaporation and underflow loss

* Assumed existing pumping plants in their present positions could have access to 66% of the available storage.

STATEMENT BY CHARLES H. LEE

REGARDING THE SAN DIEGO RIVER RIPARIAN PROBLEM.

1. There are a series of ground-water reservoirs along the San Diego River four of which lie between Cape Horn Point and Old Mission Dam. The surface of these reservoirs constitutes riparian bottom land.

2. The movement of water downstream in the contractions between the reservoirs does not exceed 2 1/2 feet per day or 0.16 miles per year.

3. The principle source of water supply is percolation from surface water flowing in the channel of San Diego River.

4. Under existing conditions, there may be no run-off for a period of three years from the area above Diverting Dam which will reach U.S.G.S. Gaging Station at Lakeside. There may be no run-off from the area between Diverting Dam and Old Mission Dam for a period of three years.

5. For the existing use of water and pump equipment, Monte, Lakeside and El Cajon basins are being drawn upon too heavily to withstand a three year drought.

6. There is enough storage capacity in the Monte and Lakeside basins with a duty of water of 3 ac. ft. per ac. per year and pump equipment designed to raise water from a fifty ft. working level to carry the present irrigated area through a three year drought. The

El Cajon basin might pull through on a 3 ac. ft. duty if the pumping plants were moved from one location to another as the sands became depleted locally.

7. The construction of surface storage reservoirs by Cuyamaca Water Company to perfect its supply would make possible a period of seven years without any flood water passing Diverting Dam. The riparian basins would thus be deprived of assistance from flood waters derived from this area for seven years instead of three as at present.

8. The Cuyamaca Water Company can perfect its supply without diminishing the supply of any lower riparian interest even in years of extreme drought by operating the basin between Cape Horn Point and Monte contraction as a ground-water reservoir.

9. The existing riparian interests can and should protect themselves from the danger of drought which they are now inviting. This may be done by greater economy in the use of water, by constructing reservoirs for the purpose of delaying flood waters in their rush to the ocean, and by consistent and thorough spreading of flood waters over the surface of the ground-water basins so as to fill them completely each year.

INDEX TO PUMPING PLANTS.

OF THE SAN DIEGO RIVER FOR 1912.

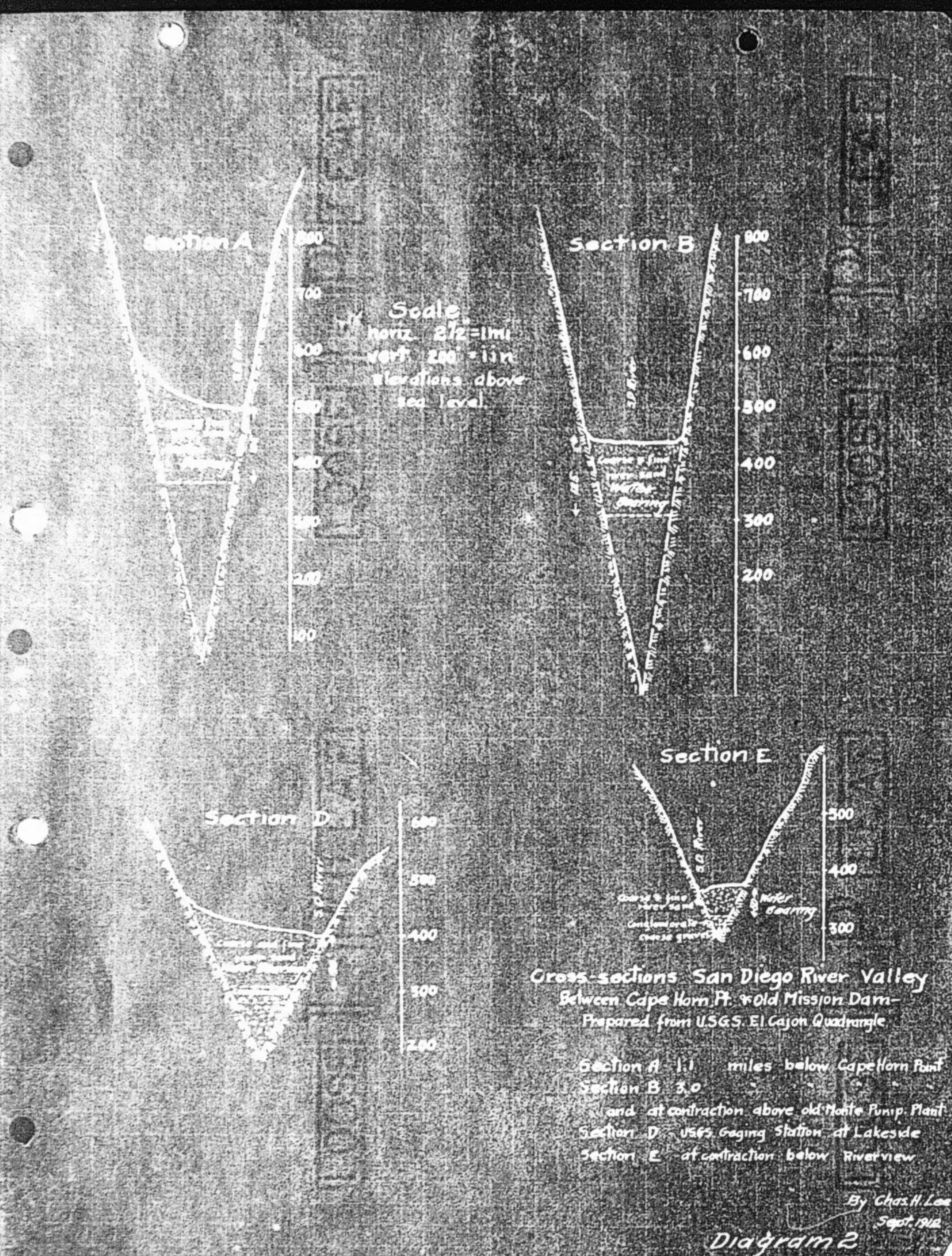
SHOWN ON PLATE 1.

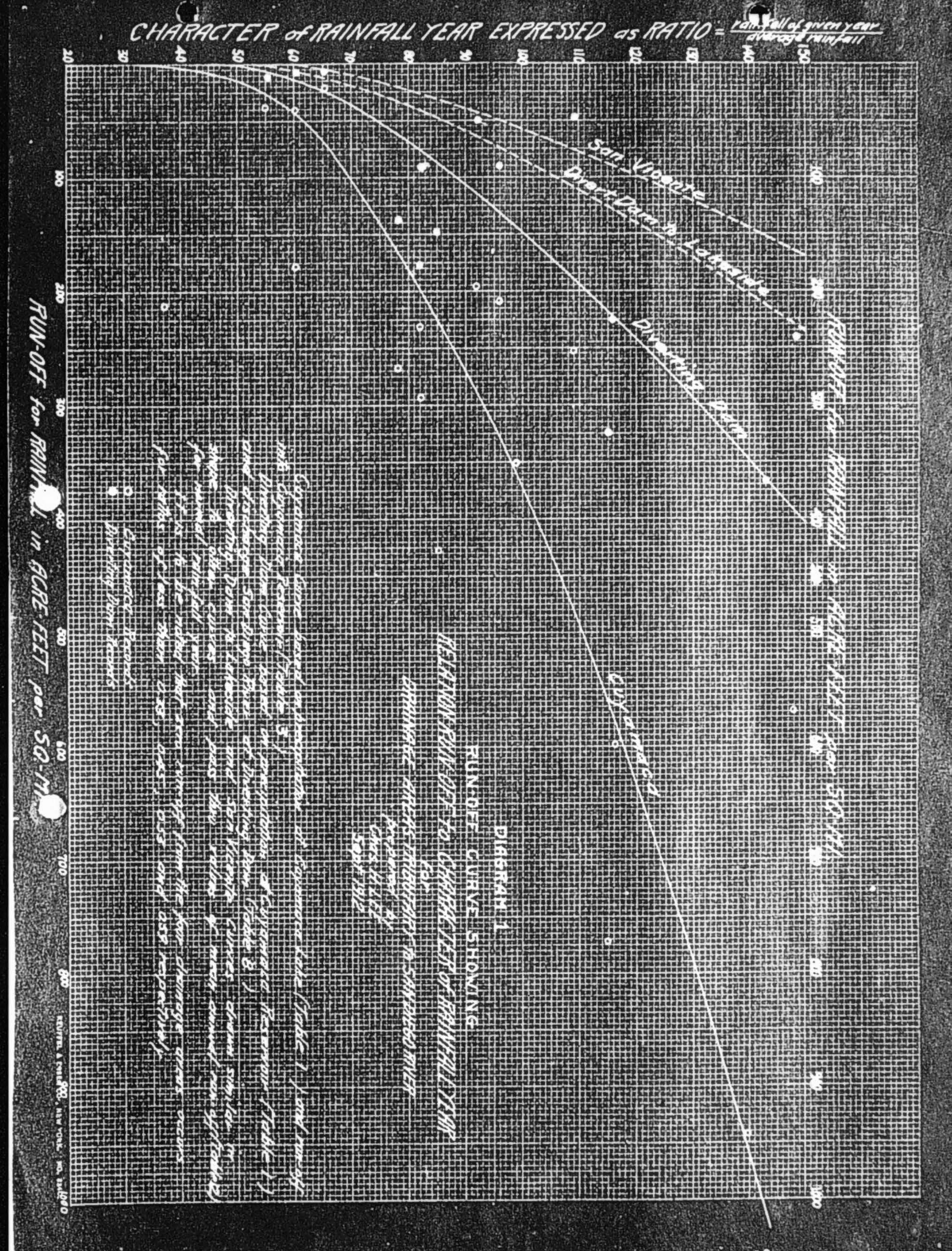
Copied from C.S.Alverson's Report of July 1912.

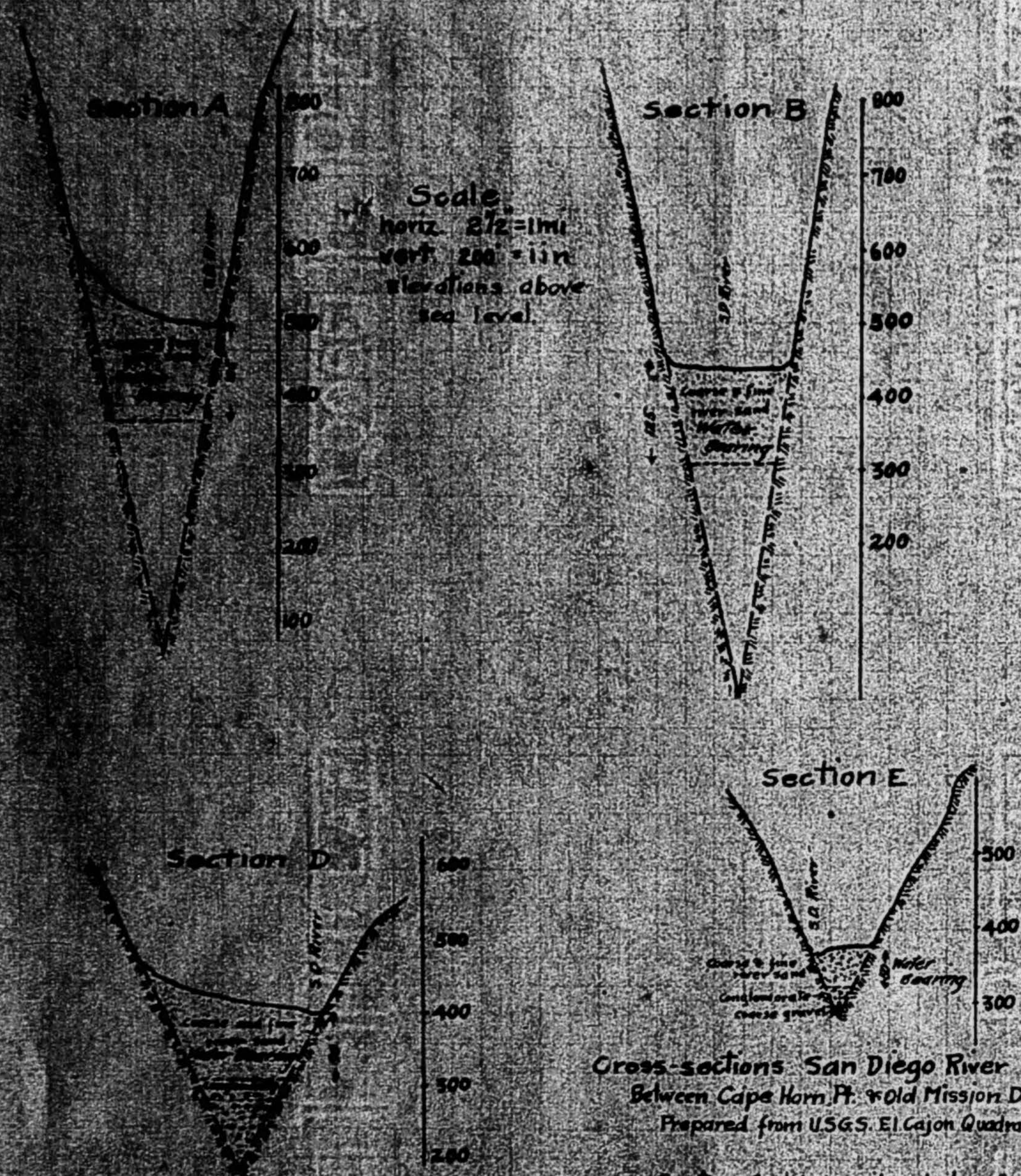
1- E. W. Scripps No.1	Pumping Plant.
2- " No.2	" "
3- Williamson	" "
4- Kinney & Sehlesy	" "
5- Balantyne	" "
6- J. Johnson Jr.	" "
7- Dr. Learn	" "
8- Lakeside Farm No.2	" "
9- " " ".1	" "
10-Theodore Barnes	" "
11-L. Kirkpatrick	" "
12-Jas. Williams	" "
13-Hugo Thum.	" "
14-U.S. Gaging Station.	" "
15-John H. Cay	" "
16-H. W. Chase	" "
17-Old Monte Plant	" "

GROUND WATER BASINS IN SAN DIEGO RIVER VALLEY Between Cape Horn Point and Old Mission Dam

PLATE 1


Section A
Scale
horiz. 2 1/2"=1mi
vert. 200'=1in
Elevations above sea level.
Section B
Section D
Section E
Water Bearing
Cross-sections San Diego River Valley
Between Cape Horn Pt. & Old Mission Dam-
Prepared from U.S.G.S. El Cajon Quadrangle
Section A 1.1 miles below Cape Horn Point
Section B 3.0
and at contraction above old Monte Pump Plant
Section D USGS Gaging Station at Lakeside
Section E at contraction below Riverview
By Chas. H. Lee
Sept. 1912
Diagram 2


CHARACTER of RAINFALL YEAR EXPRESSED as RATIO = rainfall of given year / average rainfall
RUN-OFF for RAINFALL in ACRE-FEET per SQ-MI
RUN-OFF for RAINFALL in ACRE-FEET per SQ-MI
San Vicente
Divert. Dam to Lakeside
Diverting Dam
Cuyamaca
DIAGRAM 1
RUN-OFF CURVE SHOWING
RELATION OF RUN-OFF TO CHARACTER OF RAINFALL YEAR
for
DRAINAGE AREAS TRIBUTARY TO SAN DIEGO RIVER
Prepared by
Chas. H. Lee
Sept. 1912

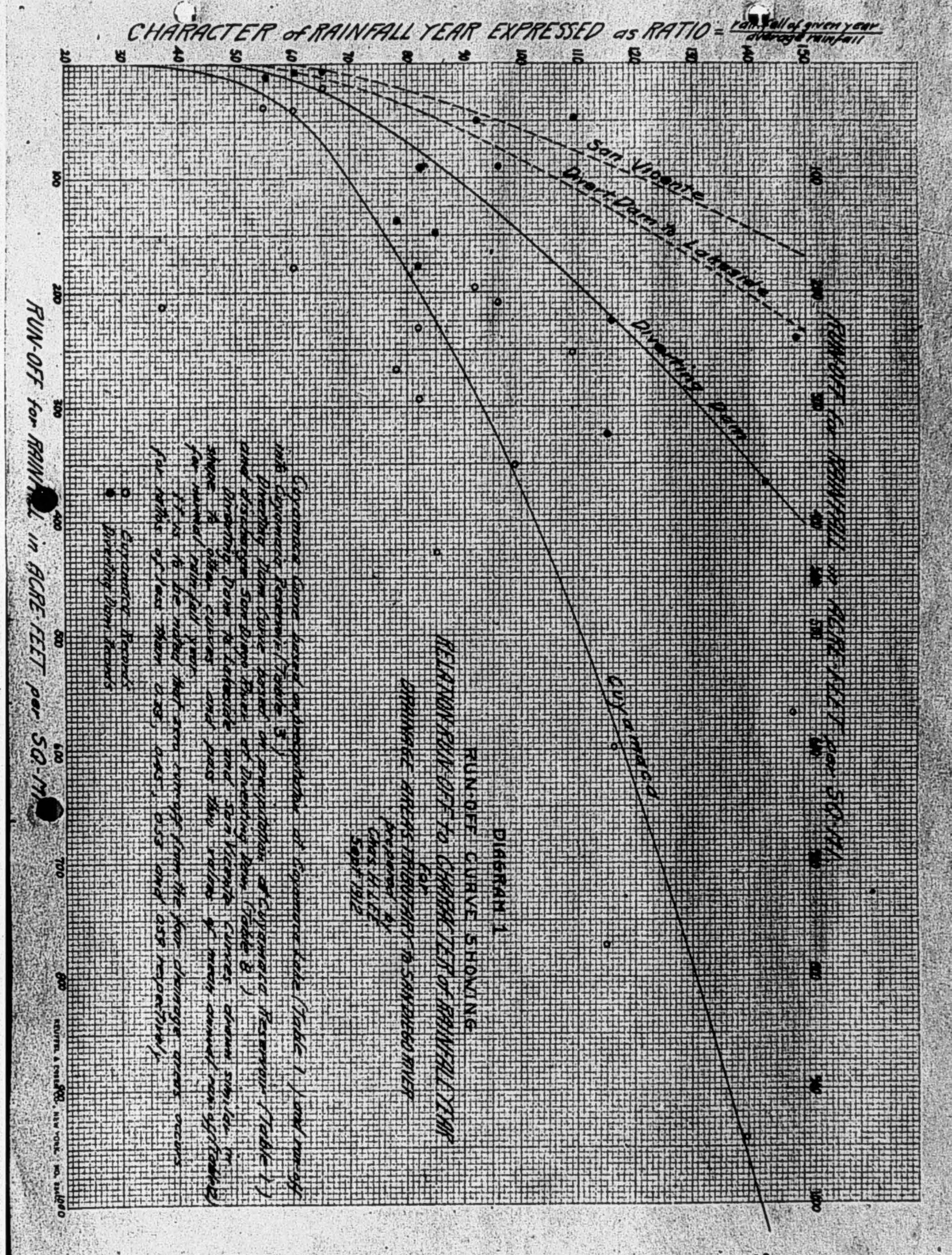


Cross-sections San Diego River Valley
Between Cape Horn Pt. & Old Mission Dam –
Prepared from U.S.G.S. El Cajon Quadrangle

Section A 1.1 miles below Cape Horn Point
Section B 3.0
and at contraction above old Monte Pump Plant
Section D U.S.G.S. Gaging Station at Lakeside
Section E at contraction below Riverview

By Chas. H. Lee
Sept. 1912

Diagram 2



Ed Fletcher Papers

1870-1955

MSS.81

Box: 39 Folder: 7

Business Records - Reports - Lee, Charles H - "Effect of Increased Development of Water by the Cuyamaca Water Co. upon the Water Supply Obtainable From Riparian Bottom Lands Along San Diego River"

Copyright: UC Regents

Use: This work is available from the UC San Diego Libraries. This digital copy of the work is intended to support research, teaching, and private study.

Constraints: This work is protected by the U.S. Copyright Law (Title 17, U.S.C.). Use of this work beyond that allowed by "fair use" requires written permission of the UC Regents. Permission may be obtained from the UC SanDiego Libraries department having custody of the work (http://libraries.ucsd.edu/collections/mscl/). Responsibility for obtaining permissions and any use and distribution of this work rests exclusively with the user and not the UC San Diego Libraries.