EXHIBIT 11

PART 2

TABLE 3

RUNOFF TO VALLEY FILL
FROM HILL AND MOUNTAIN AREAS

In Acre-Feet

Year	To San Fernando Subarea[a]	To Sylmar Subarea	To Verdugo Subarea[b]	Total to valley fill[b]
1928-29	5,960	930	140	7,030
29-30	4,740	960	0	5,700
1930-31	3,580	860	0	4,440
31-32	46,140	10,350	2,400	58,890
32-33	11,280	1,990	340	13,610
33-34	16,560	2,970	800	20,330
34-35	18,430	5,530	350	24,310
1935-36	15,000	3,530	620	19,150
36-37	71,090	17,320	3,280	91,690
37-38	140,130	31,600	5,820	177,550
38-39	24,260	3,890	850	29,000
39-40	16,610	3,470	280	20,360
1940-41	154,930	28,960	7,510	191,400
41-42	18,900	2,520	710	22,130
42-43	135,400	24,790	6,350	166,540
43-44	102,250	18,620	3,720	124,590
44-45	30,790	5,740	1,170	37,700
1945-46	21,640	3,090	340	25,070
46-47	25,490	6,410	670	32,570
47-48	5,970	390	70	6,430
48-49	2,920	740	0	3,660
49-50	4,800	1,120	90	6,010
1950-51	3,190	170	90	3,450
51-52	92,590	18,220	6,020	116,830
52-53	11,870	3,750	340	15,960
53-54	13,760	3,140	410	17,310
54-55	8,660	940	360	9,960
1955-56	12,510	1,540	420	14,470
56-57	8,560	970	450	9,980
57-58	73,620	17,540	2,110	93,270
29-Year Average 1929-57	35,450	7,050	1,500	44,000

a. Includes Eagle Rock Subarea.

b. Includes portion of Monk Hill Basin within area.

Note: Values are the sum of amounts shown in Tables F-7 and F-8, Appendix F, and include hill and mountain runoff flowing into water supply reservoirs.

Imported Water

The inadequacy of local water resources in the South Coastal area of California to meet the needs of rapidly increasing population and expanding industry made the early import of additional water supplies a necessity. The City of Los Angeles, to meet this demand in its service area, constructed the Los Angeles Aqueduct and related facilities to bring water from the Owens River into the City. The system was subsequently extended into Mono Basin to make water from that area available for diversion into the aqueduct. The first water delivered from the aqueduct to the area of investigation was in May 1915, although some water was used in the Los Angeles downtown area starting in 1913. The Department of Water and Power of the City of Los Angeles owns and operates the Los Angeles Aqueduct.

The need for additional water throughout the South Coastal area culminated in the 1927 State Legislature authorizing the formation of The Metropolitan Water District to construct and operate an aqueduct to import Colorado River water.

Construction of the Colorado River Aqueduct pursuant to the authorizing legislation, resulted in delivery in 1940 of the first water from the Colorado River to the South Coastal area of which the City of Los Angeles is a part. The aqueduct system was put on an operational basis in 1941. Other than by these two systems there are no significant importations of foreign water into the area of investigation.

There follows a description of the works and the apparent water supply under the two aqueduct systems.

Los Angeles Aqueduct System of the City of Los Angeles

The Los Angeles Aqueduct system as shown on Plate 14 was constructed to utilize the water supply of the Owens River and Mono Basin to serve the municipal demands of the City of Los Angeles. Construction was initiated in 1907 and the first Owens River water delivered to the City in 1913 and to the Upper Los Angeles River area in May 1915. Subsequent extension of the system into the Mono Basin made water from that area available in 1940.

Description and Capacity of Project. Owens River, tributary to a closed interior basin east of the Sierra Nevada, originally drained into the now dry Owens Lake. Mono Basin drains naturally into Mono Lake and is located immediately north of the Owens River, the two being separated by a low divide.

Diversion from the Owens River is made by the City of Los Angeles upstream from Owens Lake through a diversion canal of 700 cubic feet per second capacity. The canal intercepts the flow of several streams along its course and empties into the 58,525 acre-foot capacity Haiwee Reservoir which is a storage and regulating basin at the head of the aqueduct.

The aqueduct from Haiwee Reservoir is a closed conduit approximately 140 miles in length having a maximum capacity of 500 cubic feet per second. It delivers water into Fairmont Reservoir, the first of several storage and regulating reservoirs near and within the Upper Los Angeles River area. The overall storage in the group of reservoirs along the aqueduct below Haiwee and above San Fernando Reservoir is 44,763 acre-feet. The maximum capacity of the conduit between these reservoirs and the San Fernando Reservoir inlet is 485 cubic feet per second, which is the controlling capacity of the system with respect to rate of delivery to the Upper Los Angeles River area and the City of Los Angeles.

Based on a limiting capacity of 485 cubic feet per second and a seven percent annual shutdown period, it appears that the aqueduct has operated at or near capacity during the latter portion of the base period.

Upstream on the Owens River, a short distance from the head of the aqueduct diversion, is located Tinemaha Reservoir of 16,405 acre-feet capacity which is used as a regulating reservoir to equalize variations in stream flow. Pleasant Valley Reservoir of 3,885 acre-feet capacity located immediately below the lowermost Owens Gorge power plant, is used to stabilize the power plant discharge. Crowley Lake, located above the gorge with a capacity of 183,465 acre-feet, is used to store and regulate upstream runoff.

Water from Mono Basin is delivered into Owens River Valley through the Mono Craters Tunnel, which has a capacity of 365 cubic feet per second. The Mono Basin system has a further limitation in that not more than a total of 93,540 acre-feet per year and 200 cubic feet per second may be diverted from Leevining, Walker, Parker and Rush Creeks into Grant Lake, which stores and regulates the flow before it is released into the Mono Craters Tunnel conduit. Grant Lake Reservoir has a capacity of 47,525 acre-feet.

Further detailed description of the aqueduct system and its operation is set forth in Appendix G.

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Quantities of Water Diverted and Used. The quantity of water diverted by the City of Los Angeles from the Mono Basin-Owens River system is considered to be the inflow to Haiwee Reservoir, which is the sum of the diversion from the Owens River measured in the vicinity of Cartago below the Cottonwood Power Plant gates plus the flows of Ash and Braley Creeks which are intercepted by the diversion canal downstream of the power plant.

Import to the Upper Los Angeles River area as measured in the vicinity of San Fernando Reservoir, the terminus of the Los Angeles Aqueduct, is considered as the quantity delivered for use by the City of Los Angeles through the aqueduct. From 1933 to date, all measurements of import were made in the vicinity of the terminus of the aqueduct. Prior to 1933 all measurements were made at Dry Canyon Reservoir.

Quantities diverted and delivered for use by the City of Los Angeles through the Los Angeles Aqueduct system are shown in Table 4. The differences between quantities diverted and quantities delivered for use can be attributed to seepage and evaporation losses, inaccuracies of measuring devices, operational losses and unmeasured distribution along the aqueduct. Further details are presented in Appendix G.

TABLE 4

QUANTITIES DIVERTED AND DELIVERED FOR USE BY THE CITY OF LOS ANGELES THROUGH THE LOS ANGELES AQUEDUCT SYSTEM

In Acre-Feet

Year	Quantities diverted[a]	Quantities delivered[b]
1913-14	34,290	--- c
14-15	44,650	--- c
1915-16	66,290	43,710
16-17	95,930	68,180
17-18	194,730	129,330
18-19	194,820	176,030
19-20	211,980	202,260
1920-21	191,860	187,720
21-22	245,310	204,620
22-23	194,800	186,110
23-24	167,790	149,660
24-25	172,790	127,820
1925-26	191,360	169,700
26-27	244,260	173,490
27-28	220,780	194,710
28-29	204,760	190,100
29-30	245,550	198,130
1930-31	245,650	215,750
31-32	258,200	238,200
32-33	243,800	228,430
33-34	236,920	185,580
34-35	251,230	194,920
1935-36	247,680	236,940
36-37	239,250	206,670
37-38	283,090	209.080
38-39	261,510	237,250
39-40	240,870	217,160
1940-41	279,540	200,980
41-42	293,610	246,350
42-43	297,270	264,400
43-44	307,580	274,500
44-45	286,210	267,240
1945-46	307,060	283,970
46-47	338,040	291,020
47-48	326,670	306,460
48-49	308,940	298,460
49-50	316,050	305,400
1950-51	356,610	317,370
51-52	330,690	316,570
52-53	339,950	320,920
53-54	322,180	318,590
54-55	339,430	316,320
1955-56	342,730	321,260
56-57	324,330	318,390
57-58	358,470	325,390

a. Inflow to Haiwee.

b. Prior to 1933 this item was measured at Dry Canyon Reservoir. Subsequently it comprised the total flows through the Penstock meter, Maclay Highline meter and San Fernando Bypass, all located near the cascade immediately above Upper San Fernando Reservoir inlet.

c. No record.

Quantities Available for Diversion and Use. The water supply of the Mono Basin-Owens Valley area available for use is composed of storm runoff and well water. For a limited period the City of Los Angeles extracted water from deep wells in Owens Valley. These wells were pumped continuously from May 1928 to December 1931 and intermittently pumped to 1935. During the years of the period 1918 through 1958 in which there was no pumping, the annual artesian well flow reaching the aqueduct averaged approximately 11,500 acre-feet.

Runoff tributary to the diversion works of the Los Angeles Aqueduct and the amount that it exceeds actual diversions into the aqueduct are shown in Table 5. A detailed determination of these values is contained in Appendix G.

Quantities of water available for diversion and use by the City of Los Angeles from sources tributary to Mono Basin and to the Owens River are limited by the capacity of the Los Angeles Aqueduct system. Transportation of additional water to the City of Los Angeles would require the construction of additional works. Water in excess of the capacity of the aqueduct has existed in the Mono Basin-Owens Valley area; however, towns, communities and some irrigated lands in Owens Valley and Mono Basin have historically used water and rights may pertain thereto. The water use by these entities is not considered within the scope of this reference and therefore has not been determined.

TABLE 5

STREAM RUNOFF TRIBUTARY TO LOS ANGELES AQUEDUCT DIVERSION WORKS IN EXCESS OF AQUEDUCT DIVERSIONS

In Acre-Feet

Year	Runoff to aqueduct diversion works[a]	Runoff in excess of aqueduct diversions[b]
1913-14	377,900	343,610
14-15	271,990	227,340
1915-16	378,010	311,720
16-17	332,010	236,080
17-18	263,870	69,140
18-19	201,240[c]	6,420
19-20	211,980[c]	0
1920-21	191,860[c]	0
21-22	245,310[c]	0
22-23	194,800[c]	0
23-24	167,790[c]	0
24-25	172,790[c]	0
1925-26	191,360[c]	0
26-27	261,890[c]	17,630
27-28	231,530	10,750
28-29	207,870	3,110
29-30	248,880	3,330
1930-31	247,570	1,920
31-32	261,630	3,430
32-33	253,800	10,000
33-34	231,110	5,810
34-35	257,420	6,190

Year	Runoff to aqueduct diversion works[a]	Runoff in excess of aqueduct diversions[b]
1935-36	262,440	14,760
36-37	295,000	55,750
37-38	500,050	216,960
38-39	350,700	89,190
39-40	247,950	7,080
1940-41	488,160	208,620
41-42	456,260	162,650
42-43	447,440	150,170
43-44	333,980	26,400
44-45	456,880	170,670
1945-46	430,780	123,720
46-47	337,580	- 460
47-48	356,520	29,850
48-49	329,870	20,930
49-50	322,060	6,010
1950-51	386,920	30,310
51-52	495,120	164,430
52-53	359,530	19,580
53-54	299,300	- 22,880
54-55	350,570	11,140
1955-56	453,050	110,320
56-57	364,770	40,440
57-58	476,580	118,110

a. Quantities shown for 1913-14 to 1939-40 are for Owens area. For 1940-41 to 1957-58 quantities are for combined Owens and Mono areas.

b. Runoff to aqueduct diversion works less diversions (Table 4). Negative amount indicates water taken from storage in Haiwee Reservoir.

c. There is no record of flow into Owens Lake from November 1918 through December 1926; therefore, these values are too small by that amount, which ranged during the period of measurement from 1,920 acre-feet in 1930-31 to 343,610 acre-feet in 1913-14.

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Colorado River Aqueduct of The Metropolitan Water District of Southern California

The Metropolitan Water District was organized in December 1928 under the authority of The Metropolitan Water District Act (California Statutes of 1927, Chapter 429, page 694). The Metropolitan Water District serves Colorado River system water to all of the municipalities and water districts within the area described in Appendixes A and B attached to the Amended Complaint in Los Angeles vs. San Fernando, et al., with the exceptions of the City of San Fernando and the Los Angeles County Waterworks District No. 21. The City of San Fernando, although within the exterior boundaries of the City of Los Angeles, is not a part of The Metropolitan Water District service area.

Description and Capacity of Project. The Colorado River Aqueduct Project (see Plate 13), financed and constructed by The Metropolitan Water District, diverts from the main stream of the Colorado River above Parker Dam 155 miles below Hoover Dam and 175 miles above the Mexican border.

The major works of the main aqueduct, large scale construction of which began in 1933 and which was completed to the point of delivery of water in 1941, consist of transmission lines, pumping plants, tunnels, canals, covered conduits, inverted syphons, reservoirs, and related works with a designed capacity of 1,605 cfs and a maximum delivery capacity of 1,800 cfs.* The main aqueduct is 242 miles long, including 92 miles of 16-foot diameter lined tunnels and five pumping plants capable of raising the water a net 1,617 feet over mountains intervening between the Colorado River and the coastal plain of Southern California.

* Page 62 of Twenty-First Annual Report of The Metropolitan Water District dated 1959.

Service of water through the Colorado River Aqueduct system, which commenced in 1941 with three pumping units, has continued since that date. Construction authorized in 1952 to bring the system up to full capacity was completed in 1960.

Under this authorization Pumping Unit No. 4 was placed in operation in August 1956. Pumping Unit No. 5 began operating in May 1957 and Pumping Unit No. 6 in January 1959, permitting a maximum delivery of 1,200 cubic feet per second or more until full aqueduct capacity was attained in 1960. Net diversion from the Colorado River by The Metropolitan Water District from 1940-41 through 1958-59 is shown in Table 6. Quantities of Colorado River water delivered to parties are shown in Table M-3 of Appendix M.

Deducting estimated losses in transit, the aqueduct will have the planned capacity to deliver to terminal reservoirs in the Southern California Coastal Basin 1,180,000 acre-feet per annum of the 1,212,000 acre-feet per annum claimed for diversion from the Colorado River.

The major works of the distribution system consist of 232 miles of pipeline, tunnels, reservoirs, and related works serving parts of The Metropolitan Water District in Los Angeles, Orange, Riverside, and San Bernardino Counties, and 71.1 miles of the San Diego Aqueduct (a branch of the Colorado River Aqueduct) serving the parts of Metropolitan Water District in San Diego. Construction of 150 miles of that part of the system serving Los Angeles and vicinity was completed in 1941 and since that time annexations and increased demands have required a continued expansion of the original facilities. The main feeders serving the remaining area of the City of Los Angeles are shown on Plate 35.

TABLE 6

NET DIVERSION FROM COLORADO RIVER
BY THE METROPOLITAN WATER DISTRICT*

In Acre-Feet

Hydrographic year	Net diversion from Colorado River
1940-41	52,460
41-42	13,420
42-43	52,380
43-44	37,340
44-45	65,622
1945-46	65,098
46-47	89,430
47-48	180,558
48-49	172,265
49-50	183,130
1950-51	204,000
51-52	185,779
52-53	216,650
53-54	275,063
54-55	405,157
1955-56	438,247
56-57	597,283
57-58	531,338
58-59	650,617

* Source of data:
1940-41 through 1954-55, U.S.G.S. Water Supply Paper.
1955-56 through 1957-58, The Metropolitan Water District Annual Reports.
1958-59, records of The Metropolitan Water District.

Relative Rights of Constituent Areas of the Metropolitan Water District. The Metropolitan Water District delivers Colorado River water to their constituents (cities, districts, and other public entities) at various service connections.

Section 5-1/2 of The Metropolitan Water District Act provides as follows:

> "Section 5-1/2. Each city, the area of which shall be a part of any district incorporated hereunder, shall have a preferential right to purchase from the district for distribution by such city, or any public utility therein empowered by said city for the purpose, for domestic and municipal uses within such city a portion of the water served by the district which shall, from time to time, bear the same ratio to all of the water supply of the district as the total accumulation of amounts paid by such city to the district on tax assessments and otherwise, excepting purchase of water, toward the capital cost and operating expense of the district's works shall bear to the total payments received by the district on account of tax assessments and otherwise, excepting purchase of water, toward such capital cost and operating expense."

This preferential right does not, at present, limit the quantity of water available to any member but will become effective when the demand of The Metropolitan Water District equals the supply available to the District.

A summary, in terms of percentages, of the preferential rights as of November 30, 1959, of all municipalities and water districts entitled to a preferential right under Section 5-1/2 of The Metropolitan Water District Act is presented in Table 7.

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TABLE 7

PREFERENTIAL RIGHTS OF MEMBERS OF THE METROPOLITAN WATER DISTRICT OF SOUTHERN CALIFORNIA AS OF NOVEMBER 30, 1959 BASED ON TOTAL CUMULATIVE TAX COLLECTIONS*

Municipality or District	Tax collections percent of total	
Beverly Hills	2.23558	
Burbank	2.36381	
Central Basin Municipal Water District	6.59994	
Compton	.60130	
Foothill Municipal Water District	.61549	
Glendale	2.47681	
Long Beach	6.35874	
Los Angeles	49.47865	
Pasadena	3.01992	
Pomona Valley Municipal Water District	1.10728	
San Marino	.56925	
Santa Monica	2.01254	
Torrance	1.06130	
West Basin Municipal Water District (including Reannexed Exclusions)	5.36835	
Total: Los Angeles County		83.86896
Anaheim	.40686	
Coastal Municipal Water District	1.13006	
Fullerton	.66436	
Orange County Municipal Water District	3.18570	
Santa Ana	1.02634	
Total: Orange County		6.41332
San Diego County Water Authority		
Total: San Diego County		7.36589
Chino Basin Municipal Water District		
Total: San Bernardino County		1.18395
Eastern Municipal Water District	.26092	
Western Municipal Water District	.90696	
Total: Riverside County		1.16788
TOTAL:		100.

* Data from The Metropolitan Water District Controllers's Report of December 7, 1959, to The Metropolitan Water District Board of Directors; and Statement No. 7 thereof, Tax Data to November 30, 1959.

According to a statement of policy approved by the Board of Directors of the District on December 16, 1952, "The Metropolitan Water District of Southern California is prepared, with its existing governmental powers and its present and projected distribution facilities, to provide its service area with adequate supplies of water to meet expanding and increasing needs in the years ahead ...". In regard to distribution facilities it has been the policy of the District to provide trunk feeder lines of sufficient capacity to supply the demands for Colorado River water in its constituent municipalities. If a request for more capacity in a trunk line to supply increased demand were made by a constituent municipality, and it were shown that the increased requirements of the constituent municipality could not be supplied by Metropolitan's facilities then available, it would be necessary in accordance with Metropolitan's policy to provide additional feeder capacity for service to the constituent municipality. This applies to the cities of Glendale and Burbank as well as to other constituent municipalities.

Although it has been the general policy of the District to provide trunk feeder lines so that each constituent municipality would have at least one point of connection within the boundaries of the constituent municipality, the terms and conditions of annexation fixed by the District in some of the more recent annexations have required the constituent municipality to construct its own transportation facilities to a point remote from its boundaries to obtain service.

The District has not established an invariable standard to which capacities of transportation facilities are maintained in relation to annual demand of constituent agencies for Colorado River water. In the design of the initial development of the distribution facilities it was assumed that capacity should be provided to supply 130 percent of mean annual demand, but no such fixed percentage has been authorized for design purposes by the District's Board of Directors. Conditions vary among the constituent agencies in respect to justifiable need for capacity in excess of that required to satisfy annual mean demand. In many cases facilities have been constructed to serve requirements known to be short of ultimate needs, with realization that subsequent amplification of facilities would be necessary.

There have been very few instances where it has been necessary for Metropolitan to curtail deliveries due to peak demands exceeding the capability of the transporation facilities. In connection with this situation Metropolitan has urged the member municipalities to acquire adequate storage and maintain existing ground water pumping facilities for emergency service and to provide for peaking during the periods of extraordinary demand.

<u>Water Rights of The Metropolitan Water District.</u> The Metropolita Water District asserts its right to the consumptive use* of 1,212,000 acre-feet per annum of Colorado River system water. This right is based on

* Refers to the amount of water at the point of diversion.

(1) appropriations of the Cities of Los Angeles and San Diego, made respectively in 1924 and 1926 and (2) contracts with the United States, made in 1930 and amended in 1931, pursuant to the Boulder Canyon Project Act for the storage and delivery of water impounded by Hoover Dam. The appropriative and contract rights are affected in various degrees by the compacts, treaties, statutes, and contracts referred to collectively as "the law of the River".

In 1931, The Metropolitan Water District and six other major users of the Colorado River system in California executed an agreement, with the approval of the California Division of Water Resources, which specifies the following priorities of California water users:

Priority number		Agency description	Annual quantity in acre-feet
1.		Palo Verde Irrigation District - 104,500 acres in and adjoining existing district	
2.		Yuma Project (California Division) - not exceeding 25,000 acres	
3.	(a)	Imperial Irrigation District and lands in Imperial and Coachella Valleys to be served by All-American Canal	3,850,000
	(b)	Palo Verde Irrigation District - 16,000 acres of adjoining mesa	
4.		The Metropolitan Water District, City of Los Angeles, and/or others on coastal plain	550,000
5.	(a)	The Metropolitan Water District, City of Los Angeles, and/or others on coastal plain	550,000
	(b)	City and/or County of San Diego	112,000

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Priority number		Agency description	Annual quantity in acre-feet
6.	(a)	Imperial Irrigation District and lands in Imperial and Coachella Valleys to be served by All-American Canal	300,000
	(b)	Palo Verde Irrigation District - 16,000 acres of adjoining mesa	
		TOTAL	5,362,000
7.		Agricultural use in the Colorado River basin in California, as the basin is designated on Map 23000, U. S. Bureau of Reclamation	All remaining water available for use in California

This agreement is incorporated in General Regulations of the Secretary of the Interior promulgated in 1931 pursuant to Section 5 of the Boulder Canyon Project Act and in water delivery contracts between the United States and the several California agencies using Colorado River system water.

Pendency of Arizona vs. California. The quantity of Colorado River system water which will be available for diversion by The Metropolitan Water District is involved in, and may be affected by the decision in Arizona vs. California, No. 9 Original, October Term 1959, initiated by the State of Arizona in 1952 and now pending before the United States Supreme Court. The case was under submission to Special Master Simon H. Rifkind of New York City, who was appointed by the Court to hear the parties and report to the Court with proposed findings of fact and conclusions of law, and a recommended decree. The Special Master released his proposed report to the parties on May 10, 1960 and during August 1960 heard objections to the report by the parties preliminary to submitting his report to the Court. The proposed report was substantially adverse to the contentions of the California defendants in most major respects. The Special Master's final report, dated December 5, 1960, materially unchanged from his draft report, has been submitted to the Court. The parties have filed exceptions to the report, and supporting briefs, pursuant to order of the Court. A final decision of the Supreme Court in this suit is anticipated sometime in 1962.

Other Factors Affecting Water Availability to The Metropolitan Water District. At the present time, the water supply of the Colorado River system is sufficient to satisfy fully the right of all California water users and main stream users in other states of the lower Colorado River area for all their existing projects. When, whether, and to what extent a shortage develops for California water users depends on three major factors:

(1) long range dependable water supply which is determined by runoff and its conservation;

(2) the rapidity of development of water uses throughout the Colorado River Basin, particularly in the relatively undeveloped upper Colorado River Basin; and

(3) the resolution of legal issues, some of which are involved in Arizona vs. California, and some of which concern the rights of the upper Colorado River Basin

versus the lower Colorado River Basin and which are unlikely to be determined in that suit.

The decree recommended by the Special Master in his December 5, 1960 report, establishes the following proration formula for the division of the waters of the "mainstream" (defined as Lake Mead and the main stream of the Colorado River below Lake Mead within the United States):

> Of the first 7.5 million acre-feet of consumptive use available in any year from the "mainstream" waters, 28/75 (37-1/3 percent) to Arizona, 44/75 (58-2/3 percent) to California, 3/75 (4 percent) to Nevada; of the excess over 7.5 million acre-feet, 50 percent to California and 50 percent to Arizona, minus a possible 4 percent to Nevada.

The Special Master concludes that "...the evidence will not support a sufficiently accurate prediction of future supply to determine the effect of the recommended decree on existing uses in California." (Special Master's Report, page 103). Because of this asserted unreliability of water supply estimates, the Master makes no findings as to the quantity of water available for use in the lower basin. The Master states that "...the record in this case gives no indication that the 'chaotic disaster' which California fears will, or is likely to, materialize." (Report, page 102).

This statement, however, is based in part upon the availability in the lower basin of water which the Colorado River Compact apportions in perpetuity to the upper basin. The quantity so apportioned is 7,500,000 acre-feet per annum (subject to certain obligations with respect to the outflow at Lee Ferry). As the present upper basin uses (now approaching 2,500,000 acre-feet per annum) increase, the temporary supply available from the "mainstream" for use in Arizona, California and Nevada will diminish. Accordingly, the District's Colorado River supply under the seven party priority agreement could be adversely affected by about 1970 and in gradually increasing degree thereafter. Thus, it appears probable, if the Supreme Court approves the Special Master's Report, that the District would receive a full supply of Colorado River water for about 10 years and gradually decreasing quantities for about the succeeding 25 years, with the possibility of loss of its entire Colorado River supply at some time approaching the turn of the century.

It should be noted, however, that water made and to be made available to the Metropolitan Water District is firm through a contract entered into between the District and the State of California, Department of Water Resources, entered into prior to November 8, 1960, for 1,500,000 acre-feet per annum from the surplus waters of Northern California to be made available to the District by water facilities to be financed by the State (1) through the issuance of $1.75 billion in bonds authorized by the people at the General Election, November 8, 1960; (2) by the Water Fund; and (3) by the general authority of the State of California.

The California defendants opposed the recommendation of the Special Master in exceptions to his report before the Court. If the Master's recommendation is reversed by the Court in any material respect, a substantial portion of the District's water supply would be assured from the dependable or permanent supply of the Colorado River.

<u>Distribution System</u>. The distribution mains supplying members of The Metropolitan Water District are shown on Plates 13, 21 and 35. The La Canada Irrigation District and Crescenta Valley County Water District receive Colorado River water through the mains of the Foothill Municipal Water District. The City of Los Angeles takes water from the Upper Feeder. The Cities of Burbank and Glendale receive water through the Santa Monica

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Feeder. Design capacity of the Santa Monica Feeder under full flow hydraulic gradient is shown on the profile on Plate 13 and listed below.

DESIGN CAPACITY OF SANTA MONICA FEEDER
UNDER FULL FLOW HYDRAULIC GRADIENT

Section*	Design capacity, in second feet
San Rafael Tunnel No. 2 to Glendale Take-out	125
Glendale Take-out to Burbank Take-out	77
Burbank Take-out to Hollywood Tunnel	49

* Plates 13 and 21.

Amounts of Imported Water

Sole significant importations of water to the Upper Los Angeles River area are supplies brought in via the Colorado River and the Los Angeles Aqueducts by members of The Metropolitan Water District and the City of Los Angeles, respectively. The amount of Owens River water imported for use within the Upper Los Angeles River area has been determined as the quantity of Owens water delivered at the Los Angeles Aqueduct terminus, as set forth in Table 4, less the portion of this water exported out of the area, measured at the inlets to Franklin and Stone Canyon Reservoirs and at the North Hollywood Pumping Plant shown on Plate 21, plus the amount which is returned through the City's system for use within the Narrows water service area of the City of Los Angeles. Annual amounts of Owens River import thus determined and purchases of Colorado River water delivered to entities in the Upper Los Angeles River area are shown in Table 8 along with the total import.

TABLE 8

IMPORTED WATER, UPPER LOS ANGELES RIVER AREA[a]

In Acre-Feet

Year	Owens River water[b] (1)	Colorado River water[c] (2)	Total imported water (3)
1928-29	102,550	0	102,550
29-30	109,070	0	109,070
1930-31	127,720	0	127,720
31-32	126,010	0	126,010
32-33	117,630	0	117,630
33-34	100,020	0	100,020
34-35	100,400	0	100,400
1935-36	128,540	0	128,540
36-37	92,800	0	92,800
37-38	84,550	0	84,550
38-39	102,070	0	102,070
39-40	86,860	70	86,930
1940-41	73,980	250	74,230
41-42	111,750	420	112,170
42-43	120,480	1,200	121,680
43-44	115,110	710	115,820
44-45	110,790	760	111,550
1945-46	125,900	2,210	128,110
46-47	133,210	4,470	137,680
47-48	145,580	2,540	148,120
48-49	136,600	1,730	138,330
49-50	148,460	960	149,420
1950-51	156,050	2,490	158,540
51-52	144,440	3,890	148,330
52-53	160,530	5,020	165,550
53-54	154,700	8,750	163,450
54-55	156,830	9,570	166,400
1955-56	158,580	10,560	169,140
56-57	160,910	13,250	174,160
57-58	162,020	13,050	175,070
Maximum	162,020	13,250	175,070
Minimum	73,980		

a. See Appendix M for details of this determination. Does not include rain on and runoff to water supply reservoirs in the Upper Los Angeles River area.
b. Imported by City of Los Angeles.
c. Imported by City of Los Angeles and defendants numbers 2, 3, 7, and 8.

Water Quality

To determine the quality of waters within the area of investigation and effect thereon of the importation of Owens Valley and Colorado River waters, approximately 1,500 ground water analyses, 125 surface water analyses and 500 analyses of imported water were compiled and studied.

The standards of water quality and the quality of native and imported waters are discussed herein with detailed information on water quality contained in Appendix H.

Standards of Water Quality

The drinking water standards adopted by the State of California are generally based on the United States Public Health Service Drinking Water Standards of 1946. However, the adopted standards were revised by the State in 1959 to, in effect, reduce the maximum allowable fluoride content from the previous limit of 1.5 parts per million (ppm) to less than 1.0 ppm for the San Fernando Valley area. The California Department of Public Health has also adopted a policy of issuing temporary permits allowing higher limits for total solids, sulfate, chloride and magnesium than it requires when issuing regular permits.

Chemical Characteristics of Water

The chemical character of water provides a means of identifying the water source and the movement of a particular water as it occurs as runoff or as ground water. The characteristics are expressed in percent cations (positive ions) and percent anions (negative ions) of the dominant elements or compounds. For example, a sodium bicarbonate water is one in which the sodium is equal to or greater than 50 percent of the cations and the bicarbonate is equal to or greater than 50 percent of the anions; a sodium-calcium bicarbonate water is one in which sodium is more abundant than calcium but is less than 50 percent of the total cations; and a sodium chloride-sulfate water is one in which chloride exceeds sulfate but is less than 50 percent of the total anions. A discussion of the chemical characteristics of imported water, surface water and ground water within the Upper Los Angeles River area follows.

Imported Water

The Los Angeles Aqueduct waters from Owens River and Mono Basin are of excellent quality, being of sodium-calcium bicarbonate character. The total dissolved solids have averaged about 215 ppm for the past 20 years at the Upper San Fernando Reservoir inlet. The highest total dissolved solids content of record, 322 ppm, occurred on April 1, 1946, whereas the low of 149 ppm occurred on September 17, 1941. For a short period of time in 1932 the boron content exceeded one part per million. The high boron water was diluted by the addition of Mono Basin water to the system and by increased storages. The boron content during the following years varied between 0.20 and 0.88 parts per million and averaged approximately 0.53 ppm. No effect of these boron waters on ground waters of the Upper Los Angeles River area has been found.

Untreated Colorado River waters are predominantly calcium sodium sulfate in character changing to sodium sulfate after treatment to reduce the total hardness. Analysis of random samples of softened Colorado River water taken at the Burbank turnout between 1941 and 1958 indicates the total dissolved solids have varied from a high of 875 ppm in August 1955, to a low of 680 ppm in September 1958 and averaged approximately 770 ppm during the period.

Representative mineral analyses of imported waters are shown in Table 9. Copies of all available mineral analyses of waters in the area are contained in the basic data. A comparison of the two imported waters as to total dissolved solids, sulfate and chloride content is shown graphically on Plate 16. These graphs illustrate the relatively consistent quality of the Owens Valley water and the variability of The Metropolitan Water District water.

Owens Valley water is for the most part served directly to customers without being commingled with other supplies. The treated Colorado River water is generally mixed with native water, as is the case with the Cities of Glendale and Burbank. However, in the Eagle Rock area of the City of Los Angeles and the upper portion of the service area of the Crescenta Valley County Water District, Colorado River water is utilized without blending.

Surface Water

Surface runoff contains salts dissolved from the rocks existing in the tributary drainage area. The watersheds of the majority of the streams in the western portion of the Upper Los Angeles River area are underlain by sedimentary rocks which contain numerous seams of gypsum and produce runoff that is calcium sulfate in character. Runoff from streams in the granitic Basement Complex in the eastern portion of the area is characteristically

TABLE 9

REPRESENTATIVE MINERAL ANALYSES OF WATER

Well number or source	Producing aquifer	Date sampled	$EC \times 10^6$ at 25°C	pH	Ca	Mg	Na	K	CO_3	HCO_3	SO_4	Cl	NO_3	F	B	Total dissolved solids ppm	Total hardness as $CaCO_3$ ppm	Source of analysis
					Mineral constituents in Parts per million (ppm) / Equivalents per million (epm)													
IMPORTED WATERS																		
Owens at Upper San Fernando Reservoir inlet,		3-4-35	387	8.0	22	7	61			140[a]	30	23					83	LADW&P
Owens at Upper San Fernando Reservoir inlet		3-17-59	312	8.01	24	5.8	33	4.0		134[a]	21	18		0.6	0.45		84	LADW&P
MWD water at City of Burbank		6-30-41		7.7	17	9	222		6	26	374	101				760	[illegible]	DPS
MWD water at City of Burbank		9-11-58		8.0	47	16	167			162	274	91	T	0.4		860	183	DPS
SURFACE WATERS																		
Los Angeles River at Gage F-57 (Flow = 5.9 cfs)		10-6-49		8.39	91	33	143			245	186	192			0.49	849	360	SDPH
Los Angeles River at Gage F-57 (Flow = 1,060 cfs)		1-10-55	185	7.4	26 1.3	3 0.28	13 0.57	4 0.102		76 1.25	43 0.89	7 0.2	4.4 0.071	0.6	0.07	277		DWR
Los Angeles River at Gage F-57 (Flow = 303 cfs)		4-26-56	256	7.3	29 1.45	4 0.30	16 0.69	3.1 0.079	0 0	92 1.50	42 0.87	11 0.30	1.6 0.010	0.5 0.026	0.05	152		DWR
Los Angeles River at Gage F-57 (Flow = 1.6 cfs)		6-4-58		8.4	114	77.5	239			200	349	190				745	514	LAUD
Los Angeles River at Sepulveda Blvd. (Flow = 4.2 cfs)		10-6-49		7.83	207	62.5	138			29	666	77			0.56	1,557	293	SDPH
Los Angeles River at Sepulveda Blvd. (Flow = 6.7 cfs)		6-4-58		8.45	148	54	128			229	694	79				1,215	590	LADW&P
Calabasas Creek at Shoup Avenue (Flow = 30 cfs)		4-1-58	360	7.6	36 1.80	11 0.90	19 0.83	6.0 0.154	0 0	95 1.56	80 1.67	16 0.45	2.5 0.04	0.5 0.026	0.14	263	[illegible]	DWR
Bull Creek at Devonshire Street (Flow = 15 cfs)		1-20-54			110 5.5	40 3.30	56 2.45	11.7 0.300		119 1.95	396 8.25	28 0.8	8.7 0.141	0.8	0.06	789		DWR
Big Tujunga Creek at Los Angeles City Boundary (Flow = ? cfs)		11-16-54	515	7.7	60 2.99	18 1.48	34 1.48	4.8 0.123	0 0	281 4.61	59 1.23	10 0.28	0 0		0.12	310		DWR
Verdugo Wash at Estelle Street (Flow = 7.0 cfs)		3-1-51	94	6.5	11 0.549	4.9 0.402	3.8 0.165	1.7 0.043	0 0	34 0.557	24 0.500	5.2 0.147	0.6 0.010		0.10	96	48	DWR
GROUND WATER, SAN FERNANDO SUBAREA																		
Los Angeles River Narrows Area																		
2760	Fill	1-24-34	2,500		138	55	335			261[a]	306	469					570	LADW&P
2760	Fill	8-7-50	1,640	7.45	115	35	186	4		280[a]	234	275	2.0	0.40	0.39		431	LADW&P
3947A	Fill	6-13-32	463		42	19	20			210	24	21	11		0.09			DWR Bull. 40A
3947A	Fill	2-8-52	540	7.4	60	24	32[b]			220	28	39	44		0.08			DWR
3947A	Fill	7-11-56	699	7.3	69 3.44	30 2.47	31 1.35	1.7 0.044		237 3.88	46 0.96	48 1.35	62 1.00	0.4 0.021	0.02	479	293	DWR

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TABLE 9

REPRESENTATIVE MINERAL ANALYSES OF WATER
(continued)

Well number or source	Producing aquifer	Date sampled	$ECx10^6$ at 25°C	pH	Ca	Mg	Na	K	CO_3	HCO_3	SO_4	Cl	NO_3	F	B	Total dissolved solids ppm	Total hardness as $CaCO_3$ ppm	Sources of analysis
					Mineral constituents in Parts per million (ppm) / Equivalents per million (epm)													
					GROUND WATER, SAN FERNANDO SUBAREA (continued)													
					Western Portion of Subarea													
3701B	Fill	6-15-32	2,240		292	85	152			339[a]	1,015	64	23		0.47			DWR Bull. 40A
3701B	Fill	7-8-57	1,935	7.42	253	68	109	2.2		302[a]	820	72	20	0.40	0.62		911	LADW&P
4735B	Fill	6-22-32	987		129	33	39			278	228	28	31		0.27			DWR Bull. 40A
4735B	Fill	12-4-56	945	7.7	112 / 5.60	31 / 2.54	44 / 1.91	2.3 / 0.06		293 / 4.8	206 / 4.29	15 / 0.42	22 / 0.35	0.3	0.02	650	407	DWR
					Eastern Portion of Subarea													
3800	Fill	7-24-34	1,210		47	23.0				186[a]	28	9					170	LADW&P
3800	Fill	6-26-58	421	7.75	54	12	18	3.3		171[a]	31	16	10	0.2			183	LADW&P
3813A	Fill	6-15-32	1,210		125	38	91			232	400	48	6		0.27			DWR Bull. 45
3820B	Fill	8-29-56	428	7.56	47	12.0	24	3.1		190[a]	44	8	4.0	0.60	0.07		167	LADW&P
3882E	Fill	9-24-31	444		51	16	21			220	25	14	9		0.12			DWR Bull. 40A
3882L	Fill	7-2-56	541	8.0	57 / 2.85	15 / 1.25	20 / 0.85	3.2 / 0.081		216 / 3.55	24 / 0.50	18 / 0.50	21 / 0.306	0.40 / 0.021	0.01	289	205	DWR
					GROUND WATER, SYLMAR SUBAREA													
4840B	Saugus	7-3-56	675	7.7	80 / 4.0	18 / 1.48	41 / 1.79	4.6 / 0.117		244 / 4.0	101 / 2.11	46 / 1.3	0.9 / 0.014	0 / 0	0.25	447		DWR
4850B	Saugus	9-25-31	536		56	23	32			241	59	36	8		0.35			DWR Bull. 45
4850B	Saugus	3-15-59	540	7.65	64	17	28	3.1		229[a]	60	32	10	0.3	0.25		231	LADW&P
5988A	Saugus	7-3-56	615	7.8	86 / 4.3	19 / 1.60	27 / 1.18	4.9 / 0.126		287 / 4.7	67 / 1.40	16 / 0.45	36.9 / 0.595	0 / 0	0.05	427		DWR
5998A	Saugus	2-27-59			42	21	37	2.5		229[a]	17	15	5	0.4	0.04		149	LADW&P
					GROUND WATER, VERDUGO SUBAREA													
3971	Fill	6-30			41	0	22			131	18	17				167	102	UPS
3971	Fill	5-57		6.9	59	16	1			162	35	26	16	0.2		275	213	UPS
5058E	Fill	2-11-49	280	7.42	33	12	23			159	14	11	15					DWR
5058E	Fill	10-17-58	515	7.8	50 / 2.5	20 / 1.65	26 / 1.11	2.6 / 0.07		149	33 / 0.69	31 / 0.88	81 / 1.3	0.3 / 0.01	0.03	318	208	CVCWD
					GROUND WATER, EAGLE ROCK SUBAREA													
3987A	Older alluvium	1-7-33		7.5	44	15	45			226	31	33				420		Sparklets
3987A	Older alluvium	1-29-60	841	7.5	74 / 3.68	34 / 2.79	48 / 2.11	2 / 0.04		276 / 4.54	85 / 1.77	53 / 1.49	31 / 0.49	0.74 / 0.04	0.20	585	324	SWRB

a. Bicarbonate value corrected from alkalinity as $CaCO_3$.
b. Value is sum of Na + K.

calcium bicarbonate. The normal character of surface waters passing stream gage F-57 during storm runoff periods is also calcium bicarbonate.

Because of a shorter period of contact between water and rock and increased dilution at large discharge rates, storm flows at Gage F-57 normally have a lower concentration of salts than does water of reduced flows. Low flows of the Los Angeles River ranging from 3 to 15 cfs at Gage F-57 had a total dissolved solids content of about 1,000 ppm in 1948, whereas an analysis of a sample taken at a flow of 3,000 cfs in 1938 indicates 115 ppm total dissolved solids. There is evidence that a large part of the increased salinity of the lower flows has been caused by the increased discharge of industrial wastes into the river during recent years. Representative mineral analyses of surface waters are shown in Table 9.

Ground Water

Ground waters from the major water-bearing formations of the Upper Los Angeles River area are of two general characters, each reflecting the composition of the surface runoff waters draining from the immediately adjacent watersheds within the area. Ground water in the western portion of the area is calcium sulfate in character whereas water pumped from the eastern portion of the area, including Sylmar and Verdugo Hydrologic Subareas, is of calcium bicarbonate character. Representative analyses of ground water in various sections of the area are shown in Table 9.

Ground waters of the area are generally within the recommended limits as set forth in the U. S. Public Health Service Drinking Water Standards, 1946. Principal exceptions to this are wells in the west end of the San Fernando Valley which penetrate the Modelo formation and which have excessive concentrations of sulfate, and waters from wells in the lower part of Verdugo Subarea which have abnormally high concentrations of nitrate.

Ground waters of the Upper Los Angeles River area are classed as moderately hard to very hard. Geochemical charts on Plate 15 show the plots of constituents in these waters in terms of percentage reacting values. All of the native waters in the area fall into the calcium-magnesium-sulfate-bicarbonate group. A comparison of the plots (Plate 15) indicates that the ground waters have remained in the same character group over the period of record. Analyses of water from well 4947A, however, indicate a pronounced increase in the total chlorides and nitrates. This increase may have been caused by the large amounts of chemical fertilizers known to have been applied in neighboring areas.

Representative records of the total dissolved solids and sulfate, chloride and nitrate ion concentrations found in water from various wells in each of the hydrologic subareas are plotted on Plates 17A through 17D. These records indicate a general chronologic increase of total dissolved solids in all subareas with a marked increase in the San Fernando Subarea at wells 3701B and 3571J and at most of the wells in the Verdugo Subarea which, in several instances, also reflect a pronounced increase in nitrate concentration. Total dissolved solids at wells 2760 and 3673 in the San Fernando Subarea, however, decreased about 600 ppm at the former during the period 1936 to 1942 and about 200 ppm at the latter in the period 1955 to 1957.

Effect of Importation of Owens River-Mono Basin Water

Water quality studies made by the Referee indicate that, except for a short period of time in 1932 when boron concentrations were above normal, the quality of waters imported from Owens River and Mono Basin have been equal or superior to the native waters of the Upper Los Angeles River area and have not otherwise adversely affected the quality of the native waters.

CHAPTER V. WATER UTILIZATION AND DISPOSAL

Presented herein are data and information on water development and use in the Upper Los Angeles River area including a determination of consumptive use by the Inflow-Outflow Method.

The data and information pertains to the requirements of Paragraphs I. 2, F., I. 2, G. and I. 4, of the Order of Reference in regard to location and capacity of diversion works of all parties* and non-parties, the amount of each party's taking and use, the place and character of the use or uses of import and other waters, and the nature and quantity of all water use and diminution within and from the area. Material is included to show the effect of changing land use and of channel improvements on the percolation of surface water supplies to the underground.

Joint Interest of Parties in Sources of Supply

In many instances several parties have an interest in the same source (well or diversion). In reporting data on a particular source, an attempt has been made to list all information under the party having the major interest. A cross reference pertaining to the joint interest in any source is listed in Table 10.

* Plaintiff and all defendants named in the Amended Complaint and in subsequent proceedings prior to July 1, 1961.

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* Plaintiff and all defendants named in the Amended Complaint and in subsequent proceedings prior to July 1, 1961.

TABLE 10

[illegible] TO JOINT INTEREST OF PARTIES

Defendant number	Party	Described under defendant number
	City of Los Angeles, Plaintiff*	
1	City of San Fernando	1
2	City of Glendale	2
3	City of Burbank	3
4	Burbank City Unified School District	4
5	Glendale Junior College District of Los Angeles County	2
6	Los Angeles County Flood Control District	6
7	La Canada Irrigation District	7
8	Crescenta Valley County Water District	8
9	State of California	Doe Corp. 4
10	Aetna Life Insurance Company	128
11	American Savings and Loan Association	195
12	American Security and Fidelity Corporation	39
13	The Andrew Jergens Company	13
14	Bank of America National Trust and Savings Association	2 and 53
15	Beatrice Foods Company	15
16	California Bank	80
17	California Bank	80
18	California Materials Company	18
19	California Trust Company	36
20	California Trust Company	36
21	Carnation Company	21
22	Citizens National Trust and Savings Bank of Los Angeles	2, 15, 35, and 200
23	Citizens National Trust and Savings Bank of Los Angeles	200
24	Citizens National Trust and Savings Bank of Los Angeles	35
25	Citizens National Trust and Savings Bank of Los Angeles	2
26	Citizens National Trust and Savings Bank of Los Angeles	35
27	Citizens National Trust and Savings Bank of Los Angeles	2
28	Citizens National Trust and Savings Bank of Los Angeles	15
29	Color Corporation of America	46 and 82
30	Consolidated Rock Products Company	30
31	Corporation of America	2
32	Corporation of America	2 and 150
33	Corporation of America	53
34	Deep Rock Artesian Water Company	34
35	Desco Corporation	36
36	Drewry Photocolor Corporation	36
37	Frank X. Enderle, Inc., Ltd.	64
38	Forest Lawn Cemetery Association	39
39	Forest Lawn Company	39
40	Forest Lawn Memorial Park Association	39
41	Freshpure Water Company	41
42	Glendale Towel and Linen Supply Company	42
43	Glenhaven Memorial Park, Inc.	43
44	Hidden Hills Corporation	45
45	Hidden Hills Mutual Water Company	45
46	Houston Color Film Laboratories, Inc. of California	46
47	Intervalley Savings and Loan Association	195
48	Knickerbocker Plastic Company, Inc.	48
49	Lakeside Golf Club of Hollywood	49
50	Lakewood Water and Power Company	126 and 67
51	Land Title Insurance Company	42
52	Land Title Insurance Company	42
53	Livingston Rock and Gravel Company	53
54	Lockheed Aircraft Corporation	54
55	Los Angeles Land and Water Company	30
56	Los Angeles Pet Cemetery	56
57	Los Angeles Trust and Safe Deposit Company	141 and 181
58	Los Angeles Trust and Safe Deposit Company	141 and 181
59	Metropolitan Life Insurance Company	2
60	Metropolitan Savings and Loan Association of Los Angeles	173
61	Montaria Lake Association	61
62	Mulholland Orchard Company	62
63	Oakmont Country Club	2
64	Oakwood Cemetery Association	64
65	Pacific Fruit Express Company	76
66	Pacific Lighting and Gas Supply Company	66
67	George H. Platt Company	67
68	Polar Water Company	68
69	Richfield Oil Corporation	105
70	Riverwood Ranch Mutual Water Company	70
71	Roger Jessup Farms	71
72	Sealand Investment Corporation	173
73	Sealand Investment Corporation	173
74	Sears, Roebuck and Company	74
75	Southern California Edison Company	75
76	Southern Pacific Railroad Company	76

* The Plaintiff - City of Los Angeles has been so identified without any number designation.

TABLE 10

CROSS REFERENCE TO JOINT INTEREST OF PARTIES
(continued)

Defendant number	Party	Described under defendant number
77	Southern Service Company, Ltd.	77
78	Sparkletts Drinking Water Corporation	78
79	Spinks Realty Company	79
80	Sportsmen's Lodge Banquet Corporation	80
81	Sun Valley National Bank of Los Angeles	188
82	Technicolor Corporation	82
83	Title Insurance and Trust Company	45
84	Title Insurance and Trust Company	128
85	Title Insurance and Trust Company	188
86	Title Insurance and Trust Company	45
87	Title Insurance and Trust Company	101
88	Title Insurance and Trust Company	164
89	Title Insurance and Trust Company	48
90	Title Insurance and Trust Company	42
91	Title Insurance and Trust Company	188
92	Title Insurance and Trust Company	2 and 150
93	Title Insurance and Trust Company	2 and 150
94	Title Insurance and Trust Company	195
95	Title Insurance and Trust Company	45
96	Title Insurance and Trust Company	46
97	Toluca Lake Property Owners Association	97
98	Union Bank and Trust Company of Los Angeles	41
99	Universal Pictures Company	99
100	Valhalla Mausoleum Park	101
101	Valhalla Memorial Park	101
102	Valhalla Properties	101
103	Valley Lawn Memorial Park	126
104	Van De Kamp's Holland Dutch Bakers, Inc.	104
105	Walt Disney Productions	105
106	Warner Bros. Pictures, Inc.	106
107	Western Mortgage Company	2
108	Leo W. Adair	2
109	Catherine Adams	141 and 181
110	Catherine Adams, Guy Krupp, Security First National Bank of Los Angeles	141 and 181
111	Mary L. Akmadzich	53
112	Peter J. Akmadzich	53 and 111
113	Margaret E. Arine	168
114	Helen Babikian	173
115	B. A. Bannan	46
116	Clotilde R. Bannan	46
117	William C. Bartholomaus	117
118	Barbara Becker	41
119	Bert Becker	41
120	Henry W. Berkemeyer	120
121	Hildur M. Berkemeyer	120
122	Elfrieda M. Bishop	122
123	W. E. Bishop	122
124	Andrea Borgia	68
125	Frances Borgia	68
126	Mark Boyar	126
127	Stella M. Brown	127
128	George A. Burns	128
129	Louise J. Burns	128
130	Rodney E. Busk	34
131	Aurora Carlson	8
132	William M. Chace	132
133	William M. Chace	132
134	Emma S. Clausen	134
135	Donald G. Cowlin	42
136	Dorothy N. Cowlin	42
137	Josephine McC Cowlin	42
138	Cecil B. De Mille	138
139	Michael Diller	67 and 126
140	Ellen S. Du Bois	117
141	Maxine Duckworth	141
142	Maxine Duckworth	141
143	Richard Erkstohlo	143
144	Ada E. Fitz - Patrick	101
145	C. C. Fitz - Patrick	101
146	Elton George	2
147	Florence H. George	2
148	Howard Barton Griffith	148
149	Irene W. Guyer	188
150	George Hanna	2
151	Hal B. Hayes	70
152	Forrest W. Hicks	42
153	Neva Bartlett Holmgrin	153
154	Marguerite Rice Jessup	71
155	Marguerite Rice Jessup	71
156	Roger Jessup	71
157	Nathan Kates	141
158	June Kelley	2
159	Victor M. Kelley	2

TABLE 10

CROSS REFERENCE TO JOINT INTEREST OF PARTIES
(continued)

Defendant number	Party	Described under defendant number
160	Samuel P. Krown	8
161	Paul E. Lancaster	188
162	William Lancaster	188
163	Lucille Mack	62
164	B. E. Mahannah	164
165	Hazel E. Mahannah	164
166	Blanche M. Mangan	Doe 1
167	Nicholas Mangan	Doe 1
168	Celeste Louise McCabe	168
169	Mariah Y. McDougal	2
170	Murray McDougal	2
171	Irene Minkler	8
172	Dean Peter Moordigian	173
173	Kisag Moordigian	173
174	Eloise V. Mosher	68
175	W. E. Mosher	68
176	Perry Mulholland	62
177	Perry Mulholland	62
178	Rose Mulholland	62
179	Rose Mulholland	62
180	Thomas Mulholland	62
181	John E. Mullin	181
182	Marvel Elizabeth Mullin	141
183	Charles Mureau	183
184	Maria Murray	188
185	Julia M. Nathan	41
186	Paul E. Pendleton	34
187	Evelyn M. Pendleton	94
188	Florence S. Plemmons	188
189	John R. Plemmons	188
190	Charles Pryor	68
191	Pleasant Thomas Renfrow	36
192	Mary Mildred Renfrow	36
193	Helen Rushworth	194
194	Lester Rushworth	194
195	Lester R. Schweiger	195
196	Cecil A. Schweiger	195
197	Benjamin B. Smith	46
198	Sidney Smith	8
199	Walter W. Stewart	35
200	C. Henry Stetson	200
201	Steve Urquides	8
202	William Urquides	8
203	Grace C. Valliant	2
204	S. M. Warner	204
205	Elizabeth A. Wheeland	205
206	H. W. Wheeland	205
207	Constance Ray White	48
208	Leo L. White	48
209	Ray C. Wilcox	46
210	R. C. Woodward	15
211	Alice M. Wright	211
212	J. Marion Wright	211
213	Donald M. Young	2
214	Marcia S. Young	2
Doe Corp. 1	Security First National Bank of Los Angeles	195
Doe Corp. 2	Southern California Service Corporation	195
Doe Corp. 3	Verdugo Savings and Loan Association	195
Doe Corp. 4	Mullin Investment Corporation	Doe Corp. 4
Doe Corp. 5	Equitable Life Assurance Society of U. S.	2
Doe Corp. 6	Title Insurance and Trust Company	2
Doe Corp. 7	Northwestern Mutual Life Insurance Corporation	2
Doe Corp. 8	Title Insurance and Trust Company	2
Doe Corp. 9	Fidelity Federal Savings and Loan Association	2
Doe 1	Nelly Louise Herrman	Doe 1
Doe 2	Henry W. Wheeland	205
Doe 3	Kenneth H. Morgan	195
Doe 4	William N. Bell	195
Doe 5	Sallie C. Bell	195
Doe 6	Anne Morgan	195
Doe 7	Irene Evelyn Wright	195
Doe 8	Ralph Carter Wright	195
Doe 9	Thelma M. Meeker	2
Doe 10	Carl H. Meeker	2
Doe 11	Laura J. LeGuay	2
Doe 12	Gladys J. Amador	2
Doe 13	Joseph E. Amador	2
Doe 14	Lester Townes Hope	Doe 14
Doe 15	Dolores Delica Hope	Doe 14
Doe 16	Leonard W. Block	41
Doe 17	Margery J. Block	41

Location of Wells and Surface Diversions

The locations of wells and surface diversions utilized by each of the parties during the period October 1, 1928 through September 30, 1958 are listed in Table 11. The locations of the wells are indicated by Los Angeles County Flood Control District well number while the surface diversion locations are indicated by the name of the stream upon which the diversion is located and the well grid coordinates wherein the diversion point is situated. The locations of all such wells known to have existed within the area of investigation are shown on Plate 18.

Extractions and Diversions

At the beginning of the investigation each party was contacted by letter and requested to indicate the information which each could furnish regarding his use of water. Those indicating that they had information were interviewed, as were many well operators and long-time residents of the area who had knowledge of the use of water extracted or diverted.

The greater part of the historical data concerning the use of water from wells for the period from 1930 to 1955 was obtained from the files of the City of Los Angeles Department of Water and Power. These data were compiled by Department of Water and Power employees in conjunction with the Department's well measurement program. Engineers of the Board have attempted to verify all data used in determining the extractions or diversions by the parties through comparison of results with correlated information concerning types and areas of crops grown, well logs, pump records and duty of water.

Information as to the beginning of extraction or diversion, the present status of the source and type of use of water (i.e., as of September 30, 1958) are listed for each party in Table 11. The term "present", where used in other tabulations presented within this chapter, also refers to September 30, 1958.

Capacity of Diversion Works

The maximum rate at which a party can extract or divert water with presently existing works has been considered herein as the capacity of his diversion works. In this regard, it should be noted that the combined capacity of a series of wells forming a well field may be less than the aggregate of these wells operated individually because of possible differences in discharge head and increased pumping lifts which may occur under combined operation. Because of the complexity of certain systems and the operational difficulties involved in establishing comparable test conditions for the various well fields belonging to the various parties, the capacity of the combined works belonging to a party has been evaluated as the aggregate of the individual extraction rates of the wells in that system. These values were determined by individual well tests where possible and from name plate or manufacturer's rating where the former method was not feasible. Capacities so determined for the present works of each party are set forth in Table 11.

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TABLE 11

INFORMATION ON WATER DEVELOPMENT AND USE BY PARTIES AND THEIR PREDECESSORS

Party	Defendant number	Capacity of diversion works in c.f.s.[a]	First year of extraction or diversion	Status of diversion works[a]	Character of use	Methods of determining extractions and diversions
Los Angeles, City of Department of Water and Power	Plaintiff		1850[c]	Active	Municipal	1911-1958 – Sparling, Simplex, and Neptune meters; pitot measurements. 1929-1931 – production by Southern California Water Company and its predecessors based on number of services; prior to 1929, unknown.
Departments of Recreation and Parks and of Public Works						1929-1951 – owner's estimate of production rate and hours of operation. 1952-1958 – metered.
TOTAL		354				
San Fernando, City of	1	10	1911[b]	Active	Municipal	1929-1931 – estimate based on population. 1932-1958 – Sparling meter. 1951-1958 – kilowatt hours and pump test for one well.
Glendale, City of	2	39	1906[c]	Active	Municipal	1922-1958 – Venturi, Sparling, Triton meters; weir. Prior to 1950 – production by Highway Highlands Water Company unknown.
Burbank, City of	3	32	1911[c]	Active	Municipal	1926-1958 – Sparling meters.
Burbank City Unified School District	4	0	1906	Destroyed	Irrigation	1906-1938 – acres irrigated and duty.
Los Angeles County Flood Control District	6	0	Unknown	Inactive	Municipal, observation	Undeterminable.
La Canada Irrigation District	7	0.8	1924	Active	Municipal	1926-1958 – Sparling and Neptune meters. 1929-1931, 1947-1954 – estimate of surface diversions based on metered sales assuming a transmission loss.
Crescenta Valley County Water District	8	8.1	1916	Active	Municipal	Prior to 1932 – undeterminable. 1932-1958 – Sparling meter.
The Andrew Jergens Company	13	0	1943	Destroyed	Industrial	1943-1956 – owner's estimate of production rate and hours of operation.
Beatrice Foods Company	15	Unknown	1939	Active	Industrial	Prior to 1955 – undeterminable. 1955-1958 – acres irrigated and duty.
California Materials Company	18	1.5	1941	Active	Industrial	1941-1956 – owner's estimate based on production rates and hours of operation. 1956-1958 – Sparling meter.
Carnation Company	21	Unknown	1940	Active	Industrial	1940-1958 – owner's estimate of plant requirement based on period of sole use of municipal water.
Consolidated Rock Products Company	30	7.9	1924	Active	Industrial	1929-1958 – owner's estimate based on material sold and processing requirements.
Deep Rock Artesian Water Company	34	Unknown	1927	Active	Industrial	1927-1928 – owner's estimate of sales and percentage of municipal water used.
Desco Corporation	35	0	1940	Destroyed	Recreation	1940-1953 – capacity of pool and owner's estimate of number of times pool filled.
Drewry Photocolor Corporation	36	0.3	1946	Active	Industrial	1946-1958 – owner's estimate of production rate and hours of operation.
Forest Lawn Company	39	5.5	1914	Active	Irrigation	1915-1924 – owner's estimate of acres irrigated and duty. 1925-1956 – owner's estimate of production rate and hours of operation. 1957-1958 – kilowatt hours and pump test.
Freshpure Water Company	41	Unknown	About 1930	Active	Industrial	1930-1958 – owner's estimate based on volume of business.
Glendale Towel and Linen Supply Company	42	Unknown	1941	Active	Industrial	1941-1958 – owner's estimate based on volume of business.
Glenhaven Memorial Park, Inc.	43	0.2	Prior to 1935	Active	Irrigation	1942-1958 – acres irrigated and duty.
Hidden Hills Mutual Water Company	45	0.4	1950	Active	Municipal	1951-1954 – based on number of services. 1955-1958 – metered.
Houston Color Film Laboratories, Inc.	46	0	1940	Inactive	Industrial	1940-1955 – owner's estimate of production rate and hours of operation.
Knickerbocker Plastic Company, Inc.	48	0.6	1953	Active	Industrial	1953-1958 – pump test and owner's estimate of hours of operation.

TABLE 11

INFORMATION ON WATER DEVELOPMENT AND USE BY PARTIES AND THEIR PREDECESSORS
(continued)

Party	Defendant number	Capacity of diversion works in c.f.s.[a]	First year of extraction or diversion	Status of diversion works[b]	Character of use	Methods of determining extractions and diversions
Lakeside Golf Club of Hollywood	49	0.4	1928	Active	Irrigation	1928-1956 - acres irrigated and duty. 1936-1950 - partially by pump capacity and hours of operation. 1956-1958 - pump test and kilowatt hours.
Livingston Rock and Gravel Company	53	2.4	1932	Active	Industrial	1932-1958 - owner's estimate of production rate and hours of operation.
Lockheed Aircraft Corporation	54	0.9	1940	Active	Industrial	1940-1958 - owner's estimate of production rate and hours of operation.
Los Angeles Pet Cemetery	56	Unknown	1929	Active	Irrigation	1929-1958 - acres irrigated and duty.
Monteria Lake Association	61	0.1	1953	Active	Recreation	1953-1958 - owner's estimate of production rate and hours of operation.
Mulholland Orchard Company	62	1.3	1925	Active	Irrigation	1925-1956 - owner's estimate of production rate and hours of operation 1956-1958 - kilowatt hours and metered production.
Oakwood Cemetery Association	64	0.3	1932	Active	Irrigation	1932-1957 - acres irrigated and duty. 1958 - pump test and owner's estimate of hours of operation.
Pacific Lighting and Gas Supply Company	66	0	1928	Inactive	Domestic	1928-1950 - number of people served and duty.
George E. Platt Company	67	Unknown	1915	Active	Irrigation, domestic and industrial	1920-1954 - acres irrigated, number of livestock watered and duty. 1955-1958 - number of people served, number of livestock watered and duty.
Polar Water Company	68	Unknown	1888	Active	Industrial	1923-1958 - owner's estimate of production rate and hours of operation.
Riverwood Ranch Mutual Water Company	70	0.3	1914	Active	Irrigation and domestic	1924-1947 - acres irrigated and duty. 1948-1949 - based on period of metered records. 1950-1958 - metered.
Roger Jessup Farms	71	0.3	1931	Active	Industrial	1931-1958 - owner's estimate of production rate and hours of operation.
Sears, Roebuck and Company	74	1.6	1938	Active	Commercial	1938-1943 - average production based on period of record. 1944-1949 - Simplex meter. 1950-1958 - measured pumping rate and average hours of operation based on period of record.
Southern California Edison Company	75	0	1890	Destroyed	Recreation	1931-1953 - estimate of pumping rate and hours of operation.
Southern Pacific Railroad Company	76	3.5	1910	Active	Industrial	1929-1946 - operator's estimate of plant capacity and hours of operation. 1947-1958 - Collins meter.
Southern Service Company, Ltd.	77	Unknown	1940	Active	Industrial	1940-1951 - owner's estimate of production rate and hours of operation. 1952-1958 - metered. 1955-1957 - estimated from partial record.
Sparkletts Drinking Water Corporation	78	0.9	1925	Active	Industrial	1925-1951 - record of sales. 1952-1958 - record of sales and measurement of backwash and zeolite solvent water.
Spinks Realty Company	79	Unknown	1914	Active	Irrigation	Prior to 1932 - undeterminable. 1932-1958 - acres irrigated and duty.
Sportsmen's Lodge Banquet Corporation	80	0.08	1914	Active	Recreation	1928-1958 - owner's estimate of production rate and hours of operation.
Technicolor Corporation	82	1.4	Prior to 1939	Active	Industrial	Prior to 1939 - undeterminable. 1939-1955 - owner's estimate of production rate and hours of operation. 1956-1958 - volumetric measurement of production rate and owner's estimate of hours of operation.
Toluca Lake Property Owners Association	97	0.2	1931	Active	Recreation	1931-1948 - estimate based on lake evaporation. 1949-1952 - undeterminable. 1953-1958 - owner's estimate of production rate and hours of operation.
Universal Pictures Company	99	0	1916	Active	Industrial	1916-1951 - based on period of record and owner's estimate of growth of company. 1952-1958 - metered.

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TABLE 11

INFORMATION ON WATER DEVELOPMENT AND USE BY PARTIES AND THEIR PREDECESSORS
(continued)

Party	Defendant number	Capacity of diversion works in c.f.s.[a]	First year of extraction or diversion	Status of diversion works[a]	Character of use	Methods of determining extractions and diversions
Valhalla Memorial Park	101	3.5	1915	Active	Irrigation	1928-1957 - acres irrigated and duty. 1958 - pump test and record of hours operated.
Van de Kamp's Holland Dutch Bakers, Inc.	104	0.2	1941	Active	Industrial	1941-1958 - owner's estimate of plant requirement based on period of sole use of municipal water.
Walt Disney Productions	105	9.5	1939	Active	Industrial	1939-1946 - based on record of hours pumped and production rate. 1947-1958 - Sparling meters.
Warner Brothers Pictures, Inc.	106	0	1901	Inactive	Industrial	1927-1946 - capacity of pool and owner's estimated number of times filled. 1947-1953 - owner's estimate of production rate and hours of operation.
William O. Bartholomaus	117	Unknown	1885	Active	Irrigation	1933-1950 - acres irrigated and duty, less water purchased. 1950-1958 - kilowatt hours and pump test.
Henry W. Berkemeyer	120	Unknown	1929	Active	Irrigation and domestic	1929-1958 - area irrigated, people served and duty.
Elfrieda M. Bishop	122	0.07	1933	Active	Irrigation	1933-1943 - undeterminable. 1944-1958 - area irrigated and duty.
Mark Boyar	126	Unknown	1948	Active	Domestic	1948-1958 - owner's estimate of production rate and hours of operation.
Stella M. Brown	127	Unknown	1900	Active	Irrigation	1929-1935 - undeterminable. 1936-1958 - acres irrigated and duty.
George A. Burns	128	Unknown	1948	Inactive	Domestic	1948-1955 - owner's estimate of production rate and hours of operation.
William M. Chase	132	0.2	1908	Active	Industrial	1928-1958 - owner's estimate of production rate and hours of operation.
Emma L. Clauson	134	0	1900	Inactive	Domestic	1900-1947 - based on domestic use.
Cecil B. DeMille	138	Unknown	Prior to 1920	Active	Irrigation and domestic	1920-1958 - acres irrigated and duty.
Maxine Duckworth	141	1.4[b]	1926	Active	Irrigation and domestic	Prior to 1936 - undeterminable. 1937-1958 - acres irrigated and duty.
Richard Erratchuo	143	0	1934	Inactive	Domestic	1934-1952 - number of people served and duty.
Howard Barton Griffith	148	Unknown	1953	Active	Irrigation	1953-1958 - based on amount of water previously purchased.
Neva Bartlett	153	Unknown	1949	Active	Domestic	1949-1958 - number of people served and duty.
E. E. Mahanneh	164	Unknown	1953	Active	Domestic	1953-1958 - number of people served and duty.
Celeste Louise McCabe	168	Unknown	1932	Active	Commercial	1932-1958 - based on volume of business.
Kisag Moordigian	173	Unknown	1933	Inactive	Irrigation	1933-1958 - acres irrigated and duty.
John E. Mullin	181	Unknown	1949	Active	Irrigation and domestic	1949-1958 - kilowatt hours and pump test.
Charles Mureau	183	Unknown	Prior to 1900	Active	Domestic	Prior to 1945 - undeterminable. 1945-1958 - number of people served and duty.
Florence S. Plemmons	188	0	1920	Destroyed	Domestic, industrial and irrigation	Undeterminable.
Lester Rushworth	194	Unknown	1940	Active	Irrigation and domestic	1940-1958 - area irrigated and duty.
Lester R. Schwaiger	195	0	1928	Destroyed	Domestic	Undeterminable.
Sidney Smith	198	0.02	Unknown	Active	Domestic	Prior to 1943 - undeterminable. 1943-1958 - Sparling meter and weir.
G. Henry Stetson	200	2.3	1915	Active	Domestic and irrigation	1926-1958 - acres irrigated and duty.

TABLE 11

INFORMATION ON WATER DEVELOPMENT AND USE BY PARTIES AND THEIR PREDECESSORS
(continued)

Party	Defendant number	Capacity of diversion works in c.f.s.[a]	First year of extraction or diversion	Status of diversion works[a]	Character of use	Methods of determining extractions and diversions
H. H. Warner	204	Unknown	1910	Inactive	Irrigation	1924-1954 - acres irrigated and duty. 1955-1958 - kilowatt hours assuming a plant efficiency.
Elizabeth A. Wheeland	205	0.02	1924	Active	Irrigation and domestic	1924-1958 - acres irrigated and duty.
Alice M. Wright	211	Unknown	1940	Active	Irrigation	1940-1958 - acres irrigated and duty.
Hollin Investment Corporation	Doe Corp. 4	Unknown	1926	Inactive	Irrigation	1928-1958 - acres irrigated and duty.
Emily Louise Herrmann	Doe 3	Unknown	Unknown	Active	Domestic	Prior to 1940 - undeterminable. 1940-1958 - based on domestic use.
Lester Townes Hope	Doe 14	Unknown	1951	Active	Irrigation	1951-1958 - area irrigated and duty.

a. As of September 30, 1958.
b. Capacity of irrigation wells.
c. Date of incorporation. Except in the case of the City of Los Angeles and its predecessor, the Pueblo of Los Angeles, water was supplied to the named cities by private interests prior to the establishment of city services.

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Quantity of Extractions and Diversions

The annual amounts of water extracted and diverted by each of the parties have been determined from meter records or estimated on the basis of the duty of water, pumpage rates and hours of operation, or power consumption and plant efficiency. Whenever possible, estimated amounts were determined by more than one method. The primary method utilized to determine the extractions and diversions of each of the various parties is listed in Table 11. The aggregate annual amounts of water extracted and diverted by all parties are shown for the period 1928-29 through 1957-58 and the years prior to 1928-29, in Tables 12 and 13, respectively. The amounts shown in Table 12 and 13 include water extracted and diverted on the valley floor and in hill and mountain areas. The latter are comparatively minor in magnitude. The annual amounts of ground water extracted and surface water diverted from individual sources within the Upper Los Angeles River area are included in the Basic Data.

TABLE 12

GROUND WATER EXTRACTIONS AND SURFACE WATER DIVERSIONS BY PARTIES AND THEIR PREDECESSORS
1928-29 THROUGH 1957-58

In Acre-Feet

Party	Defendant number	1928-29	1929-30	1930-31	1931-32	1932-33	1933-34	1934-35	1935-36	1936-37	1937-38	1938-39	1939-40	1940-41	1941-42	1942-43
Los Angeles, City of Department of Water and Power	Plaintiff	64,280[a]	66,390[a]	68,640[a]	42,593 116	39,820 95	47,870 61	51,598 78	58,591 83	53,495 111	48,788 88	47,009 219	48,294 333	51,090 284	44,963 439	55,900 441
Departments of Recreation and Parks and of Public Works[a] TOTAL		1,750 66,030	1,750 68,140	2,450 71,090	2,370 45,080	2,260 42,180	2,360 50,290	2,030 53,710	2,520 61,190	2,990 56,600	3,540 52,420	4,030 51,260	3,800 52,430	3,470 54,840	3,000 48,400	3,040 59,380
San Fernando, City of	1	1,100	1,140	1,180	1,190	1,277	1,318	1,205	1,435	1,448	1,411	1,548	1,530	1,582	1,745	1,878
Glendale, City of TOTAL	2	7,311 1,332 8,643	8,582 1,124 9,706	9,756 532 10,288	9,156 335 9,491	9,036 342 9,378	9,665 378 10,043	8,467 399 8,866	9,681 590 10,271	9,758 497 10,255	10,194 720 10,914	10,738 1,299 12,037	10,942 1,225 12,167	10,508 1,487 11,995	11,750 1,357 13,107	12,763 1,454 14,217
Burbank, City of	3	2,560	2,902	2,805	2,655	2,506	2,819	2,736	3,036	3,140	3,861	5,378	6,290	7,420	10,285	11,570
Burbank City Unified School District[d]	4	10	10	10	10	10	10	10	10	10	10	—	—	—	—	—
La Canada Irrigation District TOTAL	7	20 140 160	102 130 232	112 118 230	108 137 245	134 112 246	145 78 223	56 142 198	96 160 256	37 283 320	22 369 391	87 350 437	134 350 484	66 610 676	156 384 540	155 464 619
Crescenta Valley County Water District TOTAL	8	*	*	*	714 0 714	732 0 732	893 0 893	659 0 659	653 22 675	598 34 632	648 39 687	662 38 700	700 83 783	629 86 715	789 89 878	668 185 853
The Andrew Jergens Company[d]	13	—	—	—	—	—	—	—	—	—	—	—	—	—	—	20[p]
Beatrice Foods Company	15	—	—	—	—	—	—	—	—	—	—	*	*	*	*	*
California Materials Company	18	—	—	—	—	—	—	—	—	—	—	—	—	80	280	300
Carnation Company	21	—	—	—	—	—	—	—	—	—	—	—	2	5	5	5
Consolidated Rock Products Company	30	220	120	130	110	0	80	170	340	350	330	300	410	500	410	340
Deep Rock Artesian Water Company	34	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
Dasco Corporation[d]	35	—	—	—	—	—	—	—	—	—	—	—	—	120	120	120
Drewry Photocolor Corporation	36	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Forest Lawn Company	39	640	790	850	840	860	760	630	770	700	790	810	790	730	710	800
Fruitgrowers Water Company	41	—	*	*	*	*	*	*	*	*	*	*	1	1	1	1
Glendale Towel and Linen Supply Company	42	—	—	—	—	—	—	—	—	—	—	—	—	3	10	10
Glenhaven Memorial Park, Inc.	43	—	—	—	—	—	—	—	*	*	*	*	*	*	*	10
Hidden Hills Mutual Water Company	45	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Houston Color Film Laboratories, Inc., of California[d]	46	—	—	—	—	—	—	—	—	—	—	—	20	20	20	20
Knickerbocker Plastic Company, Inc.	48	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Lakeside Golf Club of Hollywood	49	330	330	330	330	330	330	330	330	330	390	390	390	390	390	390
Livingston Rock and Gravel Company	51	—	—	—	100	230	230	230	230	230	230	230	230	230	230	230
Lockheed Aircraft Corporation	54	—	—	—	—	—	—	—	—	—	—	—	70[p]	310[p]	310[p]	310[p]
Los Angeles Pet Cemetery	56	1	1	1	1	7	7	7	7	7	7	7	7	7	7	7
Monteria Lake Association	61	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Mulholland Orchard Company	62	1,680	1,540	1,400	1,260	720	720	720	720	720	720	720	720	720	720	720
Oakwood Cemetery Association	64	—	—	—	—	70	70	70	70	70	70	70	70	70	70	50
Pacific Lighting and Gas Supply Company[d]	66	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
George E. Platt Company	67	240	240	240	240	240	240	240	190	270	220	230	230	140	270	190
Polar Water Company	68	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Riverwood Ranch Mutual Water Company	70	10 —	10 —	10 —	10 —	10 —	0 10	0 10	0 10	0 10	0 10	10	20	20	20	20
Roger Jessup Farms	71	—	—	10	110	110	110	110	110	110	110	110	110	110	110	110
Sears, Roebuck and Company	74	—	—	—	—	—	—	—	—	—	90[p]	90[p]	90[p]	100[p]	80[p]	96[p]

Party	Defendant number	1943-44	1944-45	1945-46	1946-47	1947-48	1948-49	1949-50	1950-51	1951-52	1952-53	1953-54	1954-55	1955-56	1956-57	1957-58	Wells and surface diversions active, October 1, 1928 through September 30, 1958
Los Angeles, City of Department of Water and Power	Plaintiff	59,536 356	74,557 485	81,781 333	87,154 708	82,375 142	81,351 110	86,733 126	78,907 86	75,126 146	95,394 95	93,707 72	87,704 49	92,708 32	98,878 27	89,380 69	See well list below. Haines and Blanchard Canyons[f].
Departments of Recreation and Parks and of Public Works[a] TOTAL		2,740 62,630	2,920 77,960	4,390 86,500	2,320 90,180	3,240 85,760	3,390 84,850	3,430 90,290	3,440 82,430	2,910 78,180	2,850 98,340	2,760 96,540	2,780 90,530	2,440 95,180	2,720 101,620	2,130 91,580	See well list at end of table.
San Fernando, City of	1	1,795	1,880	1,979	2,044	2,383	2,528	2,470	2,460	2,331	1,988	1,937	2,384	3,010	2,563	2,853	4850B, 4850M, 5959, 5969, 5969A, 5969B.
Glendale, City of TOTAL	2	12,820 1,687 14,507	13,546 1,616 15,162	16,011 1,231 17,242	17,243 1,034 18,277	19,299 660 19,959	20,166 611 20,777	17,794 532 18,326	18,500 465 18,965	17,056 707 17,763	19,459 1,076 20,535	19,922 1,120 21,042	22,188 1,046 23,234	20,918 971 21,889	23,396 945 24,341	19,392 1,056 20,448	See well list at end of table. Verdugo Canyon[f].
Burbank, City of	3	12,710	13,740	13,590	13,220	15,730	16,050	16,340	17,760	18,020	19,900	20,780	21,520	20,780	20,670	19,050	See well list at end of table.
Burbank City Unified School District[d]	4	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	3872A.
La Canada Irrigation District TOTAL	7	112 524 636	203 364 567	270 289 559	350 300 650	500 210 710	431 230 660	366 190 560	296 170 466	287 260 547	322 290 610	344 290 634	346 103 449	206 73 279	166 69 235	251 101 352	5069B, 5077A. Pickens and Snover Canyons[f].
Crescenta Valley County Water District TOTAL	8	805 211 1,016	838 130 968	1,237 72 1,309	1,480 118 1,598	2,009 185 2,194	1,817 83 1,900	1,896 104 2,000	1,910 78 1,988	2,208 99 2,307	2,588 89 2,677	2,789 67 2,856	2,409 85 2,494	2,186 81 2,267	2,223 55 2,278	1,938 89 2,027	See well list at end of table. Cooks, Dunsmore, Goss, and Pickens Canyons[f].
The Andrew Jergens Company[d]	13	50[p]	50[p]	20[p]	10[p]	30[p]	30[p]	30[p]	30[p]	30[p]	30[p]	30[p]	30[p]	8[p]			3892K.
Beatrice Foods Company	15	*	*	*	*	*	*	*	*	*	*	*	*	1	1	1	1958P.
California Materials Company	18	310	300	290	330	390	380	380	360	340	370	340	240	300	350	330	4926.
Carnation Company	21	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	3082L.
Consolidated Rock Products Company	30	440	440	820	700	740	560	560	640	580	970	1,250	1,000	1,390	1,340	1,113	4909A, 4909B, 4916, 4916A.
Deep Rock Artesian Water Company	34	4	4	4	4	4	4	5	5	5	5	5	5	5	5	5	3984C, 3987D.
Dasco Corporation[d]	35	120	120	120	120	120	120	120	90	90	7	—	—	—	—	—	3083J.
Drewry Photocolor Corporation	36	—	—	2	8	11	13	17	21	24	25	27	30	30	29	21	3935.
Forest Lawn Company	39	720	790	880	1,050	1,070	1,160	1,150	1,080	1,080	1,000	530	880	1,010	1,270	920	3947A, 3947B, 3947C, 3947D, 3884F.
Fruitgrowers Water Company	41	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	3987E.
Glendale Towel and Linen Supply Company	42	10	10	10	20	20	20	20	20	20	20	20	20	20	30	30	3936.
Glenhaven Memorial Park, Inc.	43	30	50	60	70	90	110	110	110	110	120	120	180	180	120	120	6028, 6028A, 6028B, 6028C, 6028D, 6029.
Hidden Hills Mutual Water Company	45	—	—	—	—	—	—	2	8	15	25	40	67	98	115	132	See well list at end of table.
Houston Color Film Laboratories, Inc., of California[d]	46	20	20	20	20	20	30	70	70	70	70	70	20	—	—	—	3882H.
Knickerbocker Plastic Company, Inc.	48	—	—	—	—	—	—	—	—	—	150[p]	230[p]	230[p]	230[p]	230[p]	230[p]	3810K.
Lakeside Golf Club of Hollywood	49	390	390	390	390	350	320	340	180	290	360	260	280	300	330	150	3845A, 3845B, 3845C, 3855D.
Livingston Rock and Gravel Company	51	230	230	230	230	230	230	230	210	180	160	150	440	430	440	370	4916B, 4953C.
Lockheed Aircraft Corporation	54	310[p]	310[p]	310[p]	310[p]	310[p]	310[p]	310[p]	310[p]	310[p]	310[p]	160[p]	160[p]	160[p]	160[p]	150[p]	3850P, 3870, 3871B, 3871P.
Los Angeles Pet Cemetery	56	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	3554B, 3554L.
Monteria Lake Association	61	—	—	—	—	—	—	—	—	—	20	40	40	40	40	10	4722.
Mulholland Orchard Company	62	720	720	720	720	720	720	670	660	630	600	570	540	500	460	370	4718, 4735B, 4735C, 4736.
Oakwood Cemetery Association	64	50	50	50	50	50	50	50	50	50	50	50	50	50	60	70	4674, 4684B, 4684C.
Pacific Lighting and Gas Supply Company[d]	66	1	1	1	1	1	1	1	—	—	—	—	—	—	—	—	3554.
George E. Platt Company	67	270	680	680	680	680	680	680	680	680	680	680	1	1	1	1	See well list at end of table.
Polar Water Company	68	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	3838D, 3852J.
Riverwood Ranch Mutual Water Company	70	20	20	20	20	20	10	10	10	9	13	13	12	12	13	14	4982. Big Tujunga Wash[f].
Roger Jessup Farms	71	100	100	100	100	100	100	100	100	100	100	100	100	200	200	100	3921G, 3921H.
Sears, Roebuck and Company	74	70[p]	104[p]	121[p]	90[p]	88[p]	105[p]	90[p]	90[p]	90[p]	90[p]	90[p]	90[p]	90[p]	110[p]	110[p]	3965.

* Diversion in existence, but production unknown. See last page of table for footnotes.

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TABLE 12

GROUND WATER EXTRACTIONS AND SURFACE WATER DIVERSIONS BY PARTIES AND THEIR PREDECESSORS
1928-29 THROUGH 1957-58
(continued)

In Acre-Feet

Party	Defendant number	1928-29	1929-30	1930-31	1931-32	1932-33	1933-34	1934-35	1935-36	1936-37	1937-38	1938-39	1939-40	1940-41	1941-42	1942-43
Southern California Edison Company[a]	75	—	—	—	300	300	150	150	150	0	0	120	110	110	110	110
Southern Pacific Railroad Company	76	2,135	2,315	2,140	1,570	1,680	2,150	2,340	2,170	2,180	1,870	1,750	2,010	1,890	1,600	1,890
Southern Service Company, Ltd.	77	—	—	—	—	—	—	—	—	—	—	—	—	30	30	30
Sparkletts Drinking Water Corporation	78	20	20	20	20	10	20	20	20	20	20	20	20	20	20	20
Spinks Realty Company	79	*	*	*	10	20	30	30	20	20	60	10	10	10	20	20
Sportsmen's Lodge Banquet Corporation	80	220	220	220	220	220	220	220	220	220	220	60	60	60	60	60
Technicolor Corporation	82	270	270	270	270	270	270	270	270	270	270	270	270	270	270	270
Toluca Lake Property Owners Association	97	—	—	5	30	30	30	30	30	30	30	30	30	30	30	30
Universal Pictures Company	99	140	140	140	140	140	140	140	140	140	150	150	150	150	150	150
Valhalla Memorial Park	101	230	230	230	230	230	230	230	230	230	240	240	240	240	240	240
Van de Kamp's Holland Dutch Bakers, Inc.	104	—	—	—	—	—	—	—	—	—	—	—	—	30	100	100
Walt Disney Productions	105	—	—	—	—	—	—	—	—	—	—	290	570	520	440	600
Warners Brothers Pictures, Inc.	106	1	0	0	0	0	1	0	0	0	200	200	200	200	200	200
William O. Bartholomew	117	*	*	*	*	*	150	90	0	0	40	70	150	160	170	150
Henry W. Bickemeyer	120	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0
Elfrieda M. Bishop	122	—	—	—	—	—	*	*	*	*	*	*	*	*	*	*
Mark Boyar	126	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Stella M. Brown	127	*	*	*	*	*	*	*	*	10	10	10	10	10	10	10
George A. Buyas[h]	128	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
William W. Chase	132	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
Emma L. Clauson[i]	134	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Cecil B. DeMille	138	60	60	60	60	60	60	60	60	60	70	70	70	70	70	70
Maxine Duckworth	141	*	*	*	*	*	*	*	*	*	480	480	480	480	480	480
Richard Bratshaw[j]	143	—	—	—	—	—	—	1	1	1	1	1	1	1	1	1
Howard Barton Griffith	148	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Nora Bartlett	153	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
E. E. Mahlmann	164	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Celeste Louise McCabe	168	—	—	—	—	1	1	1	1	1	1	1	1	1	1	1
Kissg Moordigian	173	—	—	—	—	—	30	20	10	30	40	50	50	50	50	50
John E. Mullin	181	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Charles Moreno	183	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Florence B. Plasmond[k]	188	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Lester Backwarth	194	—	—	—	—	—	—	—	—	—	—	—	—	2	2	2
Lester R. Schmeiger	195	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Sidney Smith	198	*	*	*	*	*	*	*	*	*	*	*	*	*	*	22
H. Henry Stetson	200	100	100	100	100	100	100	90	110	100	130	80	70	60	50	90
E. M. Warner	204	390	390	390	390	380	350	350	0	0	0	0	0	0	0	0
Elizabeth A. Wheeland	205	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Alice M. Wright	211	—	—	—	—	—	—	—	—	—	—	—	—	6	20	20
Hollis Investment Corporation (TOTAL)	Doe Corp. b	540 / 500 / 1,040	540 / 500 / 1,040	540 / 500 / 1,040	540 / 500 / 1,040	630 / 270 / 900	470 / 440 / 910	460 / 240 / 700	580 / 120 / 700	530 / 160 / 690	550 / 140 / 690	520 / 180 / 700	440 / 250 / 690	380 / 310 / 690	580 / 110 / 690	560 / 140 / 700
Emily Louise Hartmann	Doe 1	*	*	*	*	*	*	*	*	*	*	*	1	1	1	1
Lester Townes Boys	Doe 14	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
TOTAL		86,490	90,020	93,240	66,690	63,270	88,060	74,780	83,940	79,260	77,230	79,030	81,820	85,690	83,580	97,620
Surface diversions		640	630	810	750	480	590	470	400	600	650	800	760	1,070	1,020	1,220
Extractions returned directly to ground water		—	—	—	—	—	—	—	—	—	30	90	160	410	400	420
Extractions[w]		85,850	89,390	92,630	65,940	62,790	87,470	74,230	83,540	78,660	76,490	78,140	80,880	84,210	82,160	95,980

Party	Defendant number	1943-44	1944-45	1945-46	1946-47	1947-48	1948-49	1949-50	1950-51	1951-52	1952-53	1953-54	1954-55	1955-56	1956-57	1957-58	Wells and surface diversions active, October 1, 1928 through September 30, 1958
Southern California Edison Company[a]	75	110	110	110	30	30	30	30	30	30	—	—	—	—	—	—	4932 and 4932B.
Southern Pacific Railroad Company	76	1,740	1,910	2,120	2,274	2,284	2,281	2,281	2,259	2,261	2,256	2,256	2,237	2,233	2,225	1,949	2760A, 2760B, 2760D, 2760E, 2760F.
Southern Service Company, Ltd.	77	30	30	30	30	30	30	30	30	30	30	30	30	40	30	25	3934A.
Sparkletts Drinking Water Corporation	78	30	30	30	40	40	40	40	40	100	110	110	110	120	130	140	3987A, 3987B, 3987F, 3987(1), 3987(2), 3987(3).
Spinks Realty Company	79	20	20	20	10	20	40	20	20	20	20	20	20	20	20	20	4694.
Sportsmen's Lodge Banquet Corporation	80	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	3785, 3785A.
Technicolor Corporation	82	270	270	230	380	380	380	380	380	380	380	380	380	320	300	300	3864C, 3864D, 3864E.
Toluca Lake Property Owners Association	97	30	30	30	30	30	*	*	*	*	0	120	110	110	100	100	3845F, 3855A.
Universal Pictures Company	99	150	150	150	150	150	150	150	150	174	117	227	202	173	97	14	3845C, 3845D.
Valhalla Memorial Park	101	240	240	240	240	240	240	240	240	250	250	250	250	250	180	280	3830F, 3830H, 3830J, 3830K, 3830L, 3830M.
Van de Kamp's Holland Dutch Bakers, Inc.	104	100	100	100	120	120	120	120	120	120	120	120	120	120	120	120	3958A.
Walt Disney Productions	105	550	680	660	690	700	840	810	910	1,840	1,520	1,850	1,950	1,770	1,680	1,860	3874E, 3874F.
Warners Brothers Pictures, Inc.	106	200	200	200	200	200	200	200	200	200	200	0	0	0	0	0	3864A, 3864B, 3865.
William O. Bartholomew	117	140	60	110	40	30	0	0	20	2	3	3	0	0	0	20	4921.
Henry W. Bickemeyer	120	0	0	0	0	2	2	2	2	2	2	2	2	1	1	1	4685.
Elfrieda M. Bishop	122	4	4	4	4	4	4	4	4	4	4	4	1	1	1	1	5077B.
Mark Boyar	126	—	—	—	—	—	1	1	1	1	1	1	1	1	1	1	3541.
Stella M. Brown	127	10	10	10	10	10	10	10	2	2	2	2	2	2	2	2	4860C.
George A. Buyas[h]	128	—	—	—	—	3	3	3	3	3	3	3	3	—	—	—	3624.
William W. Chase	132	50	50	50	50	50	40	30	30	20	20	20	20	20	20	6	3833.
Emma L. Clauson[i]	134	1	1	1	1	*	*	*	*	—	—	—	—	—	—	—	3651.
Cecil B. DeMille	138	70	70	70	70	70	70	70	60	60	60	60	60	40	40	40	4930A, 4931, 4931A, 4940, 4940A, 6086.
Maxine Duckworth	141	480	480	480	480	480	530	520	520	530	560	520	520	500	500	520	5997A, 5998, 5998A.
Richard Bratshaw[j]	143	1	1	1	1	1	1	1	1	1	1	—	—	—	—	—	4830A.
Howard Barton Griffith	148	—	—	—	—	—	—	—	—	—	26	26	26	26	26	26	4702.
Nora Bartlett	153	—	—	—	—	—	—	1	1	1	1	1	1	1	1	1	4973J.
E. E. Mahlmann	164	—	—	—	—	—	—	—	—	—	—	1	1	1	1	1	5076.
Celeste Louise McCabe	168	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	3852, 3852D.
Kissg Moordigian	173	50	50	50	30	30	60	40	40	40	0	0	0	40	30	0	5939.
John E. Mullin	181	—	—	—	—	—	5	20	20	7	10	10	10	40	40	10	5998B.
Charles Moreno	183	*	1	1	1	1	1	1	1	1	1	1	1	1	1	1	3544.
Florence B. Plasmond[k]	188	*	*	*	*	*	*	*	*	*	*	*	*	—	—	—	4973B, 4983D.
Lester Backwarth	194	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	3540B, 3540C.
Lester R. Schmeiger	195	*	*	*	*	*	*	*	*	*	*	*	*	—	—	—	5066.
Sidney Smith	198	23	20	19	18	17	16	14	14	15	15	15	13	10	11	11	Pickens Canyon[v].
H. Henry Stetson	200	90	90	90	110	110	110	110	130	130	130	130	130	130	130	130	5937, 5937A.
E. M. Warner	204	0	0	0	0	0	0	0	0	60	60	60	50	60	60	7	3600, 3601.
Elizabeth A. Wheeland	205	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	4830.
Alice M. Wright	211	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	3937F.
Hollis Investment Corporation (TOTAL)	Doe Corp. b	540 / 160 / 700	460 / 230 / 700	550 / 140 / 690	550 / 140 / 690	520 / 180 / 700	570 / 120 / 690	700	700	400	400	400 / 0 / 400	400 / 0 / 400	330 / 0 / 330	330 / 0 / 330	270 / 0 / 270	5988A, 5989D, 5997. Pacoima Wash[n].
Emily Louise Hartmann	Doe 1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	4850L.
Lester Townes Boys	Doe 14	—	—	—	—	—	—	—	1	1	1	1	1	1	1	1	3859E.
TOTAL		102,880	120,070	131,710	136,740	137,580	137,720	140,880	134,870	130,320	155,800	156,020	151,740	154,620	162,990	147,140	
Surface diversions		1,870	1,230	850	780	230	560	430	350	500	490	440	250	200	160	270	
Extractions returned directly to ground water		440	460	360	480	430	450	430	430	430	580	510	510	490	500	490	
Extractions[w]		100,950	118,380	130,500	135,540	136,420	136,710	140,020	134,040	129,390	154,730	155,070	150,980	153,930	162,330	146,380	

* Diversion in existence, but production unknown. See last page of table for footnotes.

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GROUND WATER EXTRACTIONS AND SURFACE WATER DIVERSIONS BY PARTIES AND THEIR PREDECESSORS
1928-29 THROUGH 1957-58
(continued)

WELL LIST

City of Los Angeles
Department of Water and Power

2771D	3800B	3821D	3842E	3884N	3884JJ	3894J	3894Z	3924B	3925S	3949	4993C
3700A	3800C	3821E	3843M	3884U	3884KK	3894K	3894AA	3924C	3925T	3949A	4993D
3770	3810	3821F	3844R	3884V	3884LL	3894L	3894BB	3924E	3925U	3949B	4994
3770A	3810A	3821G	3853F	3884W	3884MM	3894M	3914D	3924F	3926A	3959E	4994A
3770B	3810B	3821H	3853G	3884X	3884NN	3894N	3914E	3924J	3926B	4840A	4994B
3771	3810C	3830B	3854	3884Y	3884PP	3894P	3914F	3924K	3926D	4840B	4994C
3780A	3811F	3830C	3854F	3884Z	3884QQ	3894Q	3914G	3924L	3926E	4840C	4994D
3790	3813D	3830D	3863B	3884AA	3884RR	3894R	3914H	3924M	3926G	4840G	5014
3790A	3820	3831E	3863D	3884BB	3893K	3894S	3914J	3924P	3926P	4840H	
3790B	3820B	3831F	3863H	3884CC	3893L	3894T	3914K	3924Q	3926R	4983F	
3790C	3820C	3831G	3863J	3884DD	3894	3894U	3914L	3925	3926S	4983G	
3790D	3820D	3831H	3863K	3884EE	3894A	3894V	3914M	3925A	3926T	4992A	
3790F	3820E	3832K	3863L	3884FF	3894B	3894W	3914S	3925B	3926U	4992B	
3800	3821B	3832L	3874A	3884GG	3894H	3894X	3924	3925C	3926V	4993A	
3800A	3821C	3832M	3884G	3884HH	3894I	3894Y	3924A	3925D	3926W	4993B	

City of Los Angeles
Department of Recreation and Parks
and Department of Public Works

2760	3813A	3894C
3650B	3823A	3894D
3661D	3833D	3894DD
3752	3844C	3904B
3762B	3893C	3914
3764A	3893E	3915

City of Glendale

3903A	3913B	3914B	3971
3903M	3913C	3914C	3971A
3903N	3913D	3924N	3971C
3913	3913E	3961	5036
3913A	3913F	3963A	5036C
		3970	5036D

City of Burbank

3841C	3851B	3882D
3841F	3851C	3882E
3841D	3851D	3882F
3850E	3851F	3882F
	3851G	3882S

Crescenta Valley
County Water District

5036A	5058	5058E
5036B	5058A	5058F
5047	5058B	5058H
5047B	5058C	5069F
5047D	5058D	5069J

Hidden Hills
Mutual Water Company

3532	3533F	3534
3532A	3533G	3534A
3533A	3533H	3534B
3533B	3533J	3534C
3533D	3533K	3543B
		3543C

George E. Platt
Company

3540D	3570B
3561A	3570G
3561B	3571E
3561E	3571H
3561G	3571J

FOOTNOTES

a. Department of Public Works extractions made only during 1945-1946.
b. Well capped in 1938.
c. Well not used after 1955.
d. Well abandoned in 1954.
e. Well not used after 1955.
f. Well not used after 1950.
g. Well No. 4932 capped in 1945; Well No. 4932B capped in 1955.
h. Well capped in 1955.
i. Well capped in 1951.
j. Well abandoned in 1953.
k. Well No. 4973B capped in 1957; Well No. 4983 capped prior to 1955.
m. Includes gravity production.
n. Diversion located in well location grid coordinate 5997.
p. Extractions are returned directly to ground water without loss.
q. Haines Canyon diversion located in well location grid coordinate 5043. Blanchard Canyon diversion located in well location grid coordinate 5035.
r. Diversion located in well location grid coordinate 3963.
s. Pickens Canyon diversion located in well location grid coordinate 5076. Snover Canyon diversion located in well location grid coordinate 5077.
t. Cooks Canyon diversion located in well location grid coordinate 5045; Dunsmore Canyon diversion located in well location grid coordinate 5055; Goss Canyon diversion located in well location grid coordinate 5066; and Pickens Canyon diversion located in well location grid coordinate 5076.
u. Diversion located in the vicinity of well location grid coordinate 4982, exact location unknown.
v. Diversion located in well location grid coordinate 5076.
w. Does not include extractions which are returned directly to ground water without loss.

TABLE 13

ESTIMATED AND MEASURED GROUND WATER EXTRACTIONS AND SURFACE WATER DIVERSIONS OF PARTIES AND THEIR PREDECESSORS MADE PRIOR TO 1928-29 FROM SOURCES IN THE UPPER LOS ANGELES RIVER AREA

In Acre-Feet

Year	Plaintiff[a]	Defendant Number[b]											
		2	3	4	7	34	39	62	67	70	78	80	138
1913-14				10[c]									
14-15				10			70						
1915-16	52,780			10			100						
16-17	50,400			10			120						
17-18	44,780			10			130						
18-19	43,370			10			140						
19-20	40,590			10			150						60
1920-21	48,110			10			160		240				60
21-22	50,130			10			200		240				60
22-23	51,640	4,156		10			240		240				60
23-24	56,240	5,492		10			270		240				60
24-25	67,180	5,619		10			320	1,440	240	10			60
1925-26	66,150	6,474	2,112	10			400	2,100	240	10	2		60
26-27	56,980	7,296	2,376	10	6		480	1,960	240	10	4		60
27-28	60,620	8,242	2,718	10	86	4	510	1,820	240	10	20	220	60

a. Records are incomplete and do not include extractions made by the Department of Recreation and Parks, Sunland-Tujunga well field and surface diversions.

b. For name of defendant see Table 10.

c. Annual amounts 1906-07 through 1912-13 equal 10 acre-feet.

Extractions by nonparties, other than those directly known by the Referee to have extracted or diverted water, were determined from the records of the City of Los Angeles Department of Water and Power. These records, which covered the period 1932 through 1949, were compiled by Mr. Frank Carr in the course of his duties while employed by that city. The data contained information as to the owner, well location, crop and acreage irrigated, and Mr. Carr's estimate of the annual amount extracted. The Referee's staff, whenever possible, confirmed Mr. Carr's data from other data collected in the course of the investigation. Prior to 1932, the amounts of extractions by nonparties were determined from the acreages irrigated by these entities. Data for the years subsequent to 1949 were collected by the Board staff to complete the amounts of water extracted by nonparties during the 29-year base period. The data collected by the Board staff formed the basis for a report filed with the Court on current extractions of nonparties made pursuant to a request of parties in Open Court on July 29, 1960. The report included all other nonparties known by the Board staff to presently be taking significant amounts of water except single domestic users in the hill and mountain areas. The names and amounts of extractions and diversions by nonparties shown in Table 14 are based on the information presented in the aforementioned report and on other records as heretofore noted.

TABLE 14

ESTIMATED AND MEASURED GROUND WATER EXTRACTIONS
AND SURFACE WATER DIVERSIONS OF NONPARTIES

In Acre-Feet

Year	Nonparty number[a]													Others[b]	Total[c]
	1	2	3	4	5	6A	6B	7	8	9A	9C	9D	9E		
1928-29				20							340			3,510	3,870
29-30				20							340			3,500	3,860
1930-31				20							340			3,420	3,780
31-32				20							190			3,270	3,480
32-33				20							540			3,980	4,540
33-34				20							460			4,010	4,490
34-35				0							320			4,310	4,630
1935-36				0							350			4,370	4,720
36-37				0					60		480			4,470	5,010
37-38				20			40		60		410			5,210	5,740
38-39				20			30		60	0	380			5,620	6,110
39-40				20			40		70	20	180		90[f]	5,170	5,500
1940-41				20			40		70	20	80		150[f]	3,550	3,780
41-42				20			40		60	20	100		150[f]	4,060	4,300
42-43				20			50		90	20	60		150[f]	3,110	3,350
43-44				20			50		90	20	110		150[f]	3,290	3,580
44-45				20			60		70	20	110		150[f]	3,570	3,850
1945-46				20			70		60	20	100		150[f]	2,500	2,770
46-47				20		20	80		40	20	100		150[f]	1,320	1,660
47-48				20		20	60		10	20	100		150[f]	1,220	1,450
48-49				20		40	60		0	20	150		150[f]	1,080	1,370
49-50				20		50	60		10	20	200		150[f]	790	1,150
1950-51	10	30		20		60	80	20[d]	0		200		150[f]	590	1,010
51-52	10	30	10	20		60	90	30[d]	0		200		150[f]	430	880
52-53	10	30	10	20		50	80	60[d]	0		200		150[f]	100	640
53-54	10	30	10	20		40	80	70[d]	0		70		0	100	510
54-55	10	30	10	20	0	30	70	120[d]	10		240		0	40	580
1955-56	10	30	10	20	10	40	60	290[d]	30		230	0	0	10	730
56-57	10	30	10	20	10	20	80	490[d]	10		230	30[e]	0	30	940
57-58	10	30	10	20	10	40	90	620[d]	40		280	30[e]	0	0	1,140

a. Nonparty numbers are those referred to in the Report made pursuant to request made in Court on July 29, 1960. Nonparty numbers and names are tabulated below.
b. Determined from the records of Los Angeles Department of Water and Power employee Frank Carr, 1929 through 1949.
c. Total considered as all extractions but contains minor amounts of surface diversions.
d. Includes water extracted adjacent to and outside of the Upper Los Angeles River topographic boundary.
e. Included in amounts shown under nonparty No. 7.
f. Included in amounts shown under Defendant No. 54.

Nonparty number	Nonparty	Method of estimating extractions and diversions
1	Simi Hills Development Association	Production rate and hours of operation.
2	Chatsworth Lake Mutual Water Corporation	Production rate and hours of operation.
3	Twin Lakes Park Company	Use per capita.
4	Restland Memorial Park	Acres irrigated and duty of water.
5	Aqua Sierra Sportsman Club	Acres irrigated and duty of water.
6	Los Angeles County	Acres irrigated and duty of water
	A. Dexter Park	Pump test and kilowatt hours.
	B. Waterworks District No. 21	Pump test and kilowatt hours.
7	North American Aviation, Inc. Rocketdyne Division	Measured.
8	Louis J. Le Messager	Water sales.
9	United States of America	
	A. Veterans Hospital, Northwest of San Fernando	Extension of one year's measurements.
	C. Sepulveda Dam lease to Frank Ghiglia	Acres irrigated and duty of water.
	D. Adjacent to North American Aviation, Inc.	Measured.
	E. Adjacent to Lockheed Aircraft Corporation	Production rate and hours of operation.

Tables 12, 13 and 14 list the extractions and diversions within the Upper Los Angeles River area that have been made by entities who are parties and nonparties including known nonparty entities and taking by others whose individual identity is unknown. Total amounts extracted from the valley fill and hill and mountain areas, compiled from the data in Tables 12 and 14 and the records on private wells maintained by the City of Los Angeles Department of Water and Power, are shown in Table 15. Surface diversions for use on the valley floor are shown in Table 16.

The total amount of ground water extracted annually during the 29-year base period has increased generally with time, from approximately 70,000 acre-feet in the early 1930's to 150,000 acre-feet in the late 1950's. During the 29-year base period the minimum and maximum annual extractions were 67,333 and 163,270 acre-feet in 1932-33 and 1956-57, respectively.

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TABLE 15

GROUND WATER EXTRACTIONS[a]

In Acre-Feet

Year	Valley Fill area Party (1)	Non-party (2)	Total (1)+(2) =(3)	Hill and mountain area Party (4)	Non-party (5)	Total (4)+(5) =(6)	Upper Los Angeles River area Party (7)	Non-party (8)	Total (7)+(8) =(9)
1928-29	85,840	3,870	89,710	10		10	85,850	3,870	89,720
29-30	89,380	3,860	93,240	10		10	89,390	3,860	93,250
1930-31	92,620	3,780	96,400	10		10	92,630	3,780	96,410
31-32	65,930	3,480	69,410	10		10	65,940	3,480	69,420
32-33	62,770	4,540	67,310	20		20	62,790	4,540	67,330
33-34	87,450	4,490	91,940	20		20	87,470	4,490	91,960
34-35	74,210	4,630	78,840	20		20	74,230	4,630	78,860
1935-36	83,520	4,720	88,240	20		20	83,540	4,720	88,260
36-37	78,640	5,010	83,650	20		20	78,660	5,010	83,670
37-38	76,470	5,700	82,170	20	40[b]	60	76,490	5,740	82,230
38-39	78,120	6,080	84,200	20	30	50	78,140	6,110	84,250
39-40	80,860	5,460	86,320	20	40	60	80,880	5,500	86,380
1940-41	84,190	3,740	87,930	20	40	60	84,210	3,780	87,990
41-42	82,140	4,260	86,400	20	40	60	82,160	4,300	86,460
42-43	95,950	3,300	99,250	30	50	80	95,980	3,350	99,330
43-44	100,900	3,530	104,430	50	50	100	100,950	3,580	104,530
44-45	118,310	3,790	122,100	70	60	130	118,380	3,850	122,230
1945-46	130,420	2,700	133,120	80	70	150	130,500	2,770	133,270
46-47	135,450	1,570	137,020	90	90	180	135,540	1,660	137,200
47-48	136,310	1,370	137,680	110	80	190	136,420	1,450	137,870
48-49	136,580	1,260	137,840	130	110	240	136,710	1,370	138,080
49-50	139,890	1,030	140,920	130	120	250	140,020	1,150	141,170
1950-51	133,910	850	134,760	130	160	290	134,040	1,010	135,050
51-52	129,240	700	129,940	150	180	330	129,390	880	130,270
52-53	154,540	440	154,980	190	200	390	154,730	640	155,370
53-54	154,860	270	155,130	210	240	450	155,070	510	155,580
54-55	150,730	360	151,090	250	220	470	150,980	580	151,560
1955-56	153,670	330	154,000	260	400	660	153,930	730	154,660
56-57	162,050	330	162,380	280	610	890	162,330	940	163,270
57-58	146,080	380	146,460	300	760	1,060	146,380	1,140	147,520
29-Year Average 1929-57	108,790	2,950	111,740	80	100	180	108,870	3,040	111,920

a. Does not include extractions returned directly to ground water without loss.
b. Extractions unknown prior to 1937-38.

TABLE 16

SURFACE WATER DIVERSION

In Acre-Feet

Year	Valley fill (1)	Hill and mountain (2)	Total (3)
1928-29	500	140	640
29-30	500	130	630
1930-31	500	110	610
31-32	500	250	750
32-33	270	210	480
33-34	440	150	590
34-35	240	230	470
1935-36	120	280	400
36-37	160	440	600
37-38	140	510	650
38-39	180	620	800
39-40	250	510	760
1940-41	310	760	1,070
41-42	110	910	1,020
42-43	140	1,080	1,220
43-44	160	1,310	1,470
44-45	230	1,000	1,230
1945-46	140	710	850
46-47	140	640	780
47-48	180	550	730
48-49	120	440	560
49-50	0	430	430
1950-51	0	350	350
51-52	0	500	500
52-53	0	490	490
53-54	0	440	440
54-55	0	250	250
1955-56	0	200	200
56-57	0	160	160
57-58	0	270	270
29-Year Average 1929-57	180	480	660

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Land Development and Use

The San Fernando Valley is a prime example of the transformation of agricultural land into a modern suburban area. Prior to 1915, the Upper Los Angeles River area had been devoted mainly to nonirrigated agriculture. In 1928-29, irrigated agriculture occupied 47 percent of the valley floor and by 1957-58 constituted only 13 percent of the valley floor. On the other hand, residential, commercial and industrial acreage has tripled during the period 1928-29 through 1957-58 (see Figure 1). Accompanying this rapid change in land use has been a population growth of from 203,000 persons in 1930 to 850,000 in 1956. Land use in the area has been classified in four general types based on the varying influence of each on water supply and disposal. These general culture types are as follows:

1. Dry farm and native crops
2. Irrigated crops
3. Residential
4. Commercial and industrial

The areal extent of lands occupied by the major culture types requiring water (i.e., residential, commercial and industrial and irrigated crops) during the years 1928, 1949, 1955 and 1958 is depicted on Plates 22, 23, 24 and 25 respectively. These plates are based on land use surveys made in 1932, 1942, 1949, 1954 and 1958; aerial photographs taken in 1928 and 1956; crop records for the period 1925 through 1958; and censuses for the years 1930, 1940, 1950 and 1956 (see Appendix K).

Land Use

Extent of the four major culture types within the valley fill area for each year of the base period is summarized in Table 17. The variation of acreages in the dry farm and native group, irrigated crops, residential, and commercial and industrial uses during the period 1928-29 through 1957-58 is illustrated graphically on Figure 1, which indicates the general trend of land use from agricultural to urban during the last thirty years.

A detailed discussion of the data available and the methods utilized to determine the areal culture for each of the years in the 1928-29 through 1957-58 period for each of the hydrologic subareas is contained in Appendix K.

TABLE 17

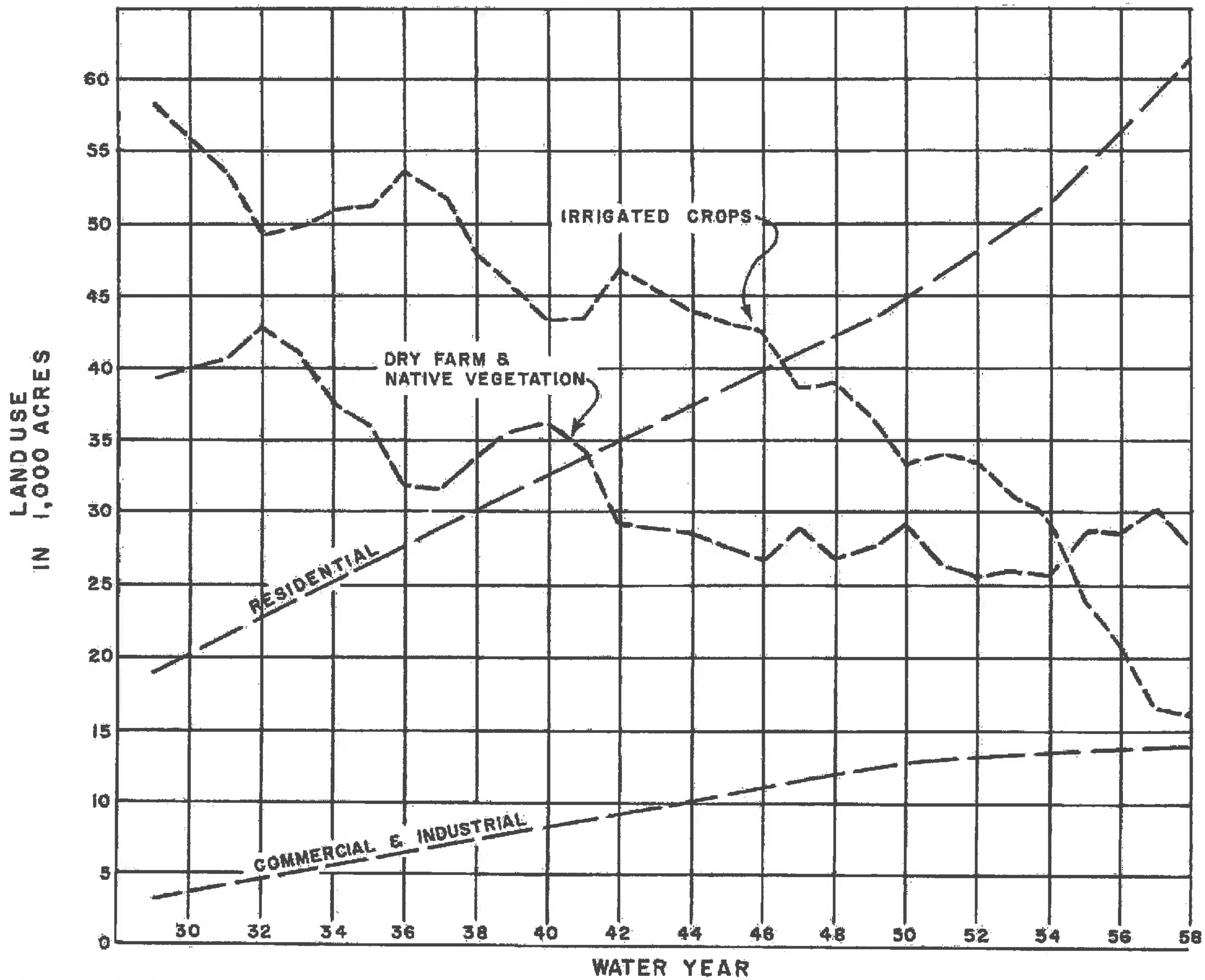
LAND USE WITHIN BOUNDARY OF VALLEY FILL

(Total Valley Fill Area = 123,400 Acres)

In Acres and Percent of Total Area

Year	Irrigated crops: Acres	Irrigated crops: Percent of total area	Residential: Acres	Residential: Percent of total area	Commercial and industrial: Acres	Commercial and industrial: Percent of total area	Dry farm and native vegetation: Acres	Dry farm and native vegetation: Percent of total area	Miscellaneous, riparian and water surface: Acres	Miscellaneous, riparian and water surface: Percent of total area
1928-29	58,380	47	19,040	15	3,010	2	39,150	32	3,820	3
29-30	55,720	45	20,260	16	3,480	3	40,120	32	3,820	3
1930-31	53,610	43	21,480	17	3,940	3	40,550	33	3,820	3
31-32	49,240	40	22,700	18	4,410	4	43,230	35	3,820	3
32-33	49,660	40	23,920	19	4,880	4	41,120	33	3,820	3
33-34	50,940	41	25,140	20	5,350	4	37,790	31	4,180	3
34-35	51,130	41	26,350	21	5,810	5	35,930	29	4,180	3
1935-36	53,550	43	27,570	22	6,280	5	31,820	26	4,180	3
36-37	52,050	42	28,790	23	6,750	5	31,630	26	4,180	3
37-38	47,910	39	30,010	24	7,210	6	34,090	28	4,180	3
38-39	45,530	37	31,230	25	7,680	6	35,560	29	3,400	3
39-40	43,350	35	32,450	26	8,150	7	36,190	29	3,260	3
1940-41	43,310	35	33,670	27	8,610	7	34,430	28	3,380	3
41-42	46,870	38	34,890	28	9,080	7	29,180	24	3,380	3
42-43	45,460	37	36,110	29	9,550	8	28,900	23	3,380	3
43-44	44,070	36	37,330	30	10,020	8	28,600	23	3,380	3
44-45	43,280	35	38,540	31	10,480	8	27,720	22	3,380	3
1945-46	42,710	35	39,760	32	10,950	9	26,450	21	3,530	3
46-47	38,400	31	40,980	33	11,420	9	29,070	24	3,530	3
47-48	38,890	31	42,200	34	11,890	10	26,890	22	3,530	3
48-49	36,340	29	43,410	35	12,350	10	27,770	23	3,530	3
49-50	33,230	27	44,990	36	12,550	10	29,100	24	3,530	3
1950-51	34,090	28	46,570	38	12,760	10	26,450	21	3,530	3
51-52	33,300	27	48,150	39	12,960	10	25,460	21	3,530	3
52-53	30,910	25	49,730	40	13,170	11	26,060	21	3,530	3
53-54	29,570	24	51,310	42	13,370	11	25,620	21	3,530	3
54-55	23,770	19	53,900	44	13,470	11	28,730	23	3,530	3
1955-56	20,960	17	56,490	46	13,570	11	28,740	23	3,640	3
56-57	16,370	13	59,070	48	13,670	11	30,250	25	4,040	3
57-58	16,170	13	61,660	50	13,770	11	27,740	22	4,060	3

FIGURE 1



SAN FERNANDO VALLEY REFERENCE

LAND USE — VALLEY FILL AREA

STATE WATER RIGHTS BOARD

Coincident with urbanization of the area there has been an increase in the proportion of the residential lot (including street rights of way) that is impervious and an increase in the miles of natural channels and washes that have been replaced by lined channels or conduits. From 1928 to 1958 the increase of impervious area occurring in privately held and publicly held areas that make up the residential lot was as follows:

Period	Percent of impervious area in a typical residential lot
1928-29 through 1944-45	35
1946-47 through 1949-50	40
1950-51 through 1954-55	45
1955-56 through 1957-58	50

Channel Improvements

The increased area of impervious lands has caused larger amounts of runoff to be discharged into the drainage system of the area. The quantity of runoff which becomes recharge to the ground water reservoir is limited by the pervious area over which the runoff flows. The need for flood control has resulted in the improvement of most of the Los Angeles River Channel and many of the tributary washes and channels. The urbanization of the area and present channel improvements have the combined effect of reducing the opportunity of native waters to recharge the ground water reservoir. The extent of channel improvements since 1928 is shown in Table 18 by a listing of the main wash and channel improvements having a constructed bottom width of 10 feet or greater and their cumulative length in relation to the total length of main channels. The locations of major improved channel reaches as well as the major storm drains existing as of 1958 are shown on Plate 12.

TABLE 18

WASH AND CHANNEL IMPROVEMENTS[a]

Year	Name of channel	Length of channel improvement, in miles	Total channels, in miles	Channels improved to date: Miles	Channels improved to date: Percent
1929-30	Verdugo Wash	0.32	137.6	0.3	0.2
1931-32	Pacoima Wash	1.32			
	Sycamore Canyon	4.97			
	Verdugo Wash	0.17	137.6	6.8	4.9
1932-33	Verdugo Wash	0.50	137.6	7.3	5.3
1933-34	Verdugo Wash	1.29	137.6	8.6	6.2
1934-35	Pickens Canyon	2.51			
	Verdugo Wash	0.64	137.6	11.7	8.5
1935-36	Dunsmuir Canyon	1.78			
	Eagle Canyon	1.86			
	Halls Canyon	2.04	137.6	17.4	12.6
1937-38	Haines Canyon	3.80			
	Verdugo Wash	1.84	137.6	23.0	16.7
1938-39	Burbank Western Storm Drain	0.65			
	Los Angeles River[b] (Station 24.3 - 33.6)	9.26	137.6	33.0	23.9
1939-40	Los Angeles River (Station 24.1 - 24.3)	0.20	137.6	33.2	24.1
1940-41	Los Angeles River[c] (Station 42.4 - 45.4)	2.92	137.6	36.1	26.2
1941-42	Aliso Canyon Wash[d]	2.60	137.6	38.7	28.1
1947-48	Los Angeles River (Station 33.6 - 35.3)	1.71	137.6	40.4	29.3
1948-49	Los Angeles River (Station 35.3 - 37.6)	2.31	137.6	42.7	31.0
1949-50	Tujunga Wash	2.08	137.6	44.8	32.5
1950-51	Los Angeles River (Station 37.6 - 39.6)	2.04	137.6	46.8	34.0
1951-52	Burbank Western Storm Drain	1.62			
	Cooks Canyon	1.27			
	Los Angeles River (Station 39.6 - 41.3)	1.65			
	Tujunga Wash	7.39	128.4	58.7	45.7
1952-53	Aliso Canyon Wash	1.96			
	Browns Canyon Wash[e]	1.32			
	Bull Canyon Wash[c]	4.36			
	Pacoima Diversion Channel	2.31			
	Pacoima Wash	1.71			
	Los Angeles River (Station 41.3 - 42.4)	1.15	125.2	71.6	57.1
1953-54	Pacoima Wash	1.86	125.2	73.4	58.6
1954-55	Bull Canyon Wash	2.26			
	Los Angeles River (Station 45.4 - 47.0)	1.67	125.2	77.3	61.8
1955-56	Bull Canyon Wash	1.52	125.2	78.9	63.0
1956-57	Los Angeles River (Station 47.0 - 48.8)	1.80	125.2	80.7	64.4
1957-58	Los Angeles River (Station 48.8 - 50.8)	2.00	125.2	82.7	66.0

a. Only washes and channels having an improved bottom width of 10 feet or greater.
b. Includes 7.72 miles of open bottom channel.
c. Open bottom channel.
d. Includes 1.07 miles of open bottom channel.
e. Includes 0.50 miles of open bottom channel.

Stations in parentheses for the Los Angeles River represents the stream miles system starting with station 24.1 at Gage F-57 and increasing upstream.

Place and Character of Water Use

The major portion of the water delivered within the Upper Los Angeles River area is served by six agencies: the Cities of Burbank, Glendale, San Fernando and Los Angeles; the Crescenta Valley County Water District; and the La Canada Irrigation District. The service area to which each of these agencies delivers or serves water within the area of investigation is shown on Plate 19. In all but two of these service areas the water delivered is a mixture of imported water and local ground water. These exceptions are the Owens River service area of the City of Los Angeles where only imported Owens River water is delivered and the City of San Fernando where the sole source of supply is local ground water.

The place of use (service area) of each of the remaining parties serving water in the area, including 77 individuals, corporations, and water companies, is shown on Plate 20. The separate location of each is identified by the defendant number used in the complaint and as listed in Table 11. Additional sources of supply may be available to the service areas of individual parties through the distribution systems of cities or districts in which the service area is located.

The character of water use or uses of each party is set forth in Table 11. The definition of each of the six general types of use reported therein is as follows:

1. Domestic - Use for residences, including incidental irrigated garden and orchard.
2. Industrial - Use by a manufacturing or service industry which requires water to be used directly in the manufacturing process or service.

3. Commercial - Use by dry manufacturing and other commercial establishments whose primary water requirement is the lavatory needs of employees and clients and includes incidental irrigation of ornamental plants.

4. Irrigation - Use for irrigated agriculture including incidental stock-water and domestic use.

5. Recreation - Use for swimming, boating, hunting or fishing.

6. Municipal - Use for domestic, industrial, commercial, irrigation and recreation purposes including appurtenant fire protection and use for other municipal functions of entities serviced by a municipality, public utility or district.

Ground and Surface Water Exports From the Upper Los Angeles River Area

Waters derived from ground and surface water sources within the Upper Los Angeles River area have been exported therefrom by the City of Los Angeles and the La Canada Irrigation District. During the 1928-29 through 1957-58 period ground water export has been made every year by the City of Los Angeles. Both ground and surface waters were exported by the La Canada Irrigation District from 1928-29 through 1949-50.

Ground water extracted by the City of Los Angeles from the Los Angeles River System, comprised of the North Hollywood, Erwin, Whitnall, Verdugo, Deep Gallery, Headworks, Crystal Springs and Pollock well fields, is all measured and is transported to reservoirs outside the Upper Los Angeles River area (see Plate 21). A portion of this water is returned to the area to meet part of the water requirement in the City of Los Angeles Narrows service area. The difference between these amounts is equal to the ground water exported by the City of Los Angeles and is shown in Table 19.

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Forty-two percent of the La Canada Irrigation District service area is located within the Upper Los Angeles River area. The District obtains its supply from surface and ground water sources in the area and from outside sources. Export by this entity has been evaluated as the amount that its extractions and diversions within the Upper Los Angeles River area have exceeded 42 percent of the total amount delivered within the District boundaries. Export occurred under these conditions during 1928-29 through 1949-50 and the amounts so determined are tabulated in Table 19. Derivation of these values is contained in Appendix M.

TABLE 19

EXPORT OF GROUND WATER[a]
FROM UPPER LOS ANGELES RIVER AREA

In Acre-Feet

Year	Exportation by City of Los Angeles (1)	Exportation by La Canada Irrigation District (2)	Total (3)
1928-29	54,810	20	54,830
29-30	57,190	80	57,270
1930-31	59,390	70	59,460
31-32	34,220	100	34,320
32-33	31,910	100	32,010
33-34	54,060	80	54,140
34-35	42,820	80	42,900
1935-36	49,510	90	49,600
36-37	44,270	160	44,430
37-38	38,550	210	38,760
38-39	36,260	230	36,490
39-40	37,860	230	38,090
1940-41	40,700	270	40,970
41-42	33,330	300	33,630
42-43	43,930	340	44,270
43-44	47,300	340	47,640
44-45	61,900	300	62,200
1945-46	68,030	210	68,240
46-47	73,170	280	73,450
47-48	67,810	280	68,090
48-49	66,890	190	67,080
49-50	72,740	50	72,790
1950-51	66,380	0	66,380
51-52	63,040	0	63,040
52-53	81,980	0	81,980
53-54	83,510	0	83,510
54-55	80,170	0	80,170
1955-56	84,000	0	84,000
56-57	90,750	0	90,750
57-58	83,280	0	83,280
29-Year Mean 1929-57	57,460	140	57,600

a. Includes a minor amount of surface water exported by La Canada Irrigation District

Source and derivation of values by column numbers:
1. Net export of ground water from Table M-6.
107 2. Export from Table M-7 rounded off to nearest 10 acre-feet.
3. Sum of columns 1 and 2.

Delivered Water

The total amount of water made available to water systems in the Upper Los Angeles River area through importation, ground water extractions, surface diversions and including minor amounts of precipitation on and runoff into surface water supply reservoirs has been considered as the gross delivered water in the area. The "gross available for distribution" has been taken as the gross delivered water less the evaporative loss in surface water supply reservoirs. Gross amounts supplied to distribution systems serving hill and mountain areas and valley fill areas have been determined separately as have the amounts of water from each basic source (i.e., import, ground water and surface diversion) which comprise the gross water available for distribution in each hydrologic subarea.

Net deliveries for use have been taken as the total of all waters delivered to agricultural, residential, commercial and industrial areas and are based primarily on the amounts of metered sales to customers. Use of water for operational spills and spreading operations and loss of water in the water system have been evaluated separately.

Gross Delivered Water in the Upper Los Angeles River Area

Annual amounts of gross delivered water have been determined for each year of the 1928-29 through 1957-58 period as the sum of the total import shown in Table 8, local ground water extractions shown in Table 15, and local surface diversions shown in Table 16, less net exportations of ground water shown in Table 19. The net effect of precipitation and local runoff inflow plus water withdrawn from storage in San Fernando, Chatsworth and Encino reservoirs, have been added to the foregoing to evaluate the gross delivered water listed in Table 20.

Gross Delivered Water on Valley Fill and Hill and Mountain Areas. The annual amounts of delivered water served to acreages in the hill and mountain areas were estimated on the basis of the acreage served and the duty of water as set forth in Appendixes J and K. Gross delivered water on the valley fill area is the total gross water delivered within the Upper Los Angeles River area less gross deliveries to the hill and mountain areas. Delivered water derived from each of the basic sources (i.e., the import, extractions and diversions) was determined for portions of the major water service areas contained in each hydrologic subarea (see Appendix J). Delivered water derived from each of these basic sources was determined for each hydrologic subarea as the sum of the above portions. Gross delivered water on the valley fill area thus determined for each hydrologic subarea is set forth in Table 21.

Gross Available for Distribution

The gross delivered water and gross available for distribution are identical for hill and mountain areas. In the valley fill area the gross delivered exceeds the gross available for distribution by the amount of the reservoir evaporation from the three major water supply reservoirs of the City of Los Angeles located around the edge of the valley fill. The historic variation in gross available for distribution on the valley fill area is shown on Figure 2, page 140. Annual amounts of gross water available for distribution on the valley fill area are shown by ordinates on Figure 2 and are tabulated in column 18, Table 20.

TABLE 20

SUMMARY OF GROSS DELIVERED WATER AND GROSS AVAILABLE FOR DISTRIBUTION

In Acre-Feet

Upper Los Angeles River Area								
Year	Ground water extractions (1)	Ground water export (2)	Ground water remaining (1)-(2)=(3)	Surface water diversions (4)	Import (5)	Gross delivered water (3)+(4)+(5)=(6)	Reservoir evaporation (7)	Gross available for distribution (6)-(7)=(8)
1928-29	89,720	54,630	34,890	640	105,750	141,280	5,270	136,010
29-30	93,250	57,270	35,980	630	113,010	149,620	5,350	144,270
1930-31	96,410	59,460	36,950	610	118,290	155,850	5,990	149,860
31-32	69,420	34,320	35,100	750	124,820	160,670	4,600	156,070
32-33	67,330	32,010	35,320	480	118,610	154,410	5,390	149,020
33-34	91,960	54,140	37,820	590	104,950	143,360	5,240	138,120
34-35	78,860	42,900	35,960	470	103,650	140,080	4,290	135,790
1935-36	88,260	49,600	38,660	400	124,910	163,970	4,830	159,140
36-37	83,670	44,430	39,240	600	99,270	139,110	4,700	134,410
37-38	82,230	38,760	43,470	650	93,240	137,360	4,500	132,860
38-39	84,250	36,490	47,760	800	104,350	152,910	4,940	147,970
39-40	86,380	38,090	48,290	760	86,000	135,050	4,800	130,250
1940-41	87,990	40,970	47,020	1,070	78,100	126,190	4,170	122,020
41-42	86,460	33,630	52,830	1,020	118,850	172,700	4,740	167,960
42-43	99,330	44,270	55,060	1,220	131,400	187,680	4,720	182,960
43-44	104,530	47,640	56,890	1,470	113,580	171,940	4,540	167,400
44-45	122,230	62,200	60,030	1,230	118,700	179,960	4,440	175,520
1945-46	133,270	68,240	65,030	850	131,170	197,050	4,560	192,490
46-47	137,200	73,450	63,750	780	139,810	204,340	4,720	199,620
47-48	137,870	68,090	69,780	730	145,660	216,170	4,970	211,200
48-49	138,080	67,080	71,000	560	144,110	215,670	4,690	210,980
49-50	141,170	72,790	68,380	430	142,750	211,560	4,620	206,940
1950-51	135,050	66,380	68,670	350	166,430	235,450	4,570	230,880
51-52	130,270	63,040	67,230	500	150,480	218,210	4,550	213,660
52-53	155,370	81,980	73,390	490	168,740	242,620	4,760	237,860
53-54	155,580	83,510	72,070	440	166,470	238,980	4,280	234,700
54-55	151,560	80,170	71,390	250	166,630	238,270	4,680	233,590
1955-56	154,660	84,000	70,660	200	164,680	235,540	4,050	231,490
56-57	163,270	90,750	72,520	160	180,900	253,580	4,630	248,950
57-58	147,520	83,280	64,240	270	175,420	239,930	4,800	235,130
29-Year Average 1929-57	111,920	57,600	54,320	660	128,460	183,430	4,750	178,690

Source and derivation of values by column numbers:

Column No.

1. Table 15, Column 9.
2. Table 19, Column 3.
4. Table 16, Column 3.
5. Table 8, Column 3 minus annual change in reservoir storage, Table M-1, Column 4, Appendix M plus rain on reservoirs and runoff into reservoir, Table M-1, Columns 5 and 6, Appendix M.
7. Table M-1, Column 11, Appendix M.

TABLE 20

SUMMARY OF GROSS DELIVERED WATER AND GROSS AVAILABLE FOR DISTRIBUTION
(continued)

In Acre-Feet

Year	Hill areas				Valley Fill Area					
	Import	Ground water		Gross delivered water	Import	Rain and runoff to reservoir	Ground water extractions	Surface diversion	Gross delivered water	Gross Available for Distribution
		Extracted in hills	Delivered from valley floor							
	(9)	(10)	(11)	(9)+(10)+(11)= (12)	(13)	(14)	(15)	(16)	(13)+(14)+(15)+(16)=(17)	(17)-(7)=(18)
1928-29	0	10	2,290	2,300	104,770	980	32,590	640	138,980	133,710
29-30	0	10	3,640	3,650	112,060	950	32,330	630	145,970	140,620
1930-31	20	10	4,340	4,370	117,140	1,130	32,600	610	151,480	145,490
31-32	30	10	4,530	4,570	120,880	3,910	30,560	750	156,100	151,500
32-33	50	20	4,650	4,720	117,440	1,120	30,650	480	149,690	144,300
33-34	60	20	4,630	4,710	103,190	1,700	33,170	590	138,650	133,410
34-35	80	20	4,410	4,510	101,910	1,660	31,530	470	135,570	131,280
1935-36	90	20	4,890	5,000	123,210	1,610	33,750	400	158,970	154,140
36-37	110	20	5,430	5,560	94,020	5,140	33,790	600	133,550	128,850
37-38	130	60	6,140	6,330	86,390	6,730	37,270	650	131,040	126,540
38-39	140	50	6,790	6,980	101,760	2,450	40,920	800	145,930	140,990
39-40	160	60	6,920	7,140	84,190	1,650	41,310	760	127,910	123,110
1940-41	190	60	6,470	6,720	68,770	9,140	40,490	1,070	119,470	115,300
41-42	220	60	7,420	7,700	117,310	1,520	45,350	1,020	165,000	160,260
42-43	280	80	6,580	6,940	127,150	3,970	48,400	1,220	180,740	176,020
43-44	320	100	6,620	7,040	109,870	3,390	50,170	1,470	164,900	160,360
44-45	440	130	6,590	7,160	116,750	1,510	53,310	1,230	172,800	168,360
1945-46	750	150	7,980	8,880	129,280	1,140	56,900	850	188,170	183,610
46-47	910	180	6,290	7,380	137,650	1,240	57,280	780	196,960	192,240
47-48	1,160	190	4,420	5,770	143,930	570	65,170	730	210,400	205,430
48-49	1,350	240	4,840	6,430	142,150	610	65,920	560	209,240	204,550
49-50	1,820	250	7,320	9,390	139,990	940	60,810	430	202,170	197,550
1950-51	2,530	290	6,930	9,750	163,120	780	61,450	350	225,700	221,130
51-52	3,170	330	7,020	10,520	143,210	4,100	59,880	500	207,690	203,140
52-53	3,750	390	7,360	11,500	163,920	1,070	65,640	490	231,120	226,360
53-54	5,310	450	6,600	12,360	160,030	1,130	65,020	440	226,620	222,340
54-55	6,960	470	6,410	13,840	158,580	1,090	64,510	250	224,430	219,750
1955-56	7,630	660	6,380	14,670	155,500	1,550	63,620	200	220,870	216,820
56-57	9,140	890	6,560	16,590	170,730	1,030	65,070	160	236,990	232,360
57-58	11,020	1,060	5,840	17,920	160,820	3,580	57,340	270	222,010	217,210
29-Year Average 1929-57	1,610	180	5,880	7,670	124,650	2,200	48,260	660	175,760	171,020

Source and derivation of values by column numbers:

Column No.

9. Table J-13, Appendix J.
10. Table 15, Column 6.
11. Delivered ground water to hill areas, Table J-13 minus Column 10.
13. Table 8, Column 3 minus change in reservoir storage, Table M-1, Column 4, Appendix M minus Column 9 herein. Column 13 equals Column 5 minus Columns 9 and 14.
14. Sum of Columns 5 and 6, Table M-1, Appendix M.
15. Column 3 minus Columns 10 and 11.
16. Table 16, Column 3.

TABLE 21

GROSS DELIVERED WATER BY HYDROLOGIC SUBAREAS

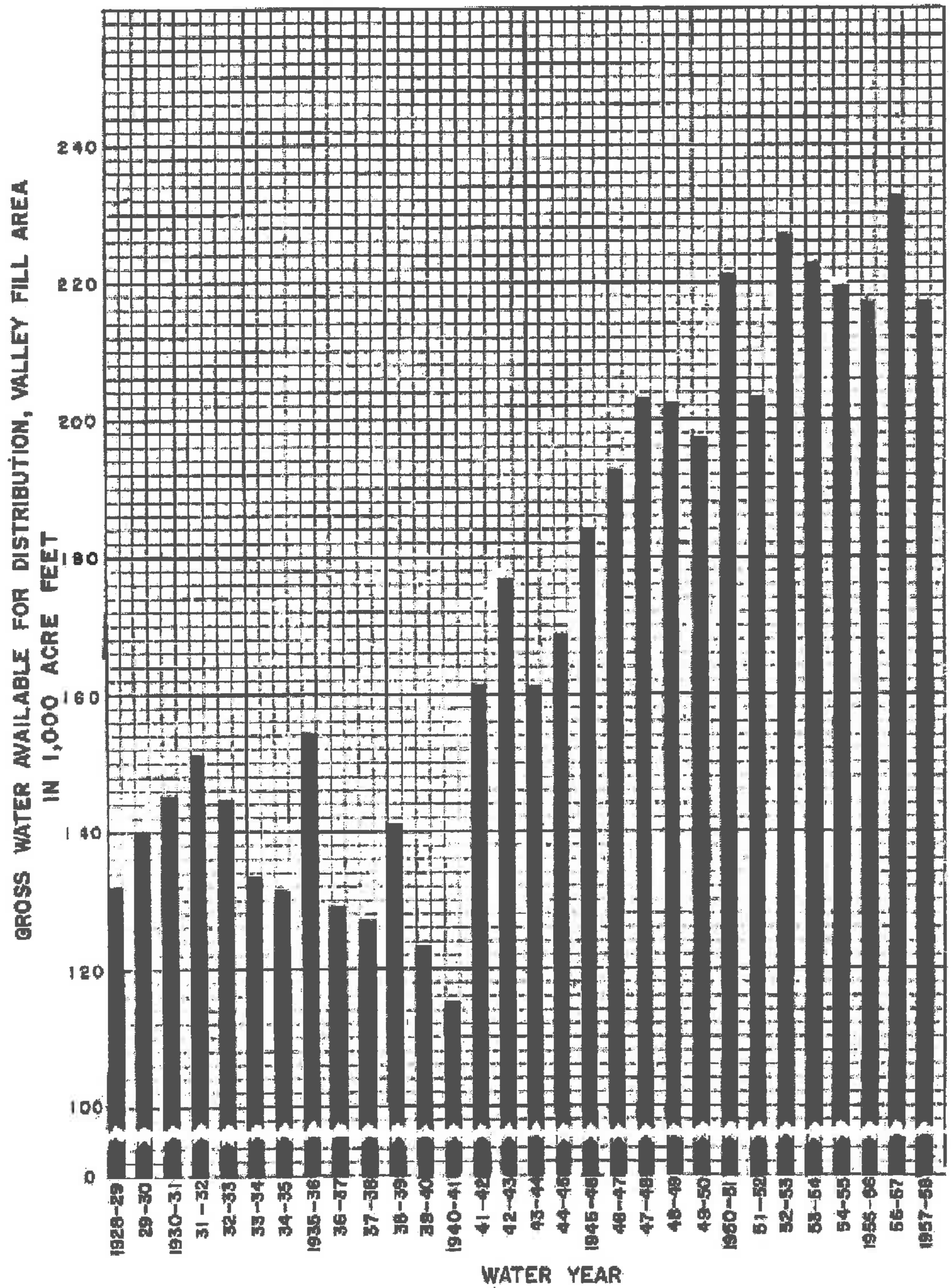
In Acre-Feet

Year	San Fernando and Eagle Rock Subareas				Sylmar Subarea				Verdugo Subarea[a]				Total gross delivered water
	Import[b]	Ground water	Surface diversion	Total	Import	Ground water	Surface diversion	Total	Import	Ground water	Surface diversion	Total	
1928-29	101,990	30,370	0	132,360	3,760	940	500	5,200	0	1,280	140	1,420	138,980
29-30	109,800	30,000	0	139,800	3,210	950	500	4,660	0	1,380	130	1,510	145,970
1930-31	115,260	30,180	0	145,440	3,010	950	500	4,460	0	1,470	110	1,580	151,480
31-32	122,300	28,140	120	150,560	2,490	950	500	3,940	0	1,460	140	1,600	156,100
32-33	115,170	28,010	100	143,280	3,390	1,060	270	4,720	0	1,580	110	1,690	149,690
33-34	101,910	30,060	70	132,040	2,980	1,100	440	4,520	0	2,010	80	2,090	138,650
34-35	100,610	28,830	90	129,530	2,960	1,040	240	4,240	0	1,660	140	1,800	135,570
1935-36	120,740	30,940	90	151,770	4,080	1,050	120	5,250	0	1,770	180	1,950	158,970
36-37	95,770	30,830	120	126,720	3,390	1,190	160	4,740	0	1,770	320	2,090	133,550
37-38	90,550	33,700	100	124,350	2,570	1,740	140	4,450	0	1,830	410	2,240	131,040
38-39	101,130	37,730	220	139,080	3,080	1,190	180	4,450	0	2,000	400	2,400	145,930
39-40	83,160	37,560	130	120,850	2,680	1,510	250	4,440	0	2,250	370	2,620	127,910
1940-41	75,110	36,930	260	112,300	2,800	1,590	310	4,700	0	1,970	500	2,470	119,470
41-42	115,040	41,020	440	156,500	3,590	1,900	110	5,600	0	2,430	470	2,900	165,000
42-43	126,740	44,090	440	171,270	4,380	1,820	140	6,340	0	2,490	640	3,130	180,740
43-44	108,730	45,820	560	155,110	4,530	1,780	160	6,470	0	2,560	760	3,320	164,900
44-45	113,470	48,800	490	162,760	4,790	1,690	230	6,710	0	2,820	510	3,330	172,800
1945-46	125,130	51,410	330	176,870	5,270	1,810	140	7,240	0	3,680	380	4,060	188,170
46-47	132,740	51,490	210	184,440	6,160	1,760	140	8,060	0	4,020	440	4,460	196,960
47-48	138,000	58,760	140	196,900	6,500	1,740	180	8,420	0	4,670	410	5,080	210,400
48-49	136,350	59,540	110	196,000	6,410	1,860	120	8,390	0	4,520	330	4,850	209,240
49-50	135,140	54,230	130	189,500	5,790	1,830	0	7,620	0	4,740	310	5,050	202,170
1950-51	157,680	54,640	80	212,400	5,990	1,840	0	7,830	240	4,960	270	5,470	225,700
51-52	142,060	53,610	120	195,790	5,120	1,530	0	6,650	130	4,750	370	5,250	207,690
52-53	158,440	58,370	100	216,910	6,150	1,250	0	7,400	400	6,010	400	6,810	231,120
53-54	155,370	57,050	70	212,490	5,350	1,240	0	6,590	440	6,730	370	7,540	226,620
54-55	153,060	57,060	50	210,170	5,650	1,280	0	6,930	960	6,170	200	7,330	224,430
1955-56	149,760	55,860	30	205,650	5,480	1,320	0	6,800	1,810	6,450	160	8,420	220,870
56-57	163,390	56,810	30	220,230	6,530	1,270	0	7,800	1,840	6,980	150	8,970	236,990
57-58	157,340	48,350	70	205,760	5,620	1,200	0	6,820	1,440	7,790	200	9,430	222,010
29-Year Average 1929-57	122,230	43,510	160	165,900	4,420	1,420	180	6,020	200	3,320	320	3,840	175,760

Note: Amounts shown are the summation of gross amounts of delivered water shown in Tables J-3, J-4 and J-5 less the amounts of water delivered to hill areas as shown in Table J-13.

a. Includes the portion of Monk Hill Basin within the Upper Los Angeles River Area.

b. Includes annual change in storage, rain on and runoff into reservoirs.



SAN FERNANDO VALLEY REFERENCE

GROSS WATER AVAILABLE FOR DISTRIBUTION
VALLEY FILL AREA

STATE WATER RIGHTS BOARD

Spread Import

Owens River water delivered by the Los Angeles Aqueduct is the only import supply of which a part is spread for direct recharge of the ground water. The City of Los Angeles commenced this operation in 1928-29 with the experimental spreading of 589 acre-feet in the vicinity of Vanowen Street and Whitsett Avenue near Tujunga Wash during that year. Including the 1928-29 experimental work, the City has spread water at its Tujunga Wash and Gravel Pits spreading grounds during 20 years of the base period. In addition to direct spreading the City rediverts Owens River water from the Los Angeles River Channel to the Headworks spreading grounds for infiltration to an underground gallery (Deep Gallery). Water collected by this gallery is then extracted through well 3884G.

The location and description of the spreading grounds and Deep Gallery are shown in Table 22 and on Plates 12 and 21. Annual amounts of Owens River water spread for direct recharge of the ground water at the Tujunga and Gravel Pits spreading grounds along with the amounts diverted to the Headworks spreading grounds from the Los Angeles River are shown in Table 23. It should be noted that the amounts of river water diverted to the Headworks spreading ground are comprised primarily of Owens River water which has been released, spilled or returned thereto from the Owens River distribution system including return from the early operation (i.e., prior to 1940) of the Los Angeles Department of Water and Power Coldwater Canyon Power Plant, line blowoff, and operational spills from reservoirs. The amounts of these diversions are included in the ground water extractions by the City of Los Angeles in Table 13.

TABLE 22

LOCATION AND DESCRIPTION OF SPREADING GROUNDS FOR OWENS IMPORT

Item	Grounds		
	Los Angeles Department of Water and Power, Tujunga Wash	Los Angeles River Headworks Spreading Grounds	Los Angeles Department of Water and Power, Gravel Pits
Type	Shallow basins	Shallow basins	Pit
Season first used	1931-32	1938-39	1930-31
Gross area, acres	180±	50±	Unknown
Wetted area, acres	25±	39.9	Unknown
Location	San Fernando Valley, east side of Tujunga Wash at Roscoe Boulevard.	San Fernando Valley, south of Los Angeles River above Mariposa Street.	Vicinity of Hansen Dam.
Source of water	Los Angeles City's Owens Valley Aqueduct.	Los Angeles River, partially controlled by various dams. Releases of Owens Valley water from Chatsworth Reservoir.	Los Angeles City's Owens Valley Aqueduct.
Remarks	Owned and operated by the Los Angeles Department of Water and Power. Prior to 1938 flood the wetted area of these grounds was 80 acres of Tujunga Wash. Tujunga Channel on westerly side of these grounds was paved in 1950.	Owned and operated by the Los Angeles Department of Water and Power. Spread at infiltration area, and pumped out from collecting galleries under area.	Operated by City of Los Angeles Department of Water and Power prior to construction of Hansen Dam in 1940.

TABLE 23

OWENS IMPORT SPREAD

In Acre-Feet

Year	Headworks[a] (1)	Spread for recharge: Tujunga (2)	Gravel Pits (3)	Total[b] (4)
1928-29	See Table 22	See Table 22	See Table 22	590[c]
29-30				0
1930-31			7,280	7,280
31-32		20,337	11,406	31,740
32-33		26,873	6,556	33,430
33-34		20,855	0	20,860
34-35		24,774	6,030	30,800
1935-36		19,309	3,407	22,720
36-37		8,736	571	9,310
37-38		5,731	1,584	7,320
38-39	9,662	12,259	2,652	14,910
39-40	10,977	3,022	385	3,410
1940-41	11,001	3,446	See Table 22	3,450
41-42	13,258	11,290		11,290
42-43	14,289	12,131		12,130
43-44	19,861	3,191		3,190
44-45	21,028	0		0
1945-46	21,141	0		0
46-47	18,738	1,687		1,690
47-48	19,016	0		0
48-49	6,451	0		0
49-50	7,691	762		760
1950-51	4,917	2,354		2,350
51-52	1,524	7,281		7,280
52-53	7,424	0		0
53-54	6,648	0		0
54-55	10,867	0		0
1955-56	6,553	1,610		1,610
56-57	4,784	0		0
57-58	6,278	0		0

a. Diversions to Headworks Spreading Grounds are composed primarily of Owens River water released, spilled or otherwise tributary to the Los Angeles River. Amounts pumped from the gallery under the spreading grounds are included in ground water extractions of City of Los Angeles.

b. Rounded off to nearest 10 acre-feet.

c. Experimental spreading in the vicinity of Vanowen Street and Whitsett Avenue during 1928-29 only.

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Operational Releases, Net Deliveries and Water System Losses

Operational releases of Owens River import, comprised of spills from reservoirs, return from power plant operations and line blowoff, are indicated in Table 24 under the caption, Operational Releases.

The net amounts of water delivered to the valley fill area have been primarily determined from metered water sales to customers when the water is transported to the customer through a distribution system. For systems comprised of a single well and for small companies where the distribution system is not extensive and sales records were not available, the gross amounts and net amounts have been taken as identical since in these instances the water system loss is minor. Net delivered water does not include water spread or spilled.

Water system loss is composed of leakage from the distribution system, unmetered water (including sewer flushing water) and meter slippage, and is equal to the gross amount of water available for distribution minus net water delivered, water spread and water spilled. The annual amounts of the foregoing items and the resulting water system loss for the Upper Los Angeles River area are shown in Table 24. The water system loss is also shown therein (column 7) as a percent of the gross water available for distribution.

The percent water system loss was assumed to apply equally to valley fill and hill areas. The total water system loss was split between the valley fill and hill areas on the basis of the gross amounts of water available for distribution in each area (see Table 20). The net delivered water on the valley fill area (Table 24) is the gross available for distribution less water spread, spilled and system loss for the valley fill area.

TABLE 24

NET DELIVERED WATER, OPERATIONAL RELEASES
SPREAD IMPORT AND WATER SYSTEM LOSS

In Acre-Feet

Year	Upper Los Angeles River area: Gross available for distribution (1)	Operational releases (2)	Spread import (3)	Net delivered (4)	Operational releases, spread, net delivered (2)+(3)+(4)=(5)	Water system loss: Acre-Feet (1)-(5)=(6)	Water system loss: Percent (7)	Valley fill area: Gross available for distribution (8)	Water system loss (7)x(8)=(9)	Net delivered (8)-(2)-(3)-(9)=(10)
1928-29	136,010	8,250	590	126,320	135,160	850	0.06	133,710	800	124,070
29-30	144,270	11,480	0	130,480	141,960	2,310	1.60	140,620	2,250	126,890
1930-31	149,860	4,680	7,280	127,440	139,400	10,460	6.98	145,490	10,160	123,370
31-32	156,070	3,290	31,740	103,960	138,990	17,080	10.94	151,500	16,570	99,900
32-33	149,020	1,920	33,430	107,910	143,260	5,760	3.87	144,300	5,580	103,370
33-34	138,120	2,010	20,860	115,230	138,100	20	0.01	133,410	10	110,530
34-35	135,790	490	30,800	105,560	136,850	- 1,060	- 0.78	131,280	- 1,020	101,010
1935-36	159,140	560	22,720	130,040	153,320	5,820	3.66	154,140	5,640	125,220
36-37	134,410	1,920	9,310	121,640	132,870	1,540	1.15	128,850	1,480	116,140
37-38	132,860	1,760	7,320	114,920	124,000	8,860	6.67	126,540	8,440	109,020
38-39	147,970	3,420	14,910	126,210	144,540	3,430	2.32	140,990	3,270	119,390
39-40	130,250	760	3,410	117,800	121,970	8,280	6.36	123,110	7,830	111,110
1940-41	122,020	0	3,450	112,210	115,660	6,360	5.21	115,300	6,010	105,840
41-42	167,960	6,270	11,290	138,000	155,560	12,400	7.38	160,260	11,830	130,850
42-43	182,960	8,700	12,130	150,920	171,750	11,210	6.13	176,020	10,790	144,400
43-44	167,400	2,860	3,190	150,470	156,520	10,880	6.50	160,360	10,420	143,890
44-45	175,520	1,310	0	158,680	159,990	15,530	8.85	168,360	14,900	152,150
1945-46	192,490	7,870	0	172,340	180,210	12,280	6.38	183,610	11,710	164,030
46-47	199,620	7,680	1,690	175,460	184,830	14,790	7.41	192,240	14,240	168,630
47-48	211,200	2,940	0	187,490	190,430	20,770	9.83	205,430	20,190	182,300
48-49	210,980	1,460	0	193,100	194,560	16,420	7.78	204,550	15,910	187,180
49-50	206,940	1,340	760	187,250	189,360	17,580	8.50	197,550	16,790	178,660
1950-51	230,880	3,940	2,350	203,780	210,070	20,810	9.01	221,130	19,920	194,920
51-52	213,660	2,830	7,280	189,630	199,740	13,920	6.52	203,140	13,240	179,790
52-53	237,860	5,410	0	211,040	216,450	21,410	9.00	226,360	20,370	200,580
53-54	234,700	3,180	0	209,280	212,460	22,240	9.48	222,340	21,080	198,080
54-55	233,590	7,860	0	203,450	211,310	22,280	9.54	219,750	20,960	190,930
1955-56	231,490	4,000	1,610	205,670	211,280	20,210	8.73	216,820	18,930	192,280
56-57	248,950	1,560	0	227,290	228,850	20,100	8.07	232,360	18,750	212,050
57-58	235,130	90	0	214,540	215,630	18,500	7.87	217,210	17,090	200,030
29-Year Average 1929-57	178,690	3,780	7,800	155,300	166,880	11,830	6.11	171,020	11,280	148,160

Source and derivation of values by column numbers:

Column No.

1. Table 20, Column 8.
2. Table M-1, Column 8, Appendix M, occur only on the valley fill area.
3. Table M-1, Column 9, Appendix M, occur only on the valley fill area.
4. Sum of net delivered water, Table J-3, J-4, J-5, Appendix J.
7. Column 6 divided by Column 1 times 100.
8. Table 20, Column 17 minus Table 20, Column 7.

Sewage and Waste

All of the sewage exported from the Upper Los Angeles River area, with the exception of occasional overflows and discharges into the Los Angeles River, is conveyed through the City of Los Angeles sewerage system to the city's treatment plant. Small amounts of ground water that infiltrate the sewer mains are also exported through the sewerage system as are minor amounts of delivered water used to flush the sewer lines. A large number of individual local sewage disposal systems, mainly cesspools and septic tanks, have been and still are in use in the area. The effluent from these represent a significant source of recharge to the ground water reservoir; also, industrial waste and sewage that have been discharged into the Los Angeles River result in minor amounts of recharge in the river channel. The methods of determining sewage export from the major water service areas within the Upper Los Angeles River area are listed in Table 25. The methods of estimating cesspool recharge in these areas is also shown in Table 25.

TABLE 25

METHODS OF DETERMINING SEWAGE EXPORT AND CESSPOOL RECHARGE

Area	Cesspool recharge	Sewage export
CITY OF LOS ANGELES		
West of Burbank	Unit sewage discharge per cesspool.	Measured.
Owens Service Area in Sylmar Subarea	Total sewage based on 45 percent of delivered water* minus measured sewage export.	Measured.
Sunland-Tujunga Service Area	Total sewage based on 45 percent of delivered water* minus estimated sewage export.	Total measured sewage export for the City of Los Angeles west of Burbank minus measured sewage export from the Owens Service Area in Sylmar. The remaining sewage is split by the areal extent of sewered areas within each service area.
Mission Wells Service Area	Total sewage based on 45 percent of delivered water* minus estimated sewage export.	
Owens Service Area in San Fernando Subarea	Total cesspool recharge in Los Angeles west of Burbank minus the sum of the three areas above.	
Narrows Service Area	None.	Estimated, based on unit sewage discharge per house connection.
CITY OF SAN FERNANDO	Unit sewage discharge per cesspool.	Measured.
In San Fernando Subarea	Split by areal extent of the City in each subarea.	Split by areal extent of sewered area.
In Sylmar Subarea	Split by areal extent of the City in each subarea.	Split by areal extent of sewered area.
CITY OF GLENDALE	Unit sewage discharge per cesspool.	Measured.
In Verdugo Subarea	Total sewage based on 45 percent of delivered water* minus estimated sewage export.	Split by areal extent of sewered area.
In San Fernando Subarea	Total cesspool recharge for the City less recharge in Verdugo Subarea.	Split by areal extent of sewered area.
CITY OF BURBANK	Unit sewage discharge per cesspool.	Measured.
LA CANADA IRRIGATION DISTRICT	Total sewage based on 45 percent of delivered water.*	None.
CRESCENTA VALLEY COUNTY WATER DISTRICT	Total sewage based on 45 percent of delivered water.*	None.

* Residential and commercial delivered water only.

Export of Sewage

The City of Los Angeles North Outfall Sewer (Plate 26) which was placed in operation in 1926 was the first trunk sewer conveying sewage out of the Upper Los Angeles River area and initially served the Cities of Burbank, Glendale and the portion of Los Angeles south of Glendale. Commencing in 1929, portions of the City of Los Angeles west of Burbank were connected to the North Outfall Sewer. The City of San Fernando operated its own treatment plant and discharged the effluent into Pacoima Wash until 1952 at which time its sewerage system was connected to the City of Los Angeles system.

Rapid growth of the San Fernando Valley caused a rapid increase in the amounts of sewage being exported. The capacity of the North Outfall Sewer was exceeded in 1952-53 and small amounts of sewage overflowed into the Los Angeles River at a point downstream from its confluence with the Verdugo Wash. The Valley Settling Basin was constructed on the south bank of the Los Angeles River south of the City of Burbank in 1954 to provide storage during peak sewage flows. On brief occasions when the capacities of the trunk sewer and the Valley Settling Basin were both exceeded, the stored sewage was chlorinated and discharged into the Los Angeles River. The amounts of sewage overflowing or discharged into the Los Angeles River are listed in Table 26.

The San Fernando Valley Relief Sewer Tunnel (Plate 26) was completed in June 1956. The amount of sewage conveyed through this sewer trunk is not measured; therefore, export of sewage from the Upper Los Angeles River area for the period 1955-56 through 1957-58 was estimated on the basis of the number of sewer connections and the expected sewage flow per connection (see Appendix N).

The amount of flow through sewer mains leaving the Upper Los Angeles River area is based on the records of sewage gaging stations of the City of Los Angeles. Location of these stations is indicated on Plate 26. Although the sewage gaging stations operate for only one week per month, the weekly measured flow has been accepted by the cities as being the average weekly flow for the month. Amounts of sewage overflowing into the Los Angeles River are estimated from partial records of the State Department of Public Health. Discharges from the Valley Settling Basin, shown in Table 26, are based on operational records of the City of Los Angeles.

Estimated Cesspool Recharge and Sewage from Hill Areas

In areas that were not completely sewered, sewage export and cesspool recharge were separated by determining the sewage discharge per house connection or the percent of delivered water becoming sewage. Studies detailed in Appendix N show that 45 percent of the delivered water becomes sewage and the sewage flows per house connection varied from 0.17 acre-foot in 1928-29 to 0.28 acre-foot in 1957-58 and averaged 0.20 during the 29-year base period. Neither of the above values include infiltration of water into the sewers. The methods utilized to determine the amounts of sewage export and cesspool recharge in each area are discussed in Appendix N. Amounts of cesspool recharge and sewage from hill areas so estimated are shown in Table 26.

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Export of Sewer Infiltration and Flushing Water

The amounts of water entering the sewer mains as infiltration were determined by comparison of the trends in sewage per connection for each of the gaged areas (see Appendix N). The amount thus determined for the City of Glendale was the sum of infiltration and flushing water. The amounts of unmetered delivered water discharged into the City of Glendale's sewers as flushing water constitute a portion of the city's water system loss. The water flowing through the flushing devices amounted to 25.3 percent of the gross deliveries in 1954-55. The city commenced removing the flushing devices in 1957 with the result that the water system loss was reduced to 7.2 percent in 1958-59. A comparison of the water distribution systems of the City of Burbank, which does not provide sewer flushing water, and the City of Glendale indicates that the two systems are otherwise comparable and that their water losses should therefore be approximately the same. The amounts of flushing water in the City of Glendale sewer mains were estimated by first comparing the water system loss in Glendale with the average water system loss for Burbank (see Appendix N) and then comparing this amount with the combined quantity of infiltration and flushing water previously estimated. Estimated amounts of sewer infiltration and flushing water exported in the sewer trunks are shown in Table 26.

TABLE 26

SUMMARY OF SEWAGE EXPORT AND CESSPOOL RECHARGE ,
VALLEY FILL AREA

In Acre-Feet

Year	Sewage export U.L.A.R. (1)	Estimated sewage from hill areas (2)	Estimated sewer infiltration (3)	Net export of sewage from valley fill (4)=1-2-3	Estimated sewer flushing water (5)	Sewage discharged to river (6)	Estimated cesspool recharge (7)	Total sewage (8)=4-5+6+7
1928-29	6,320	870	340	5,110	0	0	4,940	10,050
29-30	7,100	880	170	6,050	320	0	4,920	10,650
1930-31	8,490	900	430	7,160	490	0	4,930	11,600
31-32	9,900	910	880	8,110	810	0	4,560	11,860
32-33	9,970	920	430	8,620	610	0	4,160	12,170
33-34	10,340	940	310	9,090	700	0	4,030	12,420
34-35	11,850	960	1,700	9,190	450	0	3,950	12,690
1935-36	12,450	970	1,570	9,910	560	0	4,030	13,380
36-37	13,230	990	1,860	10,380	200	0	4,570	14,750
37-38	14,360	1,060	2,170	11,130	350	0	5,060	15,840
38-39	16,470	1,080	3,280	12,110	300	0	5,790	17,600
39-40	17,440	1,090	3,250	13,100	250	0	6,480	19,330
1940-41	21,630	1,170	6,290	14,170	150	0	7,290	21,310
41-42	21,910	1,190	5,730	14,990	170	0	7,920	22,740
42-43	22,470	1,200	5,780	15,490	0	0	8,100	23,590
43-44	23,470	1,220	6,110	16,140	0	0	7,950	24,090
44-45	23,780	1,320	5,310	17,150	90	0	8,400	25,460
1945-46	24,030	1,350	4,000	18,680	500	0	9,040	27,220
46-47	27,080	1,450	5,260	20,370	1,230	0	10,800	29,940
47-48	28,880	1,500	4,040	23,340	1,900	0	11,220	32,660
48-49	30,340	1,570	2,320	26,450	2,290	0	11,160	35,320
49-50	31,950	1,840	1,240	28,870	1,320	0	11,510	39,060
1950-51	35,660	2,160	1,170	32,330	1,520	0	13,500	44,310
51-52	39,950	2,540	2,090	35,320	2,530	0	14,600	47,390
52-53	41,590	2,890	950	37,750	2,090	10	15,400	51,070
53-54	47,260	3,470	1,840	41,950	2,620	190	17,150	56,670
54-55	45,670	4,100	1,950	39,620	2,240	4,840	18,630	60,850
1955-56	51,860	4,860	2,970	44,030	3,660	4,540	19,850	64,760
56-57	60,060	5,540	3,290	51,230	3,270	60	20,550	68,570
57-58	63,960	6,550	2,330	55,080	1,650	240	20,150	73,820
29-Year Average 1929-57	24,670	1,760	2,650	20,270	1,060		9,330	28,870

Source and derivation of values by column number:

Column No.

1. Column entitled "Total sewage export out of Upper Los Angeles River area" in Table N-8, Appendix N.
2. Column entitled "Total", Table N-9, Appendix N.
3. Column entitled "Total", Table N-5, Appendix N.
5. Column entitled "Sewer flushing Glendale", Table N-5, Appendix N.
6. Table N-10, Column 4, Appendix N.
7. Sum of the cesspool recharge for each service area in Table N-7, Appendix N.

Industrial and Sanitary Wastes

Industrial wastes discharged into the Los Angeles River were computed for the 1946-47 through 1957-58 period from permits issued by the City of Los Angeles, and for the years 1939-40 through 1946-47 by extrapolation. Industrial wastes discharged into the Burbank-Western storm drain were estimated from low flow measurements for the 1951-52 through 1957-58 period and by extrapolation back to 1939-40. Sewage discharged from the North Outfall Sewer and Valley Settling Basin and the total industrial wastes discharged into the Los Angeles River are shown in Table 26A. Waste discharges are discussed further in Appendix N. Industrial waste from the City of Los Angeles Valley Steam Plant is spread on adjacent land and is included as deep percolation on commercial and industrial land use areas (see Appendix L).

TABLE 26A

ESTIMATED WASTE DISCHARGES
TO THE STREAM SYSTEM

In Acre-Feet

Year	Industrial wastes (1)	Sewage (2)	Total wastes (3)	Industrial wastes in total wastes, in percent (4)
1939-40	0		0	
1940-41	540		540	100.00%
41-42	1,090		1,090	100.00%
42-43	1,640		1,640	100.00%
43-44	2,190		2,190	100.00%
44-45	2,740		2,740	100.00%
1945-46	3,290		3,290	100.00%
46-47	3,840		3,840	100.00%
47-48	4,090		4,090	100.00%
48-49	4,660		4,660	100.00%
49-50	4,740		4,740	100.00%
1950-51	4,810		4,810	100.00%
51-52	5,280		5,280	100.00%
52-53	6,080	10	6,090	99.84%
53-54	5,980	190	6,170	96.92%
54-55	6,350	4,840	11,190	56.75%
1955-56	5,880	4,540	10,420	56.43%
56-57	5,580	60	5,640	98.94%
57-58	5,750	240	5,990	95.99%

Source and derivation of values by column numbers:

Column No.

1. Table N-10, Column 3, estimated to be nil prior to 1940-41.
2. Table N-10, Column 4, estimated to be nil prior to 1952-53.
3. Table N-10, Column 5.
4. Column 1 divided by Column 3, expressed in percent.

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Surface Runoff

The drainage basin of the Upper Los Angeles River area is comprised of 329,137 acres of which 205,709 acres are hill and mountain lands. The surface flow in the streams in the area originates as storm runoff from hill and mountain areas, storm runoff from impervious areas on the valley floor, operational spills of imported water, industrial and sanitary waste discharges and rising water in the Los Angeles River.

The drainage system of the area is made up of the Los Angeles River and its tributaries. The important changes that have taken place in the drainage system in the past 30 years have previously been noted in Table 18. The changes that have occurred from the period when the area was essentially undeveloped to its present urbanized state may be readily seen by comparing the drainage system of 1893 as depicted on Plate 11 with that of 1958 as shown on Plate 12. As was noted in the discussion of channel improvement, the reduction in the length of pervious channels has been large.

The gaging stations at which surface flows in the drainage system are measured are shown on Plate 9 and listed as to location and length of record in Table 27. Surface outflow from the area has been measured by Los Angeles County Flood Control District at gaging station F-57 by a continuous water stage recorder, beginning in December 1929. In the period January to August 1929, only weekly measurements were available. During the remaining months, October 1928 to December 1929, no precipitation and therefore no storm runoff occurred. Various published references have been made as to the amount of water flowing in the Los Angeles River from 1898 to 1929. Some references as to the amount of water flowing in the Los Angeles River are found in the "Annual Reports" of the Los Angeles Department of Water and Power. However, the values presented in these publications lacked sufficient companion information to determine what these values represent. It is questionable as to whether they reflect the summer or average flow in the river or the amounts diverted or pumped. These were considered as incomplete data and were therefore not used.

Hydrographs of the surface flow of the Los Angeles River at gaging station F-57, prepared from daily records, were utilized to separate the surface flow into base low flow which is made up of rising water and waste discharges, and surface runoff which is composed of storm runoff and operational spills of Owens River water. The separation of the surface flow into its constituent parts is derived in Appendix O. The results of the study are presented in Table 28.

TABLE 27

MAIN STREAM GAGING STATIONS,
UPPER LOS ANGELES RIVER AREA

Station number*	Location	Period of record
2	Browns Canyon Wash at Devonshire Avenue, Chatsworth	December 1928 - September 1932 October 1936 - September 1939
5	Los Angeles River below Sepulveda Dam	December 1928 - March 1952
9	Verdugo Storm Drain at Glen Oaks Boulevard, Glendale	December 1928 - November 1933
15	Pacoima Wash at Van Nuys Boulevard	October 1952 - September 1958
16	Pacoima Wash at Parthenia Street	December 1928 - August 1952
19	Little Tujunga Wash at Foothill Boulevard	December 1928 - September 1958
43	Sycamore Canyon Channel above Solway Street	October 1938 - September 1958
44	Sycamore Canyon Channel at Adams Square	December 1927 - September 1935 October 1936 - April 1937 October 1938 - September 1958
57	Los Angeles River above Arroyo Seco	December 1929 - September 1958
105	Tujunga Wash at Magnolia Boulevard	August 1930 - February 1938 October 1938 - April 1948
105	Tujunga Wash below Moorpark Street	October 1950 - September 1958
106	Tujunga Wash - Central Branch at Magnolia Boulevard	August 1930 - February 1938 November 1941 - September 1958
110	Big Tujunga - Fox Creek, one-fourth mile above mouth	October 1930 - September 1937
111	Big Tujunga Creek below Mill Creek	December 1930 - September 1958
118	Pacoima Creek Flume below Pacoima Dam	March 1916 - September 1958
149	Limekiln Creek at Devonshire Street	November 1939 - September 1957
152	Aliso Wash below Nordhoff Street	November 1939 - August 1947 September 1948 - September 1958
168	Big Tujunga Creek below Big Tujunga Dam	December 1931 - October 1932 January 1938 - September 1958
213	Big Tujunga Creek above Gold Canyon	October 1932 - September 1958
244	Verdugo Channel at Don Carlos Street	December 1934 - September 1936
252	Verdugo Channel at Estelle Avenue	April 1936 - September 1958
266	Los Angeles River at Mariposa Street	December 1938 - September 1958
270	Calabasas Creek at Ventura Boulevard	February 1940 - November 1950
287	La Tuna Creek below Debris Basin	October 1946 - September 1958
299	Los Angeles River at Radford Avenue	February 1950 - September 1958
300	Los Angeles River at Tujunga Avenue	May 1950 - September 1958
305	Pacoima Diversion at Branford Street	October 1953 - September 1958
E-5-C	Los Angeles River below Sepulveda Dam	May 1943 - September 1958
E-20-C	Tujunga Wash above Glen Oaks Boulevard	May 1932 - February 1938 August 1940 - September 1958
E-285	Burbank-Western Storm Drain at Riverside Drive	October 1950 - September 1958
U-12	Haines Creek above mouth of canyon	February 1917 - September 1934 October 1935 - September 1958

* LACFCD gaging station number. See Plate 9 for location.

TABLE 28

SEPARATION OF SURFACE FLOW AT GAGE F-57

In Acre-Feet

Year	Base low flow			Surface runoff		Measured
	Rising water	Waste discharges		Owens River water	Net storm runoff	Outflow
		Industrial	Sewage			
	(1)	(2)	(3)	(4)	(5)	(6)
1928-29	0	0	0	650	2,950	3,600*
29-30	0	0	0	330	1,330	1,660
1930-31	0	0	0	260	3,710	3,970
31-32	60	0	0	1,550	13,630	15,240
32-33	440	0	0	0	10,200	10,640
33-34	1,670	0	0	1,750	26,400	29,820
34-35	760	0	0	440	11,350	12,550
1935-36	720	0	0	560	4,490	5,770
36-37	1,430	0	0	1,770	21,270	24,470
37-38	7,740	0	0	1,690	123,210	132,640
38-39	14,490	0	0	2,940	24,930	42,360
39-40	14,050	0	0	760	24,780	39,590
1940-41	25,770	200	0	0	138,990	164,960
41-42	28,600	410	0	5,160	20,630	54,800
42-43	25,490	620	0	8,680	89,600	124,390
43-44	26,500	830	0	2,850	79,650	109,830
44-45	16,610	1,040	0	1,210	18,130	36,990
1945-46	10,500	1,250	0	4,100	20,040	35,890
46-47	9,700	1,460	0	5,960	14,210	31,330
47-48	7,270	1,670	0	0	5,950	14,890
48-49	2,440	1,880	0	710	12,580	17,610
49-50	0	2,090	0	0	8,670	10,760
1950-51	0	1,890	0	1,080	4,870	7,840
51-52	3,110	1,750	0	1,430	101,750	108,040
52-53	0	1,400	0	1,650	15,430	18,480
53-54	0	930	30	290	19,750	21,000
54-55	0	880	670	0	16,720	18,270
1955-56	0	1,350	1,040	0	33,500	35,890
56-57	0	820	10	0	24,060	24,890
57-58	0	1,220	50	0	89,750	91,020
29-Year Average						
1929-57	6,810	710	60	1,580	30,790	39,940

* Partially estimated.

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Native Water Spread

Early protection from flood waters was provided by the construction of Pacoima and Big Tujunga Reservoirs in 1929 and 1931, respectively, by the Los Angeles County Flood Control District. Subsequent additional flood protection was provided on the valley floor area by the construction of Hansen and Sepulveda flood control reservoirs by the U. S. Corps of Engineers in 1940 and 1941, respectively.

Pacoima, Big Tujunga and Hansen Reservoirs have been operated for water conservation as a secondary function along with flood control. The location of these reservoirs and the spreading grounds situated downstream thereof are depicted on Plate 12. During the base period controlled releases from these reservoirs have been spread to recharge ground water. Four spreading grounds with an aggregate area of 266 acres have been constructed and operated for this purpose since 1932-33. The locations and descriptions of these, namely, the Pacoima, Hansen, Lopez and Branford spreading grounds, are shown in Table 29. Annual amounts of native water spread to recharge the ground waters at each of these grounds during the period 1928-29 through 1957-58 are shown in Table 30.

TABLE 29

LOCATION AND DESCRIPTION OF SPREADING GROUNDS FOR NATIVE RUNOFF

Grounds	Type	Season first used	Area in acres		Capacities		Location	Source of water	Remarks
			Gross	Wetted	Intake, cfs	Storage, af			
Lopez	Shallow basins	1956-57	18	13	25	25	Southeasterly side of Pacoima Wash northeasterly of Foothill Boulevard.	Controlled flow from Pacoima Dam and Lopez Basin.	Owned and operated by the Los Angeles County Flood Control District. The flow is diverted from Lopez Basin via canal to the spreading grounds. Gross area includes 1.3 acres in easement, Edison Company and 3.26 acres streets, but excludes canal area northwesterly side of channel. Storage capacity to be increased by permittee excavation.
Pacoima	Shallow basins	1932-33	179	122	400	330	Both sides of old Pacoima Wash channel from Arleta Street southwesterly to Woodman Avenue.	Controlled flow from Pacoima Dam. Partially controlled flow from Lopez Basin. Uncontrolled flow between Lopez Basin and spreading grounds.	Owned and operated by the Los Angeles County Flood Control District. Diversion from Pacoima diversion channel placed in use April, 1954. Gross area excludes new channel, but includes old channel from Woodman Avenue to Sharp Avenue, yard area to Paxton Street and area for access to diversion headworks. New basins built in old Pacoima channel between old headworks and Woodman Avenue and storage increased during 1956.
Hansen	Shallow basins	1944-45	157	110	450	230	Northwesterly side of Tujunga Wash from above Glenoaks Boulevard southwesterly to San Fernando Road.	Controlled flow from Hansen Dam and Big Tujunga Dam.	Owned and operated by the Los Angeles County Flood Control District. Gross area includes all land northwesterly of line 50 feet± from and parallel to northwesterly channel wall.
Branford	Deep basin	1956-57	12		1,540		Southwesterly of Arleta Street above confluence of Tujunga channel and Pacoima diversion channel.	Uncontrolled flows from Branford Street-Cantara Street drain.	Owned and operated by the Los Angeles County Flood Control District. Pit under development, therefore, storage and percolating capacity not firm. Outlet capacity = 1,540 cfs.

TABLE 30

NATIVE RUNOFF SPREAD

In Acre-Feet

Year	Name of spreading ground				Total[a]
	Lopez	Pacoima	Hansen	Branford	
1932-33		26[b]			30
33-34		230			230
34-35		1,200			1,200
1935-36		2,000			2,000
36-37		4,680			4,680
37-38		3,844			3,840
38-39		363			360
39-40		907			910
1940-41		9,775			9,780
41-42		37			40
42-43		3,744			3,740
43-44		7,223			7,220
44-45		1,467	7,651[c]		9,120
1945-46		514	2,268		2,780
46-47		3,763	8,725		12,490
47-48		0	0		0
48-49		0	0		0
49-50		245	0		250
1950-51		0	0		0
51-52		6,121	16,780		22,900
52-53		1,651	1,271		2,920
53-54		1,891	1,014		2,910
54-55		205	0		210
1955-56	0	566	2	0	570
56-57	28[d]	475	0	38[d]	540
57-58	1,030	10,924	18,407	20	30,380

a. Rounded off to nearest 10 acre-feet.
b. First used in 1932-33.
c. First used in 1944-45.
d. First used in 1956-57.

Subsurface Flow

Subsurface flow leaves the Upper Los Angeles River area at two locations, one southerly through the Los Angeles Narrows (Gage F-57 on the Los Angeles River) and the other easterly across the topographic divide in the vicinity of Pickens Canyon.

Subsurface flow takes place through the relatively thin section of water-bearing material shown as Section L-L' on Plate 5D (in vicinity of Gage F-57). Computation of annual quantities of underflow at this point by the slope area method is discussed in Appendix P. Subsurface flow from the Verdugo area easterly to the Monk Hill Basin was estimated for high and low water table conditions at the narrowest section of the valley fill east of the Verdugo Subarea boundary (about midway between Pickens Canyon Wash and the topographic boundary). The annual flow values were then determined from these data and water level conditions as indicated by well hydrographs. The total estimated annual amounts of underflow leaving the Upper Los Angeles River area near gaging station F-57 and in the vicinity of Pickens Canyon are presented in Table 31.

Conditions limiting subsurface flow between hydrologic subareas have previously been described in Chapter III. Annual amounts of such flow are discussed in Appendix P and summarized in Table 32.

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TABLE 31

ESTIMATED SUBSURFACE OUTFLOW,
UPPER LOS ANGELES RIVER AREA

In Acre-Feet

Year	Near Gage F-57 (1)	East of Pickens Canyon* (2)	Total* (3)
1928-29	340	250	600
29-30	260	250	500
1930-31	210	250	450
31-32	340	250	600
32-33	450	250	700
33-34	450	250	700
34-35	500	250	750
1935-36	440	300	750
36-37	430	300	750
37-38	410	300	700
38-39	430	400	850
39-40	400	400	800
1940-41	350	400	750
41-42	360	400	750
42-43	330	400	750
43-44	340	400	750
44-45	350	400	750
1945-46	330	400	750
46-47	330	400	750
47-48	330	300	650
48-49	300	300	600
49-50	280	300	600
1950-51	320	250	550
51-52	280	250	550
52-53	290	300	600
53-54	260	250	500
54-55	300	250	550
1955-56	330	250	600
56-57	190	250	450
57-58	160	250	400
29-Year Average 1929-57	340	300	650

* Rounded off to nearest 50 acre-feet.

TABLE 32

ESTIMATED UNDERFLOW BETWEEN HYDROLOGIC SUBAREAS

In Acre-Feet

Year	Sylmar Subarea to San Fernando Subarea			Verdugo and Eagle Rock Subareas to San Fernando Subarea
	Pacoima Notch[a] (1)	Sylmar Notch (2)	Total[b] (3)	(4)
1928-29	160	Average = 400 acre-feet per year	550	Estimated to be nil
29-30	160		550	
1930-31	160		550	
31-32	160		550	
32-33	150		550	
33-34	140		550	
34-35	200		600	
1935-36	120		500	
36-37	320		700	
37-38	250		650	
38-39	180		600	
39-40	150		550	
1940-41	300		700	
41-42	210		600	
42-43	290		700	
43-44	250		650	
44-45	200		600	
1945-46	200		600	
46-47	170		550	
47-48	110		500	
48-49	60		450	
49-50	40		450	
1950-51	20		400	
51-52	190		600	
52-53	90		500	
53-54	60		450	
54-55	80		500	
1955-56	80		500	
56-57	60		450	
57-58	150		550	
29-Year Average 1929-57	160	400	550	0

a. Values assume submerged dam impervious below elevation of 1,200 feet. For values under other assumptions see Appendix P.

b. Rounded off to nearest 50 acre-feet

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Changes in Ground Water Storage

Water in excess of other demands remains in the area, percolates to the water table and results in increased ground water in storage. Conversely, water must necessarily come from ground water storage if all demands in excess of other supplies are to be met. The resultant change of ground water in storage is indicated by rising ground water levels as water goes into storage and falling levels as water comes out of storage. Water in transit to the water table is not feasible of evaluation and on the average has been removed from consideration since both the start and end of the base period are preceded by dry years causing this unaccounted-for water to be relatively minor.

The volume of material saturated or drained is the product of the area and the mean change of ground water levels occurring therein. The resultant change in storage was evaluated as the product of this volume and the mean specific yield of the material. Methods of determining the specific yields utilized are discussed in Chapter III and Appendix D.

In general the change in storage computation procedure consisted of determining the change in each of 52 separate storage units selected so that each area contained homogeneous hydrologic and geologic characteristics. Change in storage within a hydrologic subarea was computed as the summation of the changes in the group of storage units contained therein. Details of this procedure are described in Appendix Q.

Water level data on a large number of wells were available for the area within the boundary of the valley fill. The locations of wells having water level measurements during at least a portion of the 29-year base period are shown on Plates 27 through 30. The elevations of the water surface of the ground water reservoir are shown by ground water contours for the years 1931, 1938, 1944 and 1958 on Plates 27, 28, 29 and 30, respectively. Areas on the foregoing plates labeled "area of no control", and where ground water contours are dashed, are areas in which a deficiency of water level record existed. Measurements for adjacent areas and isolated readings within the area were utilized to estimate the change in storage therein. The years 1931 and 1958 are the earliest and latest years for which sufficient reliable data were available. The maximum amount of ground water in storage during the 29-year base period occurred during 1943-44. The annual ground water levels are shown for selected wells in the hydrologic subareas on Plates 34A, 34B and 34C.

The fluctuations of water levels are shown on Plates 31, 32 and 33 for the respective periods, fall of 1931 to fall of 1958, fall of 1934 to fall of 1949 and fall of 1944 to fall of 1958. The change from 1931 to 1958, although not of the greatest magnitude during the base period, is of importance since it illustrates the large increase of extractions that has occurred in the eastern portion of the San Fernando Hydrologic Subarea. This shift of pumping from west to east is further illustrated by Plates 31A and 31B, which show the respective distribution of ground water extractions for 1930-31 and 1957-58. The period 1934 to 1949 is included since it is a period during which the net change in storage was at a minimum. The maximum change in water levels during the 1928-29 through 1957-58 period occurred in the 1944 to 1958 period (Plate 33).

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Ground water levels used for change in storage were generally measured in October of each year. The beginning of the water year was considered the best annual reference point because at this time the water surface had generally recovered from localized effects of heavy summer pumping and it was usually prior to winter rainfall which might cause abnormalities in the ground water surface. In several instances where measurements in October were not available, measurements in November and December were utilized resulting, in some cases, in the use of measurements taken after appreciable precipitation had occurred. In these cases, the computed change in storage may be in error for that year and subsequent hydrologic years because of the influence of rain on pumping draft and related water level effects. The error, however, will compensate over a period where comparable water levels were obtained; this is believed to be no greater than two years during the base period and is of major consequence only in the period 1955-56 through 1957-58.

Free ground water conditions are generally found to exist in the major portion of the valley fill including the San Fernando and Verdugo Hydrologic Subareas. Confined ground water conditions are indicated in the Eagle Rock and Sylmar Hydrologic Subareas; thus change in storage in these subareas was considered to have occurred only in the free water table or forebay portion thereof. A paucity of well data precluded a determination of the forebay extent in the Sylmar area and change in storage in this area was determined from water level changes and specific yields occurring throughout that subarea. It is believed that this approximation gives results which will not grossly affect the accuracy of the overall determination of change in storage in the combined subareas because of the relatively small specific yields used and the relatively moderate cyclic variation of water levels which has occurred in the Sylmar Subarea during the base period.

The Eagle Rock forebay area comprises 535 acres or 69 percent of that small hydrologic subarea. Specific yields for this area were obtained by correlation of existing geologic information with specific yield data determined for the neighboring valley fill in the vicinity of the City of Glendale.

Annual and cumulative amounts of change in storage in the valley fill material of the Upper Los Angeles River area thus determined are shown in Table 33.

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TABLE 33

CHANGE IN GROUND WATER STORAGE IN THE VALLEY FILL OF THE UPPER LOS ANGELES RIVER AREA[a]

In Acre-Feet

Year	Hydrologic Subarea, Annual Amount				Valley fill of Upper Los Angeles River area	
	San Fernando (1)	Eagle Rock (2)	Sylmar (3)	Verdugo[c] (4)	Annual[b] (5)	Cumulative (6)
1928-29	- 41,510	- 93	- 65	-1,370	- 43,040	- 43,040
29-30	- 15,694	- 93	294	-1,370	- 16,860	- 59,900
1930-31	- 26,322	- 93	1,019	-1,431	- 26,830	- 86,730
31-32	67,033	278	2,458	67	69,840	- 16,890
32-33	26,637	- 93	- 524	- 261	25,760	8,870
33-34	- 28,558	- 93	- 76	1,611	- 27,120	- 18,250
34-35	38,038	0	-1,127	1,670	38,580	20,330
1935-36	996	- 93	- 732	341	510	20,840
36-37	30,663	185	1,377	4,016	36,240	57,090
37-38	66,424	185	1,868	7,944	76,420	133,510
38-39	- 12,545	-185	146	2,480	- 10,100	123,400
39-40	- 32,650	-185	-3,655	-2,116	- 38,610	84,800
1940-41	116,852	93	6,042	5,030	128,020	212,810
41-42	- 31,230	93	-1,609	-1,408	- 34,150	178,660
42-43	31,029	93	20	1,390	32,530	211,190
43-44	47,205	93	1,493	330	49,120	260,310
44-45	- 74,177	0	- 296	-2,673	- 77,150	183,170
1945-46	- 33,296	-185	966	-5,676	- 38,190	144,980
46-47	- 41,202	93	-1,526	-5,261	- 47,860	97,120
47-48	- 52,768	-185	-2,478	-6,682	- 62,110	35,010
48-49	- 56,360	-464	-4,274	-8,220	- 69,320	- 34,310
49-50	- 43,390	0	24	-2,251	- 45,620	- 79,930
1950-51	- 53,288	185	- 714	- 337	- 54,150	-134,080
51-52	33,725	278	3,938	9,421	47,360	- 86,720
52-53	- 68,276	- 93	-2,563	-1,597	- 72,530	-159,250
53-54	- 56,769	185	- 782	-3,148	- 60,510	-219,760
54-55	- 51,368	- 93	- 596	585	- 51,470	-271,240
1955-56	- 71,391	- 93	-2,275	2,342	- 71,420	-342,650
56-57	- 6,279	93	-1,505	3,934	- 3,760	-346,410
57-58	- 9,159	93	229	4,565	- 4,270	-350,680
29-Year Average 1929-57	- 11,675	- 6	- 178	- 91	- 11,950	

a. Values derived in Table Q-4. Minus indicates a reduction of water in storage and positive values indicate an increase in storage.

b. Rounded off to nearest 10 acre-feet from Table Q-4.

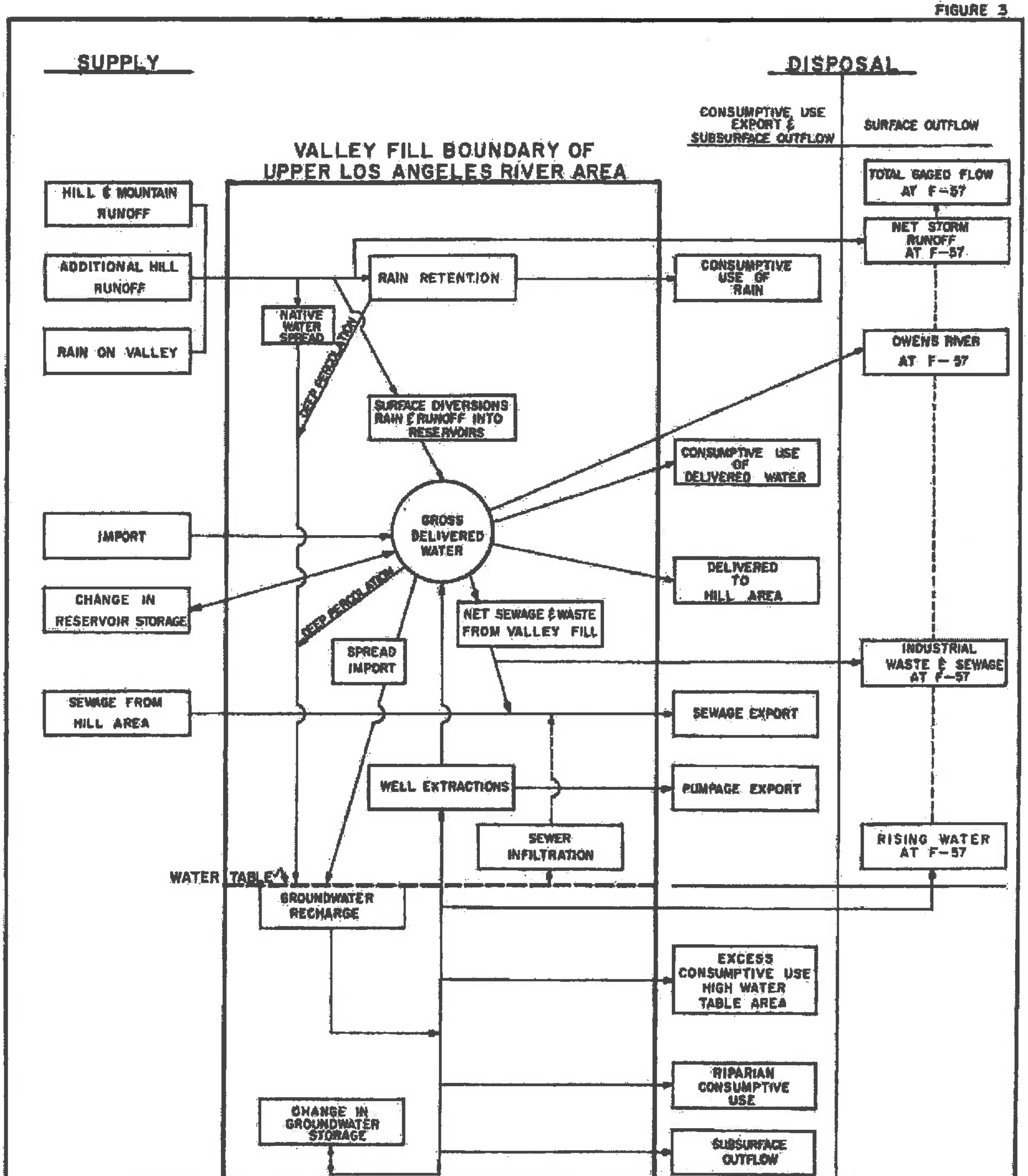
c. Includes portion of Monk Hill Basin within Upper Los Angeles River Area.

Determination of Consumptive Use by Inflow-Outflow Method

Consumptive use or disposal of water to the atmosphere through evapotranspiration accounts for a large portion of the water diminution in the Upper Los Angeles River area. It includes the amounts of water evaporated by natural or industrial processes, the water transpired by plants and the relatively minor quantities of water incorporated in plant fiber, industrial products and household uses.

Total consumptive use is computed in this chapter as the difference between already determined items of water supply and disposal by equating all such items in an inflow-outflow water inventory for the area. The various items of supply and disposal used are shown diagrammatically on Figure 3 to illustrate their physical relationship and composition. This procedure for determining consumptive use is called the Inflow-Outflow Method and the values derived by this method are shown in Table 34.

FIGURE 3



SAN FERNANDO VALLEY REFERENCE

DIAGRAM OF WATER SUPPLY AND DISPOSAL UPPER LOS ANGELES RIVER AREA

STATE WATER RIGHTS BOARD

TABLE 34

DETERMINATION OF CONSUMPTIVE USE ON VALLEY FILL AREA BY INFLOW-OUTFLOW METHOD

1,000 Acre-Feet

Year	Supply					Outflow							
						Ground water export			Outflow				
	Import, valley fill	Precipitation, valley fill	Runoff to valley fill	Surface diversion from hill areas	Total	Out of Upper Los Angeles River Area	To hill and mountain areas	Sewage and infiltration exported	Surface	Subsurface	Change in ground water storage	Total outflow and change in ground water storage	Consumptive use by inflow-outflow method
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
1928-29	104.8	122.4	7.0	0.1	234.3	54.8	2.3	5.4	3.6	0.6	- 43.0	23.7	210.6
29-30	112.1	125.7	5.7	0.1	243.6	57.3	3.6	6.2	1.7	0.5	- 16.9	52.4	191.2
1930-31	117.1	155.8	4.4	0.1	277.4	59.5	4.3	7.6	4.0	0.5	- 26.8	49.1	228.3
31-32	120.9	207.4	58.9	0.3	387.5	34.3	4.5	9.0	15.2	0.6	69.8	133.4	254.1
32-33	117.4	133.5	13.6	0.2	264.7	32.0	4.7	9.0	10.6	0.7	25.8	82.8	181.9
33-34	103.2	150.0	20.3	0.2	273.7	54.1	4.6	9.4	29.8	0.7	- 27.1	71.5	202.2
34-35	101.9	207.1	24.3	0.2	333.5	42.9	4.4	10.9	12.6	0.8	38.6	110.2	223.3
1935-36	123.2	131.0	19.2	0.3	273.7	49.6	4.9	11.5	5.8	0.8	0.5	73.1	200.6
36-37	94.0	242.2	91.7	0.4	428.3	44.4	5.4	12.2	24.5	0.8	36.2	123.5	304.8
37-38	86.4	258.6	177.6	0.5	523.1	38.8	6.1	13.3	132.6	0.7	76.4	267.9	255.2
38-39	101.8	219.1	29.0	0.6	350.5	36.5	6.8	15.4	42.4	0.8	- 10.1	91.8	258.7
39-40	84.2	172.0	20.4	0.5	277.1	38.1	6.9	16.4	39.6	0.8	- 38.6	63.2	213.9
1940-41	68.8	409.8	191.4	0.8	670.8	41.0	6.5	20.5	165.0	0.8	128.0	361.8	309.0
41-42	117.1	137.7	22.1	0.9	277.8	33.6	7.4	20.7	54.8	0.8	- 34.2	83.1	194.7
42-43	127.2	259.0	166.5	1.1	553.8	44.3	6.6	21.3	124.4	0.8	32.5	229.9	323.9
43-44	109.9	254.3	124.6	1.3	490.1	47.6	6.6	22.2	109.8	0.8	49.1	236.1	254.0
44-45	116.8	148.5	37.7	1.0	304.0	62.2	6.6	22.5	37.0	0.8	- 77.2	51.9	252.1
1945-46	129.3	141.3	25.1	0.7	296.4	68.2	8.0	22.7	35.9	0.8	- 38.2	97.4	199.0
46-47	137.7	156.0	32.6	0.7	327.0	73.5	6.3	25.8	31.3	0.8	- 47.9	89.6	237.4
47-48	143.9	80.1	6.4	0.6	231.0	68.1	4.4	27.4	14.9	0.7	- 62.1	53.4	177.6
48-49	142.2	86.6	3.7	0.4	232.9	67.1	4.8	28.8	17.6	0.6	- 69.3	49.6	183.3
49-50	140.0	111.2	6.0	0.4	257.6	72.8	7.3	30.1	10.8	0.6	- 45.6	76.0	181.6
1950-51	163.1	89.9	3.5	0.4	256.9	66.4	6.9	33.5	7.8	0.6	- 54.2	61.0	195.9
51-52	143.2	315.0	116.8	0.5	575.5	63.0	7.0	37.4	108.0	0.6	47.4	263.4	312.1
52-53	163.9	118.9	16.0	0.5	299.3	82.0	7.4	38.7	18.5	0.6	- 72.5	74.7	224.6
53-54	160.0	138.4	17.3	0.4	316.1	83.5	6.6	43.8	21.0	0.5	- 60.5	94.9	221.2
54-55	158.6	142.9	10.0	0.3	311.8	80.2	6.4	41.6	18.3	0.6	- 51.5	95.6	216.2
1955-56	155.5	171.2	14.5	0.2	341.4	84.0	6.4	47.0	35.9	0.6	- 71.4	102.5	238.9
56-57	170.7	134.0	10.0	0.2	314.9	90.8	6.6	54.5	24.9	0.5	- 3.8	173.5	141.4
57-58	160.8	278.6	93.3	0.3	533.0	83.3	5.8	57.4	91.0	0.4	- 4.3	233.6	299.4
29-Year Average 1929-57	124.6	173.1	44.0	0.5	342.4	57.6	5.9	22.9	39.9	0.6	- 12.0	115.1	227.2

Source and derivation of values by column numbers:

Column number	
1.	Table 20, Column 13.
2.	Table 1
3.	Table 3, Column 2.
4.	Table 16, Column 2.
5.	Sum of Columns 1, 2, 3 and 4, herein.
6.	Table 19, Column 3.
7.	Table 20, Column 11.
8.	Table 26, sum of Columns 3 and 4.
9.	Table 28, Column 5.
10.	Table 31, Column 3.
11.	Table 33, Column 5.
12.	Sum of Columns 6, 7, 8, 9, 10 and 11, herein.
13.	Column 5 minus Column 12.

CHAPTER VI. HISTORIC GROUND WATER RECHARGE

To determine the effect of import on the safe yield of the ground water reservoir of the Upper Los Angeles River area, a determination of the amount of recharge to the reservoir originating from supplies imported to the area is required. In Table 34, page 169, an evaluation has been made of the disposal of the combined supply of native and imported water to the valley fill area. To identify the proportion or amount of the imported supplies which reaches the ground water reservoir as recharge, requires a breakdown of consumptive use quantities on the basis of whether the use was made from native or imported supplies and the proportion of the supply which contributed to recharge through deep percolation.

The "Integration Method" for determination of consumptive use provides the means of making the required breakdown and in addition provides a check on the combined consumptive use heretofore determined by the "Inflow-Outflow Method." The ground water reservoir of the Upper Los Angeles River area consists of water-bearing materials in the valley fill area as determined on Plate 5. The maximum water in storage within the range of water levels in materials watered and dewatered during the period 1928-29 through 1957-58 occurred in 1943-44. The minimum occurred in 1957-58.

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Consumptive Use by Integration Method

Annual amounts of consumptive use are determined by the Integration Method through the use of data on unit evapotranspiration or consumptive use of water for each culture type and on the acreage devoted to that culture. The total consumptive use occurring on the valley fill lands is determined by this method as the summation of the parts. These parts are the product of unit consumptive use and area of each type of land use, the consumptive use of water system losses and the excess consumptive use on high ground water areas. The sum of these parts, each of which is separately derived, is the total consumptive use on the valley fill area.

Computations of unit consumptive use have been made by determining the supply of native and delivered water available to the areas devoted to each culture type or land use class and computing the portions of the supply disposed of through evaporation, runoff, transpiration, deep percolation and storage in the soil.

Recognition of seasonal effect on consumptive use is made by computing the consumptive use by months for the winter season of October through April when the supply is largely uncontrolled rainfall, and as a lump sum for the summer months of May through September when the use is almost exclusively from delivered water to which a relatively uniform irrigation efficiency is applicable.

Unit values of consumptive use have been determined as described in Appendix L and separate computations of unit consumptive use for each year are summarized for each culture or land use class in Tables L-13, L-14 and L-15. Methods of computation are illustrated on Figures L-1 and L-2.

The areas of different types of vegetative cover and of land and water surface areas were determined for each year of the base period from aerial maps, photographs and field surveys as described in Appendix K.

Evaporation

Evaporation is a function of vapor pressure which varies with humidity, temperature and wind movement. The evaporation pan is sensitive to these factors and is commonly utilized to determine rates of evaporation from water surfaces. Moist surfaces, such as saturated soils and wet impervious areas, have been considered to have an evaporation rate equivalent to that of a water surface. Average daily rates of evaporation were determined for each month for days of rain and for days of no rain. The average daily rates of evaporation were applied separately to pervious and impervious areas with the maximum evaporation allowed being 0.60 and 0.50 of an inch, respectively, during and following each storm (see Appendix L).

Evaporation of Irrigation Water. The evaporation of irrigation water is estimated to be 15 percent of the delivered water and is included in the consumptive use.

Residual Rain on the Valley Fill Area. Precipitation falling on the pervious portions of the valley fill area is assumed to be either consumed or to percolate while precipitation falling on the impervious portions will either evaporate or become runoff. This runoff originating on impervious areas is termed residual rain. A portion of the residual rain percolates in transit to Gage F-57 and the remainder becomes part of the storm flow passing Gage F-57.

Irrigated, Native and Residential Land Use Areas

Computations of consumptive use for land use classes containing areas of vegetation were made for two separate periods: (1) the winter season of October 1 through April 30 and (2) the summer period May 1 through September 30. Two separate periods were used because of the different rate of plant growth and the variation in the amount of water available to the plant during the two periods. During the winter season large variations occur in the amounts of precipitation; therefore, the winter season computations were made monthly by first determining the water received by the soil, which was thus available for plant growth. This was taken as the sum of precipitation and delivered water reaching pervious areas less the evaporation of each. The water available, thus determined, was considered to be first utilized in satisfying the monthly transpiration requirements of the crop and secondly to satisfy any deficiency in the soil moisture within the root zone. The remainder was considered as deep percolation recharging the ground water.

Transpiration rates of the crops found in the area were determined from field investigations made in the San Fernando Valley by the Soil Conservation Service during the late 1940's or by transposing a value determined in another area similar to the Upper Los Angeles River area. The amount of soil moisture that could be held in storage within the root zone was determined from investigations made by the Soil Conservation Service and from published information on rooting depths and moisture-holding capacities of soils. In months when water available to the plant was less than the transpiration requirements, water was taken from storage within the root zone.

Consumptive use on irrigated lands during the summer season was determined by applying an irrigation efficiency for the particular crop to the known water deliveries. Depths of water delivered for each crop during the winter months and the summer growing season for each year of the base period are determined in Appendix J. The irrigation efficiency was based on work done by the Soil Conservation Service in the area and on discussions with Mr. H. F. Blaney who was in charge of the work. The consumptive use as determined for each of the periods was split into the parts derived from precipitation and delivered water in proportion to the amounts of each supply available. The sum of the consumptive use of each supply for the two periods is applicable to the net area of the land use and was adjusted to the gross area by weighting the net values for percent of each crop or impervious area included in a land use class. Unit values of consumptive use determined by the above methods for each of the hydrologic subareas are shown in Tables L-13, L-14 and L-15 in Appendix L, in which further details of the computations are set forth. Average annual consumptive use during the 29-year base period from irrigated agriculture and residential land use classes overlying the valley fill was 105,410 and 60,430 acre-feet, respectively.

Industrial and Commercial Land Use Areas

Consumptive use by industrial and commercial areas varies with the type of industrial process and was estimated on an annual basis. The annual depth of water consumed on industrial and commercial areas was based on values published in Bulletin 2, entitled "Water Utilization and Requirements of California", State Water Resources Board. Bulletin 2 gives values of 0.40 to 1.4 acre-feet per acre for consumptive use by industrial and commercial areas, based on total water delivered to this type of land use less sewage discharged into a sewerage system.

On the basis of the above values and 1958 land use data, the Referee selected the value of 0.85 acre-foot per acre as being representative of the difference between delivered water and sewage discharged to the sewerage system for industrial and commercial areas (see Appendix L). Therefore, the 0.85 acre-foot per acre represents consumptive use plus industrial wastes discharged to the stream system. Records of water sales indicate that defense industries in Burbank, Glendale and the Los Angeles Narrows used larger amounts of delivered water during the war years; therefore, the depth of consumptive use was increased during the war years (see Appendix L). Water sales records for the breweries and steam plant in the valley show that these plants used water greatly in excess of the amount estimated by the above method. The additional use by these plants after 1952-53 is estimated in Appendix L.

Deep percolation of water delivered to commercial and industrial areas occurs primarily from the discharge of industrial wastes in the channels of the stream system with minor amounts occurring on commercial and industrial land use areas. The amount occurring in the stream system are equal to the difference between industrial wastes discharged to the stream system (Table 26A, page 151b) and wastes passing Gage F-57 (Table 28, page 153). A relatively small amount of deep percolation has been found to occur in the area of use at the Valley Steam Plant of the City of Los Angeles (see Appendix L, page L-40).

The annual consumptive use by commercial and industrial areas averaged 6,710 acre-feet during the base period, comprising less than seven percent of the total average consumptive use of delivered water.

<u>Excess Consumptive Use in High Water Table Areas</u>

In areas where ground water is within 10 feet of the ground surface, an incremental evaporation occurs from moisture brought to the surface by capillary action in the soil and certain plants increase their transpirational use because of the more readily available supply.

Areas of high ground water have existed in the San Fernando Subarea and in the lower portion of the Sylmar Subarea. Extent of the high ground water area in the western portion of the San Fernando Subarea was determined from water level measurements at wells and piezometers observed for this purpose by the U. S. Soil Conservation Service in cooperation with the City of Los Angeles. The extent of the high ground water area in the fall of 1944 is shown on Plate 29. Due to the paucity of water level data in the western portion of the Sylmar Subarea, the extent of this area where excess consumptive use of ground water occurred was determined from the relative concentration of calcium carbonate existing in the soil. Using these data to limit the area, excess consumptive use during the base period was calculated by using water level observations at wells of the City of San Fernando, the Mission Well Field of the City of Los Angeles, and test hole data.

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Characteristics of soils and their relationship to past vegetative and water table conditions in the cienaga of the Sylmar Subarea were investigated by the Department of Water Resources in cooperation with the Referee. The Department's report is set forth in Appendix C and on Plates 7 and 8.

The depth of consumptive use in high ground water areas in excess of that which would normally occur was estimated as the difference between consumption based on high water table conditions and the normal consumption shown in Tables L-13 through L-15. Consumption under high ground water conditions is based on experiments in the Lower San Luis Rey Valley. The basic data and procedures utilized in these studies are set forth in Appendix L. The 29-year average annual consumptive use of ground water (excess consumptive use) in areas of high ground water is 2,640 acre-feet. (see Table L-22, page L-70).

Riparian Areas

Consumptive use by riparian vegetation, located in and adjacent to stream channels, has occurred during the base period mainly in the lower reaches of the Los Angeles River. The total annual depth of consumptive use for this type of vegetation was taken as equal to the annual transpiration rate for similar type growth in the Upper Santa Ana Valley, transposed by mean temperatures, plus the evaporation of rain. The annual depth of consumptive use of ground water was taken as the total annual depth of consumptive use less the precipitation and is shown in Tables L-13 and L-15 (see Appendix L). The average annual consumptive use of ground water on riparian areas during the base period is 2,000 acre-feet.

Consumptive Use of Water System Losses

Water system losses are comprised of sewer flushing water, distribution loss and other loss. Only the latter two items contain portions that may become consumptive use. The amount of sewer flushing water exported in sewer mains has been evaluated in Chapter V (see Table 26). Data available on comparable systems indicated that the maximum continuous pipe system leakage, or distribution loss, to be expected was approximately six percent, computed as a percentage of the gross available for distribution.

Foliage and plant growth along the roadways is estimated, on the average, to overhang approximately 20 percent of the paved area underlain by the pipes of the distribution system; thus, it is believed that the root system of this vegetation would have access to and transpire approximately the equivalent percentage of distribution losses.

The system loss in excess of sewer flushing and distribution loss is termed other loss and is comprised of meter slippage and unmetered deliveries. This portion of the system loss is taken as consumptively used in the same proportion as is water applied to the land use classes (i.e., net delivered water less sewage and wastes). The remainder of the system loss was considered as deep percolation. Negative values shown in Table 36 indicate that the amounts shown as available were less than the amounts shown as delivered. The negative values are retained in this and following tables to permit an accounting that is mathematically correct. During the base period consumptive use of water system losses averaged 3,250 acre-feet per year.

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Summary

The annual amount of consumptive use on the valley fill area is the summation of the annual amount occurring on land use class areas, excess consumptive use, and consumptive use of water system losses. The annual amount of consumptive use on land use classes and excess consumptive use are shown in Table 35. The consumptive use of water system losses is shown in Table 36. The total amount of consumptive use on the valley fill area is the total of the amounts in Tables 35 and 36 and is shown in Table 37.

During the 29-year base period, consumptive use on irrigated lands and on residential areas averaged 46 and 26 percent, respectively, of the average total consumptive use on the valley fill area. The effect of urbanization is shown by the averages for the base period and the 9-year period (1949-50 through 1957-58). During this latter period consumptive use on irrigated lands and on residential areas averaged 31 and 43 percent respectively.

TABLE 35

SUMMARY OF INTEGRATED CONSUMPTIVE USE AND DEEP PERCOLATION[a] ON LAND USE AREAS WITHIN BOUNDARY OF VALLEY FILL

In Acre-Feet

Year	Irrigated crops: Consumptive use: Rain (1)	Irrigated crops: Consumptive use: Delivered water (2)	Irrigated crops: Deep percolation: Rain (3)	Irrigated crops: Deep percolation: Delivered water (4)	Residential: Consumptive use: Rain (5)	Residential: Consumptive use: Delivered water (6)	Residential: Deep percolation: Rain (7)	Residential: Deep percolation: Delivered water (8)	Miscellaneous[b]: Consumptive use: Rain (9)	Miscellaneous[b]: Consumptive use: Delivered water (10)	Miscellaneous[b]: Deep percolation: Rain (11)
1928-29	55,830	76,910	260	17,940	15,350	14,750	450	1,340	42,470	4,390	0
29-30	53,010	77,860	2,220	17,020	14,520	15,740	2,040	2,630	44,070	4,410	0
1930-31	59,500	72,200	5,900	17,840	18,140	15,620	3,260	2,810	54,510	4,880	0
31-32	62,210	54,690	16,760	17,330	21,670	9,840	7,470	2,530	68,710	3,240	7,920
32-33	41,760	58,570	9,860	17,040	15,410	9,720	4,410	1,730	44,790	4,550	2,600
33-34	47,220	61,960	10,430	17,730	17,410	12,030	4,860	2,130	45,760	4,270	3,620
34-35	76,580	57,490	4,330	15,420	30,990	9,460	3,260	1,120	64,370	2,880	1,190
1935-36	49,490	74,600	4,670	19,200	20,330	11,230	2,660	1,460	37,000	3,840	690
36-37	71,590	62,030	25,560	21,290	30,960	10,670	12,220	1,830	57,220	2,990	11,240
37-38	61,170	53,570	34,000	19,320	29,870	11,670	17,780	2,820	56,060	2,840	22,500
38-39	60,970	58,780	16,910	19,040	35,100	15,000	7,320	2,900	62,620	3,520	3,960
39-40	50,480	52,130	8,010	14,640	29,970	15,950	5,350	2,380	52,550	3,650	550
1940-41	70,900	42,570	65,800	18,200	41,950	12,110	40,370	3,370	70,140	1,500	48,830
41-42	49,900	65,040	340	13,810	30,230	18,600	1,460	1,810	34,960	3,870	0
42-43	56,200	61,140	33,890	22,960	35,190	21,550	21,630	4,800	45,550	3,070	20,450
43-44	55,600	58,670	31,220	21,950	36,400	22,270	21,470	6,070	45,110	2,860	17,350
44-45	48,350	68,860	1,500	15,120	32,050	27,090	3,990	3,210	36,030	3,440	760
1945-46	42,580	70,670	4,520	16,660	29,660	31,580	5,180	7,500	32,050	3,590	480
46-47	41,640	68,930	4,850	15,870	31,980	38,070	7,420	6,210	39,300	3,670	770
47-48	24,100	76,240	30	11,560	20,950	46,330	490	3,850	19,210	4,440	0
48-49	24,350	74,510	130	11,270	24,260	49,090	1,000	4,350	21,890	4,080	0
49-50	27,260	62,730	1,770	11,570	29,490	49,870	2,600	5,070	29,000	3,750	0
1950-51	24,200	69,270	90	10,780	27,600	55,830	1,060	3,790	22,640	3,840	0
51-52	50,350	45,360	30,710	17,020	49,490	47,270	34,940	10,540	49,610	2,390	21,050
52-53	20,690	57,240	600	9,440	33,110	62,080	4,580	7,470	27,860	3,070	0
53-54	28,460	44,970	3,100	10,370	33,290	60,980	9,080	10,950	30,930	3,300	740
54-55	26,400	37,840	740	6,490	45,670	62,030	4,450	6,470	36,450	3,720	0
1955-56	25,110	30,190	2,910	6,860	40,230	63,020	12,930	9,620	42,420	2,740	100
56-57	15,660	32,230	1,550	7,160	36,520	75,200	8,700	9,570	35,560	3,700	0
57-58	24,440	24,410	11,160	8,710	60,280	66,180	31,830	8,170	55,850	2,650	12,750
29-Year Average 1929-57	45,850	59,560	11,130	15,200	29,580	30,850	8,700	4,500	43,030	3,560	5,680

a. Excludes deep percolation in the stream system.
b. Includes miscellaneous, dry farm and native vegetation, water surface evaporation and riparian vegetation.

Source and derivation of values by column numbers:

Column No.

1 through 11. Summation of the weighted unit values for each land use classification and respective subarea (Tables L-13, L-14 and L-15) multiplied by the respective acreage (Table K-6) except for water surface evaporation. Water surface evaporation computed as per Appendix L.

TABLE 35

SUMMARY OF INTEGRATED CONSUMPTIVE USE AND DEEP PERCOLATION ON LAND USE AREAS WITHIN BOUNDARY OF VALLEY FILL (continued)

In Acre-Feet

Year	Commercial and industrial			Valley fill area							Consumptive use plus deep percolation[c]	
	Consumptive use		Deep percolation	Consumptive use				Deep percolation				
	Rain (12)	Delivered water (13)	Delivered water (14)	Rain (15)	Delivered water (16)	Other sources (17)	All sources (18)	Rain (19)	Delivered water (20)	All sources (21)	Rain (22)	Delivered water (23)
1928-29	1,270	2,550	0	114,920	98,600	5,850	219,370	710	19,280	19,990	115,600	117,900
29-30	990	2,950	0	112,590	100,960	5,190	218,740	4,260	19,650	23,910	116,800	120,600
1930-31	1,350	3,340	0	133,500	96,040	4,350	233,890	9,160	20,650	29,810	142,700	116,700
31-32	1,920	3,740	0	154,510	71,510	5,550	231,570	32,150	19,860	52,010	186,700	91,400
32-33	1,050	4,140	0	103,010	76,980	4,640	184,630	16,870	18,770	35,640	119,900	95,800
33-34	1,080	4,540	0	111,470	82,800	4,530	198,800	18,910	19,860	38,770	130,400	102,700
34-35	3,100	4,930	0	175,040	74,760	5,630	255,430	8,780	16,540	25,320	183,800	91,300
1935-36	2,340	5,330	0	109,160	95,000	6,590	210,750	8,020	20,660	28,680	117,200	115,700
36-37	3,330	5,730	0	163,100	81,420	5,120	249,640	49,020	23,120	72,140	212,100	104,500
37-38	3,120	6,130	0	150,220	74,210	6,130	230,560	74,280	22,140	96,420	224,500	96,400
38-39	2,860	6,520	0	161,550	83,820	4,540	249,910	28,190	21,940	50,130	189,700	105,800
39-40	3,350	6,930	0	136,350	78,650	3,930	218,930	13,910	17,020	30,930	150,300	95,700
1940-41	4,580	8,050	0	187,570	64,230	5,530	257,330	155,000	21,570	176,570	342,600	85,800
41-42	4,460	9,310	0	119,550	96,820	9,710	226,080	1,800	15,620	17,420	121,400	112,400
42-43	3,830	9,300	0	140,770	95,060	11,860	247,690	75,970	27,760	103,730	216,700	122,800
43-44	4,110	9,290	0	141,220	93,090	12,980	247,290	70,040	28,020	98,060	211,300	121,100
44-45	4,000	9,260	0	120,430	108,650	4,130	233,210	6,250	18,330	24,580	126,700	127,000
1945-46	4,060	7,630	0	108,350	113,470	4,150	225,970	10,180	24,160	34,340	118,500	137,600
46-47	4,820	5,860	0	117,740	116,530	3,090	237,360	13,040	22,080	35,120	130,800	138,600
47-48	3,350	6,010	0	67,610	133,020	3,360	203,990	520	15,410	15,930	68,100	148,400
48-49	4,720	5,840	0	75,220	133,520	3,190	211,930	1,130	15,620	16,750	76,400	149,100
49-50	4,660	5,930	0	90,410	122,280	3,340	216,030	4,370	16,640	21,010	94,800	138,900
1950-51	4,880	6,030	0	78,320	134,970	3,410	216,700	1,150	14,570	15,720	79,500	149,500
51-52	7,530	7,640	0	156,980	102,660	3,270	262,910	86,700	27,560	114,260	243,700	130,200
52-53	5,670	7,050	0	95,330	130,240	3,670	229,240	5,180	16,910	22,090	100,500	147,200
53-54	4,420	7,730	190	97,100	116,980	2,590	216,670	12,920	21,510	34,430	110,000	138,500
54-55	7,300	9,940	970	115,820	113,530	2,450	231,800	5,190	13,930	19,120	121,000	127,500
1955-56	5,430	10,890	1,700	113,190	106,840	2,000	222,030	15,940	18,240	34,180	129,100	125,100
56-57	4,440	11,930	1,960	92,180	123,060	1,930	217,170	10,250	18,690	28,940	102,400	141,800
57-58	7,460	11,900	1,920	148,030	105,140	1,640	254,810	55,740	18,800	74,540	203,800	123,900
29-Year Average 1929-57	3,720	6,710	170	122,180	100,680	4,920	227,780	25,510	19,870	45,380	147,700	120,600

c. Rounded off to nearest 100 acre-feet.

Source and derivation of values by column number:

Column No.

12. Commercial and industrial acreage in each subarea multiplied by their respective unit value (Tables L-13, L-14 and L-15).
13. Column 4, Table L-12.
14. Column 3 minus Column 4, Table L-12.
15. Column 1 plus Column 5 plus Column 9 plus Column 12 herein.
16. Column 2 plus Column 6 plus Column 10 plus Column 13 herein.
17. Sum of consumptive use of ground water (Table L-22) and consumptive use of runoff to Hansen Dam (Table L-22A).
18. Column 15 plus Column 16 plus Column 17 herein.
19. Column 3 plus Column 7 plus Column 11 herein.
20. Column 4 plus Column 8 plus Column 14 herein.
21. Column 19 plus Column 20 herein.
22. Column 15 plus Column 19 herein.
23. Column 16 plus Column 20 herein.

TABLE 36

DISPOSAL OF
WATER SYSTEM LOSSES WITHIN BOUNDARY OF VALLEY FILL

In Acre-Feet

Year	System loss (1)	System flushing water (2)	Distribution and other losses (3)	Distribution loss: Total (4)	Distribution loss: Consumptive use (5)	Distribution loss: Deep percolation (6)	Other losses: Total (7)	Other losses: Consumptive use (8)	Other losses: Deep percolation (9)	Total consumptive use (10)	Total deep percolation (11)
1928-29	800	0	800	800	160	640	0	0	0	160	640
29-30	2,250	320	1,930	1,930	390	1,540	0	0	0	390	1,540
1930-31	10,160	490	9,670	8,730	1,750	6,980	940	770	170	2,520	7,150
31-32	16,570	810	15,760	9,090	1,820	7,270	6,670	5,220	1,450	7,040	8,720
32-33	5,580	610	4,970	4,970	990	3,980	0	0	0	990	3,980
33-34	10	700	- 690	- 690	- 140	- 550	0	0	0	- 140	- 550
34-35	- 1,020	450	- 1,470	- 1,470	- 290	- 1,180	0	0	0	- 290	- 1,180
1935-36	5,640	560	5,080	5,080	1,020	4,060	0	0	0	1,020	4,060
36-37	1,480	200	1,200	1,280	260	1,020	0	0	0	260	1,020
37-38	8,440	350	8,090	7,590	1,520	6,070	500	380	120	1,900	6,190
38-39	3,270	300	2,970	2,970	590	2,380	0	0	0	590	2,380
39-40	7,830	250	7,580	7,390	1,480	5,910	190	150	40	1,630	5,950
1940-41	6,010	150	5,860	5,860	1,170	4,690	0	0	0	1,170	4,690
41-42	11,830	170	11,660	9,620	1,920	7,700	2,040	1,760	280	3,680	7,980
42-43	10,790	0	10,790	10,560	2,120	8,440	230	180	50	2,300	8,490
43-44	10,420	0	10,420	9,620	1,930	7,690	800	620	180	2,550	7,870
44-45	14,900	90	14,810	10,100	2,020	8,080	4,710	4,010	700	6,030	8,780
1945-46	11,710	500	11,210	11,020	2,210	8,810	190	160	30	2,370	8,840
46-47	14,240	1,230	13,010	11,530	2,310	9,220	1,480	1,240	240	3,550	9,460
47-48	20,190	1,900	18,290	12,320	2,460	9,860	5,970	5,350	620	7,810	10,480
48-49	15,910	2,290	13,620	12,270	2,450	9,820	1,350	1,210	140	3,660	9,960
49-50	16,790	1,320	15,470	11,850	2,370	9,480	3,620	3,180	440	5,550	9,920
1950-51	19,920	1,520	18,400	13,270	2,650	10,620	5,130	4,630	500	7,280	11,120
51-52	13,240	2,530	10,710	10,710	2,140	8,570	0	0	0	2,140	8,570
52-53	20,370	2,090	18,280	13,580	2,720	10,860	4,700	4,160	540	6,880	11,400
53-54	21,080	2,620	18,460	13,340	2,670	10,670	5,120	4,330	790	7,000	11,460
54-55	20,960	2,240	18,720	13,190	2,640	10,550	5,530	4,920	610	7,560	11,160
1955-56	18,930	3,660	15,270	13,010	2,600	10,410	2,260	1,930	330	4,530	10,740
56-57	18,750	3,270	15,480	13,940	2,790	11,150	1,540	1,340	200	4,130	11,350
57-58	17,090	1,650	15,440	13,030	2,610	10,420	2,410	2,050	360	4,660	10,780
29-Year Average 1929-57	11,280	1,060	10,220	8,400	1,680	6,720	1,830	1,570	260	3,250	6,970

Source and derivation of values by column number:

Column
number

1. Table 24, Column 9.
2. Table 26, Column 5.
3. Column 1 minus Column 2.
4. Column 3 with a maximum of six percent of Table 24, Column 8.
5. Twenty percent of Column 4.
6. Column 4 minus Column 5.
7. Column 3 minus Column 4.
8. Consumptive use of other losses equals the total of other losses (Column 7) multiplied by the ratio of consumptive use of delivered water (Table 35) to the sum of consumptive use and deep percolation of delivered water (Table 35).
9. Column 7 minus Column 8.
10. Column 5 plus Column 8.
11. Column 6 plus Column 9.

Note: Negative values were retained for mathematical purposes.

TABLE 37

TOTAL CONSUMPTIVE USE ON VALLEY FILL AREA
BY INTEGRATION METHOD

In Acre-Feet

Year	Consumptive use		
	On land use classes (1)	Of water system losses (2)	Total (3)=(1)+(2)
1928-29	219,370	160	219,530
29-30	218,740	390	219,130
1930-31	233,890	2,520	236,410
31-32	231,570	7,040	238,610
32-33	184,630	990	185,620
33-34	198,800	- 140	198,660
34-35	255,430	- 290	255,140
1935-36	210,750	1,020	211,770
36-37	249,640	260	249,900
37-38	230,560	1,900	232,460
38-39	249,910	590	250,500
39-40	218,930	1,630	220,560
1940-41	257,330	1,170	258,500
41-42	226,080	3,680	229,760
42-43	247,690	2,300	249,990
43-44	247,290	2,550	249,840
44-45	233,210	6,030	239,240
1945-46	225,970	2,370	228,340
46-47	237,360	3,550	240,910
47-48	203,990	7,810	211,800
48-49	211,930	3,660	215,590
49-50	216,030	5,550	221,580
1950-51	216,700	7,280	223,980
51-52	262,910	2,140	265,050
52-53	229,240	6,880	236,120
53-54	216,670	7,000	223,670
54-55	231,800	7,560	239,360
1955-56	222,030	4,530	225,560
56-57	217,170	4,130	221,300
57-58	254,810	4,660	259,470
29-Year Average 1929-57	227,780	3,250	231,030

Source of values by column number:

Column No.

1. Table 35, Column 18.
2. Table 36, Column 10.

Comparison of Consumptive Use Values Determined by the Inflow-Outflow and Integration Methods

The annual and cumulative amounts of consumptive use as determined by the Inflow-Outflow Method (Table 34, page 169) and by the Integration Method (Table 37, page 184) are shown in Table 38. The average annual consumptive uses for the 29-year base period are 227,200 acre-feet (inflow-outflow) and 231,000 acre-feet (integration). The difference of 3,800 acre-feet between the two average values is approximately one and one-half percent of the average consumptive use and well within the accuracy of the data. The annual differences between the two consumptive use values are shown in column 5, Table 38. The annual consumptive use as determined by each method and the annual and cumulative differences are plotted on Figure 4.

TABLE 38

COMPARISON OF CONSUMPTIVE USE AMOUNTS DETERMINED BY INFLOW-OUTFLOW AND INTEGRATION METHODS

In 1,000 Acre-Feet

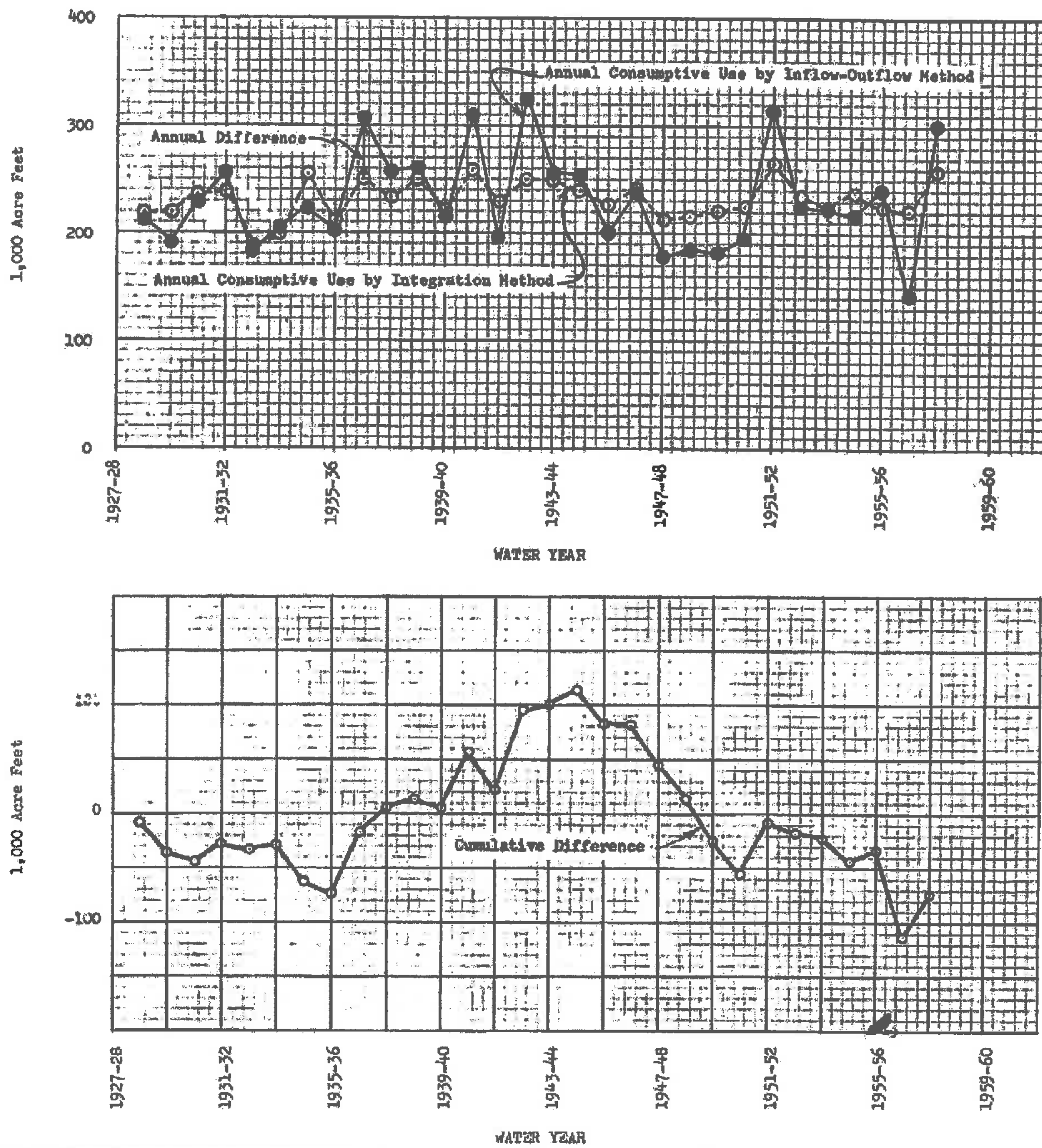
Year	Consumptive use: Inflow-outflow method: Annual (1)	Consumptive use: Inflow-outflow method: Cumulative (2)	Consumptive use: Integration method: Annual (3)	Consumptive use: Integration method: Cumulative (4)	Difference: Annual (1)-(3)=(5)	Difference: Cumulative (6)
1928-29	210.6	210.6	219.5	219.5	- 8.9	- 8.9
29-30	191.2	401.8	219.1	438.6	- 27.9	- 36.8
1930-31	228.3	630.1	236.4	675.0	- 8.1	- 44.9
31-32	254.1	884.2	238.6	913.6	15.5	- 29.4
32-33	181.9	1,066.1	185.6	1,092.2	- 3.7	- 33.1
33-34	202.2	1,268.3	198.7	1,297.9	3.5	- 29.6
34-35	223.3	1,491.6	255.1	1,553.0	- 31.8	- 61.4
1935-36	200.6	1,692.2	211.8	1,764.8	- 11.2	- 72.6
36-37	304.8	1,997.0	249.9	2,014.7	54.9	- 17.7
37-38	255.2	2,252.2	232.5	2,247.2	22.7	5.0
38-39	258.7	2,510.9	250.5	2,497.7	8.2	13.2
39-40	213.9	2,724.8	220.6	2,718.3	- 6.7	6.5
1940-41	309.0	3,033.8	258.5	2,976.8	50.5	57.0
41-42	194.7	3,228.5	229.8	3,206.6	- 35.1	21.9
42-43	323.9	3,552.4	250.0	3,456.6	73.9	95.8
43-44	254.0	3,806.4	249.8	3,706.4	4.2	100.0
44-45	252.1	4,058.5	239.2	3,945.6	12.9	112.9
1945-46	199.0	4,257.5	228.3	4,173.9	- 29.3	83.6
46-47	237.4	4,494.9	240.9	4,414.8	- 3.5	80.1
47-48	177.6	4,672.5	211.8	4,626.6	- 34.2	45.9
48-49	183.3	4,855.8	215.6	4,842.2	- 32.3	13.6
49-50	181.6	5,037.4	221.6	5,063.8	- 40.0	- 24.6
1950-51	195.9	5,233.3	224.0	5,287.8	- 28.1	- 54.5
51-52	312.1	5,545.4	265.0	5,552.8	47.1	- 7.4
52-53	224.6	5,770.0	236.1	5,788.9	- 11.5	- 18.9
53-54	221.2	5,991.2	223.7	6,012.6	- 2.5	- 21.4
54-55	216.2	6,207.4	239.4	6,252.0	- 23.2	- 44.6
1955-56	238.9	6,446.3	226.6	6,478.6	12.3	- 32.3
56-57	141.4	6,587.7	221.3	6,699.9	- 79.9	-112.2
57-58	299.4	6,887.1	259.5	6,959.4	39.9	- 72.3
29-Year Average 1929-57	227.2		231.0			

Source of values by column number:

Column No.

1. Table 34, Column 13.
3. Table 37, Column 3.

Note: Negative values indicate that values determined by integration method are in excess of values determined by the inflow-outflow method.



COMPARISON OF ANNUAL AMOUNTS OF CONSUMPTIVE USE ON THE VALLEY FILL AREA

DETERMINED BY INTEGRATION AND INFLOW-OUTFLOW METHODS

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Adjustment of Consumptive Use

The consumptive use shown in Table 34 and summarized in Table 38 is based on items of inflow, outflow and change in storage. The items of inflow and outflow are based directly or indirectly on measured items. Variations that could exist in the calculation of these items are small in comparison to the amount of the difference. The change in storage of surface reservoirs is measured indirectly and is small. Adjustment of the computed change in ground water storage would require an adjustment of water levels and/or specific yield values. Water levels are influenced, as discussed in Chapter V, by the change in pumping rate from year to year during the period water levels are being measured and by taking measurements at different times from year to year. Both of these possible variations in ground water measurements produce some differences in ground water calculations.

It appears from the above discussion that the difference between the two computations of consumptive use is more likely to be caused by inaccuracies in the integration method. The inflow-outflow method is used as a guide to make refinements in the integration method.

The trends of cumulative differences (Figure 4) are similar to the annual fluctuations of water levels (Plate 34A-C) and the mass diagram of precipitation (Plate 10). It is concluded that the item or items to be adjusted are related to precipitation. The consumptive use (plus the residual value, deep percolation) in the basin is large compared to any of the other disposal items (see Table 34) and is known to be responsive to wet and dry periods. The depths of consumptive use and deep percolation of precipitation, developed in Appendix L, were determined mainly by the use of average monthly winter transpiration rates and constant summer irrigation efficiencies. The use of average monthly transpiration rates rather than daily rates is necessary due to a lack of water supply data on a daily basis. This tends to cause the computed consumptive use to be high during dry periods and low during wet periods.

The relationship between precipitation on the valley fill and the difference between the consumptive use as determined by the two methods was ascertained as follows:

1. The amount that the annual precipitation on the entire valley fill area exceeded or was less than the annual average during the 29-year base period was computed in acre-feet for each year of that period.

2. The same computation was also made for precipitation occurring on the pervious portion of the valley fill area.

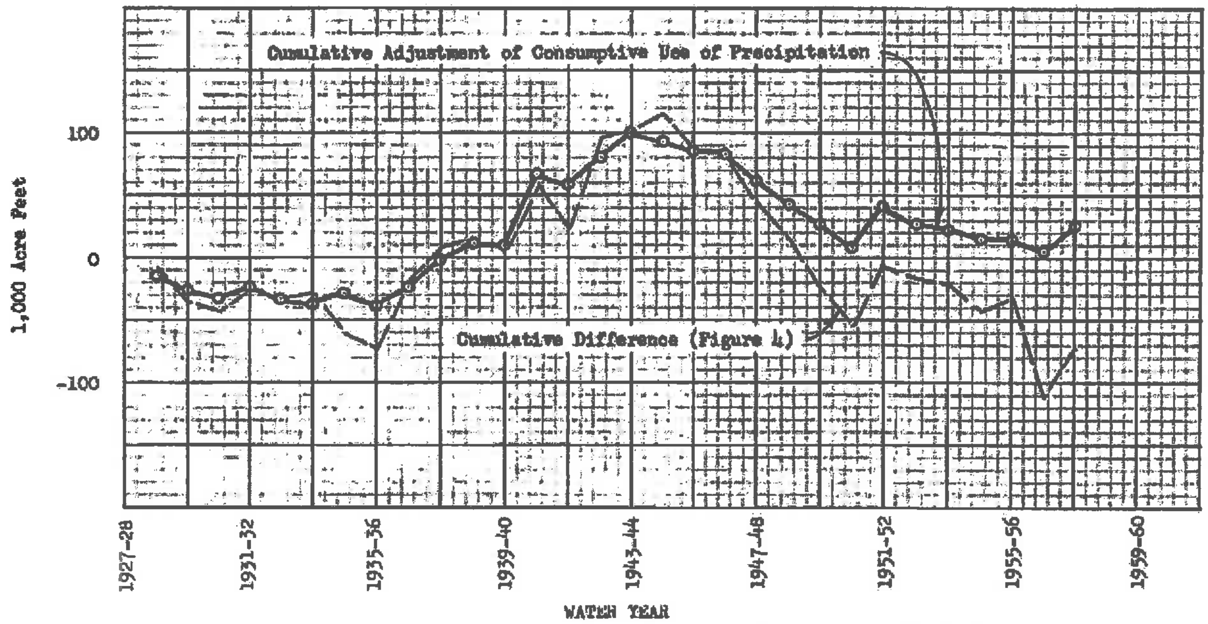
3. The cumulative amounts thus determined by each of these computations were compared with the cumulative difference in consumptive use determined by the Integration and Inflow-Outflow Methods.

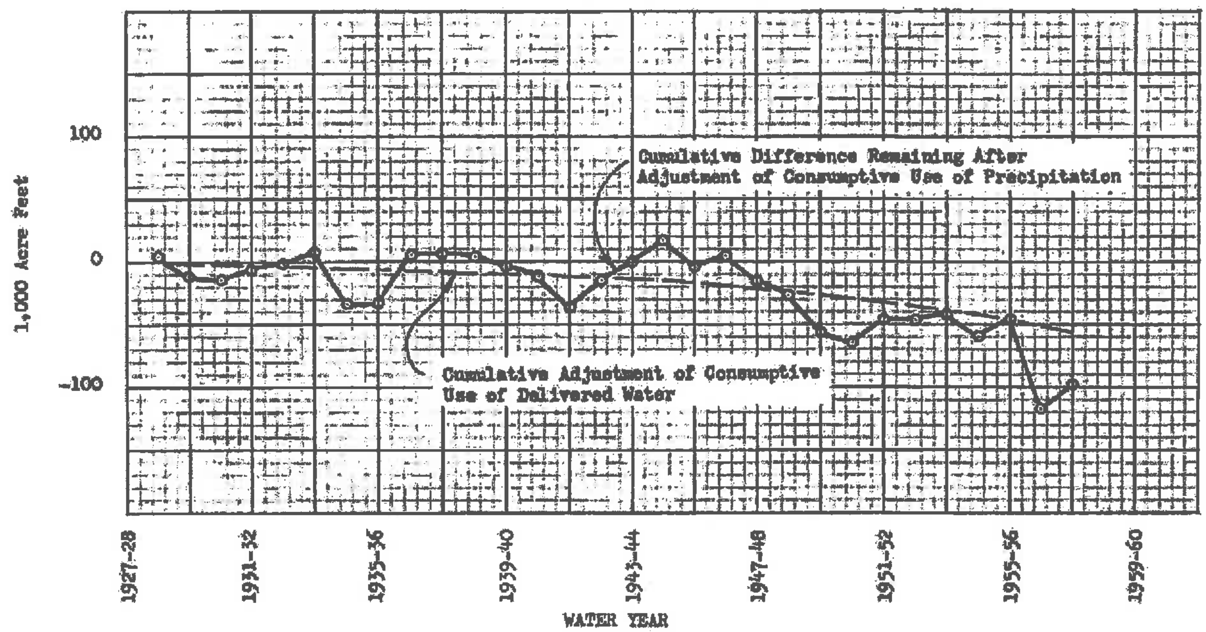
From the foregoing it was found that trends in the differences in amount of consumptive use most closely approximated those indicated by abnormality of precipitation on the pervious portion of the valley fill found in Item 2 above. A value of 30 percent was selected as the parameter giving the closest match. The annual adjustment to the consumptive use of rain

(Table 39) may therefore be expressed as 30 percent of the difference between annual precipitation on the pervious valley fill area in acre-feet and the 29-year average precipitation thereon.

The effect of the consumptive use of rain adjustment is shown by cumulative curves on Figure 5. The magnitude of the remaining difference shown on Figure 5 is within the accuracy expected for a hydrologic study. There is, however, a slight trend indicating that the total adjusted consumptive use as determined by the Integration Method, still exceeds that of the Inflow-Outflow Method.

Since the adjustments to the consumptive use of rain did not fully correct the difference, it is assumed that adjustments in the consumptive use of delivered water may also be necessary. The consumptive use of irrigated crops was based on irrigation efficiency during the summer growing season and average transpiration rates during the winter season. Residential lawn grass on the other hand was based on experimental values developed in the Raymond Basin Reference. The lawn grass values were obtained under conditions of optimum moisture being available and would produce maximum consumptive use values. Therefore, it is assumed that the computed values for consumptive use of residential lawn grass are too high. The cumulative difference remaining, after the adjustment of the





CUMULATIVE ADJUSTMENTS TO THE CONSUMPTIVE USE OF PRECIPITATION
AND THE CONSUMPTIVE USE OF DELIVERED WATER

TABLE 39

ADJUSTMENT OF INTEGRATED CONSUMPTIVE USE

In 1,000 Acre-Feet

Year	Total difference		Consumptive use of rain adjustment		Difference		Consumptive use of delivered water adjustment		Total consumptive use adjustment		Remaining difference	
	Annual (1)	Cumulative (2)	Annual (3)	Cumulative (4)	Annual (5)	Cumulative (6)	Annual (7)	Cumulative (8)	Annual (9)	Cumulative (10)	Annual (11)	Cumulative (12)
1928-29	- 8.9	- 8.9	-13.5	-13.5	4.6	4.6	-0.8	- 0.8	-14.3	-14.3	5.4	5.4
29-30	-27.9	- 36.8	-12.5	-26.0	-15.4	- 10.8	-0.9	- 1.7	-13.4	-27.7	-14.5	- 9.1
1930-31	- 8.1	- 44.9	- 4.6	-30.6	- 3.5	- 14.3	-0.9	- 2.6	- 5.5	-33.2	- 2.6	-11.7
31-32	15.5	- 29.4	9.0	-21.6	6.5	- 7.8	-0.6	- 3.2	8.4	-24.8	7.1	- 4.6
32-33	- 3.7	- 33.1	-10.3	-31.9	6.6	- 1.2	-0.7	- 3.8	-10.9	-35.7	7.2	2.6
33-34	3.5	- 29.6	- 5.9	-37.8	9.4	8.2	-0.7	- 4.5	- 6.6	-42.3	10.1	12.7
34-35	-31.8	- 61.4	8.7	-29.1	-40.5	- 32.3	-0.5	- 5.0	8.2	-34.1	-40.0	-27.3
1935-36	-11.2	- 72.6	-10.7	-39.8	- 0.5	- 32.8	-0.6	- 5.6	-11.3	-45.4	0.1	-27.2
36-37	54.9	- 17.7	17.5	-22.3	37.4	4.6	-0.6	- 6.2	16.9	-28.5	38.0	10.8
37-38	22.7	5.0	21.2	- 1.1	1.5	6.1	-0.7	- 6.9	20.5	- 8.0	2.2	13.0
38-39	8.2	13.2	11.5	10.4	- 3.3	2.8	-0.9	- 7.8	10.6	2.6	- 2.4	10.6
39-40	- 6.7	6.5	- 0.3	10.1	- 6.4	- 3.6	-0.9	- 8.7	- 1.2	1.4	- 5.5	5.1
1940-41	50.5	57.0	58.2	68.3	- 7.7	- 11.3	-0.8	- 9.5	57.4	58.8	- 6.9	- 1.8
41-42	-35.1	21.9	- 8.6	59.7	-26.5	- 37.8	-1.0	-10.5	- 9.6	49.2	-25.5	-27.3
42-43	73.9	95.8	20.8	80.5	53.1	15.3	-1.3	-11.8	19.5	68.7	54.4	27.1
43-44	4.2	100.0	19.5	100.0	-15.3	0.0	-1.4	13.2	18.1	86.8	-13.9	13.2
44-45	12.9	112.9	- 5.9	94.1	18.8	18.8	-1.5	-14.7	- 7.4	79.4	20.3	33.5
1945-46	-29.3	83.6	- 7.4	86.7	-21.9	- 3.1	-2.0	-16.7	- 9.4	70.0	-19.9	13.6
46-47	- 3.5	80.1	- 3.9	82.8	0.4	2.7	-2.2	-18.9	- 6.1	63.9	2.6	16.2
47-48	-34.2	45.9	-21.3	61.5	-12.9	- 15.6	-2.5	-21.4	-23.8	40.1	-10.4	5.8
48-49	-32.3	13.6	-19.7	41.8	-12.6	- 28.2	-2.7	-24.1	-22.4	17.7	- 9.9	- 4.1
49-50	-40.0	- 24.6	-14.0	27.8	-26.0	- 54.2	-2.7	-26.8	-16.7	1.0	-23.3	-27.4
1950-51	-28.1	- 54.5	-18.2	9.6	- 9.9	- 64.1	-3.0	-29.8	-21.2	-20.2	- 6.9	-34.3
51-52	47.1	- 7.4	30.8	40.4	16.3	- 47.8	-2.9	-32.7	27.9	7.7	19.2	-15.1
52-53	-11.5	- 18.9	-11.7	28.7	0.2	- 47.6	-3.5	-36.2	-15.2	- 7.5	3.7	-11.4
53-54	- 2.5	- 21.4	- 7.4	21.3	4.9	- 42.7	-3.6	-39.8	-11.0	-18.5	8.5	- 2.9
54-55	-23.2	- 44.6	- 6.4	14.9	-16.8	- 59.5	-3.4	-43.2	- 9.8	-28.3	-13.4	-16.3
1955-56	12.3	- 32.3	- 0.4	14.5	12.7	- 46.8	-3.6	-46.8	- 4.0	-32.3	15.3	0.0
56-57	-79.9	-112.2	- 7.8	6.7	-72.1	-118.9	-4.8	-51.6	-12.6	-44.9	-67.3	-67.3
57-58	39.9	- 72.3	20.8	27.5	19.1	- 99.8	-3.7	-55.3	17.1	-27.8	22.8	-44.5

Source and derivation of values by column number:

Column No.

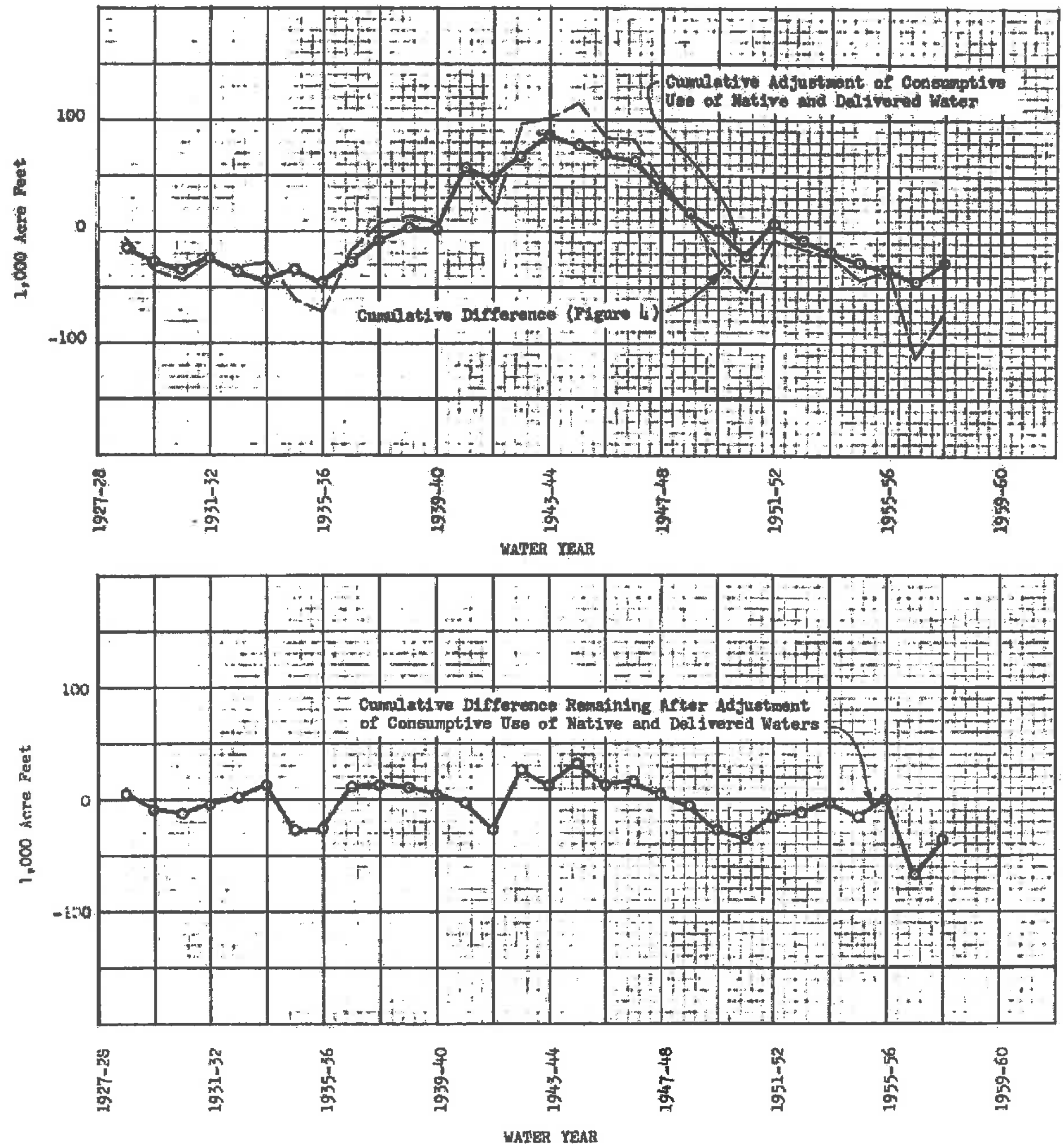
1. Table 38, Column 5.
3. 30 percent of annual precipitation above and below 29-year average falling on pervious areas.
5. Column 1 minus Column 3.
7. Five percent of the sum of Columns 6 and 8 in Table 35.
9. Column 3 plus Column 7.
11. Column 1 minus Column 9.

consumptive use of precipitation has been made (Figure 5), is an increasing function. The acreage put to residential use is also an increasing function while lands used for irrigated and nonirrigated crops have been decreasing. Both the method of determining consumptive use of residential lawn grass and the land use trends indicate that the adjustment of the consumptive use of delivered water is related to residential delivered water. An adjustment equal to five percent of residential delivered water applied to land areas (excluding sewage) was found to be the best match to the remaining difference and was adopted as the adjustment to the consumptive use of delivered water.

The annual and cumulative adjustments of the consumptive use of precipitation and delivered water and the sum of both are shown in Table 39. These adjustments are applied to the consumptive use as determined by the integration method. The effects of the adjustments are to increase the consumptive use of precipitation during wet years and to decrease it during dry years, and to decrease the consumptive use of delivered water for all years. The adjustments are transfers of water between the amounts of consumptive use and deep percolation computed by the integration method; therefore, the sum of consumptive use and deep percolation is unchanged.

The total cumulative adjustments to the integrated consumptive use and the cumulative difference remaining between the adjusted integrated consumptive use and Inflow-Outflow Method consumptive use are shown on Figure 6.

The cumulative difference curve which represents the chronological accumulation of all differences between the two values of consumptive use after adjustment shows that the adjustment formula are applicable throughout the range of precipitation influences and other effects concerning delivered water occurring throughout the base period.



CUMULATIVE ADJUSTMENT TO CONSUMPTIVE USE AND REMAINING DIFFERENCE

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Adjusted Consumptive Use of Precipitation and Delivered Water on the Valley Fill Area

The annual amounts of consumptive use of precipitation and of delivered water adopted by the Referee are shown in Table 40 and are equal to the amounts obtained by the Integration Method (Table 37, page 184) modified by the annual adjustments (Table 39, page 192). For the purposes of hydrologic inventories, the unit values of consumptive use of precipitation shown in Tables L-13, L-14 and L-15 must be used along with the adjustment to the consumptive use of precipitation (see page 190). The unit values of consumptive use of delivered water contained in Tables L-13 through L-15, with the exception of those for residential areas, may be used without adjustment. The unit values for consumptive use on residential land use areas must be decreased by five percent of the difference between residential delivered water and residential sewage (or five percent of consumptive use plus deep percolation). The above unit values are shown in Appendix R.

The total consumptive use adopted by the Referee is the sum of adjusted consumptive use of precipitation and delivered water, the consumptive use of ground water, and evaporation of runoff into Hansen Dam. The 29-year averages of adjusted consumptive use and their sources are as follows:

	1,000 acre-feet	Source
Adjusted consumptive use of precipitation	122.4	Page 197
Adjusted consumptive use of delivered water	102.2	Page 197
Consumptive use of ground water	4.6	Page L-70
Consumptive use of runoff (Hansen Dam)	0.3	Page L-71a
Total	229.5	

TABLE 40

ADJUSTED CONSUMPTIVE USE OF DELIVERED WATER AND PRECIPITATION
ON VALLEY FILL AREA

In 1,000 Acre-Feet

Year	Consumptive use of delivered water				Consumptive use of precipitation			Adjusted consumptive use of precipitation and delivered water
	On land use areas by integration (1)	Water system loss (2)	Consumptive use adjustment (3)	Adjusted consumptive use of delivered water (4)	By integration (5)	Consumptive use adjustment (6)	Adjusted consumptive use of precipitation (7)	(8)
1928-29	98.6	0.2	-0.8	98.0	114.9	-13.5	101.4	199.4
29-30	101.0	0.4	-0.9	100.5	112.6	-12.5	100.1	200.6
1930-31	96.0	2.5	-0.9	97.6	133.5	- 4.6	128.9	226.5
31-32	71.5	7.0	-0.6	77.9	154.5	9.0	163.5	241.4
32-33	77.0	1.0	-0.6	77.4	103.0	-10.3	92.7	170.1
33-34	82.8	-0.1	-0.7	82.0	111.5	- 5.9	105.6	187.6
34-35	74.8	-0.3	-0.5	74.0	175.0	8.7	183.7	257.7
1935-36	95.0	1.0	-0.6	95.4	109.2	-10.7	98.5	193.9
36-37	81.4	0.3	-0.6	81.1	163.1	17.5	180.6	261.7
37-38	74.2	1.9	-0.7	75.4	150.2	21.2	171.4	246.8
38-39	83.8	0.6	-0.9	83.5	161.6	11.5	173.1	256.6
39-40	78.7	1.6	-0.9	79.4	136.4	- 0.3	136.1	215.5
1940-41	64.2	1.2	-0.8	64.6	187.6	58.2	245.8	310.4
41-42	96.8	3.7	-1.0	99.5	119.6	- 8.6	111.0	210.5
42-43	95.1	2.3	-1.3	96.1	140.8	20.8	161.6	257.7
43-44	93.1	2.5	-1.4	94.2	141.2	19.5	160.7	254.9
44-45	108.7	6.0	-1.5	113.2	120.4	- 5.9	114.5	227.7
1945-46	113.5	2.4	-2.0	113.9	108.3	- 7.4	100.9	214.8
46-47	116.5	3.6	-2.2	117.9	117.7	- 3.9	113.8	231.7
47-48	133.0	7.8	-2.5	138.3	67.6	-21.3	46.3	184.6
48-49	133.5	3.7	-2.7	134.5	75.2	-19.7	55.5	190.0
49-50	122.3	5.5	-2.7	125.1	90.4	-14.0	76.4	201.5
1950-51	135.0	7.3	-3.0	139.3	78.3	-18.2	60.1	199.4
51-52	102.7	2.1	-2.9	101.9	157.0	30.8	187.8	289.7
52-53	130.2	6.9	-3.5	133.6	95.3	-11.7	83.6	217.2
53-54	117.0	7.0	-3.6	120.4	97.1	- 7.4	89.7	210.1
54-55	113.5	7.6	-3.4	117.7	115.8	- 6.4	109.4	227.1
1955-56	106.8	4.5	-3.6	107.7	113.2	- 0.4	112.8	220.5
56-57	123.1	4.1	-4.8	122.4	92.2	- 7.8	84.4	206.8
57-58	105.1	4.7	-3.7	106.1	148.0	20.8	168.8	274.9
29-Year Average 1929-57	100.7	3.3	-1.8	102.2	122.2	0.2	122.4	224.6

Source and derivation of values by column number:

Column No.

1. Table 35, Column 16.
2. Table 36, Column 10.
3. Table 39, Column 7.
4. Sum of Columns 1, 2 and 3.
5. Table 35, Column 15.
6. Table 39, Column 3.
7. Sum of Columns 5 and 6.
8. Sum of Columns 4 and 7.

Historic Ground Water Recharge

The items comprising recharge to and draft on the ground water reservoir are shown on Figure 7. Recharge of delivered water is shown in Table 41 and is computed as surface supply to the valley fill area less consumptive use, exports and outflows of that supply. Recharge from native water is shown in Table 42 and is computed in three parts: that occurring on land use classes; that occurring in channels of the stream system; and that resulting from the spreading of native water. The first portion equals the precipitation on land use class areas on the valley fill area less consumptive use and residual rain (i.e., precipitation not retained on land use class areas). The second is the recharge from native water in transit across the valley fill to the point of surface escape and is equal to the amounts of native water tributary to the stream channel system less diversions for spreading and use and storm outflows at Gage F-57. Recharge of delivered water in the stream channels has been included in the total recharge of delivered water.

Ground Water Draft

The draft on the ground water reservoir, shown in Table 43, is composed of well extractions, for use on the valley fill area and for export, and natural depletions.

Ground Water Inventory

The basic equation for ground water inventory (Figure 7) is ground water supply minus ground water draft equals change in ground water storage. Since the difference between consumptive use determined by the inflow-outflow and integration methods was not completely removed by the adjustments made to the integrated consumptive use, the remaining imbalance (Table 39, column 10) must be added to the basic equation. The ground water inventory for the period 1928-29 through 1957-58 lists annual amounts of supply, disposal, change in storage and the remaining difference and is shown in Table 43.

The effects of urbanization on the average recharge of delivered water to the ground water reservoir are shown below by comparing the averages for two periods of average precipitation on the valley fill area; i.e., the 9-year period (1949-50 through 1957-58) and the 29-year base period.

In 1,000 Acre-feet

Item	9-year average (1)	29-year average (2)	Difference (3)=(1)-(2)
Gross delivered water[a]	222.0	175.8	46.2
Gross recharge of delivered water[a]	57.9	49.4	8.5
Gross recharge as a percent of delivered water	26.1%	28.1%	2.0%
Cesspool recharge[b]	16.8	9.3	7.5
Gross recharge of delivered water less cesspool recharge	41.1	40.1	1.0
Gross recharge of delivered water less cesspool rechargevas a percent of delivered water	18.5%	22.8%	4.3%

a. From Table 41.
b. From Table 26

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