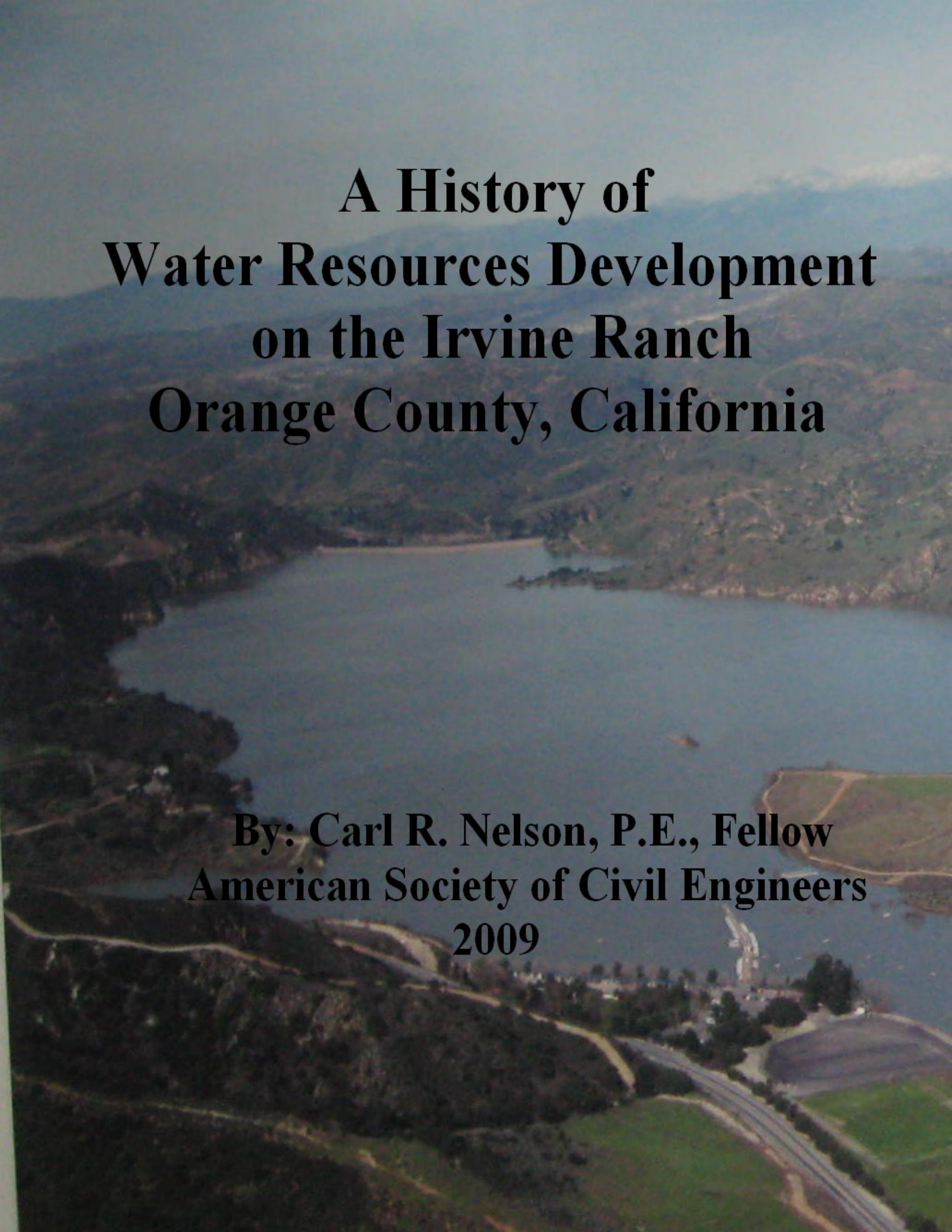

A History of Water Resources Development on the Irvine Ranch Orange County, California

By: Carl R. Nelson, P.E., Fellow
American Society of Civil Engineers

2009

A History of
Water Resources Development
on the Irvine Ranch
Orange County, California

Written to Support Recognition of
The Irvine Ranch Irrigation System
As a Historic Civil Engineering Landmark
By The American Society of Civil Engineers

By: Carl R. Nelson, P.E. Fellow, ASCE
2009

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A History of Water Resources Development on the Irvine Ranch, Orange County, California

I. Synopsis

During the 1850s some of California's entrepreneurial newcomers, including James Irvine and others, found their fortunes not in the gold fields, but in commercial merchandising and investments in the parched real estate of Los Angeles County (this was prior to the 1889 detachment of Orange County). Land holdings in the hundreds of thousands of acres were acquired from the owners of Spanish or Mexican land grant ranchos. As described in Robert G. Cleland's book Cattle on a Thousand Hills*, the empires of the rancheros had been devastated when grazing lands were turned to barren waste during the extreme droughts of the mid-1850s & 1860s. The editors of the Santa Ana Herald on December 31, 1881 described the situation; we "traveled through the rancho, the property of James Irvine of San Francisco, a distance of twelve miles, during which we saw no house, nor found an improvement…This immense estate so dreary and desolate…" The following history of the Irvine Ranch Irrigation System describes how James Irvine, during the next eighty years transformed his property into one of the most prosperous agricultural enterprises in the State of California.

In 1912, President William Howard Taft, speaking from the observation platform of the presidential train at the Santa Fe depot in Santa Ana, is said to have remarked that "the thing which impressed him most as he travelled through the highly developed agricultural lands of Southern California…was the great foresight, energy and courage of those early pioneers who first brought water onto the semi-desert lands and transformed them into productive gardens."

II. Chronology of the Irvine Ranch

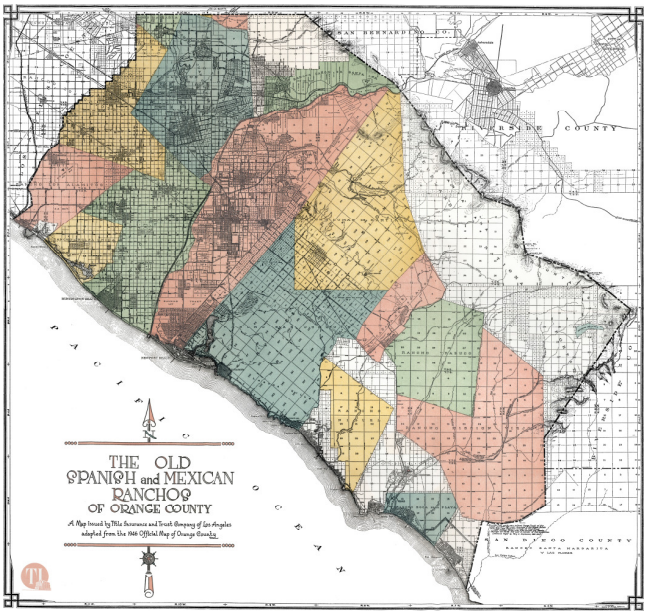
1. Era of the Ranchos

James Irvine, an immigrant from Ireland, came to the eastern United States in 1846 and in 1849 joined the California Gold Rush by way of the Isthmus of Panama. After crossing the isthmus, his passage to San Francisco aboard the sailing ship Humboldt took 101 days. Fellow passengers included Collis P. Huntington of future Central Pacific Railroad fame and Dr. Benjamin Flint. The chance acquaintanceships, along with successful mercantile and real estate business ventures, led to Irvine's partnership with Flint, his brother Thomas and Llewellyn Bixby. Their partnership acquired ownership of two Mexican Land Grants and a portion of a Spanish grant in what was then southern Los Angeles County.

The Rancho San Joaquin had been granted in 1847 to Don Jose Sepulveda as a combination of two former Mission San Juan Capistrano parcels (the Cienega de las Ranas and La Bolsa de San Joaquin). Sepulveda sold the 50,000 acre property to James Irvine and his partners, (three prosperous sheep men), for $18,000 in 1864. The Rancho Lomas de Santiago had been granted by Mexican Governor Pio Pico to

** Refers to publication listed in Bibliography*

Don Teodoso Yorba in 1846. The 47,000 acre property was too rough for cultivation, but was sold to William Wolfskill for use as a sheep ranch. He in turn sold in 1866 to the Irvine/Flint/Bixby partnership.



The Rancho Santiago de Santa Ana, was a former Spanish Land Grant to Don Tomas Yorba who died in 1845. Probate and bankruptcy litigation, settled in 1868, granted to the Irvine/Flint/Bixby partnership a portion of this rancho 8 miles in length (3800 acres) paralleling the northwesterly boundary of Rancho San Joaquin.

2. The Climate of Southern California

From an agricultural point of view, a humid semi-tropical climate with 30 or more inches annual precipitation, spread evenly throughout the year, would be ideal. However, coastal Southern California, (and Orange County) has a Mediterranean, semi-arid climate characterized by long, dry summers with little or no rainfall. The four month period from November through March is the season when the largest part of the yearly precipitation occurs. Most significantly, every year, there is usually no rainfall between May 1 and October 1.

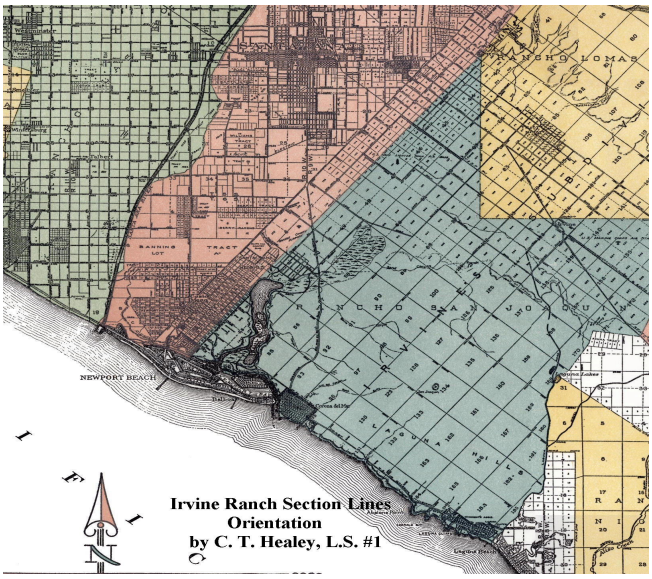
3. Sheep & Cattle Grazing

The primary business of the ranchos was cattle grazing. However, several years of less than normal winter rainfall during the 1850s led to lack of grass and water, thousands of cattle perished, rancho lands were sold to American investors to settle debts. Flint & Bixby were sheep men, having driven a flock of 2,000 sheep from Iowa to California over an eight month journey in 1853. Their objective in acquiring rancho land was to expand their profitable wool business. The winters of 1861-62 and 1867-68 had abnormally high rainfall, food and water resources increased and their lamb flock increased to more than 30,000. Their annual production of wool was said to be about two hundred thousand pounds which was shipped from Newport Bay to San Francisco and then to the east coast.

4. The Irvine Ranch

Southern California real estate values were increasing, whetting James Irvine's competitive interests, and in 1876 he bought out the Flints/Bixby partnership for $150,000, giving him sole ownership of 110,000 acres of land running from the coastline northeasterly to the Riverside County Line in Santa Ana Canyon. Another drought period began in 1869, diminishing the sheep herds. Nonetheless, nearby towns (Anaheim & Orange) were growing with agricultural uses of water diverted from the Santa Ana River. In 1882, Irvine's plan to sell 40 acre farm sites in the Tustin area was poorly received in a market depressed by exorbitant charges for shipping agricultural products.

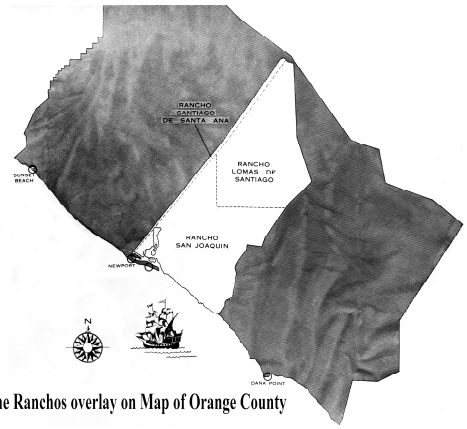
An interesting situation occurred with the formal mapping of the ranch by Charles T. Healey in 1883. Healey chose to orient the



Block and Section lines parallel with the original northwesterly Rancho San Joaquin boundary rather than the General Land Office system of north/south (see North arrow above). The Rancho boundary had first been described in the Mexican Land Grant as a line running from the Serrito de las Ranas (or Hill of Frogs, a prominent hilltop now known as Red Hill) to the coast (on a line at more or less right angle to the shoreline). Hence, Section Lines within Irvine Ranch are approximately 40 degrees askew with the remainder of Orange County. The boundary of the ¾ quarter mile portion of Rancho Santiago de Santa Ana added to Irvine Ranch later became the centerline of what became Newport Avenue between Costa Mesa and Tustin.

In 1886 James Irvine I died leaving his estate in trust until James II reached the age of 25. During the interim an uncle, George Irvine managed the ranch. In 1887 a right of way was granted to a subsidiary of the Santa Fe Railroad. With the arrival of the railroad, the ranch began a transition from sheep to cattle along with the leasing of land on a crop sharing basis. By 1888 the sheep herd was down from 35,000 to 12,000. Five thousand acres had been leased to farmers raising hay and grain.

In 1889, the State Legislature separated the County of Orange from Los Angeles County at which time Irvine Ranch occupied about one fifth of the new county.



Irvine Ranchos overlay on Map of Orange County

Of the 50,000 acre Rancho San Joaquin, approximately 21,000 acres were deemed suitable for cultivation. When James II took over management in 1892 he began to convert the ranch from a simple grazing operation to an increasingly modern, productive enterprise of field crops, grain and irrigated orchards.

III. Topographic Background

1. <u>The Santa Ana Mountains</u>

This is a northwesterly extension of the Peninsular Range of Southern California trending southeasterly from the Chino Hills in Orange County to northern San Diego County. Santiago (5,687 ft.), Modjeska (5,496 ft.) and Pleasants (4,007 ft.) peaks form the ridgeline between Orange and Riverside Counties and drain westerly to Santiago Canyon; there

melding with the alluvial plain of the Santa Ana River.

Trabuco Peak (4,604 ft.) and Los Pinos Peak (4,510 ft.) lie southerly of Santiago and drain toward the coast via San Juan Creek. Further southeast, Sitton (3,273) and Margarita (3,189 ft.) peaks drain to the ocean in San Diego County via San Mateo and San Onofre Creeks. The Santa Margarita River watershed is along the southerly edge of the Santa Ana Mountains.

2. Santiago Canyon

The watershed of Santiago Canyon runs westerly from Santiago Peak through the northerly portion of Irvine Ranch. Easterly of the Irvine property, the uppermost peaks are within the Trabuco District of the Cleveland National Forest (established by President Theodore Roosevelt in 1908). Ephemeral surface water was sufficient to host early American natives. Most of the watershed is rough, covered with chaparral.

Principal tributaries are Silverado, Black Star, Limestone and Fremont Canyons.

An extract from the "News" of August 27, 1880 in Thompson and West's History of Los Angeles County states…"Santiago Creek runs through the Santa Ana Valley, and in winter is frequently impassable, but in the summer is dry."

3. Lomas de Santiago Foothills

The Lomas de Santiago foothills of the Santa Ana Mountains form the southerly edge of the Santiago Canyon watershed. From the Loma Ridge the foothills drain southerly to San Diego Creek which flows westerly toward Upper Newport Bay.

4. San Diego Creek and Tributaries

Bounded on the south by the San Joaquin Foothills, (see Fig. A Map) the valley of San Diego Creek is a gentle, fertile plain with nearly frost-free winters and moderate-summer heat. The valley of San Diego Creek is almost entirely within Irvine Ranch. Tributaries include, Serrano Creek, Agua Chinon, Rattlesnake Canyon and Peters Canyon. Serrano Creek rises to the east of Irvine Ranch, within Rancho Canada de Los Alisos where the grantee, Jose Serrano, found sufficient surface water to support his rancho home. Also easterly of Irvine on a smaller branch of Serrano Creek, George Veeh a 20th century farmer constructed a dam circa 1930 for the conservation of winter runoff to irrigate row crops.

Within the lower Irvine Valley, only Peters Canyon and the Cienega de Las Ranas were known to have any dry weather surface water. During the late 19th century the Cienega was a large, bottomland swamp where runoff accumulated with little or no outflow to the bay according to a historical research paper* by Stanley W. Trimble of the UCLA Department of Geography.

5. San Joaquin Hills

This is a ridge of low hills in coastal Orange County extending in a northwest-southeast

direction, from Upper Newport Bay and rolling southeasterly to San Juan Capistrano.

The inland side of the ridge drains to San Diego Creek while the coastal side drains directly to the ocean, primarily via Laguna Canyon.

Near the upper end of Laguna Canyon lay the Laguna Lakes, a shallow, natural sump which historically maintained a perennial pond despite having a relatively small watershed. In 1924 Needham* reported only in extreme drought (1919-1920) were the ponds dried up completely.

IV. Hydrology

1. Precipitation

At Santiago Peak, the highest elevation of the Santa Ana Mountains, the average annual rainfall is 34 inches. Contrastingly; the driest year recorded at the peak was 2006-07 with a total of 8 inches, and 1997-98, the wettest total was 105 inches (See chart, following page).

Over the lower elevations of Irvine Ranch (Santa Ana/Irvine) the annual rainfall averages about 13 inches. Important to agriculturists, the median annual rainfall (half the years are lower and half the years higher) is only 11.85 inches.

2. Storm Runoff

Streamflow is ephemeral, very erratic with almost no flow in most streams except during and shortly following significant rainstorms. Early settlers found water for domestic purposes only in spring-fed streams at the mouths of canyons; for instance, the Santa Ana River near Burrel Point, also the narrows of Santiago Creek at Villa Park. On the other hand, the flood threat from storm runoff could increase rapidly in response to heavy rainfall.

Wm. Hamilton Hall's, California State Engineer's report * of 1888 , includes the following description; "Santiago Creek is a torrent in winter. Where it emerges upon the plain, its gravel and cobble channel is five hundred to eight hundred feet wide and several feet deep. It is often impossible to ford it for a week at a time".

According to "Notes on Irrigation" from W.P.A.'s* 1936 Orange County Historical Research Project; the "marsh between Red Hill and Upper Newport Bay is interesting. All the flood waters of the arroyos from Tustin nearly to El Toro, and…sometimes the Santiago, combined to form the 'Cienega' as it was called by the Spaniards. There were no drainage ditches in those days and not much water could get through the bottleneck into the bay. So, at flood-stage, these waters were forced west across the Martin Airport (area near Main St. at Newport Road) and around the north side of Costa Mesa…probably meeting the flow of the Santa Ana there."

Historic accounts by Jim Sleeper* and Terry Stephenson* report that near the Serrito de las Ranas, (or Hill of Frogs, a prominent hilltop now known as Red Hill) there existed a spring known as Aguage de las Ranas. Over the eons of geologic history spring flow, probably of artesian origin, fed the Cienega de las Ranas. The swamp land ran from the mouth of the Canada de las Ranas, now named Peters Canyon (after James Peters the first tenant of the canyon area) nearly to Upper Newport Bay. Hence, surface water, springs and windmills became the basic rationale for locating the Irvine Ranch home and Headquarters there in 1888. James Irvine at that time began an ambitious program of

Table 19

'ORANGE COUNTY RESOURCES AND DEVELOPMENT MANAGEMENT DEPARTMENT

Precipitation Summary 2004-2005

Santiago Peak - Sta. 208

GAGE ELEVATION:	5638'	LATITUDE	33-42-06
SEASON TOTAL:	51.94	LONGITUDE	117-32-01
RECORDS:	1950 to Present	40 YEAR BASE PERIOD:	1966-2005
MEAN:	34.52	MEAN:	37.83
SEASON AS %:	150.5	SEASON AS %:	137.3

DAY	JULY	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	DAY
1							0.75						1
2							0.04						2
3							0.18		0.08				3
4							0.59		0.12				4
5							0.04		0.63		0.04		5
6						0.28	0.16				1.14		6
7							0.20	0.35			0.08		7
8					0.12	1.22	1.38						8
9							3.56						9
10							3.96				0.16		10
11							6.10	0.47					11
12								1.26					12
13								0.20					13
14													14
15													15
16													16
17				1.16									17
18				1.32				0.47					18
19				1.12				1.14	0.43				19
20				3.82				2.05	0.98				20
21				0.83	0.51			1.32					21
22								0.96					22
23								0.55	0.98				23
24								0.24	0.12	0.51			24
25									0.08	0.08			25
26													26
27				1.89			0.31						27
28				1.22	1.18	0.59	0.04			0.75			28
29						2.52	0.63			0.04			29
30						0.87							30
31						0.12							31
	0.00	0.00	0.00	11.36	1.81	5.60	17.94	9.01	3.42	1.38	1.42	0.00	

---LEGEND---

A - ESTIMATED
B - PARTIALLY ESTIMATED
C - INCOMPLETE
D - DATE UNCERTAIN
NR - NO RECORD
T - TRACE
P - INCLUDED IN FOLLOWING TOTAL

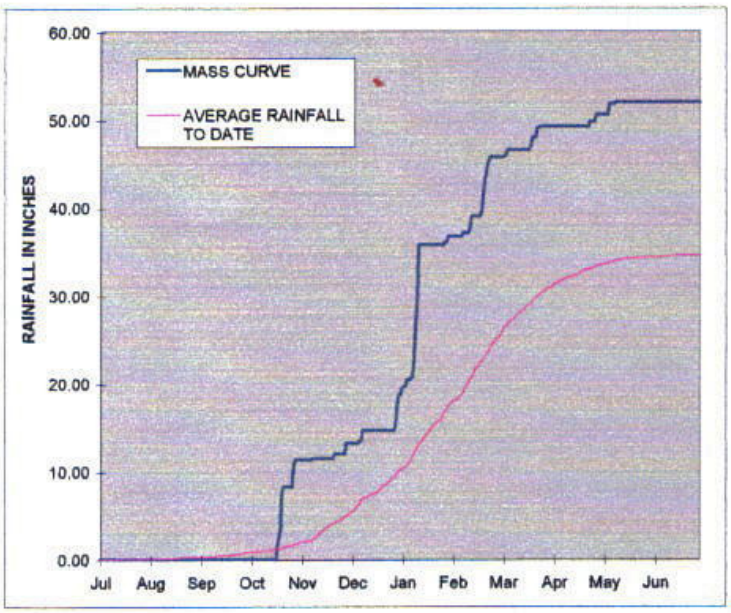
REMARKS

NOTE Prior to 1996 Season Totals taken from NWS Gage #156

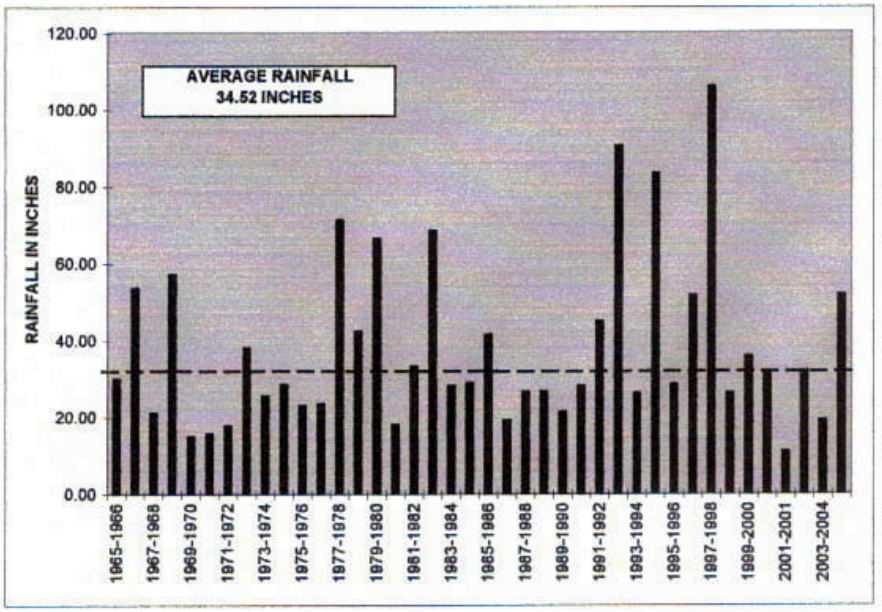
SEASON TOTAL 51.94 "

SEASON	JULY	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
1965-1966	0.58	0.18	0.85	0.00	14.98	8.65	1.44	2.00	0.72	0.26	0.43	0.00	30.09
1966-1967	0.00	0.00	0.17	0.07	2.08	29.78	7.72	0.00	5.17	8.56	0.04	0.12	53.71
1967-1968	0.00	0.02	0.48	0.00	4.58	4.13	2.32	1.16	6.19	1.87	0.49	0.00	21.24
1968-1969	0.00	0.02	0.00	0.43	1.65	3.36	21.89	25.07	2.65	1.73	0.39	0.00	57.19
1969-1970	0.08	0.00	0.00	0.00	2.65	0.16	3.45	1.31	7.52	0.00	0.00	0.01	15.18
1970-1971	0.00	0.00	0.00	0.00	4.10	5.91	2.09	0.95	0.97	1.15	0.73	0.00	15.90
1971-1972	0.00	0.00	0.00	1.50	0.60	12.30	0.00	0.80	0.00	1.40	0.70	0.60	17.90
1972-1973	0.00	0.80	0.20	0.60	5.80	4.70	6.10	10.60	9.20	0.20	0.00	0.00	38.20
1973-1974	0.00	0.00	0.00	0.50	4.90	0.90	10.90	0.10	6.20	2.10	0.00	0.00	25.60
1974-1975	0.00	0.00	0.00	1.60	0.70	6.50	0.60	4.70	8.90	5.30	0.00	0.30	28.60
1975-1976	0.00	0.00	0.00	0.90	2.90	1.00	0.00	7.80	6.20	2.90	0.30	1.10	23.10
1976-1977	0.00	0.00	4.60	0.30	0.90	2.00	6.80	1.70	2.80	0.10	4.40	0.00	23.60
1977-1978	0.00	3.40	0.10	0.00	0.30	11.30	15.90	15.80	19.70	4.70	0.10	0.00	71.30
1978-1979	0.00	0.00	2.60	0.40	4.90	4.20	9.90	8.10	12.30	0.00	0.10	0.00	42.50
1979-1980	0.00	0.10	0.00	4.00	0.80	1.00	23.00	26.00	8.60	1.70	1.50	0.00	66.70
1980-1981	0.00	0.00	0.00	0.50	0.00	2.70	4.70	3.20	4.90	1.70	0.50	0.00	18.20
1981-1982	0.00	0.00	0.00	0.70	2.90	1.50	8.30	5.00	11.50	2.40	1.00	0.00	33.30
1982-1983	0.00	0.10	2.60	0.60	9.10	9.10	10.80	11.80	15.40	8.40	0.80	0.00	68.70
1983-1984	0.00	2.30	1.40	2.70	11.80	8.07	0.00	0.00	0.50	1.60	0.00	0.03	28.20
1984-1985	0.50	0.00	0.20	0.70	6.20	10.70	2.20	4.10	4.10	0.10	0.00	0.20	29.00
1985-1986	0.00	0.00	1.00	1.20	12.50	1.80	3.10	10.90	9.30	1.70	0.00	0.00	41.50
1986-1987	0.02	0.00	5.24	0.20	0.83	2.71	3.20	4.05	2.68	0.47	0.00	0.00	19.40
1987-1988	0.08	0.04	0.71	6.39	3.40	3.70	3.64	1.18	1.69	5.48	0.48	0.00	26.79
1988-1989	0.04	0.00	0.24	0.00	2.04	10.52	1.77	7.33	4.56	0.04	0.24	0.00	26.78
1989-1990	0.00	0.00	0.63	1.34	0.95	0.00	6.50	7.96	1.03	1.30	1.34	0.43	21.48
1990-1991	0.00	0.08	0.00	0.00	1.49	0.28	3.12	4.65	18.52	0.08	0.00	0.00	28.22
1991-1992	0.04	0.04	0.20	1.61	0.20	2.87	5.15	17.48	17.06	0.36	0.00	0.00	45.01
1992-1993	0.87	0.00	0.00	2.83	0.00	12.44	46.70	21.50	3.27	0.00	0.00	3.03	90.64
1993-1994	0.00	0.00	0.00	0.44	2.80	2.05	1.18	10.71	4.91	2.99	1.22	0.00	26.30
1994-1995	0.00	0.00	0.00	2.68	2.76	2.48	36.86	14.87	18.19	1.03	1.62	3.11	83.60
1995-1996	0.12	0.00	0.00	0.00	0.55	2.95	4.45	11.50	6.33	2.72	0.00	0.00	28.62
1996-1997	0.00	0.00	0.00	3.10	6.80	22.45	17.52	1.22	0.00	0.00	0.00	0.71	51.80
1997-1998	0.00	0.00	1.85	0.00	9.49	9.41	13.56	44.92	9.91	3.71	12.27	1.03	106.15
1998-1999	0.00	0.00	0.87	0.39	6.07	3.78	2.75	4.02	1.73	5.20	0.31	1.18	26.30
1999-2000	0.55	0.00	0.00	0.00	0.75	0.00	4.52	20.42	4.57	4.57	0.55	0.00	35.93
2000-2001	0.00	0.00	0.95	4.70	0.32	0.08	5.80	11.41	2.91	5.60	0.00	0.00	31.77
2001-2001	0.00	0.00	0.00	0.00	1.97	2.80	1.62	0.63	2.13	1.58	0.51	0.00	11.24
2002-2003	0.00	0.00	0.04	0.16	9.55	4.34	0.12	7.52	5.63	2.75	1.93	0.00	32.04
2003-2004	0.00	0.00	0.00	0.32	2.29	5.75	2.33	5.80	1.22	1.58	0.08	0.00	19.37
2004-2005	0.00	0.00	0.00	11.36	1.81	5.60	17.94	9.01	3.42	1.38	1.42	0.00	51.94
Totals	2.88	7.08	24.93	52.22	148.21	223.97	319.94	347.27	252.58	88.71	33.45	11.85	1513.09
Average	0.07	0.18	0.62	1.31	3.71	5.60	8.00	8.68	6.31	2.22	0.84	0.30	37.83
Max	0.87	3.40	5.24	11.36	14.98	29.78	46.70	44.92	19.70	8.56	12.27	3.11	106.15

MASS CURVE VS. AVERAGE RAINFALL TO DATE



SEASON TOTALS vs. AVERAGE RAINFALL

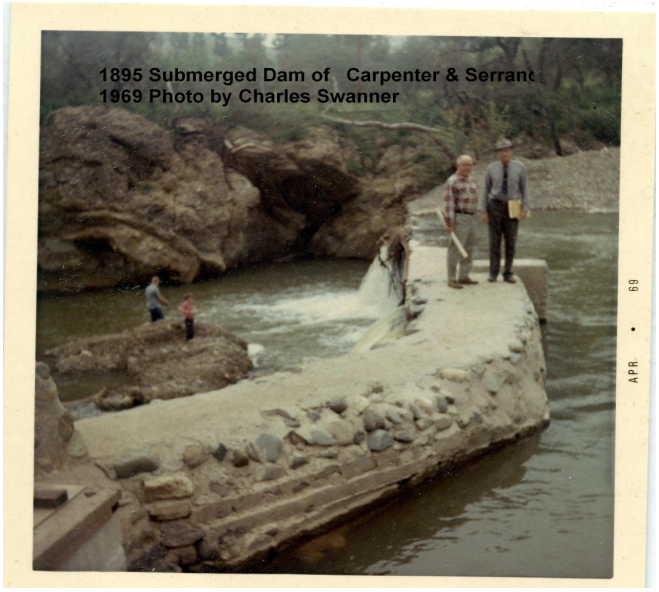


ditches, and pumping plants to drain the "Swamp of the Frogs" and convert former grazing lands to irrigated crops.

V. Water Resources Development

1. Surface Water

After the Ranchos Era, agricultural development on the Irvine Ranch was limited to the continued grazing of sheep and cattle which (in the dry summer season) were dependent upon residual streamflow (after winter storms), the low-lying spring-fed marsh area known as the Cienega de las Ranas, and the Laguna Lakes. According to Jim Sleeper* (and H. C. Kellogg), in the Santiago Canyon area (upstream from what would soon become Irvine Regional Park), James Irvine in 1893 began to divert water from Santiago Creek to an area known as "The Flats" and down Peters Canyon to the new ranch house. However, this diversion encountered resistance from the Carpenter and Serrano Irrigation Districts. Together, the districts had previously established riparian rights to irrigate land westerly of the Irvine property along lower Santiago Creek (reference Mendenhall*, 1904).



The Carpenter and Serrano "submerged dam" became visible in 1969 when scoured by flood flows released from Villa Park Dam. A photo (below left) of Carpenter and Serrano's dam was taken in the following spring by long-time Santa Ana attorney and historian Charles Swanner.

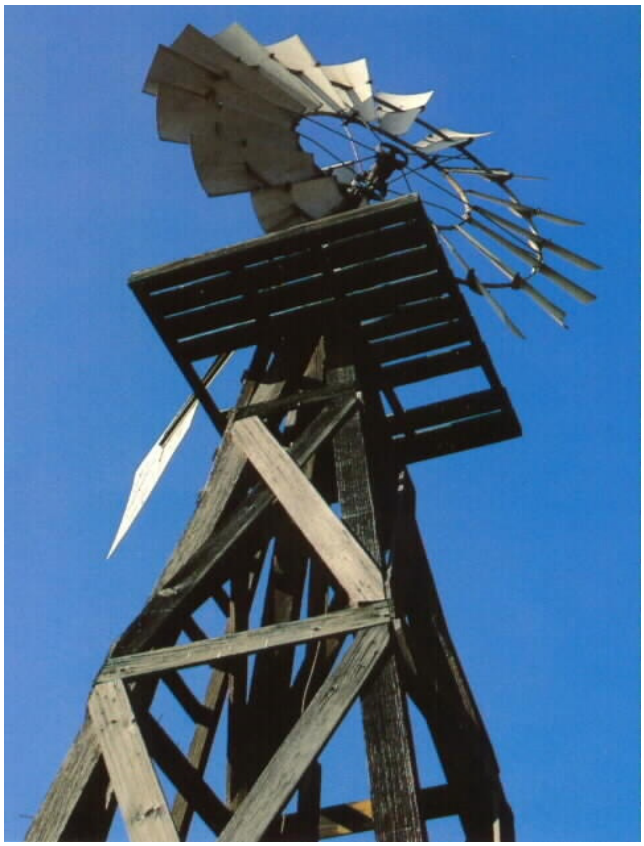
Litigation between Irvine Ranch and Serrano was eventually resolved with an agreement in 1928 to share equally in the water that could be conserved by later construction of Santiago Dam as described below.

2. Groundwater

Underground water would be the foundation for eventual success of the Irvine Ranch development. In the 1880s James Irvine had begun to offer leased land to tenant farmers for grain and bean crops which could be started during the winter and mature with minimal subsequent rainfall and no irrigation. Domestic water would be obtained from springs, or from shallow wells with windmill pumps. Cleland's* Cattle on a Thousand hills, describes the domestic water situation as follows: "Water was carried in from outdoors and was carried out to be emptied…People went to the canyon to pick up wood for the cooking stove. Kerosene lamps were used for lighting."

Beneath the valley of San Diego Creek water had naturally accumulated over geologic time in the underground basin which kept the Agua de las Ranas (marshland) moist even during extended drought periods. However, water could not be obtained in sufficient volume from underground storage to irrigate crops until around 1900 when gasoline driven

and/or electrical pumping technology became available.



As the number of would-be tenants grew, James Irvine began to develop an extensive system of water wells. A few thousand acres of land along the northerly boundary of the ranch were leased and/or sold to pioneering developers, including Columbus Tustin and C. E. Utt.

In 1906 Utt and his friend Sherman Stevens entered a partnership with James Irvine to form the San Joaquin Fruit and Investment Company. The earliest irrigated crops included olives, walnuts, apricots, sugar beets and citrus.

By the 1920s, nearly 1200 wells had been successfully drilled at a cost of several million dollars. However, it became clear from the increasing depth to good quality water that natural replenishment was insufficient to sustain Irvine's expanding acreage of irrigated cropland; meanwhile dry farming prospered. By the 1930s Irvine Ranch had under cultivation what was referred to as the largest Lima Bean field in the world, some 31,000 acres.

Some of that land would later be acquired by the federal government for the El Toro Marine Corps Air Station. A legacy of the military occupancy from 1943-1999 would be plumes of groundwater pollution caused by land disposal of liquid wastes from aircraft operations.

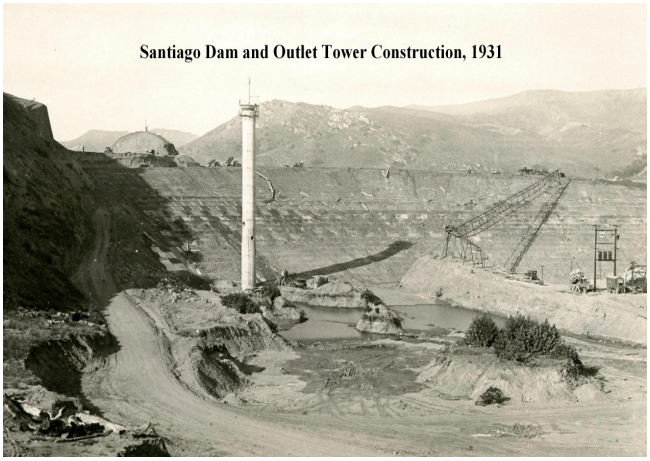
3. Conservation of Storm Runoff

The following paragraphs describe in a clockwise circuit around the central valley of Irvine Ranch (as shown on map, Fig. A), James Irvine's pioneering development of winter runoff conservation features commencing in the 1920s. This was necessary to offset declining groundwater resources. Mr. C. R. Browning, P.E. the Irvine Company's staff engineer, was the principal designer of the ranch water conservation facilities described below with the exception of Santiago Dam for which final plans were prepared by Mr. A. Kempkey, P.E., of San Francisco, California. Total storage capacity of the several reservoirs would be approximately 30,000 acre-feet as

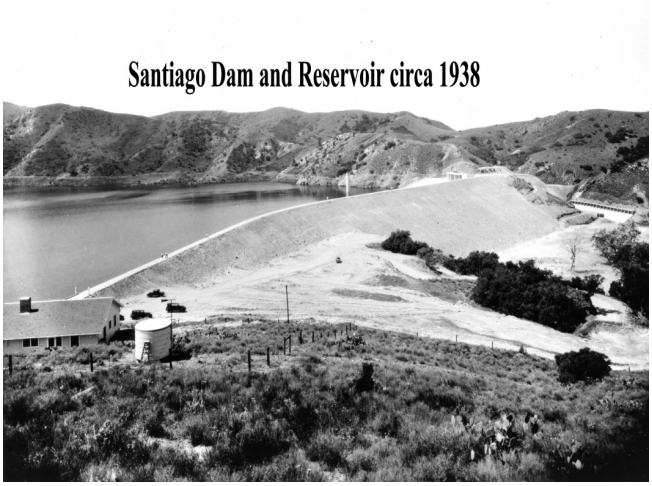
reported in R. G. Cleland's* book, The Irvine Ranch of Orange County, 1810-1950.

a. Santiago Dam (Irvine Lake, 1931)

Santiago Canyon, with a large watershed and relatively higher annual rainfall, was a natural opportunity for economic conservation of storm runoff. In 1928 an agreement was reached between Irvine and the Carpenter and Serrano Irrigation Districts over riparian rights.

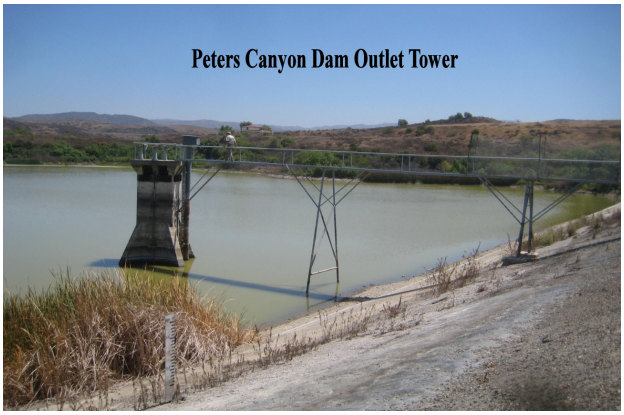


Together, the litigants agreed to the construction of Santiago Dam and Reservoir.



The 110 ft. high state approved, earthen dam with reinforced concrete facing, provides up to 25,000 acre-feet of storage during years of sufficient rainfall. Howells & Howells* in 1925 had estimated the average annual yield from the reservoir would be approximately 5,000 acre-feet (recognizing that storage in wet years would carryover to sustain years of less than average rainfall). Actual historic yield data from natural runoff are not published. Photo on page 13 illustrates the un-avoidable loss of water over the spillway during unusal flood years such as 1938 and 1969.

b. Peters Canyon Dam (1931) is located approximately 3 miles westerly of Santiago Dam, near the upper part of the Peters Canyon watershed. Irvine constructed an earth-fill dam, 50 ft. high with 700 acre-feet of



capacity. It's purpose is to regulate the draft from Santiago Dam (Irvine Lake) to lower reservoirs. Distribution to southerly Irvine Ranch was via underground pipeline for one mile to the "High Line Canal". The open channel then carried the flow by gravity several miles easterly across the ranch.

c. The High Line Canal (1930s)

The High Line Canal follows the contour of the Lomas de Santiago (See Map, Fig. A) from Peters Canyon outlet pipeline approximately 7 miles southeasterly to lower reservoirs and gravity distribution to orchards and crops. The canal is lined with unreinforced "gunite" concrete, an early example of using

this construction material. After more than 40 years in water delivery service and 30 more years of inactivity, the remnant segments of

gunite canal lining remain structurally sound today. A "splitter" on the canal just ahead of Siphon Reservoir allowed diversion of water

southerly another six miles by underground pipeline to the Laguna Reservoir.

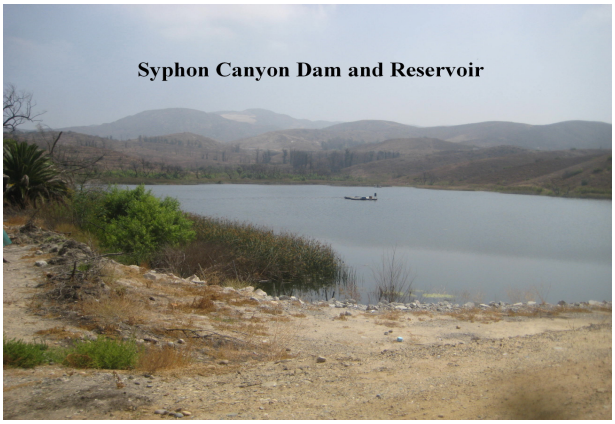
According to Peter Changala, the Irvine Company's agricultural operations manager, canal use began to decline in 1970 after connection of the new "Irvine Lake Pipeline" carrying Colorado River water to Rattlesnake Canyon Reservoir,

d. Rattlesnake Canyon Reservoir (1959)

This 70 ft. high earth-fill dam was the last-constructed element of the historic Irvine Ranch Irrigation System. It is located along the High Line Canal about four miles easterly of Peters Canyon Reservoir. Rattlesnake also conserves storm runoff from a natural watershed of about 2 sq. miles. Storage capacity is 1480 acre-feet. Ownership was transferred from the Irvine Company to the newly-formed Irvine Ranch Water District circa 1970. Spillway improvements were made to improve flood safety. Rattlesnake could then be used for

long-term storage of imported water from the Orange County Municipal Water District via the Irvine Lake Pipeline.

e. Syphon Canyon Dam (1948-49)



This spelling (Syphon) is as submitted to the State Division of Safety of Dams (DSOD) in 1948. Subsequently USGS maps have used the "Siphon" spelling. The reservoir is located

along the High Line Canal about two miles southeasterly of Rattlesnake Canyon. Water was distributed to irrigators near the two citrus packing plants along the former Santa Fe Railway spur line in the central

valley of the ranch. Irrigation service was terminated around 1970, but the reservoir is still owned by the Irvine Company and leased for recreational fishing and hunting. The packing plants have been removed to accommodate residential development.

f. Lambert Reservoir (1929) was the most easterly reservoir in the system conserving natural runoff from Bee and Round Canyons. After completion of the High Line Canal orchard lands of the Lambert Family (long-time friends of James Irvine) were irrigated. Eventually Lamberts purchased about 1,000 acres. Lambert heirs still reside at the original hilltop home. However, the dam was recently removed, and the reservoir area preserved as the "Tomato Springs" habitat reserve mitigating environmental impacts of pending residential development.

g. Laguna Reservoir (1937-38)

This small reservoir near Laguna Canyon Road drains northerly from the ridgeline of the San Joaquin Hills, and served as the terminal reservoir for water received from the High Line Canal. This is about 13 miles southerly of the source at Irvine Lake. Water could then be distributed to the area of East Irvine known then as Harkleroad Camp.

The dam was recently removed for residential development near the intersection of Laguna Canyon Road and Interstate Highway 405.

h. Sand Canyon Reservoir (1942)

Further seeking to maximize local conservation, Browning designed this dam to collect storm runoff from the San Joaquin Hills (an area of relatively lower rainfall).

According to Mr. Clint Odom, long-time (1957-2000) Irvine Ranch irrigation supervisor the conserved water was distributed to croplands between Jeffrey Road and Culver Road. Storm runoff was the only source of replenishment until Irvine Ranch Water District became the owner in the 1970s. The reservoir is now used for storage of reclaimed water from the Michelson Treatment plant and then distributed to landscape users such as the County's Mason Regional Park. The park was named after William Mason, the Irvine Company's Chief Engineer, who rose to become President of the company prior to his untimely passing in 1973.

i. Bonita Reservoir (1937-38)

This small reservoir captured storm runoff from the relatively small watershed of Bonita

Creek (a tributary of San Diego Creek). The dam was located about 1 mile above Upper Newport Bay. The dam was breached, and removed from jurisdiction of (DSOD) circa 1993-4 as a part of constructing the SR-73 Transportation Corridor. The silted up reservoir area and watercourse downstream have been retained as a natural habit area to mitigate impacts of the highway construction.

j. The Irvine Conservation Dam (1932)

The Cienega de las Ranas (or Swamp of The Frogs was a large flatland area adjacent Upper Newport Bay where surface waters of San Diego Creek and Peters Canyon sluggishly passed en route to the bay. Browning designed a State-approved earthen dam 27 feet high with concrete lined spillway across San Diego Creek less than one mile above tidewater. According to Mrs. J. E. Pleasants* History of Orange County, the winter runoff conserved would be pumped northerly to Irvine's cropland on the Tustin Plain.

In addition to conserving flood water, the dam provided incidental flood protection for evaporative salt ponds downstream within the Upper Newport Bay (See Fig. A Map).

In 1963 the dam was removed during construction of University Drive and the channelization of San Diego Creek by the Orange County Flood Control District (OCFCD).

h. Little Peters Reservoir (1940)

This was a small earthen dam, less than 20 ft. high, conserving storm runoff from about 1000 acres. Little Peters was removed and replaced by larger flood control retarding basin circa 1998 (See Fig. B Map) to accommodate residential development in the City of Tustin.

4. Flood Control:

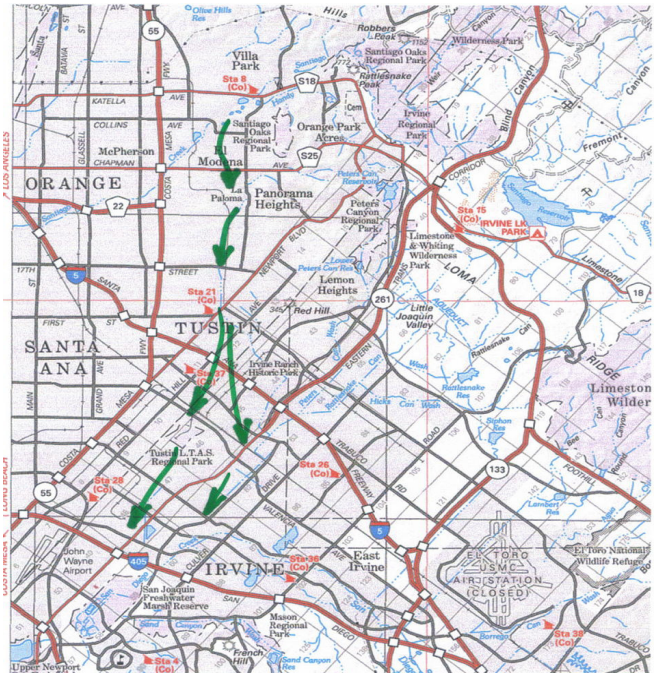
Single vs. Multi-Purpose Water Projects

During the dry-farming era, other than the Santa Fe Railroad, there was little development vulnerable to flooding around the San Diego Creek watershed. Flood damages along the "washlands" below the foothills would generally be restored with ordinary farming equipment. Until mid-twentieth century urbanization, flood control improvements (other than roadside ditches) could not be economically justified.

However, the much larger Santiago Canyon watershed with more extreme rainfall characteristics could produce extremely damaging flood peaks. Early occupants of the floodplain lands in Orange might be deceived by the long periods of drought between damaging floods. By the late 19th century rural and urban encroachments within the new cities of Orange and Santa Ana would be overwhelmed when the wide, sandy bed of Santiago Creek would become a raging torrent for a day or two following torrential rainstorms.

Santiago Creek @ Chapman Ave. Bridge

The flood of 1916 was so large that high water over-topped the banks of the normal westerly course through Orange and Santa Ana. Overbank flow diverted several miles southerly across the Tustin Plain to the former Cienega de las Ranas above Upper Newport Bay.



This was prior to Santiago Dam. Even worse, the Santa Ana River destroyed most of the west county railroads and highways. Farming centers from Santa Ana to Anaheim, Huntington Beach and Buena Park were flooded. Economic damages and loss of life substantiated the need for flood control improvements. Hence, the Orange County Flood Control District was formed by an act of the State Legislature in 1927, giving the power to issue bonds for constructing improvements <u>if approved by a 2/3rds majority of county-wide voters</u>.

Countywide flood control bond elections were held in 1929 and 1931, but <u>failed</u> the required 2/3rd majority. Passage might have allowed the new flood control district to collaborate with the Irvine Company and provide a larger dam on Santiago Creek combining both flood control and water supply benefits.

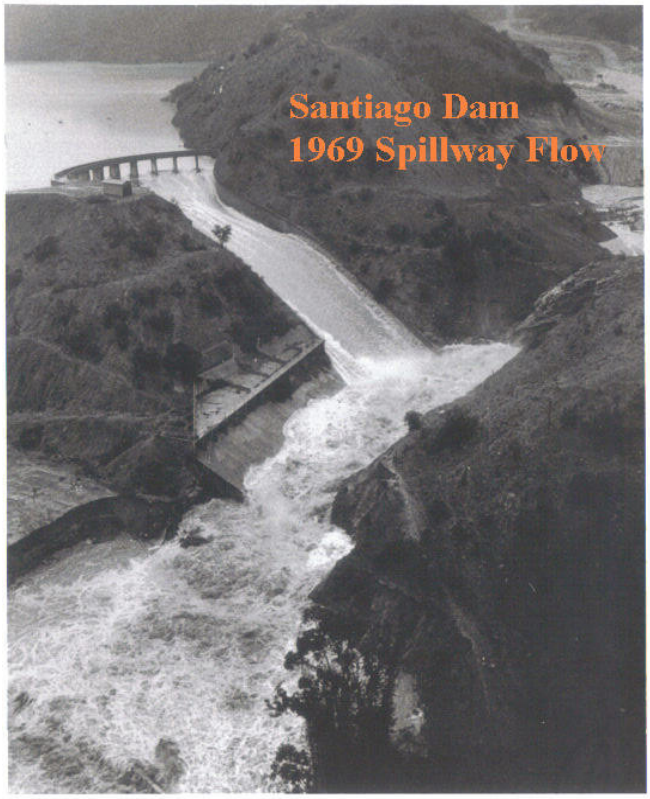
Before record keeping began, the cities of Orange and Santa Ana experienced damaging floods in 1916, 1927 and again in 1938 (even after construction of Santiago Dam, primarily a water supply project). Again in 1969 (after construction of Villa Park Dam, primarily a flood control project), bank erosion claimed many homes.

Stream gaging records (kept by the Orange County Flood Control District) substantiate the volatility of Santiago Creek flood flows. Gages are located at Villa Park (1920-1963), Villa Park Dam (1963), and Bristol Street (1928). These records (since 1931), are affected by storage and diversions at Santiago Dam (since 1931) and Villa Park Dam (since 1963).

<u>Water Conservation vs. Flood Control</u>

James Irvine, realizing the loss of large volumes of winter runoff to the ocean concurrent with receding groundwater levels, was motivated to proceed with the water conservation projects described above. Here, it must be emphasized that water conservation dams have the primary purpose of water supply enhancement. True it is that the runoff held for future water supply

partially reduces the peak flow downstream so long as the reservoir capacity has not been filled. However, when the water supply reservoir is filled before the advent of a large flood, the emergency spillway will safely pass the entire flood, but with only a small reduction of the peak flow.



Prudent economics suggest that building a reservoir large enough to remain partially empty awaiting the eventual large flood can only be justified if the cost of flood damages prevented would be of value to the builder. Accordingly, the James Irvine water conservation projects provided only incidental benefit (from smaller floods).

After the 1929 bond election failed, James Irvine would continue toward completion of his single purpose projects at private expense (during the Great Depression of the 1930s). This provided the irrigation water that would assure continued success of the great Irvine Ranch agricultural enterprise.

The Federal Flood Control Program of 1936

At the peak of the Great Depression the Congress recognized the continuing need for a national program of flood damage prevention. Also, there was a crying need for economic stimulus and

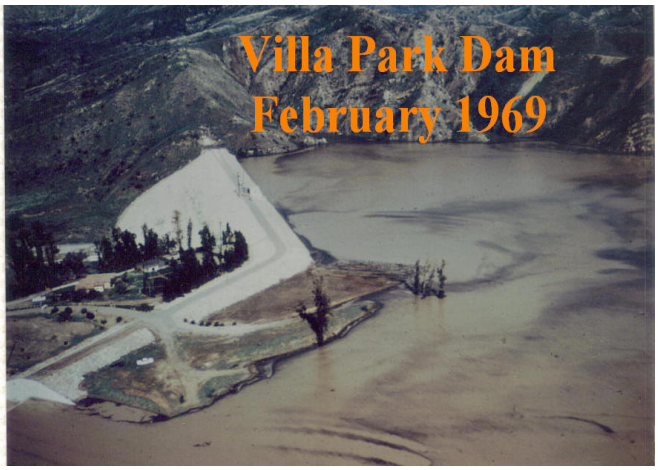
the Federal Flood Protection Act of 1936 was adopted. This authorized a nationwide flood protection construction program. Under this program Prado Dam, a single purpose flood control project was completed in 1941 shortly after the deadly 1938 "Flood of the Century" on the Santa Ana River. The program also included several other Orange County projects, among them a flood control Dam at Villa Park about two miles below Irvine's Santiago Dam. The new Villa Park Dam proposed flood prevention not achieved by Irvine's water supply Dam. However, implementation of the federal program was delayed by World War II.

Orange County's Flood Control Program

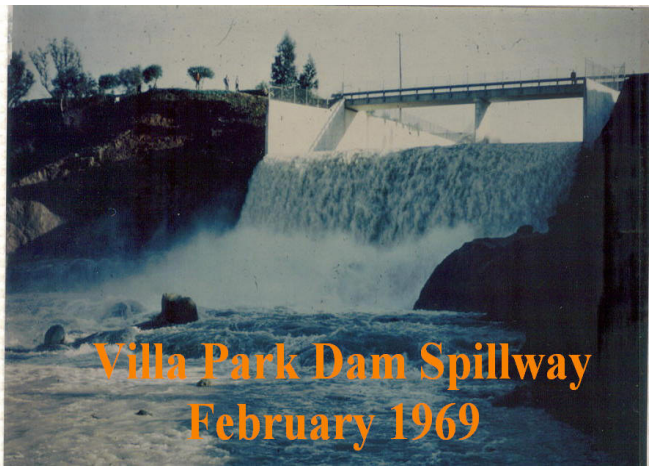
With a burgeoning post-war population boom, the Orange County Board of Supervisors could not wait for the promised federal flood control projects and undertook studies for a county-wide program of flood control projects that would be financed by a property-tax bond issue. The 1956 election passed with a small margin above the required 2/3rds approval.

This local program included, among many others, the previously authorized, but unfunded, federal dam at Villa Park. In addition, the bond program included numerous other county-wide flood channel improvements.

Villa Park Dam was completed by the flood control district in 1963 without federal assistance. The 108 ft. high dam has a reservoir capacity of 15,600 acre-feet. The peak design inflow from upstream watershed including Santiago Dam spillway flow of 12,000 cubic feet per second is reduced to a controlled discharge of 3,500 cubic from the gated outlet. As a single purpose flood control project,



it is kept empty to debris pool elevation except during flood operations. In February of 1969 a combination of extreme rainfall events produced a volume of inflow exceeding design engineers estimates. After the upper dam (Santiago) filled to capacity, Villa Park also filled.



Uncontrolled spillway discharge had peaked at 4,500 cubic feet per second. For several days the receding flow from the dam damaged highway bridges. Also, residential properties were damaged by lateral bank erosion along unimproved sections of Santiago Creek. Channel improvements needed within the cities of Orange and Santa Ana are now planned for inclusion in the newer federal program, authorized by the Congress in 1986 .

San Diego Creek Flood Channel

In accordance with OCFCD's 1956 bond issue, San Diego Creek was widened and deepened from Upper Newport Bay to Culver Road. Concurrent with the Road Department's extension of University Drive, the Irvine Conservation Dam was removed. Prior to that time, Myford Irvine had anticipated that the bay would be dredged and developed by the Irvine Company as a recreational and residential marina. Those plans were thwarted by environmental preservationists during the 1970s. The company's limited property rights in the tidelands were then sold to the State Department of Fish & Game.

The marshy, former reservoir lands upstream from MacArthur Blvd. have subsequently been acquired by the Irvine Ranch Water District and enhanced for water purification and wildlife preservation.

Removal of the Irvine Conservation Dam, though enhancing development of the University, might otherwise have been used to detain the sedimentary deposits now migrating into Upper Newport Bay. Having lost the incidental flood benefits of the old dam, the unimpeded 1969 floods destroyed the Upper Bay Salt Works, accelerated the depo-sition of sediment to the lower bay near Coast Highway, and precipitated the current state

and federal dredging/restoration projects in the "Back Bay".

Peters Canyon Flood Channel

As proposed in the 1956 bond issue, Peters Canyon Creek was widened and deepened from the confluence with San Diego Creek to the Santa Fe Railroad bridge.

El Modena-Irvine Flood Channel

Former roadside ditches in the north Tustin area were widened and deepened along with construction of a flood retarding basin located in the East Orange.

Santa Ana-Santa Fe Flood Channel

A former drainage ditch along the Santa Fe RR embankment was widened, deepened and extended to accept storm runoff from residential areas of Santa Ana and Tustin.

Lane Road Flood Channel

A former agricultural drainage ditch along Lane Road was widened, deepened and extended northerly in cooperation with Caltrans along the I-405 and SR-55 Freeways.

Privately Funded Flood Control and Stormwater Managment

In the absence of any electoral approvals of flood control funding since 1956, the burden of protecting new developments resides with developers (rather than property tax payers). Extensive improvements have been completed by developers of the Irvine Ranch using a variety of funding mechanisms. This innovative program included the cooperative planning of the Irvine Company and the (user financed) Transportation Corridor Agencies to provide stormwater quality mitigation, sediment-reduction and flood peak reduction. Along with the usual local drainage improvements required of developers to protect subdivisions, the following series of flood retarding basins has been integrated with the recently completed SR-241 Toll Road embankment construction (see Fig. B. Map).

1) **At Peters Canyon dam**, (described above as a water conservation feature originally), the over-flow spillway was modified by the Irvine Company under agreement with the City of Orange. This integrates flood control with water conservation by constructing a new underground conduit running, from the dam spillway, northerly to the Handy Creek watershed. The underground diversion allowed conversion of the former meandering (dry) watercourse to residential development of property in the City of Orange.

2) **Lower Peters Canyon Retarding Basin**, a DSOD-approved dam replaced the original "Little Peters Reservoir" circa 1998. The new basin reduces the 100 year flood discharge from the watershed (below Upper Peters Dam). This project was funded by a City of Tustin district assessing costs to the future owners of benefitting residential development. The reduced flood flow allows retention of a naturalized waterway through the Tustin Ranch Golf Course and also allows smaller downstream flood channel improvements. The basin is also an open space addition to the larger Peters Canyon Regional Park.

3) **Orchard Estates Retarding Basin**, a State-approved dam controlling runoff from the Little Joaquin Valley, was completed in 2003 to protect future residential development in the City of Irvine. Funding was arranged between City of Irvine and the Irvine Company with costs assessed to pending residential development.

The reduced flood flow also allows smaller downstream flood channel improvements.

3) **Hicks Canyon Retarding Basin,** a DSOD-approved dam was constructed in 1998 just downstream from the SR-241 Toll Road. It serves as silt retention (water quality) and flood reduction to mitigate the downstream erosional impacts of toll road construction, and also allows a reduction of downstream flood channel improvements.

4) **East Hicks Canyon Retarding Basin,** another DSOD-approved dam was integrated with construction of the SR-241 Toll Road embankment. It's silt detention and flood reduction capacities help mitigate downstream impacts of toll road construction, and also allows smaller downstream flood channel improvements.

5) **Bee Canyon Retarding Basin,** a State-approved dam was integrated with the embankment of SR-241 Toll Road and completed in 1996. It receives runoff from a large canyon where the Bowerman Landfill is operated. It's silt detention and flood reduction capacities help mitigate downstream impacts of toll road construction and upstream landfill operations.

6) **Round Canyon Retarding Basin,** another State-approved dam is integrated with the embankment of SR-241 Toll Road and was completed in 1996. It's silt detention and flood reduction capacities help mitigate downstream impacts of toll road construction and landfill operations.

7) **Marshburn Retarding Basin;** This basin was constructed in 1998 by excavating former landscape-nursery fields at the intersection of Irvine Boulevard and the SR-133 Toll Road. The basin receives storm runoff from an unnamed watercourse paralleled by the toll road. Excess flood flow is diverted to the basin from Bee Canyon when flood flow exceeds capacity of the existing underground conduit under the former El Toro Marine Corps Air Station runways. This mitigates the need to construct larger conduits running downstream to a confluence with San Diego Creek through the property of the City of Irvine's Great Park and the Irvine Spectrum development.

8) **Trabuco Retarding Basin** is a relatively flatland excavation and grade-stabilization dam designed to collect storm runoff from former flood-washlands (prior to Bee, Round and Marshburn basins) and reduce the 100 year flood discharge to rates acceptable in existing downstream facilities running westerly along Trabuco Road and the I-5 Freeway. The basin was designed to become a multi-purpose facility affording a landscaped open-space and trail complex benefitting Irvine's adjacent Woodbury residential development.

The privately funded flood control work of the Irvine Company alone included not only the usual subdivision storm drains, but also upstream extensions of the flood control district's bond-funded improvements described above.

Among the privately funded flood control improvements are:

9) **San Diego Creek Channel**, has been extended as a wide, grade-stabilized floodway with earthen invert and paved bicycle lanes on both sides running from the I-405 Freeway crossing to the Irvine Spectrum. For the segment from Jeffrey Road to I-405, a soil-cement side-slope lining was provided along

with new bridges at Jeffrey Road and Sand Canyon Road. From I-405 to Moulton Parkway, channel sideslopes are lined with soil cement to create a naturalized, sand bottom waterway. Upstream from Moulton Parkway a vertical walled concrete channel extends to the I-5 freeway.

12) **Peters Canyon Channel** has been extended from the Santa Fe Railroad to Jamboree Road with reinforced concrete sidewalls, and, where feasible, unlined channel bottom allowing natural vegetation to preserve environmental values.

13**) Agua Chinon Channel.** From Moulton Parkway to the former El toro Marine Corps Air Station the watercourse has been improved as a large underground conduit.

14) **Serrano Creek.** From Moulton Parkway to Bake Parkway the watercourse has been improved with a vertical walled concrete channel lining with the exception of the remaining strawberry field between I-5 and Alton Parkway.

15) **El Modena-Irvine Channel** was widened and deepened with reinforced concrete channel lining from Peters Canyon confluence to Browning Ave. in the city of Tustin.

5. Stormwater Management Benefits

The evolution of the foregoing flood control and water conservation projects will have additional, hard-to-quantify benefits to the local environment by way of partial containment of sediment runoff from the foothills surrounding the City of Irvine, also reducing the historic bank erosion of bay tributaries. Further, ongoing efforts of Orange County's Watershed Management group and the Irvine Ranch Water District's dry-weather diversions to water reclamation systems will provide long-range water quality improvement for Upper Newport Bay and lower Newport Harbor. All of this should reduce future dredging requirements and sustain the collaborative long-range wildlife preservation goals of both the State Department of Fish & Game and the OC Parks Department in their management of Upper Newport Bay.

6. Irrigation Distribution Facilities

The earliest distribution of irrigation water occurred with the 1893 construction of the Irvine ditch along the contour of the land from Santiago Canyon to the Peters "Flats" near the future site of Peters Canyon Dam. Along lower Peters "Wash" spring flow fed ditches serving the first olive plantings and vineyards northwesterly of the Irvine Ranch home and headquarters. Early wells were powered with gasoline engines. Eventually there were almost 1200 wells drilled and equipped with electric pumps after power became available from the Southern California Edison Company. The first large scale citrus plantings were started in 1906.

In 1913, the Frances Mutual Water Company had been formed to improve irrigation capabilities. Concurrently, the Cienega de las Ranas was dewatered by collection ditches and pumping to upland crops. After completion of the Irvine Conservation Dam on lower San Diego Creek in 1932 the same pumps would deliver surface water from the near sea-level reservoir to upland fields.

By 1916, Irvine built a 48,000-square-foot packing house and the prizewinning oranges of the Irvine Ranch were being shipped all over the world. In 1923 when the California Fruit Grower's Exchange became Sunkist

Growers, Inc., Sunkist had three local branches, two of them on the Irvine Ranch.

After completion of the High Line Canal and reservoirs described above, more than 2500 miles of gravity-fed pipelines were installed to move water to the fields. In 1970 the Irvine Lake Pipeline bypassed the old High Line Canal. With the expanded supply of water available through the Municipal Water District of Orange County and the Metropolitan Water District during the 1970s, pressure pipelines would be extended to former uplands grazing land. The Irvine Ranch expanded their Avocado and Valencia Orange plantings and became leaders in the field of drip irrigation.

7. Irrigated Acreage on the Irvine Ranch

From R. G. Cleland*, **"**Despite the Freeze of 1913, the Irvine Company greatly expanded its planting of citrus and other fruit trees during the next twenty years…Low-lying areas were drained,…land previously devoted to cattle and sheep pasture was brought under irrigation."

The following table of principal crops of the Irvine Ranch illustrates the evolution in cultivated acreage brought about by Irvine's water resources development efforts.

1950	
Irrigated Acreage	Dry Farming Acreage
4,550	33,430
1960	
Irrigated Acreage	Dry Farming Acreage
7,417	16,853

According to the Orange County Agriculture Department's Orchard Census of 1960 there was a countywide decline of 50 % in citrus acreage.

On the other hand, by 1964 Irvine's citrus plantings increased by 1,500 acres. According to the Santa Ana Register in 1963 the ranch operated one of the largest Valencia orange groves in the world. And, by 1970 the Irvine Company's citrus acreage would equal about 50% of the countywide total.

In 1960, the Irvine Company donated 1,000 acres of land (and sold another 500 acres) the University of California Regents for the new Irvine Campus.

Meanwhile, by 1970 the county's population had doubled from 689,000 to 1,423,000. In 1971 the City of Irvine incorporated much of the Irvine Ranch which signaled a transition from agricultural crops to ornamental horticulture and the commencement of urban development.

As recently as 1985 the Irvine Company still maintained 10,500 acres of irrigated land and 42,000 acres of dry pasturage.

VI. Supplemental Water

Metropolitan Water District (MWD)

When the MWD was formed in 1928, the only cities of Orange County which joined were the cities of Anaheim, Santa Ana and Fullerton. However, by the late 1940s the greater Orange County's need for supplemental water was clear. In 1948, coastal communities from Newport Beach south to the San Diego county

line formed the **Coastal Municipal Water District** as a way to participate in the benefits of MWD's importation of Colorado River.

In the 1960s Metropolitan constructed their San Joaquin Reservoir near the Newport Coast to improve the storage and distribution of MWD water from the Orange County Feeder pipeline. Recently, after being acquired by the Irvine Ranch Water District,

the San Joaquin reservoir has undergone geotechnical improvements, and converted to reclaimed water storage and distribution for agricultural and open space irrigation.

2. Municipal Water District of Orange County (MWDOC)

MWDOC was formed by Orange County voters in 1951, covering a large part of northern Orange County. Upon becoming members of MWD, the MWDOC commenced planning and development of facilities to accept Colorado River water. In 1955 a MWD pipeline was connected to Irvine Lake, hence by 1956 the High Line Canal of Irvine Ranch could receive supplemental water from the Colorado River. In January 2001 **Coastal Municipal Water District** was consolidated with MWDOC, making the combined organization the third largest customer of MWD.

3. Irvine Ranch Water District (IRWD)

IRWD was formed by the Irvine Company in 1961 with membership in MWDOC to provide domestic water for the development of the new university and planned suburban development. In the 1970s IRWD began to acquire the Irvine Company's water supply facilities. Since 1977 the Irvine Company has been a customer rather than a supplier of irrigation water for continued agricultural use of undeveloped property.

The Rattlesnake Reservoir and Sand Canyon Reservoirs are owned and operated by IRWD while Siphon Reservoir remains in operation by a recreational tenant of the Irvine Company. The Lambert, Laguna and Bonita Reservoirs have been removed but the properties remain in open space habitat mitigating impacts of residential and transportation developments.

The IRWD's Michelson wastewater treatment plant and ponds are sited within the former Irvine Conservatio m Reservoir (described on page 11) adjacent the San Diego Creek Flood Channel.

4. Orange County Water District (OCWD)

OCWD was founded in 1933 as a groundwater management agency overlying the Santa Ana Rive basinof Orange Copunty which includes the aquifers underlying San Diego Creek. Since discovery of the plumes of groundwater impacted by the military waste disposal practices described previously, OCWD and IRWD have been collaborating with federal base closure authorities to remove and treat the degraded groundwater. Healthful recovery of the San Diego Creek underground is expected to allow expansion groundwater replenishment and resumption of groundwater pumping as an augmentation of regional water resources.

VII. Conclusion

According to Liebeck's* history of Irvine, James Irvine II intended that his son James Jr. would succeed to management of the Irvine Ranch rather than son Myford, whose first love was music. However, James Jr. died prematurely in 1935, and then James II set up the James Irvine Foundation, a charitable organization, to hold controlling stock in the family corporation. James II died in 1947, at which time 53 % of the company stock vested in the foundation. Myford was appointed President of The Irvine Company and his father's long-time friend Brad Hellis

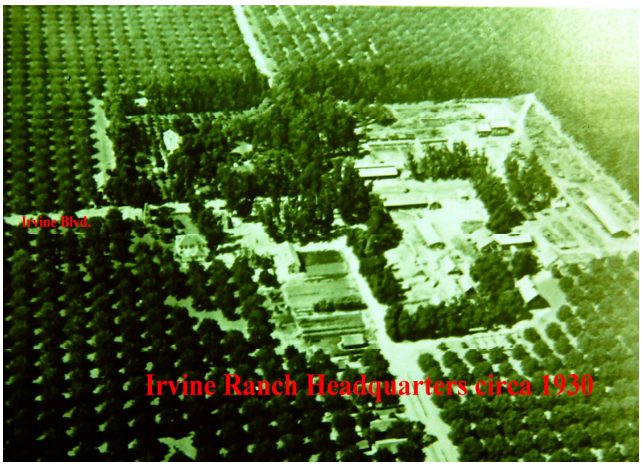
continued to manage the company's agricultural operations.

During his 11 ½ years at the helm, Myford set in motion the Master Plan of William Pereira that would lead to the 1960s dedication of land for the University of California Irvine Campus and systematically turned the company empire away from agriculture toward urban development. By 1969 the company's revenue from development had surpassed that of the Agriculture Division.

During the '60s the U.S. Congress had began investigating non-profit foundations set up as tax shelters which led to legislation forcing the Irvine Foundation to relinquish control of the Irvine Company. The Tax Reform Act of 1969 forced the Irvine Foundation to sell its stock in the Irvine Company. The 1977 sale ended the Irvine family's 101 year control of the ranch. After a series of ownership changes and litigation with Irvine family heirs the Irvine Company is now in the sole ownership of Donald Bren, a leader and innovator within the real estate industry. Just as the ranch was earlier known for adopting new agricultural techniques, the Company now enjoys a reputation for community planning and development on a large scale.

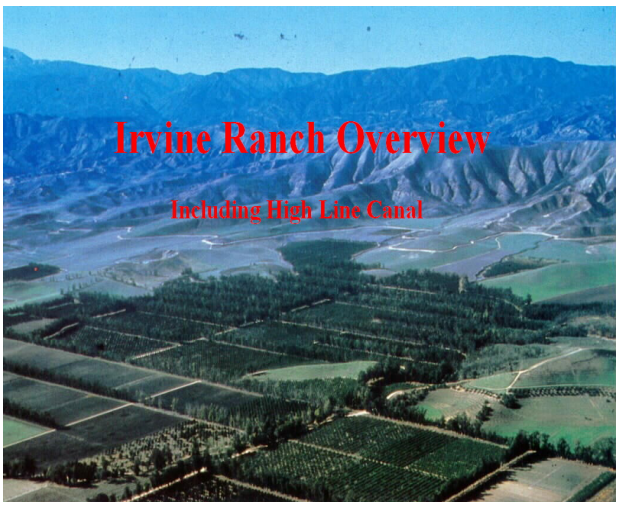
Joining the Metropolitan Water District, and establishing the Irvine Ranch Water District in 1961, was followed by incorporation of the City of Irvine in 1971. This enabled the suburbanization that has since occurred. By 2009, population of the city had reached 213,000. Although irrigated agriculture is diminishing, according to Irvine Company Vice President Peter Changala, agriculture continues to be a viable economic enterprise. The Irvine Historical Society was formed in 1977 as a watchdog for historic structures on the Irvine Ranch.

Among the structures preserved are the Irvine Ranch Headquarters, barns and offices



which are now owned and operated by the OC Parks Department.

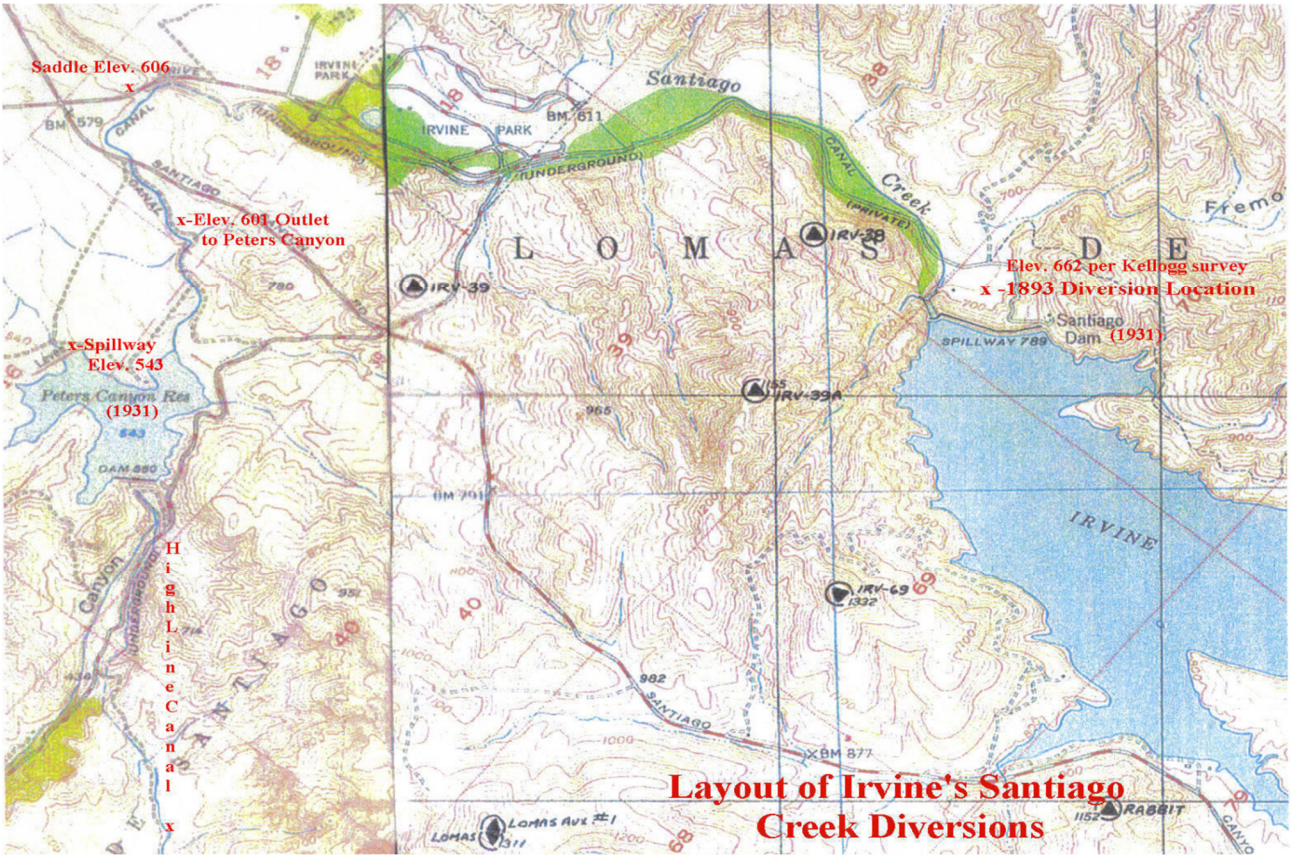
The mountainous areas of the ranch were not only unfarmable, but also undevelopable either for economic or environmental reasons. Hence, thousands of acres of ranchlands have recently been dedicated by the Irvine Company to the County of Orange for Regional Parks and open space preservation.



The Irvine family held Orange County's largest single landholding as an agricultural empire for more than 100 years through entrepreneurial water resources conservation and development.

Beyond these local resources, future expansion of water supply supporting continuing urban development of remaining ranchland is now dependent upon ingenuity and initiative of the Irvine Ranch Water District, and their wholesale partners; the Municipal Water District of Orange County, the Metropolitan Water District of Southern California and the State Department of Water Resources while pursuing completion of the California Water Plan adopted by the voters of the state in 1959.

The following composite of USGS Quadrangle maps (Tustin & Black Star Canyon) identifies key features of James Irvine's disputed 1893 surface diversion from Santiago Canyon across the low point of Loma Ridge to the valley of San Diego Creek. A 1928 agreement with Serrano Water District settled the historic 1897 litigation with a 50/50 division of conservable surface water, and the two parties the parties constructed Santiago Dam in 1931. Irvine then constructed a connecting aqueduct to Peters Canyon, along with the High Line Canal carrying conserved water to the ranch and allowing the expansion of irrigated crop acreage.



The primary objective of this paper is obtaining the **American Society of Civil Engineers** designation of the **Irvine Ranch Irrigation System** as a **Historic Civil Engineering Landmark.**

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FIGURE A

HISTORIC WATER RESOURCES OF THE IRVINE RANCH

High Line Canal

Underground

Irvine Rancho Boundary

0 6,000 12,000 Feet

SAN DIEGO CREEK WATERSHED

ANAHEIM
ORANGE
UNINC.
GARDEN GROVE
SANTIAGO OAKS REGIONAL PARK
PETERS CANYON REGIONAL PARK
IRVINE INDUSTRY COMPLEX
FORMER MARINE CORPS HELICOPTER AIR STATION
IRVINE BUSINESS COMPLEX
WOODBURY DEVELOPMENT
WOODBRIDGE
TUSTIN RANCH
UNIVERSITY PARK
UNIVERSITY OF CALIFORNIA IRVINE
MASON REGIONAL PARK
TURTLE ROCK
FORMER EL TORO MARINE CORPS AIR STATION
LIMESTONE AND WHITING WILDERNESS PARK
PRISON

N

0 2,000 4,000 Feet

- San Diego Creek Watershed Boundary
- Park Boundary
- Retarding Basin
- Former El Toro Marine Corps Air Station
- Freeway
- Road
- Water Course

Lower Peters Canyon Retarding Basin
Eastfoot Retarding Basin
Orchard Estates Retarding Basin
Rattlesnake Retarding Basin
Hicks Retarding Basin
East Hicks Retarding Basin
Bee Canyon Retarding Basin
Round Canyon Retarding Basin
Lambert Retarding Basin
Agua Chinon Retarding Basin
Marshburn Retarding Basin
Trabuco Retarding Basin
El Modena-Irvine Retarding Basin

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- Geomatics Land Information Systems Division
- Eagle Aerial Image 1 foot resolution, flown 04/2004

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DATE: May 16, 2006

Figure B

County of Orange

Watershed F
San Diego Creek