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A Brief Historical Sketch of the Growth of the Los Angeles City Water Department

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No plan for the development of any public works such as water, light and power, sewers, parks or any of the other features of the City's daily life can be intelligently prepared without an all-embracing study of the history of these departments during the previous years of the City's development.

An examination of the curve of the City's growth will show that, unlike that of our very progressive sister city of San Francisco, this has not been one of mere arithmetical progression, since every decade shows an acceleration in the curve of population, and no plan for the future would be adequate without due regard being given this peculiarity. Comparing this curve with that of San Francisco's growth it will be seen that the latter, though steady, forms a nearly straight line, while that of Los Angeles shows a constantly increasing curvature.

Many of our prominent and enterprising citizens in the past have attempted predictions as to the City's future growth. It is remarkable that while many of these prophecies at the time they were made appeared to be beyond the range of reasonable realization, there is not a single instance where such forecasts were made seriously by earnest well informed men, in which they have not been surpassed in realization.

The writer has had close acquaintance with the engineers of the public utilities of the City, and has had advance knowledge of the plans contemplated by them to supply the needs of our growth almost from their inception, and can remember of no case where such plans have ever over-anticipated the needs of the future.

In the development of the plans of the water works, it has always been found necessary to make radical expansions in every previously prepared program, which at the time of its preparation appeared to be ample for long periods in advance of present needs. This experience we find is again repeated at the present time, for we now find ourselves under the urgent necessity of seriously considering capacious and important additions to the water works. It will be well, therefore, to briefly review in condensed form, and in chronological order, the progressive growth of the water works as to their most important features.

Beginning with the year 1868, when the City had a population of between four and five thousand people, a lease was made by the City to a company known as the Los Angeles City Water Co., to supply its inhabitants with water for a period of thirty years. Up to that time the waters of the Los Angeles River were diverted in a system of ditches, the main diversion point being located in the river bed a few hundred feet above the present North Broadway Bridge, from thence the waters radiated in many ditches to serve the lands where the City now stands with irrigating water, all of the water of the Los Angeles River being so used. Following the making of this lease, the water company built an open canal, diverting water from the Los Angeles River at a point about one and one-half miles north of the present

southerly gate of Griffith Park, at an elevation of about 395 feet above sea level. This water was carried by this open ditch southerly to a ravine in what is now Elysian Park where a reservoir was constructed, now known as the Buena Vista Reservoir. This reservoir is at present in existence and still in use, located about a quarter of a mile north of the North Broadway Bridge.

From this reservoir an eleven inch pipe was carried down along the face of the bluff to about the present site of the bridge, and from thence an eight-inch pipe was carried down the present North Broadway, then known as Eternity street, to the corner of Main and Temple, from thence on it radiated into smaller sized pipes.

In 1876, the City had outgrown this pipe and the company laid a twenty-two inch pipe which was carried down San Fernando street and thence by the Plaza and Main street, terminating at First and Main streets, from which point lesser pipes radiated to serve the City.

In 1886 there began a very considerable accession of growth which developed with such rapidity that it was found necessary to lay a thirty-inch main from the Buena Vista Reservoir to the North Broadway Bridge, and from thence to carry an additional twenty-two inch pipe southerly by way of the old Eternity street route, then called Buena Vista street; thence by way of New High street and Franklin to Broadway, and southerly on Broadway to Eighth street, diminishing in diameter to sixteen inches at Eighth street; thence westerly on Eighth street to Figueroa, and southerly on Figueroa to Washington, terminating there with ten-inch pipe. This main was linked up with the older pipes of the system and served as a feeder without other aid until 1895.

In 1894 the growth of the City was so rapid in the Westlake Park region that it became vitally necessary to either work back from the Buena Vista Reservoir and parallel the last described line, or to come bodily through the Ivanhoe Hills by means of a tunnel 5,700 feet in length from the original diversion ditch. This plan would have the advantage of shortening the distance by five to six miles in coming directly into the heart of the territory designated to be served, and saving the enormous expense that would be entailed in enlarging the pipes through the paved and congested business section. In addition to this advantage, a fairly good reservoir site was discovered, the whole proposition being attractive enough, both from engineering and financial considerations to determine the company to at once begin its construction. This work was carried on during the winter of 1894-95, and water was turned into the Bellevue Reservoir in June, 1895. This reservoir is at an elevation of 375 feet above sea level and has a capacity of thirty-nine million gallons. From the reservoir southerly, a thirty inch cast iron pipe was carried down Hoover street to Seventh, connecting with a twenty-four inch coming easterly on Seventh street to connect with the old system on Broadway, the whole plan resulting in giving to the business section of the City a double ended service, making for permanent safety against interruptions of supply due to breakage in mains or other causes.

In 1898 the term of the water company's lease with the City expired, but due to vexatious litigation the City did not come into possession of the works until 1902. During the four year period of this litigation the City took on one of its spasmodic periods of growth, but due to the unsettled condition of the water question, the old company refrained from making the necessary improvements to meet the growing demands for water. Unfortunately also, during this period beginning with the winter of 1893-94 and ending with the winter of 1903-04, the whole of Southern California experienced a severe drouth, the annual rainfall for the eleven years averaged but eleven and one-quarter inches, being a deficiency for the period of 28.8% below normal. The Los Angeles River, the sole source of supply for the City, shrank from its average yield of about fifty-two million gallons daily to less than twenty-eight million gallons, and the City was on the verge of a water famine, there being times during the summers of 1900-1901 and up to 1904, when there was scarcely an extra day's supply left in the reservoirs.

Immediately upon the acquisition of the water works by the City, work was started in developing water from wells in the coastal plain to the south of the City, although it was a well known fact that this seemingly inexhaustible source was being rapidly exhausted, due to the agricultural development in the region lying between the City and Compton.

In 1904 the pumping plant at the corner of Slauson and Compton avenue was completed, having a capacity of between four and five million gallons daily. The following year the plant at the corner of Slauson and Figueroa street was finished, with a capacity of about five million gallons. The operation of these two plants constantly throughout the summer, together with the many agricultural pumping plants to the south, resulted in the lowering of the water plane of that region by more than twenty feet within a few years. It was manifest from the very first that this source of supply afforded but temporary and scant relief in view of the marked upward tendency of the City's growth.

During the latter period of the old water company's incumbency the water of the Los Angeles River was gradually diverted from agricultural to domestic uses. Fortunately this transition took place with remarkably little friction, as the farms were being cut up into town lots, so that by 1903 the incongruous condition of irrigating ditches meandering through the City was completely eliminated, the last ditch to yield to this inevitable change was what was known as the Woolen Mill Ditch, diverting its water from the Los Angeles River at a point about one and one-half miles below where Universal City is situated, at an elevation of about 465 feet above sea level. This ditch meandered along the face of the hills through Griffith Park, coming into the City by way of Ivanhoe. One of the first works undertaken by the City was to build a concrete conduit to carry the waters of and replace this open ditch, the conduit thus constructed being known as the Main Supply Conduit. The water conveyed by this conduit is delivered into three reservoirs by gravity, all of them being built from the revenues derived from the operation of the works. They are the Rowena, with a capacity of 30,700,000 gallons, the Ivanhoe with a capacity of 46,660,000 gallons (being a partitioned-off section of the Silver Lake Reservoir), and the High Gravity, with a capacity of 10,526,000 gallons, situated in Elysian Park. The first two of these reservoirs supply water to the western part of the City between Hollywood and Ninth street, and also afford two lines of pipe coming into the City, one by way of Lakeshore avenue and the Third street tunnel, and the other by way of Seventh street, together affording a duplex system for the business section of the City, and supplanting the Old Low Gravity supply from the Buena Vista Reservoir with a pressure thirty pounds greater than the old supply, thereby meeting conditions of the higher buildings of the modern town.

Early in 1904, and in consequence of the long continued drouth above mentioned, together with the continued growth of the City, the question of a greater water supply came prominently to the front. This resulted in the presentation to the City authorities of various schemes to meet the conditions, the project of Mr. Fred Eaton of bringing the Owens River water to the City easily took first place. the other schemes being the Mojave River,

Little Rock, Sespe, Piru and innumerable other lesser and more vague propositions. The Board of Public Service Commissioners realizing the urgency of the question, at once instituted an investigation of all these sources, with the result that the Owens River proposition was the one selected, due to the greater supply and reliability of its source; in fact it was the only project that measured up to the needs of the situation. Work was immediately started in the making of surveys and estimates with the result that the question of a bond issue for the purpose of acquiring the water rights in the Owens River was ready for presentation to the people by September, 1905, with the result that the project received the hearty approval of the people by a vote of 10,787 to 755. In the meantime nature came kindly to the temporary relief of the City with three successive wet winters, namely, the seasons of 1904-05, 1905-06 and 1906-07, the mean rainfall for the three years being 19.15 inches, or an excess of over 22% above normal. Also, there was put into effect a complete metering system for the City which cut the per capita consumption almost in two. These two factors together enabled the Department to bridge over the period intervening until the arrival of the waters of the Owens River in 1914. All the time throughout this period, however, it was only by the greatest economy in use that the City was enabled to maintain an adequate water supply, and it is interesting to note at this time that although during the past summer the average flow of the Los Angeles River was nearly fifty-three million gallons daily, that quantity was less than 49% of the City's requirements, the other more than 51% being supplied by the Aqueduct.

About the year 1888, the old company bought what was known as the Hazard, or Eastside Water Works, which supplied the higher portions of Boyle Heights, the water being derived from springs near Mission Road where the Southern Pacific shops now stand. This source was later abandoned due to the insufficient quantity of water and its poor quality, the regular water supply of the City derived from the Los Angeles River being substituted therefor and pumped directly from the Buena Vista Reservoir into a reservoir known as the Hazard, and which is still in use though very much enlarged and improved. This reservoir is at elevation 438 feeet above sea level and has a capacity of 2,731,000 gallons.

About this time the company replaced the old ditch of 1868 with a wooden flume clear from its source at the river bank to the Buena Vista Reservoir. This flume due to deterioration, however, was replaced with a forty-four inch iron pipe line which continues in service at the present date, except a portion at the upper end, a distance of eight thousand feet or so, which was replaced with a concrete conduit in 1903. This conduit was built large enough to supply the Bellevue Branch, leading through the Ivanhoe Tunnel, as well as the old line, and this much of it is permanent construction for all time. The pipe line, however, from this branch line down to the Buena Vista Reservoir, a distance of about eighteen thousand feet, being now twenty-nine years old, will have to be replaced at the very first opportunity by a permanent concrete conduit.

In 1893 the old water company purchased the system known as the Citizen's Water Company, that supplied the higher elevations of the northwest portion of the City, embracing all the area lying east and south of the river west of New High street, and north of Seventh street. This region was supplied by water derived from the Woolen Mill Ditch, the use of which was abandoned by the water company due to unpotable conditions, and the waters from the Buena Vista Reservoir substituted, the pumping plant to serve the Hazard Reservoir being enlarged to take care of this region, as well as that of the higher portions of Boyle Heights, formerly supplied by the Hazard system.

CITY ACQUIRES WATER WORKS

In 1902, when the City came into possession of the works, this pumping plant was still further enlarged and the works of what was known as the Highland Park System, supplying the Garvanza country were acquired, this also being supplied from the Buena Vista Pumping Station by a twenty-inch main up Pasadena avenue into a reservoir known as the Highland Reservoir, formerly the property of the Highland Park Company. This reservoir was enlarged to a capacity of 19,980,000 gallons and permanently roofed. This reservoir being at an elevation of only 613 feet above sea level was too low to serve all the Garvanza region and a pumping station was established there which pumps water to a small reservoir of 757,000 gallons capacity, known as the Garvanza, having an elevation of 730 feet above sea level. In order to assure a safe supply for the hilly region acquired from the Citizen's Water Company, the City also built a reservoir on the Solano hill at an elevation of 613 feet above sea level, which was completed in 1903. This reservoir was supplied from the same pumps that pumped the water to the Highland Reservoir and has a capacity of 5,723,000 gallons.

In 1903 the City acquired what was known as the West Los Angeles Water Works, a company supplying a large territory lying to the west of Hoover street and south of Seventh street. The water served by this company was derived from wells on Jefferson street and a partial supply from what was known as the Pirtle Cut, in the Burbank region. The waters diverted from this cut were adjudged to belong to and be the property of the City of Los Angeles, in a suit brought by the City to determine ownership. The purchase of the works of the West Los Angeles Water Company was made by a bond issue amounting to $337,500. On acquiring the property of this company the City connected up the district served by them with the Los Angeles River supply, derived from the Buena Vista and Bellevue Reservoirs.

On July 10, 1915, the City acquired also the Union Hollywood Water Company, supplying Hollywood and quite an extensive country southerly therefrom, being purchased by a bond issue amounting to $1,000,000. The supply of the Union Hollywood Company was originally obtained from the Pirtle Cut above mentioned, and later from wells in the vicinity of Sherman. The City on coming into possession of the works substituted for this supply the waters of the Owens River Aqueduct, coming in by way of Franklin Canyon. In addition to these acquired works, the City from time to time during the past sixteen years, has taken over many small works built by real estate people in connection with their development of outlying territory surrounding and mainly within the bounds of the City limits. At the present time there remains but a very few of these privately operated works, and the City is now virtually in control of the entire business of administering its water supply.

PUMPING PLANTS

The undulating nature of the City's surface makes it necessary to supply some portions of it by pumping, although seventy-five per cent of its area (being all the flat portion lying in the coastal plain) is supplied directly by gravity, either from the old River supply or the Aqueduct. Following is a list of the Pumping Plants of the City's Works, their capacities and functions:

The first of these in importance is what is known as the Buena Vista Pumping Plant, located at the Buena Vista Reservoir in Elysian Park. This plant is equipped with three (3) cross-compound condensing pumping engines, two of which have a nominal capacity of seven million gallons each, delivering water from the Buena Vista Reservoir into the Highland and Solano Reservoirs, which serve Garvanza, the higher portions of East Los Angeles, Boyle Heights and the higher elevations lying

STATEMENT OF EARNINGS

BUREAU OF POWER AND LIGHT

	Average No. Consumers on Municipal System	Earnings from Municipal System	Collections from Operating Agreement	Total Monthly Earnings
Year ending June 30, 1917.....	1662	$ 16,479.24	$ 121,339.00	$ 137,818.24
Year ending June 30, 1918.....	7872	278,737.74	604,134.01	882,871.75
Year ending June 30, 1919.....	8005	484,283.34	661,770.41	1,146,053.75
Month ending July 31, 1919.....	10581	42,750.54	40,000.00	82,750.54
Month ending August 31, 1919..	11069	47,014.60	40,000.00	87,014.60
Month ending Sept. 30, 1919.....	11166	49,099.45	40,000.00	89,099.45
Month ending Oct. 31, 1919.....	11262	46,500.93	33,000.00	79,500.93
Month ending Nov. 30, 1919.....	11348	47,370.17	25,000.00	72,370.17
Month ending Dec. 31, 1919.....	11406	53,617.46	30,000.00	83,617.46
Month ending Jan. 31, 1920.....	11479	57,385.64	75,000.00	132,385.64
Month ending Feb. 29, 1920.....	11640	61,602.59	100,000.00	161,602.59
Month ending Mar. 31, 1920.....	11812	56,369.44	75,000.00	131,369.44
		$1,241,211.14	$1,845,243.42	$3,086,454.56

southerly of Sunset boulevard. Both of these reservoirs have an elevation of 613 feet above sea level. The flow line of the water in the Buena Vista Reservoir is 374 feet, so that the exact lift of these two pumps is 239 feet, to which of course is to be added the friction in the mains, which at times of high consumption makes an added lift very materially above this height. The third pump lifts water from a gallery under the Los Angeles River, designed to receive the ground water flow passing the narrows of the river above the North Broadway Bridge, the water pumped from this gallery being discharged into the High Gravity System. The usual lift here varies with the height of water in the pit, being about 220 feet, the High Gravity Reservoir having an elevation of 448 feet above sea level. This water is used mainly in the lower portions of East Los Angeles, Boyle Heights, and also has a connection running down through the business section of the City, coupling in on the west with the supply derived from the Rowena and Ivanhoe Reservoirs, both of which for practical purposes have the same elevation as the High Gravity.

The Edendale Pumping Plant is located on the east shore of Silver Lake Reservoir and supplies water derived from the Ivanhoe Reservoir to the more elevated regions about Edendale delivering into the Edendale Tank, having a capacity of 593,000 gallons at an elevation of 764 feet above sea level. This supply is also coupled in with a supply derived from the thirty-six inch Sunset Boulevard main by means of the Las Palmas Pumping Plant located at Las Palmas and Franklin avenue, designed to serve the higher regions in Hollywood through the Hollywood High Reservoir, located on the high land immediately above the pumping station, having a capacity of 235,000 gallons.

The equipment for the Edendale Plant consists of one triple-expansion Prescott Pump, with a capacity of 1,300,000 gallons, together with an auxiliary unit consisting of one direct connected electrically driven centrifugal pump of the same capacity.

The equipment in the Las Palmas Plant consists of two (2) direct connected, electrically driven centrifugal pumps, each having a capacity of 864,000 gallons per day.

The Garvanza Pumping Plant is used to pump water from the Highland Reservoir to the Garvanza Reservoir which has a capacity of 757,000 gallons, involving a lift of 114 feet. The equipment consists of one (1) triple-expansion Prescott Pump with a capacity of two million gallons per day, supplemented by an auxiliary direct connected electrically driven centrifugal pump of the same capacity.

The Macy Street Pumping Plant installed at the east end of the Macy Street Bridge is used to pump water from the gallery recently installed in the Los Angeles River bed above that point, delivering the water directly into the High Gravity System, supplying the lower portion of Boyle Heights, the average lift being 225 feet. The equipment consists of one (1) direct connected electrically driven centrifugal pump, having a capacity of 6,500,000 gallons per day. This plant is used in the summer time only, when the rate of consumption is excessively high.

The Slauson Avenue Plant, located at Slauson and Compton avenue, derives its water from wells which is lifted by means of a cross-compound crank and flywheel engine of four-million gallons capacity, directly into the mains of the Low Gravity System against a head usually averaging 150 feet. There is also an auxiliary unit to this engine consisting of one triple expansion direct acting pump with a capacity of two and one-half million gallons daily.

The Figueroa Plant, located at the corner of Figueroa and Slauson avenue, serves the same purpose as that of the Slauson Avenue Plant, and is equipped with a cross compound air compressor to lift the water from a battery of wells delivering into a sump from where it is taken by a cross-compound crank and flywheel pump of five million gallons daily capacity. There is also an auxiliary in this plant consisting of a triple-expansion direct acting pump having a capacity of four million gallons daily. The last two mentioned plants are only used during the summer months during the period of high consumption, and in addition to the water supplied by them, they also serve a very useful function by delivering this water into the mains of the low pressure districts of the City, where the pressure is at times almost exhausted, approaching their terminals, by the normal consumption, thus saving an enormous investment that would otherwise be necessary for the enlargement of the mains leading to the southerly district.

There is an air lift plant located at the head of the Main Supply Conduit on the Pomeroy and Hooker land, used during the periods of heavy demand to supplement the flow into the filter gallery located at that point. The equipment there consists of two (2) cross compound crank and flywheel compressors, capable of delivering in excess of ten million gallons daily into the conduit.

There is located on Avenue Forty-three, a small booster pumping plant known as the Mount Washington Plant which is used to draw water from the Pasadena Avenue main and lift it to a small reservoir on Washington Hill, at an elevation of 929 feet above sea level and having a capacity of 316,000 gallons. In addition to giving service in the Mount Washington district, it also supplies water for the Rose Hill section. The equipment consists of a direct connected electrically driven centrifugal pump, having a capacity of 864,000 gallons daily.

There is located at Wilmington, a pumping plant serving the entire Harbor District, including Wilmington, San Pedro and Terminal Island. This plant is equipped with a cross compound air compressor, lifting the water from a series of

wells and delivering it into a sump, from whence it is lifted by a cross compound crank and flywheel engine having a capacity of five million gallons daily. This water is pumped through a force main directly into the system at Wilmington and over to San Pedro, delivering into a reservoir one hundred and seventy-six feet above sea level, having a capacity of nine and one-half million gallons. There is also running from this force main a branch pipe leading across the harbor to Terminal Island. There is auxiliary equipment in this station consisting of one direct connected electrically driven centrifugal pump, having the same capacity as the main unit.

THE HARBOR DISTRICT

In August, 1909, the City annexed the Harbor District, embracing the two then existing towns of Wilmington and San Pedro, including Terminal Island. This district was then being supplied by privately owned works known as the Seaside Water Company, obtaining its supply from deep wells in Wilmington. The condition of these works at that time was antiquated and wholly inadequate to safely supply even the meagre population then existing. At once the inhabitants appealed to the Water Department for immediate relief and negotiations were started for the purchase of the old works. This purchase was effected during the year 1913, and the needs of the district being so urgent, it was not deemed safe to defer the rehabilitation of the old works until a bond issue for their construction should be locally approved. Since that time these works have been almost entirely replaced by modern improvements, consisting of additional wells, an up-to-date pumping plant, the replacement of the old eleven-inch sheet iron force main by a twenty-inch cast iron pipe line, the enlargement of the reservoir from a capacity of less than two million gallons to nine and one-half million gallons and a general replacement of the distributing pipes of the old system with new cast iron pipe construction, involving a total expenditure up to date of $740,000.

PRESENT AVAILABLE WATER SUPPLY OF THE CITY

The available water supply of the City of Los Angeles at the present time consists first, of the waters of the Los Angeles River, representing the drainage of the San Fernando basin which embraces all the area of the San Fernando Valley and the mountain drainage tributary thereto, a total area of 500 square miles, the main feeders of this mountain contribution being the Big and Little Tujunga Canyons, the Pacoima Canyon, the Verdugo Canyon and the numerous tributaries on the north slope of the Santa Monica mountains, as well as the smaller contributions from the Santa Susana range to the west. The concentration of all this drainage manifests itself at the neck of the valley in the flow of the Los Angeles River, due to the immense deposits of mountain debris in the form of sands and gravel in the San Fernando valley, which absorb the normal contributions of the mountain area. The flow of the river has a perennial character of remarkable stability as, aside from the occasional torrential flows, the mountain area contributions are absorbed readily by this great mass of sand and gravel slowly by seepage, which contributes to the stream flow. The average annual yield of the river thus formed and measured at a point known as the narrows, at about the crossing of the Dayton Avenue Bridge, and including all the water diverted above that point, amounts to about fifty-five million gallons per day or the equivalent of 110,000 gallons per day per square mile. It will be remembered, however, that this does not include the run-off due to violent storms, no means for conserving which have as yet been developed.

The regular flow of the basin is but very little affected by the greater or less precipitation of any single year, but responds to the effect of persistent periodical excesses of either precipitation or prolonged drouth that may extend through several years, for instance, the period of drouth before referred to as having occurred between 1894-95 and 1904-05 inclusive, culminated in a reduced flow in 1904, of less than twenty-eight million gallons per day. During this critical period it was observed that the development of the lands in the vicinity of Burbank for farming purposes, which require for their successful operation extensive pumping of the ground water, materially affected the yield of the stream, and a suit was brought to enjoin its continuance. This suit was won by the City and a restraining order issued, but fortunately the recurrence of a series of wet years and the City's project of obtaining a water supply from the Owens River obviated the necessity for its drastic enforcement. The existence of this seemingly insignificant stream of the Los Angeles River afforded the sole original foundation for Los Angeles, for without it the City would never have been founded by the early Padres or the Aborigines who preceded them, it being definitely known that the original inhabitants were a pastoral people and in a crude way were familiar with the art of irrigation.

The Owens River project certainly would have never appealed to any one as a source of supply for this country as an original proposition, for the reason that it required the financial credit of a large existing community already capable of financing such a scheme to warrant even its conception. The Owens River has now had the check of sixteen years measurements and gaugings behind it, covering periods of drouth as well as periods of excessive precipitation, and it can be safely stated on the basis of these measurements, that the available yield from the Aqueduct will average well in excess of four hundred second feet, equal to 258,000,000 gallons daily, which was originally assumed by its designers in the Aqueduct construction. It is true there will come occasional years when it will be necessary, in order to maintain this flow, to vigorously draw on the ground waters of the artesian areas, embracing more than 50,000 acres, wisely acquired by the City at the inception of the project. The Aqueduct supply therefore, can be set down as 258,000,000 gallons daily.

In addition to these two main sources, there is available the waters to be drawn from the two pumping plants above mentioned on Slauson avenue, representing jointly about eight million gallons daily, in addition to which there is the supply drawn from wells in the Harbor District to the ultimate amount of possibly five million gallons daily. This makes an aggregate available supply for the City of 326,000,000 gallons daily, which based on the per capita consumption at the present time, which averages about one hundred gallons daily (ranging from 135 gallons during the summer to 80 gallons during the winter), indicates the ability of the supply to meet the needs of a population of three and a quarter million.

The capacity of the purely domestic service features of the water works in their present condition may be roughly gauged by the capacities of the main trunk lines conveying the water from the distributing reservoirs or other sources, to the consumer in the non-agricultural section of the City.

The average daily rate of consumption in the City during the summer months approximates about 85,000,000 gallons, but there are short hourly periods when this rate is exceeded by thirty to forty per cent, and at such times the rate of delivery through the trunk line mains may require velocities considerably in excess of the normal rate of flow of three feet per second. When such is the case the pressure in the distributing system is necessarily reduced.

SURPLUS WATER

The problem of profitably disposing of the surplus supply of water which the Aqueduct affords, over and above the domestic needs of the City, was one that engaged the attention of the Board must earnestly at the time of its introduction. This question was satisfactorily solved by the annexation to the City of such adjacent portions of the surrounding country as were capable of increasing agricultural production by the use of water, and which could be most easily and cheaply supplied by gravity from the terminns of the Aqueduct. The Board agreed that the San Fernando valley presented in the most marked degree conditions that most fully

met these requirements, this area lying immediately below the end of the Aqueduct being geographically situated between the old city limits and that point. By the formation of two separate districts in the valley, the population of that area voted themselves into the City and voted the approval of a bond issue sufficient to construct the necessary works to effect a complete plan of irrigation. The system involved an expenditure of $3,070,315.00, and has been in successful operation for nearly three years, yielding a revenue of nearly $400,000 during the past calendar year and crops during the same period conservatively estimated to have a value of over ten-million dollars. Other annexations on the same basis are being made to the City in territory equally available for the same purpose, the expense of supplying water to them being cheerfully borne by the inhabitants and land owners thereof, so that it may be stated at the present time that this problem, which seemed so vexatious at first, is almost completely solved.

Proceeding now to review the present condition of the works and the improvement necessary to adapt them to the growing needs of the City, the question of the adequacy of the water supply itself may be dismissed as settled for a period far into the future, so that only the means for conserving and properly distributing this supply need be considered.

The problem of conserving water that flows during the winter time, in excess of the demands of the consumers is one frought with the greatest importance. In the preparation of the plans originally drawn to meet these conditions, it was assumed that the irrigation period would extend over an interval of seven to eight months each year, so that the storage capacity required would represent the excess flow for four to five months, and it was hence assumed that such storage capacity would require a volume of about eighty-thousand to ninety-thousand acre feet. It has since developed, however, that due to the fact that the first use of the Aqueduct water has been applied mainly to the production of field crops with a short duration of growth, that the irrigation season is practically condensed into a period of ninety to one hundred days. This imposes a greater burden on the distributing pipes of the irrigating system than they were originally designed for, and the absence of ample storage at this end of the Aqueduct exposes a risk of running out of water before the irrigation season is completed. For the past three winters practically the entire flow of the Aqueduct has run to waste, save for the storage afforded by San Fernando Reservoir Number Two, and the Chatsworth Reservoir. These two reservoirs have a combined storage capacity of about twenty-five thousand acre feet, and are the only storage reservoirs now available, so it will be seen that to fully avail ourselves of the entire Aqueduct flow, there must be provided additional storage of at least sixty-five thousand acre feet. It must be remembered that the Aqueduct flow has to be maintained constantly, for its use is inseparably connected with the power generating plants of the City, and these plants require for their normal operation a greater flow of water during the winter than in the summer, due to the greater use of artificial light during that period. In order to provide this pressing need, the Engineering Department has been making exploratory surveys with a view to the utilization of every available reservoir site, the position of which makes it adaptable to the present or future needs of the City. The great importance of guarding against waste of such a precious element as water in this country, after the City has gone to such great expense to secure it, should be fully appreciated by those who have a knowledge of the magic aid of water in the development of the resources of the country. The development of the San Fernando Valley region during the past few years is a fine example of what may be expected in the future in the remaining fertile area that forms the City's environs. It is true that the dual use of the water in the Aqueduct for both power as well as water, in a measure in the past has excused its waste, but such waste where preventable cannot be long tolerated.

The annexation of the Westgate region has brought about the utilization of the storage site in Stone Canyon, having a capacity of seven thousand acre feet. This reservoir will be built from funds provided by the Westgate bond issue.

The annexation of the West Coast District in the vicinity of Inglewood, provides a site having a capacity of four thousand acre feet.

A site now under consideration by the Engineering Department, having a capacity of about nrteen thousand acre feet, exists at the mouth of the Tujunga Canyon, most of the property to be taken by its use being now in the possession of the Department, and proceedings for the acquisition of the remaining portions in the site are now under way. This site while somewnat expensive to reach, has a singularly unique and advantageous position for the disposal of its water. In the first place it is so located as to elevation that it utilizes nearly the full height above sea level of the south end of the Aqueduct from which it may be filled. In the second place, the Maclay High Line Conduit (already built) reaches about half way from the end of the Aqueduct to the site and is in proper position as to grade. The third great advantage is that in normal years the reservoir may be filled without the Aqueduct by the flow from the Tujunga Canyon itself. The fourth advantage is, that should the yield of the Tujunga Canyon and the surplus flow of the Aqueduct be in any year, in excess of its capacity, such excess flow will be discharged under control into the gravel wash of the Tujunga and thence into the great gravel measures of the San Fernando Valley, to be in turn fed into the Los Angeles River, which is the sole property of the City of Los Angeles. The fifth great advantage will arise from the regulating effect this great basin affords in ameliorating the effect of storm floods from the canyon. While this latter has no particular bearing on the water supply of the City, its result will be appreciated by the Flood Control officials of the County.

The Department's engineers are still engaged in the work of surveying other reservoir sites and no expense should be spared to secure and utilize them when found.

As before stated, the pipe system of both the irrigation works and the domestic works of the older portion of the City itself are in need of liberal expenditures for cross-connecting feeders to expand the capacity of the systems as they now exist.

Beginning about three or four years ago, or about the time the United States entered the World War as a belligerent, it was found necessary first, for patriotic reasons and at the request of the government, that all work that might be deferred should be suspended, and secondly, for the reason that the disturbed condition of the labor market and the great advance in prices made it not alone expedient, but necessary from a financial standpoint to suspend all additions or expansions of the water works, the execution of which would reach beyond the ability of the Department to carry out and keep within the range of its receipts. We are now confronted with the accumulated result of this suspension in the form of many items that in point of magnitude of cost, are placed beyond the financial ability of the Department to undertake and execute within the limits of its revenues, as has been customary in the past.

The following list of ten items constitutes in the aggregate the main features of the work which the Department finds itself in arrears, and which will have to be accomplished in the immediate future to place the works in an efficient condition to meet the demands of the accelerated growth which the City is now experiencing.

TUJUNGA RESERVOIR

The construction of a large reservoir, the site for which exists in the mouth of Tujunga Canyon, just before its waters debouch into the San Fernando Valley. The site possesses unique features which are adaptable to the purpose intended. The waters of the Aqueduct, as they emerge at the head of the Cascades, divide into

two streams, one of which is known as the Maclay High Line leading easterly, and the other, the Chatsworth High Line leading southerly and westerly and terminating at the Chatsworth Reservoir, the supply for both the San Fernando Reservoirs being taken out of the latter line directly in passing. These three reservoirs jointly have not sufficient capacity to store the winter flow of the Aqueduct in excess of the City's domestic needs for a longer period than about sixty days, and as the non-irrigating period lasts practically seven months a large part of the flow must necessarily be wasted. The area served with irrigating water by the Aqueduct, however, is rapidly being planted to trees, and the lower lands to alfalfa and other crops requiring longer irrigation periods, so that in time this condition of waste will be partially remedied. It will always be necessary, however, to provide storage for at least five months' flow of the Aqueduct above the needs for domestic supply. This means that a storage capacity of sixty to seventy thousand acre feet will have to be provided. The Tujunga site has a capacity of over fifteen thousand acre feet, and has the additional advantage of being at the highest possible elevation for the Aqueduct to flow into by gravity, and is so located that it is convenient for diversion into the existing pipe system of the City. This site also possesses another special advantage in that the waste water coming in from its own watershed or the Aqueduct would be automatically discharged into the gravels that supply the flow of the Los Angeles River, thereby increasing the flow of that stream which is the paramount property of the City of Los Angeles. The construction of this reservoir will bring t he available storage at the south end of the Aqueduct to about fifty-thousand acre feet.

MACLAY HIGH LINE

An extension of this line from its present terminus north of San Fernando to the Tujunga Reservoir.

ENCINO RESERVOIR

This is a small reservoir site on the south side of the valley. Though its capacity will be little over two thousand acre feet, its position and elevation will render it of great value, not alone for the water it will contain, but for its balancing effect in aiding the even distribution of the water throughout the San Fernando Valley, and its extreme value as a stand-by for water that may be drawn in time of need through the Stone Canyon and Franklin Canyon tunnels to serve the regions south of the Santa Monica Mountains, including the west portion of the City itself.

STONE CANYON RESERVOIR

The completion of this reservoir looking toward the service of water to the Westgate district, and the large area adjacent, including the town of Santa Monica, should this section later be annexed to the City.

CRYSTAL SPRINGS CONDUIT

At the present time this consists of forty-four inch pipe of very thin gauge metal, constructed in 1890, and displaying along its entire length a condition of dangerous dilapidation with imminent risk of failure. It is proposed to replace this with an enlarged concrete conduit.

24-INCH STEEL PIPE LINE,

from Western to Compton Avenues, on some route parallel with Slauson Avenue, the latter being purposely avoided to save the great cost of replacing pavement in the street. This line is designed to couple together and circularize the terminals of all the pipe lines leading southerly and will act as an equalizer to improve pressure and efficiency in the entire southerly portion of the City.

MACY STREET GALLERY

An extension of this gallery to provide additional water for improvement of the service in East Los Angeles and Boyle Heights through the Hazard Reservoir.

SAN FERNANDO VALLEY IRRIGATION SYSTEM

Three contracts were originally let for construction of this system. The figures obtained on the first two were favorable to completion of the work within the bond issue. Before the third contract was awarded the war broke and the contract was let at such a figure that the Department was confronted with a very serious possible loss. To avoid this the Engineering Department made some alterations in the design with a view to making the work as efficient as possible with the funds available. To amend the defects accruing from this curtailment of the original design, it is now necessary to expend some money for auxiliary lines designed to effect this purpose.

24-INCH CAST IRON PIPE,

to be laid on Hooper and Sixteenth to Vernon Avenue, the purpose of the line being to complete the circuit between the Buena Vista and Bellevue Reservoirs, through the large steel pipe line referred to above from Western to Compton.

PICO STREET LINE

This line is designed to connect the low gravity system water from Vermont to Main on Pico, or some other street closely parallel thereto. The purpose of this line is to supplement the duty now performed by the Seventh Street 24-inch line, thereby permitting the transference of the latter line (now distributing low pressure water along its route), to be used subsequently for high gravity water to boost the pressure in the business section of the City, which is now beginning to show signs of having outgrown the capacity of the present two large mains, one down Broadway and the other coming in through the Third Street tunnel. When this is done the capacity to supply the congested area of the City will be doubled and capable of supplying this region indefinitely into the future.

WATER RATES

When the City acquired the water works in June, 1902, the prevailing rate for water service was $1.50 per month minimum, with other rates proportionate thereto. This rate was immediately reduced to $1.00 per month minimum. In October of the same year the flat rates for water were reduced ten per cent and the meter rates from 15 cents to 10.2 cents maximum and 7 cents minimum per hundred cubic feet, proportional to the quantity of water used.

On January 31, 1907, the minimum was again reduced by city ordinance from $1.00 to $0.75. It will be observed that this ordinance remained in force for ten years during a period when the costs of labor and material were normal, common labor being abundantly available at from $2.00 to $2.25 per day, a portion of this time the working day being ten hours. The rates under this ordinance when averaged up with the schedule of rates recently recommended to the Council for adoption were about ten per cent higher.

On December 5, 1916, the rates were again reduced to $0.50 per month minimum, with a maximum rate of 7 cents per hundred cubic feet and a minimum of 5 cents for all water used in excess of fifty thousand cubic feet. So that in the eighteen years of public ownership and operation of the works the rates had been reduced 66⅔ per cent, placing the City of Los Angeles in the proud position of being among the ten cities having the lowest water rates in the United States, notwithstanding her position in the midst of a semi-arid section of the continent, remote from the points of manufacture of all manner of water works supplies, and incurring the handicap of excessive freight rates and through most of the period a markedly higher labor market than the cities more favorably situated.

It will be noted that the date of the last reduction in rates, December 5, 1916, preceded by but a short time the entrance of the United States into the World War. Up to that time the Department found no difficulty in not alone operating, but expanding the water works to meet the needs of her unsurpassed growth, out of the revenues. When the war broke, however, this Department, in common with all other large

labor and material using organizations, was appealed to by the federal authorities to restrict all work to the absolute indispensable needs of the service. This injunction was strictly observed by the Department of Public Service, but even had there been a disposition to ignore it, the great advance in cost of materials and labor would have compelled a reduction in the building program that has always been necessary to keep pace with the remarkable growth of the city.

The average advance in the cost of skilled and unskilled labor employed by the Department since the beginning of the war has been over 75 per cent, measured in money alone, and there has been a further enhancement due to the adoption of the eight-hour day that brings the total labor cost up to double what it was seven or eight years ago. There has been a loss also of 8⅓ per cent in the labor output due to the granting of the Saturday half holiday.

In a list of seventy-three items of material that enter into water works construction there has been an average advance in cost since the beginning of the war of 112 per cent. If this list were properly weighted, that is. the amount of each item with its advance segregated, the mass advance in the price would be nearer 150 per cent, while considering one item alone, Cast Iron Pipe, which is the largest item in point of value used by the Department, the advance in cost reaches nearly 200 per cent.

In view of these facts and foreseeing the rapid approach of a serious crisis in the Department's finances, and a still more serious interruption of our efforts to catch up with the three years retardation of operations necessary to keep the works up to an efficient ond serviceable condition, the Chief Engineer and Auditor have been making an intense study of the steps necessary to restore and retain a healthy condition of the Department's affairs. The conclusion reached was that it was necessary to immediately raise water rates to the schedule recommended to the Council, which passed that body by ordinance on May 28, 1920.

Recently the Engineering Department sent out a circular letter to all cities in the United States having a population of 100,000 or over, inquiring as to their existing rates, revenues, etc., so as to afford ourselves and our citizens an opportunity of comparing our rates with those in vogue elsewhere. The result of this investigation is tabulated and presented herewith, replies having been received from 48 of the principal cities. The average maximum rate per hundred cubic feet for domestic water is shown to be 11.8 cents and the average minimum 6.66 cents, a very favorable comparison for Los Angeles with a maximum rate of 10 cents and a minimum of 5 cents, or approximately 20 per cent less than the average of the other large cities.

In addition to the above replies to the questionnaire show that 24 of the 48 cities allow a credit to their water department for water used for municipal purposes, such as parks, public buildings, sewers, street flushing, etc., and also pay a fixed annual rental for each fire hydrant. The rule in Los Angeles is free water for these purposes.

	Cents per 100 Cubic Feet	
	Maximum	Minimum
Atlanta, Ga.	10	7
Baltimore, Md.	6.5	4
Buffalo, N. Y.	6	3
Cambridge, Mass	15	7.5
Camden, N. J.	18.75	7.5
Cincinnati, O.	12	12
Cleveland, O.	4	4
Columbus, O.	9	8
Dallas, Texas	18.75	11.25
Dayton, Ohio	12	6
Denver, Colo.	12.7	7.5
Detroit, Mich.	10	3.5
Fall River, Mass.	21	7.5
Grand Rapids, Mich.	5	5
Houston, Texas	11.25	6.75
Jersey City, N. J.	9	7.5
Kansas City, Mo.	17	6
LOS ANGELES	10	5
Louisville, Ky.	11.2	4.5
Lowell, Mass.	20	20
Memphis, Tenn.	16.8	7
Milwaukee, Wis.	4.5	4.5
Minneapolis, Minn.	6	6
Nashville, Tenn.	14	6
Newark, N. J.	14	10
New Bedford, Mass.	12.25	7.5
New Orleans, La.	7.5	5.25
New York City	10	10
Omaha, Neb:	26.25	6
Philadelphia	10	4
Pittsburg, Pa.	13.4	9
Portland, Ore	8	6
Providence, R. I.	15	7.5
Reading, Pa.	4	4
Richmond, Va.	10	5
Rochester, N. Y.	10.5	7.5
Salt Lake City	5.5	4.5
San Francisco	24	18
St. Louis	15	5
St. Paul, Minn.	6	6
Seattle, Wash.	10	4
Spokane, Wash.	7.5	3.75
Springfield, Ill.	22	5
Syracuse, N. Y.	11	4.5
Tacoma, Wash.	10	4
Toledo, O.	6.7	3.7
Washington, D. C.	6	4
Worcester, Mass.	15	7.5
Youngstown, O.	20	8