LIST OF

MAPS AND TABLES ACCOMPANYING THE REPORT.

General Map of Watersheds, showing collection;

Map of city, showing distribution,

Profiles of aqueducts and pipe lines from water intakes to distributing reservoirs;

Rainfall Table, ------------------------------------ page 5a;

Yield from Alameda Creek watershed, -------------- " 8

Yield from San Mateo County watersheds, ---------- " 11

Water drawn from Lake Merced,---------------------- " 12a

Water drawn from all sources,------------------- " 12b

Additional storage and supply, ------------------ " 15

Population and daily consumption, --------------- " 17

Screens and Aerators, ---------------------------- " 35

City Distributing Reservoirs, ------------------- " 37a

City Pipe system, -------------------------------- " 41

Water gates, -------------------------------------- " 41

Meters, -- " 42

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Author's Copy

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R E P O R T

on the

PRESENT VALUE OF THE PROPERTY

of the

S P R I N G   V A L L E Y   W A T E R   W O R K S ,

- - o - -

By RUDOLPH HERING,

Consulting Hydraulic Engineer,

170 Broadway, New York.

July 25th, 1903.

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(1)

To the President and Board of Directors of the

Spring Valley Water Works,

San Francisco, Cal.

Gentlemen:-

At your request, I have made an examination of your property, known as the Spring Valley Water Works, with reference to giving you my opinion as to its present value in furnishing the City of San Francisco with a suitable supply of water for domestic and public purposes, and respectfully present herewith the results thereof.

On June 14th, I arrived in this city. After meeting Mr. Chas. Webb Howard, your President, and Mr. Herman Schussler, your Chief Engineer, and after receiving detailed instructions concerning the matters which were to be examined, I proceeded with my task.

At the outset, I should say that all information I desired was furnished me as soon and as completely as practicable, and that I was shown all parts of the works which I thought necessary for me to see.

Mr. Schussler gave me a general description of the works and, to fully appreciate their extent and inter-relation, has had maps, profiles and other matter prepared for this purpose, which form a part of this report.

I learned that the water is furnished from three main districts, one comprising the city or county sources, another the Peninsular, and the third the Alameda Creek sources.

Those situated within the city are, until recently, Lobos Creek, which, however, is no longer used, and Lake Merced, which is practically a large accumulation of ground or spring water.

The Peninsular sources are Pilarcitos Lake, about twelve miles south of the southern boundary of the city, San Andres Lake, about ten miles, and Crystal Springs Lake, the center of which is about fifteen miles south of the city.

You have still other sources on the Peninsula which you hold for future use, but which are not yet wholly developed to supply the city. They are Lock's Creek, now temporarily disconnected, about two miles south of Pilarcitos Lake, Portola, about seven miles south of the southerly end of Crystal Springs Lake, and Pescadero, San Gregorio, Purissima Creeks and others.

The Alameda Creek sources are the waters which flow to the dam built in the Niles Cañon, near Suñol, and those in the Niles cone, so far as they can be pumped on your property.

Delivery pipes run from these several sources into the city, the Alameda pipes crossing San Francisco Bay near Ravenswood. In the city, they arrive at different elevations and discharge into a number of reservoirs and tanks.

Pumping stations are placed at Belmont, Millbrae, Crystal Springs, Ocean View, Pilarcitos, Lake Merced, Black Point and Clarendon Heights. These make it possible to pump water to the various heights from almost all of the sources, which are interconnected by conduits in almost every practicable way,- the advantage of this interconnection being a greater protection against temporary mishaps, or the closing for repairs of any single source.

From the city reservoirs, the pipes distribute the water throughout the inhabited parts of the city.

After thus learning of the character and extent of the water works, visits were made to all of their principal parts in company with Mr. Schussler, who explained them to me.

On June 16th, in the forenoon, he took me to see the Millbrae Pumping Station, San Andres and Pilarcitos Lakes. In the afternoon, we saw Crystal Springs Lake and dams. On June 17th, we visited Belmont Pumping Station and the Portola watershed and reservoir and, finally, the pipe-line crossings of the Bay, near Ravenswood. On June 21st, we drove to Clarendon Heights Pumping Station, Clarendon Heights tank, and University Mound and College Hill reservoirs. On June 23rd, we visited the Calaveras Valley and dam site, the filter-beds at Sunol and Pleasanton, and, on the following day, the Niles Cañon and the head of the siphon crossing the Santa Clara Valley, near Niles. On July 4th, we drove to Black Point Pumping Station, to Francisco and Lombard Streets reservoirs, Clay Street tank, the Presidio Heights tank, under construction, Lake Honda and, finally, to Lake Merced and its pumping station.

I was also furnished with a number of reports that had been made within the last few years, relating to the water rates and to projects for supplying the city with water from the Sierras, the latter written by Mr. C. E. Grunsky, City Engineer. All of these reports were carefully read by me. Being generally familiar with the character of the country, I believe that I am fully able to appreciate the statements and the deductions contained therein.

In conversations with your President, your Attorney and others, I was further informed concerning elements relating to the subject. Being thus equipped, I was able to proceed to the consideration of the main subject.

The valuation of a property established for the supply of water to a community will depend upon, first, the quantity of water available for present and future purposes, second, its quality, and third, the extent of the works and their condition for collection, distribution and reliability of service. Before taking up the question of valuation, these subjects will, therefore, be given due consideration.

QUANTITY OF WATER.

As already stated, the Spring Valley Water Works receive their supply, generally speaking, from three independent sources namely, from watersheds within the city limits, San Mateo and Alameda Counties. It will not be necessary to describe them in detail, as they are, of course, well known to you. I shall mention only those facts concerning them which are necessary for this discussion.

The origin of all the water available upon these watersheds is the rainfall. It is therefore desirable to know its amount. I have used for this purpose the rainfall observations made by your company, the compilation by Mr. Wm. Ham Hall, State Engineer, from 1869-86, and more recent information compiled by Mr. C. E. Grunsky, City Engineer. I used also the results of a compilation made by myself for the rainfall on the watershed of Alameda Creek.

A portion of the rain water runs off the surface into streams and, finally, into the bays or ocean. Another portion percolates into the soil until it reaches a subterranean body of water, which flows slowly towards and then also discharges into the nearest stream, bay or ocean. This percolating water, which forms the ground-water, sub-soil or artesian water, is the source of all springs; it is the water which supplies the pump wells and feeds all the streams after the surface flow of rain-water has ceased. Still another portion of the rain water is evaporated and thereby lost. The evaporation takes place from the plants, from the ground and from the surface of streams, ponds and lakes. Finally, a fourth portion is absorbed by the vegetation growing upon the watershed.

RAINFALL

OBSERVED BY SPRING VALLEY WATER WORKS.

Season:	Pilarcitos:	San Andres:	Lower Crystal Springs:	Upper Crystal Springs:	Crystal Springs Cottage:	Portola:	Pescadero:	Calaveras:	Suñol:	San Francisco:
1889-90	72.09	75.25	No Record	72.68	No Record	60.20	93.67	45.54	No record	52.27
91	39.02	36.57	" "	31.92	" "	(incomplete)	46.71	20.23	" "	21.05
92	52.76	33.51	19.91	24.16	" "	16.89	40.76	25.24	" "	21.90
93	67.00	49.60	29.30	47.07	" "	32.40	72.83	39.20	" "	30.58
94	67.87	41.92	29.28	33.08	" "	27.43	49.91	30.81	" "	25.54
95	76.10	57.77	45.42	55.77	42.14	39.00	68.94	38.63	" "	31.54
96	56.34	42.55	31.42	38.09	28.37	28.06	54.72	25.82	" "	28.16
97	58.57	42.38	34.55	39.37	32.95	34.61	63.13	31.20	" "	32.37
98	31.16	21.36	17.64	19.05	17.81	14.70	24.35	13.37	" "	10.08
99	51.48	33.64	30.24	30.92	29.94	28.49	42.53	20.98	20.41	14.60
00	52.75	36.68	26.98	29.12	30.87	28.04	47.73	25.84	22.27	19.87
1900-01	52.28	35.55	31.49	33.74	33.64	32.80	52.20	30.66	25.57	20.18
02	48.54	32.83	28.69	31.02	31.67	30.88	45.50	23.27	19.46	18.29
03	39.47	36.53	31.89	30.44	30.07	29.80	48.47	24.95	19.02	18.18
Average:	54.67	41.15	24.67	36.89	30.83	31.02	53.67	28.26	21.34	24.61
Average for the last six seasons:	45.94	32.76	27.82	29.05	29.00	27.45	43.46	23.18		16.86
Average for '98, '99, '00:	45.13	30.56	24.95	26.36	26.21	23.74	38.20	20.06		14.85

5a.

The rainfall, as observed by your company since 1889, is given in the appended table; also the averages for the period, the averages for the last six years and for the dry cycle of the three years ending in the spring of 1900. It will be seen that the average for the entire period is 39" for the peninsula and 24.8" for the Calaveras valley. It will also be seen how the averages for fourteen years compare with those for the last six years and for the driest three-year cycle on record.

The driest year known in this locality, namely 1897-8, gave the following records:

San Francisco,	9.38"	Mt. Hamilton,	17.66"
Sonora,	21.04"	Calaveras,	13.37
Pilarcitos,	31.16"	San Andres,	21.36
Crystal Springs,	18.10"	Portola,	14.70

Where the climatic conditions are not erratic, but rather uniform, it is generally possible to assume for the purpose of a water-supply a single dry year. But where, as on the Pacific Coast, there is not such uniformity, it is necessary, for economical purposes, to take a series of consecutive years during which the precipitation was abnormally low.

My conclusions regarding the driest years in this part of the State have been drawn from the above-mentioned data. This information shows that, beginning with the season 1897-8 and ending with the season 1899-1900, we had the lowest three-year cycle, and that beginning with the season 1897-8 and ending with the present, we have had the lowest six-year cycle. These periods would therefore determine the safe capacity of the sources.

The amount of water absorbed by plant life is a small factor in the present case, as is also that which is lost by percolation into other watersheds. There is no ready means at hand

to ascertain these quantities, but they are insignificant. The main losses are due, first, to evaporation from land and water surfaces and, second, to overflows from filled reservoirs and to high stream flows, when, in both cases, the water passes on to the ocean.

The losses from evaporation on water-surfaces have been ascertained in several parts of our country. They depend, chiefly, on temperature, wind, elevation above sea-level and humidity of air and, in the western part of central California, vary from 40 inches to 50 inches per annum. The evaporation from land surfaces and plants, varying so much with their character, is very difficult to determine. Some general facts are known, however, which indicate that in this neighborhood it might be roughly estimated to be between 10" and 20" per annum. From your company's records, it will be seen that, during the season 1897-98, there was more water evaporated from the peninsular reservoirs than was supplied by the rain.

The losses from overflows in some of the valleys have been ascertained by you at the reservoirs, and for fourteen years, and a complete record is available for the Alameda Creek, at Suñol dam.

These careful gaugings of the water drawn at Suñol dam and the amount flowing over the dam since 1889, the results of which are appended, throw much light on this question. Below is a table giving only the annual results for each season.

ANNUAL AND AVERAGE DAILY NET YIELD FROM

ALAMEDA CREEK WATERSHED

OF 600 SQUARE MILES.

Season Nov. 1 to: Nov. 1:	Rainfall:				Water run-off:				
	Calaveras:	Sunol: ± 84% Cal.	Pleasanton: ± 88% Cal.	Average:	Annual flow in million gallons:	Average daily flow in gallons:	Inches per annum:	Percent of rainfall:	Rainfall Mount Hamilton:
1889-1890	40.68	34	36	36.89	156,148	427,802,000	14.93	40.40	40.82
1890-1891	20.28	17	18	18.42	35,128	96,232,000	3.36	18.20	23.72
1891-1892	26.19	22	23	23.73	19,051	52,194,000	1.82	8.00	27.99
1892-1893	37.90	32	33	34.30	102,676	280,535,000	9.82	28.70	37.38
1893-1894	35.46	30	31	32.15	55,155	151,109,000	5.27	16.04	34.61
1894-1895	34.71	29	31	31.57	81,827	224,183,000	7.82	24.70	36.61
1895-1896	27.51	23	24	24.50	37,232	102,005,000	3.56	14.50	29.57
1896-1897	29.84	25	26	26.94	63,472	173,420,000	6.07	22.50	27.62
1897-1898	13.79	11	12	12.26	8,687	23,800,000	0.84	6.85	16.86
1898-1899	25.73	22.79	19.39	22.63	24,849	68,079,000	2.38	10.50	25.83
1899-1900	24.32	20.98	21.52	22.27	18,158	49,747,000	1.73	7.70	29.31
1900-1901	29.05	24.95	28.60	27.53	32,102	87,950,000	3.07	11.10	missing
1901-1902	22.52	18.06	20.49	20.35	19,717	54,019,000	1.88	9.20	28.95
1902-1903	23.15	18.26	20.42	20.61	23,440	64,219,000	2.24	10.80	missing
					Averages:	132,521,000	4.63	16.37	

Note: Underlined figures are interpolations.
Rainfall at Mount Hamilton is given
from July 1st to July 1st.

8.

One column shows the rainfall on the watershed for the season beginning 1889 up to the present time. The site of the proposed Calaveras dam is the only station at which the observations were made in the early part of this period. Since the season beginning 1898, observations were taken also at Suñol and Pleasanton. The record of the Mount Hamilton rainfall is given for comparison.

The gaugings made show the amounts diverted to the city and the overflow of the dam since 1889 to 1890, and therefore together represent the entire yield for this period.

Another column shows the run-off as represented by the rainfall; in other words, the depth of rain-water per annum spread over the entire area, which finally either passed over the Suñol dam or was delivered to the city. It ranges from 0.84" in the driest year (1897-98) to 14.93" in the wettest year (1889-90), the average run-off being 4.63 inches. For four individual years of this period, the run-off was less than two inches in one year.

The run-off for the

lowest	2	year	period,	1897	to	1899,	was	1.61"	per annum;
"	3	"	"	1897	"	1900,	"	1.65"	" "
"	4	"	"	1897	"	1901,	"	2.00"	" "
"	5	"	"	1897	"	1902,	"	1.98"	" "

The table also shows the percentage of rain-water which ran off during the above period. It varied from 6.85 per cent in the driest year to 40.4 per cent in the wettest year, averaging 16.37 per cent. As the rainfall was only observed at Suñol, Calaveras, and Pleasanton, it is probably in excess of that of the entire watershed of six hundred square miles, possi-

2

bly to the extent of ten or twenty per cent, and the run-off percentage is therefore consequently greater, averaging perhaps eighteen to nineteen and one-half per cent.

The rainfalls on the comparatively small watersheds on the peninsula, without large gravel storage and being confined to about six months, are torrential and, in order to utilize their waters throughout the year, as well as for several years in succession, they must be stored in reservoirs sufficiently large to hold the excess of wet years, so as to equalize the deficit of dry years, and thus bridge over the dry period and maintain a steady supply for the city.

The storage value of the existing three peninsular reservoirs, which, by their interconnection, may assist each other, is shown in the following table, headed: "Net Yield of Water from Pilarcitos, San Andres and Crystal Springs Reservoirs since the year 1889".

ANNUAL AND AVERAGE DAILY NET YIELD FROM

SAN MATEO COUNTY RESERVOIRS:

PILARCITOS, SAN ANDRES, CRYSTAL SPRINGS, ETC.

WATERSHED 36.2 SQUARE MILES.

Season: July 1st to July 1st:	Rainfall: Pilarcitos:	San Andres:	Lower Crystal Springs:	Upper Crystal Springs:	Crystal Springs Cottage:	Average:	Water collected; Annual flow in million gallons:	Inches per annum:	Per cent of rainfall:	Average daily yield in gallons:	Rainfall San Francisco:
1889-1890	72.09	75.25	65.4	72.68	65.4	70.16	22,945	36.42	51.9	62,863,000	52.27
1890-1891	39.02	36.57	28.7	31.92	28.70	32.98	5,052	8.02	24.3	13,868,000	21.05
1891-1892	52.76	33.51	19.91	24.16	21.70	30.41	2,029	3.22	10.5	5,559,000	21.90
1892-1893	67.00	49.60	29.30	47.07	42.3	47.05	9,949	15.79	33.5	27,260,000	30.58
1893-1894	67.87	41.92	29.28	33.08	29.70	40.37	6,649	10.55	26.1	18,021,600	25.54
1894-1895	76.10	57.77	45.42	55.77	42.14	55.44	11,390	18.08	32.6	31,200,000	31.54
1895-1896	56.34	42.55	31.42	38.09	28.37	39.35	4,425	7.02	17.8	12,123,000	28.16
1896-1897	58.57	42.38	34.55	39.37	32.95	41.56	6,545	10.39	25.0	17,931,000	32.37
1897-1898	31.16	21.36	17.64	19.05	17.81	21.40	net loss by evaporation: (942)	none	none	loss: (2,580,000)	10.08
1898-1899	51.48	33.64	30.24	30.92	29.94	35.24	3,062	4.86	13.8	8,386,000	14.60
1899-1900	52.75	36.68	26.98	29.12	30.87	35.28	5,749	9.12	25.8	15,750,000	19.87
1900-1901	52.28	35.55	31.49	33.74	33.64	37.34	4,119	6.53	17.4	11,252,000	20.18
1901-1902	48.54	32.83	28.69	31.02	31.67	34.55	4,049	6.42	18.6	11,093,000	18.29
1902-1903	39.47	36.53	31.89	30.44	30.07	33.68	6,993	11.10	32.9	19,150,000	18.18
							Averages:	10.53	23.58	17,991,185	

Note 1: Underlined figures are interpolations.

" 2: Upper Lock's Creek line has been out of repair since 1896, thus losing for seven years about one million gallons per day.

11.

The reservoirs are sufficiently large to be filled only in years of excessive rainfall, and the proposed still further increase of the capacity of the Crystal Springs Reservoir will allow it to be filled from the Alameda Creek watershed. Practically, therefore, no water is now wasted on this peninsular territory.

This table indicates that in the season of 1897-98, there was a net loss by evaporation in the three reservoirs to the extent of 942 million gallons. In other words, during this season, there was a daily loss of 2,580,000 gallons.

The last two columns contain the run-off, or the amount of rain-water collected and delivered to the city; the first gives the rainfall in inches that was collected during the year; the second gives the percentage of the amount that fell. It will be seen that the rainfall utilized ranged from nothing in the driest to 36.42 inches in the wettest year, the average being 10.53 inches. For three individual years, the rainfall collected was less than five inches in one year.

It shows further that the aggregate yield of the three reservoirs for several years was as follows:-

For	the	lowest	2	year	period,	1897-1899,	it	was	2.43"	per annum;
"	"	"	3	"	"	1897-1900,	"	"	4.66"	" "
"	"	"	4	"	"	1897-1901,	"	"	5.13"	" "
"	"	"	5	"	"	1897-1902,	"	"	5.39"	" "

The table also shows the percentage of rain-water which was collected since 1889. It varies from nothing in the driest to fifty-one per cent in the wettest year, averaging 23.6 per cent.

WATER DRAWN FROM BOTH DIVISIONS OF LAKE MERCED.

July 1st, 1898,	1,920	million	gallons,
July 1st, 1903,	1,429	"	"
Loss in 5 years,	491	"	"

Pumped from Lake Merced Proper:

Fiscal years:

July 1st, 1898, to July 1st, 1899,	1,546	million	gallons,
July 1st, 1899, to July 1st, 1900,	1,349	"	"
July 1st, 1900, to July 1st, 1901,	187	"	"
July 1st, 1901, to July 1st, 1902,	1,246	"	"
July 1st, 1902, to July 1st, 1903,	1,269	"	"
Total pumped during the five fiscal years:	5,597	"	"
Wasted into Ocean from North Lake Merced, 250,000, daily, or 91 million gallons annually for first four years:	364	"	"
Total drawn out of Lake in 5 years:	5,961	"	"
Deduct loss in storage, as above:	491	"	"
Net yield in 5 years: July 1, 1898, to July 1, 1903.	5,470	"	"
Net yield per annum,	1,094	"	"
Net yield per day,	3	"	"

WATER DRAWN FROM ALL SOURCES:

Season, July 1st to July 1st:	Alameda Creek via Belmont, Ann. consumption, Mill.Galls.:	Lake Merced, Ann. consumption, Mil.Galls.	San Mateo Co., Ann. consumption, Mil.Galls.	Total Ann. consumption in San Francisco, Mil.Galls.	Average daily consumption in San Francisco in Gallons:
1897-98	1,703	290	6,750	8,743	23,953,000
1898-99	2,241	1,256	5,257	8,754	23,983,000
1899-00	2,264	1,349	5,564	9,177	25,142,000
1900-01	3,192	187	6,267	9,646	26,427,000
1901-02	3,674	1,246	4,829	9,749	26,709,000
1902-03	4,770	1,269	4,741	10,780	29,534,000

From this and the preceding table, we can see that the average annual run-off per square mile from the Alameda Creek watershed was 10,756,000 cubic feet, and that the average annual amount of water collectible per square mile from the peninsular sources was 24,463,000 cubic feet, or nearly two and one-half times as much as the run-off west of the Santa Clara Valley.

Another table is annexed, showing the yield from Lake Merced since July 1st, 1898. It will be seen from it that the ground-water, which feeds it, has produced, for the last five years, an average flow of three million gallons per day.

The proposed Calaveras Reservoir is intended to have a storage capacity of fully 30,000 million gallons. The reservoir would be operated in conjunction with the remaining water of the Alameda Creek, and it is estimated that its daily average flow will be about twenty-five million gallons per day, exclusive of the La Honda watershed, which adjoins it.

It has been claimed as a disadvantage of the present works that, after a three-year low cycle of rainfall, the reservoirs were left but partially filled and that to-day, after a six-year cycle of low rainfall, they still remain unfilled. This depletion, however, during a period including the year having the lowest rainfall ever observed in this neighborhood, is what the calculations pre-suppose, and no more is ever expected by the designer. These reservoirs were built for the very purpose of allowing them to be drawn down. It is to their credit that, after six years of great draught, they still hold, at this day, over 12,000 million gallons in store.

At the present time, when about three months of the dry season have passed, there is enough water in the storage reservoirs of Pilarcitos, San Andres, Crystal Springs and Lake Merced, according to the appended table, to supply the city with about sixteen million gallons per day for 750 days, and a greater quantity for a less number of days, even if there is no replenishment by rainfall during this period. And in addition hereto is the live flow of about sixteen million gallons per day, of which twelve millions come from Alameda Creek, one million from Pilarcitos Creek and tributaries, and three million gallons per day from the inflow to Lake Merced. Before that number of days has passed, there will be again, according to all probabilities, more than a sufficient inflow during the coming rainy season. Therefore, there is no reason for anxiety that there will be a water famine in the near future.

You have extended your works only as fast as the demand required it, and have yet kept well above the demand, as the late dry cycle has proven. I consider this procedure, from a business point of view, quite proper, because it is economical and, if the margin is sufficient, it is also quite safe.

As the city is rapidly growing, you are now extending the works in the Calaveras Valley, and can develop water supplies on still other properties now held by you by building dams and impounding water. The quantities of water that can be stored thereon are furnished by Mr. Schussler, and have been approximately verified by me.

Reservoirs:	Additional Storage:	Additional Daily Supply:
Calaveras,	(30,000 million gallons)	
Arroya Honda, (+ Arroyo Valle in future)	(by diversion into Calaveras reservoir,)	30,000,000 gals.
San Antonio,	10,000 million gallons,	8,000,000 "
* Crystal Springs, by raising dam,	11,000 " "	20,000,000 " estimated
Portola, by raising dam,	3,000 " "	7,000,000 "
		65,000,000 "

* This storage is still to be developed from coast streams.

The per capita water consumption in San Francisco is unusually low for its population, compared with that in other large cities. There are no large public fountains, nor is there here any freezing, nor much hot weather. There is also not much manufacturing, requiring large quantities of water, many large consumers getting their supplies from artesian wells. On the other hand, there is no rainfall for about six months every year, and water is not paid for by meter measurement, except by the larger consumers, and, not least in its effect, there is nearly everywhere a very good pressure, ranging generally from forty to sixty pounds per square inch and, in places, it reaches seventy-five pounds per square inch.

The only reason I can ascribe to the fact that the city now uses only about seventy-five gallons per capita, including

water for all public purposes, except Golden Gate Park, is the careful and attentive management of the works. Mr. Grunsky, after a careful examination, believes the leakage from the mains to be almost nothing. The usage in private dwellings is carefully watched by inspectors and, if there is an undue waste, attention is called to it.

In my experience, I have not found so much watchfulness in any other of the large cities of our country, nor better care to prevent leakage in the construction of the piping system. Should the present persistent and apparently very thorough control of the water be relaxed, I am certain that the draft from the reservoirs would very materially increase, if other cities are to be taken as a guide in this respect.

It is certain also, from general experience, that the consumption per capita, or per water-taker, will gradually increase, because water is gradually put to more uses. It has increased here in the past and I see no reason why it should not continue to increase in the future up to certain limits.

With the water thus available, it is next of interest to see how long it will supply the city.

A diagram has been prepared by Mr. Schussler, showing by a curve the probable growth of population and corresponding water consumption. In comparison with the general growth of other American cities, with the local conditions of California, with the influences favoring growth of its population, due to our recent island acquisitions, and comparing also the present rate of consumption with that of other cities, I believe that Mr. Schussler's population curve is conservative, and that the true curve might be found to give even greater than less consumption.

The following table shows in round numbers the total population of San Francisco, the amount of water daily supplied and the consumption per capita. It will be seen that there is a gradual increase in the use of water here, as in almost all other cities. The future increase will depend on several conditions that may not be foreseen. Following the general tendency of other American cities, while holding closely to the local experience and inclinations, the continuation of the table until 1950, as given below, appears to be a fair prognostication.

Year:	Approximate Population:	Daily consumption in gallons:	Daily per capita consumption in gallons:
1865,	120,000	2,360,000	61
1870,	150,000	6,040,000	40
1880,	234,000	12,680,000	54
1890,	300,000	20,430,000	68
1900,	350,000	25,470,000	74
1910,	500,000	40,000,000	80
1920,	650,000	55,250,000	85
1930,	800,000	72,000,000	90
1940,	950,000	90,250,000	95
1950,	1,100,000	110,000,000	100

You have still two other sources on your own properties, where the water is already stored. One is the water of the Niles Cone. It would yield about fifteen million gallons per day in a dry period, before the Calaveras Reservoir is finished and in use; possibly about ten million gallons per day after

its completion, and still eight after the San Antonio reservoir is built. The other source is the Pleasanton ground-water basin, which is now a natural storage reservoir for the large watershed above it. Not knowing the exact outline or depth of this subterranean reservoir, I do not know its exact capacity.

I am informed you have still other large water-producing properties, which, in the future, could be made available for the city's supply. The total safe capacities of the present sources of your company can be estimated as follows:-

Sources:	Safe yields per day:
Lake Merced,	3 million gallons,
Other Peninsular Lakes,	18 " "
Alameda Creek,	12 " "
Pilarcitos Creek, etc.,	1 " "
	34 " "

(as your present sources can yield 34 M.G. and by increasing your storage further yield 65 M.G.

Therefore, your present properties can be made to yield a daily supply of about one hundred million gallons of good water at all times.

If we assume that the future per capita consumption would rise on the average, under continued watchfulness, to one hundred gallons, and that the estimated future population is substantially correct, then your present works, including the development of the Calaveras watershed, would serve the city until it has a population of 700,000, or about in 1923, while the addition of the other sources mentioned above, as my examination leads me to believe, would furnish a population of over one

million, or until about 1945. Should the consumption become greater than is here estimated, you have still other large sources available that are not mentioned above.

QUALITY OF WATER.

Of late years, much progress has been made in throwing light upon the hygienic quality of water required for communal purposes. The germ theory of disease and the water carriage of such germs, or rather bacteria, has given a new meaning to the subject of a healthful water supply.

We are accordingly now intent upon securing a supply which will be free from pathogenic bacteria and, therefore, one which is protected from a pollution by media which are known to carry them. Sewage is, perhaps, the most dangerous of such media and excreta of animals may be but little better. Swamps, in some ways, may also injuriously affect the water and certain species of algae give it an objectionable taste and smell. Winds, birds and insects are apt to carry disease germs from more or less distant localities to the watershed and infect the water in streams or lakes.

Bacteria, of which comparatively but a few species may become injurious to us, live chiefly either in the soil, near the surface, or in water or, perhaps, in animals and plants. They require organic matter, chiefly in liquid form, as their food and some seem to retain vitality for a long time with no food.

The indications are strong in Europe, and we are beginning to recognize them also here, that the only absolutely safe water to be used as a municipal supply for domestic purposes is that which has been freed from bacteria either by natural or artificial filtration.

Naturally filtered water is spring water or ground-water. Unless this has been polluted in the soil by mineral matter, we commonly recognize it as the best of waters. A large number of cities in Europe and some in America are supplied by spring water. Where it can be obtained, preference always should be given to it. Other waters, in my opinion, will eventually be artificially filtered when intended for municipal supplies. This view is now held by almost all sanitarians of Europe and by many also here. Artificial filtration, since we know how it can be accomplished, is reliable and its cost is known.

Whether, however, we employ either natural or artificial filtration, the territory yielding a water-supply should be as free from polluting elements as practicable. Natural springs have been abandoned, as well as wells draining densely populated areas, because of the danger that exists in the possibility of pollution by some irregularity in the percolation. Highly polluted streams have also been abandoned for the artificial filtration of their water, because of the dangers of imperfect filtering apparatus or human carelessness in operating them. Nevertheless, there has been no hesitation in thus filtering the Schuylkill River, containing the sewage from over one hundred thousand persons, for the water-supply of Philadelphia, nor filtering the sewage-polluted Ohio River water for the supply of Pittsburg, Cincinnati and Louisville. With suitable intelligence and care there should be no danger, even in such cases.

The water supplied by you, so far as its quality is concerned, can be divided into three parts: the Peninsular, the Lake Merced and the Alameda supply.

The peninsular supply is chiefly surface water. It is collected in the reservoirs or lakes built for the purpose.

The gathering grounds are unusually favorable, as you own and control the greater part of each watershed. You permit no objectionable farming, no cattle, sheep or other animals upon it. Every autumn, you burn the grass over large areas and, particularly, below the high water line, which reduces the organic matter that would be dissolved by or carried into the water. I do not know of any other case in this country or Europe where so large a proportion of the watershed is owned and kept in so favorable a condition by the municipality or a private company, for the sole purpose of protecting the water supply obtained therefrom.

Nearly the same can be said of the Lake Merced supply. In addition to a policing of the large area around the lake, from which the public is excluded and which is allowed to cover itself naturally with vegetation, it is kept in this natural condition, and the storm or surface waters, a part of which come from inhabited areas, are intercepted by specially built drains, open and closed, and carried to the ocean. This precaution is a wise one and protects the lake from the inflow of any objectionable surface water. This source is almost wholly ground or spring water, which has undergone natural filtration. The soil for such filtration is largely pure sand, the best material known for the purpose, and is effective, even if a part of the water comes from inhabited surfaces. Therefore, with the precautions that have been taken, I consider the water as it flows into Lake Merced as being of very good quality. After the water has issued from the ground, its exposure to light and heat is apt to cause algae growths, particularly along the shallow shores, where the water is warmest. A frequent cleaning of the shores and not letting the water rise above the line of vegetation is, however, materially reducing this feature of the supply.

The Alameda supply, finally, consists almost entirely of ground-water, drawn from the gravel beds of Pleasanton and Sunol, into which the water brought down by the creeks has percolated. Large areas of these gravel beds are owned by you and are protected against surface pollution partly by preserving the territory in its natural state and partly, in the populated sections, by an over-lying continuous bed of stiff clay, which prevents the percolation of any foul water which might result from any operations of the residents. The water issuing therefrom should, therefore, be unexceptional in quality, and its analyses prove it to be so. I am informed that there are no mineral pollutions in any of your sources of supply.

When it is realized that artificial filtration can thoroughly purify ordinary river water, percolating vertically, at slow rates, through sand but two or three feet in depth, it will be clear that water, percolating at still slower rates through naturally compacted sand and gravel, for horizontal distances, at least one hundred and, generally, over one thousand feet, and on territory adding no pollution, receives a purification which has shown itself to be entirely satisfactory.

Even the occasional spreading of manure on the surface would not necessarily injure the ground water. It does not injure natural spring or well water, except when the manure comes into close proximity with the flowing water, which would not be the case on any of your properties. Even sewage itself can to-day be purified to the state of drinking water by slow filtration through sand. Whatever agricultural works or habitations may exist in or adjoining your territory, beyond these gravel filter-beds, should therefore not injure the water.

From what has been said, I am therefore of the opinion that these waters are of excellent quality and, if practicable, when leaving the gravel-beds, should be directly delivered into the buildings, without first storing them in open reservoirs.

The peninsular waters must, of necessity, be stored in large open lakes, in order to equalize the continuous daily draft upon them, and all water must be stored for a short time in the city distributing basins and tanks. Storage in open reservoirs, exposed to the heat and light of the sun and to the organic dust blown in by the winds, as already said, is the cause of more or less deterioration of the quality of water so stored.

The bottom and sides of natural storage reservoirs generally contain large quantities of organic matter which, at certain seasons, is taken up by the water and becomes a favorable medium for the growth of algae and animalculae, which is true of this coast as well as of the Eastern States.

This growth is particularly favored when the current is very slight and the water is exposed to sunlight. When there is much readily decomposable organic matter on the surface of the land, an excess of nitrates is usually formed by the reduction of this matter. These nitrates are dissolved by the percolating water passing through the soil or through an artificial slow sand filter.

We, therefore, observe a more or less luxuriant growth of algae in ponded spring water or in reservoirs holding filtered or ground water. Keeping such water cool and dark, as in covered reservoirs, removes the cause and therefore the objectionable effects.

It cannot be said, from present knowledge, that this growth is necessarily injurious to health. It is, however,

unpleasant to sight and sometimes to smell.

To reduce the effect of this water-growth as much as possible, you have installed a system of straining the water through cloth, and of aerating it, before it enters the distributing reservoirs. This straining is effective in removing nearly all of the suspended matter, and the aeration, in removing odors. But the finest particles, which pass through the interstices of the cloth, and the taste and odor which have been imparted to the water, cannot thus be removed. This can only be done by a thorough filtration through sand.

Furthermore, the subsequent storage in the distributing reservoirs, though brief in time, allows of a continuation of this growth, as shown by scum and deposit, because the straining process did not remove all germs. The only way to prevent this germination is to do here what has been done elsewhere, namely, to cover all of the city distributing reservoirs.

The thorough filtration can be effected by either the so-called slow or rapid filter, now in use in Europe and in a few of our Eastern cities.

In slow filters, the purification is secured chiefly near the surface of the sand, of which they are made, by the formation of a very slight slimy coating where the suspended matter and the bacteria are retained, the latter decomposing the organic matter dissolved in the water. At great depths, where the absence of oxygen does not favor the development of bacteria, purification by this means no longer takes place. In rapid or mechanical filters, the purification is also extensively effected on the surface, but by a thicker artificial coating, caused by the addition of alum to the water which, forming a flocculent substance settling upon the sand, strains out the

bacteria as well as the suspended organic matters. Both processes are effective and economical, the first under some, the second under other conditions.

The slow filters allow from two and one-half to six million gallons to be purified on an acre of sand, or about seven to eighteen cubic feet per square foot per day, according to the character of the water. In your case, I should think the latter figure might be closely approached, if the water is given a careful preparation by the removal in other ways of most of the suspended matter, as, for instance, by strainers. The cost of this filtration, not including interest on investment or any pumping, would probably not exceed one-half cent per thousand gallons. Roughly estimated, the cost of such a filter plant would be about $35,000. per million gallons of water filtered.

The rapid or mechanical filters would pass water through fine gravel at the rate of probably two hundred cubic feet per square foot per day and would therefore cost less for installation but more for operation, the total cost per million gallons, under average conditions being about the same as for slow filtration. Local estimates and special studies can decide the preference.

Analyses have been made of your water by yourselves and by the city. The latter have been published in Mr. Grunsky's Progress Report of August 12th, 1901. In summing up the question of quality, Mr. Grunsky says: "The wholesomeness of the water delivered has been established by long continued use."

In conclusion, and after examining the topographical conditions and also the available analyses, it can be safely said, without further analyses, that the quality of your ground waters

should be and is in fact very good and that, with continued exercise of the same care as heretofore, there is no reason why it cannot so remain. The surface waters are also good in quality, as well as the Lake Merced water, except for the growth of animal and vegetal life in the lakes at certain seasons, which sole imperfection can be readily removed by filtration.

The comparative absence in your city of diseases due to polluted water is a further proof of the good quality of the average supply as delivered.

If we assume that the yield of the sources eventually requiring filtration is twenty-two million gallons per day, then, according to a rough approximation, the cost of such filter plants would be $750,000., and the annual cost of operation, including interest and depreciation, should not exceed $10.00 per million gallons filtered, and may be materially less.

~~To cover the city distribution reservoirs would, according to Mr. Schussler's estimates, require about $~~

Last two lines struck out at Mr. Schussler's request.
J. M. D.

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EXTENT AND CONDITION OF WORKS, INCLUDING RELIABILITY OF SERVICE.

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The present works for supplying the City of San Francisco with water, begun over forty years ago when the city was small and but little water was required, have grown from a small plant to their present extent, when over thirty million gallons daily are supplied to the inhabitants. These works, almost since their origin, have been designed and operated by the present company.

The policy pursued has been to meet the growing demands gradually, by constantly keeping abreast of the demand, instead of providing at once for a supply far ahead of immediate requirements. In order to purchase at low prices the lands and water rights required in the future, you had developed the plan of the present system of supply at a very early day and bought the suitable properties as the best opportunities for purchase offered, sometimes far in advance of your immediate need. You built storage and distributing reservoirs in good time, to come into service as nearly as possible during the year when they would first be needed for regular demands and emergencies. I understand that you are still pursuing the same policy and are now preparing for a supply several times as large as the present one. It is good business policy to buy such property in advance as opportunities offer, instead of waiting until it is urgently required and must be obtained at any price. While this foresight is commendable, it is even a necessary precaution to relieve the city from the effects of a drought, which might prove disastrous to health and property.

It has also been the policy, self-evidently, to gather the nearest sources that would furnish water of a suitable quality and quantity, and this has been done with a view of so connecting them as to mingle them and secure a supply of fairly equal quality throughout the city, and also to rapidly increase the supply in any one district, should this be necessary.

The availability, therefore, of a total supply, always somewhat larger than immediate needs, and of the possibility of feeding local districts from each other, has been of much benefit in securing reliability of service.

The sources from which you draw the water, its quantity and quality, have been already discussed. It remains now to describe the works by which it is utilized.

Peninsular Supply:-

The sources of water supply within the city are Lobos Creek and Lake Merced. Forty years ago Lobos Creek was the main source. The belief that the increase of population upon the watershed caused a liability of polluting its water led to its abandonment for domestic use. The continual growth of population over this territory makes this belief justifiable. I am of the opinion that this source has lost its value for domestic supply.

Lake Merced, on the other hand, yields a large quantity of good water. A large portion of the drainage or collecting area, over four square miles, is owned by your company. The pumping station is on the shore of the lake. It contains two high-duty pumping engines, with the necessary boiler outfit, and can supply in duplicate three and one-half million gallons daily, at an elevation of 460 feet. It can be used to pump

lake water into the Pilarcitos or San Andres pipe-lines or to force San Andres water, which arrives at the station under about 100 pounds pressure, into the Pilarcitos pipe-line by way of an aerator on Daly Hill, near by.

In San Mateo County there are three reservoirs and five pumping stations in use.

<u>Pilarcitos Lake</u> is a reservoir, about five miles from San Mateo, formed by an earth dam just below the junction of two valleys. The dam is 90 feet high and 730 feet long on the crest. The high water surface is 105 acres, at an elevation of 692 feet. The outlet pipe is at an elevation of 650 feet. The watershed is about four square miles, but by a flume and small feeders about 1.4 square miles of additional watershed are made tributary to the reservoir. The old dam, 30 feet high, in the upper Pilarcitos Valley, forms a settling basin for storm water.

The overflow water from this reservoir is caught by a small dam and flume, uniting with the Lock's Creek flume, mentioned below, and delivering into the San Andres Lake.

The water from the reservoir flows through a tunnel into the San Mateo Valley, thence across the same in a pipe and through another tunnel into San Andres Valley, below the reservoir dam. It then flows, partly through a pipe and flume, to the Lake Honda reservoir by way of Colma. Most of this pipe is wrought-iron and a small fraction is cast-iron. The tunnels are brick-lined.

The water collected by Pilarcitos reservoir comes from an uninhabited territory, most of which is your property. When,

during dry winters, the quantity of water collected is inadequate for the supply to Lake Honda, the supply is then supplemented by pumping from Crystal Springs, Alameda Creek, San Andrés Lake or Lake Merced.

San Andres Lake is a reservoir northeast of the former and has an earth dam 90 feet high and 990 feet long on the crest. The high water surface is 475 acres, at an elevation of 445 feet. The outlet pipe is at an elevation of 372 feet. The watershed is about 3.8 square miles, to which fully one square mile has been added from San Mateo Creek by the so-called Davis tunnel and flume. The area yielding water into this reservoir is further increased by the Lock's Creek line to the extent of 3.4 square miles, partly tributary, through a series of flumes, tunnels and pipes intercepting the water from Lock's Creek, Apanolio Creek, a part of Pilarcitos and San Mateo Creeks. One-half of the above area is tributary to San Mateo Creek and, when the conduit is running full, the excess of water flows into Crystal Springs reservoir, which also receives the overflow from San Andrés reservoir.

The water delivered from San Andrés to San Francisco flows through a tunnel and pipe line, by way of Colma, to the College Hill reservoir.

The water collected by this reservoir also comes from a territory sparsely inhabited and most of which is owned by you.

Crystal Springs Lake is a reservoir formed by a concrete dam, built of dimensions that will allow of its being raised 25 to 30 feet, thus enabling it to store waters from other watersheds. The watershed is about 22 1/2 square miles.

The water surface, at the height of the present dam, is about 1300 acres and, at the height of the final dam, about 1,730 acres. The present dam is 145 feet high and has a crest 600 feet long. The high water surface is at an elevation of 280 feet. The outlet pipe is at elevation 166 feet.

About half of the present reservoir is separated from the rest by an earth dam, provided with brick outlet tunnel and concrete waste weir. The County Road crosses upon it, slightly above the elevation of the new dam. It is used and operated as a settling basin after heavy rains.

The water leaves the lower reservoir through an iron pipe and reaches the city by the bay shore, partly through tunnel, and discharges into University Mound reservoir.

The water at Crystal Springs, as well as Pilarcitos reservoir does not contain as much suspended matter as that of San Andres. This is partly due to the larger proportional inflow of water and partly to the settling of the water in the upper basins.

Lock's Creek, situated at a point southeasterly from Pilarcitos Lake, is intercepted and the water is discharged into San Andres Lake by a conduit, already mentioned, gathering Apanolio Creeks and other waters on its way. The conduit consists of flumes, pipes and tunnels.

The general quality of the water of this source is practically the same as that of the lakes.

In the upper San Mateo Valley there is still a farm with pasturage and, below it, are two settling ponds, created by two dams, to minimize any objectionable effects. The winter waters

of the upper San Mateo Creek area are conducted to San Andres Lake by the Davis tunnel before coming to this pasture land.

Another source in this county which, however, you have not yet utilized for supplying San Francisco, is the Portola reservoir, at Searsville, about seven miles south of the southerly end of Crystal Springs Lake. A portion of this water, namely, about two and a half million gallons daily, belongs to the Leland Stanford, Jr., University. There remain for San Francisco about six and one-half million gallons daily, which it is expected to develop by storage. The present dam is of concrete about 75 feet high, but can be raised to 115 feet. The length of the crest is now about 280 feet. The direct watershed is about fifteen square miles. In addition to this watershed, the company controls about eight square miles more, which will eventually be connected with the Portola supply.

There are five pumping stations connected with the three San Mateo County reservoirs, three of which are used only for emergency purposes, as follows:-

1. Pilarcitos Pumping Station is located at the outlet of the tunnel from the San Andres Lake, and is used only for occasional service, when it is necessary to pump San Andres water into the Pilarcitos pipe line, in case of an accident to the upper Pilarcitos conduit. Generally this pumping can be done with greater economy by the pumps at Lake Merced, already mentioned. The station has three pumps, with a capacity of four million gallons per day and a lift of about 225 feet.

2. Ocean View Pumping Station is located near the San Francisco County line. It can be used, when necessary, to pump San Andres water from the Lake Merced force-pipe line to the

aerator on Daly Hill, thence flowing into the Pilarcitos line. The station has a single pump, with a capacity of two million gallons per day and a lift of about 175 feet.

3. Crystal Springs Pumping Station, just below the large dam, is also intended for occasional or emergency use in taking water from the Crystal Springs Lake and discharging it into the flume leading to San Ardres Lake. The station contains four pumps, with a capacity each of three million gallons per day and a lift of about 250 feet.

4. Millbrae Pumping Station is situated about two miles northwest of Burlingame and is used to pump water drawn from Alameda Creek or Crystal Springs, or both, out of the Crystal Springs main pipe to the screen-house at the inlet of the San Andres main pipe-line. There are two pumps, each of eight million gallons capacity and capable of lifting the water from the 190 foot level (Crystal Springs main) to the 372 foot level (San Andres main).

5. Belmont Pumping Station is situated at Belmont and is used to force the water from Alameda Creek into the main pipe from Crystal Springs Lake to the city. There are two pumps, each of five and one-half million gallons daily capacity, and three pumps, each of four million gallons daily capacity, and all capable of lifting 320 feet.

While the water running from the gravel beds at Sunol is quite clear at all times, and while the ground-water which supplies Lake Merced is also clear, yet, as already stated, the standing of the latter in a large open lake and the mingling of the former with the waters from the peninsular lakes causes some growth of vegetal and minute animal life which it is necessary to remove from the water. This is done in an economical

and fairly effective way by the use of fine screens of cotton cloth. To remove also the gases which form in the water by the presence of this organic matter and sometimes give a slight taste to it, you also aerate it.

The following tables give the location of the screens and aerators, their capacities and the source and quantity of the water treated:-

Screens at:	Source of water:	Daily quantity:
San Andres,	San Andres, Lower Pilarcitos and Lock's Creek,	10 million gallons,
University Mound,	Crystal Springs and Alameda,	20 " "
Lake Honda,	Pilarcitos and Lake Merced,	12 " "

Aerators at:	Source of water:	Daily quantity:
Daly's Hill,	Lake Merced,	7 million gallons,
College Hill,	San Andres,	10 " "
Clarendon Heights,	Crystal Springs,	1 1/2 " "

In order to control the quantity of water received and distributed from each of the sources, measuring weirs have been placed as follows:-

Location:	Source of water measured:
San Mateo Valley,	Pilarcitos,
Inlet of San Andres pipe,	San Andres,
University Mound Reservoir,	Alameda Creek and Crystal Springs,

Besides these weirs, the various pumping engines are used to check the water measurements.

Alameda Creek Supply:-

In Alameda County there is practically but one source, namely, the Alameda Creek, at Suñol, just above the Niles Cañon. This creek is made up substantially of two, the Laguna and the Calaveras Creeks. At Sunol, there is a dam which turns the water into a conduit, consisting partly of tunnels, flumes and piping, and conveying it to Centerville and Dumbarton Point, where it crosses San Francisco Bay to Ravenswood and, by way of the Belmont Pumping Station, is delivered into the pipe conveying the Crystal Springs water to the city.

Before the dam at Sunol was built, another one, near Niles, was used, which now throws the water that reaches it into a conduit, consisting of a stone aqueduct, flume and pipe line for irrigation purposes below Niles. In case of accident or necessity this pipe line can be discharged, near Niles, into the pipe leading to the city from the Suñol dam.

The water is collected at Suñol from filter galleries cut into the natural gravel beds, which cover a very large area of the valley above and, as above stated, give the water a high grade of purity at all times. These works are so operated that the ordinary flow of Laguna Creek is diverted and thrown upon them. A similar filtration is given to a large portion of the water naturally entering Laguna Creek, near Pleasanton, by the streams above sinking into the extended gravel beds and issuing below.

The overflowing water at the Niles dam disappears, up to certain quantities, into the gravel of the creek bed forming the so-called Niles cone. On another occasion, I have estimated that enough water now enters this cone to yield safely a daily supply of about fifteen million gallons of good water.

The Calaveras Creek is now about to be developed into a large supply by the building of a large storage reservoir. The drainage area above the dam is about 103 square miles. It is nearly uninhabited and an excellent territory from which to procure potable water. The dam will be about 220 feet high and the crest about 800 feet long. The supply, assuming a 900 days' storage, could add fully 25 million gallons daily to the present supply. It would be necessary to re-arrange and extend the galleries in the Sunol filter-beds for this amount.

The Calaveras reservoir can receive the water also of Arroya Honda, adding about 36 square miles, by the building of a small diverting dam and a short flume and tunnel through the separating divide.

In the valley of San Antonio Creek, adjoining the Calaveras Valley, you own the necessary property for another large reservoir. The facilities found there for storage are good and the territory is quite suitable for the purpose.

The Alameda Creek water is measured at Sunol by a weir.

Distribution System:-

The distribution system in the city is headed by a number of reservoirs and tanks, into which the water is delivered from three main pipes, already mentioned, from Pilarcitos, San Andres and Crystal Springs Lakes, including the Alameda source,- the first two going by way of Colma, the last by way of the bay shore. These three pipes discharge respectively into Lake Honda, College Hill Reservoir and University Mound Reservoir, from which the city mains take the water as needed. The first two reservoirs can receive water also from Lake Merced.

CITY DISTRIBUTING RESERVOIRS.

NAME:	Location:	Date of First Service:	Supplied from following sources:	Elevation above City Base:	Depth:	Capacity (Gallons):	Open or Covered:	Aerator or Screens:
Lombard St. Res.	Between Hyde & Larkin Greenwich & Lombard,		From Lake Honda Reservoir	298'	14'	1,980,000	Open	Water screened at Lake Honda
Francisco St. Res.	Between Hyde & Larkin Chesnut & Bay		From University Mound Res.	132'	6' / 10'	2,448,000 is to be repaired to hold 4,508,000	Open	Water screened at University Md.
Lake Honda Res.	Near 7th Ave. & N St.	July 3, 1862,	(Pilarcitos (Lake Merced Can be assisted from (Alameda Cr.& (Crystal (Spg's Res. (By Millbrae (Pump & (Pilarcitos and from (San Andres (Res. by (Pilarcitos (Pump	367'	28' 11"	32,778,000	Open	Water screened at Lake Honda Lake Merced Water aerated at Daly's Hill near point where Mission St. crosses line S.F. & San Mateo County.
College Hill Res.	Holly Park West Ave. & Elsie	May 27, 1871	San Andres Can be assisted from (Alameda Cr.& (Crystal (Spg's.Res. (by Millbrae (Pump or from Crystal Spg's by the Crystal Spg's. Pump into San Andres Res. or from Lake Merced by pump into College Hill	256'	16' 4"	13,356,000	Open	Water screened at San Andres, and aerated at College Hill " L. Merced water aerated at Daly's Hill
Lafayette Tank	Lafayette Park Octavia St. between Clay & Washington	July 3, 1883, (Recently) (abandoned)	From University Md. via Francisco St. Res. by Black Point Pump	369'	7' 0"	100,000	Covered	Water screened See U. Md.

CITY DISTRIBUTING RESERVOIRS

(Continued).

NAME:	Location:	Date of First Service:	Supplied from following sources:	Elevation above City Base:	Depth:	Capacity (Gallons):	Open or Covered:	Aerator or Screens:
Lake Honda Tank	Lake Honda Res.	Jan. 1, 1885,	Same as Lake Honda Res.	391'	5' 0"	540,000	Open	Same as Lake Honda
University Md. Res.	University Mound	July 30, 1885,	Alameda Cr. by Belmont Pump and Crystal Spg's. Res. by gravity	163'	17 3'	35,000,000	Open	Water Screened at University Mound
Clay St. Hill Tank	Jones & Washington	Jan 15, 1886,	University Mound via Francisco St. Res. by Black Point Pump	372'	8' 6"	184,000	Covered	Water screened See U. Md.
Clarendon Heights Tank	Clarendon Ave. & 18th St.	Sept. 5, 1894,	University Mound by Clarendon Hgts. Pumps	600'	15' 0"	564,000	Covered	Water screened at U. Md. aerated at Clarendon Hts. Tank
Potrero Heights Res.	Between Sierra, Humboldt, Wisconsin, Carolina,	Dec. 3, 1898,	Lake Honda by gravity, or U.Md. by Clarendon Hgts. pump, or College Hill by Clarendon Hgts. pump.	310'	17' 4"	820,000	Open	Water screened See U.Md., L. Honda C. Hill
Presidio Heights Tank	S.E. cor. Pacific & Lyon	(In process) (construction)	University Md. via Francisco St. Res. by Black Point Pumps	400	35' 0"	700,000	Covered	Water screened See U. Md. & Francisco St.

37b.

Lake Honda lies in the valley, near the Almshouse. It is lined with stone masonry, brick and concrete. As the reservoir is about twenty-five feet below the screen-house, and as it is desirable not to expose the water in the large open reservoir after it has been screened, it discharges, first, into a small tank of 540,000 gallons capacity and then directly into the mains. The reservoir is therefore used only when the consumption exceeds the pipe delivery, in which case automatic valves connect the reservoir directly with the pipe and supply the deficient quantity.

College Hill Reservoir receives the water from an aerator, supplied from an adjoining stand-pipe. It is located on a spur of Bernal Heights, west of Holly Park. It is lined with rubble stones, laid upon the embankment slope.

University Mound Reservoir is situated on the tract of the same name in the southern part of San Francisco. The water is delivered from the adjoining screen-house. The sides and bottom of the reservoir are lined with concrete and covered with felt and asphaltum.

Owing to the broken territory of the city and the number of isolated hills within the same, it was necessary to carry some of the mains, unconnected, across depressions and feed auxiliary reservoirs, from which direct distribution into the neighboring territory could follow, with shorter distances from the point of supply and greater and more constant pressure.

It was necessary, for this purpose, to make use of two auxiliary pumping stations as follows:-

The Clarendon Heights, or Seventeenth Street, Station is located at Seventeenth Street, near Sanchez. It takes its water from the College Hill system and forces it alternately into the Clarendon Heights tank, at 600 feet elevation, and into the pipe supplying the Potrero Heights Reservoir

at 310 feet elevation. When the Clarendon Heights tank is full the pumps discharge into the Lake Honda system. The station has two pumps, one of one and one-fourth and the other of one and one-half million gallons capacity daily.

The Black Point Station is located just east of the Government reservation of the same name. It takes its water also from the University Mound system and forces it into the Clay Street Hill tank, with its surplus discharging into the Lake Honda system. Until last Autumn, it discharged also into the Lafayette Park tank, which, by order of the Park Commissioners, was abandoned. It will in its stead supply the Presidio Heights tank, which is now being built on Presidio Heights. The station has two pumping engines, one having two and three fourths, the other three and one-fourth million gallons capacity.

The auxiliary reservoirs or tanks for the city distribution are as follows:-

Clarendon Heights tank is located at Clarendon Avenue and Eighteenth Street and is the highest distributing point in the city. It receives its water from the University Mound Reservoir by pumps at the Clarendon Heights Station. It is a circular iron tank and covered.

Clay Street Tank, on Clay Street Hill, west of Jones Street, is an important equalizer of pressure for the surrounding district. It receives University Mound water via the Francisco Street Reservoir by means of the Black Point pumps. It is built of iron, is circular in shape and covered.

Lafayette Park tank, which was located upon city property, has been abandoned. To take its place, the Presidio tank is

now building at the corner of Pacific Avenue and Lyon Streets, which will have a much larger capacity and be somewhat higher in elevation. It will receive its water from the Black Point Pumping Station. It will be a circular iron tank and covered.

The Potrero Heights Reservoir is located on Potrero Heights and serves an independent district. It receives its water from Lake Honda by gravity or from University Mound by pumping at Clarendon Heights. It is circular and lined with concrete and faced with brick.

The Lombard Street Reservoir is located on the summit of Russian Hill. It receives its water from Lake Honda by gravity. It is brick-lined and about forty years old.

The Francisco Street Reservoir is located on the northern slope of Russian Hill, between Hay and Chesnut Streets. This is also an old structure and is to be repaired this fall. It is intended also to enlarge its capacity. It receives its water from the University Mound system by gravity.

From the distributing reservoirs and tanks the mains within the city are supplied. No examination has been made of them. From the statements made by Mr. Schussler and in accordance with the result of Mr. Grunsky's examination in 1901, I conclude that they are in a good condition. From the accounts I have received, the material and laying of the pipes is equal to the best practice. The wrought-iron pipe is excellent.

The following table gives the length of the pipes of different diameters:

CITY PIPE SYSTEM.

Wrought-iron Pipe:

Diameter:	Feet:
44"	7,213
37 1/2"	11,312
33"	2,510
30"	12,514
22"	21,201
13"	850
	55,600

Cast-iron Pipe:

Diameter:	Feet:
30"	4,494
24	21,425
22"	23,488
20"	21,840
16"	123,212
12"	237,155
10"	9,912
8"	633,060
6"	570,856
4"	345,489
3"	130,859
	2,121,790

The distribution system is supplied with as many valves, or water-gates, for controlling the flow as experience has warranted. From the description, I judge they are well-designed and carefully made.

The following table gives a list:-

WATER GATES:-

44"	1	20"	11	8"	993
37 1/2"	1	16"	122	6"	794
30"	2	12"	400	4"	377
24"	24	10"	8	3"	61
22"	20				

The house connections are made by your company, but are paid for, at fixed rates, by the house-owner. There are at present 47,135 connections in the city. The diameter of the ordinary service pipe for a single dwelling-house is 5/8". The service pipes for manufacturing places vary from 3/4" to 4" in diameter.

For the purpose of paying the rates by meter measurements, and detecting waste, there are at present 13,496 meters in use in the city. They are the property of your company and, therefore, a part of the plant. The following table shows the number and sizes:-

METERS:

Size:	Number:
4"	40
3"	51
2 1/2"	306
1 1/2"	310
1"	348
3/4"	176
5/8"	12,265
	13,496

Of this number, 6,428 measure water charged at meter rates, the balance being used as waste detectors. In addition hereto, there are 658 hydraulic elevators, supplied with water from the mains, which elevators also act as meters, making a total of 7,086 meters for measuring water charged at meter rates.

There are 3,972 fire hydrants in use on the mains, which makes one to about 534 feet of cast-iron pipe, or about ten per mile. They are only set on the cast-iron pipe lines and, since 1895, no new hydrants have been attached to any pipe of less than eight inch diameter. They are set closer in the business parts than in the residence parts of the city. In comparison with Eastern cities, ten hydrants per mile is a good number. It must be remembered, however, that the many wooden buildings and the frequent strong winds in your city make it necessary to have as many streams as possible to be quickly turned upon the fires. The hydrants are the property of the city, which determines also their location.

Fire-service:

Fire protection depends not only upon frequently placed hydrants. A sufficient amount of water must also be capable of getting to them. As close an examination as I have been able to make shows that, according to the best practice, it would be advisable to have a greater number of larger mains in some parts of your city, so as to bring quickly a great quantity of water to any particular locality where a fire might be raging This is of special importance in those districts where, per acre of ground surface, large quantities of merchandise of great value are stored.

I understand that the reason for this deficiency lies in the fact that the city has not been willing to pay any interest on the investment required for the best fire service, and that therefore, although planned, some of those pipes have not been laid.

It should be said that the fire protection of a large city does not require a large proportion of the daily water supply. In the larger Eastern cities, which are built mostly of brick or stone, it is relatively so small that the effects upon the daily consumption of the draft of a large fire are barely noticed. Yet the water must be rapidly available at any point; therefore the necessity for pipes of ample size.

It must not be ignored, however, that the high pressure, that is almost everywhere found in your distribution system, produces a high velocity of flow and, therefore, of the discharge of the hydrants, when used for fires. This high pressure, therefore, compensates to some extent for the lack of size of some of the mains. The usual guide to determine the sizes of the pipes is obtained by the decision as to how much water is, or, at a given pressure, how many fire streams are to be available for the largest single conflagration to be expected. A calculation will then determine the diameters of the pipes which must deliver this quantity of water.

That this feature, however, has in the past not been serious is evidenced by a paragraph in your President's Twenty-fifth Annual Report, page 6, where he says:-

"In a city of wooden buildings, subjected to the prevailing winds that fan a spark into a serious fire, the conditions for an extensive conflagration exist in perfection. It is significant that, under these conditions, no serious conflagration has visited San Francisco since the water works were built." and

"Every householder has his garden hose---a private fire department of his own---capable of extinguishing an ordinary fire in any part of his house. As a result, one-half of the accidental fires in the city are extinguished without calling out the fire department."

I understand from a letter of Mr. F. K. Lane, City Attorney to the Board of Supervisors, dated March 15th, 1901, that the

city has no authority to compel you to lay water-mains of an increased size for fire protection. I also understand that you are willing to lay such mains, provided a fair return upon the capital so invested is guaranteed.

Such a return is usually fixed by the hydrant rental. In fact, in small cities, the hydrant rental is often made sufficient to guarantee a moderate interest on the capital invested in the entire works, as the domestic service in such cities is sometimes quite small.

The money paid as hydrant rental in the Eastern States generally includes also the guarantee of abundant supply of water for fire extinguishing purposes, always in readiness for use, the expense of furnishing water for the sprinkling of streets, flushing of sewers, for public buildings, schools, hospitals, parks, in short, for all public and charitable purposes.

To ascertain a fair sum to be paid for municipal purposes, we should know the additional cost for the increased size of the distribution pipes and appurtenances in the streets, the additional tank or reservoir capacity required for fire service, and the cost of supplying the water, adding a proportionate sum for taxes and administration. After determining this total invested capital, then its fair interest, adding an allowance for operating expenses, deterioration, etc., will determine the sum which the city should annually pay for hydrant rental.

The benefit of a good fire protection is felt by reduced insurance rates and, as the entire community is benefited thereby, it is but fair that it should pay for the protection.

Character of Work:

The character of the work shown in the existing water-supply system, as regards material and workmanship, is good. It is above the average of similar construction. Some of the older work, over forty years old, for instance, the Lombard Street and Francisco Street reservoirs, is not in the best condition and, I understand, would have been renovated, if funds had been allowed therefor. Much of the latter work is exceptionally well executed. In fact the concrete at the Crystal Springs dam and other places, and the wrought-iron supply pipes are equal to the best work of their kind, and enjoy a good reputation among engineers in other states.

Your machinery at the pumping stations is both well-designed and built with a view toward economical operation and the lessening of repairs. There is very little old machinery in your plant and but little need for repairs about most of the stations. These are generally plain and economical. There is neither a display of negligence nor of extravagance. The men are everywhere apparently encouraged to keep the works in good order and to give the stations a neat and clean appearance.

It has always been your policy, as I am informed and my inspection proves, to do your work in the best manner, although sometimes it may have been more expensive at the outset, because you believed it to be the most economical course in the end.

By repairing the Lombard and Francisco Streets reservoirs, which can be readily done, by laying additional large mains for fire purposes, by covering the rest of your distributing reservoirs, and by eventually introducing filtration works for the San Mateo County and Lake Merced waters, the essential parts of

your works would be fully equal to the best of modern practice.

The system as a whole is now efficient and delivers good water, at high pressure even without these improvements and additions. But with them, in my opinion, it would furnish water throughout of the best quality and in abundant quantity at all times over the improved portions of the city.

Mr. Grunsky, in his appraisement of your property, February 23rd, 1901, says concerning the character of your work:-

"The quality of workmanship on the works and structures of the Spring Valley Water Works is commendable throughout. The materials used are selected with care. Special care and extra cost has not been shunned in important cases to secure the best. This is doubly the case in the pipe work and in the concrete and in the masonry structures."

From your present sources, including Calaveras, as already stated, you could readily collect sufficient water to safely furnish the city with sixty million gallons daily. It is highly improbable that the next years will be as dry as those which have just passed. But even if this were so, the Calaveras dam alone, if you at once proceed with its construction, would yield sufficient water for the city during that period. The interconnection of your several sources and reservoirs, as already said, especially well fortifies your system and secures to it an entirely reliable service.

Mr. Grunsky, in his testimony before the Secretary of the Interior, in comparing your property with the Sierra Mountain supplies, said: "The Spring Valley Water Works system, to the extent of its capacity, ranks first in the reliability of service."

METHODS OF VALUATION.

Your company is at present supplying the City of San Francisco, for public and domestic purposes, by authority of the State Constitution, which declares that any person, company or corporation may appropriate, distribute, and sell water for public use, and collect therefor a fair and reasonable compensation or rate, which shall be fixed annually by the Board of Supervisors.

The city, as a municipality, gives your company free use of all its streets, for the purposes of pipe-laying, and must give you a reasonable return for your services; while, on the other hand, you are obliged to furnish the city and its inhabitants with water of proper quality and quantity at legal rates, fixed as above, and to conform to all city regulations concerning the streets. There are no terms of agreement, nor is there any contract between city and company.

As the chief obligations seem to be, on one side to furnish water and, on the other, to pay therefor a fair compensation, the remaining point to be determined is the fair value of your property under the existing conditions, so as to fix the proper compensation.

In order to ascertain the fair value of your works, it will be well to glance at some general aspects of the question.

We have the case of a private corporation, which has invested money in lands, water-rights and in works, built upon the ground and below the surface of the streets of the city, for the purpose of supplying water to its inhabitants. Its works

are substantially fixed in the ground; at one end, they are connected with almost every building and, at the other, with the sources of supply. They cannot be moved without losing most of their value, as they are organically connected with each other and with the buildings and streets of the city.

Besides the value of those parts and structures, which have an independent market price, such as land, water, machinery and buildings, the works therefore have a value as a whole or as a unit, organized for a definite purpose, each part of which holding a necessary fixed relation to every other part, and the removal of any one part affecting and, perhaps, destroying the value of most of the others.

This fact will appear even more evident when it is considered that, in order to complete the necessary combination of parts in a given time, it may have been and generally is necessary to pay prices for some parts of the work at much above the average market rate. For instance, the knowledge of a land owner that his property is quite essential to complete the works, may cause him to sell only at the highest price. In order to erect a pumping station or to lay certain pipes within an unexpectedly short time, so as to fulfill a contract, and in the presence of strikes or accidents, it is often necessary to pay high prices to overcome the difficulty.

Because of the necessity of certain fixed combinations in order to constitute the organic whole, a special value attaches to the completed work, in addition to that of its parts, ascertained from the average market prices.

Besides this tangible, there is also an intangible value, which is no less real, and is due to the study, skill and labor

which co-ordinated the parts into the whole and produced and maintained a live and going concern.

It is therefore customary to ascertain the value of the physical parts and then the value which should be given to the plant as a whole, provided that it is in actual operation, with an established business and a long list of water-takers.

In discussing the matter further, it will be convenient to subdivide it into three divisions, the physical plant, the land and water rights and the business value.

PHYSICAL VALUE.

Under this heading will be discussed the value of the materials and labor necessary to build the works from the points of collecting, conveying and distributing, to the point of delivery of the water on the streets and to the buildings.

The first question, however, relates to the principle upon which this value should be based.

The actual cost of constructing the works years ago is not necessarily a true measure of their present value. Centain moneys may have been spent injudiciously, having no value whatever, or, materials and labor may have been high in price at the time of construction but worth much less to-day. Accordingly, a purchaser should not pay for lack of judgment of the seller, nor for the fact of a high market price prevailing during construction. On the other hand, the works may have been designed and built with great skill and care, or, at a time when prices were lower than they are to-day. Then the seller should not be expected to lose the cost of having done specially good work and to give up the advantage of a high market price on the date of sale. The true value of labor and material at a given time cannot be other than the actual cost of replacing them.

These are simple business rules and should control in the sale and purchase of large plants. A company is supposed to know what it may eventually be obliged to accept for its property, how to provide against the loss due to a possibly declining market and to have arranged its business conduct so as "to come out whole" and with profit.

There is hardly any uncertainty in the determination of the present cost, because all necessary elements can be readily ascertained. But there may be uncertainty regarding actual conditions of the past, when the works were built. The only important doubtful point in a present valuation is the final life of the pipe, on account of its deterioration, which depends much upon a number of accidental conditions. But this doubt would prevail equally with every other principle of valuation. For the purpose of neutralizing its effect, a fund should be provided and so adjusted as to pay for the replacement of all perishable parts in due time.

For the above reasons, I am of the opinion that a valuation should be based not upon the original but upon the present cost of reproducing the works, allowing for depreciation during the time when the works were in operation.

In other words, the physical value of your plant must be ascertained primarily by the sum of money which would rebuild it in its entirety. It is to be assumed that in doing this fair prices are used, such as would pay for the same character of work when done to-day. And, secondly, it is necessary that the efficiency and life of all parts of the supposed plant are the same as those of the actual plant of to-day, which requires the making of certain deductions from the cost of a new plant for what is called "deterioration". For instance, assuming that the life of iron pipe in the ground is estimated at one hundred years, then if the pipe is twenty-five years old, one-fourth of its life has gone, although not one-fourth of its value, and it may yet be in a good condition.

It is therefore customary to fix the probable life for all parts of the plant, when new, and to compute the value of the

depreciation by the annuity which will have accumulated the cost of the particular structure at the end of its life.

The following table gives the life in years and the annuities for the principal parts of the works:-

Depreciation Table.

Structures, apparatus, etc.:	Life in years:	Annuity on One Dollar:
Masonry dam, reservoirs, tunnels and aqueducts,	Permanent,	________
Cast-iron pipe,	100	.00165
Wrought-iron pipe,	50	
Pumping engines and buildings,	40	
Boilers,	25	
Flumes, A1 redwood,	25	
Water-meters,	15	
Valves, etc.,	50	

Depreciation is, strictly, the deterioration from the disintegration or waste from age or use. This term is sometimes used to mean also inadequateness or inefficiency of parts of the work. I do not think that in this case such a meaning should be given to it. It is less confusing to separate the two conditions. When a work has become inefficient or inadequate, it has lost its value to the precise extent of this failure, which, in the extreme case, is entire loss.

I am informed that, heretofore, no allowance has been made for the depreciation of your works. But, as an offset, payments were allowed by the city, in the operating expenses, for the replacement of some worn-out structures. This custom is fair, only so long as no sale is made and no true valuation is fixed. In that case, the city pays directly by installments for what it would otherwise pay by means of a capitalized amount for keeping the works permanently in perfect condition.

In my opinion, it is on the whole preferable to establish a fund for the renewal of worn-out structures, such as is customary in most business undertakings, and have the annual payments or annuities made as a fixed charge upon the works, the same as interest on bonds, etc.

It has been said by Mr. Lane, at Washington, that the city had no power to allow any value for any of its property which is not actually used in the furnishing of water. But it is usual and, from what I have said above, in my opinion, eminently fair and just, to allow the value of any property necessarily bought, built or held for contingent or future use.

Therefore, I consider of full value the present Crystal Springs dam, although it is built heavy enough for a much higher dam yet to be built; the work on Calaveras and San Antonio dam sites, and others; the Portola reservoir and dam, and still other minor structures.

In case an income is received from any property thus held or improved in advance, then, if, in a valuation, the cost is allowed, credit should of course be given for the income therefrom.

Works which have been destroyed or become useless by age, or by being supplanted by other works, have lost their value as structures, except for the sale of any of their materials or single parts. They are supposed to have earned their cost.

On the other hand, there are cases, such as the old stone dam above Niles and the flume leading therefrom, and the upper dam at Pilarcitos, which are no longer of full service, but still serve a purpose,- the former as a safeguard, the latter as settling basins. They have partly earned their cost of construction and should be valued at such a fraction as would justify their use for present purposes. Perhaps three-fourths of their present cost of construction might be a fair value for them.

A part of the Lock's Creek line is now out of service. Such parts of it that need reconstruction have no value, except for materials. The other parts have a value in proportion to their expected term of usefulness.

The old thirty inch pipe, which took water from San Andres Lake, and has now been replaced by a forty-four inch pipe, has been abandoned and, therefore, lost part of its value.

Regarding the distributing system and, especially, the cost of iron, the estimate of cost should be based on a fair average price of iron recently prevailing. It would not be proper to assume either extremes of fluctuation. As the pipes of your system, I understand, are all of the best quality of iron, and I know this to be true of what I have seen, the price should correspond with the good quality of the material. Farther, the workmanship that I have seen is good, and better than the average in some of our large cities. Therefore, I believe

your pipes are specially durable and should have accordingly a value, if anything, greater than the average of their kind.

Regarding the value of small pipe, it must be said that wherever they are no longer of use, by failing to give adequate pressure or quantity of water, even when reinforced at all available points, then they should be replaced by others and retain only a scrap value. They may have been made small originally for financial reasons, and it must then be assumed that a full compensation has thereby already been secured. But where they continue to be useful, or can be made so by proper reinforcement, they certainly retain a value by doing the duty, at least partially, of a larger pipe that would have to be laid in its place.

While your pipes apparently are sufficiently large for the domestic service, it is said that "they are not all that could be desired when extraordinary demands for water are made upon the system in case of a large conflagration." In this valuation, no account need be taken of this fact, because no allowance should be made for any larger pipes than those actually in the ground, and because I understand that you were ready to place such pipes had the city been willing to pay the annual expense incurred thereby.

When a pipe is laid on an unpaved street, it will cost less than when the street is paved. The value of a pipe line, in the latter case, is therefore enhanced by the pavement above it. In estimating the present fair value of the distribution system, the cost of repaving is an increment of cost justly to be added.

All of the service pipes are now connected with your distribution system. If another pipe system should be laid, new services would have to be laid so as to receive water from it.

The cost of as much of the service pipes as would thus have to be relaid and reconnected is therefore a proper credit to your works, because, as the owners have already paid for their present service, they could not fairly be compelled to pay for a second connection.

The present fair value of the physical plant can be computed on the basis of what has been said above, which corresponds with what to-day is the best practice. The calculations, in accordance herewith, have been made and the results are herewith appended.

VALUE OF LAND AND WATER-RIGHTS.

The same fundamental principle which was applied to ascertain the value of the physical plant should apply to the purchase of land and water-rights, and for the same reasons.

A present purchaser should not pay for possible past injudicious investments and errors of judgment, nor for the accident of a temporary high market price at the time of purchase. On the other hand, he should not demand a profit from a bargain purchase, nor from the results of special skill and training on the part of others in acquiring the properties.

It is difficult, however, to ascertain the actual present cost of this class of property, because it can no longer be replaced by other land or water-rights at the same location. It is necessary, therefore, to estimate the value from the general market prices of to-day for similar property in similar localities. Such an estimate should, of course, be fair, without taking undue advantage of the exclusiveness of any possession.

In preparing for the future, it is necessary to look ahead of the demand, sometimes many years, in the acquisition of lands and water-rights. To purchase such property far in advance of actual use is generally an economical proceeding, and any subsequent rise in the value of such property is a just credit to the owner, just as a fall in value would be his loss. It cannot be denied that procuring a necessary part of the work in advance of its incorporation is a necessary procedure, requiring the exercise of skill and expenditure of money, and its appropriation for this purpose, therefore, at once increases its value.

The city has a benefit therefrom by thus being guarded against unforeseen mishaps. An ample water supply is one of the most necessary conditions of life, especially in a large city, and no chances whatever should be taken to secure its certainty under all possible conditions. When a valuation is made, and before the incorporation, as an integral part, of the property thus purchased in advance, it should therefore be given a value at least equal to its reasonable cost.

It should further be remembered that as the natural depreciation of structures and other property, due to wear and tear, is a proper cause for a reduction from their value when new, so should the appreciation of property since its acquirement be a proper cause for an addition to the original cost.

Land purchases are made in the case of water-supply works for any of four purposes, namely, reservoirs, rights of way, buildings or yards and protective territory.

The values of these four classes are usually different. Reservoir sites are rare and, therefore, usually demand a higher price than do rights of way, which again are more expensive than the land of the watershed, which is required to secure a good quality of water merely by protecting it from pollution. The property for buildings or yards may have any value, depending on location and accessibility.

Present market prices of land known to be intended for these several purposes, in this part of the State, should, in my opinion, govern and fix their just value in this case.

The necessity of owning as much land for the protection of your water supplies, as you actually possess, may be questioned by some. It is certainly necessary to have at least a

police protection over the watershed to prevent objectionable pollution and to have an absolute exclusion of man and animals from the shores of the lakes and streams.

It is certain that the greater the area of the watershed which can be protected from occupations resulting in dangers to health, the better it is for the water supply. No better security exists than your possession of the land, and your unusually extensive possessions give the water an exceptional security and value.

In the present valuation, I therefore consider that all your protecting lands should be included, as they are of direct benefit to the quality of the water. As such lands always have a selling price, they could be readily sold if, at any later time, such a disposition of them appears a safe proceeding. When an income is received from the rent of land or water properties, it is proper, of course, to credit all such property with this income.

An estimate of the value of your real estate properties is being made, in accordance with what has been said, and the results are appended.

As to the value of your water-rights, you have, as I understand, a title to the perpetual diversion of all of the waters. The purchase price of water-rights does not necessarily represent their value any more than that the last year's cost of a city lot is its selling price of to-day. And the adaptability for an economical collection, storage or conveyance of water, increases the value of such property for the special use for water works far above that for farming purposes.

Further, just as the land suitable for a reservoir has a value higher than for farming purposes, because it can earn a greater profit, so has a large reservoir site a higher value per acre than a small one, when thereby it can be made more useful. The San Andres and Crystal Springs sites, by their favorable configuration, are capable of storing more water than their watersheds contribute. They are therefore available for the storage of a large quantity of foreign water, i.e., from other watersheds, which makes them eventually available to act as great distributing reservoirs, located as near the future metropolis as the topography allows. This fact gives them a special value.

The value of water courses, which are or can be made useful for public water supplies, is governed by the existence, first, of a sufficient quantity of water, secondly, of adaptability or competition for its use for various purposes, and, third, of a community that can use it.

If there is no community to use it, no value attaches to the water on that account. But, in this case, there exist, in the neighborhood, large growing communities and large agricultural interests, all of which require water. Further, it is a well-known fact that the quantity of usable water is limited in this part of the state, as the rainfall, which is its source, ceases entirely during the six months of summer.

It is therefore clear that water, being limited in quantity and indispensable for this and other adjoining cities, has, when it is diverted, an intrinsic value as property above the cost of such diversion.

One measure of this value may be obtained from the cost of the least expensive supply among other than your own sources, yielding an equally good and abundant present and future supply of water. Such measure indicates a maximum price, beyond which its value cannot generally go.

Another measure of value of the water-rights is the reasonable actual cost of procuring and of holding them until required for the supply of the city. This indicates the least price which should be paid for them.

Between these two limits, the true value of the water rights should be sought, determined by a consideration of the business value of your property and by questions of expediency, of which you, yourselves, are the best judges.

Concerning the question of compensation for water-rights and lands held for reservoir purposes, Mr. Grunsky says, in the case of there being but a single economical source, that such person, "who by business foresight, judicious investment or perhaps by accident has acquired possession or brought under his control the water which has become a public necessity and which has been made or is to be made a public use" should be compensated liberally. When several sources are available, he grants that the estimated cost of constructing other works "will ordinarily stand as an upper limit". There may, of course, he says, "be cases in which an allowance of value, from the fact that the water works are already established, will carry the value of the established system beyond this limit. This comparison is always of value and, in most cases, affords the best basis for conclusions as to value of water rights and, sometimes as well, of the franchises of water companies."

In order to ascertain the above-mentioned maximum price, a discussion follows of the character and cost of the Tuolumne supply, which, according to the city's investigations, is believed to be the best source in competition with your own.

BUSINESS VALUE.

In fixing the value of a business which is fully organized and has been in active operation for a number of years, it is necessary at the outset to state several facts. As a business transaction predicates an exchange advantageous to both parties, it is necessary that a sale of the property in this case should be profitable both to the city and to the company. A satisfactory result can therefore be reached only by a careful consideration of both interests, based on the actual existing conditions. Further, as it is impossible to treat all of these conditions of a water works' valuation in, what we may call, a mathematical manner, which may be done with the purely physical conditions, we are obliged, under the present heading, to depend almost wholly upon reasonable approximations, based on sound business principles.

In the ordinary sense of the term, your franchise grants you only the right to enter upon the city's streets, to lay pipes and their appurtenances, to furnish the citizens with water and to collect a compensation or rates therefor. Your contract with the city and its inhabitants, if it may so be called, extends only over the space of a single year, and your income is annually fixed by the Board of Supervisors, which establishes the rates, which rates must yield a fair return for the service rendered.

The value of a franchise is sometimes determined from its earning capacity. This may be a proper method in some cases, but such a basis is clearly here excluded, for the simple reason, if for no other, that the city annually fixes the income, and that therefore one party to the transaction may fix the

profit or loss of the other and establish any value which it desires and believes to be reasonable from its own point of view.

There is, I understand, a tax levied upon you, ostensibly on the value of your franchise. Such a tax might be held to determine its value. As no other measure appears in your case, and, as what is indicated to be a franchise by your taxes may be taken for what I think should be more properly called the business value, I shall not consider it further.

As a fair competition is the best adjuster and regulator of business values, so also here, the highest value of your business, as said before, would be approximately measured by the capital which would have to be invested in the most available of the remaining projects for supplying San Francisco with an equally abundant source, present and future, of equally good water, built with the same good design, materials and labor and be just as reliable in its service.

And again, its lowest value would not be less than the actual present cost of procuring and holding land and water-rights and of building the entire works to-day, deducting what value is given to deterioration.

The true value of your business property, in my opinion, lies between these limits. In order to narrow them as much as possible, account must be taken of still other considerations of value and a pecuniary weight given them, which should be added to the lower of the above limits. These considerations are the following:

When a company starts in business, it does so with more or less risk. It is not always certain whether success will crown the undertaking. This is particularly so when the success depends largely upon the acts of persons only temporarily responsible for them. In order to sell bonds or stock, it is necessary to give assurance that a fair interest will follow, regularly and commensurate with the risks which generally increase the expenses and difficulties connected with the proper development of the works. Many water works companies have met with failure. All business enterprises usually reckon the percentage of their profit according to the degree of risk. The expected income of your company should, therefore, be sufficient to pay a somewhat higher than the ordinary interest on the invested capital, for the assumption of all risks incidental to its business. The assumption of all risks entitles it also th the benefits naturally arising from the same business.

There is an element of value in the fact that your works are well built and that you own the most available water sources near the city, for the reason that it signifies permanence and reliability of the supply and of the character and efficiency of the works.

There is another element of value in the fact that the property, by the topographical character of its sources, can be extended gradually instead of requiring dams and aqueducts of dimensions not required for a generation or more and, consequently loaded with a large investment, which must be unprofitable for some time, examples of which we have in many cities. This advantage is not to be construed as militating against your early investment in lands and water-rights ultimately required. The expense for the latter is very small when compared with the

price of later purchases, and usually becomes a source of special profit.

The design and operation of your works are so arranged that no accident to any one portion will seriously inconvenience the city or deprive it of water. This reliability in the delivery of water as compared with single sources and long conduits, also gives your property a special value.

When a water-supply business has become established, when water is being continuously furnished to the consumers, when the city's needs have been fully met in the past and, with existing arrangements, will be met equally well in the future, it is customary to attach to this fact a value which is commonly called "going concern", "good-will" and the like. In other words, the work organized as a whole or unit gives it a special value, as already said, both on account of the difficulties usually met in completing the necessary combination of parts and of the study, skill and labor to co-ordinate them and produce a live and going concern.

There is hardly ever a difference of opinion regarding the justice of attaching such a special value to the established business of supplying water, if this water at all times is good in quality and sufficient in quantity. The only controversies refer to the methods of computing the exact sum which is to represent it.

In some cases, the "going" value has been estimated by the earning capacity, which, in this case, cannot fairly be done. In other cases, it has been assumed equal to the expense necessary to get the business into profitable operation. This includes the preparatory expenses, the interest during construction, the securing of patronage, and, after the works earn a revenue, the interest on a gradually decreasing capital until the revenue equals the expenses. The methods suggested in the valuation of the properties of the Dubuque Water Company and the Kansas City Water Company are examples of such estimates, which might be worked out in your case.

In the case of a company furnishing water, the entire cost of establishing and maintaining the business should be covered by the income. This should be sufficient to pay for the losses from litigations, risks of uncertainty as to the city's growth and a possible depreciation in the price of labor and material after the works are constructed. In short, all risks should be allowed for in the rates, because they are the only source of income. Usually, when there is a long term contract, and the rates are fixed by it, a fair interest on these contingent expenses should be and generally is included. When the city fixes them annually, this interest allowance should likewise be included or, in a valuation of the works, the capital equivalent should be substituted.

In addition to all the above factors, which have a bearing on the valuation of your water works, still another question should be considered, which contains a certain element of fairness. There is a difference between the relationship of a water-supplying company to a city and the relationship of two parties which are wholly independent of each other. If a city wishes to own its water supply property, it has usually the choice of buying the existing works or of building new ones, but a private company has no alternative. Its works are built, the pipes are laid in the streets and connected with the buildings, and the business of furnishing water is going on. If the service is good, a duplicate service built by the city would clearly be a great injustice, as the company cannot remove its plant and sell water to another city. It is therefore but just and customary to purchase the existing plant at its fair value.

The above enumerated facts, which, in my opinion, attach to your works certain degrees of value, should be carefully considered and money values given to them. These will reduce the difference between the cost of the Tuolumne project and that of the reproduction of your own works.

Between the limits then remaining, you will find the fair value of your works to be narrowed still further only by your own best judgment concerning questions of expediency.

THE TUOLUMNE PROJECT.

The Tuolumne project is the subject of a special report, dated July 28th, 1902, made by Mr. Grunsky, and based on surveys and computations made by him. The following is a general description of the proposed work.

It is proposed to store the waters of the Tuolumne River by a dam across the narrow gorge at the foot of the Hetch Hetchy Valley and also by a dam increasing the present storage of Lake Eleanor. It is proposed at first to develop only the Hetch Hetchy Valley storage.

Mr. Grunsky proposes a dam, which will raise the surface of the river about 150 feet above the present bottom of the valley, creating a reservoir of about 1,180 acres, and extending up stream about five and one-half miles. The watershed area, above the dam, is about 452 square miles. It is described as being uninhabited, except during the summer months.

The water from this reservoir then flows down the river about fifteen miles, a short distance below the confluence with Cherry Creek, which brings down the water from Lake Eleanor.

It is then proposed to turn the water into a conduit, with alternating open channels and tunnels, including also inverted siphons where it crosses side valleys.

About forty-four miles below the Tuolumne dam, the conduit reaches the Bear Gulch Power Station, where it developes a head of 766 feet. This power is to be transmitted by wire to Altamount Pumping Station, at the western side of the San Joaquin

Valley, where the water is lifted to the Livermore Pass at Altamount. The conduit extends about sixteen miles further to the Dry Creek Power Station, where a head of 330 feet is utilized for the same purpose. Leaving this station, the conduit crosses the San Joaquin Valley to the Altamount Pumping Station, a distance of about sixty miles, where the water is pumped about 560 feet high to Livermore Pass; then it descends into the Livermore Valley, thence passes through a tunnel five thousand feet long into, and crosses, the Sunol Valley and, once more, through a tunnel two thousand feet long, enters the Santa Clara Valley, which it crosses above the head of San Francisco Bay, near Alviso. The distance from Altamount to Alviso is about forty miles. The conduit then follows approximately the line of the Southern Pacific Railroad, about forty miles, to the proposed reservoir at the House of Refuge lot in San Francisco. The total distance from Hetch Hetchy Valley to San Francisco is 199 miles.

Below the Dry Creek Power Station, the conduit consists of 48-inch riveted iron pipe.

Along the route, it is proposed to have several storage reservoirs, where moderate quantities of water can be stored. These are at Bear Gulch, at Dry Creek, at Altamount and also at Belmont. The latter is not intended to be made use of, if the reservoirs of your company are obtained.

The Stanislaus river is crossed on a steel bridge, and a long trestle structure, about 35,000 feet long, is used when crossing the lower part of the San Joaquin Valley. Another trestle, about 27,000 feet long, is used after the pipe has descended into the Santa Clara Valley.

The construction of this conduit would leave Alameda Creek system out of the supply, also the Portola, the Pescadero and other ocean slope creeks. It is proposed, however, to utilize your three San Mateo County reservoirs and also to use Lake Merced as an emergency supply, as well as the several pumping stations at the reservoirs, and on the pipe lines from the reservoirs and within the city. It is proposed, therefore, to utilize the peninsular waters and, if necessary, also fill the reservoirs with Sierra Nevada water.

The average annual rainfall on the watershed of the Tuolumne River is estimated at being over 36 inches per annum, and the average run-off at perhaps fifteen inches, with a minimum of about five inches. If we assume that four inches could be collected annually, this would give an average daily supply of about eighty-five million gallons, without Lake Eleanor.

The serious question in this case pertains to the amount of water which has already been previously appropriated. It is granted that the appropriations have already exceeded the ordinary low flow of the streams and Mr. Grunsky states that "The only available water for the city therefore is the restraint of the flood water".

It has been stated that the law applying to flood or storm water is not applicable in this case, because, above the Hetch Hetchy Valley, the rain falls are practically snow falls, and the snow is stored on the ground and gradually melts as the summer heat rises, and thus causes, as a natural condition, an increased stream flow, extended in time during the spring and early summer. Mr. Grunsky says: "Nearly all the precipitation on the watershed of the tributaries to the Hetch Hetchy Valley

is in the form of snow". After the snow is melted, there is almost no flow of water in the upper valley. If the Courts construe that the snow, melting during spring and summer, is not storm water, then the Hetch Hetchy Valley reservoir could be filled not by storm waters but, substantially, only by the ordinary flow of the stream.

The proposition to carry the water from long distances, through an earth canal, has the disadvantage that leakage will cause the loss of some of the water and, for this reason, it would be better to build a water-tight canal or, better, a covered aqueduct, and, in my opinion, this would eventually be done. It is therefore proper to consider this contingency at once.

Regarding the quality of the water, it is, as stated, mostly melted snow and ice. The water should therefore be very soft, clear and palatable, particularly as the prevailing character of the rock is granite. I do not, however, share the opinion that, after this water has been standing for months in the reservoir and then has run for long distances in an open ditch, the quality of it is much, if any, superior to the water which you can gather from your watersheds into your reservoirs.

Ground and filtered water are better protected against pollution than mountain streams. Summer visitors of the valley would have access to the water, and we still remember the Plymouth, Pa., case when a single case of typhoid fever caused the pollution of a mountain stream and produced 1,100 cases of sickness and over one hundred deaths in the city supplied therefrom, a contingency against which the ground water and filtered water are effective guards. We have now striking evidence from a number of cities where, after the filtration of

their water was introduced, typhoid fever at once dropped to a comparatively few sporadic cases.

The valley of the Hetch Hetchy, like similar valleys in the Sierras, is very warm in the summer and the bottom of the valley has accumulated much organic matter. Unless the latter is removed, the standing water of the reservoir will not only be raised to a higher temperature in the summer months, but the organic matter at the bottom would for some years be taken up by the water. If the water is conveyed for long distances in open ditches, it would be further injured, partly by surface washings and by animals, as there is said to be much sheep grazing in that country.

Mr. Grunsky says:

> "During the winter and spring months, except occasionally for a few days when the water at the intake dam in Tuolumne River is too turbid, water should be taken from the river direct without any supplemental supply from the storage reservoir in Hetch Hetchy Valley."

The storage of the water in the open reservoirs along the conduit, exposing it to sunlight, air and dust, will still further injure its original qualities. The sunlight will produce algae growths, some of which are known to give the water a taste. No filtration of the Tuolumne water has been proposed.

From what has been said, I cannot hold the opinion that the Tuolumne water, when brought to the city as proposed, will be as good as ground or filtered water from your territory. It could only be kept in its originally pure condition by being carried in closed aqueducts and pipes from the intake in the high Sierras to the distribution reservoir in the city.

Mr. Grunsky admits that storage of water in "a locality far removed from San Francisco will have less value than storage in the reservoirs of San Mateo County." It can also be said that a long conduit of 199 miles, the distance from San Francisco County line to the Tuolumne dam, with its three power stations, numerous siphons and long trestle lines, will be exposed to greater dangers of interruption than the shorter lines which you now have.

Mr. Grunsky has made a few so appropriate statements in his report, that I cannot do better than quote them. They are:

"It follows, therefore, that remoteness of a supply is a disadvantage, and that between any two practically equally distant sources the one is to be preferred which can be made available by the most reliable and the most permanent works."

"In this connection, there is also to be considered the fact that in one case works may be of a character whose reliability has been established by experience and practice and concerning the construction of which and the character of service, quality and quantity of water, no reasonable doubts can be entertained. Such works are to be preferred to works not yet constructed and particularly to works which involve departure from ordinary practice and whose execution and maintenance is at more than ordinary risk.

"Many other things may be brought into the comparison, as, for instance, the facility for the gradual increase of the capacity of conduits or other appliances required for the delivery of the water in order that the delivery may keep pace with the growth and growing needs of the municipality. A system that must at once be constructed of a capacity to meet the probable requirements fifty or more years in the future may prove relatively expensive, and this may be rated as a disadvantage when compared with one which permits an installation which, though adapted to immediate requirements, is still capable of expansion as occasion arises."

From what has been said above, it is my opinion that, as regards quality, I can see no advantage to the city in getting water from the Sierra mountains. The sentiment which attaches to such sources originated at the time when little was known about water purification. It was always conceded, however, that ground or spring water was equal to the water of mountain streams. Further, since we know that certain diseases are

water-borne and can be communicated by water which is exposed even to incidental pollution, we believe that the naturally protected ground waters are superior to mountain streams.

An extensive investigation in Philadelphia between supplying that city with water from the Blue Mountains, which was considered of unexceptionable quality, and the filtration of the river water near by, resulted in the recommendation of the latter.

Inasmuch as you now own property which will yield a water supply for this city of about one hundred million gallons daily, and control property that will yield much more, while the proposed Tuolumne source has a doubtful quantity available, on account of the snow water and the present appropriations, I do not see any marked advantage of the latter in this respect.

As stated before, the estimated cost of the Tuolumne project will throw light on the value of your own property. To ascertain this cost fairly, it is necessary to assume equal supplies, which, in this case, have been taken at daily supplies of thirty and sixty million gallons. For the purpose of assurance, it is necessary to estimate in the Tuolumne project for a reserve or safety pipe, as well as for other structures, to the same extent that you have provided such safeguards in your own works. It is therefore proper that two pipe lines should be built for a thirty, and three for a sixty million gallon supply, and their cost should be estimated in a comparison with your present works.

It is further necessary to assume the same standard of materials and workmanship, so as to secure equal efficiency and durability. In all other parts of the work equal conditions should maintain, wherever possible. A leaning has been given

to under, rather than over-estimation. For instance, the open ditches have been preserved, where I consider closed channels to be decidedly preferable. The prices for the pipes and for the masonry dam have been, however, materially raised over Mr. Grunsky's figures, in accordance with experience as to actual cost gained in your own work.

The result of such an estimate of cost, based upon local experiences, is as follows:-

To supply thirty million gallons daily from Hetch Hetchy Valley to the city, on Mr. Grunsky's alignment, but with one pipe in reserve, ---------------------------------- $ 52,000,000.

CONCLUSIONS.

It remains now to briefly sum up the conclusions reached from my examinations and studies regarding the present value of the Spring Valley Water Works.

The quantity of water which, with good management, you partly have developed and partly can develop on your present properties is between ninety and one hundred million gallons daily, during a cycle of the driest years. You have, besides these properties, still other large sources available, which can very materially increase this amount.

The quality of the water, where drawn from the gravel beds of the valleys, is equal to the best for municipal purposes, and where obtained by reservoir storage, from comparatively uninhabited and guarded territory, which is largely your own property, the water is good and could be made practically equal in clearness to your ground water by artificial filtration.

The works which you have built to supply the city, keeping pace with its growth and necessities, are well-designed and efficient for their purpose, under the local conditions, as these present themselves from time to time.

The great differences of elevation in various parts of the city, the broken topography and the numerous sources which have been acquired and developed, either from storage, live streams or ground-water, must necessarily produce a somewhat complex system of collection and distribution. There has resulted from this combination, however, an important advantage, partly by

mingling the waters, so as to get more uniform quality than otherwise possible, and partly by being able to interconnect the sources and secure thereby a guarantee against accidental shortage in any of them, or in any of the four zones of distribution into which the city is vertically divided. The works are designed also with reference to economical distribution, and a sufficient number of distribution reservoirs and tanks, scattered over the city, equalize the pressures and provide for sudden drafts for fire purposes.

A greater number of large mains, which you have been and are now constructing, will benefit the fire service by allowing of a quicker concentration of large quantities of water suddenly required.

The works are also well-built, with good and, in most cases, excellent materials, and the workmanship is also good. It is therefore possible, in my opinion, to prolong the usual estimates of life of different structures quite materially in your case.

The works are reliable, not only on account of good and safe construction, but also because it is possible quickly to supplement one source from another in case of necessity.

On the whole, I have found that the works have the foundation of becoming one of the best in this country, eventually, requiring only the filtration of your Peninsular water supply and the covering of the distributing reservoirs to make them equal to the best as regards the healthfulness, taste and appearance of the water.

From what I have been able to see, there is but little deterioration of the materials and in the pumping machinery.

As to the method by which I believe the value of this property should be ascertained, it is based on experience and on a number of previous similar valuations made in this country.

In this case, we should divide the valuation into three parts and obtain the valuation of each separately, together making the full valuation. The first is the entire physical property, the second the land and water-rights, the third the active business that has been developed.

The value of the physical property is obtained by estimating the cost of reproducing the works at present prices and deducting the value of whatever depreciation may exist in any part. This method is the most rational and also the most common one employed. The value of land and water-rights should be that of similar property in this neighborhood at this time. Finally, the business value of your works should be obtained from the principle that a business is worth what it costs to re-establish it on the same basis, and this value must depend almost wholly on judgment. It cannot exceed the cost of establishing a new and equally good water-supply from another source, which, in this case, is the Tuolumne supply, nor should it be less than the cost of purchasing land and water-rights and reconstructing your own works at this day. Between these two valuations the true cost would be found. To aid you in finding it, a number of considerations have been given, upon each of which you can place what, in your opinion, is the proper weight.

It should be said here that much of the work of compiling the estimates of cost was necessarily done under pressure of time. While the results, in my opinion, are substantially correct, a careful revision of the calculations, however, may require some modifications to be made with unimportant results.

The present value of your physical plant, after allowing for deterioration, was found to be ----------- $ 19,634,000.

The value of the land, water-rights and rights of way and that of the active business may be grouped under a single heading for the present purpose. As I am not competent to give you an opinion on either the cash value of real estate or of the water-rights in this state, I shall take such figures as are shown by the evidence before me.

It was stated above that the true value of your property, other than the above-mentioned physical plant, lay between two limits, one being measured by the least expensive supply among other than your own sources, yielding water substantially of the same quality and quantity, present and future, the other being measured by the market value to-day of similar land, water-rights and rights of way and of getting the business of supplying water to the city into profitable operation.

The present value of the land, water rights and rights of way may be estimated as being -- -------------- $ 16,366,000

The least business value, based on the above mentioned considerations, may be estimated as being ---------$ 1,800,000.

Therefore, including the physical plant, the least value of your entire property would be ------------- $ 37,800,000.

The greatest value which your property can have at this time is the cost of the proposed Tuolumne supply, which, as estimated above, would be at least ----------- $ 52,000,000.

In my opinion, the fair value lies between these figures, and can be more definitely determined only by yourselves, on the before mentioned grounds.

Respectfully presented,

RUDOLPH HERING.

ESTIMATE OF LEAST VALUE.

Black Point & 17th St (Clarendon Heights)

A.	City distributing system, including pipe system, two pumping plants, reservoirs and real estate, improvements and stock on hand in San Francisco, ----------------	$ 8,936,038.00
B.	Works collecting water and conveying it to the San Francisco distributing reservoirs, inclusive of ~~seven~~ five pumping plants, --------------------------------	11,391,792.00
C.	Reservoir and watershed properties, located in Alameda, Santa Clara, San Mateo and San Francisco Counties (Lake Merced properties) from which water is being supplied to San Francisco, ------------	13,358,600.00
D.	Rights of way, ------------------------------	527,400.00
E.	Water rights (lower limit) $ 80,000.00 per million gallons a day for thirty-one million gallons daily, being the average daily supply drawn from Alameda Creek, Pilarcitos, San Andres and Crystal Springs Reservoirs combined, ------	2,480,000.00
	Total, ----------------	$ 36,693,830.00
	Deduct for deterioration, -------------	693,830.00
		$ 36,000,000.00
	Add, for business value, five per cent,	1,800,000.00
	Total least valuation, -----------	$ 37,800,000.00

ESTIMATE OF GREATEST VALUE.

(Cost of Tuolumne Scheme).

A. Head works at Hetch Hetchy Valley, on Tuolumne River;

B. Conduit line, conveying the water to Ocean View Reservoir, near San Francisco County line:

(This conduit line, consisting of open canals, tunnels and double 48" iron siphon pipes, from the diverting dam, on Tuolumne River, near Jawbone Creek, to Dry Creek Power Station; electric power stations at Bear Gulch and Dry Creek; pumping plants at Altamount and Belmont; double line of 48" iron pipe, from Dry Creek Power Station, via Altamount, Livermore and Sunol Valleys, Mission San Jose, Alviso, Belmont and Colma, to San Francisco; various reservoirs proposed along the line of the conduit between Dry Creek and San Francisco.)

C. City distributing pipe, reservoir and pumping system.

Estimate of cost, including interest during construction, -------------------------- $ 52,000,000.00

Note: In the above estimate, the cost of the 135 1/2 miles of double 48 inch pipe line, from Dry Creek Power Station to San Francisco, has been carefully estimated according to present actual cost; also the construction of the main dam in Hetch Hetchy Valley.

Regarding the cost of the remainder of the works, as proposed by the City Engineer, his estimates of cost have been assumed and used without verification.

(2)

IN THE CIRCUIT COURT OF THE UNITED STATES, NINTH JUDICIAL CIRCUIT, NORTHERN DISTRICT OF CALIFORNIA.

IN EQUITY.

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SPRING VALLEY WATER WORKS, Complainant, -vs- THE CITY AND COUNTY OF SAN FRANCISCO, et al., Defendants.	No. 13,395.

NORTHERN DISTRICT OF CALIFORNIA,)
) ss.
CITY AND COUNTY OF SAN FRANCISCO.)

H. SCHUSSLER being duly sworn deposes and says: that he is a resident of the State of California and of the City and County of San Francisco in said State; that he has been an employee of the complainant, the Spring Valley Water Works, in its engineering department continuously for more than thirty-eight (38) years immediately preceding, and has been its chief engineer continuously for more than thirty-six (36) years last past; that during all of said last mentioned period of thirty-six years affiant as such chief engineer, has had charge and direction of all of the engineering and construction work of complainant, including the selection of sites for reservoirs, filter beds and water sheds, and the erection and construction of reservoirs, dams, pumping stations, conduits, pipe lines, and distributing utilities of complainant;

Affiant is thoroughly acquainted with the character and kind of materials used in the construction of each and all of

said works, and with the cost and value thereof, and of the real estate, and water rights of complainant, and knows the location and present condition of all of complainant's reservoirs, water sheds, filter beds, head works, conduits and distributing utilities, and the use that is being made thereof by complainant in distributing water to the City and County of San Francisco and its inhabitants;

That the value of complainant's property, excluding its water rights and its franchise, and including among other things its reservoir sites, water sheds, filter beds, head works, conduits, and distributing systems which are at the present time used in distributing water to the City and County of San Francisco and its inhabitants, in affiant's opinion, based upon his knowledge and experience aforesaid, is at least the amount set forth in the following tabulated statement, that is to say:

A. Lands in San Mateo County now in use:

Pilarcitos, San Andres and Crystal Springs Reservoir sites and watersheds- 18,740 Acres of which area 2,310 Acres constitute Reservoir Sites, viz:

Pilarcitos	105	Acres.
San Andres	475	"
Crystal Springs	1,730	"

Total Reservoir Areas-2,310 Acres.

18,740 Acres
Less 2,310 "

16,430 Acres watershed worth $100. per acre -------------- $1,643,000.

2,310 Acres Reservoir sites worth $1500. per acre - - - - - 3,465,000.

Total value of Res. and watershed properties in San Mateo County- Not including the value of Water rights- $5,108,000.

B. Laguna Merced property, including Lake Merced Reservoir, located mostly in San Francisco County, 2,700 Acres, more or less, worth $1,500. per acre - - $4,050,000.

C. Lands in Alameda and Santa Clara Counties from which water is now being supplied

to San Francisco.

Total Area 23,056 Acres,
of which area 1,800 acres constitute Reservoir sites, being:

Calaveras Reservoir site	1,300	Acres,
San Antonio " "	500	"
Total Reservoir sites	1,800	Acres,

worth $1,500. per acre - - - - - - - - $2,700,000.

A further 1,800 Acres constitute gravel and filter beds in the Sunol Valley and on Laguna Creek combined, having a value of $1,500. per acre.
1800 acres filter beds at $1500 per acre - - - - - - - - - - - - - - - - - - $2,700,000.

Watershed lands adjacent and tributary to these Reservoir Sites and filter beds, being 19,456 acres, worth $100 per acre - - - - - - - - - - - - - - - - - - $1,945,600.

Total value of all watershed, Reservoir sites and filter bed lands on the Alameda Creek System - - - - - - - - $7,345,600.00
(not including the value of the water rights.)

RECAPITULATION OF PROPERTIES AT HEAD WATERS:

A.	San Mateo County property	$5,108,000.00
B.	Laguna Merced property	$4,050,000.00
C.	Alameda Creek property	$7,345,600.00

Total value of properties, exclusive of water rights - - - $16,503,600.00

II.

HEAD WORKS, CONDUITS AND DISTRIBUTING SYSTEM:

1. Crystal Springs Dams and conduit line $3,660,000.

2. San Andres Dam and pipe line $1,047,000.

3. Pilarcitos Headworks Dam and conduit line------- - - - - -- - - - $ 977,000.

4. Improvements on Alameda Creek System, consisting of works on Laguna and Sunol filter beds, conduits, Alameda pipe line, four submarine pipes, Belmont Pumping Station - - - - - -$ 3,150,000.

5. Seven Pumping Stations in City and County (exclusive of Belmont) - -$ 1,030,000.00

6. Lake Merced Drainage System - - - -$ 195,000.-

7. Office lot and buildings and other properties in San Francisco - - - 1,300,000.-

8. Distributing reservoir sites and present distributing reservoirs in San Francisco, - - - - - - - - - $ 2,400,000.-

9. Distributing pipe system in San Francisco - - - - - - - - - - - $ 4,456,000.

Total headworks, conduits and Distributing System - - - - $18,215,000.-

RECAPITULATION

I. Reservoir sites, water sheds, and filter beds - - - $16,503,600.

II. Headworks, conduits and Distributing system - - - 18,215,000.

TOTAL $34,718,600.00

Exclusive of all water rights and franchise.

In the opinion of this affiant the water rights of complainant now used in distributing water to the City and County of San Francisco and its inhabitants, in addition to the property values set forth in the foregoing tabulated statement, and in addition to the value of the franchise, is of a value exceeding ten million ($10,000,000.) dollars; and in affiant's opinion the real property, utilities and water rights of complainant now in use for distributing water to said City and County and to the inhabitants thereof, are of a total value exceeding forty-four million ($44,000,000.) dollars;

Affiant further says that the perishable portions of the aforesaid property of complainant consists of wrought and cast iron pipes, pumping plants, and flumes, of a value of nine million eight hundred thousand ($9,800,000.) dollars, and in the opinion of affiant an annual allowance should be made to complainant for deterioration thereof, and affiant estimates that two per cent per annum upon the value of said property would be a proper allowance for deterioration.

H. Schussler.

Subscribed and sworn to before me
this 4th day of June, 1903.

(SEAL) Geo. T. Knox.
Notary Public in and for the City and County of San Francisco, State of California.

(3)

CONFERENCE BETWEEN RUDOLPH HERING, ESQ., AND

M. B. KELLOGG, ESQ.

- - o - -

VOLUME I.

- - o - -

SAN FRANCISCO, CALIFORNIA,

TUESDAY, OCTOBER 18th, 1904.

MR. KELLOGG. Q. 1. Will you give us your name?

A. My name is Rudolph Hering.

Q. 2. Where is your residence and office?

A. My residence is in Montclair, New Jersey, and my office is in New York City.

Q. 3. What is your profession?

A. Hydraulic and sanitary engineer.

Q. 4. How long have you been engaged in that business?

A. I went to Germany in 1860, and graduated as a civil engineer in 1867, at Dresden, Germany.

Q.5. What professional duties have you performed since your graduation?

A. I started in Brooklyn, in 1868, on the construction of Prospect Park. I then was engaged on a large Philadelphia park and, in

LGB

1872, spent a year with the United States Geological Survey in the Yellowstone Park. Thereafter, I was Assistant City Engineer in Philadelphia until 1880, when I was sent to Europe by the United States National Board of Health to make a report, chiefly on the sewerage system of Europe, which occupied me nearly one year. Thereafter, I was engaged by General Ludlow, then Chief Engineer of the water department in the City of Philadelphia, to make an investigation for a new water supply for the City of Philadelphia. Subsequently, I was engaged by the City of Chicago as Chief Engineer of the Water Supply and Drainage Commission. The result of this engagement was the recommendation of the drainage canal, which has since been constructed. It is the canal which runs from Lake Michigan to the Mississippi River. My next engagement was consulting engineer, for several years, to the Board of Public Works of the City of New York. Since then, I have reported on numerous engineering projects in different cities. Those referring to water supply were in the cities of New York, Philadelphia, Washington, Pittsburg, Atlanta, New Orleans, Cleveland, Buffalo, Tacoma and Sacramento.

Q. 6. You have examined numerous other properties with reference to water supply and water works?

A. Yes sir, of a similar character.

Q. 7. Many?

A. Yes sir, all together about one hundred water supply propositions.

Q. 8. In the United States?

A. In the United States, including Honolulu, and also in Santos, Brazil.

Q. 9. How long a time have you devoted your special attention to hydraulic and sanitary engineering?

A. Since 1873.

Q. 10. I will ask you if you ever have been called as an expert, where questions of values of water plants have been the subjects of litigation?

A. I have.

Q. 11. Can you mention some of the cases where you have been so connected, either in litigation or in otherwise valuing works?

A. Augusta, Maine; Gloucester and Boston, Massachusetts; New York City, New Orleans; Hornelsville, New York; Manistee, Michigan. In the two latter, I was a member of the Arbitration Board.

Q. 12. And in these questions that have arisen, either in litigation or by Boards of Arbitration, have you valued water works systems?

A. I have.

Q. 13. And you are familiar with the principles and methods involved in those valuations?

A. I think I am.

Q. 14. Are you familiar with the climatic and other physical conditions on the Pacific Slope in reference to water supply?

A. I am.

Q. 15. How many times have you visited the Pacific Slope, and within what years?

A. Since the year 1887, I have been here fourteen different times

Q. 16. On business connected with your profession as hydraulic and sanitary engineer?

A. Yes, sir.

Q. 17. What business did you transact in those visits with reference to particular localities. I do not ask anything of a private nature.

A. I reported on the best system of sewering Victoria; also on a water supply system for Tacoma; also on the water supply of Oakland and Sacramento. I was consulting engineer to the City of San Francisco on the proposed sewerage system of the city. I also made a design and reported on a system of sewerage for the cities of Los Angeles and Sacramento.

Q. 18. Have you made any studies or investigations as to the requisites and necessities for a municipal supply of water to cities in California, or general public supply in California.

A. I have.

Q. 19. Do you know the plant that is now commonly called the Spring Valley Water Company's plant, formerly known as the Spring Valley Water Works' plant, for the supplying of the City of San Francisco?

A. I do.

Q. 20. You are familiar with that plant and its properties?

A. I am.

Q. 21. And methods of supply?

A. Yes sir.

Q. 22. From your investigations and experience in reference to a public water supply on the Pacific Coast, what do you regard as the general essential requisites for that supply, considering the climatic and physical conditions which prevail here, and referring more especially to the City and County of San Francisco?

A. Inasmuch as there are no large fresh water streams in the neighborhood of San Francisco, where a sufficient water supply could be obtained during the dry seasons of the dryest years, the most essential requisite is an artificial storage of water, so that the storage, during wet seasons, will furnish sufficient water during the dry seasons.

Q. 23. How does the requisite capacity of such storage in the vicinity of San Francisco compare with the general Eastern conditions?

A. Inasmuch as the average rainfall about San Francisco is, roughly speaking, not much over half of what it is in the East, and as, for about one-half of the year, there is no rainfall at all which can replenish the water flowing in the streams, it will be necessary to store much larger quantities in this locality than anywhere in the Eastern States where the average rainfall per month does not vary much throughout the year, and where the rainfall is much more abundant. I might add, even the amount of water falling during the rainy season is much more variable than in the East. There has been a year where the rainfall in San

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Francisco, in one season (1889-90), was as much as 52.27 inches, and another year (1897-98) where it was as little as 10.08 inches. It also often happens that several dry years follow each other in succession, the most striking periods of this character occurring from the years 1868 to 1871, and 1897-1904. The run-off from the surface varies even more than the rainfall. I might further add that, in one year, the evaporation in that year was greater than the run-off.

Q. 24. Under such circumstances, in order to render the supply adequate to the necessities of the municipality, what preparation for storage do you deem reasonable, necessary and proper?

A. I should deem it absolutely necessary, under the conditions existing here, to have a provision for storing enough water to supply the City of San Francisco from stored water alone for two or even three years. This is necessary for the reason that a fresh water supply, particularly for a large city almost surrounded by salt water, is an absolute necessity at all times, and no chances whatever should be taken to leave such a city in danger of a serious reduction of its water supply.

Q. 25. I will ask you what, from your experience and your opinion, are the essential factors and necessities for a municipal water supply for a large city on this coast?

A. First, a sufficient quantity at all times; second, a proper quality; and third, reliability in service.

Q. 26. In connection with these factors or necessities, what part or figure does the character of the works maintain?

A. The works must be, in the first place, extensive enough to

furnish the necessary quantity of water at all times. They must have such constructions that the original quality of the water is either maintained or can be improved; and, thirdly, the works must be so designed and constructed that, in case of accident, breakage, necessary repairs, undue and sudden increase of consumption, the necessary supply can always be maintained.

Q. 27. Does the character of the construction bear any relation or have any effect upon the probable constancy and reliability of the supply, and, if so, in what way?

A. It certainly has a bearing upon the reliability of service. If the works are carelessly or improperly designed or built, a frequent interruption of service is quite probable; whereas, if the works are designed and built in what we would call a first-class manner, the probability of such imterruption or irregularities is reduced to a minimum, or may be entirely avoided.

Q. 28. In your opinion, in the construction of water works for a municipal supply, is first-class work in such construction warranted?

A. Decidedly so.

Q. 29. On the question of the value of a water works system, either in the service which it renders or in the original expense entailed in its construction and inauguration, does the question of proximity of sources cut any figure?

A. It cuts a large figure, in my opinion. If a source is near to the city, the necessary length of conduits is much reduced below what a more distant source would require; therefore, the number of all possible accidents that might happen to the conduits is, in general terms, proportionate to their length; that is,

the longer the pipe line the greater are the chances that at one place there might be an occasional interruption.

Q. 30. In your opinion, is a proximate source of supply liable to be more constant and reliable in its supply than a distant one, as far as the constructive work is concerned?

A. Decidedly so, and that is one reason why we generally prefer near sources.

Q. 31. Considering, now, the factor of constancy and reliability of the supply, what, in your opinion, is the relative general value, disregarding cost of a proximate source of supply, compared with a distant source of supply?

A. A proximate source has always a greater value, other things being equal, because of the assurance that, under all possible contingencies, there is an abundant supply of water near to the city.

Q. 32. Assume two sources of supply for a municipality, one proximate and the other remote, each producing the same quantity for the supply: In your opinion, would there be any difference in the monetary value of the two sources, and, if so, in favor of which source, and why, the cost of the construction being entirely disregarded in this question?

A. In that case, the proximate source would, in my opinion, have the greater value. My reason for this answer is, that I consider a near source less likely to possible interruptions, and therefore possessing a greater reliability of service. Besides, the nearer source would cost less for maintenance and repairs.

Q. 33. Now, referring again to the comparison between proximate

and remote sources of supply, is there any factor of difference in their market value, in your opinion, arising from the fact that the supply in the future may require to be increased?

A. There must be a greater market value to the nearer source, because of the fact, other things being equal, that the additional conduit necessary would be less expensive in one case than in the other.

Q. 34. In a municipal water supply, in your opinion, what is the relative advantage, if any, and the relative justification in the matter of expense, if any, in constructing a system that receives its supplies from different sources which are made interchangeable or interlacing in their distribution and distributive capacities?

A. Where the waters can be mingled so as not to cause harmful results, which is sometimes the case, I consider this interchangeability to be very advantageous, because it gives greater facilities in operating the plant, of temporarily suspending the use of unsatisfactory water in one part, and also requires less expense in construction in order to guard against possible accidents.

Q. 35. In your opinion, does a fact that various sources of supply exist, and that the construction is so made that these sources of supply are capable of interchangeability, have any effect upon the value of the general system as a whole, compared with a system, all other things being equal, not capable of interchangeability?

A. I consider the possibility of interchanging the different sources, as in San Francisco, to have great advantages, for the reasons already mentioned, and therefore to increase the value.

Q. 36. Now, referring to the water supply of San Francisco, are you familiar with the waters in the various sources of supply of the complainant in this case?

A. I am.

Q. 37. In your opinion, are those waters capable and qualified in their general characteristics for interchangeability?

A. They are.

Q. 38. Without harmful results?

A. Without harmful results.

Q. 39. In your opinion, how far ahead of a present consumption should a municipal supply provide for?

A. It should provide so far ahead that there is no question but that the interval of time is sufficiently long to construct the necessary works for an increased supply, and thereby avoid a deficiency at any time.

Q. 40. Now, considering these premises, which you have just mentioned, does the question of proximity or remoteness of supply, all other things being equal, render the proximate supply relatively more valuable than the remote supply?

A. It does, because it would take less time, presumably, to increase the supply from a shorter distance than from a longer distance.

Q. 41. If the proximate supply is capable of more frequent expansion in its quantity supplied to a municipality, does the fact that less investments are required for that purpose add anything, in your opinion, to the market value of the proximate source?

A. It does.

Q. 42. Will you give your reasons why you think so?

A. Assuming, of course, as before, that the total investments required for the proximate and remote sources are about the same,

the smaller outlay and smaller fixed charges would place an additional value in favor of the near source.

Q. 43. We have assumed in these questions that the cost of the construction of diverting methods and means for the remote supply were the same as those for the proximate supply. Is it a fact that that assumption is warranted, as a general rule?

A. I should say it was not warranted, as a general rule, because the cost of getting remote sources would generally be greater than the cost of getting near sources.

Q. 44. Mr. Hering, you say you are acquainted with the plant of the Spring Valley Water Company. Will you state what investigations you have made in reference to that plant and its source of water supply, and its methods of distribution?

A. My first acquaintance with the Spring Valley Water Works was some years ago, when I made a visit to some of its parts, particularly the Crystal Springs dam, of which some Eastern engineers had heard as being one of the best structures of its kind in the world. I also examined some of the wrought-iron pipe, which was used in the works, which likewise had an excellent reputation. A year ago last Spring, I was requested by the Board of Directors of the Spring Valley Water Works to make an examination of their works. I made such an examination, extending over a month, and visited every part of the works that were in use. I also examined very thoroughly the plans and records which were available and descriptive of the design and construction of the different parts.

Q. 45. You are familiar, then, with the methods that were adopt-

ed by the company in gathering and acquiring a water supply for this city?

A. I am.

Q. 46. You are aware that some of the supply furnished by the complainant to San Francisco is derived from reservoir sources, are you not?

A. I am.

Q. 47. What, in your opinion, is requisite, reasonable and proper to maintain the purity of water stored in reservoirs for the supply of a municipality, speaking with reference to the watershed?

A. The watershed should, of course, be kept as free as possible from polluting elements. For instance, there should be no possibility of sewage from man or beast habitually entering the reservoir. It is therefore naturally best to control as much territory as possible from which the water flows into the reservoirs, and to own outright as much as can be secured at a reasonable cost.

Q. 48. Have you made any examination of the reports that have been made by Mr. Grunsky, as City Engineer of San Francisco, concerning the proposed source of supply from the Tuolumne River and Hetch Hetchy Valley and Lake Eleanor?

A. I have.

Q. 49. To what extent have you made an examination of those reports?

A. I read them and studied them in connection with the available maps, drawings, profiles, and designs for supplying the City of San Francisco with water from the above-mentioned sources.

Q. 50. You are familiar, then, with the premises which he assumes in making those reports?

A. I am, reasonably so.

Q. 51. Have you examined the distributing system of the Spring Valley Water Company in the City of San Francisco?

A. I have, in its general features.

Q. 52. What do you find in reference to the distribution of water by the company in San Francisco, and the difficulties of that distribution?

A. I find the topography to be so broken that a distribution system becomes rather difficult and expensive on account of the many high hills, which are used for building purposes, and from the fact that some of them are isolated, requiring the construction of special mains to supply such hills before a distribution can be established.

Q. 53. I will ask you if you know the different elevations above tide of the districts in San Francisco that have to be supplied with water?

A. I do.

Q. 54. Do you know the topography of the City of San Francisco?

A. I do.

Q. 55. Is this a usual and ordinary topography for a municipal water supply compared with the generality of cities in the United States?

A. It is unusual.

Q. 56. Do you know of any other large city in the United States that is so difficult, in reference to its topography, for the

maintenance and operation of a distributing system and water supply?

A. I do not.

Q. 57. Now, referring to this topography of the City of San Francisco, what are the essentials necessary for a proper supply of water to various localities?

A. The essentials are, a sufficient quantity of water with a sufficient and proper pressure at all points. For instance, it would not be proper to subject the entire city to a pressure in the pipe equal to that necessary on the highest inhabited district; therefore, the city has been divided into several zones so as to have more uniform pressure in each one.

Q. 58. To meet such a situation as this, what is necessary on the part of a company supplying a city with water?

A. It is advisable to so lay out the distribution system that the pressures in the pipes, while sufficient for fire purposes, are yet not so great as to be a discomfort for domestic use.

Q. 59. How must that be accomplished?

A. That must be and usually is accomplished by dividing the cities, where great differences of elevation exist, into zones, each zone having its own pressure in the pipes, differing from that in the other zones.

Q. 60. How is that effected?

A. That is effected by having a different supply system, with supply reservoirs for each zone, and, in some instances, special pumping stations.

Q. 61. Does that not increase the cost of a distributing system
14. for a city of that character, compared with one that is on an

ordinary level plane.?

A. It certainly does.

Q. 62. Do you know how many zones of supply there are in San Francisco, approximately?

A. There are three main zones.

NOTE: The topographical map of San Francisco supply to be exhibited to Mr. Hering.

CONFERENCE BETWEEN RUDOLPH HERING, ESQ., AND
M. B. KELLOGG, ESQ.

- - o - -

VOLUME II.

- - o - -

SAN FRANCISCO, CALIFORNIA,
THURSDAY, OCTOBER 20, 1904.
FRIDAY, OCTOBER 21, 1904.

- - o - -

Thursday, October 20th, 1904.

MR. KELLOGG. Q. 63. Are you familiar with the general weather or climatic conditions in California?

A. I am.

Q. 64. You are aware, then, that there are two seasons, one of rainfall and one of dry conditions, in this State, called the winter and the summer months?

A. I am.

Q. 65. To what do you ascribe the fact that there is no rainfall in this vicinity and neighboring country in the summer months?

A. Chiefly the fact that there is a cool current flowing southward, near the coast of California. There is less moisture sus-

pended in cool than in warm air. Saturated air, therefore, will precipitate moisture when air is cooled, and absorb moisture when air is warmed. Consequently, in winter months, when land is apt to be cooler than the ocean, precipitation occurs; while in summer, when land is warmer than the ocean, it does not. Further, the degree of saturation depends on the density of the air; the denser the air, the more moisture can it hold in solution. Therefore, if saturated air is rarified, there is precipitation, and vice versa.

Q. 66. Do these conclusions result from your personal observations, Mr. Hering, or from your studies of the matter, or from both?

A. From both.

Q. 67. For how long a period have you examined the tables of rainfall in San Francisco and its vicinity,- that is, covering what period?

A. For as far back as I could get the records, when examining the water question in San Francisco, Sacramento and Oakland.

Q. 68. You know as a fact, then, that in the summer months rain does not fall, or falls very slightly in this region?

A. I do.

Q. 69. What are the main general features of the climatic conditions in this vicinity, as regards rainfall?

A. The year is divided into two periods of nearly equal duration, during one of which, the winter months, there is a frequent rainfall, and during the summer months there is practically none.

Q. 70. From your observations, what can you say as to the constancy and uniformity of the rainfall in the various winter seasons?

A. The rainfall in this part of the coast---I should say on the entire Pacific Coast---is quite variable. In some localities, although but a short distance of others, yet the rainfall may be much greater; also, during the different months of the year, there is a great difference in the amount of rain which may be precipitated. The irregularities in the rainfall are, therefore, very great; in fact, greater than any other part of the United States.

Q. 71. I will ask you if you have examined and read the transcript of the testimony given in these cases by Herman Schussler, a witness?

A. I have, to a large extent.

Q. 72. Have you examined and are you familiar with the exhibits which have been filed in these actions during the giving of the testimony by Mr. Schussler?

A. I have examined them.

Q. 73. You know relatively, then, the distances from the city of the various sources of supply for San Francisco as furnished by the Spring Valley Water Company?

A. I do.

4. Do you know the distance from the proposed point of diversion in the Tuolumne River to San Francisco in the scheme for a water supply of this city, proposed by City Engineer Grunsky?

A. I do.

Q. 75. What is that distance, approximately?

A. The distance is, approximately, 165 miles from the county line, along the lines of the pipe.

Q. 76. What are the distances of supply of the Spring Valley Water Company for San Francisco from its various sources, and mention them as you know them.

A. The distance of the Crystal Springs dam is about sixteen miles from the county line. The San Andres reservoir is about ten miles and the Pilarcitos about twelve miles. Lake Merced is within the city. The distance from the county line to the Sunol dam is about forty-six miles.

Q. 77. In speaking of the Tuolumne system, do you know whether the proposed watershed, or original source of supply, is a unit or separated?

A. I am familiar with the maps of this source, and will say that th chief one is the Tuolumne River, in the Hetch Hetchy Valley, obtained through a large storage reservoir to be built in that valley, and also the water of Lake Eleanor, to be increased in size for storage purposes also by the construction of a dam.

Q. 78. While these watersheds are separate, is it not a fact that they are united by both becoming a part of the Tuolumne River before they reach the point of diversion from the Tuolumne River?

The outflows from the two sources join the Tuolumne River at the point where it has been proposed to divert the water, about 165 miles from the city.

Q. 79. Is it not a fact, therefore, that from the proposed point of diversion, the system is a unit as to source of supply?

A. It is. They are united to form a unit. They are diverted to the city's use from the same point.

Q. 80. You have examined the proposed methods and means of diversion of the waters of the Tuolumne River for the supply of San Francisco, as proposed by Engineer Grunsky?

A. I have.

Q. 81. Will you state in general terms what they are?

A. A diverting dam is to be built below the point where the Tuolumne River and Cherry Creek, from Lake Eleanor, join. Thence an open, unlined canal, with short tunnels and siphons, leads to Bear Gulch, where there is a fall of about 766 feet, and where a power station is planned to furnish electricity for pumping the water to the Altamont reservoir. The open, unlined canal is then continued, partly in side cutting tunnels and siphons to Dry Creek, where there is a fall of about 330 feet, and where another power station would furnish electricity for the same purpose. Two iron pipes, each 48 inches in diameter, conduct the water from this station to the San Joaquin Valley, on the west side of which is to be a pumping station, about 180 feet above tide, at which the water would be raised by electricity about 560 feet to the Altamont reservoir, from which the water would flow again through two 48 inch pipes, through the Livermore valley, then tunnelling into the Suñol valley, then tunnelling again into the Santa Clara valley and, finally, discharging into a reservoir at San Francisco, at an elevation of about 200 feet. At Belmont, it is proposed to build a large storage reservoir, holding about 3,000 million gallons at a

low level. A pumping station, capable of raising thirty million gallons from this reservoir into the city distributing system, would be located near it.

Q. 82. With such means as are proposed in the scheme and report of Engineer Grunsky, what do you regard as the safe, constant and reliable capacity of the works?

A. Mr. Grunsky reports that each of the 48 inch pipes is capable of carrying thirty million gallons daily. The total capacity is, therefore, sixty million gallons and the connected works are proportioned to handle this same quantity. The Belmont pumps will handle only thirty million gallons daily. The great length of the pipe conduits and the open, unlined canal, together with the pumping of all the water by electricity transmitted a long distance, the comparative inaccessibility of the territory in winter, make a successful operation not only difficult and expensive, but repairs will require more time than on nearer works, and it is probable the supply would not be safe and constant, because of such interruptions. It is difficult, under such circumstances, to say what the reliable capacity would be. Counting for interruptions, for intermittent pumping, it might be from 1/4 to 1/2 in excess of the present supply, or, let us say, in round numbers 45 million gallons. To have a reliable capacity of sixty million gallons, an extra pipe would be necessary.

Q. 83. Without this extra pipe, which you mention, is the scheme, in your opinion, a reliable method for a supply of the municipality with water.

A. Not beyond the capacities I have stated, because of the

possibilities, which I do not consider even remote, that there would be an interruption to the supply by washouts or accidents to machinery or power transmission.

Q. 84. Is there any difference in the original cost of the pipe construction, as carried on by the Spring Valley Water Company, and the proposed pipe construction for the Tuolumne scheme?

A. I should say that the former was the more expensive, so far as first cost is concerned; but, considering the durability, I would consider it finally the more economical system.

Q. 85. Do you consider the extra initial cost that has been incurred by the complainants in installing and laying their pipe lines justified in reference to the supply of water to the municipality of San Francisco?

A. I consider this additional cost entirely justifiable, exemplifying good business principles.

Q. 86. In reference to a water supply, what have you to say regarding the desirability or practical necessity for safety appliances, and give your reasons?

A. I think it is absolutely essential to have sufficient safeguards around a system of water supply for a city, so that it is practically impossible that it would ever be subjected to the calamity of furnishing no water. Therefore, it is best to design the works so that any one part, be it a reservoir or pipe line or pump, may be put out of service, either on account of

accident or for repairs, cleaning or other purposes, and yet not interfere with the regular supply.

Q. 87. From that fact as a premise, what then, in your opinion, is the necessary factor of a safe plant?

A. A duplication of all such parts as will guarantee the necessary supply of water at all times.

Q. 88. Speaking now of necessary reservoir capacity, in reference to a supply of San Francisco, what are your deductions and what is your opinion as to the necessity of storage capacity in reservoirs, in view of the variable rainfall in the winter season?

A. It is necessary, for the reasons already mentioned, to have a very large storage capacity, much larger than would be required in the East. For instance, the water supply of New York City, which is obtained from comparatively small watersheds and not from a large river, and therefore, in this respect, comparable with the works of the Spring Valley Water Company, it is necessary to have here about five times the amount of storage per million gallons delivered that will be required in New York, after the new dam is finished.

Q. 89. From your examination of the complainant's plant---the Spring Valley Water Company's---in your opinion, is the storage capacity which has been provided by the company for the supply of San Francisco larger than is essential or reasonable?

A. It is not.

Q. 90. Please give the premises on which you base that opinion.

A. Irrespective of any theoretical considerations, the best proof that the storage provided is not excessive is the practical one, during the unprecedented drought of a few years ago. During that period the reservoirs were drawn down about as low as it was wise to draw them. Therefore, they were not larger than was reasonable and a smaller size, even with limited consumption, would have brought the capacity of the works dangerously near the limit. Theoretically, in view of the great irregularity of the rainfall, I would consider it wise to provide for a storage sufficient to hold an average of the greatest seasonable rainfalls that may come in any one year, as a factor of safety against possible subsequent dry years.

Q. 91. In this connection and in connection with reservoir storage, I would ask you if you are familiar generally with the watershed lands which are controlled by the complainants?

A. I am.

Q. 92. What is your opinion as to the reasonableness and propriety of the acquisition and control of these watershed lands by the company in connection with its reservoirs, and what are the reasons for your opinion?

A. I am thoroughly of the opinion that it was a very wise procedure to acquire as much land of the watershed as practicable, particularly surrounding the storage reservoirs, because it unquestionably guards the water against many sources of pollution otherwise possible, from people and cattle, and from the washing of material into the reservoir from cultivated land. It is an endeavor to place the watershed as nearly as practicable into the original state of nature, such as we find, for instance, in mountainous regions.

Q. 93. In your opinion, is any of the watershed property of the Spring Valley Water Works to be regarded as an extravagant expenditure in connection with collecting waters in its reservoirs?

A. It does not seem so to me.

Q. 94. Are you familiar with the Lake Merced property, so called, that is, Lake Merced that is used as a source of supply for the city?

A. I am.

Q. 95 . Have you examined that property, that is to say, the lake and its surrounding watershed and the pumping plant?

A. I have.

Q. 96. Are you familiar with the method adopted at that lake for the diversion of surface water from the south end?

A. I am. I saw the sewer, the drain and tunnel that are built to divert the water.

Q. 97. In your opinion, was the construction of that sewer and its diverting dam at the end of the south lake warranted by the sources of supply from the lake that were available for the city?

A. I think the expense was warranted.

Q. 98. Give your reasons for that statement.

A. If the sewage and surface water, which is now intercepted, had been allowed to flow into the lake, it would have been necessary, in my opinion, to have filtered the water at once before it could be taken into the general supply. The expense of such fil-

tration would have been greater than the expense of intercepting the polluted water.

Q. 99. Do you know the capacity of Lake Merced as to daily product?

A. It is said to be 3,000,000 gallons.

Q. 100. Do you know the distance of Lake Merced from the points of delivery or consumption, approximately?

A. About seven miles to the center of the built-up city.

Q. 101. You know that it is within the city limits?

A. I do.

Q. 102. Do you consider that a source of supply of such water, with the proximity of that lake to the city, adds anything to its value over and above a supply more remotely situated?

A. I should say that the existence of so large a body of water as that contained in Lake Merced, within a few miles of the populated part of the city, is a great advantage in the fact that it is equivalent to a storage reservoir, where a distributing reservoir ordinarily would answer, and therefore it holds ready for immediate use as large a body of water as could ever be needed for any possible contingencies of fire, earthquake, floods, breakage of pipes or reservoirs, or anything of that sort.

Q. 103. What is your opinion as to the justification of the maintenance of this lake as a source of supply to this city, considering, at the same time, the greater value of it as a property, and of its watershed as a property, compared with more remote sources of the same company?

A. So long as the purity of the water can be guarded as it is at present, I should say that the maintenance of this lake and its watershed was thoroughly justified.

Q. 104. Have you examined the Pilarcitos reservoir and reservoir site, and are you acquainted with the conduits therefrom to the city?

A. I have examined both the reservoir and portions of the conduits laid to the city.

Q. 105. What was the object of your examination of portions of the conduits?

A. To see at points easy of access how they were constructed.

Q. 106. Have you examined the dam at the Pilarcitos Reservoir?

A. I saw it.

Q. 107. Have you read Mr. Schussler's description of the construction of the Pilarcitos dam, as given in his testimony in this case?

A. I have.

Q. 108. Is that structure, as described by him, proper and expedient?

A. It is, in my opinion, both proper and expedient.

Q. 109. Was the structure extravagant in any way, or uselessly built with any too great care or too good material ?

A. I do not think it was built extravagantly.

Q. 110. You are aware that the puddle wall in the embankment is made of clay, are you not?

A. I am.

Q. 111. Is that proper in the construction of a dam?

A. It is.

Q. 112. Or is it better to build it of common earth?

A. It would not be proper, in such a position, to have built the dam simply of earth. It was necessary to have either a water-tight lining or core, in order to make the dam safe.

Q. 113. Assuming, for the sake of this question, that the clay puddle wall is built of a superior or better class of clay, and that the embankments on both sides of the puddle wall are built of ordinary clay,- would you consider that an unwarranted and extravagant method of construction?

A. I would not.

Q. 114. Would you consider the method of construction a prudent and proper one?

A. I would.

Q. 115. Have you examined the methods of transporting the water from Pilarcitos Lake, and the appliances that have been constructed therefor, for the purpose of its distribution in San Francisco?

A. I have.

Q. 116. Do you know the constructive methods that were adopted by the company in building these works?

A. I do.

Q. 117. What is their quality?

A. The quality of the workmanship that I saw impressed me as being first-class in every way.

Q. 118. Are they constructed better or with a more costly structure than was necessary, in your opinion, for a good system of water diversion?

A. I do not think that they were constructed any better or any more costly than I should have recommended myself, had I been engaged in the construction.

Q. 119. Have you examined the San Andres system, the reservoir and watershed of the San Andres supply?

A. I have.

Q. 120. You are familiar with that dam?

A. I am.

Q. 121. Have you read Mr. Schussler's report or statement given in evidence here in this case as to the manner in which that dam was constructed?

A. I have.

Q. 122. From that description, and assuming that to be true, do you regard the structure of that dam as a proper method of dam construction for a supply to a municipality?

A. I do.

Q. 123. Do you consider that dam in any manner constructed better or with greater expense than the situation warranted?

A. I do not.

Q. 124. Are you familiar with the methods of diversion from San Andres, by the usual appliances, to the city for distribution of water?

A. I am.

Q. 125. In reference to the structures and appliances for diverting water from the San Andres dam, what class of work do you find to have been performed?

A. The class of workmanship was first-class wherever I saw it.

Q. 126. Of course, some parts were under water and you could not see them?

A. Some parts were in tunnel, and others under water and others under the ground.

Q. 127. Did you find those structures in any way to have been extravagantly made?

A. I did not.

Q. 128. Have you examined the Upper Crystal Springs reservoir and dam?

A. I have.

Q. 129. Have you read the description of the construction of that dam, as given by Mr. Schussler in his testimony in this case?

A. I have.

Q. 130. What is your opinion as to the construction of that dam, in the way of workmanship, and extravagance in the expenditure of money?

A. I thought the dam was built economically and properly. I neither saw anything faulty in the design, nor anything which indicated an extravagant expenditure.

Q. 131. Do you consider that dam of present utility and, if so, in what respect, and what are your reasons for your opinion?

A. The dam is useful now in being able to retain the first flow from the surface after a rain storm, which flow generally carries with it earthy and vegetable matter in suspension, and it thus acts as a settling basin and thereby assists in furnishing the main reservoir with better water than would otherwise be possible. When I examined these reservoirs, I noticed that the water in the upper reservoir was less clear than in the lower reservoir, and the character of the watershed, as I could see it, to my mind satisfactorily explained this condition.

Q. 132. I will ask you if, in your opinion, the present value of that dam is warranted as an asset of the company for serving the purposes you have mentioned?

A. I think it should be properly counted an asset in the corporate property.

Q. 133. Coming to the main Crystal Springs lake, which is retained or formed by what we call the Lower Crystal Springs dam, have you examined that dam?

A. I have.

Q. 134. Do you know its structure?

A. I do.

Q. 135. Have you read Mr. Schussler's description in his testimony, in this case, of the method of construction of the Crystal Springs dam?

A. I have. I examined the dam at one time, some six or seven years ago, shortly after it had been built.

Q. 136. And examined it also recently?

A. And also recently.

Q. 137. What is your opinion as to the structure of that dam, its propriety, character and justification?

A. I think the site is an excellent one, giving a large storage by means of a comparatively small dam. I think the design of the dam is good, and the concrete, as it was formed, was exceptionally well done. I think that the dam was fully justified because, on the whole peninsula, there does not appear to be a site so favorable for a dam, retaining so large a quantity of water and at so small a cost per million gallons stored, as the one that has been selected.

Q. 138. As to the method of construction, what is your opinion concerning the quality of the material used, the plans of the construction, the size of the dam, considering the fact that, in the first instance, it was not built to its present height, and the further fact that it is not yet constructed to its ultimate intended height, with reference to the amount of expenditure incurred in its construction?

A. As to the method of construction, it was the best, in my opinion, that could have been adopted under the existing circumstances. Building the dam of concrete was entirely justified because of the absence of suitable stone at an economical distance. The use of English and German Portland cement, which, at that time, was the best known, allowed the construction of a mass of masonry with the existing stone, which had to be broken into small parts, of sufficiently great strength and water-tightness, at a lower cost than any other of the usual masonry constructions. The concrete was applied in the shape of blocks, made independently of each other, dove-tailing into each other, so that, as nearly as practi-

cable, the entire dam forms a monolith, and the care which was evidently given to the manufacture of the concrete has resulted in building a practically water-tight dam. Among all the concrete dams I have seen, the Crystal Springs dam is the best built. The stone used, when I examined it, appeared to be hard and durable. The cement had set perfectly hard, which indicated to me that both the cement and sand used must have been first-class and proper for the purpose. Regarding the plans, I think they were entirely proper. The curvature of the dam and the shape of the large concrete blocks, with their sides radial to the curvature, were proper. Regarding the profile or section of the dam, and its having been built somewhat larger than necessary for its present height, I also consider this a wise precaution, because it was first intended, and is still intended, to increase the height of this dam some 20 or 30 feet. To have made the thickness only sufficient for present purposes would have necessitated the widening of the dam at a later period. It is always better to have the dam of a homogeneous mass as nearly as possible, and have the entire structure on a horizontal line built at one time, because it is very difficult, if not impossible, to add to the wall on the down-stream side a mass of masonry so that there will not be interior strains, due to a different expansion of the new pieces of masonry, and thereby cause cracks, which would not secure as firm a structure as when built at the same time. It is also probable that, if such an addition had to be made, it would have required more masonry for the sake of giving sufficient security than was necessary if the dam had been constructed of the entire future width at the outset. Therefore, it is my opinion that it was ordinary prudence to have built the dam of the present width and, in view of the uncertainties as respects the time when it would be

proper to raise the dam, I think the expenditure for this additional width was fully justified.

Q. 139. In view of the fact that, in supplying San Francisco with water from the system of the company, it has been the policy and practice of the company to make periodical extensions of its sources of supply, which, in your judgment, would have been the better method in the construction of the Crystal Springs dam---either to have constructed it on the present plan, or to have added, as the increase in the size of its capacity was desired, one, two, three or several increases in the width and height of the dam?

A. In my opinion, the present plan which has been followed is altogether preferable, because, to make extensions of the dam only on top as the requirements demanded it, is a comparatively simple, safe and economical work. To have increased the width of the dam successively by adding concrete or masonry on the lower face, from the foundation to the top, although practicable, would have been not only more expensive but more troublesome, and not have rendered the final result as good, for reasons already mentioned.

Q. 140. Have you examined the appliances and structures which have been made and erected for the diversion of water from lower Crystal Springs lake?

A. I have.

Q. 141. What, in your opinion, is their character as to construction?

A. The character of construction is good, and compares favorably with similar work of the same kind.

Q. 142. Do you find in that construction any evidences of useless expenditure of money or extravagance?

A. I do not.

Q. 143. Are you familiar with what is known as the Alameda system of the Spring Valley Water Company?

A. I am.

Q. 144. Do you know the comparative amount of water drawn from that source, with the amount furnished from the peninsular system, including Lake Merced?

A. I do; about 12,000,000 to 13,000,000 gallons daily are and can be supplied from the Alameda system, during the driest years, and about 18,000,000 to 19,000,000 gallons daily from the peninsular system.

Q. 145. Do you know the sources of supply of the Alameda Creek system?

A. I do.

Q. 146. Do you know on what those sources depend?

A. I do.

Q. 147. Describe the sources of supply of the Alameda Creek system, generally speaking, as you understand them.

A. The source of the water taken from the Alameda Creek system is the rainfall. This rainfall is greater in the southern parts of the area than in the northern and eastern parts. A portion of this rainfall, called the "run-off", after it strikes the ground, flows off on the surface. Another portion of it is

evaporated. Another portion is absorbed by vegetation. The remainder soaks into and percolates through the ground until it reaches what we term the "water-table". Whatever runs off on the surface reaches, first, the brooks, then the largest streams, which it follows to tide water. In some cases the water of such streams, when reaching a porous bed, again percolates into the ground and reaches the underlying water-table, and follows its course, sometimes issuing again at the surface and sometimes not re-appearing until its final discharge at tide water. That portion of the water which evaporates from the ground or from vegetation is permanently lost as a source of supply. The same may be said of the portion of the rainfall which is absorbed by vegetation and which is but a small portion of the entire amount. The water which immediately percolates into the soil and which reaches the water-table is that which supplies the springs and feeds the flowing streams when, during dry weather, there is no surface flow from the rain. Applying these facts to the Alameda Creek sources, we observe that a portion of the rain-water flows over the so-called bed-rock dam, near Sunol. This consists of the run-off after rainfall and of the ground water which has reached the running streams. The rest of the water has been absorbed by vegetation or evaporated, and is permanently lost.

Q. 148. Are you familiar with the structures and appliances that have been made for the purpose of diverting water from the Alameda Creek system to San Francisco?

A. In a general way, I am, having visited them all once or twice.

Q. 149. What is your opinion of their character as to workman-

ship and construction?

A. All the work that I saw appeared to be well done and efficient for its purpose.

Q. 150. Did you find any evidences of unnecessary or extravagant expenditure in the construction of any of the appliances or constructed works for the diversion of water from the Alameda Creek system?

A. I did not.

Q. 151. From an examination of the whole system of the properties in use by the complainant for the supply of San Francisco, what have you observed in reference to the possibility of periodical extensions for the purposes of increased supply?

A. I observed that more than usual attention was given to planning the works as far ahead as seemed practicable, but building from time to time only such works that would guarantee a supply for as short a time in advance as seemed necessary, for the purpose of not investing money unnecessarily. In connection herewith, however, I also noticed that such works as could be most expediently built at a certain time had then been built in advance, and that such property as would be necessary in the future was secured at the earliest possible time. What I mean to say is, that, as was the case with the Crystal Springs dam, when it was found expedient and preferable to build for the future, it was done. I noticed also that all properties which would evidently be useful for increasing the supply in the future were secured as far in advance as possible.

Q. 152. Did you find any resources in the shape of a water supply for an increased consumption or demand provided for?

A. I was shown a number of them.

Q. 153. In your opinion, as an hydraulic engineer, how far in advance of present needs ought a company supplying a municipality, or a municipality supplying itself, to be at the present time provided with means of increased sources and increased means of supply?

A. The answer depends on the character of the source. If the sources are abundant and easily obtainable, such as the water from a large river, it is not necessary to go far ahead in the construction of works, such as the necessary pumping outfit; but where the sources are small watersheds or ground water, as is here the case, it is necessary to look far ahead, because such sources as are here available might be shut out from use in the near future, either by being acquired by other parties for other uses or by being rendered unfit for domestic use.

Q. 154. Taking the present plant, with the present demands upon it, and the possibility of these demands being increased, what, in your opinion, is a prudent length of time to prepare for at the present for the future?

A. If the consumption increases in the same ratio as heretofore, then I should consider it prudent to build works so that they will safely furnish the quantity of water for but a few years in advance of their completion. I should say, for instance, that if you were sure to provide enough water for the prospective growth of this city in the next two or three years, keeping for safety two

or three years in advance of the needs, that would be sufficient.

Q. 155. In view of the local situation connected with the plant of the Spring Valley Water Company, how far in advance, as a matter of prudence, ought they to acquire properties capable of a future supply for a municipality? By this, I mean properties capable of producing or storing water, or what is commonly called "water sources".

A. A large community is necessarily dependent upon a large water supply, and if the community is destined to grow and therefore naturally demand an increase of its water supply, it is prudent and, in fact, necessary, in my opinion, to set aside, as soon as possible, all of such sources for a future water supply as may be required. As to the time for securing such sources, I should have it depend upon their character. If the supply were obtained from a large river or lake, it is, of course, not necessary to acquire any property rights unless the water is limited and is again used after the city would have diverted its supply therefrom. Where the water must be obtained from an aggregation of sources of limited capacities, such as small watersheds and possibly ground water areas, I am of the opinion that is wise to secure a guarantee of the purchase of such water properties at reasonable rates for a very long time ahead, meaning at least several generations. I do not think that fifty, or even one hundred, years would be too far ahead, if the price is justified.

Q. 156. I will ask you, in this particular case of a supply of the municipality of San Francisco by the Spring Valley Water Company, how far it is at present absolute duty and necessity on the

part of the company to prepare water sources for a future supply, and I will ask you to name the very shortest period, in your opinion, that the company ought to be compelled to prepare for it in the way of water sources.

A. I would secure the essential requirements, the keys to the various situations, at the earliest possible time, such as dam sites and reservoir sites and water rights, thinking, as I said before, fifty ~~and even a hundred years ahead.~~ Other properties, such as rights of way or watersheds, I should not secure until I saw the immediate necessity for needing them, unless some project were in the air that might make it difficult ever thereafter to secure such rights. In that case, I would, when such a time arrived, endeavor to control them, so far as necessary, as soon as I could do this economically.

Q. 157. Considering the whole situation of the plant of the Spring Valley Water Company, its sources of supply, its method of conduit, and its entire system of transportation and distribution, what is your opinion of the system as a source of supply for a municipality?

A. I do not know of a water supply for any large city, in view of the difficulties under which the water is secured, which is more economically designed, better built or better managed than this one. Here you have of necessity a complex system, and the difficulty of managing a complex system is much greater than managing a simple one. Taking that into consideration, I do not know of a system in the United States which is any better managed than this one.

Q. 158. Now, you know the character of the water that is supplied from the various sources of the company, in a general way?

A. I am generally familiar with it.

Q. 159. From an hygienic point of view, how does that compare with the supply of other cities in the United States with which you are familiar?

A. In view of the fact that the Spring Valley Water Company owns a very large part of the watersheds from which the water is secured, and prevents their use for any purpose which might contribute pollution to the same, I do not know of another large city in the United States where the water furnished to its inhabitants is better protected against such pollution than the works of this company; and as for the ground water, furnished by the Alameda Creek system in part, their is no more hygienic water available.

Q. 160. Speaking, now, as to comparative permanency between what is known as the Peninsular System, excluding Lake Merced, and the Alameda Creek system, what is your opinion as to the relative permanency of one supply over the other, and give your reasons for that opinion?

A. I do not see that either of these sources can be any more permanent than the other, because the source in both cases depends upon the rainfall, and because I cannot conceive of one source being required for other purposes than might be suitable for a water supply any sooner than the other. I do not see any reason why the use of any one of these sources, for purposes of furnishing a water supply, would have to be discontinued any sooner than the other, if ever.

Q. 161. Now, speaking solely on this question of permanency,- assuming in this question that the product, or water product, of both sources, the Peninsular and the Alameda Creek system, is equal,- is there any reason, speaking solely as to the number of gallons that each is capable of producing, why the Peninsular system should be valued higher than the Alameda Creek system? I am leaving out of this question all matters of constructive work, and basing it entirely upon the proposition of the relative value of water sources; also leaving out the question of relative quality.

A. Confining thisquestion solely to permanency and to equal water production, irrespective of quality and of cost of construction, I should say that the nearer sources of the Peninsula should be valued higher, because there is greater reliability of the supply for the same outlay, due partly to the proximity of the sources and to the large storage reservoirs.

FRIDAY, OCTOBER 21, 1904.

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MR. KELLOGG. Q. 162. Mr. Hering, you have had experience in valuing water works and water-works properties and water-works plants?

A. I have.

Q. 163. Running over a period of many years?

A. Twelve years, I think.

Q. 164. In what parts of the world have you examined and valued water properties?

A. In different cities of the United States, as mentioned heretofore.

Q. 165. What premises and what methods do you observe in giving the present valuations of water properties that are in use in the municipal supply? When I say "the present valuation", I mean, of course, 1903 and 1904, as these cases cover those two years.

A. I have held the opinion, and hold it still, that the proper method to value a water-works property is as follows, depending, of course, upon any contract that has been made between the two parties. In the present case, I understand there is no such contract extending over more than one year. It is generally understood that the company is to furnish water of sufficient quantity and proper quality, and it is also understood that the compensation therefor shall be fair and reasonable. In order
3. to have a fair compensation, it is necessary to know the fair

value of the works. In order, therefore, to ascertain the fair value of your works, it is necessary to glance at some general aspects of the question. We have the case of a private corporation, which has invested money in land, water rights, and in structures built upon the ground and below the surface of the streets of the city, for the purpose of supplying water to its inhabitants. Its works are substantially fixed in the ground. At one end they are connected with the sources of supply; at the other with almost every building. They cannot be moved without losing most of their value, as they are organically connected with each other, and with the buildings and streets of the city. Besides the value of those structures and land with water rights attached thereto, as well as machinery and buildings, all of which have an independent market price attached thereto, have a value as a whole or as a unit, organized for a definite purpose, each part of which holding a necessary fixed relation to every other part, and the removal of any one part affecting and, perhaps, destroying the value of many, if not all, of the others. This fact will appear even more evident when it is considered that, in order to complete the necessary combination of the parts in a given time, it may have been, and generally is, necessary to pay prices for some parts of the work at much above the average market rate. For instance, the knowledge of a land owner that his property is quite essential to complete the works may cause him to sell only at the highest possible price, or in order to erect a pumping station, or to lay certain pipes within an unexpectedly short time, so as to fulfill a contract, or in the presence of strikes or accidents, or from other unforeseen but possible conditions, it is often necessary to pay high prices to overcome the difficulty. Because of

the necessity of certain fixed combinations in order to constitute the organic whole, a special value attaches to the completed work, in addition to that of its parts, which is ascertained from the average market prices. Besides this tangible, there is also an intangible value, which is due to the study, skill and labor which co-ordinated the parts into the whole, and produced and maintains a living and going concern. It is, therefore, customary to ascertain the value of the physical parts, and then the value which should be given to the plant as a whole with an established business and a fair complement of water-takers. In other words, the value is divided into two parts, namely, the tangible part, or the physical plant, including land and water, and the intangible part, which comprises the business value. The physical value comprises the value of the materials and labor necessary to build the entire works, and also the land and water rights connected therewith. The actual cost of constructing works years ago is not necessarily a true measure of their present value. Certain moneys may have been spent injudiciously, having no present value whatever, or materials and labor may have been high in price at the time of construction, but worth much less to-day. Accordingly, a purchaser should not pay for lack of judgment of the seller, nor for the fact that a high market price prevailed during the time of construction. On the other hand, the works may have been designed and built with great skill and care, or at a time when prices were lower than they are to-day. Then the seller should not be expected to lose the reward for having done specially good work and to give up the advantage of a high market price on the date of sale. The true value of labor and materials at a given

time cannot be other than the actual cost of replacing them at such a time. These are simple business rules and should control in the sale and purchase of large plants. A company is supposed to know what it may eventually be obliged to accept for its property, how to provide against the loss due to a possibly declining market and to have arranged its business conduct so as to make it profitable. As all necessary elements for this purpose can be readily ascertained at the present time, there is hardly any uncertainty in the determination of the present cost, while there may be uncertainty regarding actual conditions of the past at the time when the works were built. At present the only important doubtful point in the valuation is the final life of some of the structures on account of their deterioration, which depends much upon a number of accidental conditions. For the purpose of neutralizing its effect, a fund should be provided and so adjusted as to pay for the replacement of all perishable parts in due time.

For the above reasons, I am of the opinion that a valuation should be based, not upon the original, but upon the present cost of reproducing the works, allowing for their depreciation since the time when the works were built. In other words, the physical value of your plant must be ascertained primarily by the sum of money which would rebuild it to-day in its entirety. It is to be assumed that, in doing this, fair prices are used, such as would pay for the same character of work when done to-day. And, secondly, it is necessary that the efficiency and life of all parts of the supposed plant are the same as those of the actual plant of to-day, which requires the making of certain deductions from the

cost of a new plant for what is called "deterioration". For instance, assuming that the life of iron pipe in the ground is estimated at one hundred years, then, if the pipe is twenty-five years old, one-fourth of its life has gone, although not one-fourth of its value; moreover, the pipe may yet be in a good condition. It is a common experience that, for the first part of the life of, for instance, iron pipe or machinery, there is apparently no depreciation whatever, but towards the end of the term of life of a pipe, and we must include machinery, the deterioration proceeds at a much more rapid rate than at the beginning. It is, therefore, customary to fix the probable life for all parts of the work, when new, and to compute the value of the depreciation by the annuity which will have accumulated a sum of money equal to the cost of replacing the particular structure at the end of its life. Depreciation is, strictly speaking, the deterioration from the disintegration or waste due to age or to use. This term is sometimes used to mean also inadequateness or inefficiency of parts of the work. This meaning should not be given to it in this case. When a work has become inefficient or inadequate, it has lost its value to the precise extent of this failure, whichm in the extreme case, is an entire loss. It is less confusing to separate the two conditions, namely, one condition, where the question is one of purchase and sale, and value the reproduction less deterioration, and the second condition where the question is one of service rendered, whether the property rendering the service has, to some extent, deteriorated in its market value or not. If the service rendered is just as efficient, just as adequate, and just as perfect, as when the plant

was newly constructed, then, as to the question of the service rendered, the value of the plant is fully as great as when it was new.

CONFERENCE BETWEEN RUDOLPH HERING, ESQ., AND
M. B. KELLOGG, ESQ.

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VOLUME III.

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SAN FRANCISCO, CALIFORNIA,
SATURDAY, OCTOBER 22, 1904.

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A. (Continuing). I understand it has been claimed that no value should be attached to any property which, though acquired by the company for future use, is not actually used at the present time in furnishing water. In view of the conditions existing in this locality, namely, the comparative scarcity of suitable water at near points, and the absence of rainfall usually for half the year, and the great irregularity of the rainfall during the rest of the year, makes it absolutely necessary, in my opinion, on economical grounds, to secure lands and water-rights ahead of immediate use. Therefore, I consider it eminently fair and just to allow a reasonable sum for the value of any property necessarily built or held for contingent or future use. Early in the life of a city certain outlying grounds and water rights are comparatively inexpensive, being then used only for farming and irrigation purposes. At such times, all the sources of water supply for a city of established growth can be and should be secured at reasonable terms, which, later, when perhaps such property has been ac-

quired for villages or water-power, or other purposes, can only be secured at large sums. Such covering of the territory by population or industries might, later even, render the water property unfit for use as a domestic supply. In case of income received from any property thus held or improved in advance of use, then, if the value thereof is allowed in a valuation of the works, credit should, of course, be given for the income derived therefrom.

Q. 166. Mr. Hering, to go back to the first principle that you announced in your methods of valuation, in regard to the preparation for future necessities,- I will ask you to explain how you apply that principle to the structure known as the lower Crystal Springs dam in its present state.

A. The Crystal Springs dam, at present, is required to store only about 19,000,000,000 gallons. It is expected to store in the same reservoir, at some future time, practically 45,000,000,000 gallons. It is therefore necessary in the latter case to have a dam about 42 feet higher than at present. For this purpose, it is necessary to have a much wider dam for the future than for the present purpose. To add to the width of the dam at a future time would not only be difficult and make a less firm structure, but would cost more than to build the dam of the ultimate width at the time of its first construction. Therefore, I consider that it was proper to have built the dam to its present dimensions, and I consider that full value should be attached thereto at the present time, notwithstanding the full width is not yet actually required.

Q. 167. Considering the ultimate proposed height of that dam, what is your opinion as to the warrant for constructing it to its present width?

A. The dam is built of concrete, and it was built at a time when the experience with concrete dams was not very extensive. In such case, it is the duty of every engineer to be sure that his structure will not fail at any time, and, therefore, to allow what is called a factor of safety in all of his work where the exact durability, life and other qualities, are not exactly known. Even, irrespective of the future raising of the dam, it is questionable in my mind whether it would have been wise to have built the dam of less width, constructed as it is at the head of a valley, below which is valuable property, and are situated centers of population, especially the city of San Mateo. No chances at all should, in my opinion, be taken under such weighty conditions and, in my opinion, whatever excess of cost, due to an excess of material, may, after more years of experience, be found to exist, is, in my opinion, a small factor. I do not think that it would have been wise to have reduced the width under those circumstances. Moreover, the valley in which water may be economically stored, makes it possible to store even a greater amount of water than has been in contemplation by the proposed future dam. Therefore, should it be found that there was width to spare, it is possible, then, to increase the height of the dam and acquire still more storage at a comparatively insignificant expense. The Crystal Springs reservoir is the largest available storage reservoir in the neighborhood of San Francisco. In the distant future, such a a condition may, therefore, be of great value.

Q. 168. On the same line of opinion, I would ask you what you have to say as to the expenditures which have been made upon the Calaveras and San Antonio dam sites, and the work done there.

A. I saw nothing which would lead me to believe that the work done in the preliminary investigations was not fully justified at the present time, and was necessary for the future. In my opinion, it was fully justified.

Q. 169. Are you acquainted with the Portola reservoir and dam?

A. I am. I was there.

Q. 170. In reference to that work and the acquisition of that property, on the same line of opinion, I would ask you to express your views.

A. I am of the opinion that the nearness of the site and the amount of water there to be obtained were of sufficient value to have secured the rights for the purpose of supplying San Francisco with water before the present time.

Q. 171. Continuing that same line of interrogation on the same premise, I would ask your views as to the bed-rock dam at Niles, in the Alameda Creek system, whether or not that is of present value in our system?

A. In view of the fact that this bed-rock dam and the flume leading therefrom connect with the pipe leading to San Francisco, and can, therefore, at any time be used to supply water to the city, should the only other existing tunnels, flumes and pipe lines to the point of connection from the Alameda Creek be acci-

dentally disturbed, I believe that, as a duplicate or safeguard, this bed-rock dam and the flume have a certain value. I have placed it as, in my judgment, being three-quarters of the present cost of construction.

Q. 172. In reference to the distributing system, on what principles, in your opinion, should the value of that system be based?

A. The present value should be based upon reconstructing this system at the present time and under the present existing conditions of property development, pavements, etc., deducting for deterioration, however, in case of the valuation of the works for sale, an amount corresponding to the deterioration of the works. As regards the price of iron, it is customary to use the average price prevailing at the time of valuation, not using the extremes of fluctuation. From what I have already stated, I believe that all of the pipe is of the same good quality as that material which I saw and, therefore, I believe the value should be for the best quality of iron. The workmanship that I have seen is also better than the average in some of our large cities. For these reasons, your pipes are, as I believe, specially good and more durable than the average, and should have accordingly a value greater than the average value of their kind. When a pipe is laid on an unpaved street, it will cost less than when the street is paved. The value of a pipe line in the latter case is, therefore, enhanced by the pavement above it. In estimating the present fair value of the distribution system, the cost of repaving is an increment of cost justly to be added.

Q. 173. I want to ask you if you are aware of the specifications and the actual method of making the iron that is used in our main or country conduit?

A. I am.

Q. 174. What is your opinion in reference to the iron, such as has been used in the construction of these works, compared with ordinary plate-iron or steel?

A. My opinion is that the specifications are not only very carefully drawn, but I have for many years considered them as being the best we have for wrought-iron pipe.

Q. 175. Do you know that the structural work in this iron corresponds with the specifications, or to what extent do you know it?

A. I believe that the specifications were properly adhered to, and my only independent knowledge is the fact that I saw some wrought-iron pipe on a field, which had been exposed to the weather for, I believe, two years. Such pipe, if I remember, had a thickness of material of probably not more than 3/16 of an inch. It was not coated, and yet showed a very slight amount of rust,- a mere coloring of the material,- much less than ordinary wrought-iron would have shown in the same time and under the same conditions.

Q. 176. You are aware that iron of this character is more expensive than ordinary plate-iron or steel?

A. I am.

Q. 177. What is your opinion as to the justification of the use of iron, according to those specifications, by the complainant, in the structure of its mains?

A. The experience gained here, and also in England, regarding the durability of material similarly treated, has convinced me that the additional cost is, generally, fully justified by the additional length of life.

Q. 178. What is your opinion as to this method of constructing iron for use in mains, in respect to its increase of life or its possibility of longer duration?

A. My opinion is that the thorough manipulation required in the process of manufacture of the wrought-iron makes it more homogeneous and removes the elements which assist and produce corrosion.

Q. 179. I will ask you what is your opinion as to the character of the work accomplished between contract work and work by day labor?

A. It is our experience that, with some exceptions, work done by day labor is generally more thorough and more durable than contract work.

Q. 180. In reference to the construction of the various parts of the plant of the complainants, what have you observed concerning the possibilities of interlacing the various sources of supply or of fortifying, in other words, one source of supply from another?

A. I have observed that great attention has been given to such interlacing or interchangeability as regards using water from different sources and different reservoirs in different parts of the city, for the purpose of being able to substitute at once, in case of an accident, in one such part the water from another part.

Q. 181. What is your opinion as to the advantages or desirability of such conditions in a water system?

A. I think the advantages are great, and, to some extent, should be obtainable, in one way or another, in every city. Here the topography is so broken that different zones of distribution are necessary, and that there are a number of, what might be called, islands within the distribution system, and there are also three main sources delivering water at three different heights. Such a system of interchangeability is, in fact, quite desirable and of much value.

Q. 182. Speaking upon this same subject, from a general consideration, is that condition of availability or interchangeability from sundry sources of supply an advantage or disadvantage?

A. It is an advantage.

Q. 183. Mr. Hering, assuming that a company, or the municipality, owned the Pilarcitos water sources, the San Andres, the Upper and Lower Crystal Springs, and the Alameda Creek system, and were contemplating the construction of a diverting and distributing system of water works from these sources of supply at the present time,- what would be your opinion as to the advantageous plan and

construction of the diverting and distributing systems of such new plant from these sources?

A. I should say that the same reservoir sites as now exist would be the proper ones to use, and substantially the same pipe lines should be selected along which to bring water to the city as now exist. In view of the broken topography of the city, I do not see how a very different method of distributing the water than the one now in use could be advantageously adopted.

Q. 184. What is your opinion as to the efficient supply of water in sources owned by the complainants, and its method of storage and transportation to the city distributing system?

A. My examinations and rough calculations regarding rainfall, catchment areas, reservoir capacities and water sources existing have convinced me that the works are efficient to convey the amount of water to the city that has been claimed, and that the sources are able to supply such amounts.

Q. 185. And as to the city distributing system, without reference to the details concerning the pipes in the streets, do you consider the general method of distribution is efficient and proper?

A. I consider the general method of distribution efficient and proper.

Q. 186. Have you, in your examination of the properties of the company in use in supplying the City and County of San Francisco with water, discovered any structures, properties or investments that, in your opinion as an hydraulic engineer, were extravagant?

A. In all my examinations, I was not impressed that any of the expenditures which have been made, either for land or work, should be called extravagant or unnecessary or unwarranted.

MONDAY, OCTOBER 24, 1904.

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MR. KELLOGG. Q. 187. Mr. Hering, referring back to the subject of contract work as compared with day labor, I will ask you what your opinion is as to the relative cost of the two, assuming, in answer to this question, the same quality of work being insisted upon and maintained.

A. Under this assumption and with good superintendence, the day's labor work should be less expensive. Where the conditions to be met cannot be precisely stated in advance, we frequently, in the East, have such work done by day's labor, and find it often to cost less than if it had been given out by contract, because the contractor not only adds his profit, but also a contingent sum to cover the uncertainties.

Q. 188. In your examination of the work done on the plant of the Spring Valley Water Works, what has been your conclusion as to its construction, in reference to quality?

A. I have been impressed that the quality of the work in general was above the average usually found in such work, built under similar conditions.

Q. 189. Calling your attention now to the machinery at the various pumping stations, what is your opinion as to its character and operation?

A. I found the machinery, as far as I could judge, to be well designed, and built with a view towards an economical operation,

and the reduction of the expenses for repairs. There is neither a display of negligence nor of extravagance. The plants appear to be economical.

Q. 190. I will now ask you to give me your opinion of the present value, speaking, of course, with reference to the years 1903 and 1904, under the stipulation in this case, of the plant of the Spring Valley Water Company, now in use in supplying the City and County of San Francisco with water, with such added details and explanations as you deem proper to an explanation of your opinion.

A. In my opinion the value is made up of several parts: first, the city distributing system, including the Black Point and Clarendon Heights pumping stations, the reservoirs, real estate and stock on hand in San Francisco; second, the works collecting the water and conveying it to the San Francisco distributing reservoirs, inclusive of the six pumping plants; third, rights of way, pipe lines and conduits; fourth, all real estate in city and elsewhere, reservoir and watershed properties and water rights located in Alameda, Santa Clara, San Mateo and San Francisco Counties, the latter being the Lake Merced properties, from which water is being supplied to the city; fifth, a sum representing what may be called the business value, going concern or good will---in other words, all the intangible property.

Tangible value

1.	City Distributing system;	$
2.	Works for collection and conveyance to distributing reservoirs;	
3.	Rights of way;	
Real Estate 4.	Storage, reservoirs ~~and~~ watershed ~~properties~~, and other purposes.	
~~5.~~	~~Water rights;~~	
~~6.~~	~~Business value;~~	
Intangible value		
	Total:	$39,770,900
		5,000,000

Q. 191. Is that valuation, which you have given, minimum, maximum, or fair and reasonable valuation? for the whole property

A. This figure represents the lowest valuation which I think could be given to the material plant excl. all business value, going concern [illegible]

Q. 192. In speaking of ~~it~~ the 3 group as "the lowest valuation", do you mean by that that it is the fair, reasonable and proper valuation to be placed upon the plant and the intangible, in your opinion, and the figure at which it should be valued?

A. I do not. In my opinion, it would not be fair and just to value the both tangible + intangible property at this figure. As this is a business venture, embodying a number of risks, an additional allowance should be made for a successful plant, not exceeding a certain maximum limit, which, in this case, would represent the cheapest alternative project for supplying an equal quantity of equally good water.

Q. 193. In valuing the lands and water rights of the company, what are your premises as to estimating their present value? If you have more than one class of premises, state them both, or all.

A. As it is difficult to ascertain the actual present cost of this class of property, because it can be no longer replaced by other lands or water rights at the same location, the value should be estimated in accordance with the general market prices existing to-day of similar property in similar localities. Such an estimate should, of course, be fair, without taking undue advantage of the exclusiveness of any possession.

Q. 194. Now, if no similar properties exist in similar localities adapted to the use of a water supply, to use as an estimate of the value of these properties, then what would you take as a basis of their valuation?

A. I should unite the water rights with the business value and get a value for both together.

Q. 195. For what essential requisites, in a water works' supply, are land purchases necessary?

A. First, to have the necessary water courses to deliver the required water; secondly to have the necessary storage reservoirs; thirdly, to have the necessary land for the purpose of protecting the water from pollution; fourthly, for rights of way, buildings or yards necessary in connection with the work.

Q. 196. What is your opinion as to the relative values of these various classes of land property, and give the reasons therefor?

A. Reservoir sites are rare, and therefore usually demand a higher price than other property. The land upon which the water flows, i.e., the bed of stream, is valuable on account of the flowing water it contains, and it is generally valued in connection with these water rights. Rights of way are required for the purpose of conduits or pipe lines, an important requirement, and, therefore, land for this purpose is usually valued higher than the land of the watershed, which is used merely to protect the water from pollution, and which otherwise is usually unproductive. The property for buildings or yards may have any value, depending on its specific location, accessibility and adaptability. The pres-

ent market prices of land adapted and known to be intended for these several purposes in this part of the State should, in my opinion, govern and fix their just value in this case.

Q. 197. What have you to say, in this connection, regarding the desirability and necessity of owning the lands which you call protecting lands?

A. It is certainly necessary to have at least police protection over the watershed, to prevent objectionable pollution, and also to have an absolute exclusion of people and animals from the shores of the lakes and streams. It is certain that the greater the area of the watershed which can be protected from occupations resulting in dangers to health, the better it is for the water supply; therefore, no better security exists than a possession of the land, and your unusually extensive possessions give the water an exceptional security and value. I, therefore, consider that all your protecting lands should be included in the valuation, as they are of direct benefit to the quality of the water. As such lands always have a selling price, generally for farm purposes, they could be readily sold if, at any time, such a disposition of them appeared a safe proceeding.

Q. 198. I would call your attention to the fact that it has been testified to in this case by Mr. Schussler, the Chief Engineer of the company, and, possibly, it may be within your own knowledge, that the San Andres and Crystal Springs reservoir sites are both capable, by their natural condition, of storing more water than their watersheds contribute, that is to say, of aggregating and holding water from other watersheds. Will you state what your opinion is in regard to their value, or additional value, if any,

from this fact?

A. I know that they will store more water than can be obtained ordinarily from their own watersheds. If, by raising the dams, they can be made to store water from other watersheds, they, in a measure, take the place of reservoirs in other watersheds and, therefore, really have their original value increased.

Q. 199. What governs the value of water-courses or water sources of supply?

A. First, the existence of a sufficient quantity of water; second, the adaptability and competition for its use for various purposes; and, third, a community that can use it. If there is no community to use it, no value attaches to the water on that account. Large and growing communities exist in this neighborhood, and all will require water. It is a well-known fact that the quantity of usable water is limited in this part of the State, ~~because the rainfall which supplies it ceases entirely during about six months of the summer~~, and it is ~~a~~ fixed quantity, not increasing with nor bearing any relation to the growing population. It is, therefore, clear that water, being limited in quantity and indispensable for this city and the adjoining communities, has, when it it diverted, an intrinsic value as property above the mere cost of diverting it. One measure of this value may be obtained from the cost of the least expensive water supply among other than your own sources, and equally good and abundant both at present and in the future. Such measure indicates a maximum price, beyond which its value cannot reasonably go. Another measure of this value is the reasonable, actual cost of procuring the water rights, and of having held them until required for the supply of the city. This indi-

cates the least price which should be paid for them. ~~Between~~ these two limits, The true value of the water rights should be ~~sought~~. found between

Q. 200. Would you apply and, if so, how, these principles to the business value of the entire plant, and, if other principles should be added to those which you have already mentioned in such last-named valuation, please give them, and your reasons for your full answer?

A. As a fair competition is the best adjuster and regulator of business values, so also here, the highest value of your business, as said before, would be approximately measured by the capital, which would have to be invested in the most available of the remaining projects for supplying San Francisco with an equally abundant source, present and future, of equally good water, built with the same good design, materials and labor, and be just as reliable in its service. The lowest value, again, would not be less than the actual present cost of procuring and holding land and water rights and of building the entire works as they exist to-day, deducting what value may be given to deterioration. The true value of the business property would lie between these limits. There is another element of value in the fact that the property, by the topographical character of its sources, can be extended gradually, instead of requiring dams and aqueducts of dimensions not necessary for a long time and, consequently, loaded with a large investment, which must be unprofitable for some time, examples of which we have in many cities. This advantage is not to be construed as militating against an early investment in lands and water rights ultimately required. The expense of the latter is very small, when compared with the price

of later purchases, and usually becomes a source of special profit.

Q. 201. I believe you say you are familiar, more or less, with the so-called Tuolumne water supply, and that you have read the reports made by Mr. Grunsky upon that subject?

A. I have read his reports.

Q. 202. To what extent are you familiar with the facts yourself, outside of those properties?

A. I have seen the adjoining territory, namely the Yosemite Valley, on two occasions, in wet and in dry weather. I am familiar with the general geography of this country from the maps, Government surveys, and also from crossing the Sierras by rail more than a dozen times. I am, therefore, familiar with the general character of that country.

Q. 203. Now, assuming that Mr. Grunsky's reports and figures on the constructive work which he proposes are correct, and that his figures as to the cost thereof are correct, what is your opinion as to the efficiency, safety and reliability of the plan proposed by him, if nothing be added thereto for the purpose of furnishing the City of San Francisco with its present daily consumption, and the near future?

A. I do not think that the Tuolumne supply would furnish a greater quantity of water, nor a water of better quality, than can be obtained from nearer sources, nor do I think that the reliability of the works of supply would be nearly as great as the

reliability of nearer works. The proposition to carry the water from long distances through an open earth canal has the disadvantage, irrespective of washouts, that leakage will cause the permanent loss of some of the water, and the warmth of the sun would cause growths in the water. For this reason, it would be better to build a water-tight canal or, still better, a covered aqueduct, and, in my opinion, this would eventually have to be done. It is, therefore, proper to consider this contingency at once. Regarding the quality of the water, it is mostly melted snow and ice. The water should, therefore, be very soft, clear and palatable, particularly as the prevailing character of the rock is granite. I do not, however, share the opinion that, after this water has been standing for months in the Sierra reservoirs, and has run for long distances in an open ditch, the quality of it will remain superior to the water which you gather from your watersheds into your reservoirs. It would, in my opinion, not even be as good. It is reported that the Hetch Hetchy Valley, where the reservoirs would be located, is unusually warm in the summer months, which would be liable to cause growths that would tend to deteriorate the quality of the water more than in your present reservoirs. The Tuolumne water could only be kept in its original pure condition by having considerable work done in removing the large accumulations of organic matter now reported to have accumulated on the site of the reservoir, and by being carried in closed aqueducts and pipes from the Hetch Hetchy Valley to the distribution reservoir in the city.

Q. 204. In speaking of the Tuolumne project, in your opinion will the real and true and properly estimated cost of that scheme have any bearing, or ought it to have any bearing, on the value of the plant of the Spring Valley Water Company?

A. I believe it should have some effect on the value of your property, because the investigations made by the city, which were presumably thorough and fair, have resulted in the conclusion that it was the next cheapest and best source of supply available at this time. Therefore, the fair value of your works should not be very greatly below the cost of this project. To ascertain the cost of the Tuolumne supply fairly, it is necessary to assume equal supplies, which, in the preliminary studies, have been taken at 30,000,000 and 60,000,000 gallons per day. In order to make the Tuolumne supply reliable, it is necessary to estimate for it a reserve or safety pipe and other structures to the same extent that you have provided similar safeguards in your own works. It is therefore proper that one of two expedients be carried out. Either large storage should be provided between the San Joaquin Valley and the city, for use in case of a disaster to the long, single supply line from the Sierras to that valley, or two pipe lines should be built at once for the entire distance. It is further necessary to assume the same standard of materials and workmanship, so as to secure equal efficiency and durability. Wherever possible, equal conditions should maintain in all parts of the work. In making the comparative estimates, the tendency has been to under, rather than over-estimate the cost. For instance, the open ditches have been preserved, where closed channels are decidedly preferable and would have to be built eventually. The prices for the pipes ~~and for the masonry dam~~ have been, however, materially raised over Mr. Grunsky's figures, and have been based on the experience as to actual cost gained in your own work.

Q. 205. You are aware, from Mr. Grunsky's final report on this subject, that his estimated cost of this scheme is $ 39,531,000 ?

A. I am.

Q. 206. Under your statements as to other necessary additions to the scheme, what sum must be added to his estimate to make the structural estimate complete?

A. I should add for increased cost of iron 12,694,000
+ interest in construction 2,800,000

55,000,000

206 3/4

about $55.000.000

Q. 207. I will ask you if this Tuolumne scheme is the basis of what you have heretofore termed the maximum value of the Spring Valley Water Company's plant?

A. It is.

The first question omitted and now to be answered is Q.190 on page 60.

The next question is Q. 191 on page 61, which was not asked.

The next question is Q. 192 on page 61, which was not asked.

The next question is Q. 206 on page 69, which was not asked.

The next question is Q. 207 on page 69, which was not asked.

Q. 208. Comparing the plant of the Spring Valley Water Company as a water supply system for San Francisco with the water supply plant and system of the larger cities in the East, is there any variation in any particular between the relative cost of the two, that is to say, this plant located for San Francisco and the Eastern plant?

A. In many Eastern cities, the water is taken from streams or lakes which furnish them with their entire supply, irrespective of any storage. In those cases, no expense attaches to storage. In San Francisco at present, about one-half the water is obtained entirely through storage, (I do not consider Lake Merced at all in this answer,) the other half being taken from the Alameda Creek System, the low water flow of which at present supplies sufficient

water, but the necessity to increase the supply by artificial storage reservoirs, in a very few years, already exists.

Q. 209. Under these conditions, approximately what would be the differences in cost first in relation to stored water?

A. As it takes about five times the storage capacity here to furnish the same uniform delivery of water as it does in the East, it, naturally, will cost more here. I would roughly estimate it as a general proposition to be three times more here.

Q. 210. Now, in the second place, take the proposition of water in the East drawn from lakes or water courses of sufficient size compared with San Francisco and stored water?

A. In this case, of course, the additional expense in San Francisco would be that due to the provision of the storage reservoirs, none of which are needed in the other case.

Q. 211. Do you know of any other differences between the comparative cost of this plant and the plants in the East?

A. The cost of iron in California is materially greater than in the East.

Q. 212. In what respect?

A. The iron used here is brought from the East for the most part,

and, consequently, the freight is an additional item of expense.

Q. 213. Did you observe in Mr. Grunsky's reports upon the Tuolumne system that he speaks of the water supply of the Spring Valley Water Company to San Francisco as ~~being~~ ranking first in reliability of service to the extent of its capacity

A. Yes.

Q. 214. Did you also observe in that connection that he speaks of the Tuolumne system as ~~being of greater~~ ranking highest in quantity and better quality?

A. I did.

Q. 215. What is your opinion on those subjects of quantity and quality?

A. I am satisfied that your properties can be developed to yield as much, if not more, water than could be obtained from the Tuolumne water-shed as proposed? Regarding the quality, I am satisfied that the present Alameda supply has a better quality than would be found in the water from the Tuolumne after running through so long a ditch as proposed, and that the water from the peninsular system would probably be equally as good.

Q. 216. Did you also notice in Mr. Grunsky's reports on the Tuolumne scheme that he says that the Crystal Springs Lake and Lake Merced should be added to the Tuolumne scheme, the one as a storage reservoir and the other as an emergency supply?

A. I did.

Q. 217. Does he allow anything in his figures of the cost of the Tuolumne scheme, namely $39,531,000.00, for the acquisition of the Crystal Springs reservoir property and Lake Merced?

A.

Q. 218. Assuming that properties are owned by the Spring Valley Water Company in addition to properties already in use in supplying San Francisco with a combined capable product of 100,000,000 gallons per day including the 35,000,000 gallons per day already developed, what would be your estimate of the present value of the water rights, capable, when developed, of furnishing the 65,000,000 gallons of that 100,000,000 gallons per day?

A. $948,000 | 65 Mill will be used in 1945

Present value of water rights capable of furnishing the addit. 65 Million galls in 40 yrs

6%

$P = \frac{A}{(1.06)^{40}}$

$150,000 x 65 Mill galls in 1945 = $9,750,000

Present value is $948,000

CONFERENCE BETWEEN M.B.KELLOGG, ESQ., AND R.HERING, ESQ.

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SAN FRANCISCO, CALIFORNIA,

WEDNESDAY, APRIL 26, 1905.

------oOo------

CLEMENT BENNETT,
U.S.Official Reporter,
Mills Building, S.F.

h B B

CONFERENCE BETWEEN M.B.KELLOGG, ESQ., AND RUDOLPH HERING, ESQ.

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MR.KELLOGG. Q. I will ask you, Mr.Hering, if a brick or stone conduit under a gravity system, such as prevails on the peninsula here, is to be preferred to an iron pipe for the transportation of waters for the supply of this city.

A. A brick and stone conduit could only be preferred if the hydraulic grade of the water, meaning the height to which it would naturally rise, would not be higher than the location of such a masonry structure, because, unless it is in tunnel, such a masonry structure would not stand the pressure due to the water being below its natural hydraulic gradient, therefore it is necessary and customary to use ~~iron~~ metal pipe~~, or in some cases steel pipe~~.

Q. In speaking of the cost of the Chicago drainage canal, knowing the conditions under which it was constructed, the method of its construction, and the effect of its operation, to what items of expense should you say its cost was properly chargeable?

A. I should say the larger part of its cost should be chargeable to maintaining the purity of Chicago's water supply and the Lake shore. The remainder should be charged against navigation interests, because it establishes a large navigable water way between Chicago and the Mississippi River after the Illinois River and the Des Planes

River have been properly regulated.

Q. Are you aware from what fund the cost of that construction was produced?

A. I am.

Q. What was it?

A. It was produced by the establishment of what is sometimes called a blanket city, which was required according to the State Constitution, and covered the largest part of Chicago and some outlying lands. This new city was in this way authorized to borrow money, which was impossible for the City of Chicago, because this approached its debt limit

Q. Do you know how it borrowed this money -- on what security?

A. With bonds.

Q. Do you know if the interest on those bonds is chargeable to water rates which are collected in the City of Chicago?

A. It is not.

Q. Do you know the cost of that canal, approximately?

A. It has been so far pretty near $30,000,000.

Q. That brings me to a question relating to municipally owned plants. I would ask you if, from your experience, you are able to say whether the cost of water supplied to cities by municipally owned plants is charged at a rate which includes all the expense of the water supply, that is to say, with the interest on the bond issue, and matters of that character?

A. Certainly, all cities do not do this, and I believe very few,

if any, establish their water rates so as to fully and justly cover the expense of furnishing the water to the city and its inhabitants.

Q. Then, is it not a fact that the water rates, for the most part, in municipally supplied cities do not exceed the cost of the water supply?

A. That is true.

Q. Is it, then, in your opinion, fair to compare the water rates in San Francisco, where the water is supplied by private corporation, to the water rates in other cities supplied by the municipality?

A. It is not fair unless the rates in the latter cit~~y~~ies cover all of the legitimate expenses, as would be necessary in the case of a company supplying the water.

Q. I will ask you this question: How does the intensity of the rainfall in this locality compare with the intensity of the rainfall in the East, respecting and resulting in a run-off which is capable of salvage in a reservoir?

A. The rain falls in the East, during the heavy down-pours, are much more intense than here. The practical result is seen by the fact that the sewers of the cities here can be constructed for a much smaller run-off of the intense storms, which fixes their capacities, than in the East.

Q. Do you know of any practical illustrations of the fact which

you have just stated? If so, explain them.

A. As Consulting Engineer to the City of San Francisco during the time when the designs were made for the proposed sewerage system, I was obliged to look into this matter, and San Francisco is a practical illustration of what I have said. The sewers here can be built of less size per unit of area than in the East.

Q. Do you know of any report or recommendation by a local engineer on the subject of sewage of this city and county where this fact is illustrated by the sizes of the sewage conduit that he recommends?

A. The joint report of Mr.C.E.Grunsky + Mr. Marsden Manson will show this fact.

Q. Would the size of the sewers which ~~he~~ they recommend~~s~~ be sufficient to carry the run-off from intense storms in Eastern cities?

A. They would not be.

Q. Did you yourself personally examine into this question in relation to San Francisco?

A. I did.

Q. Did you find that same fact which you have spoken of to exist under your own investigations?

A. Yes sir.

Q. What is the ordinary percentage of run-off in the East? ~~under ordinary and intense storms?~~

A. The average annual run-off varies from 40% to 50% of the rainfall.

Q. From your investigations in this vicinage, what do you find to be the average annual run-off, and state the periods between which the investigation has been made.

A. The investigations were made from data collected between 1890 and 1903. For the Alameda Creek water-shed, it was found that the average per cent of rainfall which ran off was about 16%. On the peninsula, it was found that about 23% of the rainfall was collected in the reservoirs.

Q. Have you investigated to ascertain if the Crystal Springs reservoir can be utilized for the storage of water from the source commonly called the Coast streams, that is to say, the streams on the west of the summit of the peninsula range?

A. This reservoir can be so used.

Q. In what way -- how?

A. By turning into the samė the run-off from such Coast streams at an elevation sufficient to discharge the water by gravity into that reservoir.

Q. In your opinion, does this fact enhance in any way the general value of the Crystal Springs reservoir?

A. It certainly enhances its value because, if it were not in existence, another reservoir or reservoirs would have to be constructed for that purpose, if such water were to be collected and used.

Q. Have you made any allowance in your estimate of the value of the Crystal Springs reservoir based on that price?

A. I have not.

Q. You have been asked about the unit prices in reference to construction of water works in New York compared with this locality. I wish to ask you what that comparison is.

A. The prices here are generally larger than those prevailing in the East.

Q. Take the question of labor as a unit: How does that compare?

A. I understand that common labor here is rated at $2.50 for eight hours. This wage is materially greater than in the East. In New York, for instance, and in some other large cities, the wage rate is $2.00 for eight hours, and in the country districts it ranges from $1.50 to $1.75.

Q. How is it in respect to iron used in the construction of pipe?

A. Iron is more expensive here, because the freight is a large item in the expense.

Q. The same question in reference to water rights, and the reasons.

A. The water rights are not valued nearly so high in the East as they are valued here. In some cases they are quite insignificant, unless the water rights are utilized for power purposes or municipal supplies. and in the latter case they are not as large as here.

Q. I ask the same question in reference to reservoir sites.

A. There is ~~really~~ rarely a special value given to the water rights in the construction of a reservoir, although this is sometimes done. It is customary~~, though,~~ to pay a material advance over common

agricultural land, in case there is a very economical dam site and a good reservoir available for supplying water for either power or municipalities.

Q. How does such value in the East of reservoir sites compare with the value of reservoir sites in this vicinity, and state your reasons for your opinion.

A. In my experience, the value of reservoir sites on the Pacific Coast is much greater than the value for such sites in the East, and that is, in my opinion, clearly due to the fact that the rainfall is much less here and that a drought prevails for about one-half of the year. It is, therefore, a much more valuable property than in the East.

Q. The comparison between value or cost of riparian rights in the East and here, what do you say in reference to that?

A. They are also much less valuable in the East than here.

Q. Why?

A. For the reason that water is more abundant, and the streams flow more regularly and uniformly than here. I may also say that the volume of stream flow per square mile of territory ~~is~~ is less than ~~only about~~ one-half in this part of the country than what it is in the East.

Q. In the estimates which have been made regarding the prices of water in reference to New York City, are those estimates based on delivery of water at the houses, or how?

A. The estimates were based on the delivery of water at practi-

cally the city line, not including the cost of the distribution system.

Q. Have you made any estimates of the relative cost of storage water in this vicinity compared with the Eastern cities?

A. The relative cost of storing water in a reservoir in this country, which has five times the capacity of an Eastern reservoir, would be about three times as much as in the East, assuming that the cost varies approximately as the surfaces of the reservoirs.

Q. Why do you say that the storage capacity required here is five times greater than in the East for the same general average requirements?

A. Because of the different character of the rainfall.

Q. When was the report of the so-called Merchants' Association made?

A. In 1900.

Q. You have read Mr. Schussler's testimony in reference to the localities, and the number of those localities, from which he was obliged to take clay for the construction of the core wall of the earth dam, and also for the general fill of the earth dams, did you?

A. Yes sir.

Q. Considering those facts, which are undisputed, would you deem it prudent and economical and advisable, in such a local situa-

tion, to substitute for men and teams, the use of aerial tramways and the steam shovels?

A. I would not.

Q. Why?

A. Because of the expense necessary in frequently shifting the plant. Such aerial trams are economical only when large masses of material are to be handled at one place.

Q. You have familiarized yourself with the tunnels that are utilized by the company in its plant, and their size, etc. I would ask your opinion of the feasibility and economy in using power drills in running those tunnels compared with the method in which they were described by Mr. Schussler as being built.

A. The rock here is not very hard, and the tunnels are rather small. These two considerations would make me say that I do not believe power drills would be very economical, if they would at all reduce the expense of hand drills, and I do not see any error in estimating the cost on the basis of hand drills.

Q. In estimating the value of the water-shed surrounding Lake Merced, I notice that you placed the same value upon it that you did upon the water-sheds in the country, that is to say, $100 per acre. I would ask you if you are not aware, from your own investigations and observations, that that water-shed land about Lake Merced is worth more than $100 per acre, considering its vicinage to the city proper as built up.

A. I should say that this land, if available for residence pur-

poses, would be worth many times the $100.

Q. Have you not observed that in the vicinity north and east of this land, residences are built?

A. I have observed that.

Q. Do you think that this land can be acquired or re-acquired to-day for the purposes of this company, at the rate of $100 per acre?

A. I should not suppose that it could be acquired for such a sum.

Q. Then, is not your estimate of $100 an acre under its real value at the present time?

A. It is decidedly under its real value for residence purposes in San Francisco.

Q. If it was to be acquired to-day for the purpose of a water-shed to Lake Merced, would it not be, for that reason, more valuable than $100 per acre on the question of mere re-acquisition?

A. I do not believe that it would be possible to secure it to-day for that sum, or several times that sum per acre.

Q. You were asked in reference to your valuations of the rights-of-way and land. I will ask you if, in reference to those two matters, namely, rights-of-way and land, and all other matters connected with your valuations of the property of this company where you followed or adopted the figures that Mr. Schussler had given, did you give the matter personal investigation, or blindly adopt his figures?

A. I did not blindly adopt them. I went over all the items carefully, and put down whatever figures I thought were proper. If I could agree with the figures put down by Mr.Schussler, I put them down exactly as he had them. Where I disagreed, I put my own figures down and so obtained my own total.

Q. You remember Mr.Grunsky's report on the Tuolumne, do you not?

A. I do.

Q. What is the date of that report?

A. July 28, 1902.

Q. Practically three years ago?

A. Yes sir.

Q. Has there been any change since the date of that report and that estimate in any of the items which go to make it up, such as labor and the like?

A. I am under the impression that the price of labor here has increased since then.

Q. Any other items?

A. The value of lumber has also increased here as well as in the East.

Q. In reference to Mr.Grunsky's report, you expressed some differences of opinion concerning the allowances which he had made for certain costs, and some other factors which were included in his report. I would ask you to tabulate them concisely.

A. First, I think he has underestimated the future population of

San Francisco. I also consider that he has underestimated the cost of wrought-iron pipe, such as I would approve of laying and such as he recommends. Third, he has not made any allowance for the interest of the money required for the construction and before rates could be collected. Fourth, the open channel which he recommends to be built between Dry Creek and Cherry Creek, I could not approve for furnishing the excellent water which is desired. In my opinion, the water flowing in so long an open channel, generally on a side hill, about 27 miles exposed to pollution from animals, as well as leaves and vegetable refuse, and also to surface washing, would very materially lower the quality of the water. Fifth, I do not believe, in view of the experience we have had in the East, that the water stored in the Hetch Hetchy Valley, upon the present large accumulations of organic matter, would remain in a good condition. The Hetch Hetchy Valley, as well as others in similar locations, would be very warm during the summer months, and the water would partake of this temperature, and there would be a decomposition of the accumulated organic matter in this water, so that it would not be preserved in its present pure condition. In the East we are, in almost all cases, endeavoring to remove all such large accumulations of organic matter from reservoir sites. If it were too expensive to excavate ~~out~~ all of this organic matter, an alternative expedient would be the filling in of clean sand or gravel to a proper depth, and thus forming a new and clean reservoir bottom.

Q. You are aware that Mr.Grunsky, in his estimate, makes the following figures: "Lands and litigation, water rights and rights-of-way outside of San Francisco, $918,000".

A. I am.

Q. From your experience, investigations and observations in this vicinity, what have you to say of the probability of the correctness of that estimate?

A. I think it is very much underestimated. In the first place, the Belmont ~~and Altamont~~ reservoir site~~s~~, it seems to me, could not be purchased for a sum less than $1000 an acre on the average. I further believe that at least two-thirds of the entire pipe line would have to be laid upon purchased rights-of-way. Mr.Grunsky evidently cannot allow anything for the water rights and reservoir property of the Hetch Hetchy Valley and Eleanor Lakes. Whether or not these could be obtained free of expense, I do not know.

Q. Assuming that they could be obtained free of expense, does that make their value nothing?

A. It would not reduce their value, but only their cost to the city; therefore, taking all these items into consideration, I believe the item of $918,000 is very much underestimated. I also think the cost of road construction is underestimated, and no estimate has been made for excavating the mud or filling it over with clean material, in the Hetch-hetchy valley, nor has any estimate been made by him for laying

wrought-iron pipe between Dry Creek and Cherry Creek, which would be at least $5,000,000 more than the expense which he has estimated for the canals.

Q. Now, in adding to his estimates, what items have you used showing an increase in cost?

A. In my estimate of the least possible cost of the Tuolumne project, I added only two sums; namely, $12,694,000 obtained from what I believe is the difference of cost of making and laying the wrought-iron pipe between the city and Dry Creek, as estimated by Mr. Schussler and myself. I also added a sum representing interest during construction. I think that was $2,800,000.

Q. Now, in reference to the $12,694,000 concerning the iron: Did that relate solely to the extra cost of the iron, or did it relate to a third or safety pipe?

A. It did not relate to any third pipe, but merely to the cost of material, manufacture, delivery and laying complete of the two wrought-iron pipes recommended by Mr. Grunsky.

Q. In Mr. Grunsky's report, on page 242 of the printed report, did you notice that for the year 1908 he estimated a total annual consumption of 11,830,000,000 gallons in this city?

A. I did.

Q. How much is that per day?

A. That is 32.4 million gallons.

Q. According to the consumption of water by the City and County from the works of the Spring Valley Water Company, when was that estimated period actually reached?

A. From the records I notice that it was reached shortly after the expiration of 1903.

Q. What was the consumption for 1904, according to the records?

A. 12,379,000,000 gallons, in round numbers, which is almost as much as Mr. Grunsky gives for the year 1913.

Q. What was his figure for the year 1913?

A. 12,726,000,000 gallons

Q. Then, his estimate in regard to consumption was how many years under at the end of 1904?

A. About eight years.

Q. Have you read Mr. Grunsky's appraisement of the property of the Spring Valley Water Works, made on February 25, 1901, in reference to the quality of the workmanship on the works of the Spring Valley Water Works, and the materials and the care in construction?

A. I have.

Q. What does he say on that subject?

A. He says, "The quality of workmanship on the works and struc-"tures of the Spring Valley Water Works is commendable through-"out. The materials used are selected with care. Special care "and extra cost has not been shunned in important cases to se-

"cure the best. This is doubly the case in the pipe work and "in the concrete and in the masonry structures".

Q. Do you remember Mr. Grunsky's remarks in his report upon the comparative advantage and disadvantage of a remote or near supply?

A. I do.

Q. What were those remarks?

A. He says in his report: "It follows, therefore, that remote-"ness of a supply is a disadvantage, and that between any two "practically equally distant sources the one is to be preferred "which can be made available by the most reliable and the most "permanent works.

" In this connection, there is also to be considered the "fact that in one case works may be of a character whose relia-"bility has been established by experience and practice and con-"cerning the construction of which and the character of service, "quality and quantity of water, no reasonable doubts can be en-"tertained. Such works are to be preferred to works not yet "constructed and particularly to works which involve departure "from ordinary practice and whose execution and maintenance is "at more than ordinary risk.

" Many other things may be brought into the comparison, as, "for instance, the facility for the gradual increase of the ca-"pacity of conduits or other appliances required for the delivery

"of the water in order that the delivery may keep pace with the "growth and growing needs of the municipality. A system that "must at once be constructed of a capacity to meet the probable "requirements fifty or more years in the future may prove rela- "tively expensive, and this may be rated as a disadvantage when "compared with one which permits an installation which, though "adapted to immediate requirements, is still capable of expan- "sion as occasion arises." I quite agree with these opinions

Q. What would be the relative relations between the properties of the Spring Valley Water Company and the proposed Tuolumne scheme, in the way of estimates of value or cost, when the daily consumption attains the figures of 75,000,000 gallons?

A. I have made a rough estimate of cost as to what the Tuolumne project would then have cost the city, provided that a third pipe is laid, which would be necessary. I have also made an estimate of cost for additional structures which would be required to furnish 75,000,000 gallons daily, namely, 30,000,000 gallons from Calaveras and 10,000,000 gallons from San Antonio. These estimates are but rough approximations. The Tuolumne project would cost, I think, not less than $80,000,000; whereas, the additional works for the Spring Valley Company would probably not exceed a cost of $15,000,000, which, added to ~~the~~ my valuation of the present works, would amount to a total of $60,000,000.

Q. You have been asked in cross-examination, if you made a report upon the Tacoma water works system and supply in 1892, what has occurred since that time to render ~~anything, and if so, what,~~ your valuation given in your report, incorrect or erroneous in any respect.

A. Nothing so far as I know. My estimate of the value of the material or tangible property, excluding land and water, I find, was $884,650, including a new conduit, which was to be, but which was not, built, estimated by me to cost $109,150, leaving a net value of $775,500. I refused to give any estimate of value for land, water or franchise, because this was, as I stated in my report, (which is here an exhibit) a matter of business and not of engineering, and could be better determined by local parties. The Mayor, who ~~has been~~ was an engineer, asked me privately for my personal opinion, and I told him that I thought an amount equal to 25% to 35% of the tangible value might be a fair value for such property, but I might be entirely mistaken. The City Council ~~decided to, and did~~ concluded to pay instead about 125% of the tangible value in compensation for land, water and franchise. A cry of fraud went up, and a litigation ensued, lasting several years, with the result that the city recovered about $788,000, which left ~~a~~ the value for land, water and franchise to be about 24% of the value I had given for the tangible property stated by me.

Q. You were asked to examine one of the exhibits filed herein on behalf of the defendants, or several exhibits, perhaps, and to state the distance from railroad lines to the proposed pipe

line of the Tuolumne system, and you answered these questions, giving the nearest air line distance. I would ask you if you know or could ascertain from the map which was submitted to you the distance, or the average distance, of the proposed pipe line from stations on the railroad.

A. I could not. When I spoke of the inaccessibility of a portion of the conduit lines, I had in mind the upper conduits which I should have constructed, or should have recommended to be constructed, namely of iron or masonry, but which Mr. Grunsky ~~has~~ had recommended ~~as an~~ take open earth channels and so estimated the cost.

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