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Artesian Waters of Oahu

In 1909 Mr. Marston Campbell, then Superintendent of Public Works, was so impressed with the necessity of conserving the artesian water supply of Oahu that while in Washington he took steps to have a man come to Hawaii to make a thorough study of the artesian water and report upon it. Mr. Campbell had already collected some valuable data and information. Mr. Mendenhall, the Engineer appointed to undertake the work, spent several months here, but as it was necessary for him to return to Washington, I was asked to continue the work.

In this paper I shall try to present some of the points brought out by these researches, observations and investigations.

The first artesian well was sunk at Honouliuli in 1879 by Mr. James Campbell, who foresaw the great possibilities of the dry lands of Oahu if good water could be brought to them. This well was about 15 feet above sea level; it was sunk to a depth of 273 feet and gave a good flow of water; it probably flowed to 33-35 feet above sea level.

He drilled for other wells at considerably higher elevations but did not get flowing water. He then sunk a well at the base of Diamond Head, near the sea, to a depth of 1,500 feet, but struck only salt water, which did not rise much above sea level. Meanwhile, Mr. Marques in 1880, sunk the first flowing well in Honolulu, at Punahou. This well was sunk to a depth of 295 feet and rose to a little over 42 feet above sea level. It had a good flow of excellent water, and as it was near the city, it caused considerable interest and many came to see it.

Then the Government, Judge McCully and others, began sinking wells with the view to getting water for irrigating and domestic purposes. What is known as "the King's well" was sunk on the south slope of Round Top, at an elevation of 200 feet, but although they went down 970 feet, flowing water was not obtained. The Government Makiki well, elevation of 150 feet, was dug to a depth of 900 feet with the same result—the water did not flow.

These, together with other tests, seem to demonstrate that the artesian head in and around Honolulu was not much over 42 feet, and that if flowing wells were desired, they must be sunk below the 42 foot elevation.

In the sinking of these early wells considerable scientific interest was manifested to learn more of the geological formation of Oahu, and to gain more information concerning the artesian basin. A number of logs of the wells were kept. Professor Alexander assisted in gathering them, and Dana made use of them in his work.

Different ones from time to time have written upon the subject. W. L. Green speaks of it in his "Vestiges of the Molten Globe;" Judge McCully wrote on Artesian Wells in Thrums Annual of 1882; and Mr. Thrum in the Annual of 1889 gave interesting statements concerning the wells. Grisley Jackson made a graphic map showing the stratification passed through in digging some of the wells. Dr. Hitchcock makes use of the information in his "Hawaii and its Volcanoes;' and Carl Andrews wrote a thesis on the Geological Structure of Southeast Oahu. The Ewa and Honolulu Plantations have conntributed valuable information, as have Kahuku, Waialua and Oahu. The McCandless Brothers have assisted by giving information and data based on their experience.

The following are some of the strata passed through in drilling some of the wells:

PUNAHOU

Surface Clay	0-5
Rough volcanic deposit like cinders	5-11
Black sand	11-25
Yellow sandy clay	60-73
Black soft rock	25-60
Black clay	73-80
Blue Clay	80-107
Coral	107-112
Gray clay	112-170
Hard black rock	170-174
Soft black rock	174-189
Soft red rock	189-205
Soft black rock	205-207
Hard black rock	207-220
Soft black rock	220-302

Total depth 302 ft. Cased to 190 ft.

Distance from Marques Well, 117 ft.

CENTRAL HONOLULU

	Feet
Black sand	10-
Boulders	10-20
Punchbowl Rock (Red)	20-30
Boulders	30-35
Punchbowl Rock (Red)	35-75
Coral	75-210
Clay	210-370
Coral (dark)	370-405
Clay and Gravel	405-415
Clay and Coral	415-460
Sand and Gravel	460-470
Blue Lava Rock	470-510

12″ Casing 487 ft.

Red rock (water)	510-540
Blue rock	540-580
Red rock	580-590
Blue rock	590-607

Bottom 607′ 6″.

CENTRAL HONOLULU, ALONG COAST

12 inch Casing

Clay	0- 5	feet
Coral	5- 110	"
Clay	110- 145	"
Boulders	145- 150	"
Clay and Boulders	150- 160	"
Boulders	160- 165	"
Boulders and Clay	165- 190	"
Clay and Coral	190- 210	"
Coral	210- 260	"
Coral and Clay	260- 275	"
Coral	275- 330	"
Clay	330- 350	"
Clay and Coral	350- 445	"
Clay (sticky)	445- 465	"
Clay (sandy)	465- 480	"
Coral	480- 490	"
Clay	490- 520	"
Coral	520- 560	"
Clay	560- 660	"

Clay and Gravel	660- 690	"
Clay	690- 730	"
Black Mud	730- 755	"
Clay	755- 810	"
Hard Blue Rock	810- 840	"
Soft Blue Rock	840- 845	"
(flowing water)		
Hard Blue Rock	845- 900	"
Blue rock in streaks of hard and soft	900- 960	"
Hard Blue Rock	960-1080	"
Medium Hard Blue Rock	1080-1150	"

WELL AT FORT SHAFTER

Sand, loam and boulders	0- 13
Yellow Clay	13- 50
Red Clay	50- 53
Yellow clay	53-119
Gravel	119-122
Yellow clay gravel	122-140
Gravel	140-144
Yellow clay	144-157
Hard rock	157-171
Soft reddish rock	171-281
Hard rock	281-286
Hard rock	286-290
Water rock	290-298
Water rock harder	298-302

HONOLULU PLANTATION

Depth ft.	Strata
25	Boulders
125	Soft brown lava
5	Blue rock
5	Blue clay
15	Blue rock
10	Soft brown rock
15	Blue rock
10	Red rock
5	Soft blue rock
17	Blue clay
25	Blue lava
25	Blue rock
15	Red rock
10	Blue rock
5	Red rock
13	Blue rock
5	Red rock
20	Blue rock
17	Grey rock
83	Blue rock
25	Brown rock
25	Blue rock
5	Red rock
5	Blue rock

510 feet deep.

130 feet casing.

HONOLULU PLANTATION

Depth ft.	Strata
20	Coral Slab
10	Brown Clay
30	Coral
40	Clay (brown)
80	Coral
340	Brown clay
8	Brown rock
15	Blue rock
8	Red rock
15	Water rock
16	Blue rock
18	Water rock
8	Blue rock

608 feet deep

520 feet casing.

EWA

(Pump No. 7)

1- 90	Soil
90-105	Red rock
105-210	Blue rock
210-220	Red rock
220-235	Blue rock
235-240	Red rock
240-255	Hard blue rock
255-260	Red rock
260-295	Hard blue rock
295-305	Red water rock
335-375	Blue water rock
375-390	Hard blue rock
390-405	Blue water rock
405-415	Hard blue rock
415-445	Blue water rock
445-450	Red water rock
450-472	Hard blue rock
472-475	Red rock

130 ft. Water Rock.

108 ft. 12″ Casing.

(Mill)

1- 15	Soil
15-110	Coral
110-130	Brown clay
130-135	Coral
135-140	Brown clay
140-160	Coral
160-190	Brown clay
190-235	Coral
235-330	Brown clay
330-370	Coral
370-400	Brown clay
400-410	Coral
410-435	Brown clay
435-450	Red rock
450-475	Blue rock
475-485	Red water rock
485-515	Blue water rock
515-520	Red water rock
520-600	Blue water rock
600-601	Red rock

125 ft. Water Rock.

450 ft. 12″ Casing.

(Mill)

1- 20	Soil
20- 40	Coral
40- 50	Brown clay
50-110	Coral
110-125	Brown clay
125-140	Coral
140-150	Brown clay
150-180	Coral
180-200	Brown clay
200-240	Coral
240-345	Brown clay
345-365	Coral
365-435	Brown clay
435-450	Red rock
450-520	Blue rock
525-600	Blue rock

Bottom Hard at 600 ft.

12″ Casing to 451 ft.

LAIE WELL IN KOOLAU

4 ft.	Soil	
4 ft.	Coral	8 ft.
20 ft.	Clay	28 ft.
4 ft.	Boulders	32 ft.
12 ft.	Clay	44 ft.
6 ft.	Boulders	50 ft.
96 ft.	Clay	146 ft.
154 ft.	Lava or bed rock..	300 ft.

When the last Beretánia well was dug, samples were kept of all the strata passed through, and a record made of the depth of each. In order to show this stratification clearly, a long glass tube was filled with material taken from each stratum in the order and to the proportionate depth as actually passed through. It will be seen that there is a layer of coral more than 100 feet thick; then an equal layer of clay; and after going through various other strata we come to the hard lava rock which lies just above the porous water-bearing rock. This water-bearing rock is so porous you can blow through it. This seems to indicate that the artesian basin is not an under-ground lake as many suppose, but a porous rock stratum charged with water under pressure. Below this porous rock there is found a layer of hard lava rock, which with the layer above, confines the water-bearing strata.

If the water passing through the porous water-bearing rock can find its way to the sea as fast as it runs in, there will be no artesian head,—a well sunk at this point will not flow; if, however, the incoming water from the mountains is backed up by an obstruction, such as a semi non-porous stratum, there will be an artesian head, and if a well is sunk at this point the water will rise to a definite height above sea level.

In and around Honolulu the water rose to a little over 42 feet above sea level; around Ewa, we believe it rose to 33 to 35 feet.

Location and Dip of Artesian Basin

In sinking the artesian wells, it has been found that the water-bearing stratum runs at an angle from the mountains to the sea, and the nearer to the mountains the wells are sunk the nearer to the surface is the water-bearing stratum. In central Honolulu, near the sea, this stratum is 800 to 900 feet below sea level; as it approaches the mountains it rises, till at Makiki, at an elevation of 150 feet, it is about 120 feet below sea level. By following the

direction of the water-bearing stratum there would be a point where the stratum would be at or near the surface, where and above which, it receives its greatest amount of rainfall.

The artesian head (the height the water will rise in the well above sea level) in the Honolulu district was formerly about 42 feet, so that the impervious strata that prevent water from entering or leaving the artesian basin must begin above the height of this artesian head—42 feet. Probably the character of the rock at the surface of the outcropping of the artesian water-bearing stratum is very porous. It might be worth while for the Government to try to locate this out-cropping in the mountains and to tap it at, or a little below this point; and to direct the surplus surface water into the artesian basin; or to locate the pumps near here instead of at lower levels.

Relation of Rainfall to Artesian Head

For a number of years a record of the height of its artesian well has been kept at Oahu College. In considering these records and comparing them with the rainfall records for the corresponding time, it was found that there was a marked relation between the height of the artesian head and the rainfall. For the past three years I have taken records of the heights of certain artesian wells for the Department of Public Works, and have made comparative observations from the rainfall records. I find the same relation exists, that is, during the rainy season the height of the artesian head rises; in the dry season it falls, and the rise and fall is approximately in proportion to the rainfall, tho it must be taken into account that the pumps make their heaviest draft on the artesian basin during the time of least rainfall.

There is evidence enough to make me feel certain that for our particular local conditions the artesian water supply is directly influenced by the rainfall. In general, it is not so much the great amount of rainfall that keeps the basin supplied, as it is good supply evenly distributed as to time. For example, there might be heavy rains in the winter months and very light rains in the summer, making the total rainfall for the year high; but the artesian head would be lowered more than if there had been a moderate amount of rainfall more evenly distributed throughout the year, although the total rainfall in this case might be less.

RECORD "E"

Height in Feet Above Sea Level to which Water Rises in Artesian Wells. June 1911 to December 1912.

		June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mch.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
27.	Govt. Stables	31.70	31.40	31.10	31.10	30.85	.....	.....	31.30	30.91	31.00	30.66	30.10	29.45	28.80	28.65	28.17	28.10	28.22	28.50
42.	Mo Hop	25.09	25.24	24.50	25.05	25.10	.....	.....	26.20	24.95	25.38	25.14	24.03	24.10	24.65	23.47	22.99	23.06	24.51	25.71
50.	L. D. Y.	24.90	25.00	24.28	24.87	24.90	.....	.....	26.10	24.65	25.20	24.98	23.85	23.92	24.41	23.15	22.70	22.80	24.35	25.65
57.	Sing Loy	31.95	31.96	31.48	31.20	31.38	.....	.....	31.85	31.45	31.60	31.16	30.61	29.85	29.25	28.98	28.50	28.40	28.65	29.24
95.	O. R. & L. Co.	31.92	31.72	30.32	31.30	31.50	.....	.....	31.90	32.20	32.10	31.44	31.00	30.42	29.47	29.52	29.22	28.82	29.04	29.57
100.	Ah Yin	31.00	30.96	30.50	30.40	30.57	.....	.....	31.03	30.91	30.87	30.64	29.96	29.11	28.81	28.35	28.11	27.70	28.16	28.75
110.	Young Hotel Gardens	30.13	30.03	29.83	30.00	29.33	.....	.....	29.68	28.95	28.73	29.18	28.78	28.29	27.38	27.33	27.13	27.18	27.53	28.27
119.	Mr. Damon	28.30	28.11	27.33	27.15	27.23	.....	.....	27.42	27.42	27.60	27.38	26.46	25.96	25.62	25.25	25.16	24.88	25.34	26.17
172.	L. L. McCandless	23.34	23.12	22.27	22.15	23.12	.....	.....	22.75	22.37	22.47	22.42	21.08	20.53	20.22	19.92	19.62	19.55	20.92	21.22
199.	Sing Chong	20.50	20.25	19.62	20.05	19.70	.....	.....	19.25	19.55	19.45	19.20	18.10	18.19	17.45	17.15	16.95	16.90	17.10	18.49
234.	Waipahu	21.92	21.32	20.22	21.00	20.40	.....	.....	20.67	21.80	21.22	20.42	19.35	18.60	18.22	18.12	17.92	17.63	18.12	19.22
273.	Honouliuli	22.89	22.89	21.00	21.94	21.50	.....	.....	22.27	22.30	22.29	21.89	20.84	20.08	19.79	19.36	19.02	18.89	19.65	20.89
	Waialua	11.98	12.00	12.44	12.26	12.41	.....	.....	12.52	12.47	12.42	12.14	12.02	11.97	11.72	11.62	11.46	11.45	11.67	12.12
	(a) Kahuku	1.30	1.27	1.25	1.30	1.62	.....	.....	1.66	1.62	1.23	1.46	.51	.62	.54	.56	.29	.61	.96	1.00
	Hauula	20.68	20.60	20.50	20.60	20.81	.....	.....	21.27	21.15	20.80	20.96	20.37	19.96	19.37	20.03	19.57	.....	19.76	20.26
	* Oahu College	32.00	32.00	31.50	31.10	31.30	30.90	31.65	31.65	31.50	31.60	31.40	30.90	.....	29.70	29.25	28.90	28.40	28.52	29.25
		31.75	31.70	31.15	31.00	30.90	30.80	30.90	31.55	31.40	31.50	31.03	30.50	.....	29.35	28.92	28.47	28.25	28.25	28.52
	*Beretania Pump	32.12	31.90	31.32	31.04	31.19	30.84	31.33	31.66	31.52	31.56	31.39	30.83	30.43	29.68	29.31	28.98	...**	82.54	29.12
		31.80	31.60	31.13	30.92	30.83	30.65	30.75	31.41	31.37	31.43	31.00	30.43	29.82	29.27	28.96	28.83	...**	28.44	28.65

* Maximum and minimum for the month given.

** Not taken in October.

(a) Bench mark was unsatisfactory; accurate survey has not yet been made. Height taken above flange on well.

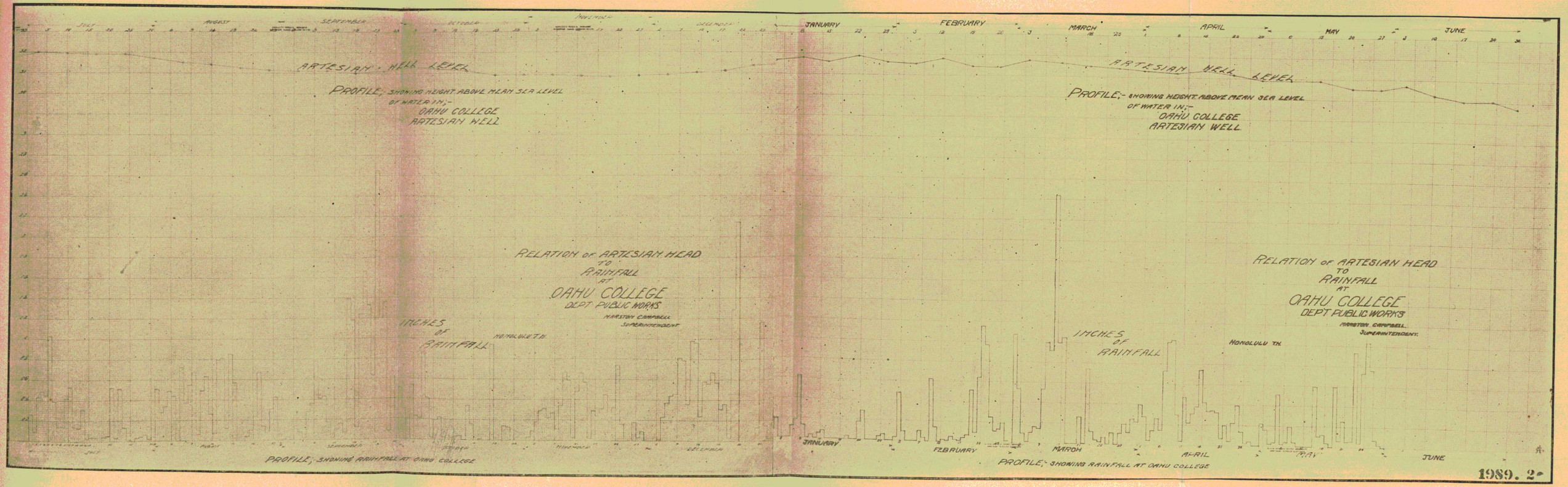

CHART SHOWING RELATION OF RAINFALL TO ARTESIAN HEAD

Local Artesian Basins

Many believe that one great artesian basin supplies the Island, while others maintain that there are a number of basins, and each basin may be confined to one valley. My observations incline me to the latter belief. At present the artesian head in Moiliili is from 22 to 26 feet above sea level; in Punahou and central Honolulu, it is about 28 to 30 feet; at Moanalua, about 25 feet; at Waiamalu about 20 feet; at Pearl City, 18 to 19 feet; at Waipahu, about 20 feet; and at Honouliuli about 22 feet. These differences are one indication that there are separate basins. To further substantiate this, our records have shown that there is an uneven rise and fall in adjacent basins. Those who support the theory of one great basin claim this difference of heights in the artesian head is caused by the difference in porosity of the water-bearing strata, so backing up the water to different levels. There have been isolated instances, I believe, of water being struck in a valley while a few hundred feet away on the ridge of the spur no water was found.

Belt of Flowing Water

On Oahu, no flowing wells have been found East of Diamond Head toward Waialae, nor on the corresponding side at Waimanalo. From Diamond Head to the Nanakuli Ridge, flowing wells can be obtained at almost any point along the coast; from Kawaihapai to above the Haleiwa Hotel, flowing water has been found in abundance; then from Kahuku to Punaluu, there is a good artesian basin which is supplying a number of flowing wells. It may be that at Waialae and at such places as Waimanalo, there is a deep under-ground flow of water from the mountains to the sea; but its progress to the sea is not impeded by a sufficiently impervious strata to back it up into an artesian head. I have not enough facts regarding this section to form an idea of the extent of the under-ground supply.

Although most of the wells have been sunk within a narrow belt along the sea, the artesian basin extends considerable distance inland, as is shown by the well near the Railroad Quarry on the line going to Wahiawa. From all reports I am able to gather, I am of the opinion that this well is tapping the artesian basin, although it is a number of miles inland.

Gradual Fall of the Artesian Head

For the past 15 or 20 years there has been a gradual fall of the artesian head. We have not sufficient records to show what the fall has been outside of the Honolulu basin (Moiliili, Punahou Central Honolulu, Palama and Kalihi), but from the facts gathered we judge the fall has been about the same as that of the Honolulu basin, so that what is said regarding it would probably be applicable to the other artesian sections of the Island that have been heavily drawn upon.

At the sinking of the Marques well in 1880 the artesian water rose to a little over 42 feet above sea level. Between 1880 and 1882 the Ontario, Kewalo, Ward, Thomas Square and Palace Yard wells were sunk. These, and other wells drilled in the Central Honolulu basin about this time, showed an artesian head of about 42 feet. At the present time the artesian head for this basin is about 28 to 30 feet, showing a total fall of more or less 14 feet.

It has been difficult to find out exactly when the artesian head began to fall. Mr. Wilson, then Superintendent of Water Works, says, referring to the drought of 1889: "The water in the Palace Yard well fell during the drought 2 feet and 3 inches. Since the break-up of the drought it has regained its full original height of 42 feet 9 inches above sea level for the first time since its first fall." Mr. Wilson's notes show that the Wilcox Well, at Kalihi, fell 2 feet 2 inches; during the rains after the drought it rose, but its normal height was not known.

In 1889 there were 47 wells in the Kalihi, Central Honolulu and Moiliili basins. We estimate the average daily flow from these wells to have been from 12 to 15 million gallons. This flow was evidently not enough to permanently lower the artesian head since after the drought broke up, it returned to its original height.

Between 1890 and 1899 the artesian head fell over 6 feet, standing in March 1899 at 35.75 feet above sea level. This fall was due to a series of droughts from '91 to '94, and to the draft on the artesian wells, which for this time was estimated to have been about 25 million gallons daily. From 1899 to 1913 the artesian head has fallen about seven feet with an estimated flow of about 35 million gallons in 24 hours.

The fall of the artesian head for the past 20 years has been at an average of .4 to .5 of a foot annually. During the last season it fell to 28 feet above sea level, which is the lowest on record.

Number of Wells

There have been about 500 wells sunk on the Island of Oahu. A number of these are either dead or have been abandoned. It has been variously estimated that the output from these wells, including pumped and flowing, is from 300 to 350 million gallons per 24 hours. Some have put it even higher. It has been figured that there is enough water drawn annually from all the artesian wells on Oahu to cover the Island (600 square miles) to a depth of one foot; or to make a lake 20 miles long, 3 miles wide, 10 feet deep. This seems to me a little high. It is not surprising that so vast an amount of water drawn from our supply is little by little lowering our artesian head.

The early wells were 6″ in diameter; later an 8″ well was sunk, and today the 10″ and 12″ wells are most common. The 6″ flowing well with a good head will deliver about 4 to 5 hundred thousannd gallons in 24 hours; the 8″, about 7 to 8 hundred thousand gallons; the 10″, 1 to 1¼ million gallons; the 12″, 1½ to 2 million gallons; a few have been measured delivering 3 million gallons in 24 hours.

Quality of the Water

The waters from the various wells differ widely in mineral content. Some are very soft, containing only a little lime and common salt, while others contain comparatively large quantities. The salt content, of greatest interest to the agriculturist, varies from about 5 grains to 30 grains. Waters have been analyzed containing only 3½ grains of salt, and others have contained 75 to 100 grains. One well contains so much that they are using the water to extract the salt from it; it contains 1600 grains per U. S. Gallon.

The following is the mineral analysis of a good artesian water:

Insoluble residue	2.10
Volatile matter	1.63
Iron and Alumina	traces
Calcium Sulphate (Ca So4)	1.19
Calcium Carbonate (Ca Co3)	1.16
Magnesium Carbonate (Mg Co3)	.93
Magnesium Chloride (Mg Cl2)	1.17
Sodium Chloride (Na Cl) Common Salt	4.85
Potassium Sulphate (K2 So4)	.52
Total Solids	13.55
Salt estimated from total Chlorine found in water	6.40

From a sanitary standpoint, most of the artesian waters are good; many are excellent, containing very few bacteria—so few, judging from our tests, that we are inclined to think that the water in the well is free from bacteria. The waters are rather high in nitrates; in most cases nitrites are absent; the albuminoid ammonia and free ammonia are comparatively low; and although the salt content for drinking water is high, compared to surface water, it is due to the inherent quality of the water and not to contamination.

Analysis of an Average Artesian Water

Location of sample, Kalihi.
Total solids, 220.
Char, Very little, grayish.
Loss on ignition, 40.
Residue, 180.
Chlorine, 70.
Hardness, 76.
Required Oxygen, .1500.
Free Ammonia, .0450.
Albuminoid Ammonia, .0150.
Nitrates, .1500.
Nitrites, .0000.
Alkalinity, 104.
Bacteria per cc., 25-35.

Temperature of Water

From a good many tests, it has been found that the artesian water, as it appears at the surface, is about 70° to 73° F. No wells have been found where the temperature was unusually high or low.

Depths of Wells

The depths vary from 160 to 1100 feet, though there are few wells at 160 or 100 feet, the majority varying from 300 to 700 feet. The strata passed through is usually surface soil, black volcanic sand and some soil again; a thick layer of coral (sometimes 100 feet thick); then a thick layer of clay; then a thinner layer of coral or coral and clay mixed; then clay; then a hard basaltic rock which varies as to depth; then the water-bearing rock which is porous and often reddish; then underlying this, another layer of hard lava rock; then under this usually another water-bearing strata.

There are stretches where no coral is struck, and there are places where there is no black sand. In the new well at the Kaimuki Pump the strata passed through was only hard rock and clay; water was struck here at 120 feet.

The early wells were cased with a thin casing, which in many wells did not go down to bed rock. Today it is the custom to run a thick casing down and into the bed rock, and from there on the well is left uncased, so that the water from the water-bearing stratum may collect.

Cost of Drilling

The cost of drilliing is variable, depending on the depth and, if possible to know it, upon the strata to be passed through. Wells are sunk according to different contracts—by the foot, or until a certain quantity of water is obtained, and other similar arrangement. The cost varies from $4.50 to $8.00 per foot to sink a well, so that an average well of 500 feet would cost about $2,500. Contracts have been made at a lower cost.

Pumping Water from Artesian Wells

By far the greater amount of water drawn from artesian wells is by the large pumping plants. A plantation like any of our large ones on Oahu, may pump from 60 to 80 million gallons of water in 24 hours. The water is raised up from a few feet to as high as 500 feet. It costs about $8.00 to $10.00 to raise 1,000-000 gallons of water 100 feet elevation It is said it requires about 2,000,000 gallons of water to grow the cane for one ton of sugar. There are probably about 30,000 acres of cane on the Island of Oahu under artesian well irrigation; and one acre may produce from 50 to 80 tons of cane. There are of course instances where it is more or less.

The pumping plants of a big plantation may cost $1,000,000, and perhaps $300 to $500 a day to run them. The fuel oil required to raise 1,000,000 gallons of water may cost as much as $6.00 to $6.50.

A number of different kinds of pumps are in use here, prominent among which are the Reidler, the Blake, the Worthington, Centrifugal and Turbine. Some of these are capable of raising from 6 to 10 million gallons of water daily. They draw on a nest of wells which are connected up to one tunnel or well head; and in order to have the suction pipe as close to the supply as possible the pumps are often located in pits 10 to 30 feet deep. The Babcock & Wilcox, Heiney, Cederholm and tubular boilers are used.

Effect of Pumping on Flowing Well

Experiments were carried on to test the effect of pumping on lowering the artesian head in a flowing well located some distance from a large pumping plant. The experiments showed that heavy drafts on the artesian basin by the pumps had a direct effect on lowering the artesian head. When the pumps were shut down for a time, the head rose; when the pumps begin working again, the head fell and the fall was more than it would have been if it were due to rainfall and a following drought.

Work of the Office

The office tries to get all the information and data available concerning the artesian wells and the artesian basin. In order to keep in touch with the general condition of the artesian basins, the water level (height of the artesian head) of 17 typical wells is taken once a month. These wells are located in the belt from Diamond Head to Hauula, including Moiliili, Punahou, Central Honolulu, Kalihi, Moanalua, Waiamalu, Pearl City, Waipahu, Honouliuli, Waialua, Kahuku and Hauula. (See Record E).

Where the water rises below 6 or 7 feet a small stand pipe is attached to the well and the water level read directly on a water gauge glass. If the water rises more than 6 to 8 feet, a mercury gauge is used. This consists of a barometer tube bent in "U" shape, both arms filled to a convenient height with mercury and attached to a board scaled to represent feet and tenths of feet. The gauge is attached to the well with a small pipe. When the water is turned on, the air bubbles are removed through properly adjusted stop-cocks. The water pressure from the well will lower one arm of the mercury in the "U" tube, and raise the other, so designating the height to which the water rises in the well.

When the wells are tested, a sample of water is taken from each well and later analyzed for its chlorine (salt) content, the object being to note if there is any change in the water from season to season or during the gradual lowering of the artesian head.

This work forms parts of a somewhat extended compilation of data which we hope will furnish valuable information in connection with the artesian supply. The work involved in keeping such records includes a tabulating of the rainfall, the heights of the artesian wells, the measurements of springs, streams and wells, and the amount of water pumped.

Assuming that the rainfall is the source of our artesian supply, the rainfall will be taken as a base of calculation, and its distribution will be accounted for as far as possible in the streams and springs, in the evaporation and in the artesian basin. While these records may be more or less approximate, they will be indicative of the supply and of the demand.

Besides this work, waters are analyzed and tested for the public, wells are inspected for individuals, information given to inquirers, correspondence entered into, etc.

But the aim and object of the Office first and last is the conserving of the artesian supply, and all the work of gathering data and compiling records is with this in mind, and as a means to an intelligent comprehension of the need of conservation, and the way by which it may be effectively done.

While the limit of the artesian basin is not known, it is generally supposed that when the water in the artesian wells is lowered to sea level, the water will become brackish and unfit for use, and therefore, sea level may be considered the practical limit of the artesian basin; but long before this most of the wells now flowing will cease to flow, and pumping will have to be resorted to. While there is no cause for immediate alarm, the welfare of the future deserves consideration, and it was this Mr. Campbell had in mind when he inaugurated the underground water research.

As the artesian basin is supplied by the rainfall, and as yet man is unable to control that rainfall, there seems to be only one way by which we can control the artesian basin to any extent, and that is by guarding against a too heavy draft on the basin; by not taking out more than can get in, and by getting the greatest benefit with the least expenditure of our water resources.

If the water that practically goes to waste, owing either to defective conditions in the wells themselves, or to unskillful or careless management in the use of the water, could be curtailed or directed into channels where it would be utilized to advantage, one of the most effective steps in the conserving of this supply would be taken.

In 1884 the Honorable Cecil Brown foresaw just this necessity of providing against an over-draft on the artesian basin, and he introduced the following bill into the Legislature of that year:

CHAPTER XLIX

AN ACT

TO PREVENT THE WASTE OF ARTESIAN WATER ON THE ISLAND OF OAHU

Be it Enacted by the King and the Legislative Assembly of the Hawaiian Islands, in the Legislature of the Kingdom assembled:

Section 1. Every flowing artesian well now on the Island of Oahu that may hereafter be made on said Island, shall be capped by the owner or owners thereof in such a manner as to give complete control over the flow of water from the pipe of such well.

Section 2. No person having the right to the use of water from any such artesian well shall allow the same to run to waste, but may use it for irrigation, domestic and other useful purposes, except for driving machinery, provided, however, that such water may be used for driving machinery in case it be utilized afterwards for irrigation or other useful purposes.

Section 3. Any person violating the provisions of Sections 1 and 2 of this Act shall, upon conviction thereof, before any Police or District Court of the Island of Oahu, be fined not more than fifty dollars.

Section 4. For the more effectual carrying out of this Act, the Marshal and Deputy Marshal of the Kingdom, and all Policemen of the Island of Oahu, may at all times of night or day, enter without warrant any premises whereon artesian water is used.

Section 5. This Act shall become a law from and after its publications.

Approved on this 21st day of August, A. D. 1884.

KALAKAUA, REX."

Today it is a matter for the people to work, through the Legislature, to have further regulations enacted to meet the present needs, so that more authoritative and systematic action may be taken to guard against too great a drain on the artesian basin, which is one of, if not the, most important asset in our island resources.