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THE CONSERVATION, DEVELOPMENT, AND PROTECTION OF THE
WATER RESOURCES
OF THE
HONOLULU URBAN AREA

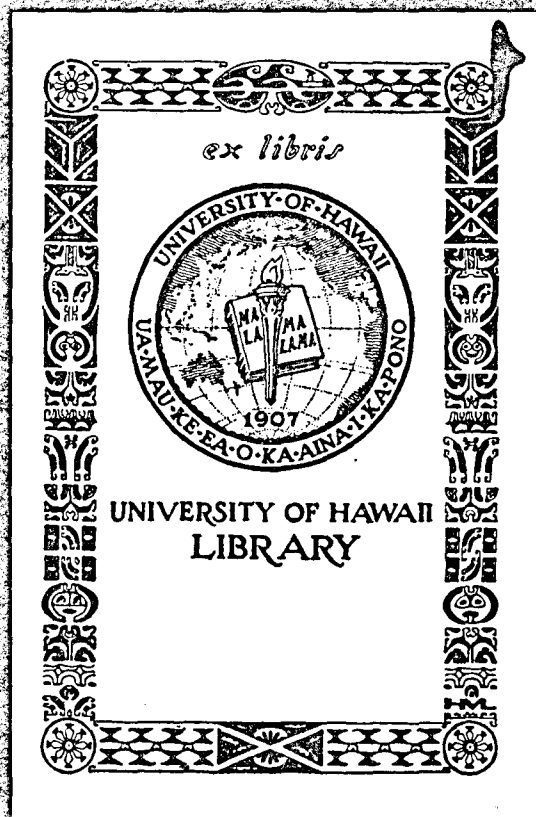
VOL. II
(OF 2)

A Staff Report by the

Honolulu

BOARD OF WATER SUPPLY
CITY AND COUNTY OF HONOLULU

1948



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THE CONSERVATION, DEVELOPMENT, AND PROTECTION OF THE WATER

RESOURCES OF THE HONOLULU URBAN AREA

(by the Board of Water Supply, June 1948)

VOLUME II

(Part III of the Report)

EXCERPTS FROM AUTHORITIES AND OTHER SOURCE
MATERIAL (IN CHRONOLOGICAL ARRANGEMENT).

(Refer to maps inside back cover of Volume 1)

F O R E W O R D

This compendium presents references, excerpts, and summaries from principal available contributions to the subject matter. Comment of the compiler has been held to a minimum. Although it has been intended that each authority should "stand on its own" without valuation of relative merit, more attention has been given to ideas which have survived rather than to those which were short-lived. The content of Part III is abstracted in Part II of this report.

The composite knowledge resulting from study of the many reports of approximately seventy years should be the best possible foundation upon which to base planning for the future. It is most important that we resist any tendency to yield to ideas of the moment, no matter how plausible they may appear.

During fifty of the seventy years, Hawaii has had the benefit of ideas of engineers, geologists, and foresters, representing the highest attainment in their professions, and it is therefore urged that all readers of this report review all available reports with that realization.

This presentation does not presume to "cover" the following important subjects, excepting insofar as mention of general progress is important:

Gift of T. Schuyler
MAR 2 '56

Basic Geology and Hydrology
 Basic Concepts with respect to the "Artesian Basins"
 Leakage to the Sea
 "Safe Yield" of the Artesian Basins
 Salt Infiltration
 Bottom Storage
 The Effect of Diminishing Artesian Heads
 Mechanical Improvements
 Distribution Improvements
 Financial Details
 Inventory of Water Available
 Caprock Water
 Botanical and Forestry Matters
 Details of all Forest Land Acquisitions

Every reasonable attempt has been made, however, within the time available, to cover the scope indicated by the report title, including legislative and other legal phases.

This ("Part III") represents intensive research including study of the following sources and authorities:

Laws enacted by Legislative Sessions . . . 1846-1947

Reports of:

Minister of the Interior (duties included Agriculture and Forestry and Honolulu Water Works) 1846-1899

Commissioners of Agriculture and Forestry 1901-1903

Board of Commissioners of Agriculture and Forestry 1903-1947

Superintendent of Public Works (in charge of Honolulu Water Works) . . . 1900-1913

Honolulu Water Works, City and County of Honolulu 1913-1929

Honolulu Sewer and Water Commission . 1925-1929

Board of Water Supply 1929-1948

United States Geological Survey and Division of Hydrography, Territory of Hawaii . All reports

- Forest Reserve Proclamations of the
Governor of Hawaii with respect to
Honolulu District All
- General research on specific subjects
in the files of the Archives of
Hawaii and in the records of the
Territorial Land Office
- File of the "The Hawaiian Forester
and Agriculturist" (published by
the Board of Commissioners of
Agriculture and Forestry 1903-1933
- Proceedings, Hawaiian Academy of
Science 1926-1940

Principal special reports, papers, etc., studied in
addition to those above listed were as follows (list arranged
chronologically to emphasize development in knowledge):

WEBSTER, WILLIAM (1854) A report to the Minister of Interior
submitting proposals for the improvement of Honolulu's
public water supply, June 30, 1854. (Territorial
Archives)

*McCULLY, LAWRENCE (JUDGE) (1882) An article entitled "Artesian
Wells" published in Thrum's Annual for 1882 describing
the first wells and the strata encountered. Probably
the earliest comprehensive speculation on the probable
rock structure and the behavior of water therein. (A
supplement to the above was published in Thrum's
Annual for 1889.)

BENDER, MAJOR A. S. (1884-85) Reports to the Minister of
Interior on Honolulu water supply and sewage disposal.
Appendix to Minister of Interior's report to the 1886
Legislative Assembly.

*SCHUYLER, J. D. AND ALLARDT, G. F. (1889) A report prepared
for B. F. Dillingham on "Water Supply for Irrigation
on the Honouliuli and Kahuku Ranchos" including a
survey of the principal Pearl Harbor Springs. Printed
by Jordan & Arnold, Printers, Oakland, Calif. (An
original copy on file in Territorial Archives.)

HERING, RUDOLPH (1897) Report: "Filtration of the Nuuanu
Water Supply" (Territorial Archives)

MAXWELL, WALTER (1899) Article: "Hawaiian Forests and Ranges"
published in "The Paradise of the Pacific,"
September, 1899. (Territorial Archives)

GRIFFITH, E. M. (1902) Letter to S. B. Dole, Governor of
Hawaii, presenting recommendations which resulted
from the forest survey made by Mr. Griffith while
on special assignment from the U. S. Bureau of
Forestry, March 5, 1902. (Territorial Archives)

* indicates that the authority is noted in the "Annotated
Bibliography" by Norah D. Stearns, published in 1933 by
the Division of Hydrography, Territory of Hawaii (in
cooperation with the U.S.G.S.) as Bulletin 3.

- GIFFARD, W. M. (1904) Letter to G. R. Carter, Governor of Hawaii, proposing procedures under which the Territory might acquire title to private lands within the forest reserves, May 19, 1904. (Territorial Archives)
- *ALEXANDER, W. D. (1908) Theories concerning artesian wells. A letter published in the Pacific Commercial Advertiser, October 9, 1908.
- *ANDREWS, CARL (1909) The structure of the southeastern portion of the island of Oahu, (manuscript; master's thesis, Rose Polytechnic Institute.
- *SANITARY COMMISSION (1911) Report of the Sanitary Commission to the Governor of Hawaii, 1912. Members: G.R. Carter G. W. McCoy, A. R. Keller, J. L. Young and C. R. Hemenway.
- HISTORY OF THE HONOLULU WATER WORKS (1913) A comprehensive outline of the development of the system since 1847. (Included in 1913 Report of Superintendent of Public Works as pages 259-295.) *Since 1847*
- HOSMER, RALPH S. (1913) Letter to Board of Commissioners of Agriculture and Forestry with respect to Honolulu Watershed Forest Reserve, June 14, 1913. Published in "The Hawaiian Forester and Agriculturist," October, 1913.
- *ALEXANDER, ARTHUR C. (1915) Honolulu's Water Supply (manuscript). A paper read before the Honolulu Social Science Association, May 10, 1915.
- *TERRITORIAL WATER COMMISSION (1917) Report to the Governor. Members: G. K. Larrison, A. G. Smith, T. F. Sedgwick.
- *SEDGWICK. T.F. (1917) "Artesian Wells in the Hawaiian Islands." Published by Hawaiian Engineering Association, April, 1917.
- *HONOLULU WATER COMMISSION (1917) Report to Mayor and Board of Supervisors. Members: L. A. Thurston, James Gibb, J. Jorgensen, J. H. Wilson, C. R. Forbes. Engineer: J. T. Taylor.
- GIFFARD, W. M. (1918) "Some Observations on Hawaiian Forests and Forest Cover in their Relation to Water Supply." Published in "The Hawaiian Planters' Record," June, 1918.
- *PALMER, H. S. (1921) Report on the possible occurrences of high-level ground water in the Honolulu region (manuscript report to Mayor and Board of Supervisors, April 16, 1921.)
- *LARRISON, G. K. (1923) Honolulu's Water Supply, a report to W. A. Wall, General Manager, Water Works Department, (manuscript) March, 1923.

- HOFFMAN, WILLIAMS, AND GRAINGER (1924) Report to Mayor and Board of Supervisors on Recommended Improvement of the Honolulu Water Works Pumping Stations by Theo. Hoffman, Fred T. Williams, and J. H. Grainger. Manuscript, June 2, 1924. (Copy in Board of Water Supply Files)
- *PALMER, H. S. (1926) "The Geology of the Honolulu Artesian System." Published by Honolulu Sewer and Water Commission, 1927.
- *HISTORY OF THE WATER WORKS (1929) Included in Honolulu Sewer and Water Commission Report for 1929 as Appendix D.
- GRUNSKY, C. E. (1929) A report for Hawaii Bureau of Governmental Research, on Honolulu Water Supply. Published by the Bureau.
- *SECOND CONVENTION ON THE FORESTRY PROBLEMS OF OAHU (1929) Report published in "Hawaiian Forester and Agriculturist," January-March, 1929.
- *STEARNS, H. T. (1931) "Preliminary Report on the Pearl Harbor Springs" (manuscript).
- *STEARNS, H. T. AND VAKSVIK, K. N. (1935) "Geology and Ground-water Resources of the Island of Oahu, Hawaii." Published as Bulletin 1, Division of Hydrography, Territory of Hawaii.
- *STEARNS, NORAH D. (1935) "Annotated Bibliography and Index of Geology and Water Supply of the Island of Oahu, Hawaii." Published as Bulletin 3, Division of Hydrography, Territory of Hawaii.
- WENTWORTH, C. K. (1936) "A Sketch of the History of Water Development in Hawaii by Tunnels and Shafts," manuscript (copy at Board of Water Supply).
- WENTWORTH, C. K. (1938-1945) Manuscript reports on the geology and ground water resources of the Honolulu and Pearl Harbor Districts, prepared by Dr. Wentworth as Geologist, Board of Water Supply, and submitted to Mr. Frederick Ohrt, Manager and Chief Engineer.
- STEARNS, H. T. (1940) "Supplement to Geology and Ground-water Resources of the Island of Oahu, Hawaii." Published as Bulletin 5, Division of Hydrography, Territory of Hawaii.
- WENTWORTH, C. K. (1942) "Storage Consequences of the Ghyben-Herzberg Theory." Published in 1942 Transactions of the American Geophysical Union.
- PALMER, H. S. (1946) "The Geology of the Honolulu Ground Water Supply." Published by the Board of Water Supply.
- WENTWORTH, C. K. (1946) "Laminar Flow in the Honolulu Aquifer." Published in Transactions, American Geophysical Union, August, 1926.

HUTCHINS, WELLS A. (1946) "The Hawaiian System of Water Rights."
Published by the Board of Water Supply, 1946.

WENTWORTH, C. K. (1947) "Factors in the Behavior of Ground Water
in a Ghyben-Herzberg System." Published in "Pacific
Science," July, 1947.

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(The above does not presume to list all
authorities. For reference it is noted that the
Honolulu Water Commission of 1917 gathered and filed
in the Territorial Archives copies of all pertinent
material that their extensive research had disclosed.
The material is listed on pages 303-311 of the
Commission's report.)

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It is important to note that many of the greatest
contributions made by individuals are hidden behind the cloak of
anonymity, ethically necessary in public or semi-public employment.
This is particularly true of the following individuals whose life
work is represented to a great extent in the departmental, bureau,
board, and commission reports generally mentioned above:

| | |
|---|---|
| Frederick Ohrt, H. A. R. Austin, J. F. Kunesh, W. N. Chaffee | Honolulu Sewer and Water Commission and Board of Water Supply |
| G. K. Larrison | U.S.G.S., Honolulu Sewer and Water Commission, Board of Water Supply, Hawaiian Homes Commission |
| W. A. Wall | Honolulu Water Works |
| T. F. Sedgwick | Territorial Department of Public Works |
| E. D. Burchard, M. H. Carson | U.S.G.S. |
| J. T. Taylor, J. Jorgensen | Honolulu Water Commission, and as consulting engineers |
| H. L. Lyon, W. M. Giffard, W. O. Clark | H.S.P.A. |
| R. S. Hosmer, C. S. Judd, William Crosby | Board of Commissioners of Agriculture and Forestry |

1846-1848

Establishment of System of Fee Simple Titles.

Excerpts from Foreword to Indices of Land Commission

Awards:

"Under the system of land tenure in early Hawaii, which was feudalistic, the title to the whole of the land was in the King. There was no such thing as fee simple title."

- - - - -

"With the advent of foreigners and foreign business methods, however, it became apparent that a change in the system of land tenure would have to be made, so, in the early 1840's, land tenure in Hawaii entered a transitional period terminating in the 'Great Mahele' of 1848, which furnished the facility for acquirement of real estate in fee simple."

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The Act signed by Kamehameha III on April 27, 1846, "To Organize the Executive Departments of the Hawaiian Islands" included provision for a Board of Commissioners to quiet Land Titles. The principal^{les} adopted by the Board to govern its procedure were ratified by the Legislative Council October 26, 1846.

The said Act also contained the following sections of special interest in this (1948) Report:

"SECTION V. The Minister of the Interior shall have the power, two thirds of the Board of Finance concurring, to lay conduits of water to supply the town of Honolulu, at an annual charge to those who may avail themselves thereof, to be fixed by order in council."

- - - - -

"SECTION VII. The forests and timber growing therein, shall be considered as government property, and under the special care of the Minister of the Interior, who may from time to time convert the products thereof into money for the benefit of the government. For this purpose he may collect fuel and timber, and dispose of the same at his discretion, but nothing herein contained shall be interpreted to prohibit the cutting of timber and fuel as specified in the laws enacted on

the 9th of November, 1840, and also at the legislative meeting at Lahaina in April, 1841. The minister of the Interior, however, shall, with the approbation of the privy council, have power to lay such restrictions on the same as he shall deem expedient."

There must have been good reason for the declaration made with respect to forest lands, but the Land Commission proceeded almost immediately to include forest lands in its awards;— as a matter of fact, the typical "ahupuaa" on Oahu as awarded to the principal chiefs who had held large tracts under the old system, included an entire valley from the sea to the top of the Koolau or Waianae Range. An additional Act negating the possible intention of the "declaration" was that taken by the 1852 Legislature in enacting a law empowering the Land Commission to "grant titles to Konohikis for whole Ahupuaas or Ilis of lands, received by them from the King in the division of 1848, awarding said lands by their proper names, without survey . . .".

June 30, 1854

A report by William Webster, to the Minister of the Interior, submitting proposals for the improvement of public water supply.

At that time the supply for shipping was obtained from a spring and piped to the water front. Mr. Webster stated that additional springs near the one already developed would yield approximately 185,760 gallons per day, "which would amount to nearly 31 gallons per head for a population of 6,000 people," but that during the dry season the supply would fall off one-third. The estimated cost of the entire program proposed by Mr. Webster was \$68,187.00.

It was also proposed to lay a pipe from a spring at Kapena; to build a new reservoir of approximately 500,000 gallons capacity; and to install a 12-inch main from the reservoir to Queen Street. The following interesting comment is made on filtration (on page 16):

"If a supply equal to that to be derived from 'Kapena,' were taken from the Nuuanu stream, anywhere below Kapena falls, it would require to be passed through a filtering reservoir, and to this course there are many objections, as not only the first cost of such a reservoir is great, but there would be a continual outlay to keep it in repair, besides the objection to the water for domestic purposes even when filtered, on account of bathers, etc."

February 26, 1855

The Minister of the Interior stated in his regular report (on page 2):

"I would beg to bring under your consideration the necessity of providing the town of Honolulu with water; a great number of the inhabitants have applied for a supply for their private dwellings, and there is no doubt that if sufficient works were executed for distributing it through town, the majority if not the whole of the residents, would pay liberally for such a convenience, and although the outlay in the first instance would be large, yet in the end I feel confident it would be a profitable investment for the government. I append the report and estimate made by W. Webster Esq., civil Engineer, (Table H,) on the present works, and on the outlay required, for carrying this into effect, which will give you every information on the subject."

May 21, 1860

In the regular biennial report of the Minister of the Interior, it is noted that a loan in the sum of \$20,000 had been negotiated for the purchase of cast iron pipe from Glasgow to improve the Honolulu Water Works.

August 18, 1860

A law was enacted "to authorize the Minister of the Interior to take possession of whatever land and water may be required for the use of the Honolulu Water Works." It provided for the taking of any property required "for laying down pipes, building dams, reservoirs and tanks, on and through the lands extending from the reservoir on the land of Kahookane, in the

district of Honolulu, along the said land of Kahookane and up the ravine of the Nuuanu Valley stream to the spring called 'Kapena,' and also extending from the said old reservoir, in a nearly direct line to the spring called 'Kunawai'."

The law set up a procedure for the determining of compensation to be paid for private property rights.

July 18, 1874

A law was enacted enlarging the powers of eminent domain given to the Minister of the Interior by the August 18, 1860 Act to include any land and water required for the Honolulu Water Works within Nuuanu Valley.

1876

THE STATUS OF HONOLULU WATERWORKS IN 1876.

This subject is well summed up in the "History of the Honolulu Waterworks" included in the 1913 Report of the Superintendent of Public Works; in the paper "Honolulu's Water Supply" presented by Arthur C. Alexander before the Social Service Association on May 10, 1915; in the 1913 Report of the Sanitary Commission which was created by the 1911 Legislature; and in Appendix D of the Report of the Honolulu Sewer and Water Commission to the 1929 Legislature.

Until 1820 Nuuanu Stream and natural springs were the sole source of Honolulu's domestic water. About that year some surface wells were dug.

The requirements of whaling ships caused a waterfront tank to be installed at the foot of Nuuanu Street. It was supplied by a lead pipe from a taro patch on Emma Street near Central Grammar School.

During 1851 a small reservoir was completed near Nuuanu and Bates Streets and in 1855, because of great demand, the Minister of Interior presented to the Legislature a report prepared by William Webster proposing an improved water system. The recommended projects were not completed until 1862 when a large reservoir was built above the original one at a location near Nuuanu Stream and between Bates and Judd Streets. (This reservoir was used until 1895 and was supplied from Nuuanu Stream)

Early recognition by the Monarchy of the importance of protecting publicly owned water sources in and near Honolulu is shown by Section 48 of the Civil Code of 1859 which is now incorporated in R.L., 1945 as Section 4530:

"Sec. 4530. Streams, springs, ponds; sale of certain, prohibited. The superintendent of public works and commissioner of public lands are prohibited from selling the water ponds, springs and streams belonging to the government in or near Honolulu; that is to say, the pond of Kunawai, in the ili of Kunawai; and the ponds of Kumu-hahane and Kalaupalolo, in the ili of Alewa, and all other government water ponds, springs and streams, wherever situated, which may be valuable for public use; and any sale in contravention of this section shall be absolutely null and void.

Considerable controversy developed with respect to private water rights. The principal settlement of early times was reached in 1870 with the purchase of water rights in Paki's auwai in Nuuanu.

By 1876 no additional development had taken place other than increased distribution mains and (as noted in the Sanitary Commission's 1912 Report) "better protection for the source of supply and a gradual absorption of the individual water rights."

September 19, 1876

There was enacted a law "for the protection and preservation of woods and forests."

The Act started out with the statement "Whereas, it is an established fact that the destruction of forests in any country tends to diminish the supply of water, ..."

The Minister of the Interior was authorized to set apart any government land in the Islands considered by him to "be best suited for the protection of water sources," and to appoint a competent person as Superintendent of Woods and Forests to enforce such rules and regulations as might be established to protect forest lands from trespass.

Section 4 of the Act provided that, whenever he considered it necessary, the Minister of the Interior could condemn private rights and compensate the owners in an amount to be determined by referees selected by the owners and the Minister of the Interior.

August 3, 1878

A law was enacted amending the Honolulu Water Works Act of August 18, 1860, (as amended July 18, 1874). It further extended the areas within which the Minister of the Interior might condemn land and water for Honolulu Water Works purposes. The 1878 Act may be said to be the original designation of the Honolulu Water Works protected area. The amended Section I of the law is quoted (from page 50):

"Section 1. The Minister of Interior is hereby authorized and empowered, in accordance with the provisions of this Act, to enter upon and take possession of and hold for the use of the Government, such land and water, real estate and property, saving and excepting the water springs of Kunawai, Wailuakio, and Kanewai, as may be required for the use, maintenance, increase, and development of the Honolulu Water Works, in the way of laying water pipes, digging water leads, building dams and reservoirs, and reserving forest land, or land for the growth of forest vegetation, on the southern and western slopes of the Konahuanui range of mountains in the district of Honolulu, and laying between and including the eastern side of Palolo Valley and the western side of Kalihi Valley, with all spurs and gulches of the said slope between the said limits."

March 14, 1878

Letter from R. Lishman, Superintendent of
Honolulu Water Works to Minister of Interior

"I beg to hand you the following statement in reference to the future supply of water for Honolulu it being necessary that the water supply be increased.

"I would recommend that all those persons having water rights for Kalo growing should be bought out, then there would be a sufficient supply of water for Honolulu. I would recommend that a reservoir be built on the left side of Nuuanu Street - facing the Palli opposite to where the water crosses the road to the reservoir. The object I have in making a reservoir in that place would be to supply those people with water on each side of the road. I have no doubt that those people having a water-right would give up their water right to the Government, and pay a water rate if they could have water from the Government pipes. The reservoir would be of great service in storing water in dry seasons. I would recommend that an 8-inch pipe be laid from this reservoir and connected with the main pipe near the drinking fountain at the 1 mile bridge. Should it be impracticable for the Government to buy out the Kalo growing privileges in Nuuanu Valley, I would recommend the Government to go to other sources for a supply of water. For instance, say the following places:

1st. In Makiki Valley where I think the water rights might be bought out for a small sum. A 6 inch supply of water could be obtained from this source which I think would be sufficient to supply the plains to Alapai Street. It would be necessary to build a small reservoir in the valley say 5200 feet from Beretania Street.

2nd. The Manoa stream, which would be large enough to supply all the requirements of Honolulu, and also Waikiki. The only difficulty would be in buying out the water rights, as the stream irrigates large tracts of lands."

1878-1884

Principal developments were:

- 1879 First successful artesian well drilled.
- 1880 Makiki Reservoir completed (725,000-gallon capacity)
- 1880 10-mile pipeline completed from new reservoir on Queen Emma's property in Nuuanu to provide principal distribution.
- 1880 Act passed to protect from trespass by domestic animals all watershed areas contributing to domestic water supplies.
- 1882 Artesian wells drilled at Pawaa, Palace Grounds and Mililani. By this year there were also wells at Thomas Square and at Waikiki.

1878-1884

(From pages 270-273 of June 30, 1913, Report of Superintendent of Public Works.)

"In 1878 appropriations were made for a clerk for the Water Works, and this move to systematize the business of the office was none too soon, for at this time the Water Works began to expand and develop in a manner heretofore unparalleled. The city was extending into the plains between the centre of town and Punahou; Palama was being settled; and the lower slopes of Punchbowl were attracting the homeseeker. All of this increase in the city's growth demanded more water for homes and better protection against fire. New parks were to be laid out, and the streets had to be sprinkled. The old water system with its reservoir built by Webster, was still good as far as it went, but the town had outgrown it, and everything seemed to indicate that it would extend still further.

"At this time a number of plans were considered for materially increasing the water supply. It was recommended that the waters of Kalihi and Makiki valleys be used, as well as those of Nuuanu and Manoa. Surveys were made of the two latter valleys with the hope of finding enough available water. But it was discovered that the water rights in both valleys were so complicated that the supply would be inadequate in a dry season, as it sometimes happened that the rights already called for more water than the streams could supply. The cost of piping water from Kaeo Falls (believed to be the same as Lulumahu Falls) in Nuuanu Valley was estimated at \$120,000, and to pipe from the head of Manoa Valley would cost more. Meanwhile it was deemed advisable to lease the lands in and

around Luakaha. A plan was also suggested to make an earth reservoir or lake of ten to twelve million gallons capacity in Nuuanu Valley, calculated to provide a supply of 30 to 40 days, allowing a daily consumption of 300,000 gallons. It was found, however, that the water from such a lake could not be turned directly into the mains as they could not stand the pressure, so that such a reservoir would only be a collecting reservoir for the one already in use, unless the entire system were changed.

"An appropriation of \$40,000 was asked for, with the object of getting all the water immediately available, and of gradually securing all the water rights, particularly of Nuuanu Valley.

"The Government considered, also, the granting of a franchise to private enterprise for supplying Honolulu with water, and likewise, the advisability of placing the whole matter in the hands of a water board.

"Meanwhile, a new and heretofore unknown supply was brought to light. Both Mr. James Campbell and Mr. Marques succeeded in obtaining good flowing artesian wells,--Mr. Campbell at Honouliuli, and Mr. Marques near his residence in Punahou. These satisfactory experiments led to the boring of wells in various sections of the city; some of them proved to be good flowing wells of excellent clear water, while others were too brackish for domestic use, or failed to flow. The knowledge gained through these costly experiments was, that in and about Honolulu the artesian water would not rise over 42 feet above sea level, and that, consequently, wells sunk above this level, although they might give a good supply of water if pumped, would not flow; that the waters from different wells differed greatly in mineral quality, particularly in the quantity of chlorine they contained. So, for certain localities, it appeared to be demonstrated that it would not be advisable to bore for flowing water, as the chances were that the effort would be futile. This information was valuable, although it was costly to gain.

"The possibilities and limitations of artesian wells were not fully known, but the people of Hawaii and the citizens of Honolulu foresaw the reclamation of great tracts of barren waste land with its consequent increase of revenue and population. It meant the building of a railroad for better transportation facilities. It may be interesting to note here that the artesian well and railway on Oahu have made it possible to ship about eight million dollars worth of sugar annually.

"Although the Government was interested in the artesian wells, it was not yet in a position to exploit them, as some of the plans for mountain supply, which had been under investigation for some time, were acted upon about the time the first well was sunk.

"During this period the Makiki Valley water rights were negotiated for. The Minister of the Interior states: 'Under the law giving the Minister of the Interior authority to take such lands and water as are necessary for the Honolulu Water Works, I have given notice that I do, under said law, take all the water of Makiki and all lands necessary from and including Round Top and Pauoa. Commissioners have been appointed, but as yet no claims have been settled.' The settlements were not concluded until 1884. The Makiki reservoir of masonry, holding 750,000 gallons, was built at this time. A reservoir was also built in Nuuanu Valley, on the Queen Emma property."

1880

A list of private lands held by the Hawaiian Government shows that the Ili of Kalawahine was then being leased from the Estate of J. H. Coney for a rental of \$300 per year. This tract (area 293.5 acres) is situated between the top of Tantalus and the land of Kaakaukukui owned by the Bishop Estate in Pauoa.

(J. H. Coney had acquired the Ili sometime prior to 1873 from the successors in interest of Keliiahonui, the original awardee to whom it was set aside in the 1848 division of lands.)

Under various arrangements with the owners, the Minister of the Interior continued to control Kalawahine until the Territory acquired title in 1907. A considerable portion of the tree planting by the Government between 1888 and 1907 was done on this land and there were frequent attempts to arriving at a settlement with the owners.

April 30, 1880

In the biennial report of the Minister of the Interior it is stated that "the building of a reservoir in Makiki Valley, thereby giving the plains water, made a demand for Homesteads."

The reservoir had a capacity of 725,000 gallons and the waters of Makiki Stream were delivered to it by an 8-inch pipe line 900 feet long. The minimum available supply appeared to be approximately 400,000 gallons per day.

From the reservoir an 8-inch pipe was laid to Beretania Street and then the water was generally distributed in the downtown area. A new reservoir was also built at Nuuanu and a 6-inch pipe line laid from it to Judd Street. Interesting excerpts in respect to additional water supply ^{and} ~~for the~~ protection of the forests are as follows (From page 31):

"It is now necessary first to obtain pure water, which can only be done by piping the water in Nuuanu and Makiki from a source so high up the valley that no foul matter will be brought down. This will take quite a sum of money, but it is absolutely necessary for the health of the country. The water we drink is not pure or anything approaching pure. The amount of pipe required is 22,000 feet, and will cost at present prices one dollar per foot. A four-inch stream of water can be obtained in Kalihi Valley; a four-inch pipe should lead it to a point at the mouth of the valley, thence distributing it by a six-inch pipe by the Insane Asylum, across to King Street, along King to Nuuanu, with a pipe up Liliha Street. Palama is virtually without water from the Government pipes, the present pipes not being of ~~sizes~~ sufficient to carry the water even when there is a full supply. Receipts from privileges sold would far more than pay the interest on the investment."

From page 32:

"Let all the mauka lands be kapu, let the forests be protected, and not only protected, but have planted trees over the whole of our mauka lands, from and including Punch Bowl, Round Top, and the whole country between, and we will not only have plenty of water, but can in a few years supply Honolulu with fire wood, and thereby pay all expenses of this work. The first cost is large, but I do trust that no member of this Legislative Assembly will hesitate to vote what is asked."

1881

The smallpox epidemic of this year provided a great incentive to government officials in their efforts to obtain authorization for necessary improvements to assure an adequate and protected water supply.

One of the earliest articles marking a milestone in the recorded history of artesian well development and speculation with reference to artesian water sources is the paper "Artesian Wells" by Judge McCullay which was published in "Thrum's Hawaiian Annual" for 1882. The following excerpts are of particular interest:

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"The theory has been advanced by Mr. George Fesler, an intelligent and skillful well borer, that in the" (Beretania) "district above described, and within which these wells are, the water reservoir has a head of from 41 to 42 feet, that no boring at an altitude exceeding this will obtain a flowing well, and that on the other hand flowing water is certain to be obtained everywhere in this territory and under the 41-2 feet line of altitude and corresponding to this that the flow of water in any well is less the higher the pipe is carried up, and would be greater from points below the level of the ground, if it were stopped and drawn off through a deep cutting."

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"But what is this water bed? The well borers all report that it is black rock and lava, generally covered by a very hard shell. Below this the rock is of varying density. This water bed has never been bored through; the deepest borings, after striking this, do not reach anything else. The water sometimes comes up in a gradual increase as the boring continues in the rock, as if it were furnished by minute veins; at other times there is a sudden flow as if a subterranean stream were opened. We have not heard of an instance of the drill dropping into an open space which is a reservoir of water.

"Whence comes the water? We should say from the mountain centre of the Island. Is it exhaustable? Time will show us whether we can exhaust, or let us say diminish, the flow of any well by the number of wells. Doubtless wells enough might be sunk to divide the supply, or cut off the flow of some.

"The question of how far these wells can be obtained throughout the Islands is yet unsolved, and can only be determined by trials. It would seem to be established that flowing water cannot be had higher than 42 feet, east of Honolulu. We should not be hopeful of obtaining a flow on higher land than this anywhere,--Mr. Campbell's spring at 700 feet notwithstanding. There is a boring east of Diamond Head, at Waialae, where the ground may be nine feet above sea level; the water bearing rock was struck at 70 feet below the surface, and water rose six feet and to within five feet of the surface. There it stands, although the boring has been run down 400 feet. Is our artesian

basin bounded on one side by Diamond Head, and is there no basin between that and Koko Head?"

- - - - -

"The following suggestions are added by another writer:

"It seems evident that the great central mass of water-bearing rock above described must be completely separated by impervious strata from the surrounding ocean. Were it not so, the water it contains would necessarily escape into the sea instead of standing 42 feet above it, as it appears uniformly to do. By the borings it appears that the containing strata are composed of very compact clay many feet in thickness. These are covered again by other strata of sand, coral and clay, with overlying beds of lava. It seems a necessary inference that these strata were gradually and successively deposited upon the ancient bed of the sea. This bed was the submarine slope of the slowly growing volcanic mountain as then existing. On all ocean beds, slow depositions of sediment from the land are constantly accumulating, upon which near the shore, sand is also deposited and coral grows. On this ancient volcanic coast, lava has occasionally over-flowed these lower strata, enlarging the area of the island. Hence the successive strata of coral, sand and clay, with lava, coral, and clay again before striking the water bearing rock beneath.

"These strata extend to a point now far inland, but which must once have been the vicinity of the sea-beach. They have a rapid slope, in conformity with the normal contour of the ancient volcanic nucleus of the island. The upper and inner edge of these strata appears to be at period of original deposition have been just below the level of the sea from which the clay was deposited. Hence it is to be inferred that a later elevation of the region at least 42 feet above sea level took place at the early period in question.

"There are abundant evidences of a somewhat recent elevation of the greater part of the Island of Oahu. Such an elevation seems to furnish favorable conditions as above suggested for flowing artesian wells. There is little evidence, so far as the writer knows, of a similar elevation in any of the other islands of this group."

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(Judge McCully did not name the writer from whom he quoted the last three paragraphs.)

April 29, 1882

Excerpt from the biennial report of the Minister of the Interior (from page 18):

"Before the successful boring of Artesian Wells, water was wholly obtained from Nuuanu and Makiki valleys. Large tracts of valuable land are now exclusively used as a water shed. The water is not wholesome and is more or less dangerous to public health. Artesian well-water is perfectly pure, and it is now evident that it can be obtained in quantities sufficient to supply the city. The water from these wells does not rise above five or ten feet from the surface. To supply it at a height of a hundred feet above the sea level will require the adoption of the steam pumping system, which will force it to any height required. While the cost of doing this will be considerable, it would be met to a large extent by throwing open to residence and cultivation of the large tracts of valley land now used for collecting the water. The Artesian wells, so far, throw water 42 feet above the sea level. The well at Makiki is abandoned for the present, owing to the want of necessary piping. But the fact that abundance of this water may be had, makes it possible to change the water supply system with great advantage."

It was stated in the report that filters had been built for the upper Nuuanu reservoir on land purchased from John H. Wood; that a small reservoir had been built near the head of Liliha Street; that the Honolulu Water Works had drilled an artesian well at Pawaa, which had been connected with the Waikiki water system; and that a well was being drilled at Mililani.

The inauguration of a forestry program was announced as follows (from page 56):

"I have caused one of the public places of the city to be set apart for a nursery, in which valuable fruit trees may be started, and the inhabitants supplied with vigorous and healthy plants, while the protected portions of the valleys may be filled with them. An appropriation of \$12,000 is asked for this purpose."

The statement of expenditures of the Department of Interior for the biennial period ending March, 1882, showed approximately \$10,000 expended for the boring of artesian wells.

April 12, 1884

A report by A. S. Bender, consulting engineer, to the Minister of the Interior on possible reservoir sites.

No specific proposals are mentioned in the report, but it was recommended that \$200,000 be appropriated to make it possible to construct dams at sites to be determined.

With respect to artesian water Mr. Bender stated as follows (from page 62):

"I have not as yet made any study of the subject of the artesian wells, and am of course unable to express any opinion as to the value of their source as one of permanent supply; but if it shall be found to present advantages above that derived from storage the appropriation suggested would be necessary to utilize it."

1884

The Legislature passed the first Hawaiian law having as its purpose the prevention of the wasteful use of water from artesian wells. The law, however, proved to be inadequate to accomplish the intended result.

October 11, 1884

Under the law "for the protection and preservation of the forests and woods," the Minister of the Interior designated Jim Kukona agent for the government forest lands at Kulaokahua, Auwaiolimu, Makiki, Puowaina, Manoa and Kalihi.

1884-1885

The "Appendix" to the Minister of the Interior's report to the Legislative Assembly in 1886 includes the reports made by Major A. S. Bender, 1884 to 1885, on Honolulu water supply (and also his reports on proposed sewage disposal). The Bender reports emphasize construction of reservoirs and installation of mains.

The "Appendix" also contains an outline of the history of appropriations made for the Honolulu Water Supply from 1884 to 1885.

1884-1886

(From page 276 of June 30, 1913, Report of the Superintendent of Public Works.)

"The Minister of the Interior (C. T. Gulick, August 6, 1883, to June 30, 1886) reported on Water Supply as follows: 'The water supply of the City of Honolulu has claimed the attention of his Majesty's Government, not only to meet the present demands, but looking to a possible increase, not only on account of increase of population, but for the requirements of sewerage, etc., and it has consequently summoned to its assistance the best talent it could command.'

"Major A. S. Bender submitted a preliminary report on the Water Supply of Honolulu. His investigations were with reference to collecting and storing the mountain waters of either Nuuanu or Manoa Valleys, either of which he thought would furnish an ample supply. His plan was to erect a large earth or masonry dam which would mean the expenditure of a large sum of money. He did not estimate the total cost of the work, as he had not investigated the matter fully, but suggested that \$200,000 be asked for to commence the works. (This dam was to be on about the same site as the present No. 4 Reservoir. It is to be noted that Major Bender asked for \$200,000 with which to begin the work. Reservoir No. 4 completed has cost about \$298,000.)

"The utilization of the artesian water supply was not reported upon, as Major Bender had not investigated the subject."

1886

The disastrous "Chinatown Fire" again brought home to the community the inadequacy of Honolulu's Water Supply.

May 22, 1886

(Letter from Minister of the Interior to President of the Legislative Assembly.)

In response to a resolution introduced in the Legislature, Minister of the Interior, C. T. Gulick, reported details of awards made on account of property taken for the water works purposes at Makiki. The total of all judgments and awards amounted to \$27,615.00 in favor of John Schnack, Rev. H. H. Parker, Queen Dowager Emma, "Land of Opu," Estate of Mrs. Bishop, Maui, Kainoa, Makaluli and Alapai, Puu, Nunui (w), J. M. Hering.

The said amounts were determined by appraisers in the report dated January 24, 1884, and by judgments of the Supreme Court made on April 10, 1885, and April 25, 1885.

March 31, 1888

A report by Charles B. Wilson, Superintendent of Honolulu Water Works, to the Minister of the Interior for the biennium period reported on the construction program which was made possible by the 1886 Legislature's appropriation of \$75,000.

Principal mains were laid connecting the Nuuanu reservoir and the city system with the "water-head at Luakaha."

It was reported that the five artesian wells that had been bored by the Water Works were not "as useful as they could be made to be with the addition of larger connections." The artesian well at Makiki was reported to be useless because of the absence of a pump.

With respect to watershed protection the report states (from page 153):

"The water springs in Nuuanu Valley, from which I have proved by experiment that an excellent supply of water is obtainable, should be taken full possession of by the Government, and immediately. The residences thereon by squatters should be prohibited, and existing kuleanas, if any, should be obtained control of."

March 31, 1888

The report by A. Jaeger to the Minister of the Interior with respect to activities of the "government forestry and nursery" shows that the forest planting in Makiki had proceeded diligently with the forester and six laborers continuously engaged in planting.

1888

As a result of the 1886 Chinatown Fire and Major Bender's water system report, new mains and two new reservoirs were completed in Nuuanu.

1889

The control of all springs and water rights in Nuuanu Valley and the removal of all squatters therefrom was strongly urged. Similar steps were recommended with respect to Kalihi, Pauoa, and Manoa Valleys (See p. 283, 1913 Report of Superintendent of Public Works).

April 8, 1889

A list of government lands in Honolulu District shows the following in Makiki Valley:

| | |
|-------------|------------|
| Haumakaawe | Mauualoha |
| Kaiwiokaehu | Opu |
| Kauhikio | Kanaha |
| Kewalo | 1/2 Poloke |
| Kumuulu | |

It is noted that the said lands (which comprise the entire Makiki Valley and Tantalus area) were "reserved for water works." (See under Jan. 2, 1902 herein for Settlement of the Poloke Land Case.)

August 26, 1889

In their report to Mr. B. F. Dillingham with respect to possible water supplies for the development of sugar plantations at Honouliuli and Kahuku, J. D. Schuyler and G. F. Allardt presented what is believed to be the first reasonably thorough explanation of the occurrence of artesian water on Oahu, elaborating upon the 1882 paper by Judge McCully. Their report also includes considerable information with respect to Pearl Harbor Springs.

The following excerpts are of special interest:

"..... Our attention was first called to the springs that burst out from the foot of the low bluffs and along the margin of the semi-swamp lands of Pearl Harbor and we cannot here refrain from expressing our surprise and astonishment at their phenomenal volume and extent. They furnish a supply for irrigating some 2,000 acres of rice fields, and a large area cultivated to bananas and taro; and in addition such large quantities go to waste, or at most are only used to furnish water power to various rice mills, that strong streams, navigable for small boats, pour continuously into the bay.

"It is owing to this great supply of fresh water that Pearl Harbor doubtless owes its existence, and the coral insect has been kept from closing its entrance.

"The largest and strongest of the streams come through the bluff at a height of 20 to 25 feet above tide level; and from this height all the way down to sea level the slopes for miles are like streams. Even in the bay beyond their springs break out so strong that it is said cattle and horses have been seen to wade out to them, plunge their noses under the salt water and drink from the fresh fountains bubbling up from beneath.

"Our measurements were confined to the streams which now flow to waste, unused for irrigation. The first was at Kalaunao near the mouth of Waimalu Gulch at Ah In's rice mill, where a portion of the stream is used to turn an overshot wheel. The total flow in the boat channel below the mill was found to be 27.8 cubic feet per second. The aggregate flow at Aki's rice mill was found to be 10-1/3 cubic feet per second. The Puikani springs, about a quarter of a mile west of Aki's rice mill, have a flow of 13.4 cubic feet per second.

"In the vicinity of the present terminal station of the Oahu Railroad are springs having an aggregate flow of $9\frac{1}{4}$ cubic feet per second.

"The unused water from springs near the mouth of Waiawa Gulch is about 5 cubic feet per second in volume. Large springs lying near and southwest of Waiawa church are held up to the highest limit of their flow to obtain power to turn a rice mill. The free discharge from these aggregate about 8 cubic feet per second.

"The largest group of springs was found at and above the mouth of Waikele Gulch; the total unused flow from which was found to be 42.5 cubic feet per second.

"We recapitulate the measured flow of unused water as follows:

| | <u>Flow in C ft. per second</u> |
|---------------------------|---------------------------------|
| Ah In's rice mill springs | 27.80 |
| Aki's " " " | 10.33 |
| Puikani " | 13.40 |
| Mausoleum " | 9.25 |
| Waiawa Gulch " | 5.00 |
| Waiawa rice mill " | 7.83 |
| Waikele Creek " | <u>42.50</u> |
| Total | 116.11 |

"These springs all lie within a range of 3 miles, and as before explained the volume here given represents only the largest streams that were gathered in such channels as admitted of measurement, and such as were not already appropriated and used for irrigation of the extensive rice fields that fringe the bay below them. It represents too the natural flow forced out against all impediments, and that after 18 months of exceptional drought. We do not hesitate to say that a systematic development of these springs would result in a large increase of the flow. Small drains in all directions through the extended areas of oozing ground, now so wet as to make unsafe footing, would so facilitate the drainage as to cut off the water that finds its way to the sea without entering the channel where the flow was measured. In Southern California, where similar springs or ciengas are of frequent occurrence, development by drain ditches, tiles and borings, has not uncommonly resulted in double and sometimes quadruple a natural flow. A definite plan for such work can only be laid out after special survey and study of each locality is made. The present measured flow as given on the preceding page is sufficient to irrigate 7,000 acres of sugar cane, and we have no doubt that the supply can be increased sufficiently to provide for 10,000 to 12,000 acres

if necessary. It would not be a difficult matter to collect all the water into one central pumping station if it was considered desirable to do so. It would probably be preferable to establish two or more pumping plants and deliver the water from each to the plantation nearest the supply.

"THE ARTESIAN WELL SUPPLY: The discovery of the possibility of obtaining a supply of flowing water by deep artesian borings around the margin of this island has been of incalculable value to all property interests, and has compensated in a measure for the loss occasioned by the perpetual robbery of the waters, that fall so copiously upon the mountains, by the porous and thirsty earth, and for the water lost during torrential storms by rapid drainage into the sea. On no other island of the group has Nature provided for such compensation, and even here the geological formation is so different from that of any other region the world over where artesian water is obtained by boring that no scientific man would have risked his reputation by predicting the possibility of securing flowing wells by boring in the volcanic and coral formations of this country before success had demonstrated the fact.

"Mr. James Campbell, the present owner of Honouliuli and Kahuku, is accredited with the honor of having been bold enough to try the experiment which resulted in the first flowing well in the kingdom. This well was bored 10 years ago on the lower slopes of Honouliuli Rancho, and a good flow obtained at a depth of 273 feet. It has been followed by so many successful attempts in the same direction that the flowing wells on the island now number over 100, some of which equal if they do not exceed the flow of the largest and most famous wells of California. One of a group of 4 wells, bored by Judge McCully on King and Beretania Streets, Honolulu, was carefully measured a few days since by Allarot and Kluegel, and the flow was ascertained to be 3.98 cubic feet per second, or 2,500,000 gallons in 24 hours. The combined flow of the 4 wells was ascertained to be 10.68 cubic feet per second, and 2 of the smallest of them, flowing 4.1 cubic feet per second, are now made to irrigate 100 acres of rice.

"A marked peculiarity of this artesian belt is that it is confined to a marginal rim around the island, from sea level back to an elevation 21 to 42 feet above. In and around the City of Honolulu, or the Kona District, water will flow at the maximum height of 42 feet. In this District also the largest and strongest wells are obtained. In the Ewa District, which includes all the margins of Pearl Harbor, and Honouliuli, the limit of rise is 32 feet; in the Waialua District it is 21 feet; and in the Koolau District, on the north side of the island, embracing

the Kahuku Rancho, the limit is 26 feet. This data is obtained from the last edition of Thrum's Almanac, in which is given a list of all the wells and their depths....."

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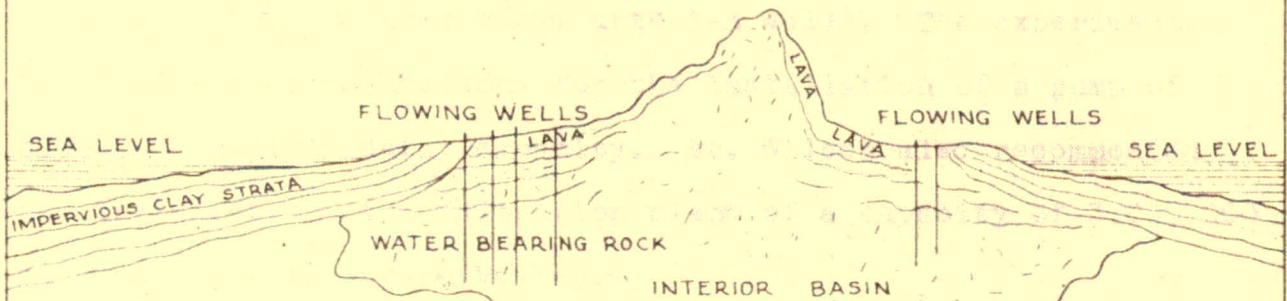
"The springs that appear at and above sea level all around the island and the artesian wells undoubtedly have one and the same source of supply and are fed from the same interior basin that overflows at sea level. This supply is maintained by direct absorption of the rainfall by the porous lava rock and by the infiltration from the mountain streams. The fact that water will rise in the well pipes a few feet higher than the level at which the springs appear indicates that the open well pipe affords a freer outlet than is afforded by the seams and crevices through which the water of the springs is forced, permitting the water to rise to nearly its full static head. The probabilities are that the island is surrounded by deep thick strata of impervious clay of sedimentary formation built up by slow deposit from the wash of ages in the streams of the island; that these strata lap into the land to the height the water rises in the wells, brought up by the gradual rise of the island above sea level, and that these strata prevent the escape of the waters into the sea beneath them."

(The diagram, of which a copy is presented on the next page hereof, shows that Schuyler and Allardt "just missed" expressing the views presented by W. D. Alexander and Carl B. Andrews in 1908-1909. They reasoned out the existence of "caprock" but not the balance between fresh-water and sea-water which is now known as the Ghyben-Herzberg principle.)

March 31, 1890

Report of the Superintendent of Honolulu Water Works for the biennial period.

Because of an unusually severe drought which lasted from November 16, 1888, to April 24, 1889, during which extraordinary time there was practically no rain, considerable attention was given to improving ditches to increase diversion of water to the Nuuanu reservoir and to further development of springs. Mr. C. B. Wilson of the Water Works stated that he even



"IMAGINARY CROSS-SECTION" OF OAHU by J. D. Schuyler and G. F. Allardt in their report of Aug. 26, 1889 to B. F. Dillingham, to illustrate their theory with respect to the occurrence of artesian water. (Enlarged from original).

[For later conceptions see diagrams by H. S. Palmer (1926); H. T. Stearns (1931); and Board of Water Supply (1941) of which copies are included in PART II-C of Board of Water Supply 1948 "Conservation Report"]

G. F. Allardt, consulting engineer, submitted to the Director of the Interior a report on hydro-electric power development in the Waianai Valley.

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traced down springs known to him only from their mention in Hawaiian legends and songs and that he had investigated all possibilities in each valley. It was believed that Makiki springs could be profitably developed to a greater extent.

During the period experiments were made on pumping from the Honolulu Water Works artesian wells. The experiments resulted in recommendations for the installation of a pump of 3,000,000 gallons daily capacity. Mr. Wilson also recommended the installation of a filtration plant of a capacity of 3,000,000 gallons daily in Nuuanu Valley.

With respect to watershed control Mr. Wilson stated as follows (from page 82):

"Control of water courses and water rights--
As recommended in my last report I would again urge that steps be taken to obtain full control of all springs, water heads, and irrigation rights in Nuuanu Valley and that all squatters be removed from the valley. I consider that the caretaker alone should be allowed to reside above the Halfway House Reservoir. During the period the land owned by Hoopii and E. Wery (the Halfway House) have been acquired in exchange for Government land situated lower down and away from all possible contamination of the water.

"I would also urge that similar steps be taken in regard to the water supplies of Kalihi, Pauoa, and Manoa, as at no very distant date they will be absolutely necessary to the Government system of water works. This would give the benefit of the district water supply to the whole population of the district instead of to a limited number of individuals, as well as facilitate the extension of settlement outside the immediate city limits."

May 6, 1890

Mr. G. F. Allardt, consulting engineer, submitted to the Minister of the Interior a report on hydro-electric power development in Nuuanu Valley.

August 22, 1890

A petition addressed to the President of the Hawaiian Legislature:

"We the undersigned, are desirous of procuring House Lots on the mountain back of Honolulu, in the vicinity of Mount Tantalus, and for which we are willing to pay fair prices.

"We would petition you further that the Road which has already been proposed, be built to open said district and that the sum asked for be appropriated by your Honorable Body."

(Signed by 66 leaders of Honolulu's financial, social, and political circles).

1890

The Legislature included in the General Appropriation Bill, the sum of \$17,500 for a "Road to open government lands back of Honolulu." (the Tantalus Road)

December 17, 1890

Report by W. M. Bruner to Minister of Interior.

A report proposing a principal dam and reservoir in Upper Nuuanu Valley at the location known as "Schussler Basin," with respect to which Mr. Schussler, San Francisco civil engineer, had made a "hasty survey." Capacity approximately 300,000,000 gallons.

1890-1892

The record shows that by this time responsible government officials had arrived at a realization of the importance of conservation of water resources and of the supporting land area.

A detailed study of government land transactions shows that since 1892 there have been no grants of land within the present (1948) Forest Reserve Line, other than grants practically forced upon public officials.

During the three years 1890, 1891, and 1892, there were only three grants of land in the said area:

1. Grant 3533 to the Bishop Estate included 224 acres of the unawarded portion of the Ili of Kaakaukui. This Grant, which includes "Paoua Flats" was given in a compromise settlement of all claims of the Bishop Estate against the Hawaiian Government. Since the Estate had vested rights in the area, the Grant cannot be considered an alienation of government property. The transaction was directed by Act of the 1890 Legislative Session.
2. Grant 3535 (signed by Queen Liliuokalani), by which a 21.48-acre parcel at Poloke and Opu was granted to H. W. Schmidt for a consideration of \$279. The reason for the grant is not known. This was the first grant of government land on Tantalus. It is important to note that the following appears in the Grant:

"This Grant is subject to the following conditions, viz.

- (1.) That no Hogs or Pigs are to be kept or raised on the land.
 - (2.) No Stock of any kind is to be kept or pastured on the land, except those for the use of the owner on, or in connection with the place.
 - (3.) No growing trees are allowed to be cut down except by and with the permission of the Minister of the Interior or his Agent and in every instance when a tree is cut down another tree is to be planted in its place.
 - (4.) No offensive use to be made of the land which would in anywise be injurious to the water supply or otherwise become a public nuisance.
 - (5.) The Government holds and reserves the right to make a road not less than forty feet in width across said land without claim or charge of damage provided the same shall be deemed necessary and provided also that said road shall be made within ten years from the date hereof."
3. Grant 3619, by which 30 acres in Waiakeakua Valley, Manoa, was sold to Helen Boyd. There is no available record explaining the justification for the sale, but, on the other hand, it must be admitted that at that time such a project as the presently proposed Manoa Recharge Tunnel could not have been thought of.

The only other grants made during the years 1890-1947 are commented on in Part I of this (1948) Report. Briefly, such other grants consist of:

- (a) Lots on Tantalus opened up as a result of action by the 1890 Legislature.
- (b) Lots on Tantalus granted in exchange transactions to make urgently needed land for public improvement available to the government.
- (c) Deeds to W. R. Castle and Martha A. Waterhouse in 1899 and 1902 to settle vested rights on Tantalus. (The "Poloke Case.")
- (d) Setting aside an area at Makiki Heights for the Hawaii Experiment Station of the U. S. Department of Agriculture.
- (e) A land exchange with the owners of "Luakaha" in Nuuanu.

1890-1892

The Superintendent of the Honolulu Water Works (John C. White) in his report to the Minister of the Interior for the biennium April, 1890 to March 31, 1892, made a strong plea for conservation through the investigation of waste and by other means, and for necessary improvements in the water system. Mr. White reported that "with a few exceptions, the water means are the same today as they were 20 years ago." He mentioned the rapid growth of the city at Waikiki, Kalihi, on the slopes of Punchbowl, and elsewhere, and his concern with respect to certain new residences on Punchbowl at elevations as high as 260 feet.

The severe droughts of 1889 and 1891 are referred to. It is noted that the principal source of water supply was from Luakaha and the second supply was from the Hoopii Springs at the Halfway House in Nuuanu and, in heavy rains, from the Emmaole Stream which discharged into No. 2 Reservoir.

With respect to the utilization of Makiki Springs Mr. White states "the bed of the Makiki Stream being so porous, the water sinks before reaching the reservoir." In view of this condition, he proposed constructing a new reservoir at the head of the Valley and piping water to the city.

The report contains a tabulation which shows clearly that the importance of rainfall studies was well realized. This is shown particularly by the following comment:

"Manoa Valley at present, does not furnish any water for the supply of Honolulu. Since October 1st, a Rain Guage has been placed on the premises of John Ena, Esqr., situated at the head of the valley, and at an elevation of 250 feet above sea level; rain guages could be placed in Kalihi and Pauoa Valleys, which would be another acquisition to the rain reports; then the rainfall from all the valleys could be accurately registered, and the available water supply for the city better defined."

Mr. White urged the necessity of a new large reservoir in Nuuanu to make it possible to utilize a portion of the storm waters (reservoir being the one which became Reservoir No. 4).

Mr. White also proposed additional utilization of the several artesian wells under the government's control by the installation of pumping plants and considerable extensions in the distribution systems and various reservoirs. He also commented on the appropriation made by the 1890 Legislature for the installation of a Hyatt Pure Water Filter for the improvement of Nuuanu water. Plans for the filter plant had been prepared, but the project had not actually been undertaken as of the date of the report.

With reference to the acquisition of water-shed lands, Mr. White stated as follows: For this paragraph please substitute paragraph at bottom of page 1918.

"The Territorial government is accomplishing much in setting aside forest reserves, and in fencing and policing these areas. The appropriations for this work are fairly large, and they are well handled. But there

is much more to be done if we consider the forest cover of the Islands as a whole--both private and public lands--and the private interests are called upon to take part in the undertaking. The proposition offers three alternate courses, all of which hold the same end in view. Each of them calls for financial aid from the Hawaiian Sugar Planters' Association to supplement the government funds. Plan I, as Mr. Giffard states it, calls for all forest reserves, both public and private, being placed under the control of the Territorial Board of Agriculture and Forestry. Plan II calls for the private reserves being controlled by a special committee of the H. S. P. A. Plan III provides for a department of forestry at the Experiment Station of the H. S. P. A., which will have general supervision of the forestry work of the sugar plantations and other cooperating estates, this department to work in conjunction with the Territorial Board of Agriculture and Forestry. This third plan will appeal to many as perhaps the most practicable of the three in that it avoids the difficulties incident to transferring private forest lands to government control and in that it takes account of a working organization with experience in handling a wide range of common interests for the sugar plantations."

1890-1892

(From report of the Minister of the Interior for the biennium April 1, 1890, to March 31, 1892.)

It is noted that the tract of land called "Palai," formally claimed by the Bishop Estate as part of the Ili of Opu, had been surveyed into 39 lots which had been sold. (These lots are not within the present (1948) Forest Reserve area.)

It is also noted that "A series of lots has also been laid out in connection with the new road to open up Government lands back of Honolulu on the Kewalo ridge and in the woods adjoining Puu Ohia (Mt. Tantalus) and Kakea." (As shown elsewhere in this (1948) Report, this opening up of Tantalus lots resulted from action taken by the 1890 Legislature following a petition presented by 66 prominent citizens.) The report shows clearly that considerable attention was being given to forestry. Concern was expressed with respect to a fire which burned for 24 hours in Makiki Valley on March 22, 1891, and which destroyed approximately 12,000 planted trees.

The attitude of responsible public officials with respect to the opening up of lots on Tantalus is indicated by the following excerpt (from page 228 of the report):

"Where the new road to Tantalus now is about 20,000 planted trees have been cut down and also thousands were killed by the earth being dumped on them over the hill sides whilst making the road."

1892 Legislative Session

A Bureau of Agriculture and Forestry was created under the Minister of the Interior.

The Legislature also passed an act making it unlawful for any person to cut or destroy any forest tree or growing shrub within 250 feet of any road through any natural forest.

By a third act, the Legislature provided for the exemption of fenced forest land from property taxes. This Act provided as follows:

"In all cases where forest land is fenced for the purpose of protecting the forest or springs or streams of water rising on said premises or flowing through the same, and all livestock are excluded from the same, and no other use of its lands or its products is made, such land, so long as such conditions exist, shall be exempt from taxation."

A sworn annual statement was required from the owner.

The above Section is incorporated in R. L. 1945 in almost identical wording as Section 5152.

1893 -1894

The severe droughts of these years intensified demands for a more adequate water supply.

March 31, 1894

In the portion of the Minister of the Interior's report of March 31, 1894, prepared by Joseph Marsden, Commissioner of Agriculture and Forestry, considerable comment is made on the conservation of forests. The condition of certain forests or

former forests on Hawaii had reached a serious stage and it was urged that cattle be excluded. In this connection Mr. Marsden stated as follows (on page 94 and 95):

"For two years in succession the districts of Hamakua and Kohala have suffered from severe and protracted droughts, causing great loss to the sugar planters of those districts, springs and natural reservoirs in the gulches diminished to such an extent that water for animals and domestic use was most difficult to procure, and in some instances water had to be taken from Honolulu in barrels. The cause of this serious state of things is accredited by the residents of those districts and in the opinion of your Commissioner rightly so, to the unrestricted roaming of cattle in the forests until tens of thousands of acres of land, which were formerly a dense forest, are now but little better than a barren desert, useless alike to the grazer and the agriculturist."

- - - - -

"The cattle, as they encroach on the forests, destroy all before them, causing water holes and springs to dry up and disappear until soon there will be none left. When this occurs and occur it will, unless action is taken to prevent it, it will be too late to effect anything that will benefit this generation; it will then be a difficult matter to do anything at all, as the people in those districts (what there will be left of them) will be too poor to assist in any plan of reforesting the country."

1895

During this year Honolulu experienced its first cholera epidemic, which again brought home to the community keen realization of the need for a protected water supply.

Two artesian wells and pumping plant were completed at Beretania and Alapai adding over 2,500,000 g.p.d. "of the first water that could be relied upon."

August 9, 1895

(Letter by J. B. Atherton and C. H. Cooke to the Minister of the Interior.)

An application to purchase or lease an area of approximately 10 acres at Luakaha, Nuuanu, to enable the applicants to "improve the gulch below the falls and back of our Luakaha lot, by planting of trees, general cultivation and improvements."

The area desired adjoined Land Commission Award No. 5 owned by the applicants.

On August 19, 1895, the Government Survey Office reported " . . . from statements of Superintendents of Public Works and of Water Works there would appear no probability that it would even be used for this (reservoir) purpose. With the proviso that this lot should at no time be used for any pasturage purpose or for any purpose detrimental to it as a watershed. . . I can name no objection to a lease . . ."

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(The applicants were given a tenancy at will which continued until 1902 when C. M. Cooke, Ltd., negotiated an exchange with the Territory under which the Luakaha property was "rounded out" to the Pali Road by Grant 4561 (area 7.29 acres) being given by the Territory in exchange for the 3.90-acre portion of Land Commission Award No. 5 on the westerly side of the Pali Road.

"Luakaha" had been occupied for many years, thus the 1902 transaction created no new harmful effect on the watershed area. It is interesting to note the Land Commission Award No. 5 was awarded to George Pelly in 1847 only as a result of intervention by the British Navy after the Hawaiian Government had refused to give the award.

August 14, 1895

By Act 26 of the Special Session of the Legislature a Board of three persons designated Commissioners of Public Lands was created to administer all government lands. This important law (which considerably revised the Land Law) is known as the "Land Act, 1895."

It was provided that the Act shall not apply to the following classes and descriptions of land, the property of the government, all of which were to remain under the control of the Minister of the Interior.

"Town lots, sites of public buildings, land used for public purposes, roads, streets, landings, nurseries, tracts reserved for forest growth, and conservation of water supply, parks, and all lands which may hereafter be used for public purposes"

October 11, 1895

An official document including a setting aside of Honolulu watershed lands for the control of the Minister of the Interior. (Extract from Dec. 31, 1895 Report of Minister of the Interior)

"... On October 11th, 1895, the following schedule defining lands and boundaries of lands to remain under the management and control of the Minister of the Interior separate and apart from those in charge of the Commissioners of Public Lands, was filed at this office with the understanding that the same should be amended and added to from time to time as circumstances should require.

"For the purpose of clearly defining what lands in certain localities are to remain under the management and control of the Minister of the Interior in compliance with Sec. 2 of Land Act of 1895, it is hereby specified and understood that all Government lands named in the schedule below shall remain under the control and management of the Minister of the Interior, separate and apart from those in charge of the Commissioners of Public Lands, but not meaning hereby to affect any other lots of land in other localities which are clearly intended by law to remain under control of the Minister of the Interior."

SCHEDULE

In vicinity of Honolulu:

1st. All Government lots and lands within the tract which is bounded on the east by West ridge of Manoa Valley from the Koolau range to "Ualakaa" or "Round Top" then by straight line to S. W. angle of Punahou pasture, then by Punahou St. Waikiki road, road passing "Moehonua" premises and beach road to sea.

"On the west bounded by the top of the west slope of Nuuanu Valley from the Koolau ridge to foot of Nuuanu ridge below Judd St. thence around the foot of ridges to Kalihi boundary to the sea, but reserving however to the Commissioners of Public Lands the land of Kapaloa in Pauoa, and Kamookahi and Kuwiliwili in Kapalama, all of which are agricultural lands under leases from the former Commissioners of Crown Lands.

2nd. All that portion of the land of Kaneloa now under lease to the Kapiolani Park Association.

In the vicinity of Hilo, Hawaii.

1st. All Government lands within the tract lying between the Wailuku river and the west boundary of Ahupuaa of Waiakea, and extending from the sea to the lower boundary of Piihonua, lease to J. Baker, and a line S. 45 E. true from said lower boundary of Piihonua to Waiakea Ah'p West boundary.

2nd. The four acres reserved from Waiakea lease for Government purposes and also the land of Makaoku which includes Coconut Island.

In Lahaina Maui.

All lots used for any Public purposes, and below the main Street (makai) in vicinity of the Market, Landings etc.

Sgd.

J. F. Brown,
Agent of Public Lands.

"

J. A. King,
Minister of the Interior

1897

Report by Rudolph Hering, hydrologic and sanitary engineer, on the "Filtration of the Nuuanu Water Supply"

Mr. Hering presented an unusually comprehensive report (for that day), including estimates of cost of both natural sand filters and mechanical filters of capacities of 500,000 gallons daily and 3,000,000 gallons daily.

Mr. Hering had come to Honolulu from New York primarily to make a report on the sewage and drainage of Honolulu. It is noted in his letter of transmittal that the filtration report was made as a result of the request of Mr. W. O. Smith, Attorney General, and President of the Board of Health.

November, 1897

Fourteen applicants for the Tantalus lots, which were opened up as a result of action taken by the 1890 Legislature, entered into agreements of sale with the Minister of the Interior.

The form of agreement contains a covenant providing that: "Number of forest trees standing on land at time of sale shall not be reduced or allowed to become reduced to a lower number than 24 trees per acre, if that number of trees are growing on the lot, that number to be kept up by replanting if necessary."

(Grants covering the property described in the agreements of sale were issued during 1901-1902. As is stated elsewhere in this (1948) Report, it is the belief of the Board of Water Supply that it was intended by the Government that the purchasers of the Tantalus lots and their successors preserve the forest cover. Reference to the agreements of sale is made in the respective grants. It is the belief of the Board of Water Supply that the government contemplated that the Tantalus lots be occupied by only one summer cabin for each lot and that, if present (1948) ideas of subdivision could have been foreseen, the lots would not have been sold).

1897

Punchbowl Reservoir completed (Capacity: 500,000 g.p.d)

December 31, 1897

(Report of the Minister of the Interior for the Biennial Period ending December 31, 1897)

During the two years, sales of land under the control of the Minister of the Interior were as follows:

14 Lots on Tantalus

6 Lots on South Slope of Punchbowl

1 Lot at Makiki

1 Lot to Hawaiian Hotel

Forty new leases were given for terms of up to 30 years. The only leases then in effect of interest in this (1948) Report were:

Lease No. 71 originally given to Queen Kapiolani covering 150 acres of Auwaiolimu. The lease was given August 15, 1882, for a term to expire August 15, 1912. Rental: \$80 per year.

Tenancy at Will given to C. H. Cooke and J. B. Atherton on September 3, 1895, covering land at Luakaha rent free, but requiring that the tenants plant trees. (See under Aug. 9, 1895 herein)

1897

In Minister of Interior James A. King's Report for the biennium ending December 31, 1897, the Commissioner of Agriculture reported that:

"The whole of the land in Nuuanu Valley set apart by the government for a Watershed, is, with the exception of the steep mountain slopes, denuded of the forest that in all probability covered the lands in former times. The importance of reforesting the whole upper Valley, with the view of conserving and regulating the water supply, can hardly be over estimated."

September 11, 1899

(Reference from Minister of the Interior's Report for biennium ending Dec. 31, 1899)

On this date President McKinley issued an order directing "that all proceedings taken or pending for the sale or disposition of the Public Lands in the Hawaiian Islands shall be discontinued until further directions."

September, 1899

An article by Walter Maxwell in "The Paradise of the Pacific" entitled: "Hawaiian Forests and Ranges."

Mr. Maxwell urged the immediate necessity of a thorough, expert examination of the Islands "and of their requirements in permanent forest areas."

(The article, although stressing the importance of sugar plantation water supplies, is generally applicable. It is a matter of record that Mr. Walter Maxwell, who was an early Hawaiian Sugar Planters' agriculturist, was a leader in the succession of events leading to the establishment of our present forest reserves.)

1899

Kalihi Pumping Station (artesian wells) and Diamond Head Reservoir (887,000 g.p.d.) authorized and construction started.

December 12, 1899 - January 20, 1900

(From Report of the Sanitary Commission, 1912)

This period was probably second only to that commencing December 7, 1941 in catastrophic proportion. On December 12, 1899, Honolulu's first case of Asiatic plague was discovered. The plague "soon became epidemic and proved one of the most costly experiences Honolulu has undergone. There has never been a published report. The direct cost was \$625,000. There were 71 cases. Every house in which a case occurred was burned. Finally by accident a great fire took place, due to which claims were finally paid amounting to \$1,315,000."

July 1, 1900

(From Report of the Commissioner of Agriculture and Forestry.)

As provided under the Organic Act, the office of the Commissioner of Agriculture and Forestry assumed jurisdiction over the matters formerly handled by the Board of Agriculture under the Minister of Interior. Mr. Wray Taylor, the new commissioner, arranged through the Territorial Government for a

study of island conditions under the U. S. Secretary of Agriculture. The activity resulted in a study by Dr. W. C. Stubbs, Director of the Louisiana Experiment Station, who recommended to the Federal Government the establishment of an agricultural experiment station on the 220-acre tract set aside by the Hawaiian Republic as an experiment station in 1893 in Makiki Valley. (The Experiment Station was not actually started until 1902.)

During the year, 30, 203 trees were planted on the Nuuanu watershed. The Commissioner recommended that funds be provided to make a more intensive planting program possible.

It is noted that application had been made to the U. S. Department of Agriculture to send out an expert to investigate and report on the forests in the Territory.

Mr. Wray Taylor summed up his comments on forestry as follows (from page 15):

"What appears to be the most immediate needs are a thorough expert examination of the different islands and of their requirements in permanent forest areas, an inspection of the existing forests, and the adoption of means for improvement and maintenance."

November 30, 1900

President McKinley approved, under Section 73 of the Organic Act of April 30, 1900, all land transactions entered into by the Hawaiian Government between July 7, 1898 and September 28, 1899, as listed in detail in a report submitted by the Governor of Hawaii.

(See December 13, 1900 letter from Secretary of the Interior to the Governor of Hawaii, which included the statement, ". . . the protest of J. E. Hine and twenty-one others against the approval of these sales and other dispositions were duly considered before favorable action was taken in the premises by the Executive.")

1901

By proclamations dated June 10, 1901, and August 16, 1901, the Territory of Hawaii set aside for the Federal Government a 141.90-acre tract in Makiki for the Hawaiian Experiment Station of the U. S. Department of Agriculture. (The tract had been set aside by the Hawaiian Government for the same purpose in 1893).

1901-1904

During this period the Kaimuki Pumping plant and water system, built by private enterprise, was purchased by the Territory for Honolulu Waterworks.

January 2, 1902

The "Poloke Land Case" which had been of particular concern to the Agriculture and Forestry officials of the Territory for some time was concluded by a partition deed and agreement (recorded in Liber 250 at Page 152).

On April 11, 1898, Haalelea (w) et al had filed a suit in the Circuit Court against the Minister of the Interior to recover an undivided half interest claimed by them in certain land of indefinite boundaries at Poloke, Makiki (Tantalus) which had been awarded to Keawekane by Mahale Award 11 which was confirmed by Royal Patent 6715.

As a result of a compromise settlement, judgment was entered on July 25, 1898, to the effect that the plaintiffs were to recover 30 acres of their selection.

W. R. Castle and Martha Alexander Waterhouse acquired the interest of Haalelea et al, and after considerable negotiation the Republic of Hawaii conveyed to Mr. Castle (on September 15, 1899) a 2.82 acre area on Tantalus in exchange for six acres

of his interest in Poloke. By the Partition Deed and Agreement of January 2, 1902, Mr. Castle and Mrs. Waterhouse conveyed to the Territory all of their remaining interests in Mahele Award 11 and the Territory conveyed to them Tantalus lands as follows, in seven parcels:

To W. R. Castle

Parcel I - 8.12 acres at Poloke

II - 0.91 acres at Opu, Tantalus

III - 1.02 acre at Opu, Tantalus

IV - 1.45 acre at Poloke and Opu

V - 2.04 acres at Poloke and Opu

VI - A portion of Auwaiolimu by a general description and having an area now (1948) shown on the tax maps as 37.10 acres.

To Martha A. Waterhouse:

Parcel VII - 9.38 acres on Tantalus.

March 5, 1902

A comprehensive report containing specific recommendations with respect to forest conservation was addressed to Governor Dole by Mr. E. M. Griffith of the Bureau of Forestry, U. S. Department of Agriculture (whose services had been made available as a result of the Governor's request).

Mr. Griffith found that throughout the Islands the forests were deteriorating rapidly and that the principal cause, in his opinion, was the indiscriminate ranging of cattle. His principal recommendation was that the forests be fenced.

In addition to discussing the reasons for the progressive deterioration of the forests, Mr. Griffith stressed the importance of forest protection in relation to water supply.

The portion of the report which applies specifically to Oahu is quoted in full:

"Forest protection on Oahu is far more important than on any other island of the Hawaiian group on account of the large interests at stake and the great value of the water supply. Probably there is a greater daily consumption of water for irrigation purposes between Honolulu and Kahuku than on any equal area in the United States. The sugar plantations alone pump over 314,000,000 gallons of water daily.

"Both the Waianae and Koolau ranges were formerly covered with a heavy forest growth extending down nearly to the shore line and in the center to the Waialua plains. But the indiscriminate ranging of cattle has resulted in the total destruction of all the undergrowth and the trees on the lower slopes so that today the remaining forests are confined to the upper slopes and the more inaccessible canyons. Still the cattle continue to rapidly destroy the forests although in many cases the land and cattle owners are far more financially concerned in the welfare of the sugar plantations.

"The water which is being pumped by the plantations to irrigate their cane is very largely that which falls within the forest belt on the higher slopes and gradually sinks to the artesian level. Consequently, if the cattle and goats are allowed to destroy these forests, a considerable amount of water will be lost through largely increased evaporation on the exposed soil and the rapid run off.

"There is a large amount of natural grazing such as the Waialua plains and the lower slopes of the two ranges above the cane lands so that the necessary protection of the forest areas does not mean doing away with the cattle business. There is also a large amount of fine agricultural land on the Waialua plains but these will be absolutely worthless unless the water supply is protected.

"The forestation of Tantalus by the Department of Agriculture and Forestry is an unusually fine piece of work very successfully carried out but it clearly demonstrates how difficult and expensive the reclamation of such land becomes when all the forest growth has been destroyed. It emphasizes the fact of how much easier it is to fence and protect the forests in time while a few trees remain to seed up the surrounding soil than it is to delay until artificial reforestation is necessary.

"If the lower slopes of the forests on the Waianae and Koolau ranges are fenced off as soon as possible, the scattering trees will gradually reforest the slopes, the young koa, which at present is being eaten off and

tramped by the cattle, will come up and only a small amount of planting on those areas which are absolutely denuded will be necessary. The fencing should have been done long ago and at present the reclamation of the forests will be very slow on account of the few seed trees which remain and the mass of Hilo grass which has covered the soil and makes reproduction very difficult if not impossible.

"So much of the Government land on this island has been leased for a long term of years that the effective protection of the remaining forests depends upon the planters and other lessees who will be direct-benefited. However, it is hoped that the government can assist in building the fences and that they will appoint a ranger to patrol the forest lands not under lease and see to it that all cattle are excluded.

"In future the forest areas on this island should never be leased for grazing purposes and the lessees of cane and agricultural lands should be obliged, by the terms of their lease, to build stock fences and keep them in repair."

June 30, 1902

(Report of Commissioner of Agriculture and Forestry for period January 1, 1901 to December 31, 1902)

Considerable emphasis was continued with reference to the reforesting of the Makiki-Tantalus Forest which had been started by the Hawaiian Republic in 1893, and the planting of trees on the Nuuanu watershed was also continued.

In December, 1901, Mr. E. M. Griffith of the U. S. Bureau of Forestry made a two months' study of forests in the Territory. The Commissioner's summation with reference to Mr. Griffith's visit is quoted (from Page 24):

"Mr. Griffith's visit was a very important event in the history of forestry in the Territory. The preliminary examination of our forests brought forth a very able report from him, which is in your hands. His recommendations are worthy of the highest consideration, and I strongly recommend they should be the basis of an exhaustive forest bill to be placed before the next Legislature for its approval with liberal appropriations. As Mr. Griffith said in his lecture, 'this is not a question of leaving forests for posterity to enjoy, it is a question of now.'"

During the latter part of 1902 Mr. Gifford Pinchot, head of the U. S. Forestry Department, made an inspection of the Nuuanu and Tantalus forests.

1902-1903

In these years, there was considerable correspondence between various government officials and principal land owners, all with the object in mind of establishing protected forest reserve lines over all the Territory.

1903

By Act 44, the Legislature reorganized the Department of Agriculture and Forestry under a Board of Commissioners of Agriculture and Forestry whose specific duties included (and still include) the following which are now incorporated in R.L. 1945 as paragraphs of Section 1006:

- "6. Care of forest reservations. To have the care, custody, control and regulation of all lands which may be set apart as forest reservations, under the terms of this chapter;
 7. Protection of forests and water supply. To devise ways and means of protecting, extending, increasing and utilizing the forests and forest reserves, more particularly for protecting and developing the springs, streams and sources of water supply, so as to increase and make such water supply available for use;
- - - - -
15. Further legislation. To formulate and from time to time recommend to the governor and legislature such additional legislation as it deems necessary or desirable for the better securing of the objects of this chapter;"

Act 44-1903 also provided for the creation of Forest Reserves. The pertinent portions of the Act are now designated Section 1013 - 1018 R.L. 1945 which are practically identical with the corresponding portions of the 1903 Act.

The law established the procedure with respect to the setting aside of government lands as forest reserves and made the following provisions with respect to private lands (unchanged since enactment in 1903):

"Any person may at any time surrender to the government the care, custody and control of any lands, whether held under lease or in fee, as a forest reservation, either for one or more years or forever. No taxes shall be levied or collected upon any private lands so surrendered for the purposes aforesaid, so long as the same shall remain exclusively under the control of the government as a forest reservation."

(Under the foregoing, many principal owners of forest lands have entered into long-term leases with the Territory surrendering control for the said purposes.)

The 1903 law included the present Section 1018 R.L. 1945:

"In case any moneys shall accrue from any forest reservation, or the products thereof, the same shall be deposited in the treasury as a special fund for the preservation, extension and utilization of forests and forest reservations and the same shall be then held available for use under this chapter, subject to withdrawal and use in the same manner as moneys appropriated by the legislature."

(Under the above, a "Forest Reserve Fund" was established in the Territorial Treasury. Receipts are only minor, the estimated income for the present biennium being only \$21,308. Rentals received by the Territory under water licenses go 70% into the General Fund of the Territory and 30% into the "Hawaiian home-loan Fund" of the Hawaiian Homes Commission.)

May 19, 1904

(Letter from W. M. Giffard to Governor Carter. Mr. Giffard was Manager of W.G. Irwin & Co. a sugar plantation agency, until that company was merged with C. Brewer & Co. He was a member of the Board of Commissioners of Agriculture and Forestry from 1903 until 1922 with the exception of a few years in said period.)

In this letter Mr. Giffard outlined a conversation that he had had with the Governor relative to their mutual belief that the Territory should secure title to lands within forest reserves.

It had been proposed that title be acquired by land exchanges. In view of the fact that the situation is basically the same today (1948) as it was in 1904, Mr. Giffard's statement of the problem is quoted in full:

"I further understand that, notwithstanding the necessity of such acquisition, you and the Board of Agriculture and Forestry are somewhat perplexed to find a means to accomplish the desired end. While that Organic Act, under the construction given it by the Attorney General of the United States, permits the Territorial officers to exchange lands, I understand you will probably object, in a great measure, to this method for the acquisition of forest areas. This stand taken by you against parting with land from which the Territory derives a revenue in the way of rentals, for forest lands, certainly, in my opinion, is sound, and no doubt meets with the hearty approval of all persons having the real interest of the Territory at heart. Unless, therefore, you adopt a course which will deplete the revenues of the Territory in the future, you cannot acquire forest reserves by exchanging other land belonging to the United States, and the sequence will be that the Board of Agriculture and Forestry will be unable to carry out the work contemplated by the Superintendent of Forestry. This same line of reasoning also prevents you from acquiring land by exchanging land owned by the Territory but not at present under lease. If such latter land be worth anything, it can be leased, and an added revenue secured; if not worth anything, no owner of forest lands would receive it in exchange."

In spite of the difficulties, Mr. Giffard pointed out that many leases of government lands were about to expire. The portions of such lands selected as forest reserves would automatically become available. Mr. Giffard suggested that in order to qualify for renewal of leases to government lands makai of the forest lines, the Government's lessees would probably be willing to convey to the Territory any forest lands under their

control, provided their water rights were reserved. The objection that Mr. Giffard saw with reference to his suggested solution was that the Organic Act then provided that no new leases or lease renewals of agricultural land owned by the Territory could be given for a longer period than five years and this would probably make the suggested solution impossible of accomplishment. In view of this Mr. Giffard suggested that the Governor during his planned trip to Washington, endeavor to ascertain whether or not the authorities there would object to a plan under which the Territory might grant leases for longer periods than five years in exchange for the fee title to forest lands. (In his letter of acknowledgment Governor Carter stated that he would be glad to take the matter up in Washington. The five year limitation was subsequently increased to 15 years but Mr. Giffard's proposal was not carried further).

December 31, 1904

(Report of the Board of Commissioners of Agriculture and Forestry for the period July 1, 1903, to December 31, 1904.)

It is noted that on November 24, 1903, the Board appointed Mr. Ralph S. Hosmer as Superintendent of Forestry on the recommendation of Gifford Pinchot, Chief of the U. S. Bureau of Forestry. Mr. Hosmer started an aggressive campaign to have both government and privately owned forest lands set aside as forest reserves and properly fenced.

During the period of the report the Tantalus and Nuuanu reforestation projects continued to be the principal reforestation effort of the Territorial Government.

The original appropriation for the Division of Forestry for the 18-month period ending June 30, 1905, was \$36,625. This

appropriation, however, was severely reduced at the Special Session of the Legislature during the period, thus greatly handicapping the start of the Board's program.

The following excerpt is taken from Mr. Hosmer's section of the report (page 43):

"KONA

"The steep slopes at the heads of the valleys near Honolulu, running up to the back bone of the Koolau ridge, ought eventually to be set apart and declared forest reserves but as they are protected because of their steepness and inaccessibility this section is not in immediate need of attention. In this connection attention is called to the report of Hon. D.P.R. Isenberg, the District Forester."

June 30, 1905

(Annual Report of the Superintendent of Public Works)

Reported the awarding of a contract for a 450 million gallon reservoir in Nuuanu.

"With the completion of this important improvement, the water supply for Honolulu will be greatly increased, and it will not be necessary to limit irrigation hours during the dry periods."

"Kalihi Reservoir situated mauka of Kamehameha School, is now in commission, and is proving to be a valuable addition to the general system."

(This reservoir, supplied by Kalihi Pump, was the first solution of the problem of giving adequate water service to the upper floors in buildings in downtown Honolulu.)

December 31, 1905

(Report of the Board of Commissioners of Agriculture and Forestry for the year ending December 31, 1905)

The following excerpt is taken from Mr. Hosmer's portion of the report (page 40):

"Early in the year steps were taken looking to the acquisition by the Territory of the portion of the Tantalus forest belonging to the Coney Estate, but as yet nothing tangible has come of it. The matter should

be taken up and put through, for under the present status there is nothing to prevent the clean cutting of a large part of the Tantalus forest at any time. A bill to create the upper part of Tantalus a public park was introduced at the last session of the Legislature but failed to pass."

December 31, 1906

(Report of the Board of Commissioners of Agriculture and Forestry for year ending December 31, 1906)

The creation of forest reserves continued to hold first place in the activities of the Division of Forestry. Mr. Hosmer reported that on November 12, 1906, the first "forest and surrender" agreement in the Territory had been signed. Under the agreement the Alexander and Baldwin plantations of Central Maui turned over to the Territory for a term of 17 years, the care and custody of certain of their privately owned lands within the East Maui forest area. Mr. Hosmer made the following comment on the matter (page 26):

"The action in this instance will serve as a precedent in future cases, of which it is hoped there will be many, for only by the putting into operation of a systematic and organic plan for the management of any given reserve as a whole, can the best results be attained.

"The foregoing statement brings the question to the point on which the whole matter turns, for unless the Government will make it evident that it can exercise an efficient and satisfactory control over the forest reserves, private interests owning land within the reserve boundaries will be slow to agree to turn the management of their lands over to the Board."

It is interesting to note that the intensive campaign to set up forest reserves throughout the islands had not, as of December 31, 1906, resulted in any definite action in the District of Honolulu other than the action taken in the 1890's in setting aside areas for the protection of Honolulu's water supply. Detailed tabulations in the December 31, 1906, report list no areas within the Honolulu district as Forest Reserve

under the jurisdiction of the Board. At that time, however, four Forest Reserve areas had been set up on Oahu (Kaipapau, Ewa, Waianae-kai and Lualualei). It would appear that the Board of Agriculture and Forestry felt that there was no particular problem with respect to the areas back of Honolulu excepting Tantalus and Nuuanu. There had apparently been no encroachments within other forest areas.

Mr. Hosmer reports the condition of reforestation in the Nuuanu and Tantalus watershed areas. With reference to his proposal that certain privately owned land of Tantalus be acquired by the Territory, he stated:

"The acquisition by the Territory of the Coney Estate property on Tantalus, on which is the larger part of the Eucalyptus forest, has not yet taken place, but during the year some progress has been made looking thereto. It is earnestly to be hoped that by an equitable exchange this tract can be secured by the Government."

Although no Territorial Forest Reserve had been established within the District of Honolulu, Mr. Paul R. Isenberg functioned as District Forester "for that portion of the District of Kona extending from Makapuu Point to and including Manoa Valley" and Mr. W. F. Dillingham, as District Forester for the Districts of Ewa and Waianae. Thus, with Tantalus and Upper Nuuanu under the combined care of the Board and Superintendent of Public Works, it appears that as of December 31, 1906, there was no definite responsibility for forest areas in Pauoa and in the portion of Honolulu District west of Nuuanu.

It is interesting to note that the area from Nuuanu to the Moanalua-Halawa boundary was not even accounted for in the list of district fire wardens, while there were four fire wardens designated for specific areas from Makapuu Point to and including Nuuanu Valley.

1905-1908

(From "History of the Honolulu Waterworks" in: Superintendent of Public Works Report for year ending June 30, 1913)

"Recommendations were made to erect a reservoir in Kalihi Valley, with the object of supplying the residents of this higher level, and of collecting the waters of the valley and conducting them to the Kalihi reservoir, situated on the slopes back of the Kamehameha Schools."

(Note: The Kalihi Reservoir referred to is the present 3,400,000-gallon concrete reservoir at spillway elevation 180)

1906 - Howland Survey

(Copied on pp. 263-264 of 1917 Honolulu Water Commission Report)

Proposed a reservoir in Upper Kalihi at substantially the same site as recommended by J.T. Taylor in his 1917 report.

December 14, 1906

Mr. W. M. Giffard wrote to the Commissioner of Public Lands, A. Pratt, stating that he had acquired title to the Ili of Kalawahine (land between Tantalus and Pauoa which had been leased by the government from the owners) and he offered this land and sundry other parcels in the Honolulu area in exchange for tracts of government-owned land on Lanai, aggregating almost 50,000 acres.

After proper advertisement, the transaction was consummated by Mr. Giffard's deed of February 1, 1907 to the Territory and by the issuance to him of Grant 5011 for which no one made a better offer than Mr. Giffard. (A letter of May 9, 1907 from the Commissioner of Public Lands to Governor G. R. Carter comments on the rumor that Mr. Giffard had paid \$54,000 to the Coney heirs for their interest in Kalawahine. It is interesting to note that although the Land Act of 1895 put a limit of 1,000

acres on the area of government land that could be sold for cash, the Act provided that, in respect to exchanges of public land for private land, there was no limit in respect to area, value, or purpose for which private land might be acquired. These provisions of law continued until 1910 when the Organic Act was amended to fix the limit, which still exists, on grants or exchanges of public lands; that is to say, up to 40 acres in area or \$4,000 in value, whichever controls.)

December 31, 1907

(From Annual Report of the Board of Commissioners of Agriculture and Forestry)

Mr. Hosmer's section of the report included the following interesting excerpt (page 26):

"EDUCATION IN FORESTRY

"The ultimate success of forestry in Hawaii depends on the continued cooperation of individuals and private corporations with the Territorial Government. In a country where so much of the forest area is in private ownership it is essential that this relation be cordial and active. To promote a better understanding and to bring home to those controlling forest land the advantages of forestry, education becomes one of the necessary parts of forest work in Hawaii. It includes the general dissemination of information about the purposes and principles of forestry and reasons why forestry is justly to be regarded as playing an important part in these islands."

(And from page 11):

"The successful development of agriculture in Hawaii, especially in the districts where irrigation is necessary, is so closely bound up with the welfare of the forest that it is of paramount importance that the forest cover on the watersheds be carefully and wisely managed. It cannot too often be said that the chief value of by far the greater part of the Hawaiian forest does now and always must rest in the influence that the forest exerts on the conservation of water. For the maintenance of a permanent, dependable supply the forest is essential."

With reference to Tantalus Forest Mr. Hosmer stated as follows (page 38):

"TANTALUS AND NUUANU FORESTS

"It may be noted that the Coney Estate lands on Tantalus Heights, Oahu, on which is the greater part of the planted Eucalyptus forest, passed to the Territory as a part of the Lanai Exchange. But as the Lanai case has not yet finally been settled by the Courts, the Government has refrained from taking active control. By agreement with the Superintendent of Public Works the management of the Forest on Tantalus is turned over to this Department. At present the care given consists mainly in the protection afforded by the presence of the Forest Ranger. Tantalus Forest and Tantalus Heights are really to be considered as a Forest Park."

May 1908

Governor Frear and certain of his staff attended the "Governors' Conference on Conservation" in Washington, D. C. This led to the initiation of United States Geological Survey Activity in Hawaii.

December 31, 1908

(From Annual Report of the Board of Commissioners of Agriculture and Forestry)

It is noted that the Board's objectives in the creation of forest reserves had resulted in the establishment of 16 forest reserves of a combined total area of 444,166 acres, of which 61%, or 273,912 acres, was owned by the Territorial Government.

(For reasons stated earlier in this 1948 compilation, the list of forest reserves included no areas within the District of Honolulu.)

June 30, 1908

(From Biennial Report of Superintendent of Public Works, Marston Campbell)

Stated that upon completion of Reservoir No. 4 it would be necessary that the water be filtered if it was to be used for domestic purposes and expressed the view that it would be better

to increase artesian pumping capacity from the then 12,000,000 g.p.d. to 20,000,000 than to construct and operate a filter plant. Emphasis was given to the prospective availability of electric power to result from the Reservoir No. 4 and Hydroelectric projects.

October 9, 1908

Professor W. D. Alexander of Honolulu is credited by many with being the first to apply the Ghyben-Herzberg principle to the Oahu artesian system. Professor Alexander's contribution is referred to as follows in the "Annotated Bibliography and Index of Geology and Water Supply of the Island of Oahu" by Norah D. Stearns, published as "Bulletin No. 3" by the Division of Hydrography in December, 1935:

"ALEXANDER, W.D., Theories concerning artesian wells: Pacific Commercial Advertiser, October 9, 1908. (P.A.) Letter to the editor in which the writer briefly reviews statements by McCully, confirms the uplift of Oahu as agreed upon by geologists, mentions a clay stratum found everywhere above the water-bearing rock, and states that the rise and fall of artesian level is related to variations of rainfall. He believes that McCully's theory is most probable, but finds that it may not be necessary to assume that the water-bearing rock is separated from the ocean by an impervious stratum, in view of the slowness with which water percolates through rock or gravel and because of the pressure of the sea water."

The line of thought suggested by the Alexander article led directly to the "skimming tunnel" principle which was carried out on Oahu in 10 important installations during the period 1936-1940.

1909

By Act 33 the Legislative Session of 1909 enacted a "Conservation Tax" whose purpose was "to promote the conservation and development of the natural resources of the Territory."

Under the Act all income of individuals in excess of \$4,000 per year was taxed 2%, and a 2% tax was levied on the net profit of practically all corporations.

The tax was made effective in the year 1909 (on 1908 income), but for the first period the rate was fixed at only 1%.

Collections were to be Territorial revenue for the following purposes:

3/4ths "for the encouragement of immigration" in aid and development of agricultural resources.

1/4th for development and conservation of natural resources.

With certain amendments the law remained in effect to end of 1915 when it was merged with the general income tax under which no specific allocations were made to conservation purposes.

1909

Professor Carl Andrews (later head of the Department of Civil Engineering of the University of Hawaii) presented a master's thesis that is recognized, with Professor W. D. Alexander's article of October 9, 1908, as being an important milestone in the development of understanding of Honolulu's "artesian basins."

The Andrews thesis is referred to as follows in "Bulletin No. 3" published by the Division of Hydrography:

"ANDREWS, CARL, The structure of southeastern portion of the island of Oahu, Hawaiian Islands (manuscript; master's thesis, Rose Polytechnic Inst., Terre Haute, Ind.), 19pp., 18 figs., 1909 (P.A.) Gives a general description first of the Hawaiian Islands and then of Oahu. Discusses briefly the artesian basin of Honolulu, the use of water for rice and cane, the springs of Pearl Harbor and elsewhere, and records of the well borings. Refers to well diagrams and deduces structure

of artesian basin therefrom. Describes the valleys near Honolulu in detail, also the lateral cones and craters. Suggests lines of fissuring along valleys and connecting lateral cones. Practically all his geology is based on previous geological reports. Utilizes the Ghyben-Herzberg principle to account for the artesian head of the wells in Honolulu."

May 1909

(From Report of the Superintendent of Public Works for the year ending June 20, 1909)

Mr. Marston Campbell, Superintendent of Public Works, visited Washington, D.C. in the spring of 1909 to interview the Secretary of the Interior, the director of the U.S. Geological Survey, and the Chief Hydrographer to interest them in advising the Territory in conservation matters. Arrangements were made for Federal officials to visit the Territory to assist in the establishing of permanent investigations as contemplated by the Legislature's Conservation Act of 1909.

October 21, 1909

Excerpts from letter addressed by Mr. W. C. Mendenhall (in charge of Ground Water Investigation, U. S. Geological Survey) to Mr. Marston Campbell, Superintendent of Public Works, under date of October 21, 1909. (For entire letter see pages 136-8 of Superintendent of Public Works Report for biennium ending June 30, 1910):

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"As a result of the attendance of Governor Frear and his advisors at Governors' Conference on Conservation, held at Washington, in May of 1908, and more immediately of your visit in the Spring of 1909, the Director of the U.S. Geological Survey instructed Mr. M.O. Leighton and myself to visit Hawaii, during the summer of 1909 there to determine, as far as possible, the nature of the problems of territorial water supply, surface and underground, and to submit plans for a systematic investigation of these problems."

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"In order to determine somewhat more accurately the nature of this problem, I have extended the time that I originally planned to spend here by two or three weeks, in order to study personally the conditions in the Honolulu basin, and to secure data for the preparation of a report on this field. In the light of these investigations and of such observations as it was possible to make during the reconnaissance carried out, through your courtesy, on the Islands of Maui, Kauai and Hawaii, I am able to recommend to you the following general plan:

"The study of that portion of the Island of Oahu that has been made and the report that is to be based upon this study should be supplemented by a further study of the remainder of the Island, the final results to be embodied in a complete report for the use of water users throughout the Island. This work can be done at the same time and upon the same allotment suggested below for work upon Kauai."

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"In accordance with the terms of our oral agreement, Mr. T.F. Sedgwick has been instructed to collect as full information as possible on the statistical and engineering phases of all the underground water developments in the Honolulu basin. These data are to be used to supplement the geologic studies which I have carried out and are to be embodied with the results of these studies in a final report."

1910

New reservoir completed in Nuuanu at a cost of \$298,563.

Excerpt from A.C. Alexander's paper of May 10, 1915:

"This seems like a very large sum and its expenditure for the purpose has been severely criticised, but in view of the great expense of pumping and the great drain on the artesian system the writer believes it was thoroughly justified."

During the year two 12-inch wells were drilled at the Beretania Station and the Kaimuki Reservoir (750,000 gallon capacity) was started.

June 30, 1910

(From Report of Mr. Marston Campbell, Superintendent of Public Works, for the year ending June 30, 1910.)

(From pages 91-94):

"Poor Water Conditions in Manoa

The only distressful condition, as far as water supply is concerned, is in Manoa Valley. The high levels of this valley receive their supply from what is known as Makiki Spring, or Makiki Upper Reservoir. This spring has an average daily flow of 400,000 gallons. Unfortunately, the reservoir constructed a few years ago was placed in the bottom of the valley so that in times of heavy precipitation the washings from the mountain pollute the water in the reservoir, and there has been constant and reasonable complaint from the residents of Manoa Valley in regard to the supply. The department however, has made arrangements whereby the reservoir will be practically abandoned, and the water taken through a pipe line 1300 feet long and connected to the main distributing system, practically abandoning the reservoir, and it is expected that this will materially relieve the conditions existing in Manoa. However, at the best, this arrangement will be purely as a temporary expedient, as with the cultivation and increase in population now taking place in the watershed tributary to the spring, this spring will sooner or later have to be abandoned. Anticipating such conditions, the department is maintaining so far as it can, a sanitary control, not alone of this water, but of all the waters supplied to the City of Honolulu for domestic purposes. It is necessary that an independent means of supplying Manoa Valley with water must be constructed. Definite plans have been prepared for this supply, requiring the purchase of a small piece of property near Beretania Street, and in a locality where it is known that good wells with satisfactory water may be obtained, and the installation of a direct-connected electrically-driven turbine pump capable of lifting water to the highest point in the valley, --343 feet above sea level. The present system in Manoa was turned over by the Oahu College to the Government and is not a satisfactory system, the mains being small and of various kinds of pipe. It is impossible in this report to go into particular details as regards all the points of contemplated improvement in the waterworks system. The scheme and plan, however, are on file in the office of the Superintendent.

"Artesian Supply

The most important investigation which has been carried on by the department during the last year has been the securing of data in regard to the artesian water supply of the Island of Oahu. The present agricultural development has been mainly due to the underlying artesian or ground water supply. Contrary to the general idea, the underground water supply of the Island of Oahu is not inexhaustible and is not one

large basin, but is made up of numerous basins, sharply and clearly defined. Each basin has a well-marked watershed from which it derives its supply, varying in area and rainfall. The watershed of the Island of Oahu is definitely defined by two mountain ranges: one, the Koolau, the backbone running the entire length of the island practically from north to south, and the other, the Waianae range, which parallels the main range and which has created the large mesa lying between Pearl Harbor and Waialua. The rainfall is heavier in the Koolau range than the Waianae, and is mainly caused by the northwest trades sweeping across the Pacific, gathering moisture, then impinging against the eastern side of the Koolau range and forced into the cooler atmosphere of the mountains, resulting in heavy precipitation. This mountain range is extremely rugged and steep and extremely sensitive to run-off, with the consequent result that only a small proportion of the entire rainfall is absorbed and reaches the artesian belts. The draft on the artesian systems or basins is only replenished by a small proportion of the entire rainfall. Investigations are being made in an attempt to determine the total precipitation, run-off and absorption.

"The first artesian well was bored in 1879. The success of the original well had its immediate effect on the agricultural possibilities of the island and from that date to this, 430 artesian wells have been bored; some are dead, many of which were flowing wells, while others are delivering from a minimum of 10,000 gallons per day to a maximum of 3,000,000 gallons, the maximum rate being taken from the result of measurements of the last two wells bored for the Territory at Beretania and Alapai Streets. The artesian level in Honolulu was, as shown by the first wells bored, at 42 feet above sea-level. This is the Honolulu section; in other basins the water stood at 37 and 33 feet. Where there has been a fall, it is about 12 feet. Up to 1889, 100 wells had been bored on Oahu. The artesian level at one time in that season in Honolulu regained the level of 42 feet. This was due to extraordinary precipitation followed by a drought. Between that date and June, 1910, 330 additional wells were bored. The height of the artesian water above sea level now being 29.7 feet or an average for the year of 30 feet.

"It is evident from the investigations that the draft on the artesian supply is gradually reducing its height above sea-level. Appended hereto will be found a complete tabulation of the wells so far investigated, with the elevation of the top of casing and the elevation which the water rises above sea-level. A careful investigation has revealed in one of our basins, upon which the draft is at present exceedingly heavy, that only once has the artesian level risen close to its original height, this being in 1889-90, 21 years ago,

and at that time there being only 100 wells in existence. The results of the investigation have to my mind shown that there is a limit of draft upon the artesian supplies, and if the present wanton and reckless waste continues, the level of the various basins will gradually reduce until the salt content will increase to such a degree that it will be detrimental not alone to the agricultural interests of the islands, but also to domestic supply. That there is sufficient water for all of the present agricultural, industrial and domestic uses, and for an enlargement and increase of such uses, is true, but it is also the fact that the permanency of the supply is absolutely dependent upon the beneficial use of this, the greatest natural resource of the islands of the Territory.

"It has been shown that there is a fixed relation between rainfall and artesian level. After a heavy rainfall there generally follows a rise which is designated as the seasonal increase varying from 14 to 18 inches. Notwithstanding this seasonal rise there is an additional fall of from .4 to .6 of a foot, especially in the Honolulu basins.

"A study of losses in irrigation ditches was made in Kapaa, Island of Kauai. These ditches were constructed in soils similar to those on Oahu, and in a locality where the geologic formation was older, such ditches being by reason of such formation less susceptible to losses through percolation than those on Oahu. In 5,000 feet of ditch the measurements of the incoming and outgoing water showed a loss of 11 3-10 per cent. Under less favorable conditions, these losses would have been materially greater. The overdraft on the wells within the City of Honolulu has been estimated to be between 10,000,000 to 12,000,000 gallons of water per day, which is mainly made up of preventable waste and losses which are unnecessary and criminal. The average person, unless familiar by reason of having investigated all conditions, does not appreciate the limitations of the supply of artesian water, consequently on the broad principle that the underground water of the Islands is not an individual or corporate one, but that such water belongs to the people at large, and in order to preserve our present magnificent agricultural development and aid in its advancement, some authoritative action must be taken to regulate wastes and require the owners of lands and industrial enterprises to control the use of water to the point of its beneficial application. Such legislation would not in any way be detrimental to present or future operations but would, when our people realize the tremendous and inestimable value of our underground water supply, materially aid in the future development and prosperity of our country."

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(From pages 98-99):

"CONSERVATION

General

A point has been reached in the conduct of governmental affairs in Hawaii where work must be done and money spent now for the future welfare of unborn generations. This fact should be recognized by our Territorial Legislature and Liberal appropriations should be made for the scientific study and investigations of many of the important problems that are vital to the future interest and prosperity of the Territory; in fact, to widen the scope of usefulness of the Department, and the development of general plans, whereby the future agricultural, industrial and social conditions of the Territory may be advanced, and beneficial use made of our natural resources. Too often do legislators fail to appreciate the importance of work of this character, in view of the fact that the results therefrom are not immediately discernable. Particular reference is made to investigations of our natural resources, surveys, underground waters, soil investigations, and topographic surveys.

"TOPOGRAPHIC AND HYDROGRAPHIC SURVEYS

Under the Act of the last Legislature, imposing a special tax of 2% on incomes in excess of \$4,000 one-fourth of the proceeds derived therefrom was set aside for the purpose of conservation. Arrangements were made by the Superintendent at Washington in May of 1909 whereby Mr. M.O. Leighton, Chief Hydrographer, and Mr. Mendenhall, Geologist in Charge of Ground Water Investigations, came to Hawaii in the following August. A complete reconnaissance of the Islands was made by these gentlemen in company with the Superintendent, and a scheme outlined for the investigation of ground and surface waters. Later, Mr. W.F. Martin was detailed by the Geological Survey of the Department of Public Works to take charge of the surface water investigations. Upon Mr. Martin's arrival, he was appointed by the Superintendent as Chief Hydrographer of the Department. Mr. Mendenhall remained for some time and gave particular attention to the ground water investigation. On his recommendation Mr. T.F. Sedgwick was employed for the particular purpose of securing data in reference to the existing artesian wells."

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(From page 101):

"These surveys and investigations are of such importance that I sincerely trust that the funds now at the disposal of the Department will be materially

increased by the next Legislature. This work should not drag over a period of years, but every effort should be made by the Territory of Hawaii to have it completed at as early a date as possible, as there is nothing that will bring so forcibly to the notice of the public of this Territory how rapidly our natural resources of water and forest are being destroyed, and only by careful mapping can there be shown the relation existing between present and past conditions, as by these maps cultivated areas and forest areas as existing at the present time will be shown. Natural conditions on these islands are, by reason of the fact that they are of late geological formation, on a delicate balance, and present conditions are such that it is evident that by the carelessness and thoughtlessness of man we are reaching a point of inevitable destruction unless governmental authority takes immediate and vigorous action to restore, so far as is advisable, past conditions. I have a due appreciation of the difficulty of impressing upon the general public and legislators recognition of the grave dangers presented and of the absolute necessity of the liberal expenditure of public moneys by way of restoring conditions and of safeguarding the interests of the future by continued and vigorous effort along the line of conservation and the prevention of waste."

July 1, 1910

Cooperative agreement entered into between the Territory and the United States Geological Survey for a survey of the water resources of the Territory.

(See pp. 48-49 of the June 30, 1913 Report of the Superintendent of Public Works.)

Under the agreement, stream measurement stations and rainfall stations were established all over the Islands. Mr. G.K. Larrison was the first designated District Engineer.

1911

By Act 161, the 1911 Legislature provided for the acquisition of 387 acres owned by the Palolo Land and Improvement Co., Ltd., at the end of Palolo Valley, including Kaau Crater, and all water rights owned by said Company in Palolo

Valley. The Company had agreed to such a sale for \$40,000, provided the Territory installed on the "Palolo Hill Tract" (Wilhelmina Rise) a reservoir at an elevation of at least 700 feet.

The Act required that the purchase not be made unless the Superintendent of Public Works determined that the said water rights amounted to at least 500,000 g.p.d.

The Company was to convey to the Territory 5 acres at the reservoir site.

(Note: The transaction was completed as outlined above.)

1911

By Act 162, the Legislature of 1911 appropriated \$100,000 for the acquisition of all rights of the Estate of Charles W. Booth in all springs and waters of Pauoa Valley and in the Pacific Heights Waterworks.

This appropriation marked the first definite action to make the acquisition of the Pauoa Springs possible. Formal options in favor of the Territory with respect to Kahuawai and Kaaikahi Springs and development rights were given by the owners in 1903, but not exercised at that time.

(See pp. 286-287 of 1917 Report of Honolulu Water Commission.)

(Note: The acquisition of the Booth water rights and certain land was not consummated until 1946 by the Board of Water Supply. Just why the water right acquisition was not completed in 1911 has not been investigated. The privately developed Pacific Heights Waterworks, including a Spring Lot and Pump Lot near the mauka boundary of the Booth

land and an easement for "Pauoa Valley Pipe Line" (leading to Pacific Heights) was acquired by the City and County on September 20, 1921.

1912

(From the Board of Commissioners of Agriculture and Forestry report for period January 1, 1911 to December 31, 1912)

In a plea for additional legislative appropriations to make more aggressive reforestation and forest protection possible, the Board proposed that a portion of the money received from the Territory from the sale of water in certain forest reserves be set aside for forestry purposes. The Board suggested that, since water is the product of the forests, such funds could be made available under the existing law. The following excerpts are taken from the Board's comments on the proposal. (page 4):

"At present this money is covered into the Territorial Treasury as a general realization, through the Land Office. That it, or part of it, should be used to establish a revolving fund for fencing, protecting and extending the forest cover on the areas that yield water for irrigation, either directly through streams or indirectly through artesian wells, is certainly a logical demand.

"By the reinvestment in the forest of money derived from the waters coming from the forest the whole circle is strengthened. The forest protects the water heads. Let the water help make the forest permanent, for the better cared for the forests, the more water will be available.

"Under the forest law (Chapter 28, Section 385, Revised Laws of Hawaii), the Board of Agriculture and Forestry has the right to set apart as a special fund for forest work all revenues derived from the sale of forest products in forest reserves. The contention of the Board is that in our Hawaiian forest reserves water is essentially a forest product, and that money received from its sale should accrue to the special forest fund.

"Because of points that have been raised of technical, legal objection, it may be necessary slightly to change the wording of the law. If so, that should

be done, for the need of better protection for our native water-bearing forest is a real and vital one, and this way of meeting it is a straight business proposition, too good not to appeal to this community." (The foregoing proposal was endorsed by the H.S.P.A. by resolution of Dec. 6, 1911).

1912

(Report of the Sanitary Commission created by the 1911 Legislature. Members: G.R. Carter, G.W. McCoy, A.R. Keller, J.L. Young, C.R. Hemenway)

This Commission was probably the first organized body to attempt to awaken the people of Honolulu to the great need of attention to all phases of sanitation, including an adequate water supply. It is significant that the Commission named by Governor Frear included individuals outstanding in their respective fields.

With reference to the general water situation the Commission stated:

"... the level of the water in the artesian basin has dropped 12 feet in 20 years. The important question arises as to how long the supply will last..."

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"By 1910 there were 117 wells drawing from the supply and the artesian level in the city is now 30 feet. If this can be depended upon, we have only 50 years' supply. We are therefore consuming our reserves and eating into our principal at about the rate of 7 inches each year."

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The Commission stated that the 1910 Honolulu population was 52,183 and that "... if we are to profit by the experience of the past, we ought to plan for nearer 500,000 people than simply to provide for the present needs." (It is believed that the foregoing is one of the most farsighted statements that has ever been made with reference to Honolulu's water problem.)

1912-1913

The thoughts and problems of this year are shown by the following excerpt from pages 291-293 of the June 30, 1913, Report of the Superintendent of Public Works.

"June 30, 1912, to June 30, 1913. The work of conserving the artesian supply was continued. The old law of 1884 (somewhat revised), concerning artesian wells, was put into force and many heretofore uncapped wells were properly capped. It was found difficult to determine the exact significance of certain wordings of the law, and consequently the extent of the Government's authority according to this law. One important question arose as to what constituted 'waste' in connection with the discharge waters of certain manufactories using water from their own wells, the discharge waters being of good quality and fit to be delivered into the city mains. The total amount of these discharge waters from the manufactories of the city was about 4-5 million gallons per day--equal to about one-third of the amount pumped by the Government for the public supply.

"A bill, providing for greater control by the Government over the artesian wells, was presented to the Legislature and passed with some modifications, but failed to become a law.

"Lack of rain resulted in excessive drought both in the uplands and lowlands; the mountain supply fell short and all the pumps were worked to the limit of safety; it was necessary to restrict irrigation for the entire city to four hours a day, and inspectors were sent out to enforce the restriction regulations.

"The shortage of water brought up again the question of meters. A bill, providing for the installation of meters, was introduced into the Legislature of 1900, notwithstanding there was considerable opposition, and the bill passed and became law -- Act 112.

"An appropriation of \$100,000 had previously been made for the purchase of the Booth water rights in Pauoa Valley, but the purchase had never actually been made. The Government again investigated the water rights of the valley and made careful surveys.

"Water rights in Palolo Valley were purchased by the Government from the Palolo Land and Improvement Company for \$40,000, and additional appropriations of \$25,000 and, later, \$15,000 were made for the installation (pipe line, reservoir, etc.) necessary to deliver water to the higher levels of Palolo Hills. The water comes from springs at the base of Palolo Crater, and is a good clear water. The discolored surface water

from the crater was side-flumed to a point below the intake, so separating the spring and surface water. Pipes were laid to conduct the water to a concrete reservoir on Wilhelmina Rise. Besides this water right, the purchase included an old water system comprising springs, concrete reservoir, and some pipe line. The concrete reservoir had been built by one Phillip Milton in the early '80's with the idea of irrigating some of the lower lands.

"The discolored surface water in the Palolo Crater was examined and it was found that a treatment with lime and either alum or clay would render it unobjectionable.

"Venturi meters for measuring the amount of water pumped were installed at the Kalihi, Beretania and Kaimuki Pumping Stations. These meters do away with the old method of measuring the amount of water pumped by piston displacement.

"An electric pump, intended for the Punahou plant, was temporarily installed at the Kaimuki Pumping Station and attached to the two new wells. It is capable of delivering 1,500,000 gallons per day and cost \$6829.

"A concrete reservoir was built on one of the higher elevations of Alewa Heights to receive water from the Nuuanu Reservoir. It has a capacity of 480,000 gallons and cost \$5040 first, reconstruction, \$6125, Total \$11,165.

"During the period extensive additions were made to the pipe lines throughout the city."

January 1, 1913

(From Report of Honolulu Water Works for year 1912)

Proposed the "enlargement of Reservoir No. 1 and of the watershed of Reservoir No. 4" in Nuuanu.

Reported that a new reservoir was being planned on Punchbowl for the high-lift pump and the Pauoa Spring System. Reservoirs also were being planned "for Makiki spring water, Manoa high elevation supply, Waiomao water supply and lower Palolo Valley."

1913 Legislature

By Act 138 the Legislature transferred the Honolulu Water Works from the Territory to the City and County of Honolulu. (This might be said to mark the real birth of the Board of Water Supply. By the Board of Water Supply Act of 1929 the powers and functions given to the Board included those given to the Board of Supervisors by the 1913 Act.)

June 14, 1913

Letter by Ralph S. Hosmer, Superintendent of Forestry
to Board of Commissioners of Agriculture and Forestry.

(Published in "The Hawaiian Forester and Agriculturist"
October, 1913, pages 305-308)

Recommended the creation of a Honolulu water shed
Forest Reserve of total area of 6,950 acres, of which 5,000
acres was owned by the Territory.

The area extended from the Westerly boundary of Kalihi
to the Westerly boundary of Waialae.

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"The object of the proposed Honolulu Watershed
forest reserve is to protect the water sources, both
surface and artesian, on which the city of Honolulu has
to depend for its domestic supply. With rapidly in-
creasing population the time is not far distant when every
drop of water that can be developed in the vicinity of
Honolulu will be needed."

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"Under Section 565 of the Revised Laws of Hawaii
(a law based on one enacted in 1860), the Superinten-
dent of public works has the right to take and use for
the Territory any land and water needed for water works
purposes on the southern and western slopes of the
Konahuanui range . . . between Palolo and Kalihi Valleys.
Under this law the upper part of Nuuanu Valley has for
many years been held as a water reserve, various pieces
of private land having been acquired from time to time
to round out the government holdings. The Makiki Valley
water reserve was taken over by the government under the
same law. It has been so held since 1881."

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The 6,950-acre area was officially proclaimed a Forest
Reserve October 13, 1913. The entire area (with minor exceptions)
is now (1948) in the Forest Reserve, as enlarged in 1926, 1932,
and 1947, excepting an important privately owned area extending
4,000 feet (mauka and makai) in Palolo Valley which was excluded
from the 1926 Proclamation, thus reducing the Reserve to only

an even mile in depth in Palolo. This area is commented on particularly by J.T. Taylor in his November 1, 1916, report to the Honolulu Water Commission (pages 114-118 of the Commissioner's Report). Aside from any possibility that there may be of the area having reservoir potentiality (as suggested by Mr. Taylor), it would appear that the area has a vital importance as a salient protruding into most valuable Forest Reserve areas that must be afforded protection. Unfortunately the area (which could have been acquired from a single owner not many years ago) is now subdivided into several holdings.

June 30, 1913

(Report of the Superintendent of Public Works.)

Excerpt from the report by T.F. Sedgwick of the Department:

"For the city of Honolulu--Fort Shafter to Ocean View--we have roughly estimated that there are about 35,000,000 gallons of water taken from the artesian supply daily. We are of the opinion that an average of about 25,000,000 gallons a day is the maximum limit of draft on the basin without lowering it. It seems important that every thing possible be done toward reducing the draft to this limit, by enacting effective laws for controlling waste, abandoning wet farming under artesian irrigation within the city limits and by placing the underground water supply under government control."

June 30, 1913

(Report of the Superintendent of Public Works, J.W. Caldwell, for the fiscal year 1912-1913.)

Mr. Caldwell urged the need for an effective law covering the development and utilization of both surface and underground water.

The Report contains two notable sections:

"Appraisal of Honolulu Water Works and Sewers, giving methods used, notes on proper rates and the probable effect of metering," and

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"Appraisal of Honolulu Water Works and Sewers, giving methods used, notes on proper rates and the probable effect of metering," and

"History of the Honolulu Water Works, from its inception in 1847 to December 31, 1913."

(All principal developments have been noted chronologically in this (1948) Report.)

July 1, 1913

Acts 56 and 57 of the 1913 Session became effective. Act 56 authorized the Board of Agriculture and Forestry to create and maintain a Division of Hydrography to investigate water resources of the Territory in cooperation with the U.S.G.S.

Act 57 provided that all revenues derived from water licenses during the period July 1, 1913, to June 30, 1915, be held as a special fund under the Board of Commissioners of Agriculture and Forestry to be utilized equally for forest improvement and for the investigation of water resources of the Territory.

July 23, 1913

(Report of G.K. Larrison, District Engineer, U.S.G.S. to the Superintendent of Public Works.)

The report listed stream gaging stations and rainfall stations established within the Territory by the U.S.G.S. under the cooperative agreement of July 1, 1910.

October 13, 1913

Proclamation by the Governor creating "Honolulu Watershed Forest Reserve."

Total area: 6,950 acres.

(Published in "The Hawaiian Forester and Agriculturist" October, 1913.)

1913

The Waiahole Tunnel project contributed a great deal to knowledge with respect to the effect of dike complexes on the occurrence of water. Dr. Wentworth, geologist of the Board of

Water Supply, comments on this matter as follows in his 1936 paper "A Sketch of the History of Water Development in Hawaii by Tunnels and Shafts":

"In 1913, when the Waiahole project was commenced, the aim was to drive a tunnel through the Koolau range to bring surface water from the windward side of the range to the drier leeward slopes.

"It was recognized by J.B. Lippincott that large amounts of water might be developed in driving the first 2000 feet of tunnel on the windward side of the range, and also that a considerable amount of percolating water tributary to the leeward side might be encountered in the tunnel on that side. On the other hand there is no indication in the report cited of any knowledge of the possible impounding of water behind dikes, of the existence of a dike complex, or of its hydrologic significance. Mr. J. Jorgensen has stated, however, that he and perhaps others connected with the work were aware of this possible source of developed water. At any rate the amount actually developed with successive penetration of dikes and the difficulties of driving tunnels in so much water brought attention forcefully to the fact of water storage behind dikes and suggested the possibility of development of high level water by tunneling in other sites so selected as to penetrate dikes in districts of high rainfall. In selecting such sites, a study of the geologic structure was required, and the need for systematic geologic surveys was more and more evident."

It is interesting to note that among those connected with the Waiahole project were several engineers who then had, or subsequently acquired, outstanding stature locally as engineers of unusual competence in the development of water. The group included A.A. Wilson, H.K. Bishop, Jorgen Jorgensen, W.A. Wall, and several young engineers including Frederick Ohrt, Fred Koelling, George M. Collins, Fred P. Pierce, Robert S. Mowry, and Clarence Brown, all of whom have contributed greatly to our present knowledge of the water resources of the Territory.

December 31, 1914

(From Report of the Honolulu Water Works for period ending December 31, 1914)

Excerpt from report by F.G. Kirchhoff, Construction Engineer, to W.A. Wall, General Manager.

"It seems to me that eventually this city must go back to the original source of its supply--the mountains, for its entire supply."

Expressed concern with respect to rate of decrease in artesian head.

"Investigations in the Valleys around Honolulu--Pauoa in particular, indicate that abundant water may be obtained by intercepting the underground flow. For instance a report by Messrs. Grimwood, Richardson and Holloway states that in Pauoa Valley, by proper development, a flow ten times the present discharge from the springs may be obtained."

Excerpts from report of W. A. Wall:

"We are installing two purification plants on the Nuuanu Valley system. . . all sections of the City will then be supplied with pure water, with the exception of a few premises that are on the high-pressure pipe line from Reservoir No. 2, Nuuanu Valley. The Kaimuki section supplied with water from Palolo Valley can be made pure by using spring water only. A little development at the springs and a proper arrangement of a by-pass for storm waters will keep the spring water clear and pure."

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"The spring in Makiki Valley should be developed. . . . Should the development be a success the Wilder Avenue Pump could be shut down . . . at a saving of \$7,000.00 a year."

Suggested a tunnel at approximately 700 feet elevation in Nuuanu extending "under Nuuanu Ridge (between Tantalus and Konahuanui.)"

December 31, 1914

(From the Board of Commissioners of Agriculture and Forestry Report for period January 1, 1913 to December 31, 1914)

It was noted that the forest reserve designated "Honolulu Watershed" was created October 13, 1913, containing a total of 6950 acres, of which 5,000 acres was Territorial land and 1,950 acres privately owned. The 214-acre portion of Government land

at Kuliouou was set up as Kuliouou Forest Reserve. (These were the first forest reserves in the Honolulu District to be created by the Board.)

The resignation of Mr. Ralph Hosmer as Superintendent of Forestry was announced effective as of September 1, 1914, when he left to become head of the Department of Forestry at Cornell University.

In June, 1914, former governor, G.R. Carter formally turned over to the Board for a period of five years the custody and control of the tract of 132 acres owned by him at the head of Manoa Valley. This was the second such transfer in the history of the Division of Forestry, the first being the surrender agreement between the Alexander and Baldwin interests on Maui and the Government in 1906. Mr. Hosmer commented as follows on Mr. Carter's action (page 56):

..."Mr. Carter's action is more important in that it confirms a precedent, than in the actual transfer itself. With a better system of protecting and administering its forest reserves the Territory would doubtless be in receipt of many applications from private owners of forest land requesting that the management of their lands be taken over by the Board."

It was reported that the special forest improvement fund made available by Act 57, S.L. 1913, amounted to \$33,000 for each of 1913 and 1914 for forest improvement purposes.

The report contains the first report of the Division of Hydrography which is separately summarized below.

December 31, 1914

(From Report of the Division of Hydrography of the Board of Commissioners of Agriculture and Forestry for the period January 1, 1913 to December 31, 1914, by G.K. Larrison, Superintendent of Hydrography.)

It was reported that for the first half of 1913, the work of the division was carried out under the Superintendent of Public Works in cooperation with the U.S.G.S. and that since

July 1, 1913, the work had been carried on under the provisions of Acts 56 and 57 of the 1913 Legislative Session. Under the authority of Act 56 the Governor of the Territory and the Director of the U.S.G.S. signed a cooperative agreement on June 26, 1913, with respect to the investigation of the water resources of the Territory.

1915 - General Water Supply Situation

The general status of Honolulu's water supply was ably presented in the paper read by Mr. Arthur C. Alexander before the Social Science Association on May 10, 1915.

Mr. Alexander presented a most convincing and alarming picture with respect to the wasteful manner in which artesian water was used in rice irrigation and otherwise and emphasized the necessity of conservation measures which, although first enacted in 1884, had never been adequately enforced.

In urging the desirability of acquisition of private water rights, Mr. Alexander stated as follows (in the section of his paper referring to the various springs at approximately the 90-foot elevation):

"The Kapena Springs, with a daily flow of about 150,000 gallons belongs to the government, but, in order to utilize the other springs it would be necessary to acquire a mass of water rights. This would be an expensive procedure and hardly warranted in the present depleted condition of the Territorial and County treasuries, especially since many of these water rights are being abandoned as the taro land irrigated by these springs is drained and turned into building lots. However, in planning for the future water supply of Honolulu every available source must be considered, even if it can furnish a daily quota of only a few hundred gallons and cannot be immediately utilized."

Mr. Alexander recommended that the government acquire "all private rights to the water from the valleys back of Honolulu," also "the control of the entire artesian supply underlying Honolulu." He also urged that all wet-land farming be discontinued within the city.

Throughout his paper Mr. Alexander emphasized the need for greater utilization of surface water in order that the draft on the artesian basin might be held to safe limits.

Mr. Alexander in this paper (and at other times) advocated the control of Honolulu's water supply by a commission.

The following extract is taken from his 1915 paper:

"The wise and economical development and administration of Honolulu's water supply is a task that is going to require time and careful planning. The demands of the future must be provided for as well as those of the present. It is too important to be left to the judgment of any one man, or to any body of men in control for a comparatively short period of time. For these reasons, the writer believes, that the control of Honolulu's water supply should be placed in the hands of a commission of able and clear-headed men appointed for a long term of years like New York City's Rapid Transit Commission, and with similar powers."

1915 - Status of Mountain Water System

(From A.C. Alexander's 1915 paper "Honolulu's Water Supply")

The High-Pressure System was supplied from streams and springs in upper Nuuanu Valley, Makiki Valley, and Palolo Valley, supplemented as needed by water from the high-lift pumps at Beretania and Makiki Pumping Stations. The system supplied the upper portions of the city, including Alewa Heights, Manoa, and Palolo Hill. Surpluses, when available in rainy streams, were utilized in the lower levels, thus relieving the pumps.

The Nuuanu System consisted of four reservoirs:

| No. | 1 | Capacity | 21 M.G. | Elevation | 393 ft. |
|-----|---|----------|---------|-----------|---------|
| | 2 | | 7 | | 739 |
| | 3 | | 11 | | 846 |
| | 4 | | 625 | | 1028 |

Also a distributing reservoir of 482,500 gallons capacity on Alewa Heights at elevation 568 connected with the Nuuanu System and serving Alewa Heights and Kalihi-uka.

Although quantity data was not considered satisfactory, the delivery of the Nuuanu System was considered to be approximately 3,500,000 gallons per day.

The Makiki Valley System supplied by several springs in the upper branches of Makiki Valley at an elevation of about 900 feet and supposedly delivering approximately 265,000 g.p.d.

The Palolo Valley System, installed not long prior to 1915, was used almost solely to furnish water to the Palolo Hill Tract. The System consisted of a 426,000-gallon reservoir at elevation 805 ft. on Wilhelmina Rise supplied by a pipe line from a spring on the Waiomao, or East Palolo Stream. No quantity figures were available.

1915 - Proposals for Greater Utilization of Stream and Spring Water

(From A.C. Alexander's 1915 paper on "Honolulu's Water Supply")

KALIHI VALLEY

Kalihi Stream had been measured at elevation 500 feet for 14 months in 1913 and 1914. The minimum flow was only 520,000 gallons on October 31, 1913, and November 1, 1913. The flow was found to be very variable and at times insufficient for the large taro area dependent upon it. Mr. Alexander stated:

"There are few, if any, sites in the valley suitable for storage or distributing reservoirs..." (in Kalihi).

"...the day is not far distant when the government will be obliged to buy out the private water rights and take steps to conserve this water for its own use. It seems an anomaly to have to bring water from Nuuanu over the separating ridge in order to supply upper Kalihi, when this valley has such a fine stream of its own."

"In the large branch on the eastern side known as Kamaikai, there is a stream at a high elevation on land belonging to Queen Liliuokalani, which almost disappears further down, and might be developed into an important source of water."

NUUANU VALLEY

Mr. Alexander proposed diverting additional Nuuanu tributary streams into the Nuuanu reservoir and increasing the utilization of the large Reservoir No. 4 by tunneling to Manoa to intercept the storm water coming over the falls at the head of Manoa Valley. "This storm water has never been measured, but when the increasing value of water to Honolulu is considered, the writer believes enough would be obtained to warrant the expense of tunneling."

The suggestion was also made that a development tunnel be driven under the swamp at the head of Pauoa Valley.

PAUOA VALLEY

Emphasis was given to the importance of the principal springs in Pauoa Valley in which the interests of the principal owner were offered to the Territory in about 1905. The 1913 Legislature authorized condemnation, but no action had been taken.

The highest of the springs (at elevation approximately 670) supplied the private Pacific Heights Reservoir. A larger spring of up to 250,000 g.p.d. situated just makai (Kahuawai Spring at elevation 590) was described by Mr. Alexander, also the Kaikahi Spring at elevation 275 feet. Both springs were described as easily adaptable to public water supply utilization.

Mr. Alexander also discussed the possible utilization of the water contributed to Pauoa Stream by the swampy Pauoa Flats.

MANOA VALLEY

The paper described the Manoa water as almost entirely privately owned and used for irrigation in Manoa, Moiliili and Waikiki. "If these water rights...were acquired by the government, at least 1,500,000 gallons per day at an elevation of about 400 feet could be immediately added to Honolulu's water supply, and if in addition the storm waters were stored up, this would be increased to over 4,000,000 gallons per day." However, no suitable reservoir sites were available in Manoa.

PALOLO VALLEY

The paper suggested the possibility of developing a storage reservoir in Kaau Crater to conserve waters of the Palolo streams as a supply for the Kaimuki and Diamond Head areas.

WAIHAOLE WATER

Mention was made of the fact that 4,000,000 gallons of government water per day would be subject to withdrawal from the "Waiahole Lease" in 30 years and that the withdrawal could be increased to 6,000,000 gallons per day in 40 years and to the full amount owned by the government in 50 years.

March 31, 1915

By Act 36 the Legislature created a Commission to "collect and examine available data and information relative to the water sources, both underground and surface, and both privately and publicly owned or controlled, in the Territory of Hawaii;" to make a study of existing laws pertaining to the diverting, developing, using, conserving, holding, and wasting of water and to make recommendations with respect to such legislation "as may by it be deemed necessary to serve the best interests of the people of the Territory of Hawaii."

The sum of \$5,000 was appropriated for the Commissioner's expenses.

(The Governor appointed to the Commission Messrs. G. K. Larrison, Arthur G. Smith, and T.F. Sedgwick. The Commissioner's Report, which was prepared with the assistance of A.E. Chandler, nationally recognized authority, was submitted January 13, 1917, under which date the report is commented on herein.)

June 23, 1915

By Resolution of the Board of Supervisors, the "Honolulu Water Commission" was created "to make investigations for the purpose of determining whether or not an adequate supply of potable water is available for distribution to the inhabitants" and to make preliminary surveys and explanations.

The sum of \$20,000 was appropriated for employed assistance.

(On July 9, 1915, the following were appointed to the Commission: L.A. Thurston, Chairman; C.R. Forbes; Jorgen Jorgensen; James Gibb; and John H. Wilson.

The Commission retained James T. Taylor as its engineer and also utilized the services of T.F. Sedgwick (of the Territorial Department of Public Works), F.G. Kirchhoff (of Honolulu Water Works), and others. For notes with respect to the Commission's Report, see under June 12, 1917, herein.

December 31, 1916

(From Report of the Board of Commissioners of Agriculture and Forestry for period January 1, 1914 to December 31, 1916)

The Board, by resolution of December 28, 1916, recommended to the Governor that the Division of Hydrography be transferred to some other department. (The transfer to the jurisdiction of the Commissioner of Public Lands became effective March 23, 1917. Transfer made by Act. 27, S.L. 1917).

It is noted that Mr. C.S. Judd was appointed Superintendent of Forestry on January 16, 1915.

Two additional forest reserves in the Honolulu District were created during the period. Mr. Judd's comment on these reserves are as follows:

"The Manoa Ranger Station, 15 acres in area, which includes a part of the land of Kahoiwai, in Manoa Valley, Oahu, near Honolulu, set aside by proclamation of the Governor on May 9, 1916. It is a narrow strip of land, entirely in government ownership, running from near the Manoa Stream to the top of a spur of the Manoa-Palolo ridge and embracing a small valley the upper portion which is covered with a splendid grove of koa, kukui, and other native forest trees. The land was set aside partly for headquarters for the ranger in this district, but mainly because the location afforded a suitable site for experimental tree planting. What has been accomplished in this respect will be mentioned later on in this report.

"The Round Top Forest Reserve, 115 acres in area, which includes a portion of the land of Makiki, Oahu, set aside by proclamation of the Governor on August 10, 1916. This reserve includes only government land on the familiar hill back of Honolulu called Round Top, beginning at the upper turn of the new Round Top Drive and extending as far back as Sugar Loaf. The Makiki valleys of the Honolulu Watershed Forest Reserve bound it on the northwest side and Manoa Valley lies on the other side. The area has great scenic value and is accessible by a new, well-constructed road."

January 13, 1917

Report of the Water Commission of the Territory of Hawaii
(See under March 31, 1915, herein for the creation
and personnel of the Commission.)

This important report is almost exclusively devoted to the need of artesian well control. Recommended greater use of surface waters is implied, although not stated, in comment on the critical artesian well situation.

The report was one of the earliest contribution to understanding of the artesian basins.

A principal conclusion: "The artesian supply in Honolulu city area . . . is being steadily and surely depleted on account of the draft . . . largely exceeding the supply."

The Commission recommended an Artesian Well Control Statute, having as its primary purpose the prevention of wasteful use of artesian water to take the place of the then existing law which had proved inadequate.

(The 1917 Legislature passed the recommended law in revised form as Act 156)

April, 1917

Monograph by T.F. Sedgwick, "Artesian Wells in the Hawaiian Islands," published by the Hawaiian Engineering Association.

Mr. Sedgwick did not presume to set forth geologic and hydrologic reasoning explaining our artesian sources, but he was, nevertheless, a pioneer in presenting pertinent data. For the purposes of this (1948) Report, the following excerpt from pages 14-16 of Mr. Sedgwick's report is of interest:

"Is the artesian basin being overdrawn upon? When it is considered that an average of at least 300,000,000 gallons of artesian water are being discharged daily from the wells on Oahu, and that all the evidence points to the rainfall as the source of it, the question arises, Is there a limit to which the artesian supply may be drawn upon?"

"Since the sinking of the first well over thirty-five years ago, the water level in and around Honolulu has had a maximum fall of 15 feet; this low water mark was reached in 1914. Fortunately, since then there have been seasons of rainfall exceptionally favorable for replenishing the artesian supply--not only a good amount of rain, but well distributed as to time. At present the water level for Honolulu is about 12 feet below the original height. The fall of the artesian level in wells having different artesian basins has been proportionate to the fall of the level in the Honolulu basin; but it must be remarked that the favorable rains since 1914 have caused the level of some wells in other sections to rise proportionately higher than in Honolulu--even to within a few feet of the original height.

"It is estimated that, for the Honolulu section, the artesian head under normal conditions of rainfall is being lowered at the rate of from 0.4 to 0.5 of a foot a year. It is believed that when the artesian head is lowered to sea level, the water will become brackish and unfit for use, so that sea level may be assumed to be the practical limit to which the artesian head may be lowered.

"Legislation. It is said that when the first wells were sunk in the early 80's, an engineer predicted that the artesian supply would be exhausted within a year. Although this was an exaggerated prediction, the probability of a limited artesian supply was recognized, and an act aiming to prevent waste of water from artesian wells was passed in 1884. The necessity for this act was not immediately apparent, as the water level in the wells did not begin to fall till some years later. The certainty in the past few years that the artesian head is gradually lowering has led to efforts to secure better legislation relative to artesian wells, but thus far they have failed. The Legislature of 1915 passed an act authorizing the Governor of the Territory to appoint a commission to examine into the water resources and water laws of the Territory. The report of this commission has been devoted very largely to the artesian well question, and it is hoped that the present Legislature will take some definite action for the better protection of our artesian water supply, upon which so much of the commercial and financial prosperity of the Islands depends."

June 12, 1917

(From Report of "Honolulu Water Commission"-June 12, 1917)

(For creation of Commission, see under June 23, 1915 herein)

The report on pages 18-20 suggested the utilization of Kalihi Valley storm waters by an intercepting ditch across the head of the valley and a tunnel from Kalihi to Nuuanu.

A reservoir site of 668 million gallons capacity was proposed near the 800-foot level in Kalihi.

"Whether the storm waters of Upper Kalihi should be carried through to Nuuanu, stored there and distributed ... or whether these storm waters should be stored in an Upper Kalihi reservoir, conveyed thence by an independent pipe line to the Lower Kalihi reservoir,... is a question which requires close and extended study."

The possibility of generating hydro-electric power was given considerable attention in the report.

It was thought that there would be but little expense in acquiring private rights in the storm waters.

The Commission, in its detailed recommendations, emphasized utilization of stream water by diverting the waters of both Kalihi and Manoa to Nuuanu, and urged (on page 26) "that the most vitally necessary item in connection with the Honolulu water system is the installation of a filter system in Nuuanu Valley."

A most cautious view was expressed with respect to the advisability of increasing the draft from the artesian basin. Referring (on pages 53-54) to the January, 1917, Report of the Territorial Water Commission, the Honolulu Water Commission stated:

"The first and most serious objection to the scheme to substitute artesian for surface water is that the supply of artesian water is so limited that it cannot continue to meet the present demands made upon it, much less furnish an unlimited further supply."

And on pages 25-26:

"The Commission is of the opinion that it will be unsound to abandon the use of the surface waters and substitute the use of pumped artesian water, for two reasons, viz:

1. That the expense of pumping is too high;
2. That the surface water in question cannot be spared."

Mr. Jorgensen recommended (see page 27) "that a series of concentrating ditches and tunnels be run along the face of the windward side of the Koolau Mountain, both north and south of a point opposite Kalihi Valley, a tunnel to then be run through the Mountains, emerging in Kalihi Valley on the Honolulu side at an elevation of 600 feet." He estimated that the tunnel would develop a considerable flow (in the same manner as the Waiahole Project).

The Commission commented on stream flow and its utilization as follows (pages 21-24):

"SUMMARY OF NORMAL FLOW SITUATION

The Commission had planned under the original authorization of \$20,000 to make a comprehensive investigation of the amount and ownership of normal water flow of the valleys in question. The curtailment of the scope of the investigation has prevented this, but a considerable amount of information has been obtained and is submitted herewith as material in connection with further investigation. A summary of the situation found is as follows:

"NORMAL FLOW FROM PALOLO VALLEY

"Measurement of this flow has been recorded during the last two years only. The data are therefore too meagre for final estimate. The records available show a daily average flow of approximately two million gallons, the bulk of which belongs to the Government. Only 20,000 gallons per day or 1% is now being utilized. The main flow is used for irrigation of taro and rice or runs to waste.

"The problem of the utilization of the Palolo water is a simple one. Most of the land and water involved belongs to the Government; there are no engineering difficulties; the distance from the city system is short, and the amount already spent thereon is at present almost dead capital.

"A detail investigation and report on the ownership of private water rights in Palolo should be made, with estimate of cost of securing the same, and of connecting the water with the city system.

"NORMAL FLOW FROM MANOA

The normal flow of water from Manoa is chiefly from springs at the foot of the mountain near the head of the valley. It is estimated at approximately three million gallons of water per day. This water is nearly all owned by private interests and is used for irrigation of rice and taro. There are no engineering difficulties involved.

"A systematic and comprehensive investigation of the Manoa normal flow should be made with a view of identifying the water right owners and estimating the cost of obtaining the same.

"There is a fair reservoir site near the upper end of the flat portion of the valley, at an elevation of approximately 500 feet. A survey should be made of this site and estimate made of cost of a reservoir and of connecting it with the city system.

"NORMAL FLOW FROM MAKIKI VALLEY

The entire water-shed at Makiki belongs to the Government, except a few house lots at the upper end.

"The average flow from the stream is 150,000 gallons, which comes exclusively from springs. There is no opportunity for storage on a large scale.

"The suggestion has been repeatedly made that the Makiki supply of water could be increased by tunneling.

"There is no indication that Makiki water has any other source of supply than the visible water-shed. This is so small that there is no reason to believe that a permanent increase of supply could be obtained by tunneling. While tunneling might temporarily increase the flow the inevitable result would be to more speedily drain off the available supply without permanently increasing the annual flow. Moreover, tunneling might injure the present supply.

"NORMAL FLOW FROM PAUOA VALLEY

No water from Pauoa is now used in the city system. The normal flow is entirely from springs.

"The water supply from the Pauoa Valley has been investigated and reported upon more than any other local water source excepting Nuuanu, chiefly through the activity of a water right owner desirous of selling out to the city. The quantity of available water set forth in the various reports differs widely, ranging from one million to three hundred and seventy-five thousand gallons per day.

"The water is of high character, but little engineering is involved in securing it and the distance from the city is short.

"The quantity of the water available and the title to the same is involved, however, and any taking of the land and water rights required should be done through condemnation proceedings, so that all rights involved could be ascertained and settled at one time.

"There are other projects which will furnish water for the city system at a lower unit cost, but the purity of the water and its proximity to the city are in its favor. Full estimates of cost of purchasing this water and of engineering cost of connecting the same with the city system should be secured.

"NORMAL FLOW FROM NUUANU VALLEY

"There are a number of fine springs in Nuuanu Valley below the upper level of the built up portion of the city. These cannot safely be used for domestic purposes and are not therefore available for addition to the city supply.

"The Government already controls so large a proportion of the normal flow which can be made use of in the city system, that little increase, if any, other than from the Hillebrand Glen stream now being diverted, can be anticipated from this source.

"CONTAMINATION OF NUUANU NORMAL FLOW WATER

The outstanding factor in connection with the present Nuuanu surface flow is that by reason of the surface drainage from the road which runs across the water-shed, and the likelihood of trespassers, it is safe and unsanitary during a large part of the time. This same condition will attach to any additional waters which may be brought to and stored there.

"This status of affairs can be greatly relieved by the simple expedient of constructing a concrete gutter alongside of the road, from the Pali to a point below the reservoirs and the construction of a man-proof wire fence along the sides of the road for the same distance.

"It is estimated that this concrete gutter and wire fence would not cost to exceed \$19,400.

"Full details and estimates of this plan are set forth in Exhibit "C" and Exhibit 1 herewith.

"NORMAL FLOW FROM KALIHI VALLEY

The status of the normal flow of Kalihi is quite similar to that of Manoa. The amount averages approximately three and a half million gallons per day; it is all utilized for irrigation; it is nearly all owned by private persons.

"There are no engineering difficulties, and the grade of the valley is steep enough so that a large amount of electric power can be developed and the water still delivered at the present Kalihi reservoir for distribution to consumers.

"This source of supply appears, superficially, to promise a larger quantity at a lower unit cost per million gallons than any other normal flow surface supply source in the district.

"NORMAL FLOW FROM MOANALUA VALLEY

Although the examination of Moanalua has been but slight, the personal knowledge of members of the Commission, corroborated by the investigation of Engineer James T. Taylor, is such that the available water supply from this source can be stated to be so limited and the conditions so disadvantageous, that no further investigation is recommended, at least until other possible projects have been completed.

The Conclusions and Recommendations of the Commission were presented as follows (from pages 27-29 of the Commission's report):

"CONCLUSIONS AND RECOMMENDATIONS

The Commission concludes with the following recommendations:

1. PROTECTION OF NUUANU WATER.

That the most urgent present duty of the Honolulu Water Works is to protect the Nuuanu water supply;

First, by excluding the drainage from the road, by means of concrete drains;

Second, by erecting a man-proof wire fence along both sides of the road to exclude trespassers;

Third, by constructing and operating a filter plant below Reservoir 1.

2. SURFACE WATERS.

That all storm and normal flow waters of the seven valleys from and including Palolo, to and including Moanalua, should be considered as potential sources of city supply, as well as the spring waters along the windward side of the island, and the possible waters which may be developed by tunneling through the mountains.

3. ARTESIAN WATER.

That a matter of vital importance is to utilize all possible artesian wells, securing the water from those having the best flow; plugging up those no longer in beneficial use, and limiting the drilling of new wells until an equilibrium in the height of the water in the wells has been reached.

4. EXPERT INVESTIGATION.

That a complete and detailed investigation, survey and report upon every phase of every possible water source should be made by an expert hydraulic engineer, each possible source being reduced to a common basis of:

- (1) Principal cost per million gallons, and
- (2) Operating cost per million gallons.

By this means the Water Department will be able to intelligently compare one project with another, and proceed with the development of the several projects in the order which will yield the largest amount of water for the least money, due regard being paid to quality of the water obtained and the maintenance of a permanent supply."

1917 - Proposed Kalihi Reservoir

(From James T. Taylor's 1917 Report to Honolulu Water Commission, pages 246 et seq):

Stated that the Kalihi Stream flow varied from a minimum of 1.5 million gallons per day, which amount was largely required for taro patches, to a maximum of 88 million gallons per day.

Presented detailed studies of flow, ownership, etc., and plan for a 668-million gallon reservoir at approximately 800-foot elevation.

Stressed the fact that the stream flow at the reservoir site "is largely supplied from numerous springs in the valley 800 to 2500 feet above sea level, and there are more numerous on the west side of the valley" and "that the flow from the springs is constant.

"The site is particularly adapted to the storage of water for several reasons, the principal one being the fact that the entire watershed tributary to the proposed reservoir and the site itself is uninhabited

and at the present time is used as a cattle range at nominal figures, for rental for pasturage purposes. There is no public road leading through the upper valley and no occasion for one; consequently, the opportunity for the contamination of the natural or stored waters, by traffic of any kind, is entirely eliminated."

1917

(From Annual Report of Honolulu Water Works by F.G. Kirchhoff, General Manager)

During the year the Maole Conduit of 40 m.g.d. capacity was constructed to divert water from Maole Stream at elevation 1026 and other streams to Nuuanu Reservoir No. 4.

June, 1918

The June, 1918, edition of "The Hawaiian Planters Record" includes an outstanding paper by W.M. Giffard of the H.S.P.A., entitled, "Some Observations on Hawaiian Forests and Forest Cover in their Relation to Water Supply."

With respect to the Oahu watersheds and their relation to the water supply of the Honolulu and Ewa basins, Mr. Giffard stated that "more can be said as to what has not been done than otherwise, when it comes to their protection and conservation for water supply," and elaborated considerably on the manner in which the forest cover had been permitted to deteriorate. This section of the report closes with the following:

"Water itself, as well as the forest that clothes the catchment areas, must be conserved, and, what is more, action must be taken at once. The people of this island face a serious condition, one that can no longer brook delay."

The following excerpt is from the introduction to

Mr. Giffard's paper: For this paragraph please substitute paragraph at bottom of second page 1892.

"In Mr. Wilson's report to the Minister of the Interior in 1890, he recommended that steps be taken to obtain full control of all springs, water heads, and irrigation rights in Nuuanu Valley, and that squatters

be removed from above the reservoirs. I heartily endorse his recommendation, and I also recommend that none but the caretaker of the reservoirs be allowed to reside above the Halfway House. Steps should be taken with regard to the water supplies of Manoa, Pauoa and Kalihi Valleys, if funds can be made available, as, at no very distant date or period, they will be absolutely necessary to the Government System of Water Works."

(Mr. Giffard's paper is of special importance because of the fact that he was Manager of W. G. Irwin & Co., sugar factors, until that company merged with C. Brewer & Co., Ltd. Furthermore, Mr. Giffard was a member of the Board of Commissioners of Agriculture and Forestry from 1903, during certain of which years he served as President.)

1918

(From Annual Report of Honolulu Water Works, by F. G. Kirchhoff, General Manager)

Mr. Kirchhoff recommended the construction of a Nuuanu filtration plant of 6,000,000 gallons daily capacity.

Urged that such a project was essential to protect the health of the city, and because of the dependence of the city upon Nuuanu Valley's water stated the opinion that as the city grows, its dependence upon Nuuanu Valley's water will increase.

Noted that a filtration plant was proposed by Rudolph Herring in his 1897 survey and that nothing further was done until in 1916-1917 two attempts were made to obtain the peoples' approval of a bond issue for the purpose but that the necessary 60 per cent affirmative vote was not obtained.

1918

In 1918 the Hawaiian Sugar Planters' Association added a Department of Forestry to their Experiment Station. Dr. Harold L. Lyon, who had been with the H.S.P.A. since 1907 as plant pathologist and in charge of the Department of Pathology, was

placed in charge. He had become prominently identified with forestry in the Territory in assisting land owners and the Board of Commissioners of Agriculture and Forestry in problems of forest improvement and protection.

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Under Dr. Lyon and H.P. Agee, Director of the Experiment Station, the H.S.P.A. organized a program of forest research which still continues in close cooperation with the Board of Commissioners of Agriculture and Forestry. Dr. Lyon played a great part, with Messrs. Giffard, Hosmer, and C.S. Judd, in influencing land owners to cooperate in the creation and maintenance of forest reserves.

(Upon retirement as Director of the Experiment Station, in 1948, Dr. Lyon announced his intention to continue his participation in the solution of land forestry problems.)

1919

(From 1923 Report of the "Future Water Supply for the City of Honolulu" by W.A. Wall and G.K. Larrison)

The "Alewa Heights Spring" in Upper Nuuanu was developed and the water piped to Alewa Heights and Kalihi Valley area. Prior to 1919 the said sections were served with Nuuanu Reservoir No. 4 water which was usually of poor quality.

(In 1922 the main was enlarged to 6" and service was extended to Nuuanu areas along Pali Road, Dowsett Tract, and Laiki.)

1919

(From Annual Report of Honolulu Water Works, by W.A. Wall, General Manager)

Mr. Wall recommended development of mountain supplies, particularly by additional tunneling at sites of all utilized springs in Makiki, Nuuanu, and Palolo Valleys.

March, 1920

Dr. Harold S. Palmer, who had come to Honolulu as a result of the efforts of Dr. H.E. Gregory, geologist of the Bishop Museum (and later a member of the Board of Water Supply), to teach geology at the University of Hawaii and to study the Honolulu water problem in cooperation with the U.S.G.S., began his investigation under a part-time salary plan arranged by the Board of Supervisors.

The "Palmer Report" was submitted under date of April 16, 1921, (see notes under said date herein).

1920

(From Report of Honolulu Water Works, by W.A. Wall, General Manager)

Mr. Wall reported that during the year a short tunnel was driven into the northwest side of Upper Palolo Valley, that the initial flow was approximately 2,000,000 g.p.d., and that the 6" pipe line was extended to the tunnel, thus giving to the residents of the higher levels of Kaimuki good water in place of the surface water formerly used.

(See also page 34 of 1923 Wall-Larrison Report which states that the 6" pipe line carried only 800,000 g.p.d. and that the tunnel flow had reduced to from 200,000 and 500,000 g.p.d. The pipe line was swept away in the 1921 cloudburst and replaced with two lines, one 2-1/2 inch and one 3 inch.)

December 31, 1920

(From the Board of Commissioners of Agriculture and Forestry Report for period January 1, 1919 to December 31, 1920)

With reference to privately owned lands within the forest reserves the Board stated as follows (page 3):

". . . if continued support in the work is given by adequate appropriations the government lands will soon be under such efficient management that the owners of private lands in the reserves will be more inclined to turn such lands over with confidence to this Board for administration. If this is not brought about voluntarily, the title to all lands within forest reserve boundaries should be acquired by purchase or condemnation proceedings, for only by having complete control of all lands in the forest reserves can the Territory protect and administer them with efficiency and make them serve as satisfactory conservers of the water supply. The purchase of these private lands will require large appropriations, but the sooner a start is made toward their acquisition the sooner will the Territory benefit from the result of possessing them and bringing them up to their higher state of usefulness."

Mr. Judd, in his section of the report, included the following comment (page 19):

"Except for a few areas of private lands within forest reserve boundaries, which have, by provision of law, been turned over to the control of this Board for a term of years, the activities of this Division in the line of forest protection have necessarily and legally been confined entirely to lands within the reserves which are owned by the Territory. As a result of the peculiar system of Hawaiian land surveys, private lands are indiscriminately interspersed with government lands in the reserves. When it comes to the administration and protection of a reserve the work of this Division is thereby hampered and the result is unsatisfactory unless the owner of the private land cooperates to the fullest extent in the protection of his forest. An example of this failure to cooperate in forest protection occurs on Hawaii, where a large cattle ranch utilizes, as a pasture, a section of forest land within the recommended boundaries of the largest forest reserve on the island. Such a situation requires the construction and maintenance of fences which, in the mind of a forester, are entirely uncalled for and results in the destruction of the forest on the private land as the inevitable result of grazing.

"Eventually, and the sooner the better, the title to all privately owned lands within the finally established boundaries of forest reserves should be acquired by the Territory so that situations, like the above-cited example, will be impossible and so that each reserve can be treated as a unit. In this manner only can the reserves be protected and administration facilitated with the most satisfactory results. To accomplish this, large appropriations will have to be made by the Territory for an additional force of efficient men to manage them."

(The above excerpt constitutes the first suggestion since that made by W.M. Giffard in 1902 to the effect that the Territory's objective should be such as will assure the permanent use as forest land of all land within the forest reserves that in event of their being no other recourse to assure the continuation of such use, the private lands whose owners will not cooperate should be condemned.)

It is interesting to note that the members of the Board at the time of the 1920 action were: A.L.C. Atkinson, President; J.M. Dowsett; H.M. von Holt; W.M. Giffard; and A.H. Rice.

Mr. Judd reports the first withdrawal of land from the "Honolulu Watershed" forest reserve, a parcel of only 3,230 square feet at Tantalus Heights which was desired by the Land Commissioner for a certain land exchange.

April 16, 1921

Dr. H.S. Palmer, in his "Report on the Possible Occurrences of High-level Ground Water," concludes with comment on the projects considered by him to be the "Major and More Favorable Projects" of those discussed in his report. Projects so classified are:

KALIHI VALLEY

The project proposed by Mr. Jorgen Jorgensen in his report of November 13, 1916, to the Honolulu Water Commission, involving an 8100-foot tunnel in the Koolau Range from the 600-foot elevation in Kalihi, expected to develop water in a manner comparable to the Waiahole Tunnel.

MANOA VALLEY

A tunnel within the Koolau Range from Manoa similar to that proposed by Mr. Jorgensen from Kalihi.

NUUANU VALLEY

A tunnel into the Konahuanui massif from Nuuanu.
(Not recommended.)

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In his classification "Areas Unfavorable for Development of Ground Water," Dr. Palmer stated:

"No structures likely to control the movement of ground water and so warrant prospecting for water were seen in the following valleys: South branch of Halawa, Kalawahine, Moanalua, Opu branch of Makiki, Kaea branch of Palolo, Waialae and Wailupe. Kapalama and Kapahulu were also ruled out because they are short and because they lie largely within areas of low rainfall. Niu and the valleys to the east were ruled out because of the narrow character of the ridges between them which would afford little bulk of mountain for water storage."

Dr. Palmer classified as "Fairly Favorable Projects" the following:

KALIHI.

The view was expressed that short tunnels in the banks of tributary streams at the upper end of the valley might develop additional water, but on the other hand they might serve only to concentrate useable water which then reached the stream. Dr. Palmer made other suggestions with respect to ditching plans to skim the surface of the ground-water body. He suggested that a very complete system of tunnels and trenches might possibly result in an average yield of approximately 556,000 gallons per day.

"In the middle and lower reaches of Kalihi Valley some water could probably be developed by short tunnels in the moderately steep slopes that lie between the stream and the steep rock walls. It is believed, however, that supplies obtained in this way would be of small volume and would not be dependable, judging from the experience at the Catholic Orphanage and also from the rather small volume of alluvium and rock that would be tapped."

(The Orphanage Tunnels are described as follows on page 21 of the report: "About half way between the Catholic Orphanage and Kioi Pool, at an elevation of about 475 feet above sea level, two water development tunnels were driven into the slopes on the south-east side of the valley to obtain a supply for the Orphanage. These tunnels pass through a surface layer of soil and into deeply decomposed material. The yield of the tunnels is not great and almost ceased during the dry summer of 1920.")

MAKIKI

Dr. Palmer expressed the opinion that further development of the Makiki Springs would be worthwhile.

NUUANU

It is stated that the prospect of obtaining additional water by tunneling in upper Nuuanu is promising.

PALOLO VALLEY

Certain additional development projects were suggested, particularly at Waiomao Springs.

PAUOA VALLEY

Tunneling into the body of ash at an elevation between 900 and 1000 feet was suggested.

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May 31, 1921

(From letter by George Otis Smith, Director U.S.G.S., to Mayor John Wilson, relative to the "Palmer Report" of April 16, 1921)

Excerpts with respect to proposed tunnel into Koolau

Range from Kalihi:

"Before the proposed tunnel leading into Kalihi Valley is constructed, transverse tunnels should be run into the mountain mass from the windward side in order to ascertain at comparatively small cost the amount of high-level water that would be available for this tunnel. The exact procedure in the prospecting and development work must be determined from time to time in accordance with the results that are obtained."

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"I agree with Mr. Meinzer that it is by no means certain that it would be wise to proceed with the Kalihi project at this time" (but) "on the other hand, it should be considered that with the rapid growth of Honolulu the ultimate capacity of the artesian basin may eventually be reached and that any substantial high-level supply would add to the available resource and in general make the water supply of the city more secure."

1921

(From Honolulu Water Works Annual Report for 1921)

"Alewa Heights Springs. This spring is supplying water to the residents of Alewa Heights, part of the McInerney Tract, and upper Kalihi Valley.

There is, however, a surplus of 600,000 gallons running into Reservoir No. 2. This water should be used for the Dowsett and Laimi Tracts."

Mr. Wall's report noted the completion of several additional tunnels in Nuuanu Valley, resulting in a total of 5.00 million gallons average flow.

It was reported that the Palolo development tunnel was flowing at a rate of one million gallons per day, but that no pipe line had been authorized. Mr. Wall recommended increasing the tunnel length to a total of 1000 feet, which in his opinion, would increase the yield to 4 or 5 M.G.D.

Additional tunnel work in Makiki Valley was reported and continuation was recommended.

Mr. Wall also recommended additional development tunnels in Manoa and Kalihi and stated the belief that "water in such quantities would be secured as to allow the shutting down of the Makiki, Wilder Avenue, and Kalihi pumps."

September 18, 1922

(Letter by Honolulu Chapter, American Association of Engineers, to the Mayor and Board of Supervisors)

Requested that funds be appropriated to make possible the preparation of a comprehensive plan for water development for the City.

(Mr. G.K. Larrison was retained by the Board and his report was submitted on March 27, 1923.)

1922

(From Honolulu Water Works Annual Report for 1922)

Mr. W.A. Wall stated:

"Tunneling work was started in Kalihi Valley on July 10, 1922, and up to the end of the year 380,000 gallons of water were developed. This water will be used for upper Kalihi and will do away with any future water shortage in this section of the city."

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"I might say here that water in Manoa and Kalihi Valley can be secured by a system of short tunnels, the same as has been done in Nuuanu and Palolo Valleys. Water in such quantities would be secured as to allow the shutting down of the Makiki, Wilder Avenue, and Kalihi pumps."

- - - - -

Mr. Wall reported the acquisition of the Pacific Heights Water System, including springs, water rights, and tunnel concessions. He recommended development of tunnels in Manoa and Pauoa and the construction of the Palolo Tunnel, also additional tunnels in Nuuanu and further development of Makiki Springs.

November, 1922

In "The Hawaiian Forester and Agriculturist" (published by the Forestry Board), Territorial Forester C.S. Judd reported as follows:

"On account of the dependence of the main agricultural industry of these islands on a steady flow of water, the protection of the forests which conserve this water is a territorial necessity. It has been planned for some time to impress this upon the students at the University of Hawaii but not until this year has any regular instruction in forestry been given.

"As a temporary expedient, the course is being first presented by the Superintendent of Forestry and his assistant who have undertaken the work in addition to their regular official duties in the hope that several of the students will be attracted to forestry and sufficiently trained to take up forest work as rangers for which position qualified young men of the proper temperament are not available in the islands.

"The course, which will be given only during the first semester, from September 13, 1922, to January 15, 1923, includes 34 lectures and 17 field periods and covers the history of forestry, forest protection, forest mapping, dendrology, forest plant, silvics, and forest mensuration."

December 31, 1922

(From the Board of Commissioners of Agriculture and Forestry Report for January 1, 1921, to December 31, 1922.)

Mr. Judd's portion of the report stated that on June 28, 1921, 5.44 acres were withdrawn from Honolulu Watershed forest reserve for certain building site requirements of the Commissioner of Public Lands, and that on March 20, 1922, there was a similar withdrawal of .07 acres.

Mr. Judd recommended the acquisition by purchasing or condemnation of 5,478 acres of privately owned lands within the forest reserves of the Territory as necessary to properly assure that the land be used perpetually for forest purposes. The list includes a 260-acre portion of Kamañaki within the Honolulu Watershed forest reserve.

With reference to this matter Mr. Judd stated as follows (page 23):

"When privately-owned lands are included within a forest reserve as an integral management unit, the proclamation recommends that such private lands be protected and managed as reserve lands. In some cases, however, the owners have not felt disposed to comply with this recommendation and use the lands at times for grazing purposes with consequent detriment to the forest growth. Under such circumstances it is desirable for the government to acquire control of the land in order to give it the needed protection."

Continued reforestation was reported in the upper Makiki Valley, particularly above the Nering Springs.

March 27, 1923

(Report by W.A. Wall, General Manager, Honolulu Water Works presenting the G.K. Larrison Report requested by the Board of Supervisors.)

A detailed report entitled "Report on Future Water Supply for the City of Honolulu." (The letter of transmittal indicates that the report was essentially the report submitted by Mr. G.K. Larrison on March 27, 1923.)

The Report presented data with respect to the diminishing artesian head and the "artesian well bill" which was introduced by Representative R.A. Vitousek in the 1923 Session to correct weaknesses found in the 1917 Act. (Mr. Vitousek's bill was enacted as Act 228 by the 1923 Legislature.)

The report submitted a re-estimate of the cost of the Jorgensen-Palmer project to bring water from Koolau to Nuuanu via Kalihi and analyzed possible utilization of Waiahole water owned by the Territory by an aqueduct from the Waiawa Portal to Nuuanu Reservoir No. 3.

The total water supply then available, or prospective, to Honolulu is estimated as follows:

| | |
|---|------------|
| Artesian Water | 40 M.G.D. |
| Surface and Storm Water at 700-foot elevation | 34 |
| Possible development tunnels | <u>15</u> |
| Total available | 89 M.G.D. |
| Add surface and storm water if at 400-foot elevation | <u>26</u> |
| | 115 M.G.D. |

The tabulation showing the computation of the foregoing is presented on the page following. This is the first comprehensive inventory of water available to Honolulu District found by the compiler of this (1948) report.

The Report presented a proposed general improvement program in which considerable emphasis is given to the importance of water development in Kalihi, Nuuanu, Pauoa, Makiki, Manoa, and Palolo Valleys, although additional artesian wells at the pumping stations are proposed, and also reservoir, distribution, and mechanical improvements and installation of meters.

I N F O R E S T & W A T E R R E S E R V E :

(Upper)

| SECTION: | RUNOFF | | | | | | UNDERGROUND STORAGE | | | | | | | | | |
|---------------|------------------|------|--------|---------|--------------------|--------------------|---------------------|--------------------|--------------------|--------|-----------------------|---------------------------|-----------------------|---------------------------|-----------------------|--------|
| | Area | Avg. | Annual | M.G. | M.G.An- nual 50 | M.G.An- nual 40 | Avg. | M.G.An- nual 50 | M.G.An- nual 40 | Avg. | 50% runoff | 10% evapora- | 50% runoff | 20% evapora- | 30% evapora- | |
| Acre | Rain- fall in | Feet | feet | percent | runoff | runoff | percent | runoff | runoff | runoff | Plant Absorp- tion | Plant Absorp- tion and | Plant Absorp- tion | Plant Absorp- tion and | Plant Absorp- tion | |
| | feet | | | 50% | 50% | 40% | 50% | 40% | 40% | 40% | tion | tion | tion | tion | tion | |
| | | | | runoff | runoff | runoff | runoff | runoff | runoff | runoff | M.G.Yr. | M.G.D. | M.G.Yr. | M.G.D. | M.G.Yr. | M.G.D. |
| Kalihi Valley | 1353.2 | 11.1 | 15021 | 4894.6 | 2447.3 | 6.7 | 1957.8 | 5.4 | 1957.8 | 5.4 | 1957.8 | 5.4 | 1468.4 | 4.0 | 976.9 | 2.7 |
| Nuuanu Valley | 2242.1 | 12.2 | 27354 | 8913.3 | 4456.7 | 12.2 | 3565.3 | 9.8 | 3565.3 | 9.8 | 3565.3 | 9.8 | 2673.0 | 7.3 | 1782.9 | 4.9 |
| Pauoa Valley | 1164.1 | 11.3 | 13154 | 4286.2 | 2143.1 | 5.9 | 1714.5 | 4.7 | 1714.5 | 4.7 | 1714.5 | 4.7 | 1285.9 | 3.5 | 857.2 | 2.3 |
| Manoa Valley | 1254.5 | 11.9 | 14929 | 4864.6 | 2432.3 | 6.7 | 1945.9 | 5.3 | 1945.9 | 5.3 | 1945.9 | 5.3 | 1449.4 | 4.0 | 972.9 | 2.6 |
| Palolo Valley | 896.7 | 7.9 | 7084 | 2308.3 | 1154.2 | 3.1 | 923.3 | 2.5 | 923.3 | 2.5 | 923.3 | 2.5 | 692.5 | 1.9 | 461.7 | 1.3 |
| Totals | 6910.4 | | 77542 | 25267.0 | 12633.6 | 34.6 | 10106.8 | 27.7 | 10106.8 | 27.7 | 10106.8 | 27.7 | 7579.2 | 20.7 | 5053.4 | 13.8 |

(Lower) BETWEEN CONTOUR 400 AND FOREST AND WATER RESERVE :

| SECTION: | Area | Avg. | Annual | M.G. | M.G.An- nual 50 | M.G.An- nual 40 | Avg. | M.G.An- nual 50 | M.G.An- nual 40 | Avg. | 50% runoff | 10% evapora- | 50% runoff | 20% evapora- | 30% evapora- | |
|-----------------|------------------|------|--------|---------|--------------------|--------------------|---------|--------------------|--------------------|--------|-----------------------|---------------------------|-----------------------|---------------------------|-----------------------|--------|
| Acre | Rain- fall in | Feet | feet | percent | runoff | runoff | percent | runoff | runoff | runoff | Plant Absorp- tion | Plant Absorp- tion and | Plant Absorp- tion | Plant Absorp- tion and | Plant Absorp- tion | |
| | feet | | | 50% | 50% | 40% | 50% | 40% | 40% | 40% | tion | tion | tion | tion | tion | |
| | feet | | | runoff | runoff | runoff | runoff | runoff | runoff | runoff | M.G.Yr. | M.G.D. | M.G.Yr. | M.G.D. | M.G.Yr. | M.G.D. |
| Kalihi Valley | 2042.6 | 10.9 | 22264 | 7254.8 | 3627.4 | 9.9 | 2901.9 | 8.0 | 2901.9 | 8.0 | 2901.9 | 8.0 | 2176.4 | 5.0 | 1451.0 | 4.0 |
| Nuuanu Valley | 959.7 | 10.7 | 10269 | 3346.2 | 1673.1 | 4.6 | 1338.5 | 3.7 | 1338.5 | 3.7 | 1338.5 | 3.7 | 1003.9 | 2.7 | 669.2 | 1.8 |
| Pauoa Valley | 539.7 | 11.0 | 5937 | 1934.6 | 967.3 | 2.6 | 773.8 | 2.1 | 773.8 | 2.1 | 773.8 | 2.1 | 580.0 | 1.6 | 386.9 | 1.1 |
| Manoa Valley | 1191.5 | 11.4 | 13702 | 4464.8 | 2232.4 | 6.1 | 1785.9 | 4.9 | 1785.9 | 4.9 | 1785.9 | 4.9 | 1339.4 | 3.6 | 893.0 | 2.4 |
| Palolo Valley | 1333.0 | 5.5 | 7332 | 2389.1 | 1194.6 | 3.3 | 995.6 | 2.6 | 995.6 | 2.6 | 995.6 | 2.6 | 716.7 | 2.0 | 477.8 | 1.3 |
| Totals | 6065.5 | | 59504 | 19389.5 | 9694.8 | 26.5 | 7795.7 | 21.3 | 7795.7 | 21.3 | 7795.7 | 21.3 | 5816.8 | 15.9 | 3877.9 | 10.6 |
| COMBINED TOTALS | 12975.9 | | 137046 | 44656.5 | 22327.4 | 61.1 | 17902.5 | 49.0 | 17902.5 | 49.0 | 17902.5 | 49.0 | 13376.0 | 36.6 | 8911.3 | 24.4 |

NOTE: Means for nine years. All percentages based on yearly rainfall = 100%. Earth evaporation 15% of pan evaporation = 15% of 44 feet = 6.6 or 5% of rainfall. Plant absorption from 0 to 25% of rainfall.

Stations: (a) Kalihi; (b) Pali, upper Luakaha and lower Luakaha; (c) Manoa and lower Nuuanu; (d) Shingle and Rhodes; (e) Kaau and Waiamau; (f) Upper Kalihi and lower Nuuanu; (g) Lower Luakaha and Electric Light Station; (h) Lower Nuuanu and upper Pauoa; (i) Lower Pauoa and upper Manoa; (j) Waiamau.

It is estimated that sufficient surface and flood water can be obtained in the several valleys in the back of the City at an elevation sufficiently high to provide a gravity filtration supply of approximately 34.0 - M.G.D. The above tabulation shows the mean runoff for a period of nine years.

TOTAL AVAILABLE SUPPLY AT APPROXIMATELY 700 FEET AND 400 FEET ELEVATIONS, RESPECTIVELY:

| | | | |
|--|--------------|---------------|---|
| Artesian Water | 40.00 M.G.D. | 40.00 M.G.D. | |
| Surface and storm water in forest reservations | 34.00 M.G.D. | 60.00 M.G.D. | |
| Possible development tunnels | 15.00 M.G.D. | 15.00 M.G.D. | |
| Total in forest reservations and artesian supply | 89.00 M.G.D. | 115.00 M.G.D. | (From p. 32 of G.K. Larrison's 1923 report) |

Mr. Wall's proposals with respect to development of water in the valleys were as follows:

PALOLO

1923 "dry weather flow" was 450,000 g.p.d. Estimated that 5.0 M.G.D. could be developed and that if this is not done, a new pump at Kaimuki Station will be necessary.

MANOA

Mr. Wall "feels confident that 3.0 to 5.0 M.G.D. can be secured from springs and tunneling."

MAKIKI

Additional high elevation development was recommended as worthwhile.

PAUOA

Recommended that surplus from the springs supplying Pacific Heights be piped to serve the upper Papakolea area (the location proposed for a new 6.0 M.G. Reservoir). Development work also recommended.

NUUANU

Additional development recommended.

KALIHI

800,000 g.p.d. had been developed since July, 1922. Further development recommended.

PUMPING PLANTS

It was recommended that additional capacity be deferred "until all available water is obtained from the development as recommended above." (Valley water developments and storage for pumping station water.)

May 2, 1923

Act 228 (H.B. 380) approved by the Governor, thus adding considerable effectiveness to the "Artesian Wells Law."

In his June 1, 1923 report Mr. W.A. Wall, General Manager, Honolulu Water Works, stated as follows with reference to H.B. 380 (on page 13):

"The artesian basin on the island of Oahu is the most wonderful in the world, and can produce more water per square mile than any other known. The mere fact that we have this wonderful supply of artesian water is no reason why it should be wasted, as is now being done, through leaky wells, wells running wild (allowed to flow without regulation), without consideration for the amount required for irrigation or other purposes.

"The artesian basins (4) between Diamond Head and Red Hill are now producing, not including leaks or underground waste, approximately 50.0 M.G. daily. The Honolulu Water Works Department is pumping 19.0 M.G. daily and supplies the entire lower levels of the city to an average height of 150 feet with water for domestic purposes, irrigation, shipping, etc. The question now is what is being done with the remaining 31.0 M.G. daily. Is it being used in a judicious manner, or is it being wasted? This should be investigated and a remedy applied immediately.

"Through the efforts and recommendation of the local chapter of the American Association of Engineers and the superintendent of Hydrography, Division of Hydrography, Territory of Hawaii, House Bill No. 380, An Act to Amend Act 156 of the Session Laws of 1917, relating to the use of water from artesian wells, was introduced April 10, 1923, by R.A. Vitousek. Should this bill become law, the question of wasting artesian water will soon be solved, and the proper remedies applied to restrict and prevent any future waste. The Water Works Department believes the Artesian Basin should be conserved for the future uses and benefit of the city, as well as the present."

1923

(From Annual Report by W.A. Wall, General Manager, Honolulu Water Works)

Total water delivered in 1923 was 9476 million gallons of which 1825 was gravity water. Increase of 1,277,000 g.p.d. was made possible by the new 2-1/2 million gallon concrete reservoir in Nuuanu. (This is the present (1948) Reservoir No. 5 at the 400 ft. elevation. Its completion made it possible for the first time to discontinue the use of surface water from streams or earth reservoirs).

Mr. Wall stated, "With additional tunnels in Nuuanu Valley, and Kalihi and Manoa Valleys connected to the city system, the increase of gravity water will be more than doubled."

The report urged that development of water in the several valleys be continued until each valley has been thoroughly developed and that "filtration sites" be located and water developed by drift tunnels under the filtration areas.

Reported the following details of water development of the year in Manoa:

| | | |
|--------------|----------------|-----------------|
| No. 1 Tunnel | 680,000 g.p.d. | at 58 ft. depth |
| No. 2 Tunnel | 95,000 g.p.d. | " 56 ft. depth |
| No. 3 Tunnel | 125,000 g.p.d. | " 32 ft. depth |

"Kalihi Valley. Water in this valley has been developed to the extent of an average of 600,000 gallons daily. A pipe line has been ordered, to arrive about January 15th 1924. The installation of this pipe line will begin in February 1924. Approximately three months time will be required for this work, and when completed will supply the upper levels of Kalihi Valley, which is now receiving its supply from Nuuanu Valley through a 6" pipe, a distance of several miles. The Nuuanu water should be kept in the Nuuanu section of the city, in fact each valley should produce enough water to take care of its own section of the water system in the higher levels during the summer months, and with a surplus in the winter months which can be let down into the lower levels assisting the pumping plants to a great extent."

June 2, 1924

Messrs. Theo. Hoffman, Fred T. Williams, and J. H. Grainger, who had been appointed by the Board of Supervisors on April 15, 1924, as a Special Committee, submitted their report and recommendations with respect to the mechanical improvement of the pumping stations of the Honolulu Water Works.

With respect to the general situation the Committee reported as follows (from page 23):

"It is the opinion of the Committee, after carefully considering past reports and records of the artesian water basin, and discussing the subject with other engineers who have carefully studied this problem for years, that the available artesian supply, provided it is properly conserved, is capable of supplying the City for many years to come without serious overdraft. We unanimously agree, however, that the City should make provision to take full advantage of any suitable Tunnel Water supply which may be available at the upper levels; and thus not only reduce the draft on the artesian basin, but also reduce the cost of pumping."

The Committee also endorsed the principal recommendations made by Mr. G. K. Larrison in his report of March 27, 1923.

December 31, 1924

(From Report of the Board of Commissioners of Agriculture and Forestry for period January 1, 1923 to December 31, 1924)

During the period Mr. H. P. Agee of the H.S.P.A. was appointed to the Board to take the place of Mr. W. M. Giffard. Mr. Giffard, as this (1948) report will show, was one of the members appointed to the original Board by Governor Dole in 1903 and had been on the Board continuously since that time; and with Mr. R. S. Hosmer, Superintendent of Forestry, may be said to have had a great part in creating the forest reserves as they are today.

During the two years, forest reserves on Oahu were increased to 118,310 acres, or approximately 31% of the total land

area of the Island, an area described by the Commissioner as "none too large for the proper conservation of the forests on the watersheds from which are derived the water supplies necessary for the needs of this Island."

With respect to the acquisition of private lands, Mr. Judd stated in his section of the report (page 15):

"During the period the Land Commissioner has acquired title to 260 acres of the land of Kamanaiiki in the Honolulu Watershed reserve on Oahu. It is still felt that where the owner of private lands within proclaimed reserve boundaries does not arrange for the protection of the forests thereon, the way should be cleared by legislative action for the government promptly to acquire them. The following are the most important of such lands which it is hoped the Legislature will make it possible to acquire at this session. Molokai, Kahanui 1,048, Iloli 166, Kahanui 326, Naiwa 67, Waileia 330 acres; Hawaii, Mauluanui in Hilo reserve 1,907 acres; Oahu, Kahuku 5,950, Honouliuli 4,936, and Waimea in Kawaiiloa reserve 3,660 acres; total 18,390 acres."

1924

(From Annual Report - Honolulu Water Works
by W. A. Wall, General Manager)

Recommendations:

PALOLO VALLEY

Continuation of development in Palolo by extending existing tunnel approximately 100 feet towards and under Kaau Crater "which is a natural reservoir, in fact the best on the Island of Oahu."

A dam at the opening in the rim of Kaau Crater 80 feet in width at the top to create a reservoir of 703 million gallons capacity. Mr. Wall stated that 315 acres of watershed could be made tributary to such a reservoir and that about 4/5ths of the stored water would percolate through the bottom of the reservoir and thus it would function as a 36-acre infiltration area to contribute to the proposed tunnel and to the artesian basin. "The time is not far distant when all storm waters will have to be conserved and the damming of Kaau Crater will prevent a large portion of the storm waters of Palolo Valley from running to waste, and will augment the artesian basin supply in the Kaimuki Section to a great extent" . . . "The amount of water consumed would be from three million to five million gallons daily."

MANOA VALLEY

Additional tunnel development adding to the supply resulting from the tunneling of 1923-1924 (which was described as from 500,000 to 800,000 g.p.d.).

MAKIKI VALLEY

Additional development considered justifiable because of the need for water in Makiki Heights and Round Top areas. Mr. Wall indicated, however, that results may or may not be satisfactory.

PAUOA VALLEY

"Development work has been recommended in this valley for the past two years, but as yet no funds have been appropriated for the work.

"In the purchase or transfer of the Booth Springs and Pacific Heights Water System to the City and County the right to tunnel and develop water was included in the agreement. With the rapid growth of Pacific Heights and vicinity since the water works system has been under the control of the City and County, it is absolutely necessary that a larger quantity than the present springs supply be secured." Recommended that development tunnels "be tried" above the elevation of the springs supplying Pacific Heights, and that all lands in the vicinity of the Booth Springs be purchased.

NUUANU VALLEY

Recommended further development to meet the requirements of subdivisions proposed for sale.

KALIHI VALLEY

"The Upper section of Kalihi Valley is owned and controlled by the City and County, and development work should be continued throughout the entire reservation. The main pipe lines and connecting tunnels are installed and constructed. All additional water developed can now be connected to the main pipe line with very little expense as compared to the value of the water."

GENERAL

"With the proper conservation of the artesian supply the artesian basins will, with the assistance of mountain water for the higher elevations, be able to supply all demands for the city's needs up to and including 1939 . . . it is readily understood that water must be supplied from some source other than the artesian basins. It is therefore recommended that development of mauka or tunnel water be continued in the valleys adjacent to the city."

"It is estimated that ten (10) to twelve (12) million gallons daily can be obtained as a minimum flow from the following valleys;- Palolo, Manoa, Makiki, Pauoa, Nuuanu, Kamanaiki and Kalihi. Each valley should, and I think can, produce enough water to take care of all needs within its boundaries above the 150 foot elevation.

"The slopes of the mountains back of the city in the Forest and Water Reservation are located the water sheds which supply the artesian basins. These artesian basins are slowly, but surely, being depleted, and something must be done to furnish a way or means to prevent it. With the increased consumption daily this natural supply is not sufficient to keep up with the demand; it, therefore, becomes necessary to put into the artesian basins an additional supply. This may be done by constructing dams in blind gulches, which are not exposed to heavy freshets, and supply water by ditch and tunnel from the larger streams during heavy rains or freshets, thereby saving the greater portion of the run off or storm water. It being understood, however, that the location of these reservoirs or filtration beds be so located that they are protected from heavy freshets, and supplied only by ditch or tunnels. The bottom of these reservoirs should be of a porous formation to allow of percolation, which will in time find its way into the artesian basin.

"Under or near these reservoirs or filtration beds, a system of tunnels should be constructed to intercept a portion of the percolating water which would be used to supply the higher levels of the city's water system. The artesian basins which are underground reservoirs should be depended upon to catch the greater portion not intercepted by the tunnels. It is possible this would maintain the present artesian head, if not increase it. That this system can and should be tried at very little expense, is strongly urged and recommended by this department."

April 21, 1925

(Letter from C. S. Judd, Superintendent of Forestry,
to the Board of Commissioners of Agriculture and Forestry)

Proposed increasing Honolulu Watershed Forest Reserve from 6,950 acres, as created in 1913 (less 5 acres withdrawn), to a total of 14,173 acres, principally by extending the Reserve to the Halawa boundary on the west and to the Kuliouou Forest Reserve on the east.

"In Palolo the old line remains the same in Waiomao, but on the Kaea or west side the new line swings mauka and around the cultivate vegetable gardens on private lands in the valley. Swinging makai again past Pukele, more forest land is taken in on the Palolo-Manoa ridge on both slopes, the line joining the old boundary again at the head of the short valley in Kolowalu.

"At the head of Manoa Valley the new line keeps below the cliffs and waterfalls, instead of above, and crosses Waaloa just below the two springs in the banana fields and continues along the upper edge of present cultivation.

"In Aihualama and Kaukulu the line is lower than before and takes in the tree plantings of the H.S.P.A., but excludes the lands planted to cane.

"There is no change in the line in the remainder of Manoa or in Makiki.

"Across Pauoa Valley the new boundary has been brought slightly lower so as to include and give adequate protection to the sources of water supply for Pacific Heights.

"In Nuuanu the old line remains the same except that it runs up the new instead of the old road, and on the northwest side of the valley takes in the government remnant above Niniko and following down the Waolani ridge, takes in the major part of the side valley back of the Country Club.

"Crossing Kapalama the new line is more than a mile below the old boundary so as to include tree forest land, and in Kamaikai, the line crosses at the waterfall which is the makai boundary of the 260 acres purchased recently by the Territory from the Liliuokalani Trust.

"Across Kalihi the new line is slightly mauka of the old so as to avoid cultivated land on the south side of the valley, but it runs up the north side of the valley slightly makai of the old line so as to include a government remnant."

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Of the total of 14,173 acres, only 6,169 acres, or 43%, was government owned.

April 29, 1925

Act 150 passed by the Legislature creating the Honolulu Sewer and Water Commission.

The authority and responsibility of the Commission included the following (which now apply to the Board of Water Supply):

"The Commission shall report in full to the regular sessions of the legislature its doings and expenditures and such recommendations as it may deem advisable to expedite and complete the . . . water system, and to insure its adequacy, and to safeguard the watersheds and artesian basins of Honolulu."

(The Commission was basically a planning and construction agency and as projects were completed they were turned over to the Honolulu Water Works of the City and County for operation. In 1929, however, the Legislature created the Board of Water Supply in which all activities were combined.)

(The original members of the Commission were G. S. McKenzie, chairman; G. F. Wright; L. H. Bigelow; C. J. McCarthy; and F. O. Boyer. Mr. Frederick Ohrt was appointed Chief Engineer.)

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The Act directed that insofar as practicable the Commission's water supply construction program follow the report of Messrs. Theo. Hoffman, Fred T. Williams and J. H. Grainger, bearing date June 2, 1924. (The subject matter of the said report is largely confined to pumping and accessory equipment.)

Bond issues of an aggregate amount of \$3,000,000 were authorized for the sewer and water projects to be undertaken.

August 15, 1925

(A "Preliminary Report on Water Situation"
by Frederick Ohrt, Chief Engineer, Honolulu
Sewer and Water Commission)

Mr. Ohrt submitted to the Commission recommendations based upon the Hoffman-Williams-Grainger Report and other reports. He recommended that the Commission urge the Board of Supervisors to make funds available immediately for:

| | |
|--|----------|
| Artesian well drilling and improvement (at Pumping Stations) | \$44,000 |
| Mountain water development tunnels in Palolo, Manoa, Makiki, Nuuanu and Kalihi | 10,000 |
| Recording instruments at water sources . . . | 15,000 |

"It should be the policy of the commission to approve the development of mountain water."

Universal metering was recommended.

Recommended that no principal pumping station improvement that would increase capacities be made until the commission had had time to determine the extent to which the draft on the artesian basins could be safely increased.

1925

Annual Report - Honolulu Water Works
by E. C. Wilder, Chief Engineer
(under C. J. McCarthy, General Manager)

Reported the installation of a pipeline for the utilization of water developed by Manoa Valley development tunnels.

May 19-21, 1926

Proceedings of the First Annual Meeting,
Hawaiian Academy of Science (B. P. Bishop
Musuem Special Publication 11)

At their first annual meeting the members (of whom there were 123 at the time) devoted considerable attention to Oahu's water resources. The papers on the subject were as follows:

Harold S. Palmer:

"The Form and Structure of the Artesian
Areas Underlying Honolulu"

Harold L. Lyon:

"The Source, Conservation, and Increase of
Artesian Water"

G. K. Larrison:

"The Adequacy of Artesian Water for Future Supply"

John McCombs:

"Natural and Artificial Losses of Artesian Water"

Max H. Carson:

"Available Surface Water"

Herbert E. Gregory:

"Water Supply for Honolulu"

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Particularly interesting excerpts from the published "Abstracts of Papers" pertinent to the subject-matter of this 1948 report are presented below:

Harold L. Lyon:

"The upper slopes of the Koolau Mountains constitute the watersheds which gather the water that falls as rain and delivers it into our artesian basins. All of the water that soaks into the ground on these watersheds may be considered as on its way into these basins."

"Under primeval conditions, the watersheds of the Koolau Mountains were covered with a heavy rain forest, protecting a dense undergrowth of ferns and moss, which held back the rain water in a most effective manner. Then the soil was kept in a loose, open condition by the many burrowing roots and thick mulch of organic matter: in fact, the dense vegetation not only served in itself to check the run-off during heavy rains, but also kept the soil in such a condition that it, too, held back the water and at the same time absorbed it rapidly.

"Now, it is well known that through the acts of man and his domesticated animals, the effective area of water-conserving forest on the Koolau Mountains has been greatly reduced; that the remaining native forest is in a diseased and decadent condition throughout its entire extent; that the forest is rapidly becoming more open through the death of native plants and their prompt replacement by Hilo grass; and that the soil is becoming more compact and less absorptive as the nature of the vegetation changes. As an inevitable result of the above conditions, the water-absorbing capacity of our watersheds has greatly lessened in recent years, and will continue to lessen until steps are taken to alter the trend of events on these watersheds.

"We must realize that while we are encouraging growth and development that will make ever-increasing demands upon the water in our artesian basins, we are, at the same time, permitting, if not actually fostering, conditions that are constantly decreasing the amount of water entering these basins.

"The steps which we can, and must, take to insure the maintenance of our artesian water supply at its present magnitude are obvious. We should at once take effective measures to protect and preserve the forest remaining on the Koolau Watersheds; we should make every effort possible to rehabilitate these forests so as to increase their water-holding capacity, and we should add to these forests until we have all lands on these watersheds, not otherwise, employed, covered with an effective rain forest."

John McCombs:

"Natural losses are those which occur before the artesian water enters the collection and distribution system and are not under human control. The chief natural loss is that through low level springs and can only be avoided by using this water, thus relieving the direct draft through wells. Deforestation is a second cause of natural loss by decreasing the absorption of water into the artesian system. The remedy lies in the province of the forester. A third natural

loss is due to the diffusion and mixture of the underlying salt water into the fresh water lens. The contact between the two is not a surface but a zone of gradual transition. As the artesian head fluctuates, this zone rises and falls and gradually thickens. The remedy is to build up the artesian head.

"Artificial losses are those which occur in the processes of recovery and utilization, and may be classified as complete and partial losses. The complete losses are those in which the fresh artesian water finds its way to the sea without having conferred any benefits, for example the loss through well casings which have corroded, thus allowing the water to escape. The Division of Hydrography has greatly reduced this loss. But the work must be continued since more wells become defective every year. A second type of complete loss is due to leaks in the city distribution system, and accounts for a considerable part of Honolulu's excessive per capita daily consumption of 270 gallons. The Honolulu Sewer and Water Commission expects to reduce this to 175 or even 150 gallons by metering every service connection and by locating leaks in the mains. This wholly avoidable loss is estimated at 9,000,000 gallons a day, of which more than 1,000,000 gallons is due to leaky reservoirs.

"The partial losses are those in which high grade artesian water is used where sea water or non-potable water could be substituted. A partial loss of several million gallons a day occurs in condensing steam and in industrial plants where sea water could be utilized with complete success. Commercial irrigation is a very wasteful process. In the cultivation of rice in particular, much water is wasted because of the indifference or ignorance of the irrigators. Another waste is in swimming pools, which use a half-million gallons daily, whereas filtration and chlorination would reduce this to less than a hundred thousand gallons.

"Some phases of waste prevention are being carried on well. Others are scarcely touched, but all can be carried through, provided the public can have the facts and will support proper action."

Herbert E. Gregory:

"Regarding water supply, a popular notion prevails that Providence usually takes care of people; and if Providence fails mankind is amply able to care for itself. But the amount, quality, and availability of water depends on rainfall and geologic structure--factors over which mankind has no control.

"It is possible, however, to learn where water is, how much there is, how good it is, and what it costs to obtain it. With that knowledge Honolulu can wisely plan its future; without that knowledge, expenditure of funds is a gamble and may be definitely injurious. For many years the solution of the water problem of Honolulu has been delayed by the failure to appreciate its seriousness and by political bickering. Fortunately, the solution is now in the hands of a group of competent engineers and scientists, and the duty of the community is to support whole-heartedly the work of the Sewer and Water Commission."

September 9, 1926

Report by Dr. H. S. Palmer: "The Geology of the Honolulu Artesian System" (prepared for the Honolulu Sewer and Water Commission)

The Palmer Report was the first comprehensive presentation of the (now) generally accepted basic geology and hydrology of the Honolulu artesian "system."

From a conservation point of view the important statement in the report is the following:

"VII. HEEDLESS EXPLOITATION AND ITS PENALTY

"The continued fall of the artesian head and the increase in salt content show that Honolulu is exploiting its artesian water resources in a way that cannot be kept up indefinitely. The artesian supply is much like a bank account. The deposits are represented by the recharge by absorption of water in rainy seasons. The withdrawals are represented by the discharge of flowing wells and the water pumped from other wells. The principal is represented by the fresh water stored in the voids of the rocks. Honolulu is now living on its principal, and will have to pay a penalty equivalent to that of a spendthrift unless the policy with regard to the artesian supply is changed."

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"It behooves us, then, to keep our expenditure within our income, to draw no more water from the artesian system that nature puts into it."

In view of the "pioneer" status of Dr. Palmer's presentation the following extract from his chapter "Artesian Conditions

at Honolulu" is included herein to add to the completeness of this (1948) report (from pages 41-43):

(The figures referred to are reproduced in Part II-C of this report.)

"Figure 15 is a generalized structure section in the mauka-makai direction across Honolulu, and shows a cross section of the triangular prism of cap-rock lying on the sloping flank of the great mass of water-bearing lava rock. Figure 16 is a modification of figure 15 in which there have been added lines showing the boundaries between the various hydrologic zones. Two wells have also been added. It is in a sense also a modification of figure 9, in that it applies the general principle to the specific types of rock and attitudes or rock masses found at Honolulu.

"Rain falling in the mauka region to the left of the diagram is in part absorbed and moves downward under the influence of gravity. Rain falling on the upper surface of the prism of cap-rock does not enter the artesian system but either runs over the surface to the sea or is absorbed to give rise to shallow ground water like that found in various excavations made in the central part of the city. It is desirable that we know the location of the boundary between the regions where absorbed water joins the artesian system and where it makes only shallow ground water. Two conditions make this difficult to ascertain. In the first place the artificial changes made in the surface by man in grading, making lawns, and the like, obscure much of the evidence. In the second place, the boundary is obscured by passing under the areas of volcanic matter erupted by Kaimuki Crater, Mauumae Crater, Round Top, Sugarloaf, Tantalus, Punchbowl, and the Salt Lake group of craters. Thomas Square is underlain by Punchbowl volcanic ash, and rain falling on Thomas Square cannot get into the artesian system, as is shown by the fact that the Thomas Square well passes thru the impervious cap-rock. On the other hand rain falling on the mauka slopes of Punchbowl may enter the artesian system. The best generalization that we can make is that the region above 100 or 200 feet elevation, except on Punchbowl and the other recent volcanic masses, is likely to feed into the artesian system, and that the region less than 40 feet in elevation cannot possibly feed into it. The zone between 40 and 100 or 200 feet is doubtful.

"Returning to a consideration of figure 16, rain falling to the left of the diagram is in part absorbed and moves downward under the influence of gravity until it comes near to sea level. Then it must either move shoreward over the ground water body already present or displace it by shoving it downward and shoreward. There thus results a shoreward movement of ground water, which is opposed by the prism-shaped dam or impervious cap of clay,

mud, coral, etc. The shoreward moving ground water might conceivably escape either thru, over, or under the cap-rock. Since the cap-rock is impervious there is little natural escape thru it. The springs at Moiliili may be due to escape thru the cap-rock. The artesian wells cause artificial escape thru the cap-rock. Since the cap-rock, in general extends a considerable distance above sea level there are only a few places where ground water escapes over its upper edge. The springs at Waiau and elsewhere along the shores of Pearl Harbor appear to be due to escape of ground water at points where the inland edge of the cap-rock is relatively low. Escape beneath the lower edge of the cap-rock is opposed by the body of sea water which exerts a pressure in all directions, dependent in amount on its specific gravity and on the depth. Since sea water is one-fortieth heavier than fresh water the pressure will be one-fortieth greater than would be produced by an equal depth of fresh water. Or in other words, the pressure produced by the given depth of sea water will be equalled only by that produced by a depth of fresh water one-fortieth greater than the depth of sea water. This means that the seaward moving fresh water will not be able to pass the lower edge of the cap-rock until it has saturated the lava rock to a height above sea level one-fortieth as great as the depth below sea level to edge of the cap-rock.

"No doubt in the countless centuries before the first artesian well was drilled at Honolulu, rain had been absorbed, had sunk and had made its way seaward in such volume that the foregoing conditions had been fulfilled. It is definitely known that prior to the drilling of the first artesian well there were various springs discharging over the inland edge of the cap-rock and perhaps a few discharging thru leaks in the cap-rock. Some of these are still flowing. It is probable that there was also submarine leakage past the lower edge of the cap-rock. In figure 16 the point, A, would have been the site of a spring had it been a little lower so that it would have been below the level of the dashed line representing the piezometric surface, or surface to which water would rise in wells. Submarine leakage might have occurred at the point Z. The C-Z represents the contact zone or boundary between the region where the voids in the rock are filled with fresh water and the region where they are filled with salt water."

December 3, 1926

Letter by C. S. Judd to Board of Commissioners of Agriculture and Forestry. (Published in "The Hawaiian Forester and Agriculturist" for October-December, 1926)

Reported the adjustment of boundaries of the proposed enlarged Honolulu Watershed Forest Reserve to meet two objections made at the public hearing held on the matter, and, as a result of consultation with the Chief Engineer of the Honolulu Sewer and Water Commission, to bring the lines down lower in the Kalihi, Pauoa, and Makiki sections.

Recommended that the revised description (containing 14,809 acres) be submitted to the governor:

Mr. Judd stated:

"In my opinion, every acre in this extension is needed to guarantee the continuity of the water supply of Honolulu."

December 24, 1926

Proclamation of the governor, modifying the boundaries of Honolulu Watershed Forest Reserve by increasing the area to 14,808.

December 31, 1926

Report of Honolulu Sewer and Water Commission

Reported that investigations to date had led to the conclusion that the draft on the artesian basin of the District of Honolulu should not be permitted to exceed 42 m.g.d. "and unless the present overdraft is eliminated at an early date, the problem will not only become critical sometime between 1931 and 1935, but will also become a menace to the economic development of this Island."

One of the principal recommendations to the Legislature was, "That the problem of safeguarding the Honolulu Watersheds be placed entirely within the control of the Board of Agriculture and Forestry."

The report outlined plans for complete integrated improvement and expansion of the water system. The principal projects complete, or under contract, provided additional artesian wells, pumping station equipment and buildings, and principal trunk mains. The program included no important projects for greater development or utilization of surface or tunnel water. Tentative plans for the future, with respect to service to the "Mountain Water Area" and increased utilization of surface and tunnel water were presented as follows:

"Above the 300 foot level, to include all existing highland districts and their probable extensions up to the forest reserve lines. This zone will be served by mountain tunnel and spring water when available and with artesian water pumped by electric motor driven booster pumps during drought periods should the mountain water fail.

"It is also planned to utilize excess clear mountain spring and existing and proposed tunnel water when available, by letting it down into the high pressure zone with suitable head breaking facilities.

"It is also planned to utilize all flood runoff by storage, filtration and purification and distribution in the various zones and in this way relieve the pumping plants as much as possible.

"The plans for the high level area are subject to modification as further studies and developments justify."

The overall improvement plan presented by the Commission included the following, with reference to the subject matter of this (1948) report:

Booster Pumps and Mains to serve the heights and thus serve the two-fold purpose of alleviating complete reliance upon spring and mountain tunnel supplies and of making additional tracts available for residential purposes.

| | |
|---|-----------|
| <u>Water Development by Tunnels in Mountain Areas</u> | \$100,000 |
| <u>Flood Water Tunnels and Filtration Plant</u> | 500,000 |

(No details were presented with reference to the above projects.)

1927 Legislative Session

The Honolulu Sewer and Water Commission, acting under the directive contained in Act 150, Session Laws 1925, to report to the Legislature such recommendations as it may deem advisable ". . . to safeguard the watersheds and artesian basins of Honolulu," proposed to the 1927 Session a bill prepared by Mr. L. J. Warren, an outstanding member of the bar acting as a deputy of the Attorney General, "To Provide for the Conservation and Economic Use of the Water Resources of the District of Honolulu."

Mr. Warren's proposal included (as Section 3, page 274 of the January, 1929 report of the Commission):

"All water resources within the District of Honolulu, both above and below the surface of the ground, and whether in springs, streams or channels, or in artesian areas, strata or basins, and whether in mass or impressed into porous rock, gravel, sand or soil, are hereby declared to be public property, subject only to such rights to water as have become vested prior to the passing of this act; provided, that such vested rights shall be deemed to be confined only to the right to use such water for beneficial purposes and to be usufructuary only, not extending to an absolute property right in the water itself."

A considerably modified version of Mr. Warren's draft was enacted as Act 222, S. L. 1927 (the so-called "Artesian Well Statute"), amending and enlarging the scope of the 1917 and 1923 Acts relative to this subject.

The legislation, however, did give the Commission broad authority to make investigations and to present recommendations to succeeding legislatures. The Act was entitled:

"An Act to provide for an investigation and report by the Honolulu Sewer and Water Commission upon the water resources available for the District of Honolulu, with recommendations for legislation to provide for their proper conservation, development, use and control, and further providing for the immediate control and regulation of new or reopening of old artesian wells in the District of Honolulu."

The authority and responsibility of the Commission under the said Act is now held by the Board of Water Supply as Section 6806, R. L. 1925:

"It shall be the duty of the Board to survey, study and compile records, statistics and estimates relating to the amounts of water required for current and reasonably prospective uses in the districts, including public, domestic, industrial, agricultural and other practicable uses, and relating to water resources on island of Oahu which, in the judgment of the board, may, with reasonable regard to cost of development or acquisition and practicable utilization, be made available for such uses; and to devise and recommend to the legislature and the board of supervisors of the city and county from time to time prospective ways and means by which such water may be conserved and distributed for such uses, with estimates of costs in connection therewith. For any of such purposes, all records and information in the control or within the knowledge of any department or officer of the Territory or the city and county shall be at the disposal of the board. The board shall keep a record of its proceedings and decisions had or made under this subtitle."

The underlined portion of the above was added by Act 201, S. L. 1929, to broaden the Commission's (now the Board of Water Supply's) long-term planning.

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By Act 40 the 1927 Session amended Act 150, S. L. 1925, in certain financial details and also to make it clear that, in addition to planning and construction of water works facilities, the Honolulu Sewer and Water Commission had the authority to carry

out "such conservation measures, investigations and water development in the district of Honolulu as the Commission may deem necessary."

The Act increased the amount of bonds for the Commission's program to \$6,000,000.

December 31, 1928

(From report of Board of Commissioners of Agriculture and Forestry for period January 1, 1927 to December 31, 1928)

Mr. Judd reported the successful consummation of forest surrender agreements under which 16,704 acres of forest land on Oahu were surrendered to the Territory under cooperative forest maintenance plans. The surrenders included the John Ii Estate's Waipio forest area (until June 1, 1929), Zions Securities Corporation's forest lands at Laie and Kaipapau (until June 6, 1942), and the James Campbell Estate's Honouliuli and Kahuku forest lands (until December 31, 1956). This marked a tremendous expansion of the surrender program which theretofore had included only the Alexander and Baldwin Plantation forest lands on East Maui and two or three small areas elsewhere.

With respect to forest land acquisition by the Territory, Mr. Judd stated as follows (from page 20):

"In other parts of the Territory certain privately-owned forest lands within the recommended boundaries of proclaimed reservations are being managed, contrary to general practice, in such a way that the forest thereon is deteriorating on account of the presence of cattle. Although attempts have been made to induce the owners to stop the grazing on these lands, they have not met with success and the excuses usually given is shortage of grazing land. In some cases the Commissioner of Public Lands has been requested to purchase these lands so that this destruction may be stopped and, with this in view, he has had appraisals made of some of them but the proceedings have stopped here because of lack of available funds. In one case a piece of land in the ditch country of Maui should be acquired by the Territory so that it may be reforested rather than planted in pineapples."

"The only possible way, now apparently left open to acquire these lands and to place them under forest management, is to condemn them for this purpose and appropriation will naturally be necessary."

(No Honolulu lands are included in the list of lands recommended by Mr. Judd to be condemned by the Territory.)

January 22, 1929

Report of the Honolulu Sewer and Water Commission
for the period to December 31, 1928

The Commission in its transmittal of the report to the Legislature, summed up its principal findings as follows (from page 7):

"The supply phase of the water problem is still critical, with consequent necessity for conservation as the outstanding immediate requirement.

"The fundamental facts regarding water supply are:-

- (1) The artesian supply, though inadequate to meet all future needs, should always remain our major source.
- (2) Development of surface and flood waters within the District of Honolulu is our first supplemental source and the beginning of this development, including filtration of Nuuanu and Kalihi water, is an urgent need at this time.
- (3) Filtration of surface and flood waters from other valleys within the District of Honolulu will follow of necessity, in the event of this development.
- (4) Development of water from short tunnels back of the City should be given proper consideration.
- (5) Collection of water from outside areas is possible, including--

- (a) Artesian water from the Aiea area; (b) Koolau or windward Oahu tunnels; (c) Waiahole tunnels; and (d) especially the Pearl Harbor Springs.

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The Commission gave emphasis to, and concurred in, the following recommendations of the Chief Engineer (from pages 8, 9):

"(1) Authorize by legislation the consolidation under one body of any and all phases of the water problems, including investigations and development, conservation measures, construction, supply distribution, equipment and finances. Such a body, we believe, should be charged with definite responsibility for solving the Honolulu water problem and should be clothed by the Legislature with full authority to do so.

"(2) Authorize the sale of \$3,000,000 worth of bonds, the proceeds thereof, including premiums to be expended for the purpose of carrying out such conservation measures, investigations and water development as the Commission may deem necessary, and for the construction of as much of the basic sewer and water system outlined in the report of the Chief Engineer as the funds will permit.

"(3) That the problem of safeguarding the Honolulu water sheds be placed entirely within the control of the Board of Agriculture and Forestry, and that this body be commended for extending the forest reserves, as such extensions and reservations are an important factor in the solution of Honolulu's water supply."

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In the Chief Engineer's section of the report, the following recommendations were presented with respect to surface water:

"1. STORAGE RESERVOIRS.--The conservation of surface-water supplies within the Honolulu District by large impounding reservoirs is, at this time, and for generations to come, impractical and unecological.

(a) Nuuanu reservoir No. 4 leaks at a very undesirable rate and the geologic similarity of its site to other volcanic sites in the Honolulu region discloses a probable general unreliability (of whatever degree) of all reservoirs, together with at least a shade of danger to a heavily populated district below the dam.

(b) Losses of seepage and leakage in this reservoir are entirely beyond the bounds of reasonable comparison with paying reservoirs. Seventy-five per cent (75%) of the inflow to Nuuanu reservoir No. 4 has been wasted through these agencies.

(c) Up to a development of 12-M.G.D., a filtration plant of 30-M.G.D. capacity will augment the city's supply at the same initial cost and by the same amount as a safe, leak-proof storage reservoir and 12-M.G.D. filtration plant.

(d) Fourteen years of records indicate an average supply of only:

a. 1.83 million gallons per day at an elevation of 800 feet in Kalihi;

b. about 3.6 million gallons per day at elevation of 965 feet in Nuuanu.

Of the former (a.), about 0.40 M. G. D. is normal low-water flow, available without impounding, and the storage effected, including evaporation, therefore would be only 1.83--0.4=1.43 M.G.D. Of the latter (b.), about 0.6 M.G.D. is normal low-water flow, available without impounding, and 0.4 M.G.D. is evaporation that cannot be prevented. The storage effected, therefore, would be only 3.6--(0.6/0.4)=2.6 M.G.D. The total amount available would be 3.6--0.4=3.2 M.G.D., of which 1.7 could be utilized and 1.5 would augment (somewhat uncertainly) the artesian supply.

(e) NUUANU RESERVOIR NO. 4--This storage facility is contemplated in connection with the proposed development of surface water, and therefore the investigations of this dam, started a year ago, must be continued on a larger scale and provisions for repairing, draining, cleaning, etc. made to insure absolute safety to the City.

"2. TUNNELS, HONOLULU REGION--The benefits of high-level tunnel water are fully appreciated. The development of this water as an auxiliary to other supplies, thereby saving costs of pumping and boosting, is to be encouraged and is recommended on a small scale.

"Short tunnels, such as have been driven into Honolulu's background, are comparatively inexpensive as compared with long tunnels of an extensive nature. However, it is to be remembered that, even though comparatively inexpensive, this resource is in reality a tributary part of the artesian supply, and its development only subtracts from our artesian quantity, available at lower elevations.

"Moreover, hydrologic analyses indicate a total Honolulu-region yield of only 9 million gallons daily, available at the 300-foot elevation; 7 million gallons daily at the 700-foot elevation; and 5 million gallons daily, at the 1,000-foot elevation. These total yields may be doubled; they may be nil. Their collection would in all events necessitate a highly elaborate and perhaps expensive tunnel system.

"This supply, therefore, should be tapped only for small, local boosting relief. Should contamination of the artesian supply occur as a consequence of overdraft and resulting invasion by the sea, extensive tunneling to catch this fresh water, before it became mixed with dilute salt water, would become a most desirable development. But the effect of complete development now would be only to hasten contamination.

"3. UNUSED PEARL HARBOR SPRINGS FLOW.--This source, though promising, is based on observations which have lasted only one year, and a comparatively wet year, at that. More studies and more thorough analyses are necessary, before conclusions to warrant the adoption of a development program could be obtained. For this purpose adequate funds should be appropriated.

- "4. KOOLAU TUNNELS--OUTSIDE HONOLULU REGION.--It is believed that, with proper conservation and development of the Honolulu surface supplies, the development of water resources outside the City of Honolulu can be postponed a decade. Especially promising are the Kahaluu and Waihee Springs. However, more stream-gaging data will then be required, and it is recommended that adequate funds be appropriated to establish gaging stations at strategic points, to be determined as part of this study.
- "5. SHALLOW WELLS.--Shallow-underground resources have been encountered in various sewer tunnels and other excavations, but their yield has been too limited to obscure the issue of a major water supply.
- "6. CHECK DAMS.--'Check' dams for the catchment of surface flows at higher elevations would necessarily have to be many and expensive. The fruits of their existence would be lost, it is believed, by seepage and leakage due to the nature of the extrusive formation.

"Present available data indicate that the major part of the artesian water enters the catchment area below elevations of about 500 feet. Practical and economical dam and storage sites below this elevation are lacking.

- "7. INFILTRATION COLLECTION WELLS.--Infiltration wells to admit water into the artesian structure are, in my opinion, impractical. Their local nature, the large number necessary and the risk of filling up with silt during periods of heavy erosive rains, render their consideration more than doubtful."

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The Chief Engineer's list of proposed improvements included:

"Filtration Plant in Nuuanu Valley complete with tunnel to Kalihi Valley, diversion works in Kalihi and Nuuanu, etc.--\$800,000." (The report contains detailed proposals with respect to the said project.)

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The portion of the report entitled, "Honolulu Artesian Water Supply," by W. N. Chaffee, now Assistant Manager of Board of Water Supply, contains a statement outstanding in its truth with respect to the importance of conservation of our artesian supplies:

"The conservation of this most valuable asset should be the prime consideration of each and every citizen of the community."

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The thought-trend developed by the Commission's staff with reference to future water development is well shown by the following excerpt from the report (from pages 125-126):

"The necessity for going into the Koolau Range outside of the Honolulu region for additional water for the City is believed to be at least a decade in the future. The reasons for this belief are:

- (a) Metering will affect conservation and reduce the per capita consumption;
- (b) Investigation will disclose leaks in the present distribution system and the leakage losses will be reduced from the present thirty-nine per cent to probably twenty-five per cent;
- (c) Sealing of defective wells and government control will result in a more efficient use of the artesian water supply;
- (d) Complete use of present tunnel and spring water and probable drifting of other short and, therefore comparatively inexpensive tunnels will augment the present supply;
- (e) Artesian water from isopiestic area No. 4 (Moanalua) and the Aiea region may be brought in to add to the yields from the three developed isopiestic areas;
- (f) The proposed filtration plant will add about 5.5 million gallons per day to the present supply;
- (g) Manoa and Palolo Streams will probably be developed next in order after Kalihi and Nuuanu Streams; and
- (h) Further investigation of Pearl Harbor Springs may bring in a new major supply.

"In view of these considerations and the lack of specific data concerning the possible yields of these outlying areas, it is not now necessary to go into much detail in the analysis of these distant projects. It is sufficient to point out here briefly only what the possibilities are in this direction and that their development will fit in with the proposed plans.

"Since surface adit water must be contemplated to make any extensive major tunneling pay, and since this supply is, therefore, subject to all the turbidity of Oahu's flashy mountain streams, the water must be filtered.

"Since the storage of flood waters within the Honolulu region is impractical, the quantity of surface water caught in addition to strictly tunnel water is dependent on (1) tunnel and (2) filtration capacities.

"And, since, this is essentially a gravity supply, the elevations of the tunnels must be right with respect to the elevations of existing and proposed facilities, to enable the incorporation of each step into a Comprehensive Plan."

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There then follows a discussion of various alternate plans of utilizing waters of Waiahole Tunnel, Kahana and Punaluu Streams, Waihee and Kahaluu, Wahiawa Reservoir, and Kalihi and Nuuanu Streams, with a filtration plant in Nuuanu, (thus including the Jorgensen (1916) and Palmer (1921) suggestions).

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The report contains (pages 136-149) a study of the possible increased utilization of the streams of Honolulu District. The conclusion reached was that the project offering the best results would be a 10 m. g. d. filtration plant in Nuuanu Valley at 500 foot elevation.

January 10, 1929

Report by C. E. Grunsky for Hawaii Bureau of Governmental Research

A review of the Honolulu water problem in which Mr. Grunsky, nationally recognized consulting engineer, substantially endorsed the findings and the program of the Honolulu Sewer and Water Commission.

January 22, 1929

As a supplement to the Honolulu Sewer and Water Commission's report for the period ending December 31, 1928, the Commission published "Surface Water Supply of the Island of Oahu 1909-1928" which had been prepared by J. F. Kunesh, the Commission's hydraulic engineer.

The book is an invaluable reference. The following data from "Plate A" is of particular interest:

The average rainfall in million gallons per day was reported as follows:

| | |
|--|------|
| Makapuu Point to Wilhelmina Rise | 1.86 |
| Remainder of Honolulu District | 3.56 |
| Pearl Harbor Area, from Honolulu District to Wahiawa and extending to the Koolau Ridge | 4.30 |

The "probable amounts of water escaping as run-off and entering artesian supply" are given as follows for a "dry year":

| | |
|--|-----------|
| Makapuu Point to Wilhelmina Rise | 1 m.g.d. |
| Remainder of Honolulu District | 31 m.g.d. |
| Pearl Harbor Area | 81 m.g.d. |

For the "average year" the corresponding figures are, respectively, 8, 84, and 180, and for a "wet year," 16, 146, and 325.

The report presents characteristic curves showing the relation of discharge to duration and elevation for all principal streams and other water sources on Oahu.

January 28, 1929

Report of the Honolulu Sewer and Water Commission on the "Feasibility of a (Vehicular) Tunnel from Kalihi Valley through the Koolau Mountain Range" (Presented in accordance with Act 210, S.L. 1927)

This report was reviewed because of possible pertinence in water matters.

It is interesting to note that it was assumed that the estimated traffic over the Range in 1945 would be about 2530 vehicles daily. The report found the project not feasible and made the same finding with respect to alternate routes in Nuuanu and Manoa.

After reviewing water supply phases the report stated:

"It is believed that, because of the uncertainty of the water supply phase of the problem, no monetary value of water supply can be consistently used in determining the relative merits of the various vehicular tunnel projects. It may be stated, however, that there is a possibility of developing water in sufficient quantity to make its use worthy of diversion for use in augmenting Honolulu's water supply in either the Kalihi or Manoa project."

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(The actual traffic over the Pali had increased to approximately 4000 cars per day in 1940 and at the present time, 1948, the traffic is approximately 6000 cars per day; thus, in any review of the report's findings with respect to economic justification, the financial computations should be viewed accordingly.)

January 31, 1929

The members of the "Second Convention on the Forestry Problem of Oahu" reported (in "The Hawaiian Forester and Agriculturist") that the forestry activities of all interests should be coordinated through annual conferences and that a "Forestry Association of Oahu" should meet yearly and have an executive committee to meet between the annual sessions.

The members urged that "further geologic study bearing on water conservation is needed" and that "experiments should be undertaken in diverting surface water into porous strata and in increasing the percolation of water in stream beds by check dams."

The report was signed by representatives of the Bishop Estate, Bishop Museum, Honolulu Sewer and Water Commission, Hawaiian Pineapple Cannery, Territory, H.S.P.A. and Army, all of whom indicated approval of a "Ten-year Program" described in an appended memorandum. The individuals who signed the report were Messrs. A. F. Judd, H. E. Gregory, G. S. McKenzie, A. L. Dean, George Ii Brown, C. S. Judd, H. P. Agee, H.L. Lyon and Major J. Kemp.

The following excerpts are taken from the memorandum
(pages 4 and 5):

"The project pertains to those watershed areas which are included within the boundaries of the forest reserves denoted by the Board of Agriculture and Forestry and officially proclaimed according to law by the Governor of the Territory.

"As to whether these areas may in the future be extended to advantage will, it is thought, depend upon:

1. The future water requirements of the island of Oahu.
2. Geological studies to determine with reasonable accuracy the relation of rainfall on areas not in the reserves to the artesian supply of Oahu.
3. The relative value of such lands for forestry or other purposes, considering the interests of the community as a whole.

"No doubt many interests will plant to trees waste areas not within the reserve boundaries. Such work should be encouraged in every reasonable way, but is not included as a part of the broad cooperative endeavor that is now proposed."

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(from page 6):

"It is hoped that the University will take part in educational work on forestry and water conservation, placing before the public, through their extension department, and before their student body as a whole through occasional lectures, information on the vital nature of the issue as it pertains to the Island of Oahu. We defer to the judgment of University authorities on the matter of courses in forestry, either complete ones, or short, cooperative ones, by which students may cooperate in active forestry endeavors on a part-work part-study basis.

"It appears desirable for the schools to do what they can to place the importance of forestry work before the children."

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(from pages 7 and 8):

"Reforestation work in relation to water conservation on Oahu contemplates retarding the run-off and thereby increasing the seepage into soil made looser and more porous by the forest growth. This cares for

the work on the slopes and hillsides. The problem of increasing the seepage of water into the artesian basin after it has reached the stream beds or by diverting it to porous strata is a subject of great importance that needs careful consideration and experimental work."

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The following excerpts are taken from the exhibits which were presented to the 1929 Conference with the memorandum (from Exhibit "A-1" by Territorial Forester, C. S. Judd; page 9):

"We are dependent entirely on the rainfall for our water supplies. We have no power to increase this rainfall, but it is within our power to increase percolation so that the water, instead of running off at once to the sea, will be held back and made available during the dry season in streams and springs and in the artesian basins.

"A continuous and adequate supply of water on Oahu depends not so much upon a heavy annual rainfall as it does upon the way in which this rainfall is held and conserved so as to be made available for use during the intervening dry intervals.

"For a continuous supply of water, we must depend upon the slow surface run-off from our watersheds and upon the replenishment in the artesian basins of water which finds its way into these basins by percolation.

"The amount of water available for use in the dry periods, therefore, will depend upon the efficiency of the cover on our watersheds to hold back and delay the excessive run-off in such a manner that it will find its way into the springs and streams and into the artesian basins. In our manner of using water on Oahu it is more important that water be delivered into the artesian basins from which a vast amount is pumped daily."

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"The ideal to be sought, in order to present the largest possible and most efficient percolation areas, is to extend a fitting water-conserving forest to every available acre on the island in the mountainous region that is not in cultivation."

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The memorandum referred to in the convention's report includes as Exhibit "L" the following contribution by Dr. Herbert E. Gregory of the Bishop Museum (from pages 44-45):

- "1. It is desirable to determine with a reasonable degree of accuracy what areas contribute water to the Oahu artesian basins and the proportionate amount contributed by each area. At present it is known that the zone lying less than about 50 feet above sea level contributes nothing; that the zone above 200 feet contributes amounts varying with topography, soil, and plant cover; that the zone between 50 and 200 feet may or may not be contributing significant amounts. To obtain the desired information involves detailed geologic investigations, for it is not improbable that in the basalts of Hawaii as in those of Oregon, Arizona, Abyssinia, and India areas acres in extent permit percolation exceeding that of adjoining square miles.
- "2. The efficiency of appropriate trees, shrubs, and grass in checking runoff and increasing percolation is obvious, but it seems doubtful that forestation alone can produce the desired results. On steep, soil-covered slopes, even within the forested area, some engineering works may be helpful, and outside forested areas they may be found necessary. The experiments in Europe might be profitably studied.
- "3. For areas from which the soil has been stripped, it is probable that the building of check dams should precede attempts at forestation. In this connection a study of the highly successful practice in Japan and Korea is recommended.
- "4. As an educational project, it seems desirable to stress the seriousness of soil loss. As soil once stripped from the underlying ledge can be replaced only by centuries of weathering of new rock, the healing of scars and the prevention of further soil removal might well be considered an emergency to be met at whatever cost."

March 25, 1929

An important milestone in conservation history (although in the wrong direction) was the decision of the Supreme Court in the case of City Mill Company, Ltd., v. Honolulu Sewer and Water Commission in which the Company challenged the authority of the Commission to prevent them from boring an artesian well.

The opinion is summarized:

"In our opinion section 5 of Act 222, S. L. 1927, in so far as it seeks to authorize the Honolulu sewer and water commission to wholly deprive any co-owner of the waters of the basin under consideration, without due compensation, of his right to share in the artesian waters of that basin, violates the provisions of the Constitution and is invalid."

(The Court established a theory of "correlative rights," which, to the present time (1948), has not been clarified to a point of administrative practicability or understanding.)

May 1, 1929

By Act 201, the "Artesian Well Law" (Act 222 S. L. 1927), was amended in the following respects:

The long-term planning authority of the Honolulu Sewer and Water Commission was broadened to include all water resources of Oahu of any practicable future use to Honolulu.

As a result of the City Mill Co. decision of the Territorial Supreme Court on March 25, 1929, the following was eliminated from Section 5 of Act 222 with respect to permits for new wells:

"If, in the opinion of the Commission, the proposed work would threaten the safety of the water of the artesian area or basin which would be drawn upon by such well, by lowering its level or increasing the salt content of any existing well or wells, the application therefor may be denied."

Also, as a result of the City Mill Co. case, subsection 3 of Section 8 of Act 222, S. L. 1927, was amended from its original wording:

"3. To prescribe and regulate the manner in which new artesian wells in said District may be bored, drilled or driven, encased, capped, or unused wells reopened, controlled and operated, including methods and materials of construction and means of control; and to install or require the installation of measuring devices of water from any such well, and provide for the maintenance and protection of such devices;"

to read as follows:

"3. To prescribe and enforce such rules and regulations as may in its judgment be necessary or advisable in connection with any matters within the scope of its duties or powers, including (a) the prevention of waste and pollution of water, (b) the manner in which new artesian wells in said District may be bored, drilled or driven, encased and capped, (c) the manner in which artesian wells generally shall be maintained, controlled and operated to prevent waste of water from any artesian basin or area or the impairment of its potability, (d) the limitation to beneficial uses of all water, (e) in times of shortage or threatened shortage of water, or of danger to potability of the water of any artesian basin or area by overdraft on said basin, the restriction of the drawing of water in all wells supplied from said basin on a basis proportionate to the proper and beneficial uses served by them respectively, (f) and other matters having for their object the proper conservation and beneficial use of the water resources available for said District."

The above is incorporated unchanged in R. L. 1945 as subsection 3 of Section 6872 (with respect to powers of the Board of Water Supply).

1929

By Act 96, S. L. 1929, the Legislature created the Board of Water Supply to take over the combined activities of the City and County's Honolulu Water Works (the operating agency) and the Honolulu Sewer and Water Commission (the planning and construction agency) as of July 1, 1929.

The Act was challenged by the Board of Supervisors and, as a result of the litigation (which was decided in favor of the Board of Water Supply on January 14, 1930), the Board of Water Supply did not assume control until February 1, 1930.

The Governor's appointments to the Board were:

G. S. McKenzie, Chairman
(Mr. McKenzie had been chairman of the
Honolulu Sewer and Water Commission)

C. C. Crozier (who had also been a member of the
Commission)

A. G. Budge

E. W. Greene

H. E. Gregory

L. M. Whitehouse, ex-officio

L. H. Bigelow, ex-officio

Mr. Frederick Ohrt (who had been Chief Engineer of the Commission) was appointed Manager and Chief Engineer of the Board.

December 31, 1930

Report of Board of Commissioners of Agriculture and Forestry for period January 1, 1929 to December 31, 1930

During this period the South Halawa forest lands of the Queen Emma Estate were added to the list of areas surrendered to the Territory. (Although the surrender agreements were for various terms, depending on the policies of the respective owners and estate trustees, all important agreements have been extended more or less automatically for additional terms as their stated terms expire.)

February 12, 1931

Report of the Board of Water Supply for 1930.

Highlights of the Board's report were as follows

(from page 4):

"The artesian system of the District of Honolulu must continue to be the major source of water supply in the future as it has been in the past. All of the evidence which has been obtained from studies of hydrologic conditions in the Honolulu artesian area indicates that the maximum draft which it could support would not exceed 42 million gallons a day in a year of average rainfall.

"A margin of safety must be preserved between the actual daily draft and the maximum limit of draft as computed for the District, in order to allow for conditions during recurrent years of less than normal rainfall and for variations between the several

sections of the artesian area. The artesian system is one of the most important assets, if not the most important of the City of Honolulu and its availability as a source of supply must be kept unimpaired. Investigation and all reasonable means of effecting conservation must be continued to accomplish this aim.

"It is estimated that the total draft from the artesian area underlying the district of Honolulu is now approximately 32 million gallons per day of which 19 million gallons per day is drawn by pumping for the public city water supply and 13 million gallons per day is taken through privately owned and operated wells."

The Board recommended to the Legislature that a \$1,200,000 bond issue be authorized for the "immediate installation of a filtration plant in Nuuanu, a tunnel from Nuuanu to Kalihi, reconstruction of Nuuanu Reservoir No. 4, and other items, including a water system for Pacific Heights.

April 29, 1931

By Act 185 the 1931 Legislature authorized the issuance of up to \$700,000 in bonds to finance projects as follows:

Reconstruction of Reservoir No. 4 Nuuanu

Water System for Pacific Heights

Filtration Plant in Nuuanu (5 m.g.d. capacity)

(See amendments of May 15, 1935 and April 22, 1939)

August 13, 1931

"Preliminary Report on the Pearl Harbor Springs"
by Harold T. Stearns

Excerpts of special interest:

(from page 2):

"As frequent requests concerning the geology of this area and the origin of these springs have been received from the members of the Board of Water Supply of Honolulu and other interested persons it has been thought advisable to release this preliminary report in advance of the general report now being prepared on the geology and ground water of the entire island of Oahu. Since in this general report the fundamental principles involved in the present

report will be developed as fully as possible with the data available, such development, with its supporting data, for the sake of brevity has been omitted, and statements have been made more or less categorically, which will be dealt with at greater length in the later report."

(from page 7):

"The block diagram in the Plate 2 was drawn to illustrate the relation of the Pearl Harbor springs to the geologic structure. These springs discharge at the low points in the upper boundary of the caprock, hence they represent overflow of the artesian basin. Palmer¹ anticipated that this was the case from his study of the Honolulu area. The spring vents are usually slightly lower than the static level of the artesian wells in the same vicinity because of a local loss of head at the discharge points."

¹/Palmer, H. S. The Geology of the Honolulu artesian system: Honolulu Sewer and Water Comm. Rept., supplement, p. 43, 1927.

(A copy of Plate 2, above referred to, is included in Part II-C hereof.)

(from page 14):

"The water discharged by the Pearl Harbor springs can be recovered by shafts sunk to sea level on the slopes above the springs and by tunnels tributary to the bottoms of these shafts or by tunnels driven at the springs. The shaft type of development might yield water with lower salt content than that which would be obtained from tunnels at the springs. However, if most of the salt in the spring water is derived from return irrigation water, shafts inland from the springs might yield no better water than tunnels at the springs. The shaft type of development would probably be the more expensive. Furthermore, the flow of the springs, and therefore the waste of fresh water, would not be entirely stopped by the shaft method until the water table were considerably lowered and the lifts of existing pumping plants correspondingly increased.

"The Pearl Harbor springs discharge a few feet above sea level. It will therefore be feasible to start the tunnel sufficiently above sea level so that the tunnel debris will not have to be hoisted and so that the water developed will drain out by gravity.

"If the water is to be delivered to Honolulu a single development at Kalauao Spring, the one nearest Honolulu, would require the shortest pipe line and the least pumping equipment. Kalauao Spring is situated

midway between the Navy and Aiea pumps and the large pumps of the Honolulu Plantation Co. in Waimalu Gulch. A development at Kalauao in excess of the flow of the spring would affect these pumps."

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Dr. Stearns' published report on the Pearl Harbor Springs is included in the Division of Hydrography's Bulletin No. 1 of 1935, wherein the following summation is presented (from page 370):

"Unless diverted, these springs insure the plantations in area 6 a perpetual water supply. However, in any comprehensive development of the water resources of Oahu this great quantity of water wasting into Pearl Harbor should be conserved. The water can be used in area 6 either by diverting the flow of the springs directly by means of collection ditches, or by replacing the artesian pumping plants on the plantations by wells of the Maui type dug as far inland as possible, so that the static level of the basal water in area 6 can be lowered safely. By the use of Maui wells, as the static level was lowered there would be a progressive decrease in the discharge, both visible and submarine, of the Pearl Harbor Springs. If the discharge of the submarine springs is now large, this method would result in a substantially larger net yield from the area than could possibly be recovered by diverting the springs directly."

September 15, 1931

With respect to the proposed lowering of the established forest line on the Manoa-Palolo ridge, C. S. Judd, Territorial Forester, wrote as follows to the Trustees of the B. P. Bishop Estate:

"Acting on the suggestion of Forester G. R. Ewart, III, I have had a portion of the B. P. Bishop Estate land of Kalaepohaku on the ridge between Palolo and Manoa Valleys included in a proposed addition to the Honolulu Watershed Forest Reserve.

"A blueprint map of this proposed addition showing the portion of the B. P. Bishop Estate land of Kalaepohaku to be included is enclosed herewith for acceptance by you.

"With your consent I will have this addition presented at the next forest reserve hearing to be held probably in December of this year so that the land may be set aside for forestry purposes by proclamation of the Governor, the title of Kalaepohaku to remain in the Bishop Estate."

1932

By Act 41 of the 2nd Special Session, there was added to the forest land exemption law as enacted in 1892 the following:

"Provided, however, that the exemption herein provided shall apply only to such lands as the board of commissioners of agriculture and forestry shall certify to be necessary for the official forest policy of the Territory, and that non-user thereof by the owners seeking exemption is calculated to result in benefit to the public by checking erosion, moderating the force of freshets, regulating the flow of streams and/or assisting in the recharge of the artesian basins."

The above remains in the statutes as part of Section 5152, R. L. 1945. The reference to "the recharge of the artesian basins" is of particular interest as an indication of increased general understanding of the nature of our water sources.

March 1, 1932

Letter by C. S. Judd to Board of Commissioners of Agriculture and Forestry (from "The Hawaiian Forester and Agriculturist - April-June, 1932")

Recommended two additions to the Honolulu Watershed Forest Reserves:

A 77-acre portion of the land of Kolowalu in Manoa, owned by Punahou School.

A 488.7-acre tract on the ridge between Palolo and Manoa and extending from the forest line as established in 1926 to the St. Louis Heights tract which (area) "is believed . . . (to be) . . . an important factor in contributing water to the underground artesian basins not only because of its juxtaposition, but also because of the fact that the soil on the area is much more porous than the puddled soils in the two adjacent valleys. It is, therefore, very desirable to increase by a vegetative cover the porosity of the soil so as to facilitate the percolation of surface waters into the artesian basins. The Trustees of the Bishop Estate, who own the land of Kalaepohaku, of which 180.201 acres are included in this addition, are cognizant of this fact and have voluntarily asked that their land be added to the forest reserve."

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(Note: In the 1944 reconsideration of forest reserve lines, the Bishop Estate and the Board of Agriculture and Forestry agreed that 83.62 acres of the 180.20 acres referred to above be excluded from the Reserve.)

April 13, 1932

Proclamation by the Governor, adding to the Honolulu Watershed Forest Reserve, the parcels recommended in C. S. Judd's letter of March 1, 1932.

February 15, 1933

Report of the Board of Water Supply for the years
1931 and 1932

The report of the Board to the Legislature noted that \$350,000 was appropriated by the 1931 Legislature for a filter plant in Nuuanu. "No effort has been made to float the bonds then authorized and none will be made, until there is substantial evidence, in the judgment of the Board, that there is need for the plant." (Note: This indicates an important change in opinion resulting from study of the adequacy of the artesian supplies.)

A summation of the general situation of the time was given as follows in the report of Mr. Frederick Ohrt, Manager and Chief Engineer (from pages 91-92):

"For the last six years, in and out of season, I have been preaching to Honolulu the urgent need of an aggressive policy of water conservation. Unless such a policy was undertaken immediately, I said (biennial report of the Honolulu Sewer and Water Commission, 1927),

'the situation will become critical between 1931 and 1935. It is not too late to solve this problem, but any delay, or discontinuance of effort, or modification of an aggressive policy, may result in a condition that never can be properly solved The problem is to provide the City of Honolulu with a permanent and adequate supply of water, without immediately

going outside the District of Honolulu and thereby depriving the agricultural and industrial enterprises of water necessary for irrigation and manufacture.'

"Two years later, in the 1929 report of the same commission, I repeated the same thoughts:

'By far the most important problem facing Honolulu is the water problem; and particularly that phase of it including supply. Unless an aggressive policy of conservation is clearly enunciated, insisted upon and carried out, there is no good reason why the situation, despite what has already been accomplished, may not nevertheless become critical between 1931 and 1935.

'By critical, I mean that first indications of salinity at any of our pumping stations--that is to say, the encroachment of salt water upon our underground supply of drinking water--may appear within the period noted, and even probably will appear. The immediate consequence would be to precipitate an expenditure of possibly four or five million dollars, long before the time when recourse to an augmented supply would normally become necessary in order to keep pace with the increase of population.'

"That problem I now feel, for the first time, has been solved, as far as any problem can be called solved in the life history of a growing waterworks of a modern city, for which stagnation spells death. This report tells elsewhere in detail of economies in the daily consumption of water and resultant rise in the artesian head throughout the Honolulu area. The actual progress made can be seen and measured.

"No longer do we feel quite so much like the tight-rope walker, to whom I have been fond of comparing the waterworks--proud and happy to be where he was, but not too sure how long he could stay there. In other words, I feel, for the first time, that we have established something better than the delicate balance between artesian supply and pumping draft that has obtained heretofore.

"At the same time, I realize that a prolonged period of drought--such as Honolulu has known in the past and will know again--would quickly cut down our painfully built up reserves and dissipate our self-satisfaction."

1933

In the 1933 legislative session there was introduced as S. B. 199 a proposal to repeal the law providing for the exemption of certain forest lands from real property taxes on an annual basis.

The Committee on Ways and Means, in recommending passage of the bill, stated that:

"this section could easily be made the subject of abuses, and that it is preferable for the government to rely merely upon the provisions of Section 593 of the said Revised Laws whereby tax exemption may be secured on land surrendered to the exclusive care, custody and control of the government for a specified time."

The bill came up for third reading in the usual procedure and failed of passage by a 6 to 8 vote, with Senator Francis Brown excused and not voting.

On the next day Senator C. A. Rice moved that the Senate again consider the bill, and the bill then passed unanimously with Senator Brown excused and not voting.

In the House the bill was referred to the Committee on Finance and that committee reported the bill favorably in substantially the same language as that used in the report of the Senate Committee.

The committee report was adopted and the bill placed on the order of the day for the following day, April 28. From that time the bill encountered unusual difficulty. On April 28 the third reading was deferred until May 1, but it did not appear on the calendar until May 16. On each of the 16th, 17th, and 18th the matter was deferred, by appropriate action, "until tomorrow." On the 19th it was deferred until the 22nd, from the 22nd, to the 23rd, and on May 23, Representative Lee's motion that the bill be tabled was carried by a vote of 18 to 8.

February 20, 1935

Report of the Board of Water Supply for the years
1933 and 1934

The fact that the year 1933 proved to be one of the five driest years of record since 1890 inspired increased investigations. For 1936 the rainfall was almost exactly the average. The general situation was summed up by the Board as follows:

(from pages 7-8):

"The most important problem facing this board is that of additional water supply, and as prudence indicates the necessity of seeking at a very early date an augmented supply, a program of research has been initiated.

"The Manager and Chief Engineer in his report states that during the coming biennium intensive studies are to be continued of the possibilities of adding to Honolulu's water supply from the following sources:

- (1) Nuuanu and Kalihi Valley surface and underground development including filtration;
- (2) The three central artesian areas--Kaimuki, Beretania, and Kalihi;
- (3) Moanalua artesian area;
- (4) Waialae artesian area;
- (5) High-level tunnel developments in Makiki, Manoa and Palolo Valleys;
- (6) Low-level underground development.

"In the opinion of the Manager, the next addition to Honolulu's water supply will be from one or more, ultimately all, of the above-named sources, and that at some future date the surplus waters of Pearl Harbor Springs or the high-level waters of the Kalihi-Waiahole area may need to be developed and utilized.

"The members of the Board of Water Supply are at this time in accord with this program and believe that when all of the engineering facts regarding each of these sources are at hand it will be possible definitely to outline the order of development.

"The Manager and Chief Engineer has also recommended, as a measure of insurance and preparedness against any possible emergency, the amendment of Act 185,

S. L. 1931, in such a way as to permit the construction of a 10-M.G.D. filtration plant in Nuuanu Valley, together with the tunnel to Kalihi Valley. This would require an addition of \$450,000 to the present bond authorization of \$350,000.

"Regarding this recommendation, the board hopes that the results of complete studies of the various sources of supply will be in hand and may even lead to the development of sufficient water from underground sources before any emergency arises that might necessitate the construction of a filtration plant. However, in order to be prepared for just such an emergency, should it arise, the board recommends that the Legislature amend Act 185, S. L. 1931, by removing the restriction limiting construction to a 5-M.G.D. filtration plant for \$350,000 to permit at least the construction of a 10-M.G.D. filtration plant for not more than \$500,000, but eliminating at this time the \$300,000 request for an appropriation for the tunnel from Nuuanu to Kalihi."

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In Mr. Ohrt's portion of the report it is noted that, in order to carry out the geologic research necessary in the continuing study of future additions to Honolulu's water supply, Dr. Chester K. Wentworth, Associate Professor of Geology, Washington University, had been added to the Board's staff. (At the instigation of Dr. H. E. Gregory, member of the Board, Dr. Wentworth^{had} made certain geologic studies for the Bishop Musuem.)

May, 1935

The first reasonably complete geology of Oahu and compendium of all known geological reports and facts available at the time was published under the title "Geology and Ground-Water Resources of the Island of Oahu, Hawaii" by the Division of Hydrography, Territory of Hawaii, in cooperation with the U.S.G.S. The publication, of which H. T. Stearns and K. N. Vaksvik of the U.S.G.S. were the authors, was published as "Bulletin 1."

Familiarity with the contents of this book is a "must" for all "water engineers" in the Territory.

The scope of the book is such that no short summary would suffice. The following excerpts, however, are taken from the "Abstract" presented by Messrs. Stearns and Vaksvik on pages 1 and 2 of the book:

"Owing to the danger of the wells becoming brackish with increased draft, it is believed that further large developments will be more successful if shafts are sunk to sea level in the basalt as far inland as practicable, and tunnels are driven from the bottom of the shafts near the top of the saturated zone. Favorable places for such development exist in Honolulu."

With reference to the possibility of the development of high-level water mauka of Honolulu, the "Abstract" contains the following statement:

"An extensive tunnel system is proposed to develop a large supply of high-level water for Honolulu from the dike complex of the Koolau series, and high-level water can be recovered by tunnels at many other places."

In the volume Dr. Stearns presented the first known published description of the local method of developing basal water by means of a dug shaft with gathering or "skimming" tunnels near sea-level, which method had actually been first utilized at Kihai, Maui, in or about 1900; at Kaunakakai, Molokai; at McBryde Sugar Co., Kauai, shortly thereafter; and, on a large and highly successful scale by Pioneer Mill Co., Ltd., of West Maui; and by plantations of Central Maui from 1923. The Maui installations were made under the responsibility of J. H. Foss and Robert Hughes of the Alexander and Baldwin plantations and Clarence Brown of Pioneer Mill Co., Ltd., and they reflect advice given by O. E. Meinzer, chief of the Division of Ground Water of the U.S.G.S.; W. O. Clark, Geologist of the U.S.G.S. (and subsequently of the H.S.P.A.); H. S. Palmer; and (from the time of his arrival in 1930), H. T. Stearns.

The following excerpt from "Bulletin No. 1" is sufficient for the purpose of this (1948) report (from pages 324-325):

"During the last decade more and more wells in the Honolulu area have been plugged because of defective casings or abandoned because of salt. By abandoning virtually all the rest of the wells and sinking wells of the Maui type into Koolau basalt at the ends of the spurs adjacent to Honolulu it would be possible to increase the safe yield of basin without appreciably increasing the pumping lift.

"The Maui type of well consists of either a vertical or an inclined shaft, driven a few feet below the water table, with one or more horizontal tunnels driven from the bottom of the shaft to skim fresh water from the upper part of the zone of saturation. Although it is not essential for the shaft to be in water-bearing rock, the tunnels are always driven into permeable basalt, the location of which is often predetermined by test holes. The most effective direction to drive these tunnels is generally at right angles to the strike and inland across the dip of the lavas. Where the zone of fresh water is thick, as it is under most of Oahu, tunnels may be unnecessary. The pumping machinery is placed in a chamber at the bottom of the shaft, and the shaft is locally deepened to provide a sump for the suction pipes. The well is usually dug at the altitude from which the water is to be distributed, thereby saving pipe line. The shaft is either lined or unlined according to the character of the materials encountered, but the tunnels are not lined. A well of the Maui type encounters a much greater amount of pervious rock than a drilled well, but the essential difference is that the Maui well skims the fresh water from the top of the zone of saturation, whereas the drilled well passes through many feet of non-water-bearing rock and then must penetrate deep into the zone of saturation in order to have effective yield. The drilled well therefore derives its supply from the lower part of the zone of fresh water rather than from the upper part."

May 14, 1935

Act 174, "The Revenue Bond Act of 1935" was signed by the governor.

This law (now Sections 6081-6095 R. L. 1945) gave to certain political subdivisions, including the Board of Water Supply, the right to issue "revenue bonds," thus adding greatly to financial flexibility.

The original act was effective for a term to expire June 30, 1937, but each regular session of the Legislature has extended the law for two years. The presently effective extension is to June 30, 1949.

May 15, 1935

By Act 179, Act 185, S.L. 1931 was amended to increase from \$700,000 to \$850,000 the amount of the bond issue authorized to finance the reconstruction of Reservoir No. 4 in Nuuanu, the construction of Pacific Heights Water System, and a filtration plant in Nuuanu.

The authorized capacity of the filtration plant was increased to 10 m.g.d.

It was stipulated that the bonds to finance the filtration plant (\$500,000) be issued only "in the event of an emergency declared by the governor."

(See amendment of April 22, 1939, eliminating the Filtration Plant.)

December, 1935

"Annotated Bibliography and Index of Geology and Water Supply of the Island of Oahu, Hawaii" by Norah D. Stearns, published by the Division of Hydrography, Territory of Hawaii, in cooperation with the U.S.G.S. and the Board of Water Supply as "Bulletin No. 3."

This bibliography and index comments on 436 articles, books, and other publications, thus indicating forcefully the extent to which the unique problems incidental to the subject matter have attracted the attention of men of scientific training.

"Bulletin No. 3" shows convincingly the very great importance of the subject of Oahu's water supply and the extent to which it has challenged the professional interest of engineers, geologists, and other scientists of our country.

Obviously, only a few of the 436 contributions are referred to in this (1948) report.

January 28, 1937

Report of the Board of Water Supply for the years
1935 and 1936

The outstanding development of the two years was the two underground water development projects of the "skimming tunnel" type started at Kalihi and Waialae in 1936 to take fresh water from the top of the artesian lens at approximately sea level, instead of taking it from near the bottom of the lens by deep wells as in the past at the principal pumping stations.

Other important portions of the Board's report are quoted below (from page 8):

"RECOMMENDATIONS FOR THE FUTURE

"Under the provisions of Act 185, S. L. 1931, \$350,000 of bonds was authorized for the construction of a five-million-gallon-filtration plant in Nuuanu Valley. This act was amended by Act 179, S. L. 1935, increasing the authorized bond issue to \$500,000 for the construction of a ten-million-gallon-filtration plant, with a proviso that the bonds only be issued in the event of an emergency declared by the Governor of the Territory of Hawaii.

"We hope that, as a result of the construction of the two underground water developments referred to in the Manager's report, we will be able to postpone for some time the need for this expenditure; however, as pointed out by the Manager, there is absolute need for additions and extensions to the distribution system, and, for the purpose of meeting this situation, we recommend that Act 174, S. L. 1935, known as the "Revenue Bond Act of 1935" be amended in such a manner as to permit of the sale of \$300,000 of revenue bonds per year for a period of at least two years beyond June 30, 1937."

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The following excerpts are quoted from the report of the Manager and Chief Engineer (from pages 12 and 13):

"The Forest Reserve of the Honolulu Watershed comprises 24 square miles of the higher parts of the Koolau Range, extending from Kahauiki to Waialae-nui. It was established by acts of the Legislature in 1913, to be administered by the Board of Agriculture and Forestry. They were instructed 'to devise ways and

means of protecting, extending, increasing and utilizing the forests and forest reserves more particularly for protecting and developing the springs, streams and sources of water supply, so as to increase and make such water supply available for use.' Certain sections of the Forest Reserves have been designated and set aside as Water Reserves, under the jurisdiction of the Board of Agriculture and Forestry, by Rules III and V, adopted March 31, 1916, and May 13, 1922, and revised February 29, 1932. Many violations of these rules by trespassing and depredation occur within these Water Reserves despite prominent signs posted on the main trails. Constant patrolling by two forest rangers of the Board of Agriculture and Forestry has resulted in apprehending many violators, but it is impossible for them to guard all of the Water Reserves at all times.

"In the present law governing the Forest Reserve, provision is made for the transfer of control and custody of private land holdings to the Board of Agriculture and Forestry for one or more years or indefinitely, in return for which the lands are exempt from taxes. Such lands are administered by the Forest Department as forest reservations. Because of the uncertain tenure in some such transfers, it is believed that it has been impracticable for the Forest Department to formulate and carry out a long term program for the conservation and improvement of forests and water supply on such lands. Moreover, the provision in the law^a protecting vested rights in water, raises serious doubts as to the ultimate effectiveness in increasing the public water supply by the conservation measures carried out under existing conditions. The ultimate aim of conservation carried out under government auspices, especially insofar as the City of Honolulu is concerned, should be the safeguarding of general public interest and it is believed that intensive conservation measures cannot wisely be applied where doubt exists as to the ultimate division of benefits. These considerations suggest that the Government or the Board of Water Supply should acquire in the near future additional areas within the district of Honolulu as Forest and Water Reserves."

^aRevised Laws of Hawaii, 1935, Section 181

1938

Manuscript report, "Geology and Ground Water Resources of the Palolo-Waiialae District," by the Geologic Division, Board of Water Supply

(from page 274):

"Recommended Activities and Projects

"Subject to local need, and various conditions outside, as well as inside, this area, the following are recommended:

(1) General and low level water supply

- (a) Investigation - Continue measurements of water table elevations in drill holes, develop and carry out program of mechanical testing of relationship between Kaimuki Pump Station and Waiialae shaft by general methods of Hoyt and Kunesh, and complete computation of results.
- (b) Development - Increase length of tunnel at Waiialae shaft at an elevation of about 2 or 3 feet below water table and fill lower part of sump with concrete.
- (c) Development and investigation - Construct Waiamao basal water recharging tunnel and other works, and carry on detailed measurement of results in available drill holes and other measuring points.

(2) High level and inland water supply

- (a) Development - Extend present Palolo tunnel to develop water to limit of capacity of present pipe line.
- (b) Investigation - Diamond drilling in Waialaenui Valley between 800 and 100 feet to determine ground water conditions and possible supplies in that area."

December 31, 1938

Report of Board of Commissioners of Agriculture and Forestry for the period January 1, 1937, to December 31, 1938

With respect to acquisition of private lands the Commissioners stated as follows (from page 8):

"Attention has been given lately to land classification and plans are being laid for acquiring title to private lands in reserves which are sorely needed for water development and improvement of watershed areas."

The following excerpt is from Mr. Judd's portion of the report (from page 47):

"Much interest has been taken lately in land classification by the recent activities of the Territorial Land Planning Commission and the value of our watershed areas, within and adjacent to the forest reserves, and the managing of them for water production purposes has been emphasized. The opinion has been widely expressed that the Territory should own all lands in forest reserves. This is correct because they are in fact communal forests. Thirty-four per cent of such lands or 357,428 acres, however, are still in private ownership.

"A recent instance of the necessity of government ownership exists in Kalihi Valley where it is quite essential that the Territory acquire 379.28 acres of privately owned lands, before the price goes higher, in order to comply with future city water supply development, the prevention of present waste by cattle grazing and erosion, and to extend water conservation principles on the lands still in private ownership. The office of Public Lands has recently been requested to acquire these lands and it is hoped that ways and means may be determined upon by the present Legislature to purchase them. The Meyer lands on Molokai are in the same category and it is most essential that they be acquired as soon as possible because they bear the important forests which conserve the present water of Hooluhua homesteads."

January 3, 1939

Report of the Board of Water Supply for the years
1937 and 1938

The recommendations made by the Board to the Legislature and the Board of Supervisors included the following (pages 3 and 4):

- "1. That the Territorial Board of Agriculture and Forestry be enabled to carry out its program for the extension of the Honolulu Watershed and the acquisition of privately owned areas therein, and that control of said Watershed remain under the able administration of said Board;
- "2. That Act 185, S. L. 1931, as amended by Act 179, S. L. 1935, authorizing the issuance of \$500,000 bonds for the construction of a 10-million gallon filtration plant in the event of the declaration of an emergency by the Governor of the Territory of Hawaii, be repealed inasmuch as it places an unnecessary limitation on the bond limit of the City and County of Honolulu and there is no immediate necessity for the issuance of the bonds provided for therein;"

Mr. Ohrt's portion of the report presented the following general summation (from pages 7 and 8):

"Our work is still in its infancy and will never be completed until we can say with firm conviction that we have, safe from salt encroachment, an available water supply that is not only sufficient for our present population but is ample for all the population Honolulu may expect in the future, and that we have pumping and distribution and storage facilities that will adequately provide for our domestic and industrial needs as well as fire protection at reasonable costs.

"Our problem remains just what it was back in 1925 when our late Mayor, George Frederick Wright, then President of the Hawaiian Engineering Association, foresaw the danger that threatened the community's most important resource, laid the matter before Honolulu's business men who, instantly grasping the significance of the situation, conferred with Legislators and they in turn came immediately to the City's rescue. The problem of that day, and of today, and of tomorrow is:

To provide the City of Honolulu with a permanent and adequate supply of water without immediately going outside the District of Honolulu and thereby depriving agricultural and industrial enterprises of water necessary for irrigation and manufacture.

"We have not yet had to go outside the District of Honolulu for a water supply; we may never have to go outside. But that depends on the success that attends us in our efforts:

1. To conserve our existing supply through prevention of waste and stoppage of leakage;
2. To control the ever increasing draft on the artesian areas by private wells;
3. To utilize all surface water through filtration or in recharging the artesian supply; and
4. To develop all high level water resources."

On page 12 of Mr. Ohrt's report there is the following reference to a proposed "recharging tunnel" project:

"Plans also have been made to conserve surface water by means of infiltration tunnels allowing percolation into the artesian areas. One plan calls for the construction of a diversion dam in Waiomao Stream at about the 600-foot elevation to discharge surface waters into a diversion ditch, thence into a horizontal tunnel driven into the Koolau rock formation to promote percolation into the Waialae artesian area. Similar

plans for other districts have been outlined during the past biennium for future consideration. Large quantities of water now running to waste in the ocean will be conserved if these experiments are successful. Further study of the subject will be continued through the engineering and geologic divisions during the present period."

The following excerpt from pages 12-14 of Mr. Ohrt's report is an unusually comprehensive presentation of the Board's views with respect to conservation and development of surface waters and watershed areas:

"TUNNEL AND SPRINGS

"As early as 1921 the Board of Supervisors was advised that while the extreme flow from all high-level sources, tunnels and springs, then utilized by the City Water Works was less than one million gallons daily, full development would possibly average five million gallons, with a minimum of two or three million gallons daily. In 1938 this source had been developed to a point where an average of 4.2 million gallons daily was being used in the Honolulu water supply and it is believed that an additional flow may still be developed. This will be one of the major problems for solution by our geologic division during the coming biennium.

"Additional storage for mountain water was commented upon by the Commission in its 1929 report, and a successful program to that end was undertaken soon thereafter.

"The possibility of bringing water from outside sources has always been recognized and has been the subject of close study, although the objective of the Department is to confine its sources to the District of Honolulu. In this connection the Aiea artesian area has been investigated and surveys have been made of Pearl Harbor Springs, Koolau and Windward Oahu tunnel possibilities and Waiahole tunnel proposals as previously noted in this report. Study of Pearl Harbor Springs was begun in 1928 and has continued since, but a large portion of this source has already been absorbed.

"In his report in 1929, Mr. Kunesh counseled considering short tunnels above the City to tap the high-level sources that long had been known to exist there.

"High-level tunnel developments in Makiki, Manoa, and Palolo Valleys were seen in the 1935 report of the Manager and Chief Engineer as some of the next additional sources of water supply.

"At the same time experiments in aeration of Alewa Heights Spring water were progressing so favorably that plans were made for the same treatment of corrosive waters in Nuuanu Valley. These experiments, conducted by Mr. Kunesh and Mr. L. T. Bryson, chemist, continually showed a two-thirds reduction of the high carbon-dioxide content of the Alewa water, and the two Nuuanu aerators, commissioned in 1936, have reduced the corrosive content of Nuuanu tunnel and Alewa Heights Spring waters 92 per cent.

"Use of the Upper Nuuanu aerator has provided a surplus of water for high-service reservoir No. 5 at the 405-foot elevation in Nuuanu Valley and it is planned to use this water by installing a pump there to boost the excess supply into the Kaimuki high-service reservoir where it is needed. First service from this aerator is to a tank at the 780-foot level and then to a tank at the 640-foot level, from which the surplus gravitates to Nuuanu Reservoir No. 5 opposite the Dowsett Tract.

"Lower Nuuanu aerator, supplied by Tunnel No. 3 and Alewa Heights Spring, is conserving a considerable quantity of water that heretofore has been wasted.

"WATERSHEDS

"There can be no question that the control of the watersheds upon which we depend for our supply, should remain wholly with the Board of Agriculture and Forestry. This policy was adopted in the beginning when the Commission commended the Board for its activity in extending the forest reservations for the protection of the water supply and expressed its complete confidence in, and satisfaction with, the administration as it then was, and still is being conducted.

"Our present watershed consists of an area of 24 square miles of land in the Koolau Mountains extending from Kahauiki to Waialae-nui in a Territorial Forest Reserve, part of which is owned by private interests that are not required to pay land taxes while their property is devoted to forest purposes. The provision that makes possible the withdrawal of these private areas at will makes for uncertainty of tenure that does not appear to be in the public interest. The Board of Agriculture and Forestry has recognized the instability of this condition and, in cooperation with the Territorial Planning Board, has taken steps towards the acquisition of private holdings within the public forests, a movement that merits the cooperation of the community."

The recommendations of W. H. Samson, engineer in charge of Water Resources, presents a ten-year program in which the following items of special interest in the scope of this (1948) report were included (see pages 117-118):

Extension of development tunnel at Waiialae Underground
Pumping Station

Palolo Infiltration (Recharging) Tunnel

Underground water development projects at Punchbowl
and Makiki

Nuuanu Infiltration (Recharging) Tunnel

1939

Incidental to the construction of its Waiiau Plant, the Hawaiian Electric Company completed a tunnel at Waiiau (classified by geologists with the "skimming tunnel" type) to utilize waters of the Waiiau Spring which had formerly flowed into Pearl Harbor. Of the water used in power-plant purposes, a maximum of approximately 23 million gallons daily is now (1948) pumped into the sugar plantation irrigation ditches inland from the generating plant.

This development was an important milestone in the conservation of the water resources of Oahu.

April 22, 1939

By Act 73 of the 1939 Legislature, Act 185, S. L. 1931 and Act 179, S. L. 1935 were amended to exclude the proposed Nuuanu Filtration Plant from the projects to be constructed with the fund provided by said Acts.

May 17, 1939

By Act 253 the Legislature authorized the Board of Supervisors to transfer the Rural Water Works of the City and County to the Board of Water Supply at such time as the Board of Supervisors "shall deem advisable." (This provision of the law now appears as Section 6863 R. L. 1945.)

December, 1940

A supplement to the May, 1935 bulletin of the Division of Hydrography was published as "Bulletin No. 5" of the Territorial Division of Hydrography under the authorship of Dr. H. T. Stearns of the U.S.G.S.

A principal feature of the bulletin is its report on "Shaft-type Wells" or "Skimming Tunnels" of which ten had been completed on Oahu since 1936, including the Board of Water Supply's installations at Kalihi and Waiialae which were made during 1936-1937, the Navy's Halawa Plant in 1937, and Hawaiian Electric Company's Waiiau Tunnel in 1939.

The construction of the ten shafts within five years marked a remarkable development in local practice. The aggregate tested capacity of the ten installations was 85 m.g.d.

Dr. Stearns' general comment follows (from page 9):

"The important point emphasized in Bulletin 1 was the feasibility of tapping the artesian water on Oahu by shafts inland of the caprock, thereby avoiding salt-water contamination during dry years and increasing the safe yield of the isopiestic areas. A low water table leaves more space available for ground-water storage during wet years and reduces leakage from the basin through springs of which there are probably many below sea level. The shafts already constructed have thoroughly demonstrated the success of this method and the advisability of discontinuing drilling deep wells except in places where relatively small quantities of water are needed. The final result will be the recovery of more water of better quality."

December 31, 1940

Report of Board of Commissioners of Agriculture and Forestry for period January 1, 1941 to December 31, 1942

Mr. William Crosby, who had been appointed Territorial Forester upon Mr. Judd's death, recommended that the law granting annual exemptions from taxation on forest lands certified by the Board be amended to make long-term planning possible. His comments were as follows (page 24):

"The latter provision for the annual certification of lands has served well for allaying uncertainties of land owners in the process of establishing Forest Reserves, but for the proper control and improvement of the Reserve areas as a whole it is highly desirable that the Territory should have the full legal control, if not ownership of the lands within the forest reserve boundaries and it would be desirable for the Board to consider a policy of requiring owners of such lands to surrender the control of the lands on which they request tax exemption for periods of ten to twenty years in order to obtain such exemption."

1940

Manuscript report "Geology and Ground Water Resources of the Manoa-Makiki District" by Dr. C. K. Wentworth, Board of Water Supply

The possibility of additional inland water development in Upper Manoa Valley had received considerable study. A plan of explanatory core drilling was suggested to determine the form of the water bodies in certain localities.

Major projects recommended include basal water shafts at Papakolea and Moiliili as important units in the program of eventually supplementing or retiring the artesian well stations.

Possible location, and the general features, of a recharge tunnel in Upper Manoa to divert stream flow to the artesian basin is discussed in an appendix to the report. In this matter it is stated that, "whether . . . one, or several of these projects are feasible, will require further study and a considerable amount of engineering and economic analysis."

January 2, 1941

In order to solve the Navy's problem with respect to meeting the water requirements incidental to the great Army and Navy expansion in the Pearl Harbor area, the District Public Works Officer proposed that a shaft and sea-level water tunnel be included in the Red Hill Fuel Oil Storage project and that there

be provided an interconnection with the Board of Water Supply's system. Extension of the "skimming tunnel" at the Navy's Halawa Shaft was also proposed.

The recommendation was approved and the Red Hill Pumping Plant was completed on or about November 1, 1942, with an installed capacity of approximately 32 million gallons per day.

Pumping reached the station capacity during the war years 1943-1945. This great draft on the Moanalua Artesian Basin, combined with the subnormal rainfall of the period, created a situation of great concern to the Board of Water Supply and the Navy.

Fortunately, the Navy freely recognized the future needs of the City of Honolulu in the water resources tapped by the Red Hill Plant and also in the Pearl Harbor Artesian Basin beyond.

The Board of Water Supply's immediate needs were met by its Halawa Shaft project which was put into operation August 22, 1944. It is expected that the greater problem will be solved by the Navy's proposed Waiawa Gulch project as proposed in January, 1948, and described in notes herein under that date.)

January 16, 1941

Report of the Board of Water Supply for the years
1939 and 1940

The Board's report to the Legislature and the Mayor and Board of Supervisors is unusually short and earnest in emphasizing the desirability of public ownership of the forest reserve area. The principal portion of the report is quoted in full (pages 3-4):

"We call particular attention to the immediate urgency of further development of water resources within the District of Honolulu as the result of increased population that has caused an unusually heavy demand for water service. This condition requires legislative cooperation so that the obligations placed on this Board by the provisions of Act 96, S. L. 1929, as amended, may be fulfilled, the adequacy of the water supply may be insured, the watersheds and artesian basin of Honolulu may be safeguarded, the Territorial forest be preserved, and the best interest of the public be served.

"With this situation clearly in mind, and after careful consideration of the Report of the Manager and Chief Engineer, it is apparent that continued close cooperation is required between the Board of Water Supply, the Territorial Board of Agriculture and Forestry and the Commissioner of Public Lands for the execution of a program for the extension of the Honolulu watershed within the District of Honolulu, and the acquisition by the government of privately owned areas therein, where practicable; control of said watershed to remain under the able administration of the Board of Agriculture and Forestry.

"It is therefore respectfully recommended:

1. That such legislation as may be required be enacted to waive certain restrictions on the sale, purchase, transfer and exchange of public lands, and to authorize the Commmsioner of Public Lands to make such sales, purchases, transfers and exchanges of land within the District of Honolulu as may be required for the extension and boundary realignment of the Honolulu Watershed Forest Reserve; and to authorize said Land Commissioner to use the proceeds of such sales, transfers, and exchanges for the acquisition by the government of lands that may be required for the extension and boundary realignment of said Forest Reserve, with the definite provision that such land transactions be restricted to the District of Honolulu, and shall be for the benefit of the Honolulu Watershed Forest Reserve."

On the subject of "Watershed Areas" Mr. Ohrt's report stated as follows (pages 14-15):

"WATERSHED AREAS

"In connection with the problem of water development it is also proposed that a joint resurvey be made by the Territorial Board of Agriculture and Forestry, which is charged with the administration of the public watersheds, and the Board of Water Supply for the purpose of establishing a permanent boundary for the Honolulu Watershed Forest Reserve, based on present-day knowledge of watershed conditions possessed by both of these governmental agencies. This proposal includes the recommendation that, insofar as it is practicable, all privately-owned land within the realigned watershed forest reserve be acquired by the Board of Water Supply and/or the Territory, to be subsequently placed under the jurisdiction of the Board of Agriculture and Forestry.

"Realignment of the watershed forest reserve boundary is important to adequate protection of the projected recharge works and the purity of the water they conserve."

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The Board's report indicated approval of Mr. Ohrt's recommendations from which the following excerpts are quoted (from pages 169-171):

- "3. That subject to necessary limitations the makai boundary of the forest reserve within the District of Honolulu be resurveyed jointly by the Board of Agriculture and Forestry and the Board of Water Supply and a permanent location be established, based on present-day knowledge of both of these governmental agencies;
- "4. That all privately owned land within the proposed permanent forest reserve area, when its boundaries are established as above, insofar as practicable, be acquired by the Board of Water Supply and/or the Territory and subsequently placed under the jurisdiction of the Board of Agriculture and Forestry;
- "5. That insofar as the District of Honolulu is concerned no tax exemption be allowed on lands within the permanent forest reserve boundaries as established above;"

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- "8. That the Board of Water Supply set aside from the proposed bond issue a fund of about \$260,000 for the purpose of driving tunnels to augment the present supply by about 9 million gallons a day approximately as follows:
 - (a) Extend Waialae Underground Shaft Tunnel . . . 1,000 ft.
 - (b) Extend the present Palolo Development Tunnel located near the Kaau Crater about 500 ft.
 - (c) Construct a recharging tunnel in Palolo Valley about a mile above the old Chinese Home . . . 500 ft.
 - (d) Construct a recharging tunnel in Manoa Valley just above the old Shingle home 1,000 ft.
 - (e) Construct a development high level tunnel in Manoa Valley 1,000 ft.
 - (f) Construct a development high level tunnel in Pauoa Valley 1,000 ft.
 - (g) Construct a recharging tunnel in Nuuanu Valley opposite Reservoir No. 2 1,000 ft.
 - (h) Construct a recharging tunnel in Kalihi Valley at about the gauging station 500 ft.
- "9a. That additional research be continued on further ground-water developments in Nuuanu and Kalihi Valleys before undertaking any construction program other than that herein proposed.
 - b. That additional research be continued, insofar as is practicable on the possible relocation of the present Kaimuki, Beretania and Kalihi pumping plants with a view to eventually substituting for them inclined shafts located farther inland.

- c. That the future possibilities of water development in Moanalua and Halawa Valleys and on Windward Oahu be kept in mind as potential sources of City Supply after our resources within the District of Honolulu have been developed to their full extent, as proposed under the program here presented.

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"CONCLUSION

"In conclusion, I wish to again emphasize the importance and urgency of this proposal. My recommendations are based on prolonged study of the water supply situation as it exists in the City of Honolulu today, and I have no hesitancy in urging their acceptance and your approval of the issuance of the bonds required to get them under way.

"The nature of the work to be undertaken increases the urgency of its early beginning. This entire program is not one under which plans and specifications can be prepared, bids called for and contracts let. It involves many time-consuming details, including cooperative action with the Board of Agriculture and Forestry, the Land Commissioner, legislative and possible congressional action on land procedures, possibly land condemnation actions, careful consideration of water rights and other phases that cannot be disposed of quickly. Delay is inadvisable, and almost certainly would be costly."

(A copy of the schematic diagram showing "Recharge of Artesian Structure by Proposed Infiltration Tunnel," which was published as page 45 of the Board's 1939-1940 report, is included in Part II-C hereof.)

1941 Legislative Session

In the 1941 legislative session the Board of Water Supply sponsored H. J. R. 35 which would have authorized the Commissioner of Public Lands to dispose of about 30 acres of land in the Honolulu Watershed Forest Reserve and to use the proceeds in the acquisition of some 300 acres of additional lands required for the protection of water sources proposed to be developed, particularly in connection with the Manoa and Kalihi Basal Recharge projects.

The Board also sponsored H. B. 388 which would have simplified procedures in the condemnation of land for Board of Water Supply purposes by clarifying the authority of the Board in eminent domain.

Both measures were referred by the House County Committee to the Board of Supervisors. The Board recommended the passage of both.

Although H. J. R. 35 was passed by the House in an amended form, it was tabled in the Senate. (Any review of the proceedings in the Legislature should "work back" from the April 30, 1941 report of the Senate Committee on Public Lands, which is available on page 1502, Senate Journal 1931.)

H. B. 388, which had been prepared by the City and County Attorney, was favorably reported by the House Committee on Municipal, County, and Civil Service (page 903 of Journal). The bill passed the House unanimously (page 939).

In the Senate the bill was referred to the Select Committee of Oahu Senators which then reported the bill favorably on April 17, on which date the report was adopted and the bill passed 2nd reading and placed on the Calendar for 3rd reading on April 18.

On April 18 the bill was recommitted to the Select Committee of Oahu Senators. No reason for this procedure is stated in the Senate Journal.

On April 30 Senator David Akana reported orally for the Select Committee, returning the bill with the recommendation that it be considered by the Senate as a whole. The report was adopted and Senator Harold Rice then moved that the bill be tabled. The bill failed to pass by a 1 to 12 vote (with 2 not voting).

Senator Heen then moved for a reconsideration, but the motion to reconsider was lost by a 3 to 11 vote (with one not voting).

1941

Manuscript report "Geology and Ground Water Resources of the Nuuanu-Pauoa District" by Dr. C. K. Wentworth, Board of Water Supply

No geologic structures were found which favored the development of high-level, confined or perched, water in the Koolau lava flows in the district.

Five projects at lower levels are recommended (pages 210-211):

"These are (1) Nuuanu Stream Recharge Infiltration Tunnel, (2) Nuuanu Valley Bottom Underground Development Tunnels, (3) Pauoa Valley Bottom Underground Development Tunnel, (4) Punchbowl (Papakolea) Basal Shaft (Beretania Area) and (5) Diffusion Zone Test Hole."

The said proposed projects are described in some detail.

1941

Manuscript report "Geology and Ground Water Resources of the Kalihi District" by Dr. C. K. Wentworth, Board of Water Supply (including findings with respect to the entire District of Honolulu)

The recommendations presented include:

1. Kalihi Valley Sub-Surface Exploration by core drilling to lead to the determination of the feasibility of the development of valley bottom water from the Kalihi basalt.
2. A Basal Recharge Tunnel in Kalihi Valley.
3. A Basal Water Shaft at Kapalama.

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It is stated that, "Studies of the Honolulu watershed are sufficiently far advanced to indicate that chances of developing at high levels quantities of water of the order of 10 or 20 M. G. D. is negligible."

The following tabulation of estimated amounts that the various projects under consideration would add to available supplies is presented on page 99:

(Flow in millions of gallons per day)

Recharge Tunnels

| | | |
|--------|-------------|------|
| Palolo | 0.50 | |
| Manoa | 3.00 | |
| Nuuanu | 2.00 | |
| Kalihi | <u>1.30</u> | 6.80 |

Extension of Tunnel at
Waialae Shaft

1.50

"Development Tunnels"

0.25

| | | |
|----------------------------|-------------|--|
| Palolo Tunnel Extension | 0.25 | |
| East Manoa Springs Tunnels | 0.50 | |
| Pauoa Tunnel | 0.30 | |
| Nuuanu Valley Bottom | 2.50 | |
| Kalihi Valley Bottom | <u>1.00</u> | |

4.55

Total

12.85

The following excerpt is taken from the general summation in the report (page 98):

"Estimated amounts of water indicate that the additions to present supply which seem at this writing feasible are mainly basal water, with the help of recharge and with a substantial amount from valley-bottom developments in cap rock formations and only very small quantities from high-level improvements. It appears at this time that the main resource of the Honolulu system is the basal or artesian water. Even the prospect of securing water from the Waiahole system, up to a total of 15 M. G. D. after 1962, considering the necessary expense in transmission system, does not materially change this picture. It is quite likely that larger amounts of water at less cost could be had by fully developing the basal water of the Moanalua Isopiestic Area."

(Notes in this 1948 report under 1947 show that the Waiahole water referred to became practically dedicated to the future needs of the Suburban Water System in Koolau).

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With respect to adding a second Basal Water Shaft in the Moanalua Artesian Basin (the "Kalihi Shaft" having been completed there), Dr. Wentworth includes the following in his comment (pages 101 and 102):

". . . it is thought that a basal shaft should be driven in the Red Hill Spur from the elevation of about 160 feet in Moanalua Valley. It is probable that the rock valley in Moanalua is not cut below sea level and that there is no valley-fill barrier below sea level. Because of this probable condition, there is perhaps no great choice between a basal shaft in the Red Hill Spur and one in the spur east of Moanalua Valley, if the latter site proves to be superior from an operating standpoint (2). A basal shaft at either of these sites would probably not interfere with the present Kalihi Shaft at the eastern edge of the Moanalua Isopiestic Area.

"With the construction of the basal shafts in the Moiliili, Beretania, and Kalihi areas, and the extra basal shaft in the Moanalua area, as proposed above, the Board of Water Supply will be prepared not only to meet temporary extreme conditions in the interest of the public and of national defense; but also, and more important, to undertake such long-term management of the artesian system as seems most prudent in the light of existing knowledge."

(Notes further on in this 1948 report will show that the Navy installed a Basal Water Shaft in the Red Hill Spur, and that it thus became necessary for the Board of Water Supply to "leap over" the Navy installation and install a shaft at Halawa in the Pearl Harbor Artesian Basin.)

1942

C. K. Wentworth's monograph "Storage Consequences of the Ghyben-Herzberg Theory," which was published in the 1942 Transactions of the American Geophysical Union, although of a technical nature beyond the immediate scope of this (1948) report, is noted here because of its contribution.

The content is indicated by the following introductory comment:

"Contemplation of the history and functioning of the GHYBEN-HERZBERG lens of stored ground-water which forms the Honolulu Artesian System has led to a consideration of the long-term hydraulic consequences of artificial draft along lines suggested by the work of THEIS and others. This paper is offered as an elementary elaboration of the probable behavior of this lens of ground-water."

November 1, 1942

Navy's Red Hill Pumping Plant placed in operation.

1942

Manuscript report, "Geology and Ground Water Resources of the Moanalua-Halawa District" by Dr. C. K. Wentworth, Board of Water Supply (including certain findings on the Honolulu area in general)

The report deals, to a considerable extent, with the interrelationship between the Moanalua and Pearl Harbor Artesian Areas.

The following excerpts are taken from the summation of the report (pages 140-141):

"Moanalua-Halawa District

- "1. No conditions were found which indicate that a profitable development of high-level water can be accomplished in either the Moanalua or Halawa districts.
- "2. Until more data are available from practical operation and observations of basal head, no further basal stations or additional basal or artesian water development can be recommended beyond the three stations now under construction, Red Hill, North Halawa and Aiea. These stations, with Kalihi and Navy Halawa, make five basal shafts in a distance of 5.5 miles, at intervals respectively as follows: Kalihi-Red Hill, 2.7 miles; Red Hill-North Halawa, 0.9 mile; North Halawa-Navy Halawa, 1.3 miles; Navy Halawa-Aiea, 0.6 mile. These stations all told have capacity installed or planned of 100 M. G. D., which is of the order of 3 times the present yield of this area. No other area on Oahu is so favorably situated to determine by full-scale hydraulic testing what increased yield can be gained by lowered heads and what the quantitative relationships between two major isopiestic areas are."

(from pages 142-143):

"Honolulu System in General

- "5. With the emergency modification of program which will result in construction of the North Halawa Shaft and interconnection with the Red Hill, Fort Shafter, and Pearl Harbor systems, emphasis on Honolulu projects may be somewhat changed. In this writer's opinion, the most urgent project is the extension of the Waialae Tunnel as previously planned. This project, with No. 6 and No. 7, will greatly strengthen the supply for the eastern part of the Honolulu district.
- "6. Construction of the Palolo (Waiomao) Recharge Tunnel, concurrently with the lengthening of the Waialae Development Tunnel, to increase the supply at Waialae Basal Station.
- "7. It is increasingly evident that the entire Honolulu low-level supply will eventually come from basal underground stations rather than artesian wells. It is believed that the station strategically next most desirable for construction is that in the east wall of Manoa Valley, corresponding to the Moiliili Artesian Area (No. 1). This station would facilitate safe draft of the Moiliili head to lower levels, and would decrease the head difference between areas No. 1 and No. 5. Combined with the transmission tunnel under Mauuma'e, with projects 5 and 6, this project would greatly improve the water supply situation of Diamond Head."

December 31, 1942

Report of Board of Commissioners of Agriculture and Forestry for period January 1, 1941 to December 31, 1942

Excerpt from report of Mr. William Crosby, Territorial

Forester:

"In this connection I should like to again urge the consideration of eliminating Section 1973, R. L. H. 1935. This section is an inadvertent survival of the original law passed before the existence of a forest department and creation of forest reserve areas, as an inducement to forest land owners to protect the forest conditions of their lands.

"In spite of the specific provisions in Section 1973 that granting of tax exemptions on privately owned forest land places full control of the area in the Board of Commissioners of Agriculture and Forestry, the continued operation of this Section since the passage of the law containing Section 182 R. L. H. 1935 has induced

the impression among many, if not all owners, that they retain full control of the land when securing tax exemption under Section 1973. The value to be gained through the granting of tax exemption on private forest lands is in the long term management of such areas as forest lands as provided for in Section 182. It is highly desirable that all private areas granted tax exemption should be placed on this long term basis rather than the annual status provided for under Section 1973."

January 28, 1943

Report of the Board of Water Supply for the years
1941 and 1942

The outstanding paragraph of the Board's report is as follows (from page 1):

"Fortunately, the need of an additional source of water supply for the City of Honolulu was recognized early in 1941 and the North Halawa underground water development project is now well under way. This \$1,500,000 project, which is being financed jointly by the Board of Water Supply and the Federal Works Agency, upon completion will assure the City of an additional 10 million gallons of water whenever required."

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The following summary from Mr. Ohrt's report is of particular interest (from page 4):

"NORTH HALAWA PROJECT

"From the outset it was the Board's major problem to supply the City of Honolulu with water from sources within its own boundaries as long as that remained possible. Development of water sources proceeded along lines designed to take every drop of recoverable fresh water from these sources before going into Rural Oahu for an additional supply.

"The Board's long range plan, however, contemplated the eventual necessity of going outside the boundaries of the District of Honolulu for additional artesian water but it had been thought that the time when this would have to be done was far in the future. However, when the emergency arose it was possible to advance this phase of the program by deferring the infiltration projects.

"Bond moneys that would have been applied to infiltration were transferred to a new project through which additional artesian water will be brought into the city from a 284-foot 30° inclined shaft and electrically-operated underground pumping station in North Halawa

Valley. This project includes the laying of a bout four miles of 42-inch and 36-inch bell and spigot cast-iron pipeline. Initial installations at the pumping station will be two pumps, each of 5 million gallons daily capacity, with provision for expansion by the addition of another pump of 10 million gallons daily capacity, should the necessity arise.

"The infiltration project, through which it is hoped to conserve about 9 million gallons of water daily to the five artesian areas underlying the city, has not been abandoned. It retains a preferred position in post war development plans, with a start on the Palolo unit of the project at an early date.

"War has delayed the completion of the North Halawa project and has greatly increased its cost. Army and Navy authorities have given us splendid cooperation on this project, and, although we cannot be certain how soon all the materials and equipment required for completion of the installation will reach us, progress on its construction has been satisfactory, and it should be completed within the year 1943."

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Mr. Ohrt, in his summation of the report, included in his recommendations (from page 103):

"1. That the Board of Water Supply undertake as soon as practicable the construction of the Palolo Recharging Project, one of the units of the water development program adopted on December 16, 1940."

August 22, 1944

Board of Water Supply "Halawa Shaft" placed in operation.

November 30, 1944

On this date the Board of Commissioners of Agriculture and Forestry approved certain changes in the forest reserve line as described in the Governor's Proclamation of April 13, 1932.

With reference to the changes so approved, Mr. Colin G. Lennox, President of the Board of Commissioners of Agriculture and Forestry, stated as follows in his letter of April 12, 1948, to the Board:

"The gradual utilization of privately held lands within the Honolulu Forest Reserve for other than forest purposes has been a fear of this Board for sometime and this fear was culminated in 1944 when the Board ordered a complete resurvey of the existing forest reserve boundaries to determine where changes should be made to further protect the infiltration area and where recessions could be permitted to release lands that may be of more value for building sites than as infiltration areas. The survey was made by the joint technical staffs of the Honolulu Board of Water Supply and the Board of Agriculture and Forestry. Recommended forest boundary line changes were approved on November 30, 1944."

The important changes so approved were as follows:

1. Inclusion of a small area in the Waiomao Branch of Palolo Valley, primarily because of the proposed Waiomao Recharging Tunnel.
2. Exclusion of the lower 53.62 acres of the 180.20-acre area of Bishop Estate land mauka of St. Louis Heights, which area had been added to the Reserve in 1932.
3. Inclusion of an important area in Upper Manoa Valley because of the proposed Manoa Recharging Tunnel.
4. Inclusion of an area mauka of Punchbowl and comprised principally of the land owned by the Territory leased to H. A. and B. V. Moreira by G. L. 2578 and a parcel owned by A. L. Castle.
5. Inclusion of an area east of the Dowsett Tract in Nuuanu.
6. Inclusion of an area at Halawa to lower the Reserve line to include the Board of Water Supply's Halawa Shaft.

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(As of May, 1948 no revised description of the Forest Reserve had been proclaimed by the Governor because the necessary survey description had not been completed. The additional areas were, however, included within the areas shown as Forest Reserve on the "Master Plan" adopted by the City Planning Commission in 1947.)

December 14, 1944

(Memo submitted with H. B. 414)

"A motion was passed by the Board of Water Supply, City and County of Honolulu that 'it is recommended that the revised forest reserve line be approved by the Board of Water Supply, and that the Board of Agriculture and Forestry be urged to take whatever steps are necessary to acquire all privately owned lands within this area.'"

December 19, 1944

(Memo submitted with H. B. 414)

"The Board of Commissioners of Agriculture and Forestry submitted a resolution to the Governor of the Territory requesting his approval and support for 'legislation to provide monies for the purchase of all privately held lands falling within the boundaries of the newly established forest reserve line, which are not presently used for residential purposes by the owners, between the Kuliouou Forest Reserve to and including the valley of the North Halawa Stream, said lands to total 12,249 acres more or less.'"

December 31, 1944

Report of Board of Commissioners of Agriculture and Forestry for period January 1, 1943 to December 31, 1944

Excerpt from page 18:

"FOREST RESERVE POLICIES:

"The Board of Commissioners have taken up for review the policy of safeguarding the Honolulu Watershed from encroachment. It reviewed with geologists and foresters the present boundaries of the Honolulu watershed and made certain changes in boundaries to better utilize and protect the water resources for that area. A resolution was presented to the Governor requesting that legislation be prepared to allow for the acquiring by the Territory of all privately held lands within this water reserve. At the present time a majority of lands within the Honolulu watershed are privately owned and therefore subject to withdrawal from the forest reserve status on one day or six months' notice. As long as these lands remain under private ownership the Board of Agriculture and Forestry is not at liberty to expend Territorial monies in improving their forest covers.

"A general survey of all watersheds supplying domestic water to communities within the Territory is being made for the purpose of determining where forest reserve boundaries should be changed to insure a better water supply for each source."

Excerpt . from the Territorial Forester's portion of the report (page 33):

"The extent of sugar plantation development in the Territory and need of irrigation water has been a heavy stimulus in maintenance and improvement of forest cover to maintain optimum conditions for water supply, but where pressure of population and other industry may develop as in the case of Honolulu, the present move of the Board of Agriculture and Forestry and Water Supply to establish government ownership of all watershed land and control of further residential and agricultural development is a most desirable step in the right direction."

January 26, 1945

The Board of Commissioners of Agriculture and Forestry adopted a resolution requesting the Governor to support legislation to provide funds for the purchase of all privately held lands within the Honolulu Watershed Forest Reserve as enlarged by the Board's action of November 30, 1944.

1945

Manuscript report, "Geology and Ground Water Resources of the Pearl Harbor District" by Dr. C. K. Wentworth, Board of Water Supply, (including a summation of all principal recommendations made by the author with respect to the Honolulu and Pearl Harbor Areas, 1938-1945).

Excerpts from such of the recommendations presented in the report as are of particular interest in this (1948) report are as follows (from pages 152-156):

"(8) Basal recharge

"Completing of one or more of the proposed basal recharge projects is considered of very great importance, both because of the increase of water supply to be expected and because the testing of this method on a full scale is extremely desirable. The long-term value of such a project can only be fully assayed after several years of operation and it is desirable, as a matter of policy, to determine what may be expected. Projects of this kind have been laid out for Palolo, Manoa, Nuuanu and Kalihi valleys. Existence of extensive data on water levels for the past 10 years make the Palolo project most likely to yield valuable data on water quantities, though the other projects involve larger amounts of water.

"(9) Basal stations

"Building of basal stations in the Waahila, Papakolea, and Kapalama areas to replace the present Kaimuki, Beretania, and Kalihi artesian well stations in areas 1, 2, and 3 (Moiliili, Beretania, and Kalihi) is regarded as imperative within the next 10 years. These stations are needed in order to provide adequate water supply without the existing hazard from salting due to lowered head, and to enable this public agency to lead, rather than to follow, in the orderly transition from artesian well development to basal water development, with attendant slow lowering of head to a mean level of 15 feet by 1970. It is not financially desirable to retire the investment in the existing stations for another 10 to 15 years but it is believed that orderly transition in solving the hydrologic problem will justify accelerating the process somewhat over the simple financial procedure, as in any other case of technological obsolescence.

"(10) Waialae tunnel extension

"The extension of the development tunnel of Waialae basal station, as planned and interrupted by war conditions, is a project which should be completed as soon as sufficient distribution relief for the Waialae area has been provided so that the station can be shut down."

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"(12) Pearl Harbor program

"The construction of water supply projects in the Pearl Harbor area is mostly outside the province of the Board of Water Supply. As a result of the study here reported, it is evident that the most important problem facing the Pearl Harbor area is that of transforming the development facilities for maximum, controlled use of the total supply. With the present machinery and with the premise of holding heads above 20 feet and salinities at present value, the area is at present being overdrawn. The present writer believes that the head would fall at a considerably greater rate if large benefits were not coming from deep storage. These benefits will decline in course of time.

"On the other hand, with retirement of more wells and their replacement by basal stations, and with conditions thus set to permit lowering the Pearl Harbor head permanently to as low as 12 feet in the course of the next 30 years, it is believed that the total draft can be continuously held as high as 270 M. G. D., particularly with greater use of spring flow. It must be emphatically stated that this does not mean that any single user should take comfort in drawing apparent new water because he has built a basal station. Only by the meeting of all the conditions of this paragraph by all users does it appear that the present or slightly greater draft be made permanent; under existing conditions the present amount is believed to be overdraft.

"(13) Pearl Harbor spring repair

Appendix II carries a suggestion in regard to repair of leakage of the Pearl Harbor Springs. This can only be considered as a conservation measure on a regional basis under federal or other overall authority. From its nature, it is probable that no single user of water can undertake it on the basis of short-term water supply economics.

February 13, 1945

Report of the Board of Water Supply for the years
1943 and 1944

The principal recommendations of the Board (within the scope of this (1948) report) were as follows (from page 3):

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- "2. That legislation be enacted, as contained in the suggested Ground Water Statute, to create an Oahu Ground Water Commission for the purpose of utilizing the ground water resources of the Island of Oahu to the fullest extent possible consistent with beneficial use, prevention of waste, and preservation of vital water storage reserves.
- "3. That such legislation, as may be required, be enacted to provide and preserve the forest reserves in the Honolulu and Halawa areas to assure necessary protection and development of the water resources of the City."

Mr. Ohrt's report contains the following outstanding sections (from pages 6-7):

"Wells A. Hutchins, authority on water rights law for the Soil Conservation Service of the Department of Agriculture, came to Hawaii in 1940 and made a survey of the Hawaiian water rights law. The complete manuscript of this subject is being reviewed by the Department of Agriculture before release. Mr. Hutchins at the request of the Board of Water Supply, again came to Hawaii in 1944 to observe the changes that had taken place in the past four years and to suggest legislation to safeguard the water resources of the Island of Oahu for present and future requirements. Following a detailed study of the present water situation on Oahu, as it exists under wartime conditions, he prepared a ground water statute which could be introduced at the coming session of the Territorial Legislature for its consideration.

"The salient points of this statute are:

- "1. That subject to existing rights of use as validated under provisions of this statute all ground waters within the Island of Oahu are declared to be public waters and to be the property of the public.

- "2. Creation of a commission, appointed by the Governor, to study ground water supply, control withdrawals of ground water and possible uses of ground water and review claims of rights of use of such water.
- "3. Authorizes the commission to maintain an office and to employ such persons as may be necessary.
- "4. Grants the commission the power to intervene on behalf of the public in any suit at law or in equity in any court in which the control or withdrawal of any ground waters in the Island of Oahu or rights to their use is in issue; and to institute proceedings for the determination of ground-water rights.

"The provisions of this proposed statute will have far-reaching effects on the public as well as the agricultural and industrial interests. Its primary purpose is to regulate and control water uses to the extent that the water resources can be most wisely developed and put to beneficial use.

"The proposed statute would eliminate certain powers of the Board of Water Supply, as now authorized under present statutes, particularly those powers relating to investigations of water use and issuance of permits for drilling wells within the district of Honolulu. It would mean that future construction of ground water developments by the Board of Water Supply would be subject to approval by this proposed commission."

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(from page 12):

"RECHARGING TUNNELS.--Several projects under consideration for developing additional water sources for the city are the construction of recharging tunnels in Nuuanu, Manoa and Palolo valleys. By diverting the water of these streams into tunnels drilled into the Koolau lavas that form the aquifer of the artesian water structure we expect to increase the available artesian water. Computation based on the stream flows and capacities of development works show that 4 million gallons daily in Nuuanu Valley, 5.3 million gallons daily in Manoa Valley, and 0.8 million gallons daily in Palolo Valley are available. The Nuuanu recharging tunnel project has been approved and will be started in the near future.

"FOREST RESERVES.--The Honolulu and Halawa forest reserve areas are important in protection of the underground water supply of the city, as all of the forest reserve area lies within the intake or infiltration area supplying the artesian structure. A careful study of this area was made by the Board of Water Supply working in conjunction with Colin G. Lennox, President, and the Commissioners of the Board of Agriculture and Forestry, and certain revisions of the boundary lines were proposed and adopted.

"At present a considerable portion of the land within this forest reserve area is privately owned and tax exempt. The objection to this arrangement, however, is that owners may withdraw their lands from the forest reserve area at will for development or various other reasons. To prevent further encroachment or subdivision of the forest reserve, essential for the protection of the water supply of the city, the Commissioners of the Board of Agriculture and Forestry have recommended the public ownership of all lands within the Honolulu and Halawa forest reserve area. A request for an appropriation to acquire this land will be transmitted to the Governor and to the Territorial Legislature."

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The interest of the Board in the Pearl Harbor area appeared as a new development because of the Board's new Halawa Station and the Navy's Red Hill development. Mr. Ohrt commented on this as follows (from pages 23-25):

"RESEARCH ON PEARL HARBOR ARTESIAN AREA.--The need for complete data on artesian water levels, salinity, draft and interference by draft on adjacent pumping stations in artesian area No. 6, generally known as the Pearl Harbor Artesian area, has been recognized for many years. The construction of the Board of Water Supply station at Halawa, the increased water requirements from the Navy pumping stations, and large requirements from the various pumping stations of the sugar plantations, have shown the need of additional investigation and studies to obtain necessary information for proper development and conservation in the area. Two observation holes are now being drilled, one in Manaiki Valley and one near the junction of Kunia Road and the Ewa-Waianae Road. Two others, one in Waimalu Valley and the other near the Waiawa cut-off, will be drilled in 1945. Continuously recording water-level gages will be installed on these observation holes.

"It is also planned to install several continuously recording rain gages in the area. These will be correlated with existing 'daily-read' stations of long record. A detailed study started in 1943, of the various pumping stations' records of discharge, rates of pumping and salinity, will be continued."

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Mr. Ohrt, in his review of the report, presented the following in his recommendations (from page 128):

- "2. That the Honolulu-Halawa forest reserve be maintained as a protection to the underground water supply of the city and that all privately-owned land lying within the forest reserve be acquired.
- "3. That the legislature be requested to enact legislation to control the underground water resources of the entire Island of Oahu."

February 21, 1945

The Land Laws Revision Commission (Judge E. C. Peters, George M. Collins, and J. Garner Anthony), which was appointed under Joint Resolution 10 of the 1943 Legislature, reported on their activities.

The report comments principally with respect to homestead lands and urges a two-year extension to permit the Commission to complete its studies.

March 14, 1945

There was introduced in the House of Representatives as an administrative measure, H. B. 414, sponsored by the Board of Commissioners of Agriculture and Forestry and the Honolulu Board of Water Supply, "providing for the acquisition of lands within the forest reserves of the Honolulu-Pearl Harbor area, and appropriations therefor."

The bill proposed the acquisition by the Territory of all privately owned rights within the Forest Reserve from Aiea to Kuliouou-iki and to make an appropriation in the sum of \$1,046,120 from the general revenues of the Territory for such purposes.

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The bill was referred to the Committee on Finance, and after the Committee's favorable action in an amended form, the bill was passed by the House. In the Senate it was then referred to the Committee on Ways and Means which did not act, excepting at the end of the session with the routine recommendation that the bill "be filed."

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As passed by the House the bill was amended to provide that no lands be condemned in cases where the owner was willing to enter into "forest surrender agreements" with the Territory. Further, the House reduced the proposed appropriation to \$600,000.

April 3, 1945

There was introduced in the House of Representatives, as H. B. 611, an administrative proposal sponsored by the Honolulu Board of Water Supply, "Relating to wells and to the ownership, control and use of ground waters of the Island of Oahu; providing for the condemnation, forfeiture, or loss of rights in wells and ground waters in certain instances; creating the Oahu Ground-Water Commission, prescribing its powers and duties, authorizing it to charge fees and making an appropriation; prescribing penalties for violations of this act; and repealing certain laws relating to wells and ground waters."

The purpose of the bill is shown by the following excerpt:

"SECTION 4. Declaration of emergency and public policy.
(1) It is hereby declared that because of the conditions existing on the Island of Oahu, the general welfare requires that the ground-water resources of the Island be put to beneficial use to the fullest extent of which they are capable, and that the exhaustion or depletion of the supply or the waste or pollution or the deterioration by salt encroachment or the unreasonable use or unreasonable method of diversion or use of ground water be prevented, and that the conservation and protection of the supply and quality of such waters is to be exercised with a view to the reasonable and beneficial use thereof in the interest of the people and for the public welfare. Owing to continually increasing demands for and withdrawals of water from the ground, water tables in vital areas of the Island have seriously declined and the danger of salt encroachment in some such vital areas has become critical, thereby requiring public control to prevent further unwarranted depletion in supply and deterioration in quality of the water and the serious results to the public welfare that the lack of adequate control will cause.

"(2) It is further declared that the highest use of water is for military purposes during war-time; the next highest use is for domestic, municipal, and comparable peacetime military purposes; and the third highest use is for agricultural purposes.

"SECTION 5. Public ownership and control of ground waters.
(1) All ground waters within the Island are hereby declared to be public waters and to be the property of the public, subject to existing valid rights of use and to the acquisition of new rights of use, and to be subject to public control in the interest of the general welfare.

"(2) Nothing herein is intended to prevent the holder of any valid right to withdraw and use water from a well, as defined in section 6 of this act, from exercising his right of beneficial use of the water or otherwise to impair such right; provided, however, that the exercise of such right of use hereafter shall conform to the provisions of this act. Nor is anything herein to be construed as interfering with or impairing any valid existing right of any user of water from a spring or from a surface stream supplied in whole or in part from ground water.

"(3) All ground waters in the Island in excess of the requirements for the exercise of valid rights of use, as defined in section 6 of this act and as otherwise provided for in this section, shall be subject to the acquisition of rights of beneficial use under the terms of this act and not otherwise. It is the express intention of the Legislature that the procedure provided in this act for the acquirement of new rights by first applying for permits and by taking all of the subsequent steps required, shall be exclusive method by which rights, not in existence when this act takes effect, to withdraw and use water from wells shall be hereafter initiated and acquired, and that no right or title to such water or to its withdrawal or use that is claimed to have been made or initiated or its exercise commenced hereafter in any other way shall be recognized by any court or public administrative agency as valid."

The bill was meticulously drafted by Mr. Wells A. Hutchins, national authority on water legislation, who was first brought to the Territory in November, 1944 by the Board of Water Supply through the efforts of Governor Stainback and by the courtesy of the Secretary of the Interior and the Secretary of Agriculture of the United States.

The proposal follows recent developments in water-rights law on the Mainland and it is interesting to note how closely it conforms with the principles proposed by Mr. L. J. Warren outstanding member of the local bar and for many years attorney for local sugar interests and land-owning estates, in his recommendations to the Honolulu Sewer and Water Commission referred to in this (1948) report under "1927 Legislative Session." (Mr. Warren's proposal included surface waters as well as underground waters.)

During Mr. Hutchins' stay in Honolulu many conferences were held with persons holding positions of intimate connection with water-right ownership and with other persons particularly interested in the subject matter from a legislative or legal viewpoint.

Typical of the reaction of outstanding local leaders is that expressed by Mr. John E. Russell, Manager of T. H. Davies and Co., Ltd., and Trustee of the Damon Estate in his letter of January 8, 1945 to Mr. Ohrt:

"Your letter of December 28, 1944, with its enclosure has been reviewed by us and our attorney, Mr. A. G. M. Robertson, who has been and will again be in touch with you on the subject which we consider one of pressing public importance.

"There are of course questions of ownership of ground waters involved on which we are not expressing an opinion at this time, because our position is that of Trustees for other people's property.

"In general, your plan appears to us as a wise and timely recognition that the ground waters of this Island, which are essential to support life and industry now and even more so in the future - if we correctly foresee a great future for Honolulu - are very seriously threatened to-day by unbalanced and probably wasteful withdrawals."

Mr. R. Penhallow, Manager of Honolulu Plantation Co., stated as follows in his letter of January 9, 1945 to Mr. Ohrt:

"Thank you very much for referring to me the preliminary draft of a suggested Ground Water Statute. I have read it carefully, as have several members of my staff. We are all of the opinion that such a Statute is needed for the protection of the Oahu water supplies, and wish to commend you for your foresight in preparing it for presentation at this time."

With respect to the principal point of law in the bill, Hon. A. G. M. Robertson included the following comment in his letter of January 12, 1945 to Mr. Ohrt:

"Section 3:

"The main point is as to the validity of the declaration in this section that ground water is public property. Much can be said on each side of this question. Nothing less than a court decision would settle it."

Governor I. M. Stainback, in his letter of March 30, 1945, transmitting the bill to the Legislature, included the following statement:

"For the various reasons recited here, and as a logical and progressive step forward in the conservation of natural resources, it is deemed advisable that some form of legislative action be taken at this time. With this thought in mind, I am transmitting herewith, for your consideration, a draft of a proposed act for the control and regulation of the ground waters of the Island of Oahu. As stated in my previous message, this draft has been prepared by Mr. Wells A. Hutchins, in consultation with Mr. Ohrt. Mr. Hutchins of the U. S. Department of Agriculture, is an authority on this type of legislation and has made a thorough study of our local water problems.

"It seems essential that our ground-water supply be developed and conserved to the fullest extent possible. Our future prosperity depends upon the continued availability of our underground supply and I therefore recommend your favorable consideration of this measure."

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In the House of Representatives the bill was originally referred to the Committee on Agriculture, Forestry, and Manufactures, and subsequently recommitted to the Committee on Judiciary.

The Judiciary Committee, in its report of April 30, 1945, concluded with the following:

"The Governor's letter dated March 30 indicates the importance and needs of such legislation and with this your Committee concurs. The Bill which is thirty pages in length was introduced on April 3, 1945 and on the following day was referred to the Committee on Agriculture, Forestry and Manufactures. On April 8, 1945 it was referred by that Committee to your Committee on Judiciary. Your Committee met with the City and County Attorney and the Manager of the Board of Water Supply, holding two meetings, and soon came to the conclusion that this thirty-page Bill, which appears to have been well prepared, was of such vital and far-reaching importance to our economic future, affecting the interests of all owners of wells on the Island of Oahu, that it would require many public hearings and warrants much more time and study than this Committee could give it in the few remaining days of the present session.

"Accordingly, your Committee, in view of the above, recommends that the enactment of future ground water legislation be made a prime objective of study of the 1945-1947 House and Senate Holdover Committee and that House Bill No. 611 be referred to said Committees for study and report to the next special or regular session of the Legislature."

The Committee's report was adopted. There was no Holdover Committee study, and thus the 1945 effort resulted only in further delay.

1945

The Board of Water Supply drilled observation wells and installed continuous water-level recorders at Manaiki, Waimalu, ^{Waiawa} and Kunia, in the Pearl Harbor Artesian area as a means of obtaining important basic data.

June 30, 1946

Report of Board of Commissioners of Agriculture and Forestry for biennium ending June 30, 1946

Excerpt from the Board's report (page 67):

"The Honolulu watershed may be considered the most vital watershed in the Territory. The future growth of the city will be vitally affected by the water supply obtainable from the artesian area fed by this watershed which covers some 26 square miles. The entire problem of areas back of the city feeding rainfall to the artesian areas was reviewed with geologists and engineers of the Honolulu Board of Water Supply, and necessary revisions in the forest reserve boundary were outlined. Certain changes in the location of the forest boundary have been approved by the Board as a result of this study, and the revised line and area of the reserve are being surveyed and computed by the survey office.

"A majority of the land within the Honolulu watershed is privately owned, and may therefore be withdrawn from forest reserve status at any time and used for purposes detrimental to watershed use. In view of this potential danger to the Honolulu artesian water supply through possible reduction of the filtration area, legislation was introduced at the 23rd session of the Territorial Legislature to provide funds and authority for acquisition of such private lands within the watershed. This legislation failed to pass, and since that time there has been activity started along the lines which can prove serious to the future water supply of the city."

Table 21 of the report . presented details with respect to all effective "surrender agreements" showing that the prevailing present practice is for 20-year agreements or renewals.

The only surrender agreements in effect with respect to the Honolulu Watershed Forest Reserve cover the 151 acres owned by Punahou School at Kolowalu, Manoa, (20-year term to expire in 1950) and 193 acres of the Oahu Country Club property (20-year term to expire in 1949).

The only additional agreement with respect to areas in which the Board of Water Supply is directly interested is with respect to the South Halawa forest land owned by the Queen Emma Estate. The term of the surrender of this 1,145 acres will expire in 1963. Beyond Halawa the first area covered by a surrender agreement is the 5,542-acre forest portion of the John II' Estate's land of Waipio on which the present agreement will expire in 1963.

August 8, 1946

Letter by Mr. Ohrt to Chairman and Members of
the Board of Water Supply

In recommending the acquisition of a 3.34-acre parcel of land in Upper Manoa, mauka of the proposed point of diversion to the proposed "recharge tunnel," Mr. Ohrt stated, in part:

"Permitting the subdivision of this parcel of land and the construction of homes with cesspools, which would be practically at the intake of the proposed Manoa recharge tunnel would in my opinion be very unfortunate.

"The Manoa recharge project is of greater importance to the future plans for the use of all surface water supplies as the mean flow at the proposed point of intake is 6 million gallons daily which is greater than that from any of the other valleys, all of which must eventually be used.

"As shown on the map this property is in a very important position in connection with the use of available stream water and it is only due to the fact that our Manoa Valley Tunnel line passes through the property that makes it salable at this time."

(The Board approved the purchase, and the acquisition was completed by a voluntary transaction.)

1946

"The Geology of the Honolulu Ground Water Supply"
by Dr. H. S. Palmer, published by the Board of
Water Supply

The following excerpts are taken from Mr. Ohrt's "Foreword":

"Recently, water from the adjacent Pearl Harbor area has been made available to the city through the Halawa underground pumping station. While this additional source has been of great assistance in meeting the augmented war-time demand of Honolulu, the lowering of ground water heads in both the Pearl Harbor and Honolulu areas indicates progressive depletion of stored water and withdrawal at a rate greater than that of addition by rainfall.

"Delivery of water from a distance will always remain expensive and the development of sources within the Honolulu area should be carried to their ultimate capacity. Modification of operating methods and particularly decrease in the number of deep wells may permit some gain through regulated head lowering. Because of financial, legal and mechanical impediments, such gain will come very slowly and its value must be weighed against the corresponding loss of storage. Responsibility of this board for the maintaining of the city water supply enjoins great deliberation in determining its future course. Gains through water development, over long periods, are often far short of the apparent initial additions. Experience does not support the view that water anywhere on Oahu can be considered as permanently plentiful.

"Accordingly, Dr. Palmer's paper is presented as a primer on the Honolulu ground water system, in an effort to emphasize in simple terms its advantages and limitations. It offers an important beginning in the discussion of the broader problem of the Honolulu water supply, a problem for the solution of which data are being gathered, but on which no conclusive statement has yet been attempted."

Excerpts from Dr. Palmer's report (from pages 1-2):

"Surface water has the advantage that it can be collected in reservoirs at high levels and distributed by gravity without expense for pumping, but it has the disadvantage that it is easily contaminated, is often turbid and discolored, and that droughts may empty the reservoirs. The conformation of the long, narrow valleys and their steep gradients limit markedly the amount of water that can be impounded by a dam of reasonable size. Furthermore, the great variations of rainfall from year to year and the relatively high rate of leakage into the permeable basalt bedrock are serious handicaps to large scale utilization of surface waters.

"High-level ground waters, derived from springs or from tunnels driven into the mountains, are sanitary, clear and sightly and can also be distributed by gravity without pumping expense, but are unfortunately inadequate in amount. The painstaking researches of Dr. Chester K. Wentworth, for the Board of Water Supply, show that it is improbable that any major supply of ground water can be developed by tunnels at high levels in the Honolulu district.

"The main dependence of Honolulu for nearly half a century has been on the artesian part of the main ground water body, which yields water that is of excellent quality but which requires steady expense for pumping. In the last decade considerable water has been obtained by means of shafts and tunnels which reach the free or unconfined part of the same main ground water body as that tapped by artesian wells. The water from the shafts, like that from artesian wells, involves pumping expense. Nevertheless, the high quality and the supposition that the supply was inexhaustible have made the community willing to bear the expense of pumping. Unfortunately, the supply is not unlimited and the penalty will inevitably be paid if we withdraw water, whether by artesian wells or by shafts, from the main ground water body in the rock beneath Honolulu faster than it is replenished."

August, 1946

C. K. Wentworth's paper "Laminar Flow in the Honolulu Aquifer" (published in the Transactions of the American Geophysical Union) presents certain phases of the geology and hydrology of the "artesian basins," (or more accurately "the aquifer") in a manner contributing considerably to technical matters which, although beyond the scope of this (1948) report, will eventually lead to facts having a direct bearing on "conservation."

The following excerpt is of present interest:

"The total average rainfall on the Honolulu watershed for the ten shore-line miles from Diamond Head to Red Hill is about 214 mgd; the rainfall on the area tributary to the main aquifer as outlined through geologic studies is about 123 mgd. Basal infiltration has been estimated as about 40 mgd. Estimates by another method suggest that somewhat over 90 mgd may reach the basal water body and be divided between draft and natural leakage. Without further discussion, we can plausibly take the figures 50 and 100 mgd as reasonably lower and upper limits to the rate of movement of water through the basal body. These figures represent five to ten mgd per shore-line mile. This amount moves through a prism one mile wide, whose thickness and porosity we may postulate within certain limits."

December 12, 1946

Excerpt from Mr. Ohrt's "Foreword" in Mr. Wells
A. Hutchins' 1946 book "The Hawaiian System of
Water Rights"

(from pages vii-viii):

"For many years it has been apparent that the increasing demands of the growing City of Honolulu coupled with cycles of years of less than average rainfall and uncontrolled development and use of the artesian water supply, would eventually cause serious depletion of the ground water. The Board of Water Supply with this knowledge and background in mind, wisely foresaw the need of a study of water rights in Hawaii as the basis for subsequent legislation and other possible action that might be taken towards conserving these vital resources by the control and regulation of ground waters. In 1939 Mr. Philip M. Glick, Chief of the Land Policy Division, Office of the Solicitor, United States Department of Agriculture, was first contacted about the possibilities of such a study. Mr. Glick's friendly and sympathetic understanding of the problem encouraged further negotiations which subsequently resulted in an agreement between that Department and the Board of Water Supply of the City and County of Honolulu for a cooperative study of Hawaiian water rights. Fortunately, it was possible to secure the services for this study of Mr. Wells A. Hutchins, Senior Irrigation Economist, Division of Irrigation Soil Conservation Service, United States Department of Agriculture. Mr. Hutchins, who has been a recognized authority on water rights for many years, is the author of a report covering a similar field entitled 'Selected Problems in the Law of Water Rights in the West.'

"Mr. Hutchins visited Hawaii for a month during 1940 at which time he was able to study at first hand the physical and economic factors relating to water law in Hawaii and to hold conferences with many persons particularly informed on this subject. After returning to the mainland, he spent many additional months in detailed studies of court decisions and statutes before finally compiling the necessary data and writing the report.

"This comprehensive study and resulting report of the Hawaiian system of water rights, completed after some seven years, is considered a valuable contribution to this particular field of research. It should be helpful to us here in Hawaii in formulating the necessary statutes for the control and orderly development of ground waters in the Honolulu-Pearl Harbor area. The Board of Water Supply is grateful to Mr. Hutchins for his painstaking study of this subject and his excellent presentation herewith, and takes considerable pleasure in making this report available in printed form."

December 31, 1946

The Land Laws Revision Commission created by the 1943 Legislature and continued by Act 180 of the 1945 Legislature presented its report to the Governor.

The report contains a summarized history of all land laws and traces their development and changes made therein. One of the interesting conclusions is that "conservation has been notably absent in the administration of the land laws."

February 6, 1947

Report of the Board of Water Supply for the years
1945 and 1946

Excerpts from the Board's report of special interest in this (1948) report, are as follows (from pages 2 and 3):

"Legislative assistance and cooperation is necessary in order that the obligations placed on this Board may be fulfilled to the extent that the adequacy of the water supply may be assured, the watershed and artesian supplies of Honolulu may be safeguarded, and the best interests of the public may be served. Accordingly, this Board, after carefully studying the recommendations of its Manager and Chief Engineer, approves the same and respectfully recommends:

"(1) That this Board cooperate in every way to the end that the Territorial Board of Agriculture and Forestry be enabled to carry out its program for the extension of the Honolulu watershed and the acquisition of privately owned areas therein, and that control of said watershed remain under the able administration of said Board;

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"(3) That the Legislature be requested to enact legislation as contained in the proposed Oahu Ground Water Statute to control the underground water resources of the Island of Oahu;"

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Outstanding excerpts from Mr. Ohrt's portion of the report (within the scope of this (1948) report), are as follows (from pages 12-13):

"FUTURE WATER DEVELOPMENT PROGRAM.--To provide sufficient developed capacity for future needs of the community, a water development program is being formulated to be carried out as labor and finances permit.

Major items in this program are:

- "1. Recharging Tunnels.--This plan comprises the conveying of stream water by means of small diversion dams into horizontal tunnels driven into the Koolau lava to permit the water to percolate down into the artesian aquifer of the Honolulu area. Two projects, one each in Palolo and Nuuanu Valleys, will be undertaken as soon as feasible.
- "2. A ten-million gallon per day centrifugal pump has arrived and will be installed at Halawa to supplement the existing two five million gallon per day units there. The completion of the 42-inch crosstown water main now under construction will make it possible to supply Halawa water to any part of the low-service system in the City, although it will generally be discharged at the eastern end of the City.
- "3. Preliminary studies will be continued for the construction of two underground pumping stations, one in the Kaimuki artesian area and one in the Beretania artesian area. It is expected that the planned underground stations eventually will replace the existing Kaimuki and Beretania artesian well stations.

"FOREST RESERVES.--It is essential that privately owned land within the Forest Reserve be acquired by the government for the protection of the water supply of the City. The Board of Water Supply has taken initial steps by acquiring during the past four years, as finances permitted, four parcels of privately owned land lying within the present forest reserve boundaries.

"These parcels are in Kalihi, Pauoa and Manoa Valleys and were acquired in fee simple. They contain a total of 240.15 acres and were obtained at a cost of \$72,114.

"The control of all land within the forest reserve is required for the protection of the underground water supply that the City of Honolulu is dependent upon. The forest areas should be publicly-owned and steps should be taken immediately to acquire, in fee simple all privately-owned land in the Kalihi, Pauoa and Manoa Valleys. The Board of Water Supply with its limited finances has authorized proceedings in eminent domain to acquire nine parcels of privately-owned land in Kalihi, Pauoa and Manoa Valleys lying within the forest reserve. These parcels total 294.37 acres and the estimated cost of acquisition is \$61,000.

"In connection with the acquisition of the Booth Estate property in Pauoa Valley, the Board of Water Supply also purchased approximately 70 per cent of the water rights to Kahuawai Spring which were adjudicated in 1878. The purchase price of \$5,000 included, in addition to water rights, 40 acres of steep land located in the forest reserve in Pauoa Valley.

| LOCATION | GRANTOR | AREA ACRES | DATE PURCHASED | LIBER | PAGE |
|----------|--|---------------|-------------------|-------|------|
| Kalihi | Harry E. Hoffman, et. al. | 86.0 | Feb, 27, 1943 | 275 | 313 |
| Kalihi | Bishop Trust Co., Ltd. | 59.72 | June 25, 1943 | 281 | 5 |
| Pauoa | Hawaiian Trust Co. (Booth Trust Estate) | 72.89 | Nov. 26, 1946 | 2000 | 432 |
| Manoa | Punahou School | 21.54 | Feb. 2, 1946 | 1944 | 11 |

"WATER RIGHTS.--A separate report on "The Hawaiian System of Water Rights" has been completed by Mr. Wells A. Hutchins, a nationally known authority on this subject. In order to have the report available for immediate study, the Board of Water Supply has had the report printed locally. It is thought that this report will be of considerable value to those concerned with water supply problems in the Hawaiian Islands!"

Mr. Ohrt, in his summation of the report, included the following in his recommendations (from page 126):

"RECOMMENDATIONS

"Indications point to the fact that the war has made the postwar City of Honolulu larger than was formerly anticipated. The providing of an adequate water supply for this community is the responsibility of the Board of Water Supply and in order to fulfill this obligation, your Manager and Chief Engineer submits the following recommendations:

"1. That this Board cooperate in every way to the end that the Territorial Board of Agriculture and Forestry be enabled to carry out its program for the extension of the Honolulu watershed and the acquisition of privately-owned areas therein, and that control of said watershed remain under the able administration of said Board;

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"3. That the legislature be requested to enact legislation as contained in the proposed Oahu Ground Water Statute to control the underground water resources of the Island of Oahu;

"4. That the Board of Supervisors of the City and County of Honolulu be requested to expedite the sewer construction program, especially the sewer trunk and laterals for the Wilhelmina Rise and Waialae areas which have recently developed so rapidly."

1947 Legislative Session

The Legislature passed two important land laws, Act 107 and Joint Resolution 25, which resulted from certain of the recommendations of the Land Laws Revision Commission. Act 107 amended the laws with respect to the use of certain special funds and to methods of appraisal in the acquisition on private lands, and added provision for the improvement of public land to be offered for homesteading or for sale. Joint Resolution 25 requested Congress to amend the Organic Act in various details, particularly with reference to homesteading.

(Neither the Commission's report, nor the acts of the 1947 Legislature, affected the subject matter of this (1948) report. The recommendations presented to the Board of Water Supply herein will include certain proposals in reference to law changes to facilitate the acquisition by the government of perpetual control of all land within the forest reserves.)

March 21, 1947

The proposed Oahu Ground-Water Control Act, sponsored by the Board of Water Supply, was submitted to the Legislature as S. B. 200 and H. B. 418, in practically the same form as H. B. 611 of the 1945 Session.

There was no effective action in the House.

In the Senate the bill was referred to the Select Committee of Oahu Senators, which Committee ended up its report with the following paragraph:

"Your Committee has examined this administration bill in sufficient detail to become convinced of the fundamental importance of establishing some form of ground-water regulation. Its examination has shown the wide range and complexity of various interests in this matter and necessity for very thorough study, with public hearings and an opportunity for all citizens to be heard. It is therefore our recommendation,

after conferring with various interested persons, that this measure be referred to a holdover committee for the extended and detailed study it merits, a study which could not be completed during the balance of this session."

No holdover committee was provided, and thus, once again there was no effective action.

April 1, 1947

Senator Francis H. I. Brown introduced, as Senate Bill No. 304, (an administrative proposal sponsored by the Board of Commissioners of Agriculture and Forestry), a bill "Relating to forest reserves and watersheds; providing for acquisition of rights in private land therefor as well as use of government land; amending sections 1016 to 1018 inclusive of the revised laws of Hawaii 1945; and making an appropriation."

In view of the experience gained by the Board in over 40 years' effort, the bill attempted to recognize the reluctance of principal land owners with respect to parting with fee simple title to their forest lands, and therefore it was proposed that the Territory acquire only the right to control forest lands in perpetuity "for forest reserve purposes." Accordingly, the principal portions of Section 4 of the bill were drafted as follows:

- "(c) The board of commissioners of agriculture and forestry is hereby authorized and directed to acquire control for forest reserve purposes of all lands which it has determined or shall determine to be essential watersheds for domestic water supply. Such determination shall be made by a resolution or resolutions, after consultation with foresters, geologists, hydrographers, sanitary engineers, public health officers and other experts, as may be appropriate, and after public hearing called in the manner set forth in section 466 of the Revised Laws of Hawaii 1945.
- "(d) If control for forest reserve purposes of private lands within said essential watersheds cannot be acquired by voluntary surrender in the manner provided by section 1017 of the Revised Laws of Hawaii 1945, as amended, the board of

commissioners of agriculture and forestry is directed to so inform the commissioner of public lands. The commissioner of public lands is hereby authorized and directed to negotiate with the owners of said lands to obtain such control for forest reserve purposes, hereinafter called "forest reserve rights," or in his discretion, to cause eminent domain proceedings to be instituted to obtain such forest reserve rights, provided, that (without prejudice to the powers of condemnation of the several counties, the board of water supply, city and county of Honolulu, and public utility water companies supplying water for domestic use) forest reserve rights shall not be condemned hereunder in respect to any parcel of land which on the effective date of this act and also at the date of commencement of the eminent domain proceedings, is in actual use for residential purposes. The commissioner of public lands is further directed to assist the board of commissioners of agriculture and forestry, at its request, in the making of surveys, and otherwise as may be of assistance, without reimbursement for such services."

The Board was directed to present a full report on the entire matter to the 1949 Legislature.

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The bill was referred to the Committee on Ways and Means. The Committee took no action other than to recommend, in the last days of the Legislature, that the bill "be filed."

May 8, 1947

The Board of Water Supply authorized the sale of a \$2,000,000 revenue bond issue, the proceeds of which, together with other available funds, to be expended in carrying out projects listed in the Master Plan submitted by Mr. Ohrt.

The Master Plan list represented the Board's first post-war comprehensive improvement program, and in addition to new proposals, it may be considered a re-evaluation of projects considered during past years.

Aside from booster stations, distribution mains, reservoirs and other improvements of no direct pertinence to this (1948) Conservation Report the projects included in the list are:

| | <u>Estimated Cost</u> |
|--|-----------------------|
| Nuuanu Recharge Tunnel | \$ 80,000.00 |
| Pauoa Valley Spring Development and Pipe Line | 100,000.00 |
| Manoa Spring Development | 130,000.00 |
| Palolo Recharge Tunnel | 50,000.00 |
| Waialae Shaft Tunnel Extension | 300,000.00 |

May 22, 1947

Letter by Mr. Ohrt to Chairman and Members of
the Board of Water Supply

Mr. Ohrt reported to the Board that in a conference held on May 12 with the owner of a parcel of land within the Forest Reserve his action was as follows:

"At that time I stated that the problem of water supply to serve the general public was paramount to any individual view and that the development and use of the run-off water in upper Manoa, which would amount to about five million gallons per day, is one of the few available water supplies remaining within the District of Honolulu, and that its use through recharging the Honolulu artesian area is absolutely necessary for the future growth of Honolulu."

The Board indicated general approval of the policy stated in Mr. Ohrt's letter and the purchase of the parcel in question was authorized (and subsequently consummated) for a compromise consideration.

Consideration of the matter by the Board led to discussion of the policy to be followed in further acquisition of lands within forest reserves. Mr. Ohrt was authorized "to submit a complete overall plan showing all land proposed to be acquired within the next five years for further action by this Board."

July, 1947

The monograph "Factors in the Behavior of Ground Water in a Ghyben-Herzberg System" by C. K. Wentworth (published in "Pacific Science" of July, 1947) although dealing with a highly

scientific subject presents it in a manner that (to the reviewer writing this comment) seems unusually understandable even to those of only limited geologic training.

The characteristics of the "diffusion zone," the effect of draft on quality, and the problem of reversibility of the process of saline encroachment, are presented in a manner that should make the paper another of the several contributing to the gradual development of facts which may not become fully established within the next hundred years.

1947

Construction plans were completed by the City and County Public Works Department (under a contract to H. A. R. Austin and R. M. Towill) for the diversion of the Territorial government's portion of the water of the Waiahole Tunnel System to the Suburban Water System in the Koolaupoko District.

Although the construction of the works necessary for such utilization of Waiahole water is not programmed, it seems clear that the needs of Koolaupoko will require the said water and that the 1929 proposals of the Honolulu Sewer and Water Commission, contemplating the use of the Territory's Waiahole water in the District of Honolulu, should be considered revised accordingly.

January, 1948

The Fourteenth Naval District included in its improvement program as the project of highest priority for the fiscal year 1950, a principal shaft and basal water tunnel project at elevation 150 in Waiawa Gulch at an estimated cost, including principal distribution mains, of \$4,108,000.

The principal justification for the project is the need for the integration of the Navy's Pearl Harbor, Pearl City, and Barbers Point water systems into a single system and the desirability of the Navy's recognizing that in the future the Honolulu Board of Water Supply will require the water sources in the Halawa area which are now utilized by the Navy.

In accordance with a cooperative plan suggested to the Navy Department by Captain George Wetsel (CEC) U.S.N., District Public Works Officer, the technical staffs of the Board of Water Supply and of the local office of the United States Geological Survey are participating in the geologic exploration and in the design problems incidental to the Waiawa project. (The first \$2,500,000 for the project was appropriated by Congress early in 1948.)

1948

Pre-election platforms of the Republican and Democratic parties

It is significant that at the 1948 Territorial Convention, each of the parties adopted platform plank with reference to protection of the forest reserve and water supplies. The planks are quoted:

Republican Party (adopted April 24):

"Obtain control of, or acquire forest reserve areas for the protection of our watersheds.

"Support the acquisition of privately owned water rights that are needed for public use."

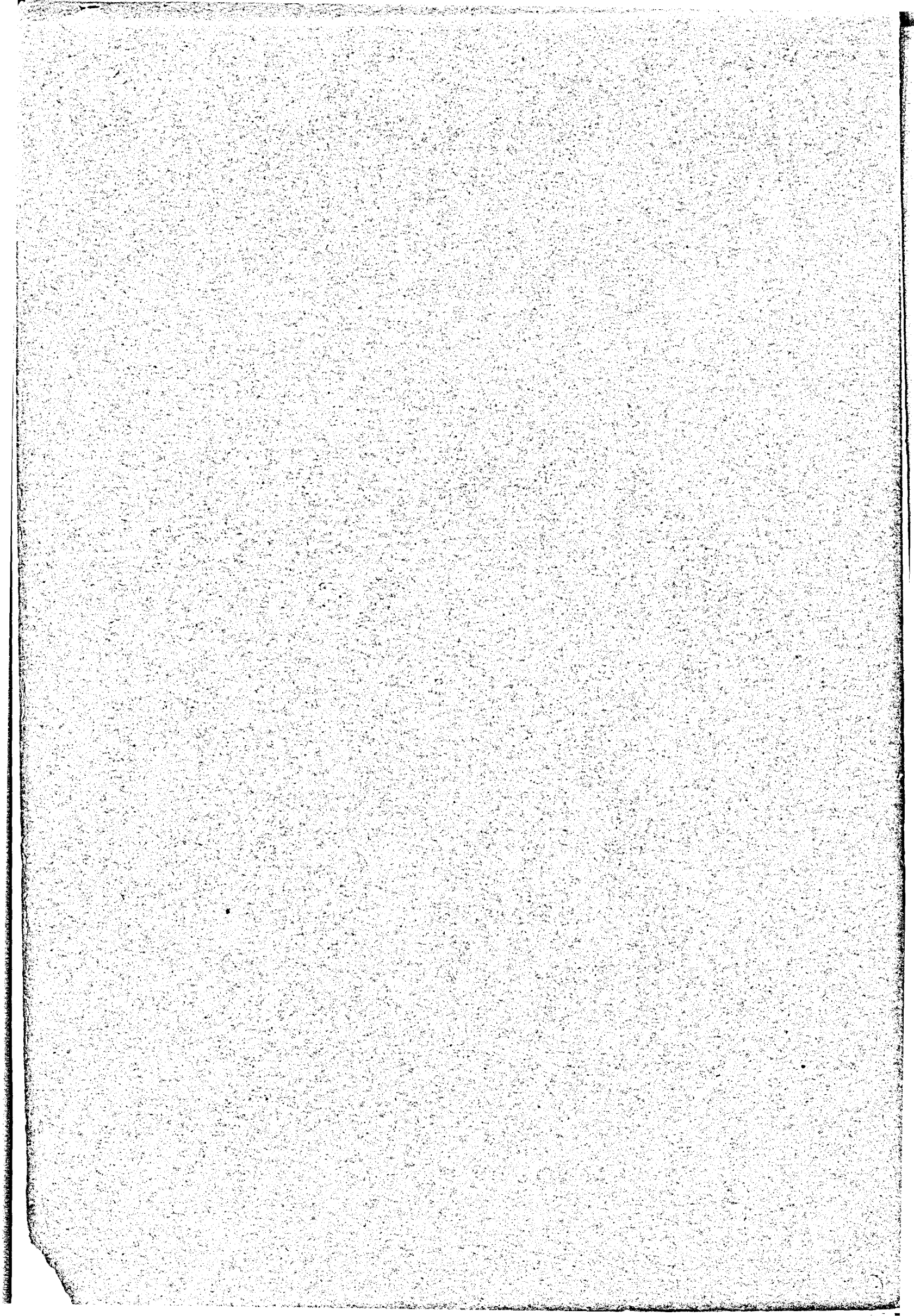
Democratic Party (adopted May 2):

"Protection of Water Supply - We recognize the seriousness of any threat to our domestic and agricultural water supplies and advocate an adequate step be taken to protect the same."

May 26, 1948

The Forestry Board adopted a resolution reciting the ownership status of the Honolulu Watershed Forest Reserve and asking that:

". . . the Governor of the Territory of Hawaii be requested to take legal action through the Office of the Attorney General to prevent a further removal of private lands falling within the Honolulu Forest Reserve from a status of forest reserve cover."





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