MEMORANDUM

To: Mr. Donald Bremner, Chairman
    Environmental Quality Commission

Subject: Environmental Impact Statement for Pump and Controls for
        Keel Well "C", South Kona Water Project, Hawaii

Based upon the recommendation of the Office of Environmental
Quality Control, I am pleased to accept the subject document as satisfactory
fulfillment of the requirements of Chapter 343, Hawaii Revised Statutes.
This environmental impact statement will be a useful tool in the process of
deciding whether or not the action described therein should or should not
be allowed to proceed. My acceptance of the statement is an affirmation
of the adequacy of that statement under the applicable laws, and does not
constitute an endorsement of the proposed action.

When the decision is made regarding the proposed action
itself, I expect the proposing agency to weigh carefully whether the
societal benefits justify the environmental impacts which will likely
occur. These impacts are adequately described in the statement, and,
		together with the comments made by reviewers, provide a useful analysis
of alternatives to the proposed action.

George R. Ariyoshi
Governor
ENVIRONMENTAL IMPACT STATEMENT (REVISED)

PUMP and CONTROLS for KEEL WELL "C"

SOUTH KONA WATER PROJECT

SUBMITTED BY DEPARTMENT OF WATER SUPPLY COUNTY OF HAWAII
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PUMP AND CONTROLS FOR
KEEI WELL "C"
SOUTH KONA WATER SYSTEM

REVISED
ENVIRONMENTAL IMPACT STATEMENT

Submitted by
Department of Water Supply
County of Hawaii

Prepared by
Division of Water and Land Development
Department of Land and Natural Resources

Revised August, 1979

AKIRA FUJIMOTO, Manager
Department of Water Supply
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SUMMARY

This Environmental Impact Statement describes a State funded water development project for the South Kona Water System, Hawaii County, in compliance with the EIS Regulations of the Environmental Quality Commission.

Three wells have been drilled and tested in Keel, South Kona. The first two wells are the present sources for the South Kona System. Development of the third well, Keel Well "C", is the subject of this Impact Statement. The following facilities will be installed and constructed:

- 500 GPM deepwell pump, controls, chlorinators, and appurtenances
- Pump Control Building
- 50,000 gallon control tank
- Booster Pump Station
- 1200 feet of 8-inch pipeline

The deepwell pump will lift water from the basal aquifer to the control tank with spill elevation at 899.5 feet, and the booster station will raise the control tank water to higher levels in the water system. The new 8-inch main will connect these facilities to the existing water system. The cost of improvements is estimated as $500,000.

The proposed pump in Keel Well "C" will increase the supply of domestic groundwater to the system from 0.86 to 1.58 mgd. The safe yield of the system (total source capacity minus largest pumped source) will be 0.86 mgd from two 300 gpm pumps in Wells "A" and "B".

In 1978, the average daily consumption for South Kona was about 0.54 mgd. The maximum day demand (including 10% allowance for losses) was close to 0.88 mgd. The proposed facilities will provide the system with a safe yield which just about matches the 1978 maximum day demand. Although the total system capacity will be 1.58 mgd, this output can be attained only if all three wells are pumped 24 hours per day.

The two earlier wells, Keel Wells "A" and "B" are presently producing water with a chloride content between 125 and 200 parts per million. The new Well "C" has water which has tested at 27 ppm. The new source is hence expected to lower the salinity level of the domestic water in South Kona.

The project site is in an agricultural area on the western slope of Mauna Loa at an elevation of 900 feet. The well site is 1000 feet from an existing country road, 900 feet from the nearest home, and adjacent to macadamia nut and coffee farms.
Construction impacts will be mitigated in part by the separation from the nearest homesites. The work will be controlled by job specifications and field inspections. Some jobs may be provided for South Kona residents, but these would be for the project duration only. Water supply will be increased to South Kona, but the safe yield, as noted previously, would just about meet the 1978 maximum day demand. As present, the impact of breakdown of a single pump is that South Kona would experience a shortage amounting to 50% of the needs on a maximum demand day. When this project is completed, even if one pump breaks down, the remaining two sources will still be able to meet present maximum day demand. As noted also, the new source is expected to lower the chloride content of the drinking water in South Kona.

This project is not expected to produce significant, adverse impacts. The physical environment and endemic biota are not threatened because of the nature of the work, the relative evenness of the terrain, and because the area is an agricultural district. The water development project, although a significant increase in supply capacity over the existing output, actually only meets the maximum day demands of 1978 with a safety feature against pump failure. This impact statement was written because of the general interest in water development projects, and to obtain public input regarding the project. More detailed information is contained in the body of this statement.
ENIRONMENTAL IMPACT STATEMENT

Job No. 8-HW-45
Pump and Controls for Keel Well "C"
South Kona Water System

I. Project Description

The project objective is to install a 500 gpm deepwell pump, chlorinator, 50,000 gallon control tank, booster pump station and 1200 feet of 8" pipeline to connect Keel Well "C" (Figure 1) to the South Kona Water System. The facilities are being constructed in an attempt to keep pace with the burgeoning water demands of the South Kona service area. The low chloride (27 ppm) content of Keel Well "C" water will improve the quality of supply water from Keel Wells "A" and "B" which produce water with about 125 to 200 ppm chlorides.

The control tank and booster station will be located at the well site on a 0.91 acre parcel. Access from the Lower Government Main Road is by a 30-ft. wide easement (0.71 acre) for road and utility purposes.

The project is funded through appropriations from Act 226/SLH 1976, and Act 10/SS 1977. The preliminary estimate of cost is $500,000.

II. The Environmental Setting

A. Location of Project: Keel Well "C" is in West Hawaii, 3 miles southeast of Kealakekua Bay and 2.3 miles northeast of Honaunau Bay (Figure 1). Hualalai (8,251') to the north and Mauna Loa (13,679') to the east provide imposing backdrops for the communities in South Kona.

B. Physical Features at Project Site

1. General Character of Land: The project site is on the lower western slope of Mauna Loa at elevation 900'. The terrain is a gradual (11%) and even slope. Coffee trees are grown west of Keel Well C and a macadamia nut farm is to the north.

2. Soil: Kaimu extremely stony peat, a very dark brown soil about 3 inches thick underlain by fragmented Aa. Permeability is rapid; runoff is slow, and the erosion hazard is slight. The soil is generally not suited to cultivation, but
some areas are used for pasture, macadamia nuts, papaya, citrus and coffee. The natural vegetation on this well-drained, thin organic soil includes Christmas berry, guava, quineagrass and lantana. (Soil Survey of the Island of Hawaii, SCS, 1973).

3. Geology: Mauna Loa rocks are made up of three different units, although all are olivine basalts. The core of the mountain was formed by the Ninole volcanic series of highly permeable rocks which carry fresh water at sea level. An erosional unconformity separates the Ninole lavas from the overlying Kahuku volcanic series which is more than 600 feet thick in places. These highly permeable rocks carry brackish water near shore, but may contain fresh water near sea level farther inland. Pahala ash 5 to 50 feet thick separates the Kahuku from the topmost Kau volcanic series. These extremely permeable kau rocks were formed during prehistoric and historic flows of lava. (Geology of the Hawaiian Islands, H. T. Stearns, 1969).

4. Hydrology: The area in the lee of Hualalai and Mauna Loa receives very little orographic trade-wind rainfall, but obtains considerable moisture from convective type showers. The South Kona rainfall, unlike other areas of the State, is greatest during the summer months. At Keel Well "C", 2.3 miles from the coast, annual rainfall is 45 inches; but only 2 more miles inland, at the Honauau Forest Reserve, the precipitation exceeds 75 inches per year. The Hawaii Water Resources Regional Study (Surface and Ground water Resources Study Element Report) estimates groundwater flux to be about 10 mgd per mile for the wetter parts of West Hawaii.

5. Keel Well "C": Well "C" (2653-01) is 4000 feet south of Well "B" and 5000 feet south of Well "A". Ground elevation is 882 feet; depth of well is 913 feet; casing diameter is 12 inches. From August 7 to August 10, 1978 the well was pumped at rates between 750 and 780 gpm. The original static water level was 4.25 feet msl and the drawdown during the well test varied from about 1.3 feet to 1.5 feet. The chloride content of the pumped water was less than 30 ppm. Figure 2 is a plot of the well test results.
C. South Kona Water Service Area

The South Kona Water System extends along Mamalahoa Highway from Kealakekua in the north to Hookena School in the south. In between, the communities of Captain Cook, Keokea, and Kealia are served by the 11 miles-long pipeline. On the coast, Napoopoo on Kealakekua Bay and the Honaunau City of Refuge are served by this water system. The supply for this network is located in Keel between the coast and Mamalahoa Highway. Figure 3 is a schematic diagram of the South Kona Water System.

Although the facilities are physically contiguous with the North Kona water system, the South Kona system is hydraulically separated from the north by a normally closed gate valve near Kealakekua Village. The water supply, except for emergencies, must therefore originate in South Kona. The two Keel wells, each producing 300 gpm, barely meet the present needs of the extensive service area.

Information contained in the 1977-78 Annual Report of the Hawaii County Board of Water Supply indicates that the present average day consumption is about 0.54 mgd. Assuming system losses of about 10%, and a demand factor of 1.5, the maximum day demand is about 0.88 mgd. Since the two existing sources produce 0.86 mgd, if one pump breaks down, the impact on South Kona is a shortage of 50% of the water needs on a maximum demand day. Even on an average demand day, if a single pump breaks down, the remaining source will be able to meet less than 80% of the demand.

The annual water consumption of South Kona increased by a factor of nearly five from 36 million gallons in 1968 to almost 169 million gallons (Figure 4a) in 1977. This represents a growth in demand of almost 19% compounded annually. During the same period, the number of service connections almost tripled from 306 to 913, and the average consumption per household has increased from 318 to 507 gallons per day (Figure 4b). Clearly, the water consumption habits of South Kona have changed; not only has the total use increased, each household now demands much more water.

The changes in the character of South Kona as reflected in the water consumption changes of the seventies, began in the sixties. The work force, which in 1960 was composed largely of self-employed and unpaid family agricultural workers, by 1970 (as coffee production costs rose) turned into a predominant group of clerks, craftsmen, laborers and service personnel working for private wages and salaries (Kona Community Development Plan, Donald Wolbrink & Associates, Inc. 1975). The age and ethnic character of the district also changed, as the number of Caucasians increased and the number of Part-Hawaiians and Japanese decreased, while the number of elderly people increased.
Although the City of Refuge and Kealakekua Bay are important visitor sites, South Kona has no resort development, and no hotel units are definitely planned or proposed for this area (State Tourism Study, DPED, 1978).

D. Historic and Archaeological Sites

The West Hawaii coastal tract "is one of the richest areas in archaeological, historical and legendary materials. All threads of Hawaiian culture, physical remains and traditional history are found" (Recreation Program Handbook, DLNR, 1978). The Kealakekua Archaeological and Historical District was nominated to the National Register of Historic Places in 1972; and the Honuakau City of Refuge was placed on the NRHP in 1966. Numerous other archaeological remains are scattered along the coast between Kealakekua and Honuakau Bays. Historically, South Kona was the stage for Captain James Cook's landing and eventual demise in Hawaii, and the Battle of Mokuohai may have been Kamehameha's steppingstone to the conquest of the Hawaiian Islands chain. At the project site, however, no evidence of archaeological significance was uncovered during construction of the access road and drilling of Keel Well "C".

E. Biota

Endemic upland birds with ranges which could possibly extend to the project site include the Hawaiian Crow (Alala), Hawaiian short-eared owl (Pueo), and the Hawaiian Hawk (Io). The Nene is another possibility, but its present habitat is high on the sparsely vegetated slopes of Hualalai and Mauna Loa. Endemic forest birds would generally be found above 2000' elevation (Hawaii's Birds, Hawaii Audubon Society, 1975).

Endemic terrestrial mammals of the Big Island include the Hawaiian (Hoary) Bat, Feral Dog, Hawaiian Rat, and Feral Pig (Recreation Program Handbook, DLNR, 1978).

The project site is covered by grasses and weeds and is located adjacent to macadamia nut and coffee farms.

III. Relationship of the Action to Land Use Plans, Policies and Controls

Detailed Land Classification is E262. The overall rating of "E" is the bottom value of a five-class productivity rating system. The number 262 refers to a land type "poorly suited for agriculture". The project is a permitted use in E262 lands under HRS 205-2.

The site is in a State Land Use Agriculture district. The proposed facility is a permitted use in the "A" district as defined in the State Land Use District Regulations.
County zoning for the project site is AG-5, and the General Plan designation is "orchards", as established by Ordinance No. 439, and shown on the Land Use Allocation Map, County of Hawaii.

IV. Probable Impacts

The portion of land on which Kei Well "C" is located was unused and weed-covered. No archaeological artifacts were discovered during construction of the access road and drilling of the well. Construction noise and dust, erosion hazards and historical sites are controlled or protected by existing laws and job specifications which will be performed project inspections. Most of the work will be performed away from public roads, although the project may generate some minor traffic inconvenience during mobilization and demobilization. The construction will be confined primarily to the well site which is 900 feet from the nearest home. Pipeline work, except for connection to the existing system, is limited to installation within the existing access road. Because of the above factors, construction is not expected to produce adverse short-term impacts.

The project may provide some jobs for South Kona residents, although most of these positions may be for the project duration only. Some project funds may filter into the local economy through payrolls and to fulfill the ancillary needs of the contractor and workers during the life of the project.

The 500 gpm pump for this project, together with the existing 300 gpm pumps in Kei Wells "A" and "B" will provide a total source capacity of 1.58 mgd (if the pumps are operated for 24 hours). The present capacity is 0.86 mgd. In a typical system, the source is designed to meet demand on a "maximum" day (usually assumed as one-and-one-half times the average daily demand plus 10% for system losses) and storage is designed to accommodate fire flow or water demand for one day.

The average daily demand for South Kona in 1978 was 0.54 mgd. The maximum day demand was therefore about 0.88 mgd. If the growth in demand continues at the rate experienced in 1978 (extrapolated on Figure 5), the difference between the maximum day demand and the present capacity (0.86 mgd) of Kei Wells "A" and "B" will continue to increase until a new source is developed. In its 1971 "Water Master Plan" the County expected a "fully developed" (according to the existing zoning) South Kona to require
about 0.63 mgd of water, exclusive of the needs of Napoopoo which was not part of the system then. By the time this project is completed in 1980, the new 500 gpm pump will probably relieve a shortage in South Kona.

As noted earlier, if one of the two existing pumps breaks down, the remaining 300 gpm pump can only meet half of the maximum day demand, and 80% of the demand on an average day. When the new Keel Well "C" source is added to the system, even if the largest (and newest) source pump breaks down, the remaining two pumps will be able to meet present maximum day demand. This project will therefore reduce the impact of pump breakdown from a possible 50% shortfall to zero shortage on a maximum demand day.

Besides increasing the source capacity, this project will provide a supply which is less salty (27 ppm chlorides) than the water from Wells "A" and "B" (200 ppm chlorides). The new source is at least 4000 feet away from the other sources and water quality should not be affected by operation of Wells "A" and "B".

V. Unavoidable Adverse Effects

Construction noise and dust, as well as some traffic inconvenience, especially during mobilization, would be unavoidable. However, pollution control laws require the contractor to operate within specified guidelines. The major part of the project is also more than 1000 feet away from the existing roadways, and the separation should mitigate the construction impacts.

Some grading will be required for the construction of the booster station and control tank, but because of the relatively even character of the terrain, earthwork will be minimal. Most of the area was graded prior to well drilling and testing.

VI. Alternatives

Other sites could be and were considered for a well source. The use of Keel Well "C" entails the expense of pumping through a long and relatively small transmission line. The operation costs could be reduced by a well closer to Wells "A" and "B", but the chloride content of the water would probably be around 200 ppm instead of Well "C"'s 27 ppm.
Since no perennial streams nor sewage systems are available, use of surface or recycled water was not considered. Desalination of brackish or salt water at the coast would require installation of over two miles of new pipeline, booster stations, high pumping costs, and construction of a desalting plant.

Postponing this project to a later time would probably mean shortages within one or two years, if not sooner. Actually, although the present maximum yield of 0.86 mgd meets the present maximum day demand, the safe yield (total capacity minus the largest source) is only 0.43 mgd, which is less than the 1977 average day demand. In this respect, this project is already overdue, since the present system safe yield cannot meet the average day demand. The "No-Action" alternative is therefore out of the question.

One other alternative could be considered. This would involve use of water developed in North Kona and piped to South Kona. Although the pipeline is available, the 8-inch main is relatively small and includes several booster stations along Mamalahoa Highway. Also, the North Kona system presently can be regarded as an emergency standby for South Kona. If some North Kona water is committed to everyday use in South Kona, the standby capability of the North Kona system would be diminished. Because the 8-inch main would have high friction losses and require booster pumping costs, and because the South Kona system needs the North Kona system as a backup source, the Keel Well should be developed for the needs of South Kona.

VII. Short-term Uses of Environment and Long-term Productivity

About 1.6 acres of land for the site and access road will be taken out of potential agricultural use, but the site is not now actively used for agricultural production. South Kona includes thousands of acres zoned for agriculture, and land required for this project is insignificant in the overall picture.

Use of groundwater from Keel Wells "A", "B", and "C" will be monitored to assure the long-term productivity of the aquifer as a source of domestic water.

VIII. Mitigation Measures

As noted previously, job specifications, construction inspection and Hawaii statutes control construction and protect historic finds. Monitoring of well water withdrawal
and quality have also been mentioned as measures to protect the quality of the aquifer. Spacing of Keei Well "C" 4000 feet south of Well "B" is itself a measure to protect against mutual well interference and possible degradation of water quality.

IX. Irreversible Commitment of Resources

The only irreversible commitment of resources would be for labor and materials required to construct and operate the proposed facilities. A small plot of non-producing agricultural land will be committed to public utility use, but such use is not irreversible. No cultural resources are affected by this action. Groundwater is a renewable resource, continuously replenished by percolation of rainfall.

X. Parties Consulted in the Preparation of the EIS

A. Hawaii County
   Planning Department
   Department of Public Works

B. State
   Division of State Parks, Outdoor Recreation and Historic Sites, DLNR
   Division of Fish and Game, DLNR
   Department of Health

C. Others
   Bishop Estate

XI. Comments and Responses

Reproductions of comments and responses made during the consultation process are included in Appendix A.

XII. Necessary Approvals

Construction plans approvals will be obtained from the Manager-Chief Engineer of the Hawaii County Department of Water Supply and the Manager-Chief Engineer of the Division of Water and Land Development. Prior to use of Keei Well "C", approval must be obtained from the State Health Department for use of the new raw water source under Chapter 49 of the Public Health Regulations.
XIII. Figures

Figure 1: Site Map, State Land Use Districts
Figure 2: Keel Well "C" 2653-01, Pumping Test No. 1
Figure 3: Schematic Diagram, South Kona Water System
Figure 4a: South Kona Consumption and Services
   4b: South Kona Consumption per Connection
Figure 5: Supply and Demand, South Kona Water System
Keei Well C-2653-01
Pumping Test No. 1
South Kona, Hawaii

Figure 2
XIV. References


"Surface and Ground Water Resources" (an unpublished report of the Hawaii Water Resources Regional Study), 1975

"Annual Report", Department of Water Supply, County of Hawaii, Reports from 1968 through 1978

"Kona Community Development Plan", Donald Wolbrink and Associates, Inc., prepared for the County of Hawaii, 1975


"Detailed Land Classification - Island of Hawaii", Land Study Bureau, University of Hawaii, 1975

"The General Plan, County of Hawaii", Ordinance No. 439, County of Hawaii, 1971

"Water Master Plan, Island of Hawaii", Department of Water Supply, County of Hawaii, 1971
Akira Fujimoto, Director  
Department of Water Supply  
County of Hawaii  
P.O. Box 1820  
Hilo, Hawaii 96720

Dear Mr. Fujimoto,

SUBJECT: Environmental Impact Statement for Pump  
and Controls for Ke'ei Well "C", South Kona,  
Hawaii

We have reviewed the subject document and offer the  
following comments for your consideration:

1. Page 3

   We question some of the conclusions concerning  
   increased water demand in the project area. In the  
   discussion, increased demand is mainly attributed  
   to new housing and to increased average household  
   consumption. We suggest that a significant factor  
   affecting the increased consumption rate may also  
   be that many households previously served by water  
   catchment systems are now relying on the county system.  
   Consequently, projections for future water demand  
   should take that phenomenon into consideration, as  
   well as the demand generated by new housing.

2. Page 5

   According to the EIS, the capacity of Ke'ei Wells  
   A, B, & C will be approximately 1.58 mgd. The maximum  
   day demand is about 0.88 mgd. With the capacity  
   increased by almost 80 percent, what is the justification  
   for such increase? Does the increased capacity conform  
   to the county general plan? What is the population that  
   the proposed action will service? Because the project  
   seems to be somewhat oversized, a discussion is warranted.
3. **Alternatives**

Although alternatives are considered in the EIS, there is no discussion regarding people retaining the water catchment tanks or moving the well further mauka to reduce the impact of increased chloride content in the water.

4. **There should be further discussion on the water quality of the existing wells.** During times when overpumping of the existing wells occur, the chloride content is increased. If the proposed wells is pumped within the same basal lens, there may be a possibility of increased chloride content. What studies or data demonstrate that well C is not within the aquifer?

5. **The EIS lacks discussion on secondary impacts.** Because water service is one of the key factors of growth within an area, there should be discussion on the stimulation of growth due to the proposed action. How many people will the system eventually service? What is the existing population that wells A and B service? How many existing homes still use water catchment tanks? How many homes presently having water catchment tanks will be hooking up to the water system? How does the proposed action affect the future land use patterns? What subdivisions will the proposed action service? Will Bishop Estates subdivision in keei be included in this proposal?

6. **Pages 7 & 8**

The EIS mentions that water withdrawal will be monitored. Who will monitor the water quality? How often will this be done?

We trust that these comments will be helpful to you in preparing the revised EIS. An attachment sheet lists the commenting agencies and/or organizations.

We thank you for the opportunity to review the EIS. We look forward to the revised statement.

Sincerely,

[Signature]

For Richard L. O'Connell
Director

Attachment
LIST OF COMMENTING AGENCIES AND/OR ORGANIZATIONS

FEDERAL
* Fourteenth Naval District
* Department of the Air Force
* U.S. Fish and Wildlife Service
* Department of the Army
* Soil Conservation Service

STATE
* Department of Planning and Economic Development
  Department of Accounting and General Service
  Department of Defense
* Department of Land and Natural Resources (Historic Preservation Program)

COUNTY OF HAWAII
* Department of Parks and Recreation
* Planning Department
* Department of Public Works

* denotes comment forwarded by reviewer
August 27, 1979

Mr. Richard L. O'Connell, Director
Office of Environmental Quality Control
Office of the Governor
550 Halseakaula Street, Room 301
Honolulu, HI 96813

PUMP AND CONTROLS FOR KEEI WELL "C"

We have reviewed your comments on our EIS for the subject project and respond as follows:

1. Conclusions on Increased Water Demand. For areas now serviceable by the South Kona distribution system, the number of households still relying on water catchment for everyday needs is negligible. The areas which still utilize catchment could only be served if the distribution system is extended. Our experience has been that almost all serviceable households connect as soon as the County system is available.

2. Capacity of Keel Wells "A," "B," and "C." We tried to point out in the EIS that the 1978 maximum day demand of 0.88 mgd already exceeded the present pumped capacity of 0.66 mgd in Keel. We further pointed out that if one of the existing Keel pumps breaks down, the remaining one can provide only 0.43 mgd or less than the average day demand of 0.54 mgd. While we could speculate that the proposed 0.72 mgd pump in Well "C" could theoretically support a population of about 4000 persons, the consumption statistics amply indicate that the proposed pump is long overdue because no backup is available to meet the present average day demand.

3. Alternatives. We do not feel that the retention of water catchment tanks is a socially acceptable alternative. Our experience has been that almost every serviceable household connects to the system as soon as service is available. This project will have no direct impact on those who decide not to connect to the public system, and the number of households opting for retention of water catchment is not now and will not have a significant impact on the Keel water sources.

On the matter of well relocation, since a well (a hole in the ground) cannot be "moved," by "moving the well further mauka," we assume you mean drilling a new, deeper hole. Besides imposing an unnecessary added cost to the project, we do not see what can be gained by such an alternative since Keel Well "C" has already been drilled and the well water has been tested at 27 ppm, a chloride level lower than most well sources in the State.

...Water brings progress...
4. Water Quality of Keei Wells. During a two-year period from June 1976 to July 1978, the chlorides in Keei Wells "A" and "B" ranged between 113 ppm and 225 ppm. Keei Wells "A," "B," and "C" are arranged in a north-south orientation (Figure 1.). The direction of groundwater flux is from east (mauka) to west (makai), or perpendicular to the north-south alignment of the wells. This arrangement and the separation of Well "C" (4000 feet from "B"), plus a mode of operation utilizing Well "C" with either Well "A" or "B," should provide improved quality water for South Kona, not worse as you fear, even though all three (3) wells tap the basal aquifer. Pumping test results for Wells "A" and "B" have been added to Appendix "C."

5. Stimulation of Project on Growth. We have tried to point out that even with the proposed pump in Well "C" included in the analysis, the "safe yield" of the system (total sources minus largest pump source) is only adequate to support the present resident population of slightly less than 5000 persons. We also noted that based on past use, the proposed 0.72 mgd pump could theoretically support an additional 4000 persons but only if all three (3) pumps never broke down and lasted forever. These are unrealistic suppositions for planning and operating a water system. A corollary to this is that any large subdivision or land project would require a concomitant development of a new water source.

If we consider the yield of the Keiei system equal to total sources minus oldest pump, on the other hand, we would have 1.15 mgd available or about 30% more than the 1978 customers required. The water supply would not be a hindrance to the present growth trends in South Kona; but if the largest pump (the proposed Keiei Well "C" pump) breaks down, South Kona may have a shortfall in supply and the chloride content would probably be close to 200 ppm.

6. Monitoring Water Quality. The Department of Water Supply will maintain a continuous record of well level and pump discharge and arrange for periodic sampling for chlorides, bacteriological counts and chlorine residuals, consistent with accepted utility practices, but within our operational capabilities.

We thank you for your input and apologize for our late response. Your comments and this response will be included in the Revised EIS which we will file shortly.

Akira Fujimoto
Manager
Environmental Quality Commission  
350 Halekauwila St., Rm. 301  
Honolulu, Hawaii 96813

June 18, 1979

Dear Sir:

Subject: Comments on EIS for Pump and Controls for Keel Well "C", South Kona Water Project

Thank you for sending the subject EIS for our review and comments. We have the following points for your consideration:

1. Based on the trend of rising chlorine (Cl) during the pump testing (Cl rose from about 20-27 ppm after 3 days, Figure 2), it seems highly unrealistic to expect Cl to remain this low during long-term use (p. 6, a probable impact is producing 27 ppm Cl water from this well to mix with Keel Wells A & B). Mr. Dan Lum apparently agrees with this assessment and has stated that the Cl content could possibly rise to a range of 100 to 200 ppm (Memo of March 30, 1979 in Appendix B).

2. Bacteriological data have not been included in this EIS to justify the installation of a chlorination for the Keel Well "C". What is the bacteriological quality of the existing water supply? Is it chlorinated and, if so, what residue is maintained?

3. A comparison of the 3 wells should be given and the impact of chlorinating drinking water supplies should be considered.

Sincerely,

Yu-Si Fok, Professor  
WRRC EIS Review Coordinator

cc: H. Gee  
F. Peterson  
Department of Water Supply, Hawaii County

AN EQUAL OPPORTUNITY INSTITUTION  
2540 Dole Street - Honolulu, Hawaii 96822
August 27, 1979

Mr. Yu-Si Fok, Professor
WRRC EIS Review Coordinator
Water Resources Research Center
University of Hawaii
2540 Dole Street
Honolulu, HI 96822

PUMP AND CONTROLS FOR KEEI WELL "C"

Thank you for your comments on the EIS for the subject project. We apologize for our late response. Our reply is as follows:

1. Chloride Levels. We did not intend to imply that the chloride level in Well "C" will forever remain at 27 ppm nor did we intend to imply that 500 gpm at 27 ppm mixed with 300 gpm (or 600 gpm if all three 3) wells are pumped) water at 200 ppm will produce 27 ppm water. You correctly quoted the memorandum on the pumping test that the "chloride content could possibly rise to a range of 100 to 200 ppm," but failed to mention that this content would be reached only with a 700 gpm pump. The memorandum also suggests "an initial production rate of 500 gpm...at which rate..."the chloride content of the pumped water should remain below 100 ppm."

2. & 3. Chlorination. Our groundwater supplies are normally treated with continuous chlorination during pumping, maintaining a range of 0.35 to 0.8 ppm residual chlorine. We do not, at present, have an alternative operational method for disinfecting our water supply, and we would not consider using the Keel sources without disinfection as a normal practice. We stated in the EIS that Wells "A" and "B" are 5000 feet and 4000 feet, respectively, north of Well "C," and that the earlier wells could produce water with 200 ppm chlorides. We do not expect significant mutual interference between the earlier wells and Well "C" because of the physical separation coupled with the fact that the groundwater flux is perpendicular to the alignment of the wells. Pumping test results of Wells "A" and "B" have been added as Appendix C of the EIS.

Akira Fujimoto
Manager

...Water brings progress...
June 12, 1979

Office of Environmental Quality Control
550 Halekauwila Street
Room 301
Honolulu, Hawaii 96813

Dear Sirs:

SUBJECT: Pump and Controls for Keel Well "C"
South Kona Water Project Job No. 8-HW-45

Thank you for the opportunity to comment on the Environmental Impact Statement for the above named project.

On June 11, 1979, Pat Beggerly, an archaeologist from this office conducted a reconnaissance survey on the area of impact for Job 8-HW-45 and found that no archaeological resources are apparent on the surface.

Because the area is heavily vegetated it is possible that sites were not located during the reconnaissance it is therefore our recommendation that the applicant be informed that in the event that any unanticipated sites or cultural remains such as shell, bone or charcoal deposits; human burials; rock or coral alignments, pavings or walls are encountered during construction that work should stop and this office should be notified immediately.

Sincerely yours,

[Signature]

Ralston H. Agata
Acting Director
Historic Preservation Program

cc: Dept. of Water Supply
County of Hawaii
July 23, 1979

Mr. Ralston H. Nagata  
Acting Director  
Historic Preservation Program  
Division of State Parks  
P. O. Box 621  
Honolulu, HI  96813

PUMP AND CONTROLS FOR KEEL WELL "C"

Thank you for your comments on the Environmental Impact Statement  
for the above project. Please rest assured that if any archaeological  
sites or cultural remains are encountered during construction, work  
will stop and your office will be notified immediately.

Akira Fujimoto  
Manager

... Water brings progress ...
MEMORANDUM

To: Department of Water Supply
   County of Hawaii
   P.O. Box 1820
   Hilo, Hawaii 96720

From: Deputy Director for Environmental Health

Subject: Environmental Impact Statement (EIS) for Pump and Controls for Kekii Well "C", South Kona Water Project

Thank you for allowing us to review and comment on the subject EIS. We would like to reiterate our comment on the preparation notice. The proposed additions to the test facility will qualify the Kekii Well "C" as a new source of potable water. As such, Section 29 of Chapter 49 requires approval of the source by the Director of Health prior to its use.

This approval is based primarily on information required to be submitted under that section.

We realize that the statements are general in nature due to preliminary plans being the sole source of discussion. We, therefore, reserve the right to impose future environmental restrictions on the project at the time final plans are submitted to this office for review.

cc: Office of Environmental Quality Control
July 23, 1979

Dr. James S. Kumagai  
Deputy Director of Environmental Health  
Environmental Protection and  
Health Services Division  
Department of Health  
State of Hawaii  
P. O. Box 3378  
Honolulu, HI  96801

PUMP AND CONTROLS FOR KEEI WELL "C"

Thank you for your comments on the Environmental Impact Statement for the above project. We will submit an application for approval of the new source as required by Section 29, Chapter 49, of the Public Health Regulations.

Akira Fujimoto
Manager

...Water brings progress...
Office of Environmental Quality Control
550 Halsey St, Room 301
Honolulu, Hawaii 96813

11 Jun 1979

Gentlemen:

The Environmental Impact Statement (EIS) for Pump and Controls for Koolau Well 'C', South Kona Water Project has been reviewed and we have no comments to offer at this time. There are no Army installations or activities in the vicinity of the proposed project.

The EIS is returned in accordance with your request.

Sincerely,

1 incl
As stated

CARL P. RODOLPH
Colonel, CE
Director of Engineering and Housing

Copy Furnished:
Department of Water Supply
County of Hawaii
P.O. Box 1820
Hilo, Hawaii 96720

Original signed by E.K. Shirem...
DEEP (Mr Shiroma, 449-1831)

SUBJECT: Pump and Controls for Keel Well "C", South Kona Project

To: Office of Environmental Quality Control
   550 Halekauwila St., Room 301
   Honolulu, Hawaii 96813

1. This office has reviewed the subject EIS and has no comment to render relative to the proposed project.

2. We greatly appreciate your cooperative efforts in keeping the Air Force apprised of your project and thank you for the opportunity to review the document.

Signed by

ROBERT O. K. CHING
Chief, Engrg & Envm'l Plng Div
Directorate of Civil Engineering

Cy to: Dept of Water Supply
County of Hawaii
P. O. Box 1820
Hilo, Hawaii 96720

RECD JUN 7 1979
Mr. Akira Fujimoto
Manager
Department of Water Supply
County of Hawaii
PO Box 1820
Hilo, HI 96720

Dear Mr. Fujimoto:

We have reviewed the environmental impact statement for the pump and controls project for Keesi Well "C" - South Kona Water System - dated April 1979. We have no comments on the project. The project does not affect any of our planning activities or other areas of jurisdiction. We thank you for the opportunity of participating in the review process.

Sincerely yours,

KISUK CHEUNG
Chief, Engineering Division
May 31, 1979

Office of Environmental Quality Control
550 Halekauila Street, Room 301
Honolulu, HI 96813

SUBJECT: ENVIRONMENTAL IMPACT STATEMENT
PURP AND CONTROLS FOR KEEI WELL "C"
SOUTH KONA WATER PROJECT

Thank you for affording us an opportunity to review the subject
environmental impact statement.

We have reviewed the subject statement and have no comments to offer.

/EDWARD HARADA
Chief Engineer

cc: Department of Water Supply
May 30, 1979

Office of Environmental Quality Control
550 Halekauwila Street
Room 301
Honolulu, HI 96813

Gentlemen:

EIS-South Kona Water System,
Pump and Controls for Keai Well "C"
Job No. 2-HW-45, Keai 2nd, South Kona
(TTM: C-3-08:portion of 41), Hawaii

Thank you for sending us the subject EIS. We have reviewed the text and have no adverse comments to offer.

Sincerely,

SIDNEY FUKU
Director

BS: wkm

cc: Dept. of Water Supply

RECU MAY 31 1979
MAY 30 1979

Mr. Richard L. O'Connell
Director
Office of Environmental Quality Control
550 Hahamoku Street, P.O. Box 301
Kona, Hawaii

Dear Mr. O'Connell:

Subject: EIS for Pump and Controls for Keah Nui
"C", South Kona Water Project

Thank you for this opportunity to review and comment on the subject project.

The project will not have any adverse environmental effect on any existing or planned facilities serviced by our department.

Very truly yours,

HIROKA HIBISHI
State Comptroller

cc: /Dept. of Water Supply, Hawaii County
June 19, 1979

Mr. Richard L. O'Connell
Director, Office of Environmental Quality Control
550 Halekulani St., Room 301
Honolulu, Hawaii 96813

Dear Mr. O'Connell:

Subject: Pump and Controls for Keesi Well "C" South Kona Water Project - Environmental Impact Statement

We have reviewed the subject environmental impact statement and have no comments to offer.

Thank you for the opportunity to review this document.

Sincerely,

Jack P. Kanalz
State Conservationist

Enclosure: EIS

cc: Department of Water Supply
    County of Hawaii
    P. O. Box 1820
    Hilo, Hawaii 96720
May 25, 1979

Ref. No. 9117

Mr. Richard L. O'Connell, Director
Office of Environmental Quality
Control
550 Palokakuila Street, Room 301
Honolulu, Hawaii 96813

Dear Mr. O'Connell:

Subject: Environmental Impact Statement, Pump and Controls for Keel Well "C," South Kona Water Project

We have reviewed the subject EIS and find that it has adequately assessed the major environmental impacts which can be anticipated from the implementation of this project.

Thank you for the opportunity to review and comment upon this document.

Sincerely,

HIDETU KONNO

cc: Department of Water Supply
    County of Hawaii
Mr. Richard L. O'Connell  
Director  
Office of Environmental Quality Control  
550 Halekauwila Street, Rm. 301  
Honolulu, Hawaii  

Dear Mr. O'Connell:  

Subject: EIS for Pump and Controls for Keel Well "C", South Kona Water Project  

Thank you for this opportunity to review and comment on the subject project.  

The project will not have any adverse environmental effect on any existing or planned facilities serviced by our department.  

Very truly yours,  

HIDEO MURAKAMI  
State Comptroller
Environmental Quality Commission  
Office of the Governor  
State of Hawaii  
250 Middle Street, Room 301  
Honolulu, Hawaii 96813

Subject:

Perp and Controls for Kea'au Well #C  
South Kona Water Project  
Environmental Impact Statement

The Environmental Impact Statement for Perp and Controls for  
Kea'au Well #C has been reviewed and the Navy has no comments to offer.  
For your record, the subject EIS is returned.

Thank you for the opportunity of reviewing the EIS.

Sincerely,

J. E. (ML)  
Lt. Commander, C9, US  
Navy District Civil Engineer  
By direction of the Commanding

Copy to:  
Dept of Water Supply  
County of Hawaii  
P.O. Box 1820  
Honolulu, Hawaii 96820
Office of Environmental Quality Control  
550 Halekaunui Street, Room 301  
Honolulu, Hawaii 96813  

Dear Gentlemen:  

Pump and Controls for Ke'ei Well "C"  
South Kona Water Project  

Thank you for sending us a copy of the "Pump and Controls for Ke'ei Well "C", South Kona Water Project, Environmental Impact Statement. We have no comments to offer at this time. The attached document is returned for your use.  

Yours truly,  

[Signature]  
WAYNE R. TOMOYASU  
Major, CE, HARN  
Contr & Engr Officer  

Enclosure
June 6, 1979

Office of Water Quality Control
540 Kapiolani Boulevard, Room 301
Honolulu, Hawaii 96813

For: H.T. Camp and Controls
Koolau "C"
South Foa, Hawaii


We have performed referenced Environmental Impact Statement and
determined that the proposed project will have little if any
adverse impacts on fish and wildlife resources. In view of this
we have no additional comments to offer.

Please note this opportunity to comment.

Sincerely yours,

[Signature]

Manager, Water Quality, Hilo, HI

[Organizational Markings]

Save Energy and You Serve America
July 3, 1979

Akira Fujimoto, Director
Department of Water Supply
County of Hawaii
P. O. Box 1820

SUBJECT: Environmental Impact Statement for Pump and Controls for Keii Well "C", South Kona, Hawaii

Dear Mr. Fujimoto,

We have received a comment on the subject statement dated June 20, 1979. We are transmitting a copy of the comment for your appropriate action.

Sincerely,

Richard L. O'Connell
Director

attachment
Office of Environmental
Quality Control
550 Halekauwila St., Room 301
Honolulu, Hawaii 96813

Gentlemen:

Subject: Environmental Impact Statement
Pump and Controls for Kesi Well "C"
South Kona Water Project

Thank you for giving us the opportunity to review and
comment on the above-captioned statement. We have no sub-
stantive comments which can improve the document.

Very truly yours,

[Signature]
Ryokichi Higashionna
Mr. Akira Fujimoto  
Manager  
Department of Water Supply  
County of Hawaii  
25 Anuenue Street  
Hilo, Hawaii 96720

Dear Mr. Fujimoto:

Subject: Pump and Controls for Keai Well "C"  
South Kona Water System, Hawaii

We would appreciate it if our agency be consulted in the preparation of the EIS for the subject action.

Very truly yours,

RIKIO MISHIKOA  
State Public Works Engineer

cc: DLNR, Div. of Water and Land Dev.
Mr. William Y. Thompson  
Chairman of the Board  
Department of Land & Natural Resources  
P. O. Box 621  
Honolulu, Hawaii  96809

Dear Mr. Thompson:

Subject: Request for Comments on Proposed Environmental Impact Statement (EIS) for Job No. 8-HW-45, Pump and Controls for Keel Well "C", South Kona Water System

Thank you for allowing us to review and comment on the subject proposed EIS.

It is our understanding that to date, Keel Well "C" has been used only as a test facility. The additions and intended use of the existing facility will qualify it as a new raw water source, and as such will make it subject to the terms and conditions of Part D of Public Health Regulations, Chapter 49, Pocable Water Systems. The requirements of this section must be fulfilled before the public can be served by this source.

We realize that the statements are general in nature due to preliminary plans being the sole source of discussion. We, therefore, reserve the right to impose future environmental restrictions on the project at the time final plans are submitted to this office for review.

Sincerely,

[Signature]

JAMES S. KUMAGAI, Ph.D.  
Deputy Director for  
Environmental Health

cc: DHO, Hawaii
February 26, 1979

Mr. Rikio Nishioka
State Public Works Engineer
Dept. of Accounting and
    General Services
State of Hawaii

Dear Mr. Nishioka:

Pump and Controls for Keel Well "C"
    South Kona Water System, Hawaii

Your request to the Hawaii County Department of
Water Supply to be a consulted party on the above project
is acknowledged. A copy of the EIS-Preparation Notice
which was filed with the EQC is enclosed for your use.

Your comments on our EIS-Preparation Notice and
any information on the impacts our proposed action may
have on State Public Works projects in South Kona would
be appreciated.

Very truly yours,

ROBERT T. CHUCK
Manager-Chief Engineer

LA:jes
Enc.
November 27, 1978

Dr. James S. Kumagai  
Deputy Director for Environmental Health  
Department of Health  
State of Hawaii  

Dear Dr. Kumagai:

Job No. 8-HW-45, Pump and Controls  
for Keel Well "C", South Kona Water System

Thank you for your comments on our draft EIS. Keel Well "C" is, as you correctly noted, only a test facility at present and will not be connected to the county public water system until this project is completed. Please rest assured that the requirements of Chapter 49 of the Public Health Regulations will be met before this new source serves the public.

Very truly yours,

W. Y. THOMPSON  
Chairman of the Board

RTC: LA: jes
MEMORANDUM

To: Robert T. Chuck, Manager-Chief Engineer
Division of Water and Land Development

From: Kenji Ego, Director, Division of Fish and Game

Subject: Job No. 8-HW-45, Pump and Controls for Kealii Well "C",
South Kona Water System

We have reviewed the draft of your EIS-Preparation Notice and
have determined that the subject project will not impact significantly
on fish and wildlife values.

[Signature]

KENJI EGO, Director
Division of Fish and Game
Mr. William Y. Thompson, Chairman  
Board of Land and Natural Resources  
P. O. Box 621  
Honolulu, Hawaii  96809  

Dear Mr. Thompson:

EIS Preparation Notice - Pump and Controls for  
Keel Well "C", South Kona Water System  
Job No. 8-HW-45

We have reviewed the subject document and have the following comments to offer:

1. Besides the County zoning of AG-5, the project site  
   TMK: 8-3-08;por 41 is designated as orchards by  
   the County General Plan.

2. The project description should discuss the size of the  
   project site and access easement.

3. The proposed action should be discussed in relation to  
   the County Water Master Plan.

4. The adequacy of this project should be addressed not  
   only in terms of present water needs but also in terms  
   of expected future needs of the South Kona area.

We hope that the above comments will be of help in the  
drafting of the EIS for this project. Should you have any  
questions concerning the above, please contact us.

Thank you for the opportunity to review this project.

Sincerely,

SiDNEY FUKEm  
Director

BS:ak
November 15, 1978

Mr. Sidney Fuke, Director
Planning Department
County of Hawaii
25 Aupuni St.
Hilo, Hawaii 96720

Dear Mr. Fuke:

Job No. S-HW-45, Pump and Controls
for Keai Well "C", South Kona
Water System, Hawaii

Thank you for your comments on our draft EIS-
Preparation Notice. Your suggestions will help us in
the preparation of our EIS.

Very truly yours,

W. Y. THOMPSON
Chairman of the Board

RTC:LA:jes
November 6, 1978

Mr. William Y. Thompson  
Chairman of the Board  
Department of Land and Natural Resources  
P. O. Box 621  
Honolulu, Hawaii 96809

SUBJECT: JOB NO. 8-HW-45, PUMP AND CONTROLS  
FOR KEEI WELL "C", SOUTH KONA WATER SYSTEM

In response to your October 30, 1978 letter regarding your EIS Preparation Notice for the subject project, we have reviewed the EIS Preparation Notice and have no comments to offer.

Thank you for affording us an opportunity to review the EIS Preparation Notice.

[Signature]

EDWARD HARADA  
Chief Engineer
APPENDIX B

Pumping Test Results of Keel Well "C"
March 30, 1979

MEMORANDUM FOR THE RECORD

FROM: Dan Lum

SUBJECT: Pumping Test Results, Keel Well "C" 2653-01, South Kona, Hawaii (Job No. 8-HW-44)

Keel Well "C", drilled June 1978, was tested for 73 hours at a continuous rate of roughly 760 gpm on August 7-10, 1978, with an apparently stabilized drawdown of 1.3 feet. A tidal fluctuation of 0.15 feet was recorded in the recovery data. The salinity of the pumped water was a low initial 20 parts per million but increased at a somewhat linear rate to a final 28 parts per million of chlorides.

Based on experience and the results of the pumping test, Keel Well "C" is capable of producing upwards of 700 gpm of fresh potable water from a thin 4-foot basal lens in highly permeable basalts.

Keel Well "C" taps a thin basal ground water lens having a static head of only 4.2 feet above mean sea level and a demonstrated chloride sensitivity under pumping conditions. Maximum production of potable water from a well tapping a thin basal lens, such as Keel, can be achieved simply by observing two basic production criteria:

(a) Withdrawal of water from the upper-most part of the basal lens, and
(b) Withdrawal of water at a rate which will not produce a highly variable and intermittent pumping pattern.

Fortunately, having penetrated highly permeable basalts, Keel Well "C" meets the first criteria with a minimal depth of 31 feet below mean sea level. Regarding the second criteria, indications from the pumping test results and from experience with similar thin basal lenses suggest an initial production rate of 500 gpm for Keel Well "C". At this pumping rate, the chloride content of the pumped water should remain below 100 ppm. However, if the water demand is sufficiently high to warrant installing a higher pumping capacity of say 700 gpm, then the chloride content could possibly rise to a range of between 100 and 200 ppm, especially during drought periods. Installation of a 700-gpm pump capacity at this time is not recommended, if the water demand is so low as to cause a highly variable and intermittent pumping pattern.

Attachment:
- Location Map
- Pumping Test Graph
- As-Built Section
- Chemical Analyses

[Signature]

DAN LUM
Keei Well "C" 2653-01, South Kona, Hawaii

As Built Section

Drilled: June 1978
Driller: Roscoe Moss Co.

Nipple

FT. MSL - Top of Casing: 882
FT. MSL - Finish Grade: 777

Feet

Total Depth Drilled Hole: 293
In. Diameter

Gross Hole: 288.3
Feet Solid Casing, In. I.D. x 12 In. Wall

Feet Cemenet Grout

Cement Basket

4.5 Ft. Above MSL
Static Water Level

Ft. MSL

-31 Ft. MSL
Bottom of Well

Not to Scale
KEE WELLC: 2653-01
PUMPING TEST NO. 1
SOUTH KONA, HAWAII

PHYSICAL DATA
Depth Completion 180 ft.
Date of Completion: 9-14-78
Depth of Pump Stage: 238 ft.
Depth of Summer: 95 ft.
Water Temperature: 75°F
Water Level: 25 ft.

RHYTHM RATE
(1000 GALLONS PER HOUR)

HOURS
2000 2400 2800 3200 3600 4000 4400 4800 5200 5600


HOURS
2000 2400 2800 3200 3600 4000 4400 4800 5200 5600


HOURS
2000 2400 2800 3200 3600 4000 4400 4800 5200 5600


HOURS
2000 2400 2800 3200 3600 4000 4400 4800 5200 5600


HOURS
2000 2400 2800 3200 3600 4000 4400 4800 5200 5600


HOURS
2000 2400 2800 3200 3600 4000 4400 4800 5200 5600


HOURS
2000 2400 2800 3200 3600 4000 4400 4800 5200 5600


HOURS
2000 2400 2800 3200 3600 4000 4400 4800 5200 5600


HOURS
APPENDIX C

Pumping Test Results of Keel Wells "A" and "B"
KEEI WELL PUMPING TEST
WELL "A"
KOHA, HAWAII, T. H.

October 2 - December 15, 1958
PUMPING TEST OF KEHI WELL A

Location: Keal, South Kona
Owner: Hawaii Water Authority
Date Started: October 2, 1958
Date Completed: December 15, 1958
Diameter: 12 inch OD casing
Depth in Feet: 780 feet
Altitude of Ground Surface (M.S.L): 744 ft.
Average Altitude of Water (M.S.L): 2.17 ft.
Average salt content (gr./gal.): 10 grains
Elevation of Top of Casing (M.S.L): 745.95 ft.
Elevation of R. M. #1 (Top of steel spike): 747.10 ft.
Length of Airline: 753.19 ft.
Elevation of Top of Airline (M.S.L): 746.24 ft.
Elevation of Bottom of Airline (M.S.L): -6.95 ft.
Test Pump - Byron Jackson 18135 Subette

Pump test conducted by Raymond K. Chun and Manabu Tagomori of the Hawaii Water Authority.
<table>
<thead>
<tr>
<th>Time</th>
<th>Pumping Rate GPM</th>
<th>Water Level Above MSL</th>
<th>Sample</th>
<th>Salinity PPM-Chl.</th>
<th>Temp-erature</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Wednesday, December 10, 1958</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1:00 p.m.</td>
<td></td>
<td>Hole at 756 ft.</td>
<td>1</td>
<td>200</td>
<td></td>
</tr>
<tr>
<td>1:30 p.m.</td>
<td></td>
<td></td>
<td>2</td>
<td>200</td>
<td></td>
</tr>
<tr>
<td>12:00 midnight</td>
<td></td>
<td>Hole at 770 ft.</td>
<td>3</td>
<td>200</td>
<td></td>
</tr>
<tr>
<td><strong>Thursday, December 11, 1958</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8:00 a.m.</td>
<td></td>
<td></td>
<td>4</td>
<td>200</td>
<td></td>
</tr>
<tr>
<td><strong>Tuesday, December 16, 1958</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8:30 a.m.</td>
<td></td>
<td>Water sample at surface</td>
<td>5</td>
<td>150</td>
<td></td>
</tr>
<tr>
<td>8:35 a.m.</td>
<td></td>
<td>&quot;        &quot; 1/3 depth</td>
<td>6</td>
<td>150</td>
<td></td>
</tr>
<tr>
<td>8:40 a.m.</td>
<td></td>
<td>&quot;        &quot; 2/3</td>
<td>7</td>
<td>150</td>
<td></td>
</tr>
<tr>
<td>8:45 a.m.</td>
<td></td>
<td>&quot;        &quot; bottom</td>
<td>8</td>
<td>200</td>
<td></td>
</tr>
<tr>
<td><strong>Wednesday, December 17, 1958</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7:45 a.m.</td>
<td></td>
<td>2.75</td>
<td>9</td>
<td>200</td>
<td></td>
</tr>
<tr>
<td>10:20 a.m.</td>
<td>Pump started</td>
<td></td>
<td>10</td>
<td>200</td>
<td>68.5</td>
</tr>
<tr>
<td>10:45 a.m.</td>
<td>Start of Pump Test. Rate adjusted to 25 GPM</td>
<td></td>
<td>11</td>
<td>150</td>
<td>71.3</td>
</tr>
<tr>
<td>10:47 a.m.</td>
<td>28</td>
<td>2.29</td>
<td>12</td>
<td>150</td>
<td>72.5</td>
</tr>
<tr>
<td>11:00 a.m.</td>
<td>27</td>
<td>2.29</td>
<td>13</td>
<td>125</td>
<td>72.5</td>
</tr>
<tr>
<td>11:15 a.m.</td>
<td>27</td>
<td>2.29</td>
<td>14</td>
<td>125</td>
<td>72.5</td>
</tr>
<tr>
<td>11:45 a.m.</td>
<td>28</td>
<td>2.29</td>
<td>15</td>
<td>125</td>
<td>72.5</td>
</tr>
<tr>
<td>12:15 p.m.</td>
<td>28</td>
<td>2.29</td>
<td>16</td>
<td>150</td>
<td>72.5</td>
</tr>
<tr>
<td>12:45 p.m.</td>
<td>28</td>
<td>2.29</td>
<td>17</td>
<td>150</td>
<td>72.5</td>
</tr>
<tr>
<td>1:15 p.m.</td>
<td>28</td>
<td>2.29</td>
<td>18</td>
<td>125</td>
<td>72.5</td>
</tr>
<tr>
<td>1:45 p.m.</td>
<td>27</td>
<td>2.29</td>
<td>19</td>
<td>100</td>
<td>72.5</td>
</tr>
<tr>
<td>2:15 p.m.</td>
<td>27</td>
<td>2.29</td>
<td>20</td>
<td>150</td>
<td>69.5</td>
</tr>
<tr>
<td>2:45 p.m.</td>
<td>26</td>
<td>2.29</td>
<td>21</td>
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<td>69.0</td>
</tr>
<tr>
<td>3:05 p.m.</td>
<td>54</td>
<td>2.06</td>
<td>22</td>
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</tr>
<tr>
<td>3:20 p.m.</td>
<td>54</td>
<td>1.83</td>
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</tr>
<tr>
<td>3:50 p.m.</td>
<td>53</td>
<td>2.06</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time</td>
<td>Pumping Rate GPM</td>
<td>Water Level Above MSL</td>
<td>Sample</td>
<td>Salinity ppm Cl.</td>
<td>Temperature</td>
</tr>
<tr>
<td>-----------</td>
<td>------------------</td>
<td>------------------------</td>
<td>--------</td>
<td>------------------</td>
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</tr>
<tr>
<td>4:20 p.m.</td>
<td>53</td>
<td>2.06</td>
<td>23</td>
<td>125</td>
<td>69.0</td>
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<td>4:50 p.m.</td>
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<td>6:20 p.m.</td>
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<td>6:50 p.m.</td>
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<tr>
<td>7:00 p.m.</td>
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<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>end of 50 GPM Test.</td>
<td>Rate adjusted to 75 GPM</td>
<td></td>
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<tr>
<td>10:54 p.m.</td>
<td>Changed to Static Water Level Reading</td>
<td>2.75</td>
<td>2.29</td>
<td>Static Water Level Reading</td>
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<tr>
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<td>Changed to Static Water Level Reading from USGS gage</td>
<td>2.75</td>
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<td>Static Water Level Reading</td>
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<td>100</td>
<td>1.78</td>
<td>49</td>
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<tr>
<td>12:00 noon</td>
<td>99</td>
<td>1.78</td>
<td>50</td>
<td>82</td>
<td>67.0</td>
</tr>
<tr>
<td>12:45 p.m.</td>
<td>100</td>
<td>1.71</td>
<td>51</td>
<td>98</td>
<td>68.0</td>
</tr>
<tr>
<td>3:25 p.m.</td>
<td>Pump Stopped. Electricity shut off to check starter box.</td>
<td>2.17</td>
<td>2.17</td>
<td>Recovery Test</td>
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</tr>
<tr>
<td>3:26 p.m.</td>
<td>2.17</td>
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<td></td>
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<tr>
<td>3:27 p.m.</td>
<td>2.17</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>3:28 p.m.</td>
<td>2.17</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>3:29 p.m.</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>3:30 p.m.</td>
<td>Pump Started</td>
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<tr>
<td>3:32 p.m.</td>
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<td>1.60</td>
<td>52</td>
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</tr>
<tr>
<td>4:00 p.m.</td>
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</tr>
<tr>
<td>Friday, December 19, 1958</td>
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<tr>
<td>3:00 a.m.</td>
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<td>7:30 p.m.</td>
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<tr>
<td>8:30 p.m.</td>
<td>74</td>
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<td>32</td>
<td>125</td>
<td>63.0</td>
</tr>
<tr>
<td>Time</td>
<td>Pumping Rate GPM</td>
<td>Water Level Above MSL</td>
<td>Sample</td>
<td>Salinity PPM-Cl.</td>
<td>Temperature</td>
</tr>
<tr>
<td>--------------</td>
<td>------------------</td>
<td>------------------------</td>
<td>--------</td>
<td>------------------</td>
<td>-------------</td>
</tr>
<tr>
<td>9:00 p.m.</td>
<td>73</td>
<td>1.83</td>
<td>33</td>
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</tr>
<tr>
<td>9:30 p.m.</td>
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<td>34</td>
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<td>10:00 p.m.</td>
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<td>1.83</td>
<td>35</td>
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<td>10:30 p.m.</td>
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<td>36</td>
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</tr>
<tr>
<td>11:00 p.m.</td>
<td>73</td>
<td>1.83</td>
<td>37</td>
<td>125</td>
<td>68.0</td>
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<tr>
<td>11:03 p.m.</td>
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<td><em>End of 75 GPM Test. Pump Wide Open</em></td>
</tr>
<tr>
<td>11:05 p.m.</td>
<td>100</td>
<td>1.71</td>
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<td>11:15 p.m.</td>
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<td>11:30 p.m.</td>
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<td>1.71</td>
<td>39</td>
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**Thursday, December 18, 1958**

<table>
<thead>
<tr>
<th>Time</th>
<th>Pumping Rate GPM</th>
<th>Water Level Above MSL</th>
<th>Sample</th>
<th>Salinity PPM-Cl.</th>
<th>Temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td>12:00 midnite</td>
<td>100</td>
<td>1.71</td>
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<td>100</td>
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<td>45</td>
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</tr>
<tr>
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<td>100</td>
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<td>100</td>
<td>1.83</td>
<td>48</td>
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<tr>
<td>10:52 a.m.</td>
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<td></td>
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<td><em>Pump Stopped. Starter Box Trouble</em></td>
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**Saturday, December 20, 1958**

<table>
<thead>
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<th>Time</th>
<th>Pumping Rate GPM</th>
<th>Water Level Above MSL</th>
<th>Sample</th>
<th>Salinity PPM-Cl.</th>
<th>Temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td>3:00 a.m.</td>
<td>100</td>
<td>1.60</td>
<td>58</td>
<td>102</td>
<td>67.0</td>
</tr>
<tr>
<td>8:00 a.m.</td>
<td>100</td>
<td>1.60</td>
<td>59</td>
<td>102</td>
<td>67.0</td>
</tr>
<tr>
<td>11:00 a.m.</td>
<td>100</td>
<td>1.60</td>
<td>60</td>
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<tr>
<td>7:30 p.m.</td>
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<td>61</td>
<td>102</td>
<td>67.0</td>
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</table>

**Sunday, December 21, 1958**

<table>
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<th>Water Level Above MSL</th>
<th>Sample</th>
<th>Salinity PPM-Cl.</th>
<th>Temperature</th>
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</thead>
<tbody>
<tr>
<td>3:00 a.m.</td>
<td>100</td>
<td>1.60</td>
<td>62</td>
<td>104</td>
<td>67.0</td>
</tr>
<tr>
<td>8:00 a.m.</td>
<td>98</td>
<td>1.60</td>
<td>63</td>
<td>104</td>
<td>67.0</td>
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</table>

*End of Pumping Test*
<table>
<thead>
<tr>
<th>Time</th>
<th>Pumping Rate</th>
<th>Water Level Above MSL</th>
<th>Sample Salinity</th>
<th>Temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td>3:25 a.m.</td>
<td>1</td>
<td>1.60</td>
<td>Pump Stopped</td>
<td></td>
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<td>3:25:15 a.m.</td>
<td>2</td>
<td>2.06</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3:26 a.m.</td>
<td>2</td>
<td>2.06</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3:26:30</td>
<td></td>
<td>2.17</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3:27</td>
<td></td>
<td>2.17</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3:27:30</td>
<td></td>
<td>2.17</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3:28</td>
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<td>2.17</td>
<td></td>
<td></td>
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<tr>
<td>3:29:30</td>
<td></td>
<td>2.17</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3:30</td>
<td></td>
<td>2.17</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Total water pumped during test = 518,570 gallons**

**Total power used during test = 2930 kWh**

**Comments:**

1. Chloride content of water improved with pumping from 200 ppm to 100 ppm and steadied off at that salinity.

2. Recovery of water level after stopping pump was almost immediate.

3. Average drawdown at pumping rate of 100 GPM was 0.57 foot.

RAYMOND K. CHUN
PUMPING TEST, KEEI WELL NO. 12-8
WELL "B"
CHEMICAL ANALYSIS OF THE WATER
KEEI WELL "B"
Keei Well 12-8
Keei, South Kona, Hawaii

Water Sample Taken On: 12:45 p.m., May 16, 1963
Analysis made by: Hawaii State Department of Health
May 23, 1963

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH @ 25°C</td>
<td>7.00</td>
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<tr>
<td>Color</td>
<td>0</td>
</tr>
<tr>
<td>Odor</td>
<td>Musty</td>
</tr>
<tr>
<td>Turbidity</td>
<td>3</td>
</tr>
<tr>
<td>NO₂</td>
<td>0.002 ppm</td>
</tr>
<tr>
<td>NO₃</td>
<td>1.09 ppm</td>
</tr>
<tr>
<td>Carbonate Alkalinity</td>
<td>0.00 ppm as CaCO₃</td>
</tr>
<tr>
<td>Bicarbonate Alkalinity</td>
<td>40 ppm as CaCO₃</td>
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<tr>
<td>Total Alkalinity</td>
<td>40 ppm as CaCO₃</td>
</tr>
<tr>
<td>Total Hardness</td>
<td>55.7 ppm as CaCO₃</td>
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<tr>
<td>Total Solids</td>
<td>320 ppm</td>
</tr>
<tr>
<td>Loss on Ignition</td>
<td>60 ppm</td>
</tr>
<tr>
<td>SiO₂</td>
<td>48.8 ppm</td>
</tr>
<tr>
<td>Fe₂O₃</td>
<td>0.07 ppm</td>
</tr>
<tr>
<td>Al₂O₃</td>
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<tr>
<td>Ca</td>
<td>7.8 ppm</td>
</tr>
<tr>
<td>Mg</td>
<td>8.92 ppm</td>
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<tr>
<td>SO₄</td>
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<td>Na</td>
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<tr>
<td>K</td>
<td>2 ppm</td>
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<tr>
<td>Chlorides</td>
<td>106 ppm</td>
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<tr>
<td>As</td>
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<tr>
<td>F</td>
<td>0.3 ppm</td>
</tr>
<tr>
<td>Mn</td>
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</tr>
<tr>
<td>Pb</td>
<td>0.05 ppm</td>
</tr>
<tr>
<td>Cu</td>
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</tr>
<tr>
<td>Zn</td>
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</tr>
<tr>
<td>Se</td>
<td>0.006 ppm</td>
</tr>
<tr>
<td>Phenols</td>
<td>0.005 ppm</td>
</tr>
</tbody>
</table>

Remarks: Oil film in sample.
CERTIFICATION

I HEREBY CERTIFY THAT THE MICROPHOTOGRAPH APPEARING IN THIS REEL OF FILM ARE TRUE COPIES OF THE ORIGINAL DOCUMENTS.

DATE

SIGNATURE OF OPERATOR