OFFICE OF THE MAYOR
CITY AND COUNTY OF HONOLULU
HONOLULU, HAWAII 96813 • AREA CODE 808 • 523-4141

FRANK F. FASI
MAYOR

August 30, 1989

Dr. Marvin T. Miura
Office of Environmental
Quality Control
State of Hawaii
465 South King Street
Kekuanaoa Building, Room 104
Honolulu, Hawaii 96813

Dear Dr. Miura:

Subject: Final Environmental Impact Statement (FEIS) for Waahila 180 and Waahila 405 Reservoirs, Manoa, Oahu, Tax Map Key: 3-3-56: Por. 1 and 2

Based upon the discussion and recommendation of the Board of Water Supply, I am pleased to accept the FEIS for Waahila 180 and Waahila 405 Reservoirs as a satisfactory fulfillment of the requirements of Chapter 343, Hawaii Revised Statutes.

This FEIS will be a useful tool in deciding whether this project should be allowed to proceed. My acceptance of the statement is an affirmation of its adequacy under applicable laws and does not constitute an endorsement of the projects.

When the decision is made regarding this action, I expect the Board of Water Supply to carefully weigh the societal benefits against the environmental impact which will likely occur. This impact is adequately described in the statement, and together with the comments made by the reviewers, provide a useful analysis of alternatives to the proposed action.

Warm personal regards.

Sincerely,

FFF:do

OEQC

September 22, 1989

'89 SEP 25 P1:07

The Honorable Kazu Hayashida
Manager and Chief Engineer
Honolulu Board of Water Supply
City and County of Honolulu
630 South Beretania Street
Honolulu, Hawaii 96843

Dear Mr. Hayashida:

Based upon the recommendation of the Office of Environmental Quality Control, I am pleased to accept the Final Environmental Impact Statement for the Waahila 180 and Waahila 405 Reservoirs, Manoa, Oahu, 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 the action described therein should be allowed to proceed. My acceptance of the statement is an affirmation of the adequacy of that statement under 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 the proposed action.

With kindest regards,

Sincerely,

JOHN WAIHEE

cc: Marvin Miura, Ph.D.
Office of Environmental Quality Control

FINAL
ENVIRONMENTAL IMPACT STATEMENT
FOR THE
WAAHILA 180 AND WAAHILA 405 RESERVOIRS

Manoa, Oahu

Tax Map Key: 3-3-56:por. 1 & 2

Proposing Agency

HONOLULU BOARD OF WATER SUPPLY
City and County of Honolulu
630 South Beretania Street
Honolulu, Hawaii 96843
Contact: Lawrence Whang, Telephone 527-6138

Prepared by

BELT COLLINS & ASSOCIATES
680 Ala Moana Boulevard, Suite 200
Honolulu, Hawaii 96813

August 10, 1989

FINAL
ENVIRONMENTAL IMPACT STATEMENT
FOR THE
WAAHILA 180 AND WAAHILA 405 RESERVOIRS
Manoa, Oahu
Tax Map Key: 3-3-56:por. 1 & 2

Proposing Agency

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City and County of Honolulu
630 South Beretania Street
Honolulu, Hawaii 96843
Contact: Lawrence Whang, Telephone 527-6138

Accepting Authority

GOVERNOR, STATE OF HAWAII

Board Members:
Donna B. Goth, Chairman
John K. Tsui, Vice Chairman
Sister M. Davilyn Ah Chick, O.S.F.
Edward Y. Hirata
Walter O. Watson, Jr.
Maurice H. Yamasato

Kazu Hayashida
Manager and Chief Engineer
Board of Water Supply

8/10/89
Date

Prepared by

BELT COLLINS & ASSOCIATES
680 Ala Moana Boulevard, Suite 200
Honolulu, Hawaii 96813

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CHAPTER 1

INTRODUCTION AND SUMMARY

1.1 PURPOSE OF THIS DOCUMENT

The City and County of Honolulu Board of Water Supply (BWS) proposes to construct two 4.0-million gallon (mg) reservoirs on the hillside between Saint Louis Heights and Manoa Valley. The reservoirs will substantially increase water storage capacity in the BWS's Honolulu District, which extends from Aliamanu to Hawaii Kai. In accordance with Chapter 343, Hawaii Revised Statutes, the Board has determined that an Environmental Impact Statement is required for the proposed Waahila Reservoir Project. The determination has been made based primarily on the project's potentially detrimental impact on the physical environment.

1.2 PROJECT OBJECTIVES

The Board of Water Supply's overall objective is to operate and maintain its systems in a manner which is economically sound and to public advantage. Its objectives for the project are to:

- significantly increase storage capacity in the Honolulu District to meet demand and more closely comply with the BWS standard of 1.5 times average daily use;
- provide uninterrupted service to customers; and
- stabilize pressures and supply water during peak demand periods and for fire fighting purposes.

Applying the current Board of Water Supply standard for reservoir capacity to the average daily water use in the Honolulu District indicates that the existing capacity is deficient by approximately 85 mg. Construction of the two proposed reservoirs would increase storage capacity available to the BWS in the District by almost 18 percent—still short of the Board's standard but a substantial improvement nonetheless.

One of the Board of Water Supply's objectives is to provide uninterrupted service to its customers. With its limited reservoir capacity, however, the BWS system is heavily dependent upon pumpage from wells rather than storage to meet daily demand. While this is normally not a problem, an extended power outage which prevents pumping could leave some users without water. Additional reservoir capacity would reduce the likelihood of this occurrence.

1.3 PROJECT AND SITE DESCRIPTION

The proposed Waahila 180 and Waahila 405 Reservoirs will be constructed on the hillside above the University of Hawaii Waahila Faculty Apartments on Dole Street (see Figures 1-1, 1-2, and 1-3). (The numbers 180 and 405 indicate the spillway elevations, or the maximum design elevations of water level in the reservoirs measured in feet above sea level.) In addition to the two tanks, each with a capacity of 4.0 million gallons, other improvements will include an access road, transmission mains, instrument houses, landscaping, irrigation, and fencing. Approximately 5,400 linear feet of 24-inch diameter transmission main will be installed to integrate the new reservoirs with the existing water mains on Dole Street and on Waialae Avenue. The routing of the underground pipeline and location of system controls are shown in Figure 1-3. The location of Hawaiian Electric Company facilities in proximity to the project, both overhead and underground lines, is shown in Chapter 8; see the letter from Hawaiian Electric commenting on the Draft EIS.

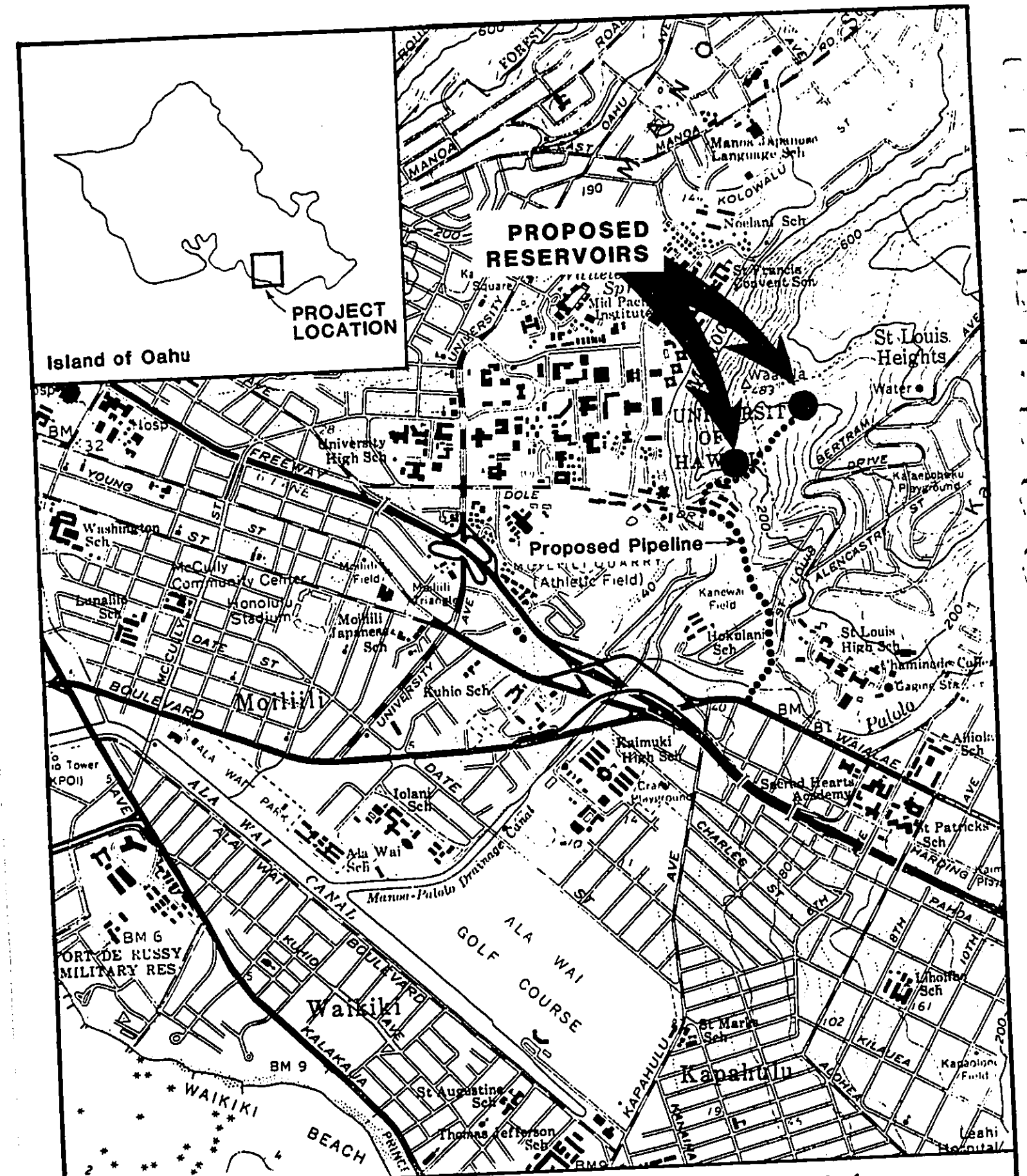
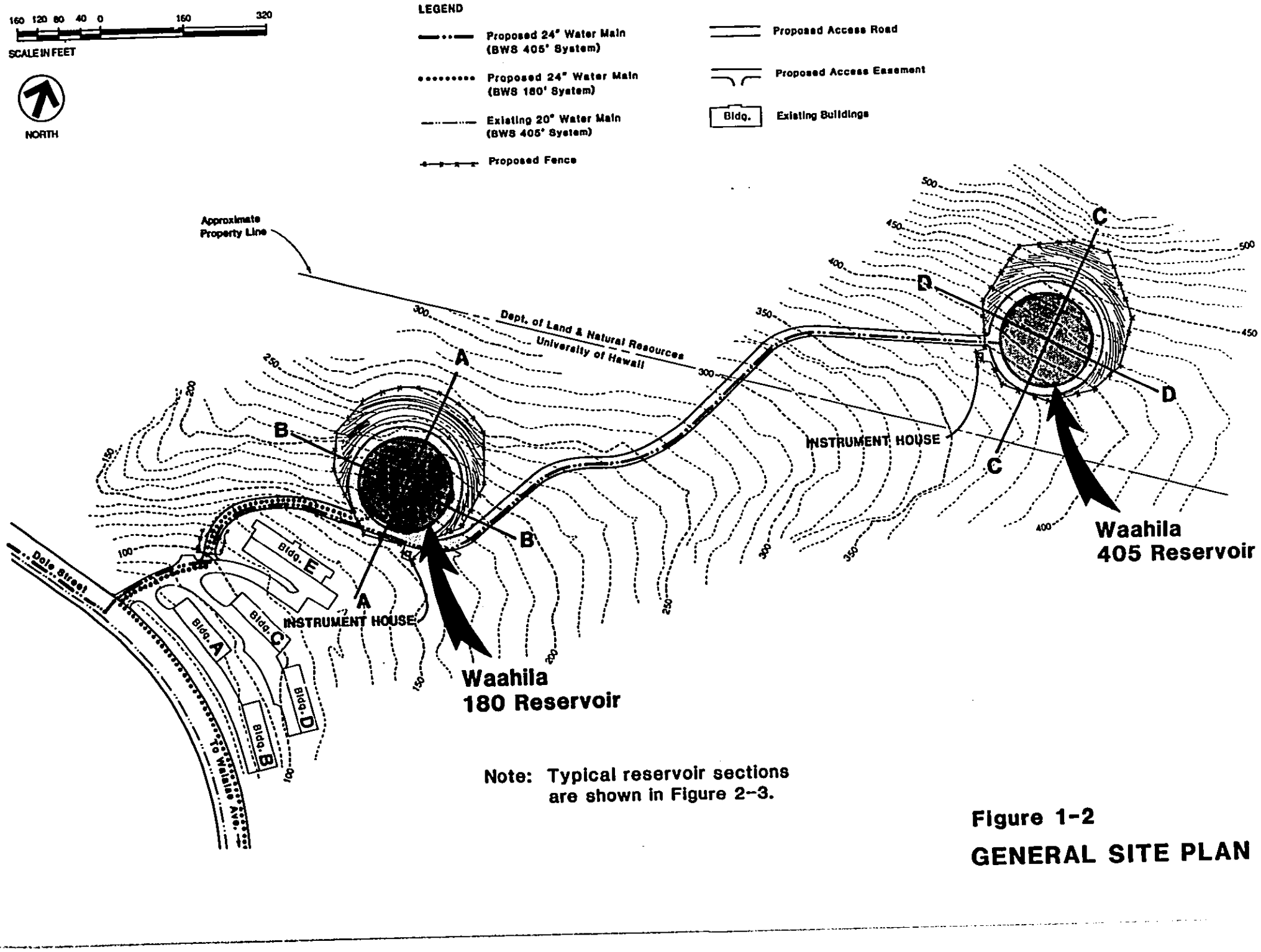


Figure 1-1

LOCATION MAP

Waahila Reservoir Project



Note: Typical reservoir sections are shown in Figure 2-3.

Figure 1-2

GENERAL SITE PLAN

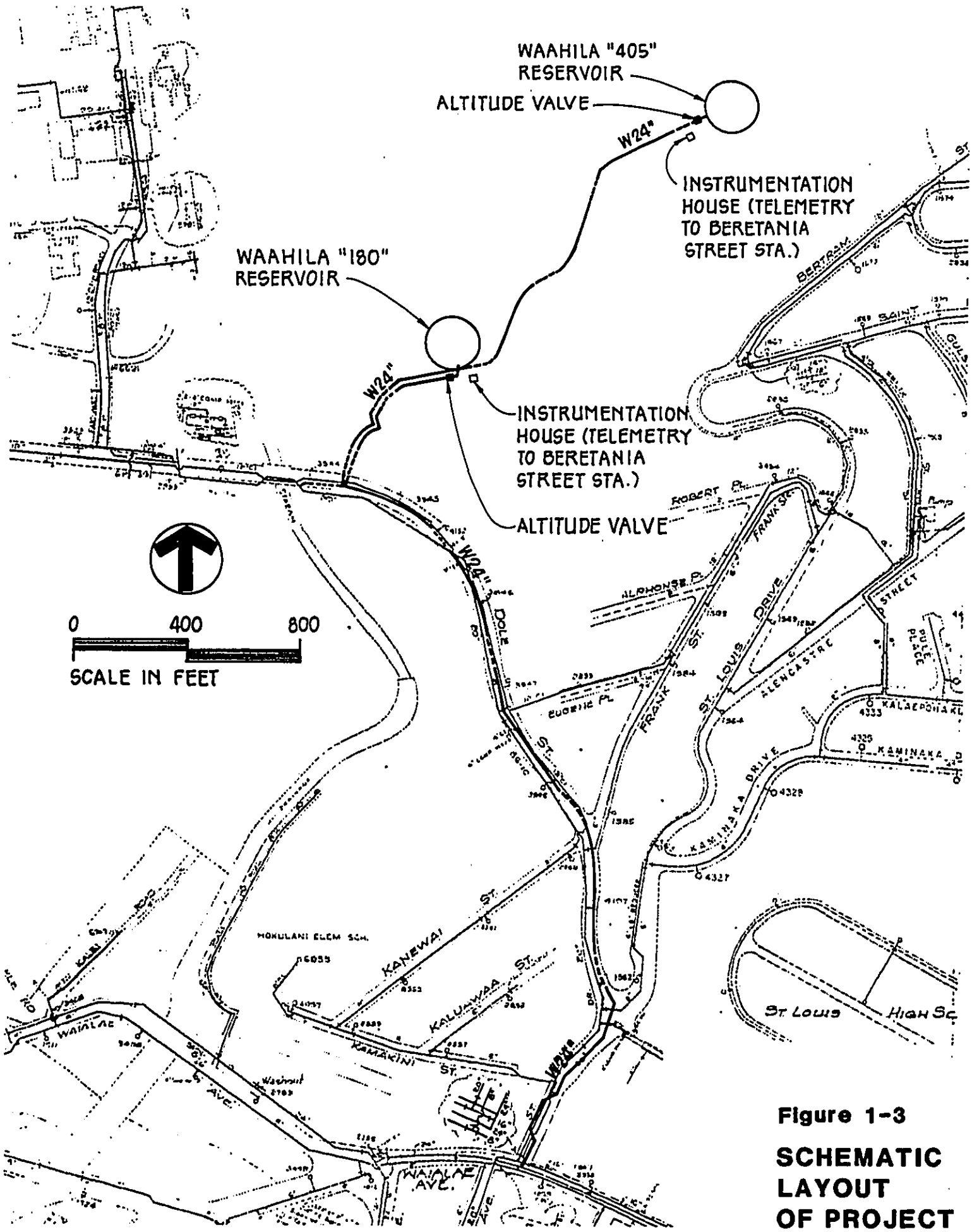


Figure 1-3

SCHEMATIC LAYOUT OF PROJECT

The reservoir sites are characterized by steeply sloped lava rock with a relatively thin soil layer, covered with a dense growth of grasses, brush, and small trees. The land is in the Urban district on State-owned land presently under the jurisdiction of the University of Hawaii and the Department of Land and Natural Resources.

Construction of the reservoirs will require deep cuts in the hillside; approximately 137,000 cubic yards of material will have to be excavated for the reservoirs and access road. At least some blasting may be desirable to minimize the construction period, cost, and environmental effects. The excavated material (except for about 6,400 cy used for roadway fill) will be disposed of offsite.

Total construction cost is estimated at $16,884,500 if blasting is used as an excavation technique, or $19,604,500 if the contractor relies solely on hoe ram equipment (back hoe with a large jackhammer-like attachment) for the reservoir cuts. The construction duration for each reservoir would be one year with blasting or two years without blasting.

1.4 SUMMARY OF POTENTIAL IMPACTS

1.4.1 PHYSIOGRAPHIC CHANGES

Construction of the reservoirs will result in major, permanent changes to the existing landforms. Because the two reservoirs will be constructed on steeply sloping terrain, large-scale excavation of the hillside will be required. The cuts will be extensive but since they will be in rock, the slopes will be stabilized. Soil erosion potential is expected to increase during the site preparation phase of the work, however, and the steep ground exposed to rain and runoff will make erosion control and re-vegetation a critical issue. In addition, there are potential hazards from loose rocks and boulders. A geotechnical field exploration indicates that the basalt underlying the site will provide adequate foundation support for the proposed reservoirs.

Natural drainage patterns will not be substantially altered by the project. With the proposed project, a flow increase of 12 cubic feet per second (cfs) is expected to occur—an increase of less than one percent of the total runoff within the drainage basin.

1.4.2 FLORA AND FAUNA

No significant adverse impacts relative to flora or fauna are anticipated as a result of the project. Plants observed at the site are primarily exotic species, and none are rare, threatened, or endangered. No Hawaiian endemic species were encountered in a botanical survey. Since the proposed reservoirs and access road will be constructed in the midst of an area that has been heavily developed for a long time, it is unlikely that the site provides a habitat for any significant bird or other wildlife species.

1.4.3 ARCHAEOLOGY

An archaeological reconnaissance survey of the property identified no potentially significant archaeological sites or features of any kind.

1.4.4 NOISE, VIBRATION, AND AIR QUALITY IMPACTS

Excavation of the reservoir sites will require removal of approximately 137,000 cubic yards of soil and rock by use of hoe ram equipment and blasting. Temporary noise impacts and vibration will accompany this activity. In addition, noise will be generated by construction equipment and by vehicular traffic (especially from trucks hauling excavated material away from the site).

Air quality is also likely to be affected due to the extensive earthwork and, to a lesser degree, emissions from construction equipment and vehicles.

Residents of the Waahila Faculty Apartments will be most affected by the noise and dust generated during construction.

1.4.5 TRAFFIC

Installation of the proposed water main will temporarily affect traffic along Dole Street, Saint Louis Drive, and at the Saint Louis Drive-Waialae Avenue intersection. The availability of on-street parking will be limited during this phase of the project.

Traffic impacts will result from the trucks removing excavated material from the site. Another issue to be addressed is the potentially hazardous traffic mix on the Waahila Faculty Apartments entrance road during construction.

1.4.6 VISUAL IMPACT

The size of the reservoirs and their cuts will make them visible from a fairly wide area, including parts of Saint Louis Heights, Kaimuki, Kapahulu, Waikiki, and Moiliili. A view analysis indicates that the project will not significantly affect the overall panoramic view of the Koolau Mountains. However, the reservoirs will be quite apparent from various locations within a mile from the site, and mitigation measures will be required to lessen the visual impact.

1.4.7 SOCIOECONOMIC CONSIDERATIONS

The anticipated socioeconomic impacts are primarily consequences of the noise, air quality, and traffic impacts expected during construction of the project. The most serious is the possibility that the University of Hawaii may be unable to rent out units in the Waahila Faculty Apartments for the duration of the construction period, or at least during excavation. This would result not only in a loss of revenue but also the loss of an important benefit and convenience for newly arrived faculty members who depend on these apartments for interim housing.

Another potential effect of the project is some loss of business by Consumer Tire Warehouse if traffic congestion discourages customers during installation of the transmission main.

1.5 UNAVOIDABLE ADVERSE IMPACTS

The following unavoidable adverse impacts have been identified. They will require special mitigation measures to reduce the effects to acceptable levels.

- Short-term impacts during construction of the project, including noise, dust, runoff, and traffic congestion.
- Alteration of the appearance of the hillside due to the size of the reservoirs and cuts in the terrain.

1.6 SUMMARY OF PROPOSED MITIGATION MEASURES

The following is a list of the mitigation measures suggested in this EIS. A number of them will be implemented as a matter of course, while others will require discussions and coordination with affected parties, such as the University of Hawaii. It cannot be emphasized enough that in order for

the project to proceed smoothly, the Board of Water Supply must maintain open communication with the University and others likely to be affected. The Board needs to develop means to keep people informed and to provide a way for any problems to be quickly addressed and solved.

Erosion Control:

- Grade the reservoir sites incrementally.
- Install a sediment basin prior to grading.
- Limit grading to the drier months (May through October), and seed the area after grading.
- During excavation, minimize erosion due to runoff by diverting surface water away from the areas above the slopes and preventing water from flowing across the slope face.
- Install check dams, containment dikes, sediment traps, and filter inlets where needed.
- Construct the drain line in the makai pavement of Dole Street to minimize dust and erosion impacts on the nearby Hawaiian Studies Program loi'i.
- Specify that the contractor shall remove all visible rocks and boulders after grading is completed to reduce the hazard of rock slides.

Drainage Improvements:

- Alleviate drainage impacts by designing site grading and installing drainage structures to divert surface water away from the reservoir foundations and the edges of the cut slopes.
- Provide drainage swales and other structures on the access road.

Noise, Vibrations, and Air Quality:

- Shorten the duration of excavation activities by blasting.
- Implement dust control measures such as sprinkling, mulching, or installation of a temporary vegetative cover. Water the site seven days a week.
- Consider special measures to alleviate potentially severe impacts on Building E of the Faculty Apartments.
- Minimize noise impacts by limiting construction operations to daylight hours, generally between 7:30 a.m. and 4:30 p.m., Monday to Friday (excluding holidays). Restrict blasting operations which exceed 95 dBL at residences to the hours between 9:00 a.m. and 4:30 p.m.
- Impose strict controls on blasting activities; e.g., reduce maximum air blast levels to less than 110 dBL at the nearest noise sensitive residences.
- Schedule blasting during warm periods of the day to minimize the possibility of thermal ducting.
- Reduce or eliminate "flyrock" risk by increasing the depth of the charges and by using large-diameter hemp rope safety mats.

Traffic:

- During installation of the pipeline, minimize impact on traffic flow through the use of proper signs, barricades, flagpersons, etc. to insure ease and safety of motorists and pedestrians. Limit construction activity liable to affect traffic to non-peak hours, generally between 8:30 a.m. and 3:30 p.m., Monday to Friday (excluding holidays).

- Install the transmission main during the summer when the University traffic is lighter to minimize the loss of on-street parking as well as traffic congestion. Do the installation in phases. Publicize the construction to keep students and residents well informed.

- Segregate traffic on the faculty apartments entrance road—one lane for construction vehicles and one for tenants/visitors. Establish traffic control in this area during working hours.

- Minimize impacts on campus traffic by having the trucks hauling away excavated material turn left on Dole Street toward Saint Louis Drive.

Visual Impacts:

- Minimize the visual impact with landscaping, including plantings around the reservoir structures and landscaping of the cuts.

- Stain the walls of the reservoir structures to blend with the background; use colored roof gravel. Color the concrete access road so it blends with the surroundings.

- Impede access to the reservoirs to prevent the reservoir walls from being defaced by graffiti. Keep the facilities and grounds well maintained and paint the reservoirs on a regular basis.

Socioeconomic Impacts:

- Reimburse the University of Hawaii for lost rental revenue should any vacancies occur in the faculty apartments during the construction period.

1.7 COMPATIBILITY WITH LAND USE PLANS AND POLICIES

The project is consistent with State and City and County land use plans and policies.

1.8 ALTERNATIVES CONSIDERED

Several alternatives, listed below, were evaluated before settling on the proposed project. Results of the analysis indicated that none of these alternatives met the stated objectives as well as the current proposal.

- No action.
- Delayed project.
- Construction of only one reservoir on the Waahila site.
- Construction of two smaller reservoirs (2.0-mg capacity) on the Waahila site.
- Construction of four 2.0-mg reservoirs on the Waahila site.
- Construction of taller reservoirs with smaller diameters on the Waahila site.
- Construction of underground or partially buried reservoirs on the Waahila site.
- Construction of lined reservoirs on the Waahila site.
- Construction of reservoirs at alternate hillside locations, e.g., Kalani-Iki and Diamond Head.
- Construction of elevated water tanks at other sites.

- Alternate access road alignments.
- Onsite disposal of excavated material.

1.9 RELATIONSHIP BETWEEN SHORT-TERM USES AND LONG-TERM PRODUCTIVITY

The proposed project will enhance both the long-term and short-term productivity of the Waahila site, since it will result in improving the Board of Water Supply's service to its most highly populated district and enable the Board to accommodate future water demand. Long-term losses will include a commitment of land for this purpose and permanent changes in the terrain. However, the proposed action does not foreclose future options for use of the hillside. The University of Hawaii's Long Range Development Plan calls for relocation of faculty housing to another area and redevelopment of the site for high-rise student dormitories. Construction of the "180" reservoir at its proposed location was taken into account during the planning process. No long-term risks to health or safety are anticipated as a consequence of the project.

1.10 IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES

Resources that will be irreversibly and irretrievably committed include funds, raw materials, labor, and energy required during construction and operation of the proposed facilities. Land will also be required for the two reservoirs and access road. Since the transmission mains will be installed underground, there will be no irreversible or irretrievable commitment of land for this purpose. Surveys indicate no significant botanical or archaeological resources on the site. The commitment of land and permanent changes to existing landforms are unavoidable impacts in terms of the extent to which the action makes use of non-renewable resources. Other potential uses would not be precluded, as discussed above.

The possibility of environmental accidents resulting from any phase of the action is remote. A severe rainstorm occurring during the excavation phase could result in heavy runoff. Loose boulders on the site could possibly be dislodged at any time (for example, during blasting), but mitigation measures will to decrease the likelihood of this happening.

1.11 UNRESOLVED ISSUES

The University of Hawaii and Board of Water Supply have resolved the issue of possible loss of revenues in the event that construction activities cause vacancies in the nearby faculty apartments. No further unresolved issues remain.

1.12 NECESSARY PERMITS AND APPROVALS

Development Plan Land Use Map Amendment	City Department of General Planning
Building Permit	City Building Department
Grubbing, Grading and Stockpiling Permit	City Department of Public Works
Street Usage Permit	City Department of Transportation Services
Variance from Pollution Controls	State Department of Health
Approval of Land Exchange for "180" Site	University of Hawaii
Acquisition of Land for "405" Site	State Department of Land and Natural Resources

CHAPTER 2

DESCRIPTION OF THE PROPOSED PROJECT

2.1 NEED FOR THE PROJECT

2.1.1 BACKGROUND

The Board of Water Supply (BWS) is a semi-autonomous agency of the City and County of Honolulu charged with the management, control, and operation of Oahu's municipal water system. As of 1987, total reservoir capacities in the BWS's seven service districts were as follows (City and County of Honolulu Board of Water Supply, 1987):

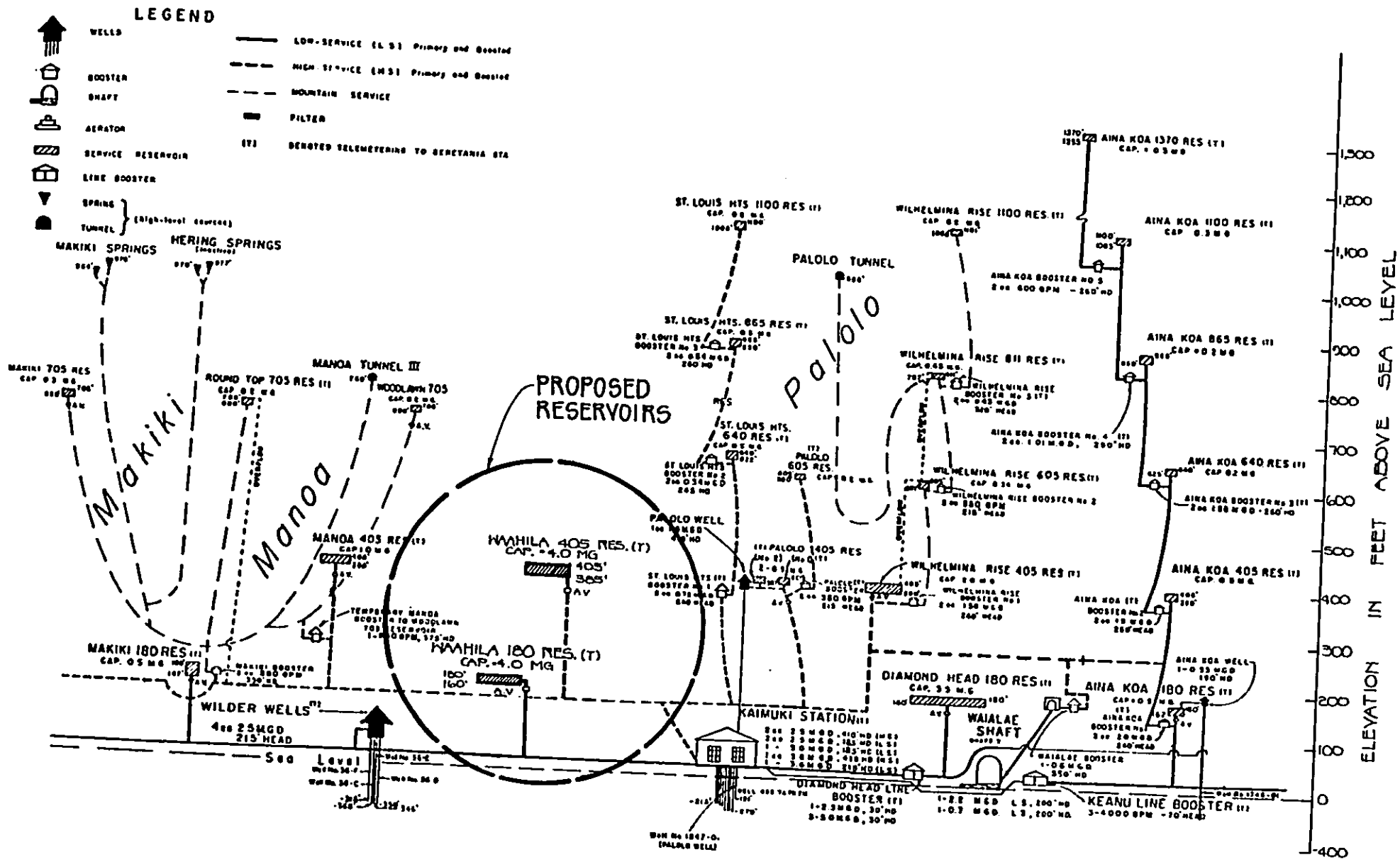
Service District	1987 Reservoir Capacity
Honolulu	44.8 mg (million gallons)
Windward	19.5
Waialua-Kahuku	6.8
Wahiawa	4.5
Pearl Harbor	30.8
Waianae	7.5
Ewa	14.5
Total Capacity	128.4 mg

2.1.2 HONOLULU DISTRICT EXISTING RESERVOIR CAPACITY

The Honolulu District of the Board of Water Supply extends from Aliamanu to Hawaii Kai. In the 1986 fiscal year, water use in the Honolulu District averaged 86.7 million gallons per day (mgd) (City and County of Honolulu Board of Water Supply, 1987). The Board's reservoir listing shows that existing reservoirs in the District have the following capacities:

Sub-Area	Spillway Elevation (feet above sea level)	Reservoir Capacity (millions of gallons)
Low Service System, Primary	170 & 180'	22.20
Low Service System, Boosted	297-1,370'	9.60
High Service System, Primary	405'	7.72
High Service System, Boosted	597-1,100'	2.42
Mountain Service	578-1,100'	2.87
Total Reservoir Capacity		44.81 mg

The existing water supply system in the Makiki/Manoa/Palolo area is depicted schematically in Figure 2-1. The Honolulu District is made up of three independent service zones: low, high, and mountain. Reservoirs in the low service system not served by booster pumps (primary) have water surface levels of 170 and 180 feet. Boosters pump to reservoirs with spillway elevations as high as 1,370 feet, providing "boosted" low service. Reservoirs in the high service system not served by boosters have spillway elevations of 405 feet (primary high service); boosters in the high service system pump to reservoirs with spillway elevations as high as 1,100 feet (boosted high service). Mountain service is provided where the water source is located at a very high elevation. The proposed Waahila 180 reservoir will be part of the low service system (primary), and the Waahila 405 reservoir will be part of the high service system (primary).



SCALES: HORIZ.: NOT TO SCALE
VERT.: AS SHOWN

Figure 2-1

SCHEMATIC DIAGRAM OF WATER SUPPLY SYSTEM

Each BWS reservoir has an altitude valve which prevents the tank from overflowing. Data from liquid level indicator, recorder, and controller equipment is transmitted via telemetering devices to the Board of Water Supply's Beretania Street station, where an operator then determines which pump(s) to turn on or off.

2.1.3 NEED FOR ADDITIONAL RESERVOIR CAPACITY

The Waahila reservoir project will enable the Board of Water Supply to achieve its general objective of operating and maintaining its systems in a manner which is economically sound and to public advantage. Specific project objectives are to:

- significantly increase storage capacity in the Honolulu District to more closely comply with BWS standards;
- provide uninterrupted service to customers; and
- stabilize pressures and supply water during peak demand periods and for fire fighting purposes.

Current Board of Water Supply standards call for reservoir capacity equal to 1.5 times the average daily use. Meeting this standard in FY86 would have required approximately 130 million gallons of storage capacity in the Honolulu District, or nearly three times the amount that was actually available. Construction of the two reservoirs will increase the storage capacity available to the Honolulu District by almost 18 percent. This will still leave the District with only 40 percent of the storage capacity needed to meet the Board's standards, but the improvement would be substantial.

Because of the limited reservoir capacity, the BWS system is heavily dependent upon operational sources (wells) rather than reservoir storage to meet daily demand. This is not a problem under normal circumstances, but if operation of the sources is interrupted for any reason (e.g., when a power failure prevents pumping from the wells), water levels in the reservoirs drop quickly. In the event of an outage lasting more than half a day, some users could be left without water. Additional reservoir capacity is desirable to reduce the likelihood of this occurrence. Several primary pumping stations have been adapted for mobile power generation, which will make it possible for water pumpage to continue during power outages. Work on adapting additional pumping stations is ongoing.

However, more reservoirs are also needed to stabilize system pressures, supply water during peak demand periods, and meet fire fighting requirements. Additional storage is especially needed to accommodate the high water demand in Waikiki, as well as projected demand in Kaka'ako, which is in the process of redevelopment. The Waahila site was selected, among other reasons, for its proximity to these areas.

2.2 PROJECT SITE

2.2.1 LOCATION

The proposed reservoir sites are located above the University of Hawaii Waahila Faculty Apartments on the western slopes of the valley separating Waahila and Kalaepohaku Ridges (TMK No. 3-3-56: por. 1 & 2). The Waahila 180 Reservoir will be situated about 500 feet northeast of (above) Dole Street, and the Waahila 405 Reservoir will be another 1,100 feet to the northeast (i.e., approximately 1,600 feet from Dole Street). Access to the site will be via Dole Street, the existing faculty housing entry road, and a proposed new access road as shown in Figures 1-1 and 1-2.

Each reservoir will be served by its own 24-inch diameter water main running beneath the access road. From the Waahila 405 Reservoir, a new main will be installed through the faculty housing entry road and connect to an existing 20-inch main on Dole Street. The Waahila 180 Reservoir water main will follow the same route through the housing area, turn southeast along Dole Street to its intersection with Saint Louis Drive, and then proceed one block south to the existing 24-inch transmission main beneath Waialae Avenue.

The project site lies between the Manoa campus of the University of Hawaii and the Saint Louis Heights residential area. In addition to the Waahila faculty housing complex, which is less than 120 feet from the Waahila 180 reservoir, single-family residences are located about 500 feet southeast of the 405 reservoirs and 800 feet from the 180 reservoir along the edge of Saint Louis Heights. Also nearby are Kanewai Playground, University dormitories, Hokulani School, Saint Louis High School, and the Kaimuki and Moiliili business districts. Dole Street is heavily used by students, faculty, and staff bound to and from the University of Hawaii and by residents of the student housing located near the intersection of Dole Street and East-West Road.

2.2.2 LAND OWNERSHIP

All of the land to be occupied by the reservoirs and access road is owned by the State of Hawaii. The lower portion, on which Waahila 180 will be constructed, is controlled by the University of Hawaii; the remainder is administered by the Department of Land and Natural Resources (DLNR). Figure 1-2 shows the property line between the two portions. The Board of Water Supply is currently negotiating with the University to acquire the 180 reservoir site and access road easement through a land exchange. Arrangements to obtain ownership of the DLNR parcel are also in progress.

2.2.3 LAND USE DESIGNATIONS AND CONTROLS

The reservoir sites and routes of the access road and new transmission main linking the 180 reservoir with the existing transmission main on Waialae Avenue are all within the State "Urban" Land Use District. Both reservoir sites are designated on the Development Plan Public Facility Map for the Primary Urban Center. On the Development Plan Land Use Map, the 180 reservoir site is within an area designated for public facilities and the 405 reservoir is designated "Preservation"; however, the Department of General Planning will amend the land use map after the project is completed to reflect the presence of these facilities.

The 180 reservoir is located in an area zoned "R-5 Residential" by the City and County of Honolulu; the 405 reservoir is on land zoned "P-2 Preservation." Reservoirs and other public uses and structures are "Principal Uses" within these districts. Hence, the proposed facilities are consistent with the existing zoning. These land use designations are illustrated in Figure 2-2.

2.3 DESIGN OF THE PROPOSED FACILITIES

The proposed project consists of the following elements:

- Two 4.0-million gallon (mg) capacity concrete reservoirs.
- A 12-foot wide concrete access road between the faculty housing complex and the two reservoirs.
- Two 24-inch diameter transmission mains connecting the reservoirs to the existing water system.

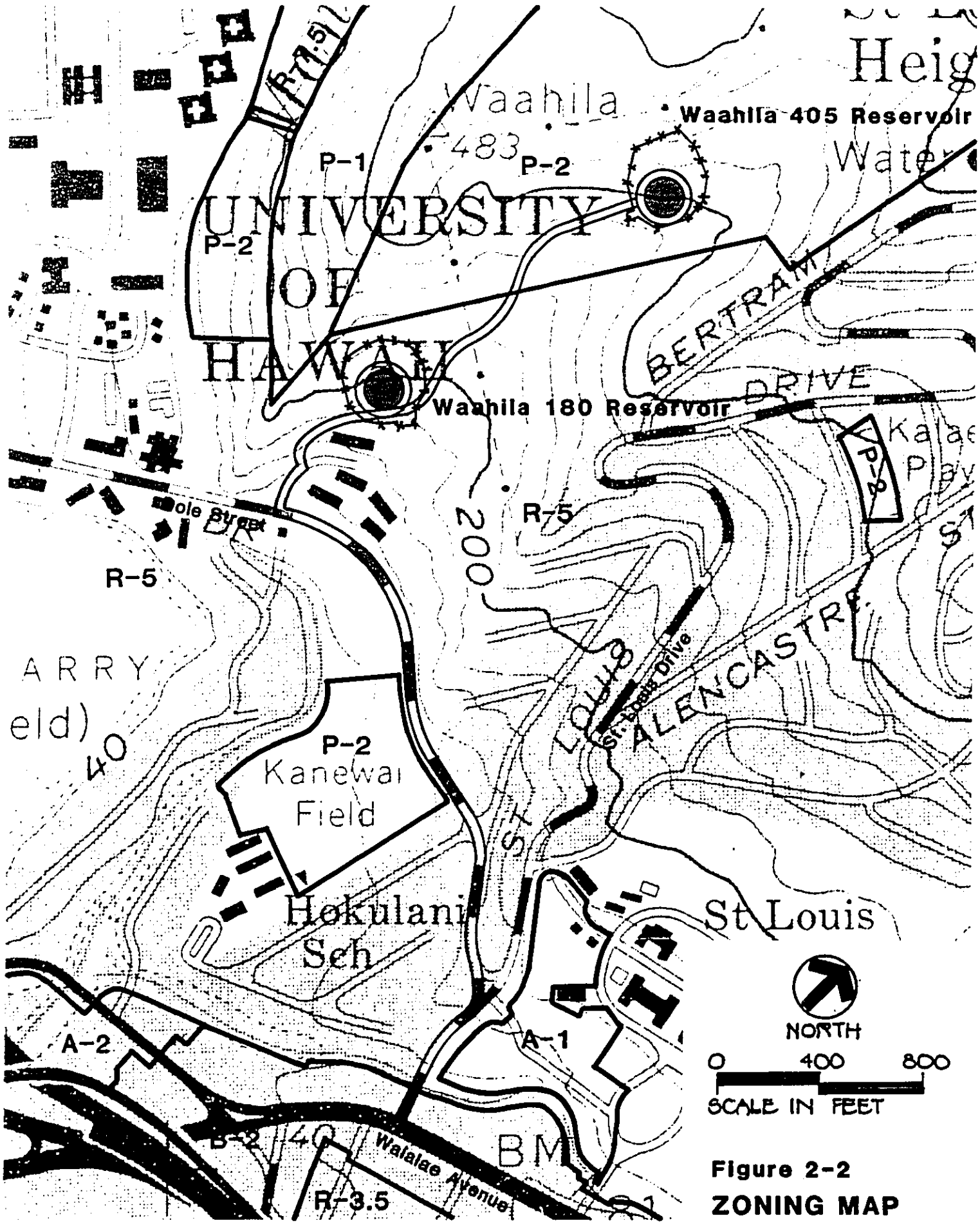


Figure 2-2
ZONING MAP

- Landscaping and a landscape irrigation system.
- Other facilities: drainage structures, fencing and gates, instrument houses, etc.

2.3.1 RESERVOIRS

The proposed Waahila 180 and Waahila 405 reservoirs will have spillway elevations of 180 and 405 feet, respectively. Their planned finished floor elevations are 160 and 385 feet, respectively. Each concrete tank will be 190 feet in diameter and 22 feet high, with a 10-foot wide perimeter road including drainage swale. BWS standards call for reinforced, prestressed concrete storage tanks which are accessible around the entire perimeter for maintenance purposes. [Note: "BWS standards" refer to the Water System Standards for the State of Hawaii (1985) adopted by the Board of Water Supply, effective March 1, 1986.] The height of each reservoir needs to match that of other tanks serving the same pressure zone. If the reservoir heights within the same service zone are unequal, the reservoir with the highest water level would be totally drained before the others are used. Since the water levels rarely get that low, the lower reservoirs within the same zone would go virtually unused.

Because the two reservoirs will be constructed on steeply sloping terrain, large cuts in the hillside will be required; typical sections are shown in Figure 2-3. Section 2.4 contains a detailed description of the proposed excavation.

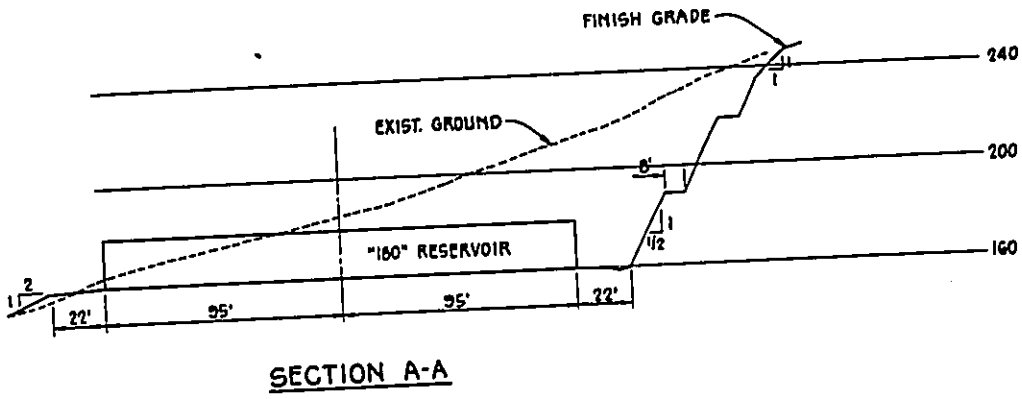
Each reservoir will be painted in a color that blends with the surroundings, and landscaping will be used to reduce the visual impact of the structures. This is in keeping with the Board of Water Supply's emphasis on the appearance and beautification of its facilities.

Several alternate locations on the Waahila site were considered for the reservoirs. The range of possible reservoir locations is shown in Figure 2-4, along with the recommended siting. Locations B and D were rejected as being too steep and too close to the houses on the St. Louis Heights ridge. Locations A and C, also very steep with several knolls, would require larger amounts of excavation than the recommended sites. The topography is flattest near the existing drainage way, but since its floodway boundaries should not be crossed, the reservoirs will be located on steeper ground just outside these limits.

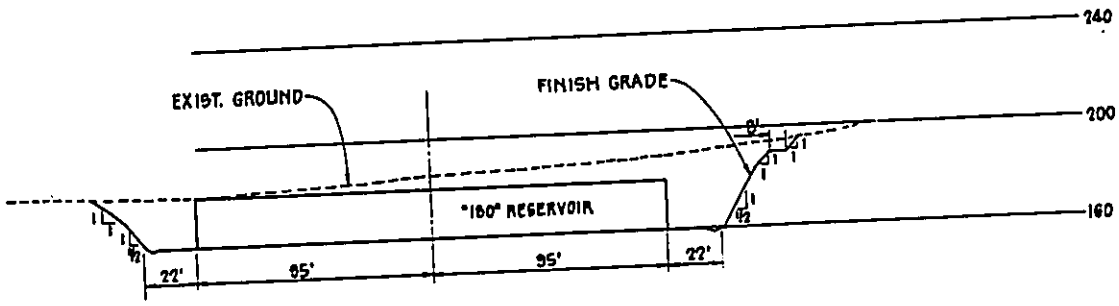
2.3.2 ACCESS ROAD

The 1,800-foot long concrete road providing access to the reservoirs will begin at the northern edge of the existing entry to the Waahila Faculty Apartments, shown as alternative A in Figure 2-4. Alternate starting point B, at the west end of the upper parking lot in front of Building E, was rejected by the University of Hawaii because of safety considerations. Under alternative B, access to the reservoirs would have been via the upper parking lot and too close to the existing playground at the west end of Building E. Alternative C—having the road start at the east end of the upper parking lot—was considered since it provided a shorter path and less steep grade to the 180 reservoir, but it would have required costly alterations to the existing drainage system.

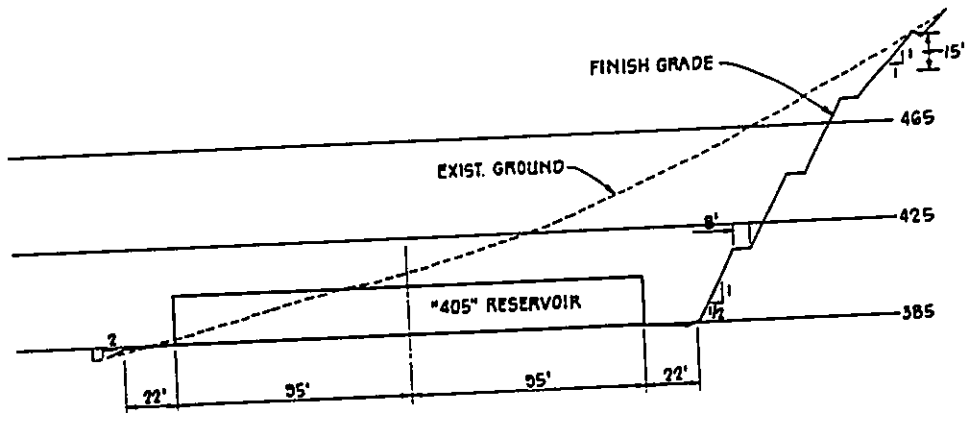
Alternative D is at the end of Robert Place in Saint Louis Heights. This location was considered because of a 60-foot wide access easement under State jurisdiction which begins at this point and follows approximately along the 260 foot contour line to the vicinity of the 405 reservoir. However, this starting point is less feasible than alternative A because a road constructed from the end of Robert Place would have to cross the existing drainage way and would be longer than the proposed roadway.



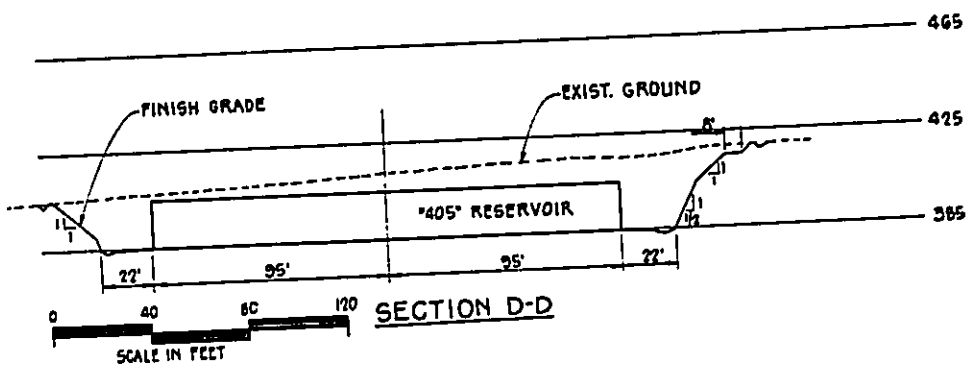
SECTION A-A



SECTION B-B



SECTION C-C



SECTION D-D

Figure 2-3

TYPICAL RESERVOIR SECTIONS

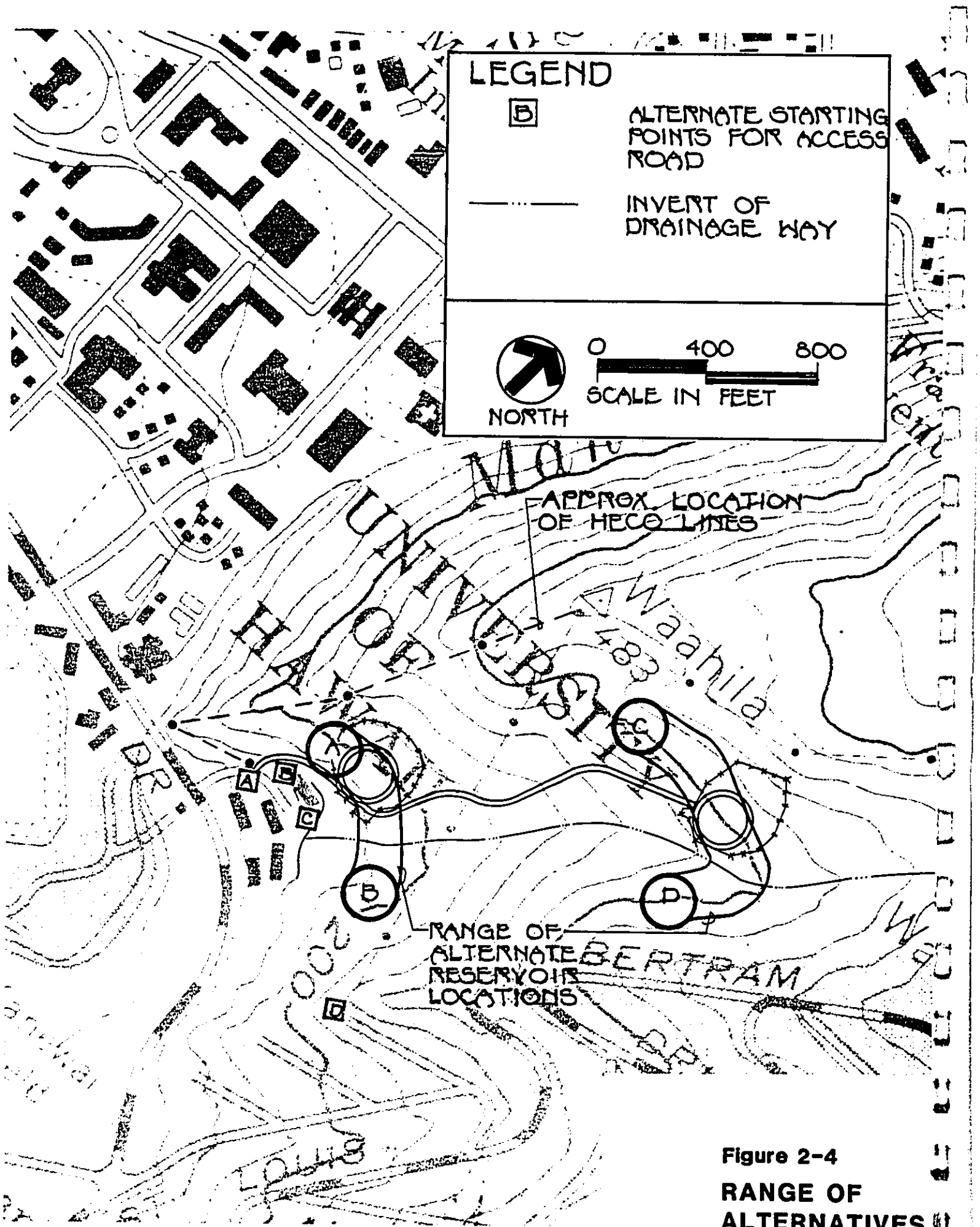


Figure 2-4

RANGE OF ALTERNATIVES

The possibility of accessing the reservoirs by using the same route that the Hawaiian Electric Company (HECO) uses to reach their power lines on Waahila Ridge was also investigated. HECO has confirmed, however, that no road exists and that it would gain access by walking or by helicopter (telephone conversation with HECO Maps and Records Division personnel, March 2, 1988).

Figure 1-2 shows the proposed road alignment, which includes a "double back" curve in order to avoid the existing buildings and maintain a reasonable roadway slope. An alternate design could include switchback curves in the horizontal alignment, which would increase the length of the road, allow for a flatter grade, and require a different drainage scheme. The criterion of minimum length was chosen because it represents the least expensive cost and also minimizes the length of transmission pipeline required.

Roadway slopes will range from 8 percent at the approach to the tanks to 20 percent elsewhere. Since most of the road has a slope greater than 12 percent, it will be constructed of concrete for its entire 1,800-foot length. The road will be 12 feet wide, with 3-foot shoulders on each side. A typical roadway cross section is shown in Figure 2-5. Earthwork quantities are estimated at 9,600 cubic yards of excavation and 6,400 cubic yards of embankment, for a net excavation quantity of 3,200 cubic yards. Swales on both sides of the access road, along with several drainage structures, will be required due to the topography of the site (see section 2.3.4 for details). The lower portions of the access road will have retaining walls.

A guard rail will be required on the right side of the roadway, and a gate will be installed at the start of the access road to prevent unauthorized vehicles from entering the area. A retaining wall will be constructed around the existing faculty apartments playground area for safety.

2.3.3 TRANSMISSION MAINS

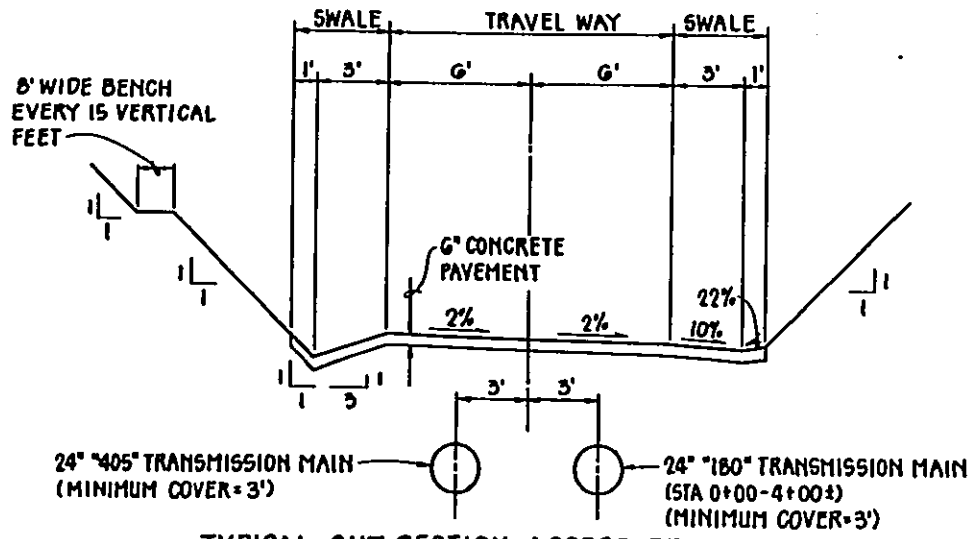
Figure 1-3 is a schematic drawing of the pipelines and appurtenances required to assimilate the reservoirs into the existing water system. In general, the single influent/effluent water lines from both reservoirs will be placed within the access road easement and under existing roadways. Approximately 2,100 feet of 24-inch pipeline will run from the 405 reservoir beneath the new access road and the faculty housing entry road to Dole Street; there, it will connect with an existing 20-inch water main. The transmission main from the Waahila 180 reservoir, approximately 4,700 feet in length, will run beneath the access road to Dole Street, eastward along Dole Street to Saint Louis Drive, and down (southward) Saint Louis Drive to an existing 24-inch water main beneath Waialae Avenue.

2.3.4 OTHER FACILITIES

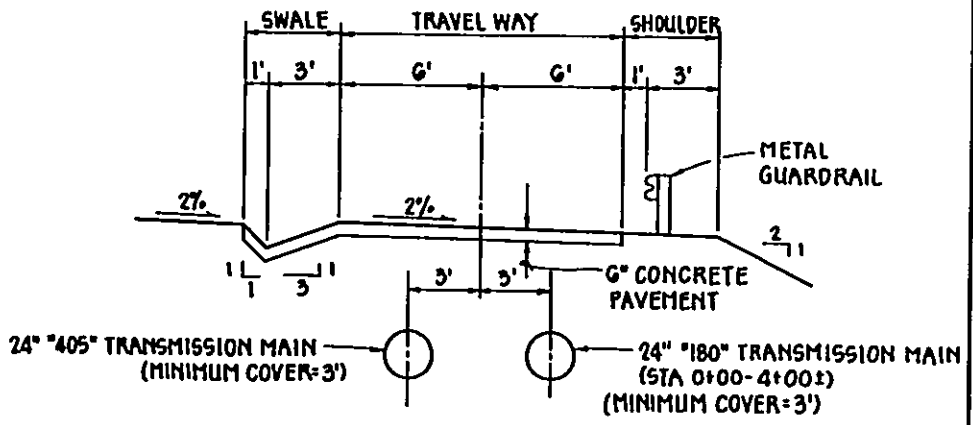
Landscaping will be planted around the reservoirs and on the cut slopes, and an irrigation system will be installed. In recent years, the Board of Water Supply has given increased attention to the landscaping of its facilities, including the use of plants and trees requiring little or no irrigation. It is expected that the Waahila landscaping will feature drought tolerant plant species.

The project will include two instrument houses (each about 10' x 10') and other control equipment associated with the reservoirs. Electrical service will be required for telemetry equipment, lighting for the instrument houses, and compressors located in each instrument house. Telephone service will be installed for the transmission of reservoir water elevations by telemetry to the BWS Beretania Street station.

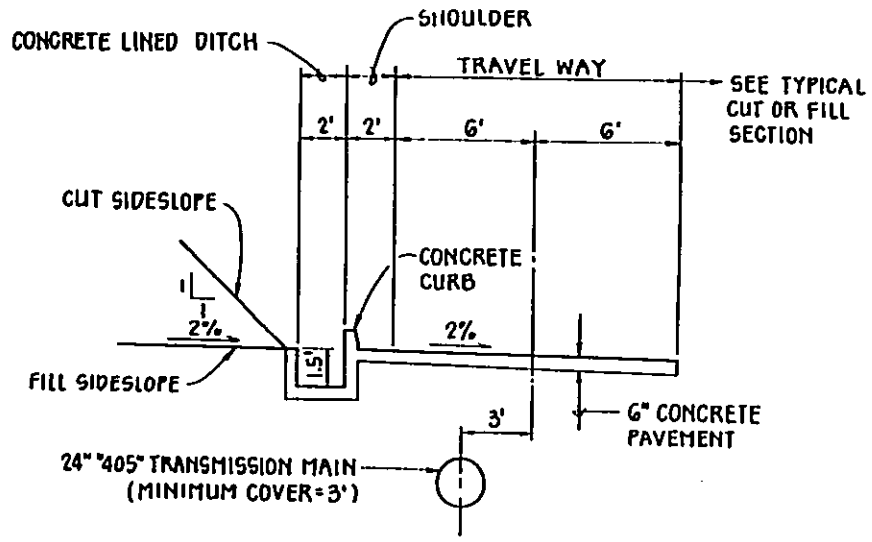
Fencing will be installed around each of the reservoirs and associated cut slopes, and gates will be placed where the reservoir fences cross the access road.



TYPICAL CUT SECTION-ACCESS RD.



TYPICAL FILL SECTION-ACCESS RD.



TYPICAL SECTION-ACCESS RD.
(STA 9+00-11+00)

Figure 2-5

ACCESS ROAD CROSS SECTIONS

The drainage system for the project was designed with the objective of not adding any area to the existing drainage basin. It will include the following:

- Eight-foot wide drainage swales around each reservoir perimeter road to divert runoff around the edges of the cut slopes. This swale will lead to an intake box for conveyance through a culvert to the floodway side of the road (except where the swale can "daylight" near the floodway without crossing the road at the 405 reservoir.

- A swale on the Waahila Ridge side of the access road along its entire length. Runoff will be led into culvert intake boxes, with the culverts outletting on the floodway side of the road. Culverts will not be placed where the floodway side of the road is in cut. When the floodway side of the road is in cut, a swale will be necessary to capture runoff from the cut sideslope. Roadway swales between culverts will be designed to hold approximately 15 cubic feet per second (cfs) of runoff.

Discussion of the drainage analysis carried out for the project is contained in Chapter 3.

2.4 CONSTRUCTION ACTIVITIES

2.4.1 GRADING

Extensive grading will be required to prepare the site for the proposed facilities. Before the earthmoving begins, the area within the grading limits (about two acres for each reservoir) will be cleared and grubbed of all vegetation, organic material, and debris. Rough grading of the access road, the first step, will be followed by installation of the pipelines beneath the roadway and paving of the road. Due to its steep grade, the necessary sections of the access road should be fully constructed before construction vehicles travel on them. The road can be constructed in two sections so that work can start on the 180 reservoir.

Based on the recommendations of the soils engineer, site grading for the reservoir structures will require cuts of approximately 90 to 100 feet in depth. The slopes will be cut at 0.5:1 (horizontal:vertical), with an 8-foot wide bench every 30 vertical feet (see Figure 2-3, Typical Reservoir Sections). Slopes will be flattened to 1:1 for the upper 15 feet (vertical) of excavation to accommodate the less competent, highly weathered basalt formation and thin layer of slopewash. To reduce the potential of damage due to rock falls from the steep cut slopes, the toe of the slopes will be set back from the edge of the perimeter road pavement to create a catchment area. About 67,000 cubic yards of materials will be excavated from each reservoir site. No fill placement is likely to be required at the site of the reservoir structures. If layers of soil or extremely weathered rock are exposed in the 0.5:1 slope, these layers will be cut back into the slope and faced with grouted riprap, lean concrete, or masonry grout.

Surface water from areas above the cut will be collected by an interception ditch and prevented from flowing across the exposed face of the cut. If water seepage is encountered in the cut faces, special provisions such as horizontal drains or toe drains may be required to stabilize the slopes. Site grading will be designed to divert surface water away from the reservoir foundations.

The roadway sideslopes will be graded at 1:1 in cut, in accordance with the soils engineer's recommendations. When in fill, the right sideslope will be graded at 2:1; the left fill sideslope will be as flat as possible to avoid creating a second drainage swale at the top of the slope. Approximate earthwork quantities for the roadway are 6,400 cubic yards of embankment and 9,600 cubic yards of excavation.

Road grading can be accomplished using bulldozers and other heavy construction equipment. It is anticipated that excavation for the proposed waterline trench will be in weathered basalt and may require hard excavation techniques (e.g., hoe rams or ripping). The large quantity of material that must be moved to prepare the reservoir sites, as well as the expected hardness of the material, make it likely that at least some blasting will be desirable to minimize the construction period and cost. The other excavation technique is to rely on a hoe ram (a large back hoe with a jackhammer-like attachment) to break up the rock. It is estimated that excavation by blasting would take about six months; by hoe ram alone, this phase would be extended to 12 months. From an environmental standpoint, blasting may be preferable since less dust and noise would be generated and the excavation period would be significantly shorter. On the other hand, there is a potential for damage to nearby buildings due to vibrations and the danger of loose rocks and boulders being dislodged. The University of Hawaii facility management staff has agreed that blasting is a preferred alternative since it will shorten the duration of the project and, hence, effects on the nearby faculty apartments.

Based on the conceptual plans, as well as soils and topographical information, it is estimated that approximately 137,000 cubic yards of excavated material will have to be removed from the reservoir sites and roadway alignment. Assuming an average of 20 cubic yards per truck load, approximately 6,900 round trips by heavy trucks will be required to remove and dispose of the material. The University of Hawaii has indicated that it has no use for the material, so the Board of Water Supply has written letters to State and City and County agencies asking whether they might be able to use it for anticipated projects. To date, no interest has been expressed. If public agencies are unable to use the waste, the contractor will be responsible for disposal.

2.4.2 FACILITIES CONSTRUCTION

Once the grading is completed, work on the 180 reservoir can begin. Reinforcing steel will be placed on the ground and forms placed around it; ready-mix concrete will then be trucked to the site and placed in several separate pours. After the pad is cured, the concrete pillars which support the roof and the walls will be erected, followed by installation of the reservoir's concrete roof. The transmission mains will be laid prior to the construction of the access road above them, although the roadway prism will be formed first. Next, the lower section of the access road will be fully constructed. Construction of the upper section of the access road and the 405 reservoir will follow.

Geotechnical studies conducted to date indicate that the basalt formation underlying the site provides adequate foundation support for the proposed reservoirs. The entire reservoir floor must be in cut for a stable foundation base. Due to the frequent occurrence of cavities and voids in Koolau pahoehoe lava flow, the geotechnical consultant has recommended that the footing construction portion of the project include a program of probing and grouting to detect potential voids below the reservoir foundations.

Some flexibility is possible in scheduling the installation of the transmission main along the faculty housing entrance road, Dole Street, and Saint Louis Drive. It is preferable that the work be initiated in the summer months when the University traffic is relatively light. The work will be done in sections.

Construction of the instrument houses and installation of an irrigation system, landscaping, and fencing will be the final steps.

2.5 PROJECT SCHEDULE, CONSTRUCTION COST, AND FINANCING

It is expected that the project will begin in mid-1989 and be completed by the end of 1991. It will be phased in the following increments:

Contract 1: 180 Reservoir, June 1989-December 1990

- Excavation of the 180 reservoir site (approximately 6 months).
- Construction of the 180 reservoir.
- Construction of the access road from the faculty apartments to the 180 reservoir site.
- Installation of the 24-inch low-service pipeline from Dole Street to the 180 reservoir.
- Installation of the 24-inch high-service pipeline from the high-service main on Dole Street to the end of the new access road at the 180 reservoir site.
- Installation of a drainage system from the 180 reservoir site to the existing drain line on Dole Street which empties into Manoa Stream.

Contract 2: Pipeline Installation, March 1990-March 1991

- Installation of the 24-inch low-service pipeline on Dole Street from the faculty apartments toward Saint Louis Drive and ending at Waialae Avenue. This pipeline will connect to the 24-inch low-service pipeline leading from Dole Street to the 180 reservoir that was installed in the first contract. The contractor would initiate orders for the pipe, etc. in March 1990, but would be required to hold off trenching work until the end of the University of Hawaii spring session.

Contract 3: 405 Reservoir, June 1990-December 1991

- Excavation of the 405 reservoir site (approximately 6 months).
- Construction of the 405 reservoir.
- Construction of the access road between the two reservoir sites.
- Installation of the 24-inch high-service pipeline from the 405 reservoir to the high-service pipeline at the 180 reservoir site that was installed in the first contract.
- Installation of the drainage system between the two reservoir sites.

The total estimated construction costs are:

	Blasting Option	Hoe Ram Option
180 Reservoir and Main	$8,443,750	$9,803,75
405 Reservoir and Main	7,734,500	9,094,500
Access Road	706,250	706,250
Total	$16,884,500	$19,604,500

These costs include provisions for soil erosion and sediment control but do not allocate costs for special measures to control noise and dust, such as air conditioning the faculty apartments. The estimates were made assuming off-site disposal of excavated material.

The Waahila project is included in the Board of Water Supply's Six-Year Capital Improvement Program (CIP) for 1988-1993. The budgeted amounts for the project are lower than the above estimates: $7,620,000 for the 180 reservoir and $6,620,000 for the 405 reservoir, for a total of $14,240,000 (cost of the access road is included in the reservoir figures). Planning and engineering costs are covered in the Board's CIP budget for fiscal year 1987-88, with monies coming from the Special Expendable Fund. This is the fund to which fees collected as "Water Facilities Charges" are credited to future capital construction. Authorization is being sought to issue general obligation bonds in fiscal year 1988-89 to finance construction of the project.

CHAPTER 3

PROBABLE IMPACTS AND MITIGATION MEASURES

3.1 INTRODUCTION

The assessment of probable impacts and development of mitigation measures have been conducted by the Board of Water Supply and its consultant through a process that has included a series of public informational meetings. Presentations were given before the following Neighborhood Boards representing communities likely to be affected by the project: Diamond Head/Kapahulu/St. Louis Heights Neighborhood Board No. 5, Palolo N. B. No. 6, Manoa N. B. No. 7, and McCully/Moiliili N. B. No. 8. A presentation was also given to the executive board of the St. Louis Heights Community Association, and to a general assembly of the Association at its annual meeting.

In addition, BWS and its consultant is working closely with various offices at the University of Hawaii responsible for facilities planning and management. The purpose of these ongoing discussions is to agree on mitigation measures relating to impacts on the faculty apartments, the Hawaiian Studies Program facility located makai of the apartments, traffic, parking, and future University development plans. As a result of these discussions, the Board of Water Supply authorized two special studies to provide information for this EIS that has been requested by the University. The findings of these studies are covered in this chapter.

3.2 THE PROJECT IMPACT AREA

The Waahila Reservoir Project is near Manoa Valley, Saint Louis Heights, Kaimuki, and Moiliili. Land uses within these neighborhoods, all of which are in the Urban District, include residential, commercial, park, and educational facilities.

The residential areas most likely to be affected by the proposed construction include the University of Hawaii Waahila Faculty Apartments, the University dormitories on Dole Street between East-West Road and Manoa Stream, and portions of Saint Louis Heights along Dole Street and overlooking the reservoir site. The faculty housing complex is composed of five three-story buildings. The student housing closest to the project site are the four circular, multi-story dormitory buildings known as Hale Aloha. Saint Louis Heights is a neighborhood of single-family homes. Other residential areas farther from the project site but still in the vicinity include Kaimuki (primarily single-family dwellings and low-rise apartment buildings with a fairly high density), and Moiliili (a mix of all types of housing).

Located across the street from the faculty apartments is Kapapa Lo'i 'O Kanewai, an irrigated taro terrace maintained by the Center for Hawaiian Studies, as well as the site of the future Hawaiian Studies building.

Commercial activities are generally found in Kaimuki and Moiliili, as well as in certain areas of Manoa Valley (University Avenue adjacent to the campus). Nearby schools include the Manoa campus of the University of Hawaii, Chaminade University, Hokulani Elementary School, and Saint Louis High School. Kanewai Playground, a City and County park, is located across Dole Street from the faculty housing complex. Waahila State Recreation Area, featuring picnic facilities and hiking trails in the forest reserve, is located above the Saint Louis Heights residential area.

The project impact area is potentially wider than the immediate neighborhood, since the reservoirs will be visible from other areas as well and would provide added water storage capacity

for all Board of Water Supply Honolulu District customers who are served by the high (405') and low service (180') systems. The District extends from Aliamanu to Hawaii Kai, serving an estimated population of more than 433,000 residents, tourists, and military personnel and dependents (Board of Water Supply, 1987).

3.3 PHYSIOGRAPHY

3.3.1 EXISTING CONDITIONS AND CONSTRAINTS

3.3.1.1 Topography

The proposed reservoirs will be located in the small valley between Waahila Ridge and Kalaepohaku Ridge. The valley is an erosional feature on the southern flank of the Koolau Range. Construction of the reservoirs and access road will involve work at elevations between 90 and 550 feet above sea level, and on hillside slopes varying from 25 to 45 percent (see Figure 1-1).

The Dole Street section of the proposed pipeline extending from the Waahila Faculty Apartments entry road to Waialae Avenue is nearly level. The pipeline route then drops sharply beginning at Saint Louis Drive and crosses Palolo Stream just above Waialae Avenue.

3.3.1.2 Geology

The island of Oahu is composed of two shield volcanoes, Waianae and Koolau, built by the extrusion of basaltic lavas during the late Pliocene and Pleistocene epochs. Preliminary reconnaissance of the project site and its vicinity indicates that it is underlain by thin residual and transported soils over Koolau lavas. The Koolau Volcanic Shield consists of thinly-bedded basaltic lava deeply dissected by streams. Portions of the eroded stream valleys may be filled with recent sediments. Observations indicate that the site will be excavated in basaltic lava flows, a large percentage of them *pahoehoe*, which generally average 10 feet or less in thickness. Cavities or voids, such as lava tubes, are common in *pahoehoe* lava flows and frequently encountered in cuts or excavations. Inspections of clinker (basalt fragments) layers at the ground surface reveal that these highly fractured to granular layers may vary from six inches up to several feet thick, as observed in road cuts along Dole Street.

The earthquake risk is minimal. The island of Oahu is classified as a Seismic Zone 1 area, in which damage would be minor in the event of an earthquake (Uniform Building Code, 1979). [Note: Seismic risk is measured on a scale ranging from Zone 0 (no damage) to Zone 4 (major damage; proximity to major fault systems).]

3.3.1.3 Soils

According to the U.S. Department of Agriculture Soil Conservation Service (August 1972), the soils in the project site are of three types, which are described below. None are well suited for agriculture.

- **Kaena Very Stony Clay,** 12 to 20 percent slopes (KanE): very deep, poorly drained soils occurring on talus slopes and alluvial fans, with many stones on the surface and in the profile; medium to rapid runoff; moderate to severe erosion hazard; very sticky and plastic soils with high liquid limit and high shrink-swell potential; low shear strength.

- **Pamoa Silty Clay,** 5 to 20 percent slopes (PID): representative profile characterized by a thin silty clay surface layer, over a thick subsoil (about 55 inches) of clay and silty clay, and a substratum of soft, weathered rock. The clay is very sticky and very plastic when wet but

friable when moist, with a low liquid limit, high shrink-swell potential, and low shear strength. Runoff is medium, erosion hazard is moderate to severe, and the soil is susceptible to gullying and piping.

- **Rock Land** (rRK): characterized by rock outcrops (covering 25 to 90 percent of the surface) mainly of basalt and andesite, as well as very shallow soils; typically very sticky and very plastic soils with high shrink-swell potential. This land type can be nearly level to very steep. On steep slopes, buildings constructed on soil covered areas are susceptible to sliding when the soil is saturated; foundations and retaining walls constructed on the soil pockets are susceptible to cracking.

The soil on the site of the 180 reservoir is a combination of KanE and rRK; the soil on the 405 reservoir site is a mix of all three types.

Subsurface conditions at the lower reservoir site were explored by drilling and sampling borings to depths ranging from 31 to 37 feet below the existing ground surface. Test pits were excavated throughout the project area to explore near-surface conditions at the reservoir sites and along the access road alignment. In addition, seismic refraction surveys were performed at both reservoir sites. (The geotechnical engineering report prepared by Geolabs-Hawaii for this project is contained in Appendix A.)

In general, the field exploration encountered a surficial layer of very stiff brown clays with boulders, cobbles, and gravel ranging in thickness from 0 to 3.5 feet, which represents the transported soil (or slopewash) commonly found on hillside sites. A weathered basalt formation (Koolau Basalt), ranging in thickness between 5 and 10 feet, was encountered below this stratum. The site is underlain by moderately to slightly weathered basalt formation which would provide adequate foundation support for the proposed reservoirs.

The geotechnical engineering study recommends that the footing construction portion of the project include a program of probing and grouting to detect potential cavities and voids below the reservoir foundations, due to the frequent occurrence of such features in Koolau *pahoehoe* lava flows.

Relatively hard ripping is anticipated in the dense basalt which underlies the site of the two reservoirs and most of the roadway at fairly shallow depths. The more massive basalt in the deeper reservoir cut slopes will likely require special excavation procedures, such as hoe ram equipment or blasting.

Groundwater was not encountered during the soils survey. However, due to the relatively high rainfall in the vicinity of the site and the nature of the geologic materials, it is possible that zones of seepage (particularly intermittent seepage) could occur in the cut faces.

3.3.1.4. Climate

Average annual rainfall at the 180 reservoir site is approximately 40 inches, with most of the rain occuring in the winter and early spring months. Rainfall is somewhat higher at the 405 reservoir site, probably on the order of 50 inches per year. Temperatures range from an average (mean) minimum in the mid 60s (Fahrenheit) in the winter to an average maximum in the mid- to high-80s during the summer and early fall. The prevailing wind throughout the year is the northeasterly trade wind; in general, the trades are more persistent in the summer than the winter. Because the ridges on either side of the narrow valley tend to block the prevailing winds, wind speeds at the site of the reservoirs tend to be lower.

3.3.1.5 Drainage

The existing drainage pattern in the project area is shown in Figure 3-1. During periods of moderate to heavy rainfall, ditches immediately above the faculty apartments intercept overland flow and carry it into a culvert which passes beneath the apartments and Dole Street, eventually discharging into Manoa Stream. The floodway limits of the existing drainage way are shown in Figure 3-1. Both reservoirs and the access road will be located outside of the floodway boundaries.

According to the National Flood Insurance Rate Map, the reservoir and access road site is outside the 500-year flood plain (Other Areas, Zone X) (Federal Emergency Management Agency, National Flood Insurance Program, September 4, 1987).

3.3.2 PHYSIOGRAPHIC CHANGES

3.3.2.1 Topography

Large-scale grading will result in major, permanent changes to existing landforms. Excavation for the reservoir structures will require cuts of approximately 90 to 100 feet in depth. The cut slope ratio will be 0.5 horizontal to 1 vertical in competent, slightly weathered basalt formation. The ratio will be flattened to 1 horizontal to 1 vertical in the upper 15 feet of cut slopes, where the basalt formation is less competent, highly weathered, and covered with a thin layer of slopewash. Since they will be cut in rock, the slopes will be stabilized.

3.3.2.2 Erosion

With steep ground exposed to rain and runoff, soil erosion will likely increase during the site preparation phase of the project. A soil erosion assessment was carried out for this project, based on the Soil Erosion Standards and Guidelines of the City and County of Honolulu (Department of Public Works, 1975). In these standards, a project's Severity Rating Number (H) indicates the degree of hazard from potential damage by erosion and sediment. For Oahu, the maximum allowable value of H is 50,000. No project with a severity rating number substantially above this value will be approved until measures have been taken to reduce the number to meet the standard. The H value for construction of the Waahila project without erosion control measures (using either blasting or hoe ram for excavating) will be substantially greater than 50,000. In addition, there are potential hazards from the numerous rocks and boulders found throughout the site which will be loosened during the grading.

3.3.2.3 Drainage Impacts

Natural drainage patterns will not be substantially altered by the project. Results of the drainage analysis carried out as part of the engineering feasibility study for the project are shown in Figure 3-1. One objective of the study was to determine the channel flow rate at critical points along the drainage way and the effects of the proposed construction on the flow. Based on a flood recurrence interval of 100 years, the peak discharge at three critical points was calculated as follows:

Critical Point	Peak Discharge (cfs)
Near the 405 reservoir	1,000
Near the 180 reservoir	1,175
At the existing culvert inlet	1,200

The analysis showed that the change in topography and alteration of ground surface due to construction of the reservoirs and road and associated cut and fill will increase runoff by less than

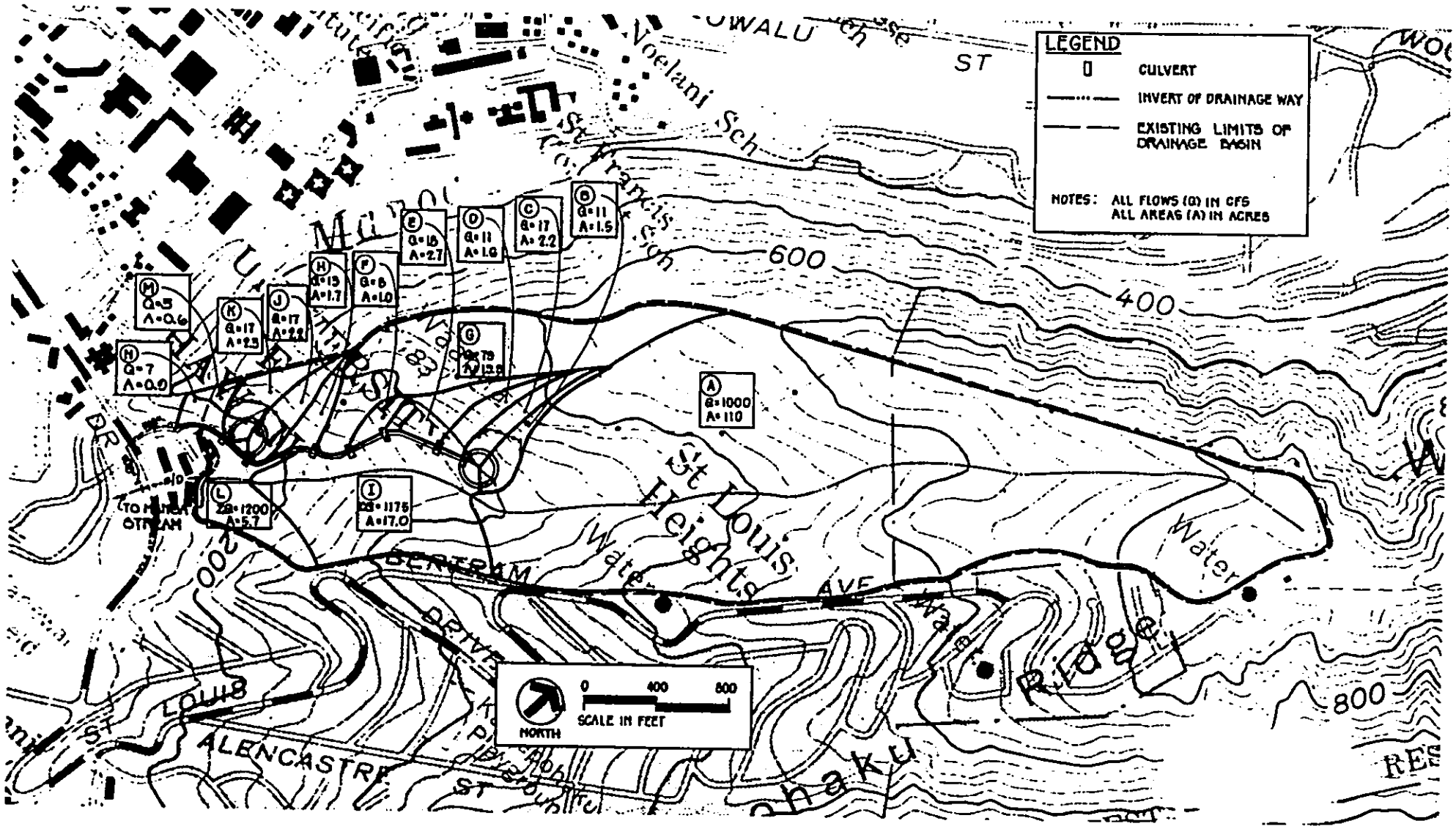


Figure 3-1

DRAINAGE MAP

one percent of the total runoff in the drainage basin. This negligible increase is partly attributed to the decrease in the size of the drainage basin, since subarea "M" as shown in Figure 10 is excluded. Because the access road will be in cut from its starting point to the 180 reservoir, it will not be possible to place a culvert so that discharge from subarea "M" can flow to the existing culvert. Instead, discharge from subareas "M" and "N" will go from the access roadway swale to an intake box and be piped to the outlet of the existing culvert crossing Dole Street. The runoff will then discharge to Manoa Stream regardless of the drainage system in the area, so the flow to the stream will not be altered. This setup will prevent flooding of the faculty apartment entrance road.

As illustrated in Figure 10, all subareas of the basin except for "G" will generate flows of less than 18 cfs. Subarea "G" runs along the roadway for only 200 feet but has a discharge of 79 cfs, so a special drainage ditch has been designed for this section.

The drainage study also noted that limits of the 100-year storm floodway will encroach on the faculty apartment buildings, with or without the reservoir project.

Concern has been expressed by the University's Center for Hawaiian Studies regarding the possible impact of the project on its irrigated terrace, known as Kapapa Lo'i 'O Kanewai, and the site of the future Hawaiian Studies building. The lo'i is located across Dole Street, makai of the faculty apartments. There is concern that the Waahila project will alter the upper portion of the drainage basin which empties into the area of the lo'i, and that construction activity and erosion may adversely impact the facility. Given the estimated increase in runoff of less than one percent, it is projected that during a 100-year storm, water level in the lo'i area would rise by no more than 1.56 inches. This additional runoff would be handled by the drainage improvements which will be constructed as part of the reservoir project. The *increase* in velocity in a 100-year storm would be minimal—at the most, 0.05 feet per second on the banks of the stream, resulting in a bank velocity no greater than 1.6 feet per second. The magnitude of change would be relatively small and would be even smaller in a one-year (annual) storm.

The drainage improvements will be aligned to avoid impacts on rare and endangered native species planted in the lo'i area, as well as the Hawaiian Studies 'auwai ditch which runs along the Manoa Stream base of Waahila Ridge. Likewise, existing plantings and buildings at Kapapa Lo'i 'O Kanewai will not be affected by the transmission lines to be installed. To prevent any detrimental effect on the complex, the 24-inch water line from the 405 reservoir will run down the faculty housing entry road, cross over to the makai side of Dole Street, turn and continue in the paved road area to Manoa Bridge, and connect to the existing 20-inch water line near the bridge. The other 24-inch water line from the 180 reservoir will run down the faculty housing entry road, enter Dole Street, and turn and continue in the paved road area to Saint Louis Drive.

3.3.3 PROPOSED MITIGATION MEASURES

A number of measures are proposed to lessen the impact of the project as a result of the changes in physiography. Some of these have been developed as a result of discussions held with the University of Hawaii. The purposes of these measures are to minimize erosion and sedimentation during construction and, hence, the impact on streams and coastal waters, as well as assure proper drainage on the site. In addition, it is recommended that a geotechnical engineer be retained to review plans and specifications for the proposed construction and to provide services during the excavation and foundation phases of the work. The purpose of this construction monitoring is to assure compliance with design concepts, specification, and recommendations, as well as to allow design changes in the event that subsurface conditions differ from those anticipated prior to construction.

CORRECTION

THE PRECEDING DOCUMENT(S) HAS
BEEN REPHOTOGRAPHED TO ASSURE
LEGIBILITY
SEE FRAME(S)
IMMEDIATELY FOLLOWING

one percent of the total runoff in the drainage basin. This negligible increase is partly attributed to the decrease in the size of the drainage basin, since subarea "M" as shown in Figure 10 is excluded. Because the access road will be in cut from its starting point to the 180 reservoir, it will not be possible to place a culvert so that discharge from subarea "M" can flow to the existing culvert. Instead, discharge from subareas "M" and "N" will go from the access roadway swale to an intake box and be piped to the outlet of the existing culvert crossing Dole Street. The runoff will then discharge to Manoa Stream regardless of the drainage system in the area, so the flow to the stream will not be altered. This setup will prevent flooding of the faculty apartment entrance road.

As illustrated in Figure 10, all subareas of the basin except for "G" will generate flows of less than 18 cfs. Subarea "G" runs along the roadway for only 200 feet but has a discharge of 79 cfs, so a special drainage ditch has been designed for this section.

The drainage study also noted that limits of the 100-year storm floodway will encroach on the faculty apartment buildings, with or without the reservoir project.

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3.3.3.1 Erosion Control Measures

- Install check dams in the roadway swales and ditch, sediment traps at the base of fill, and filter inlets at culvert inlets.
- Grade the reservoir sites incrementally to lessen erosion and sedimentation of Manoa Stream during heavy rainfall. Start with the 180 reservoir site first (after the lower section of the access road is paved), followed by construction of the remainder of the access road and grading of the 405 reservoir site.
- Provide dust control by sprinkling, mulching, or temporary vegetative cover.
- Prior to grading the reservoir sites, install a sediment basin.
- Limit grading of the reservoir sites to the summer months and seed the entire area immediately after grading. Rainfall in the area is lightest from May through October.
- Install containment dikes around the reservoir perimeters and check dams in the swales.
- Specify that the contractor should remove all visible rocks and boulders from the site after grading is completed to lessen the hazards of rock slides.
- Where the existing ground has a slope steeper than 5:1 (horizontal:vertical), key and bench any fill into firm existing ground to properly bond it to the slope.
- During excavation, minimize erosion due to runoff by diverting surface water away from the areas above the slopes and preventing water from flowing across the slope face.
- If seepage is encountered in cut faces, install horizontal drains or toe drains to stabilize the slopes.
- Insert a clause in the Special Provisions portion of the contract specifications for the contractor to take extra precautions to prevent erosion problems.

3.3.3.2 Drainage Improvements

- Design the site grading to divert surface water away from the reservoir foundations. Provide drainage swales around each reservoir perimeter road to divert runoff around the edges of the cut slopes.
- Provide drainage swales on the access road, along with several roadway drainage structures. (See section 2.3.4 for a description the drainage systems). Construct subsurface drainage systems (subdrains or weepholes) behind the roadway retaining walls to drain water away from the walls.
- Construct the drain line in the makai pavement of Dole Street outside of the Hawaiian Studies Program lo'i property to minimize adverse impacts on the facility.

3.4 FLORA AND FAUNA

3.4.1 EXISTING CONDITIONS

On October 17, 1987, a walk-through botanical survey was conducted on the site by Char & Associates, Botanical/Environmental Consultants. A copy of the report is presented in Appendix B. The vegetation was found to be largely grassland, with scrub and small trees where the soil permits. A total of 46 vascular plant species were found on the site, of which 42 are exotic and 4 are considered native or Polynesian introductions. Not a single Hawaiian endemic species was encountered, and none of the species are rare, threatened, or endangered. Those considered indigenous are questionably so, as they are widespread weedy species in the Pacific which may have accompanied early voyagers to Hawaii.

As the survey was done at the very end of the dry season, the number of species encountered may be slightly less that actually present. Some characteristic weedy annuals were missing, and there was only slight evidence that germination of the season's seeds was beginning. Later in the season, after heavy rain, a number of additional annual species are expected to appear on the site. However, because they are exotic weeds, their being undetected in this survey is not considered a serious limitation.

Grass cover on the project site is about 70 to 80 percent, with the grass reaching heights of 2 meters or more. The most prevalent plant is Guinea grass *(Panicum maximum* and its smaller form, var. *trichoglume).* Two small trees—kolomona *(Senna surratensis)* and koa-haole *(Leucaena leucocephala)*—form an open scrub over much of the site, but probably not much more than 30 to 40 percent coverage. Patches of scrub often have an undergrowth of Chinese violet *(Asystasia gangetica).* On top of rocky ledges, where the soil is too thin to support Guinea grass, sour grass *(Digitaria insularis)* predominates instead. A number of trees were found widely scattered on the site with little evident pattern or trend, including kiawe *(Prosopis pallida),* silk-oak *(Grevillea robusta),* Chinese banyan *(Ficus microcarpa),* and logwood *(Haematoxylum campechianum).*

With regard to fauna, it is unlikely that the site provides a habitat for any significant bird or other wildlife species. The proposed reservoirs and access road will be constructed in the midst of an area that has been heavily developed for a long time. Moreover, the site is not a native forest area. Birds commonly found in urban Honolulu include the red-crested cardinal, barred dove, spotted dove, common mynah, mockingbird, Pacific golden plover, pueo, ricebird, house sparrow, and white eye. All are introduced species except the pueo or Hawaiian short-eared owl *(Asio flammeus sandwichensis)* and Pacific golden plover *(Pluvialis dominica fulva).* Neither of these is threatened or endangered. Native to Hawaii, the pueo inhabits open grassland, pastures, forests, lava flow areas, and residential areas. The Pacific golden plover, an indigenous migratory shorebird, is a common winter resident on all of the islands, usually favoring lawns and golf courses.

3.4.2 PROBABLE IMPACTS

According to Char & Associates, there do not seem to be any botanical impediments to developing the Waahila site. The proposed project is not expected to have any significant negative impact on the existing flora, which are almost exclusively exotic weedy species found throughout the islands in similar habitats.

Likewise, the project is not expected to have any adverse effects on significant bird or wildlife species.

3.5 HISTORIC AND ARCHAEOLOGICAL RESOURCES

3.5.1 EXISTING CONDITIONS

An archaeological reconnaissance survey of the Waahila reservoirs site was conducted by Paul H. Rosendahl, Ph.D., Inc. (PHRI) to determine the presence or absence of sites and/or features of potential archaeological significance. Field work was carried out on October 13, 1987. It consisted of 100 percent ground coverage of the transmission line/access road corridor, the two reservoir sites, and adjacent areas to be affected by construction grading. The findings were discussed with Dr. Joyce Bath, staff archaeologist with the State of Hawaii Department of Land and Natural Resources, Historic Sites Section. PHRI's report is contained in Appendix C.

No previously identified archaeological sites are known to exist within or immediately adjacent to the project area. Likewise, no potentially significant archaeological sites or features of any kind were encountered during the survey. A short segment of irregularly spaced small boulders was noted along the edge of a natural outcrop in the transmission line/access road corridor near the 335-foot elevation contour, but it could not be determined whether the segment was natural or cultural in origin.

3.5.2 PROBABLE IMPACTS AND MITIGATION MEASURES

Based on the essentially negative results of the reconnaissance survey, it was concluded that no further archaeological work of any kind was necessary in the project area. PHRI recommended that the site be granted full archaeological clearance. Since this recommendation is based on a surface reconnaissance of the site, there is always the possibility—however remote—that unknown or unexpected subsurface cultural features or deposits might be present. If such features are found during grading and construction activities, work will be halted and immediate archaeological consultation sought.

3.6 TRAFFIC

The project will affect traffic and parking in two principal ways. First, construction trucks and construction workers' vehicles will temporarily increase the number of vehicles using the area's roadways. Second, installation of the water main along Dole Street and the lower portion of Saint Louis Drive will temporarily reduce the available roadway width and the number of on-street parking stalls along Dole Street. These effects will be limited to the construction phase of the project. Outside of occasional trips by BWS maintenance vehicles, the two reservoirs will generate virtually no traffic once they are operational.

The following will be covered in the remainder of this section:

- Number, timing, and expected routing of construction-vehicle-trips.
- Existing traffic volumes along the expected route.
- Ability of the existing road network to accommodate the forecast increase in traffic volume.
- Steps to be taken to mitigate the effect of the increase in traffic volume.

3.6.1 TRIP GENERATION, TIMING, AND ROUTING

In terms of trip-generation, the proposed project can be divided into two distinct phases:

- Site preparation, including roadway grading, reservoir pad excavation, and road paving.
- Erection of the reservoir and construction of the pipeline.

The project's third phase, actual operation, will not generate significant amounts of traffic. Hence, it is not discussed further in this analysis.

3.6.1.1 Site Preparation Phase

The following assumptions were used to calculate the number of large-truck-trips that will be generated during the site preparation phase:

- Excavation volume = 137,000 cubic yards (cy)
- Average truck capacity = 20 cy
- Number of working days per year: 50 weeks @ 5 days/week = 250
- Number of one-way truck-trips per truck-load = 2.0

Based on these assumptions, the reservoir excavation is expected to produce approximately 55 one-way large-truck-trips per day. These trips will be spread between the hours of 8:30 a.m. and 3:30 p.m., or seven hours. Hence, the average is approximately eight one-way trips per hour. In response to concerns expressed by the University of Hawaii, the Board of Water Supply has agreed to require the heavy trucks carrying the excavated material to follow a Dole Street-Saint Louis Drive-Waialae Avenue route to and from the H-1 Freeway. This would avoid the congestion frequently present farther west on Dole Street.

In addition to the large-truck-trips, construction workers, suppliers, City inspectors, and others will also drive private automobiles and light trucks to and from the site. The average construction crew will be about 20-25 during site preparation.

Combining these, adding miscellaneous trips, and distributing them over the course of the day results in the following trip generation table for the site preparation phase of the project:

Trip Generation by Category

	Employees		Light Trucks		Heavy Trucks		Total		Total
	In	Out	In	Out	In	Out	In	Out	Trips
7-8:00 a.m.	5	0	2	0	0	0	7	0	7
8-9:00 a.m.	20	0	3	1	4	3	27	4	31
9-10:00 a.m.	0	0	3	3	4	4	7	7	14
10-11:00 a.m.	0	0	3	3	4	4	7	7	14
11-12:00 p.m.	4	4	3	3	4	4	11	11	22
12-1:00 p.m.	0	0	3	3	4	4	7	7	14
1-2:00 p.m.	0	0	3	3	4	4	7	7	14
2-3:00 p.m.	0	0	3	3	4	4	7	7	14
3-4:00 p.m.	0	20	0	4	2	3	2	27	29
4-5:00 p.m.	0	5	0	0	0	0	0	5	5
Totals	29	29	23	23	30	30	82	82	164

3.6.1.2 Reservoir Erection and Pipeline Construction

During this phase of the project, the size of the construction crew would increase slightly, to perhaps 30 persons, but the number of heavy-truck-trips will decrease. Peak-hour construction worker traffic on the order of 25-30 one-way vehicle trips is anticipated on the Waahila Faculty Apartments entry road. It is estimated that inbound traffic from this source will peak between 6:30 and 7:30 a.m., while outbound traffic will peak between 3:30 and 4:30 p.m.

The number of construction trucks coming to and from the reservoir sites will not exceed ten per hour except, perhaps, on the few days when concrete is being poured for the floors and walls of the reservoir. These will not normally occur at the same time that commute trips peak, and so will not increase peak-hour traffic on the area's roadways.

Pipeline construction will involve a crew of about 15 workers who will commute to and from the job site. Construction trucks bringing pipe, concrete, reinforcing bar, select fill, and other materials will also travel to and from the site, mostly at off-peak hours. These trips may occur at the same time as the commute trips generated by the reservoir work.

The following table summarizes these different components:

Trip Generation by Category

	Employees		Light Trucks		Heavy Trucks		Total		Total
	In	Out	In	Out	In	Out	In	Out	Trips
6-7:00 a.m.	45	0	0	0	0	0	45	0	45
7-8:00 a.m.	0	0	3	3	2	0	5	3	8
8-9:00 a.m.	0	0	5	4	2	2	7	6	13
9-10:00 a.m.	0	0	5	4	2	1	7	5	12
10-11:00 a.m.	0	0	5	2	1	2	6	4	13
11-12:00 p.m.	8	8	6	7	2	1	16	16	32
12-1:00 p.m.	0	0	4	5	1	2	5	7	12
1-2:00 p.m.	0	0	4	5	2	1	6	6	12
2-3:00 p.m.	0	0	4	5	1	2	5	7	12
3-4:00 p.m.	0	45	2	3	0	2	2	50	52
Totals	53	53	38	38	13	13	104	104	208

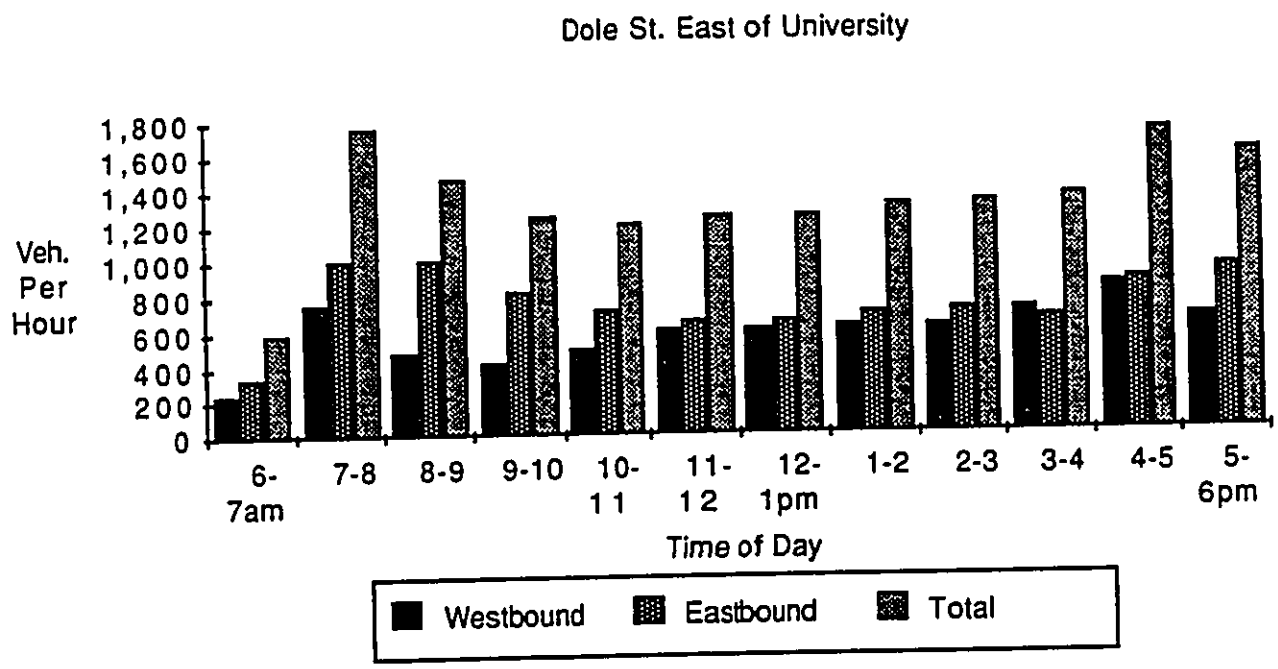
3.6.2 EXISTING TRAFFIC

As indicated in Section 3.6.1, vehicles traveling to and from the proposed project will use the Waahila Faculty Apartment entry road, Dole Street, University Avenue, Saint Louis Drive, and Waialae Avenue. Recent peak-hour traffic counts at critical locations on those roadways are summarized in the charts presented in Figures 3-2, 3-3, and 3-4. These charts illustrate several important points.

- University Avenue is the busiest road affected by the project. The highest volumes on that road occur between 7:00 and 8:00 in the morning and between 4:00 and 6:00 in the afternoon. Traffic on University Avenue exceeds 3,000 vehicles per hour during both periods.

- Traffic on Dole Street is highest just east of its intersection with University Avenue. There, the peak-hour volume is nearly 1,800 vehicles per hour. Peak volume at the Manoa Stream Bridge is 20 percent less, while traffic near Saint Louis Drive is still lower.

Figure 3-2. Traffic on Dole Street and on University Avenue



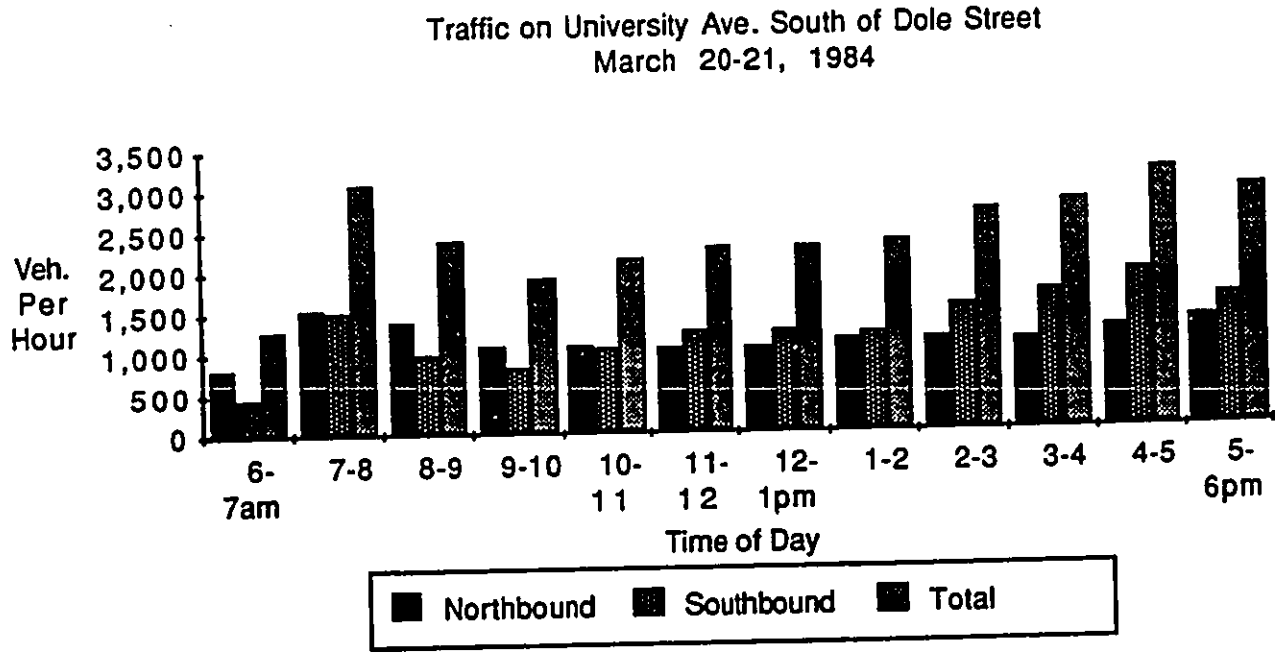
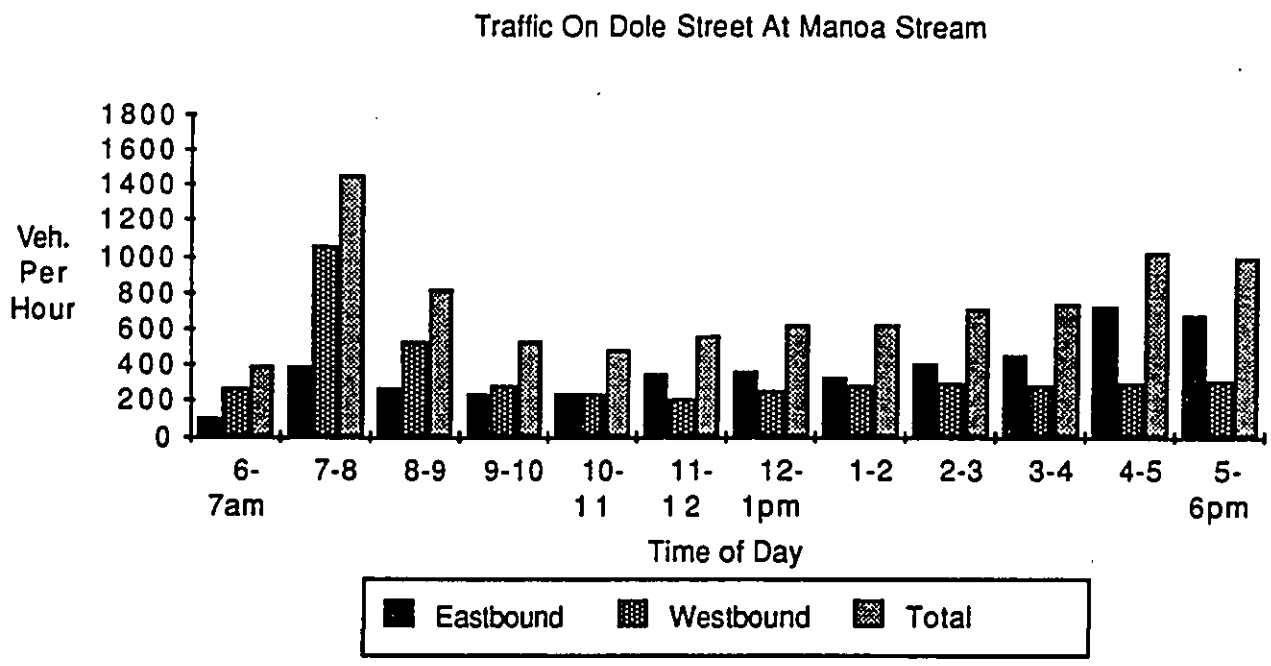


Figure 3-3. Traffic on Dole Street at Manoa Stream and West of St. Louis Drive



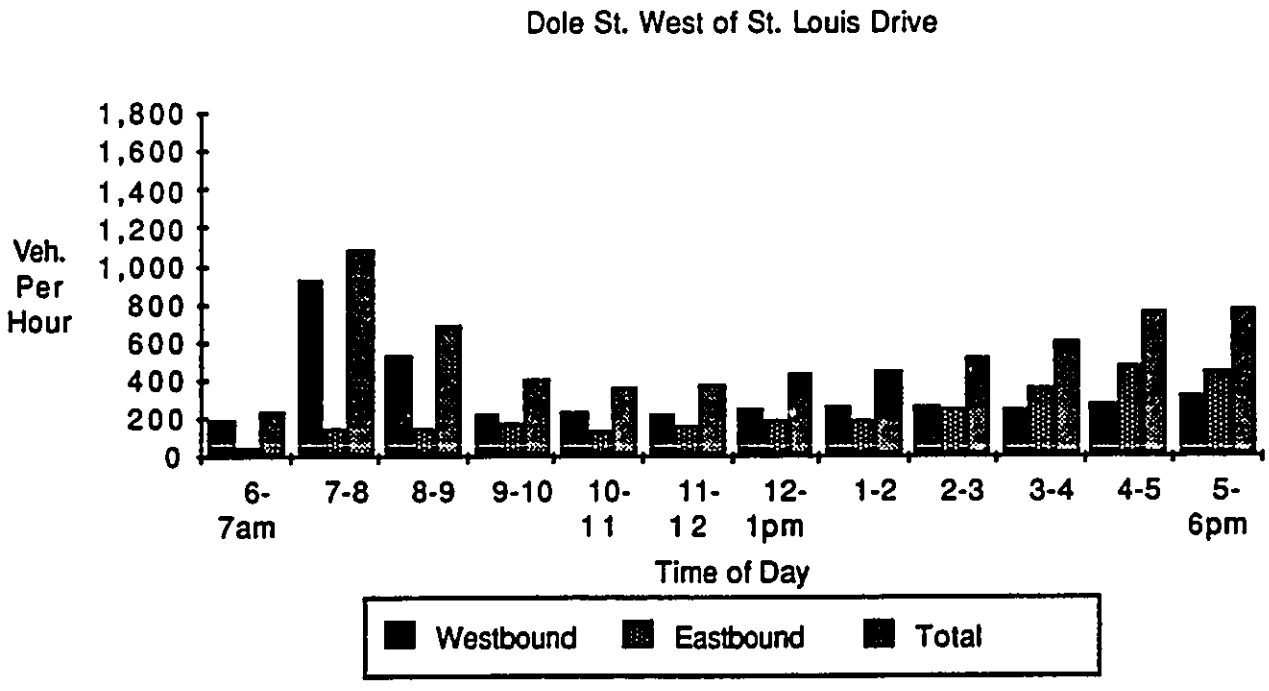
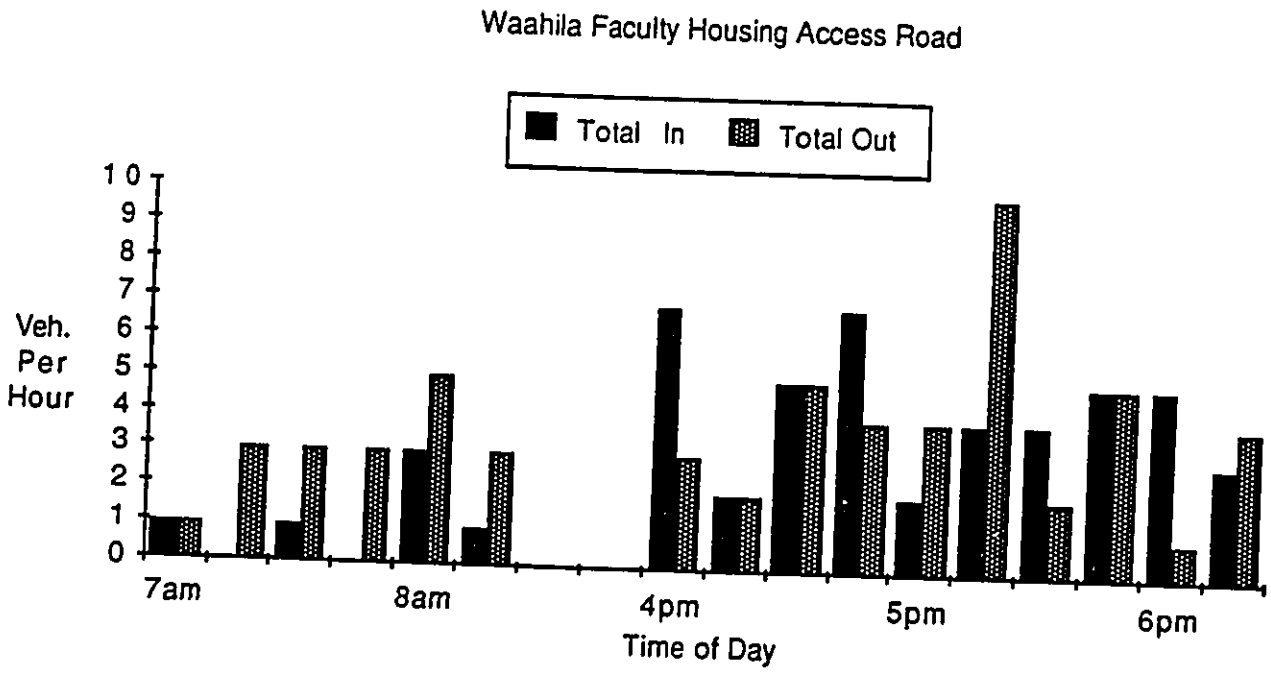
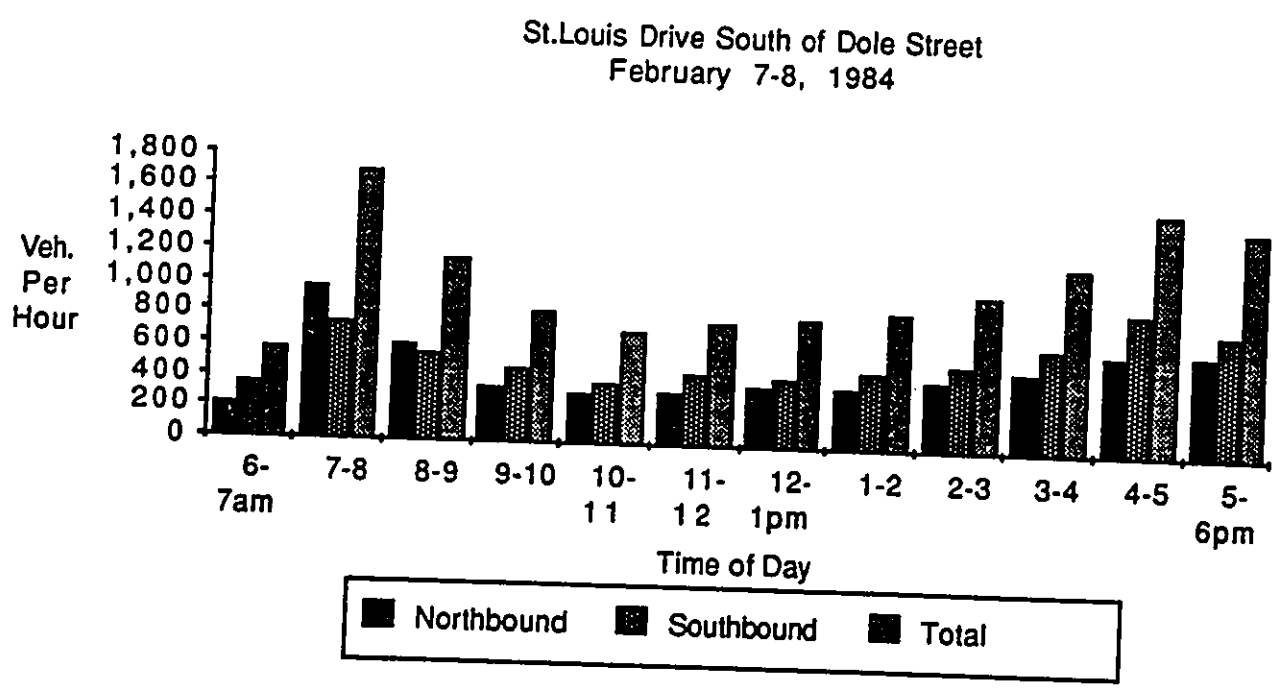


Figure 3-4. Traffic on the Faculty Apartments Entry Road and on St. Louis Drive





- Peak traffic at all locations on Dole Street occurs between 7:00-8:00 a.m. and 4:00-6:00 p.m.

- Eastbound traffic on Dole Street just east of University Avenue exceeds westbound traffic except between 3:00 and 4:00 p.m. During the busiest hours, the ratio of eastbound to westbound traffic at that location is approximately 2:1. However, during the middle part of the day the directional split is nearly even.

- The directional splits are reversed in the counts from Manoa Stream Bridge and just west of Saint Louis Drive. At those locations, westbound (i.e., University-bound) traffic is nearly three times the eastbound traffic during the morning rush hour, while eastbound traffic exceeds westbound traffic by a 2:1 margin in the afternoon. This reflects commuter trips made to and from East-West Center Road and the quarry parking area. Once again, the directional splits during the middle part of the day are relatively even.

- Traffic on Saint Louis Drive between its intersection with Dole Street and Waialae Avenue peaks at the same time as traffic on Dole Street. However, the directional splits are less pronounced. This is because University-generated trips on this segment are balanced by traffic to and from the Saint Louis Heights/Chaminade Terrace residential area.

- As indicated by Figure 3-4, existing traffic on the Waahila Faculty Apartments entry road is extremely light. Counts conducted for the University of Hawaii indicate that peak-hour traffic is about 20 in the morning and 30 in the afternoon.

3.6.3 EFFECT OF THE PROPOSED PROJECT

3.6.3.1 Pipeline Construction

As indicated in Section 2.3.3, new pipelines will be installed connecting each of the new reservoirs with the Board of Water Supply's existing water mains. Short segments of both these lines will be installed beneath the Waahila Faculty Apartments entry road. This will require excavation within the existing roadway, but it is so wide at this point that this can be done without blocking access to the faculty housing.

405 System. The existing 405 system water main is located beneath the makai side of Dole Street. Hence, it will be necessary for the line connecting the new 405 reservoir to the water main to cross Dole Street. A trench must be dug across the roadway; some lanes will have to be closed, thereby reducing the road's capacity.

To minimize the effect on traffic flow, the trench will be open only between 8:30 a.m. and 3:30 p.m.; during other hours, it will be covered to make the full width of the roadway available to motorists. By limiting lane closures to off-peak hours, traffic congestion will be minimized.

180 System. Construction of the water main connecting the Waahila 180 Reservoir with the 24-inch water main on Waialae Avenue will require excavation within the existing roadway. Because of the length of the line, it would be impractical to cover the trench during peak traffic periods. Hence, the available roadway width will be temporarily reduced while the pipeline is being installed. This will be particularly critical on the Saint Louis Drive segment between Dole Street and Waialae Avenue, since only three lanes are available from a point mauka of the Palolo Stream Bridge to Waialae Avenue.

At the request of the University of Hawaii, the Board of Water Supply has agreed to hold up construction of the pipeline until after the spring term is completed. This will make it possible to complete the majority of the work during the summer when traffic is lightest, but some work will last

well into the fall term. To minimize the effect on roadway capacity, the pipeline will be installed in segments, with one segment being completed before the trench needed to install the next is opened. If possible, the Saint Louis Drive segment of the pipeline will be constructed during the summer, when schools are not in session and peak traffic is lowest.

Parking will be prohibited in areas where active trenching is underway, freeing the portion of the road that is normally taken up by parked cars. This will tend to exacerbate the parking shortage that already exists, but the shortness of the construction period and the use of the summer to complete much of the work will help mitigate this impact.

3.6.3.2 Reservoir Construction

The size of the construction crew needed to erect the reservoirs is slightly larger than the number involved in site preparation. This work may also start earlier in the day than the site preparation phase. However, the number of heavy truck trips will be substantially less.

It is expected that about half of the trips generated by this activity will be to and from the east (Saint Louis Drive), while the remainder will be to and from the west (University Avenue). The addition of 25 trips in each direction to the existing volume represents an increase of approximately 1.5 percent. A change of this magnitude will not have a measurable effect on the level of service. Even if all of the trips were in the same direction, the increase would amount to no more than 3 percent of the existing volume. This is far below the normal day-to-day variation, and it would not significantly increase congestion on the area's streets.

3.7 NOISE AND VIBRATION IMPACTS

3.7.1 NOISE AND VIBRATION FROM BLASTING

3.7.1.1 Introduction

As explained earlier, two methods are available for fragmenting rock at the reservoir sites: blasting and/or the use of hoe ram equipment. At least some blasting is desirable, given the sheer volume of material that needs to be excavated and the amount of time required if only hoe ram equipment is used. It is necessary, however, to compare the environmental impacts associated with each of these techniques. The impacts are of three kinds: dust, noise, and shock waves. Both techniques will generate dust and noise; shock waves relate only to blasting. Hoe ram noise impacts may be greater since the noise would be relatively constant over a much longer period of time. Dust impacts and mitigation measures have been discussed above. University of Hawaii staff responsible for management of the faculty apartments have agreed that blasting is an acceptable alternative since it would significantly decrease the amount of time required for excavation. It was requested, however, that the EIS address the potential impacts of blasting and recommend mitigation measures to minimize those impacts. Yoichi Ebisu, acoustics consultant, was retained to carry out this assessment. The hazards associated with blasting, as well as suggested mitigation measures, are further discussed in section 3.10.2 of this document.

3.7.1.2 Description of Potential Impacts

Ground and air vibrations are induced by blasting, and both have the potential to startle or annoy area residents and to cause damage to structures. Air blasts are concussion-type, low-frequency vibrations of relatively short duration (or impulsive); they are generally described in terms of peak overpressure in psi (pounds per square inch) or in dBL (decibels). The dominant sources of the air blast are the air pressure pulse, caused by the large displacement of the ground surface near the charge, and the stemming release pulse, the result of gas pressure ejecting the

stemming (fill) material from the hole bored for the explosive charge. When exposed to high peak overpressure levels exceeding 141 dBL, large plate glass window may break. At peak overpressure levels of 171 dBL, most windows can be expected to break. Thus, air blast levels during blasting are generally limited to levels below 141 dBL to minimize risks of damage to structures.

Given its low-frequency characteristic, together with the low resonant frequency of buildings (10-25 Hz), air blast noise tends to induce vibrations in structures. High-frequency sounds of equal amplitude to blast noise generally do not induce vibrations or cause physical damage to structures. Although the human ear is not particularly sensitive to low-frequency sounds, vibrating structures can produce secondary audible effects such as the rattling of windows, doors, and fixtures, as well as effects which are sensitive to touch. Sound levels at which these secondary effects occur may vary with the weight and stiffness of the structure. The inception point of sound induced vibration is difficult to establish, but it may occur at levels as low as 80 dBL. These levels are significantly below the peak levels of 120 to 136 dBL associated with low risk of damage to structures.

Ground vibrations, or seismic waves, are also generated during blasting operations. These are generally described in terms of peak particle velocity in inches per second. Most of the seismic energy remains trapped in the ground, but some of it is released as an overpressure pulse (or rock pressure pulse) into the air. Ground vibrations and airborne rock pressure pulses are usually less intrusive than air pressure and stemming release pulses. For example, the current tunneling work along Dole Street for a sewer project generated some initial air blast complaints from nearby residents during blasting of the surface entrance to the tunnel. The complaints stopped once the entrance to the tunnel was formed and blasting was confined to tunneling underground. Maximum ground vibration levels during this tunneling work is limited to 2 inches/second, but blasting is conducted during all hours of the day and night (approximately 5 blasts per day). A total of 6 delays are typically used, with fixed delays of approximately 200 milliseconds, and with a maximum charge weight per delay of about 8.6 pounds.

Predictions of peak overpressure or ground vibration levels versus scaled distance from the blast are not precise, with initial uncertainties for a given location in the order of 20 to 30 dBL. For this reason, it is standard practice to employ seismograph monitoring of air and ground vibrations during blasting operations with a three-axis geophone for ground vibrations and a microphone for air vibrations. Construction specifications for blasting operations generally require seismograph monitoring at the structure(s) closest to the bore holes. Based on the monitoring data, explosive charge sizes or weights are adjusted in order to limit peak overpressures of the air blasts to levels below the threshold of possible damage to structures. Assuming the use of standard practices, it is expected that without special mitigation measures, maximum vibration levels at structures closest to the bore holes will be approximately 136 dBL for air blasts and 2 inches/second for seismic vibrations.

3.7.1.3 Mitigation of Blast Noise and Vibration

Since complaints resulting from air blast noise may occur at levels considerably below those necessary to cause damage to structures (120-136 dBL), special mitigation measures will probably be required to minimize antagonizing nearby residents. The following measures are recommended:

- For initial blasts prior to the establishment of a data base of air blast levels versus scaled distance, use a maximum charge weight (in equivalent pounds of TNT) per delay of less than $(D/70)^2$ pounds, or distance divided by 70 and quantity squared, where D is the distance in feet between the charge and the nearest noise sensitive residence or structure.

- If practical, reduce maximum air blast levels to less than 110 dBL at the nearest noise sensitive residences in response to air blast complaints. Possible methods of accomplishing this are to

(1) reduce charge sizes, (2) increase delay intervals, (3) increase hole depths, (4) orient bore holes to direct the stemming release pulse away from noise sensitive properties, (5) truck in high-quality stemming material to minimize stemming blow-outs, and (6) fill over (sandbag) the area to be blasted as well as the detonating cord.

- Schedule actual blasting during warm periods of the day to minimize the possibility of thermal ducting and focusing of air blast noise at large distances from the blast. If possible, schedule blasting during fixed time periods which are publicized and made known to area residents.

- Restrict blasting operations which exceed 95 dBL at residences to the hours between 9:00 a.m. to 5:30 p.m. of the same day, and to weekdays (excluding holidays). For other noise sources associated with excavation operations, follow State Department of Health permit procedures and requirements for construction activities.

- Monitor air blast and ground vibration levels simultaneously at both the faculty apartments and the Saint Louis Heights homes closest to the bore holes.

- Retain a qualified contractor with a proven record of experience to do the blasting, and carry out all operations in accordance with applicable statutes and regulations.

- Reduce or eliminate other risks associated with explosive, such as flying rock or debris resulting from the force of detonation, by increasing the depth of the charges and by using safety mats (large-diameter hemp rope mats).

3.7.2 OTHER NOISE IMPACTS

Noise will also be generated by construction equipment and trucks. As discussed earlier, traffic noise is a concern. Construction will take place during working hours, weekdays only, to minimize noise impacts on nearby residents, and truck movements will be limited to non-peak hours. The contractor will operate in accordance with Department of Health regulations controlling construction noise. No adverse noise impacts are anticipated during operation from the stationary equipment in the instrument houses (e.g., telemetry equipment and compressors).

3.8 AIR QUALITY

3.8.1 PROBABLE IMPACTS

No long term air quality impacts are expected during operation of the reservoirs, but there is a potential for significant levels of fugitive dust throughout the construction period. Emissions from construction vehicles and equipment are expected to be an insignificant factor.

Dust impacts will be heaviest during excavation of the hillside, expected to take anywhere from six months to one-and-a-half years, depending on the method used. The effects will be less severe with blasting since it will shorten the duration of excavation activity and result in larger particles less likely to become airborne.

Dust will also be generated by trucks and other construction vehicles traveling over the construction access road to the reservoir sites. There is special concern over the large number of truckloads required to remove excavated material from the project site.

Once excavation is completed and while the reservoirs and other facilities are under construction, dust will be less of a problem but could still have an impact on air quality.

Residents of the Waahila Faculty Apartments will be most affected by fugitive dust from the project. Windows in the buildings need to be kept open since the units are not air conditioned. Dust is also expected to be carried downwind to the Hale Aloha dormitories.

3.8.2 MITIGATION MEASURES

The following measures could be taken to reduce fugitive dust during construction:

- Pave the construction access road early in the process.
- Shorten the duration of the excavation phase by blasting.
- Implement dust control measures on the construction site seven days a week (e.g., watering).
- Install air conditioning in the Waahila Faculty Apartments.

3.9 VISUAL IMPACTS

3.9.1 EXISTING VISUAL CHARACTER OF THE SITE

The valley between Waahila and Kalaepohaku Ridges has steep sideslopes, with gradients ranging from 25 to 45 percent. There are a number of rock leges and outcrops, as well as loose boulders. Ground cover is dense, including grasses (about 70 to 80 percent coverage), brush, and small trees. The project site is located in the midst of an urban area which includes single family dwellings, apartments, university buildings, schools, a public playground, and small businesses.

The presently undeveloped hillside on which the reservoirs and access road will be constructed is visible to varying degrees from the Saint Louis area, Kaimuki, Kapahulu, Moiliili, and Waikiki. Photos of the Waahila hillside were taken from a number of locations; these locations are marked on the map in Figure 3-5 as points A, B, C, etc.

Photo A, View from Saint Louis Heights. Taken from Saint Louis Drive (A), near its intersection with Bertram Avenue, overlooking the 180 reservoir site.

Photo B, View from Kanewai Playground. Taken from the left field position on the baseball field, about 2,000 feet from the 180 reservoir site.

Photos C and D, Views from Kaimuki. Taken from the Saint Louis Drive/Waialae Avenue intersection (C) and from Kapaolono Field on 11th Avenue between Kilauea and Maunaloa Avenues (D).

Photos E through H, Views from Kapahulu . Taken from the Kapahulu Avenue/Kaimuki Avenue intersection near Crane Park (E), about 1 mile from the 180 reservoir site; from Kapahulu Avenue and Winam Avenue (F); from Kapahulu Avenue and Date Street (G), about 1.5 miles from the 180 site; and from the Monsarrat Avenue/Trousseau Street intersection on the lower slope of Diamond Head near Fort Ruger (H).

Photos I through K, Views from Moiliili. Photo K was taken from King Street near the Hawaiian Humane Society, less than a mile from the 180 reservoir site. Photo L was taken from Honolulu Stadium Park near the King Street/Isenberg Street intersection, about 1.3 miles from the 180 reservoir. Photo K was taken from Ala Wai Park on Kapiolani Boulevard.

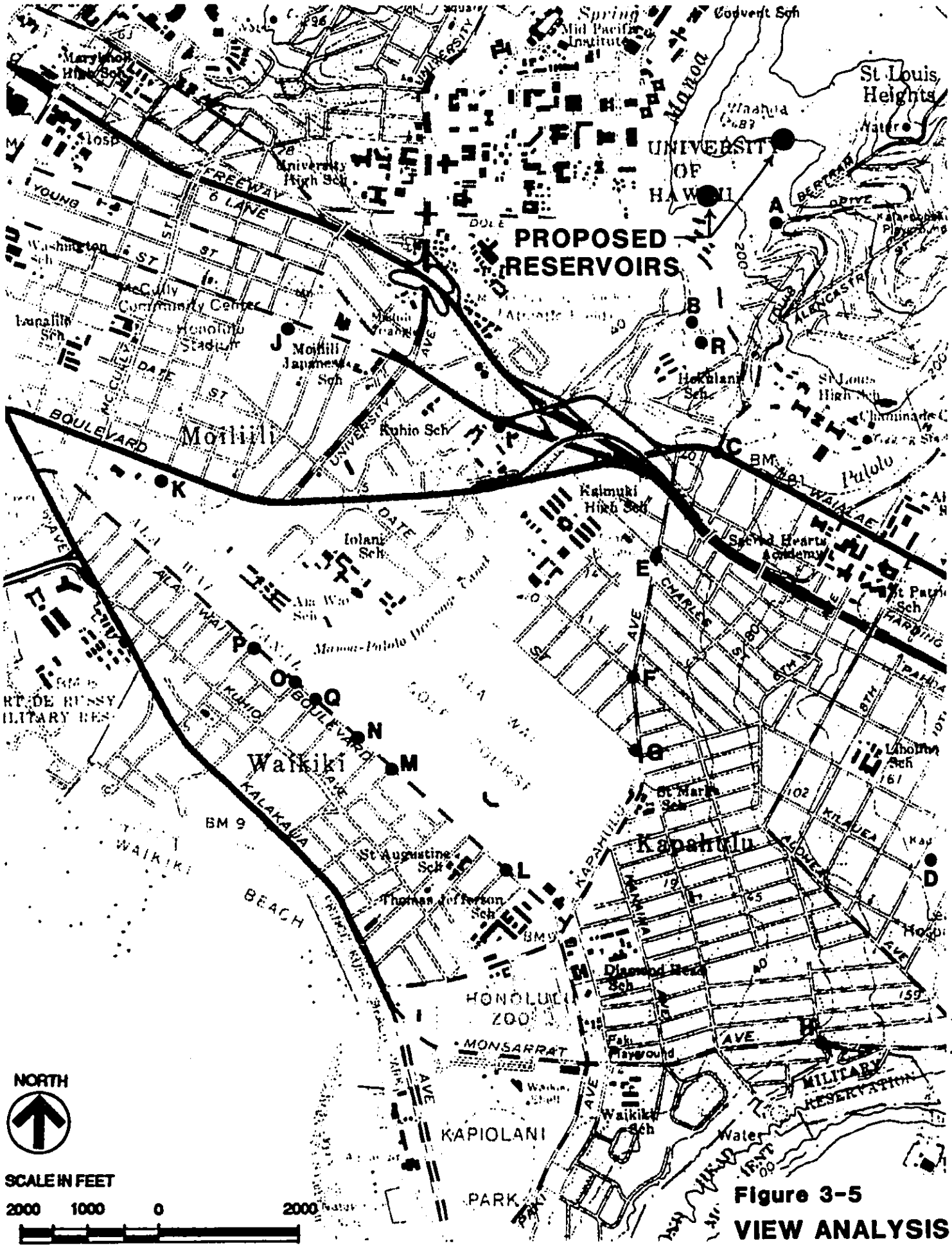


Figure 3-5
VIEW ANALYSIS

Photos L through P, Views from Waikiki. Photos were taken along Ala Wai Boulevard at its intersection with Wainani Street, Kaiulani Avenue, Walina Street, Seaside Avenue, and Lewers Street. The distance to the 180 reservoir site is approximately two miles from these points.

3.9.2 EXPECTED VISUAL IMPACT

Each of the Waahila reservoirs will be 190 feet in diameter and 22 feet high, with cuts approximately 90 to 100 feet high from the base of the reservoirs and 300 wide. The reservoirs and cuts will be highly visible from the upper floors of the Hale Aloha dormitory buildings located across Dole street. They will not be visible from ground level because of the heavy vegetation fronting the buildings. Users of Kanewai Playground will have a clear view of the reservoirs. Views from the Waahila Faculty Apartments will vary; the 180 reservoir will be visible from the upper units, but the 450 reservoir will be less visible. This is because the apartments themselves are built on a fairly steep slope. Likewise, the reservoirs will not be apparent to pedestrians and drivers along Dole Street. The proposed facilities will be visible from about 20 homes located on the ridge of Saint Louis Heights overlooking the project site.

Observations from numerous locations in Kaimuki indicate that the Waahila hillside cannot generally be seen from this neighborhood, except from the lower part of the Kaimuki business district bordering on Moiliili. Driving toward town on Waialae Avenue, motorists cannot see the site until reaching Saint Louis Drive (Photo C). The site is visible from certain condominium units of The Regency Park (adjacent to Chaminade College), as well as from sections of the H-1 Freeway passing through Kaimuki and Moiliili. However, it is barely visible from much of the residential section of Kaimuki (Photo D).

In general, the impact on Moiliili and Kapahulu is expected to be minimal due to existing visual distractions and obstructions. The exception to this are the views of the hillside from high-rise buildings. It is noted that all of the photos were taken from street level to illustrate the view from the pedestrian's or motorist's perspective.

Photos M through O illustrate that the Waahila hillside is clearly visible from the section of Ala Wai Boulevard across from the Ala Wai Golf Course, which provides a stretch of open space between Waikiki and Date Street. However, there is no impact on the view from the Waikiki Beach due to high density of tall buildings.

To assess the visual impact of the project, representations of the reservoirs and cuts (reproduced approximately to scale) were superimposed on photos of the site taken from Ala Wai Boulevard and from Kanewai Field. These are two locations from where the site is clearly visible with no obstructions. The Ala Wai Boulevard location is also thought to be representative of the view from many Waikiki highrises. All photos shown in this section were taken using a 50-millimeter lens in order to approximate the actual view.

Photo Q, View from Waikiki. Expected view of the reservoirs from Ala Wai Boulevard and Nohonani Street, approximately two miles from the 180 reservoir site. A "before and after" comparison indicates that the visual impact of the proposed reservoirs from this vantage point will be minimal.

Photo R, View from Kanewai Field. Expected view of the reservoirs from the centerfield position on the baseball field, approximately 2,000 feet from the 180 reservoir site. Due to the proximity of the park to the reservoirs, the view of the Waahila hillside will be significantly altered.

Photo A. Existing view of site from Saint Louis Helghts near Saint Louis Drive/Bertram Avenue intersection.

Photo B. Existing view of site from Kanewai Field, Dole Street.

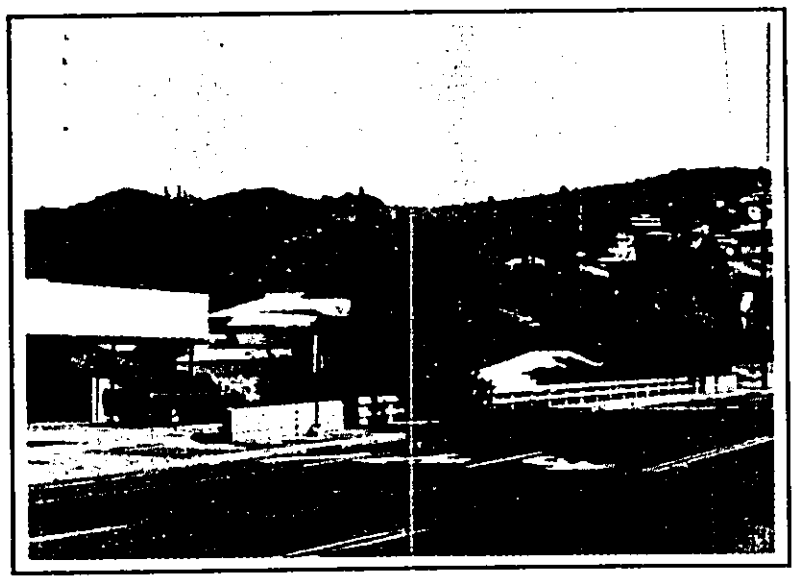


Photo C. Existing view of site from Saint Louis Drive and Walalae Avenue, Kaimuki.

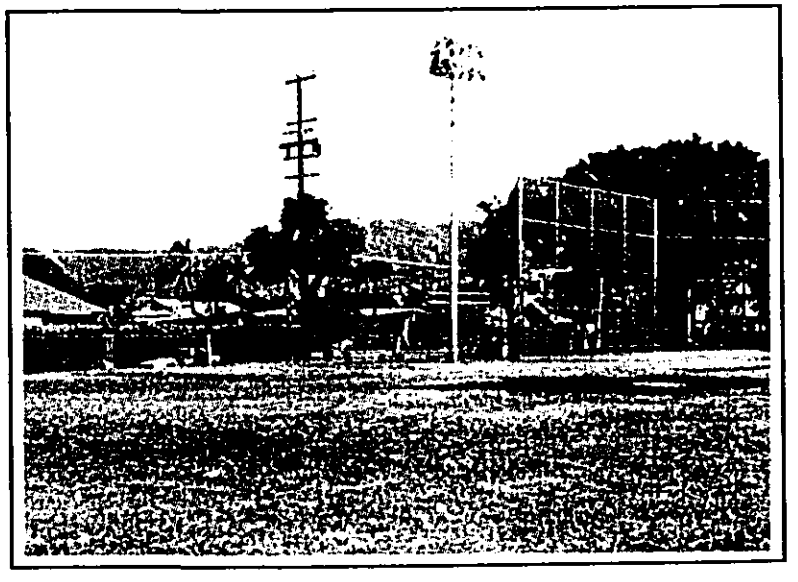


Photo D. Existing view of site from Kapaolono Field on 11th Avenue, Kaimuki.

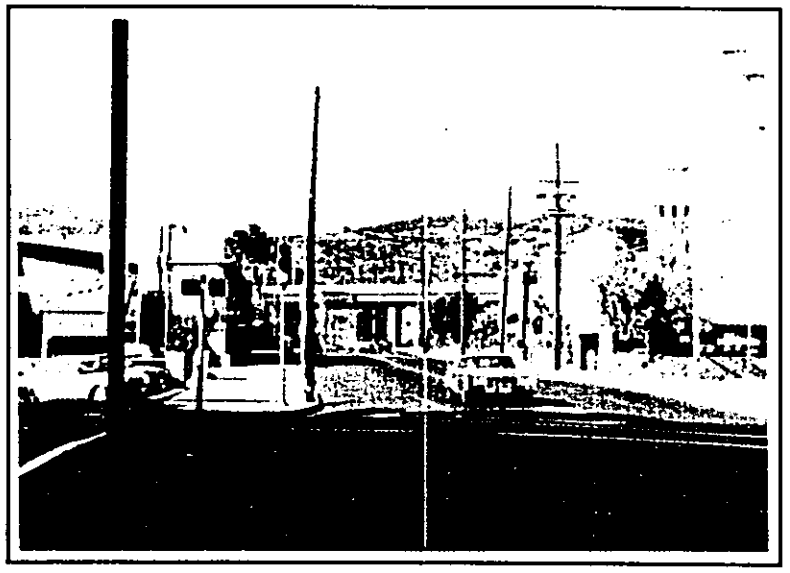


Photo E. Existing view of site from Kapahulu Avenue and Kaimuki Avenue (near Crane Park).

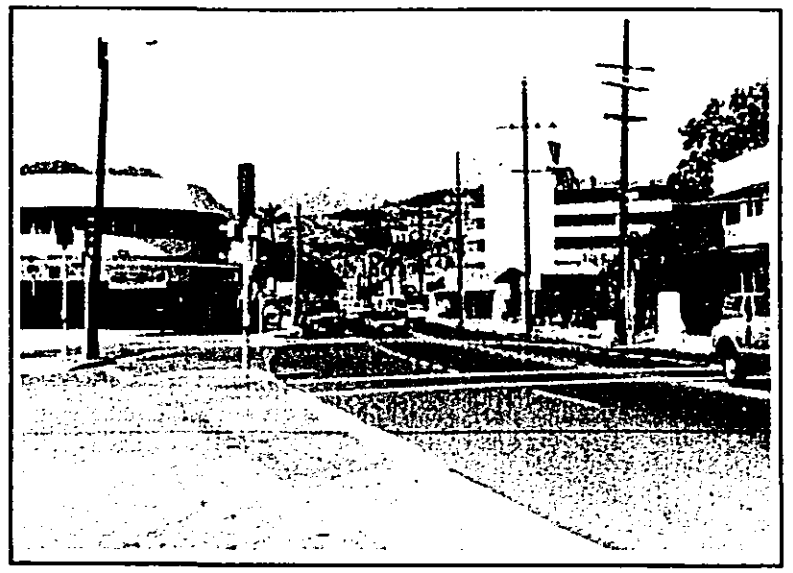


Photo F. Existing view of site from Kapahulu Avenue and Winam Avenue.

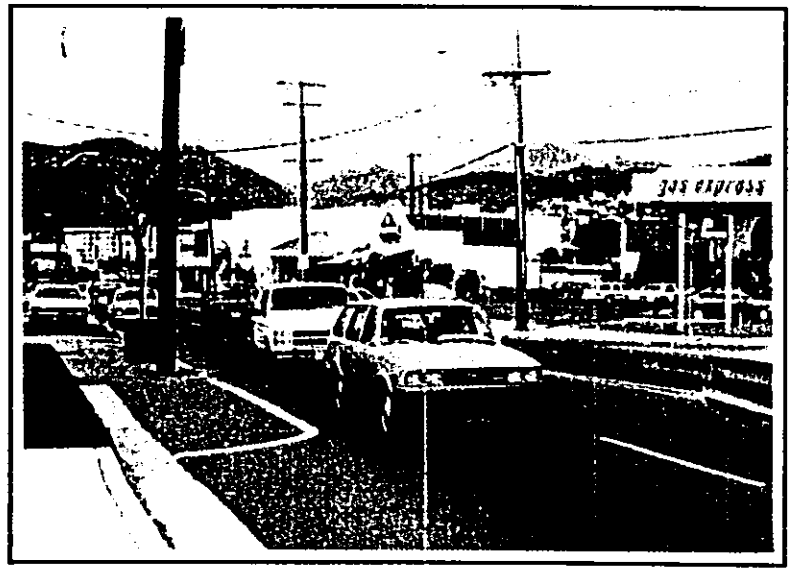


Photo G. Existing view from Kapahulu Avenue and Date Street.

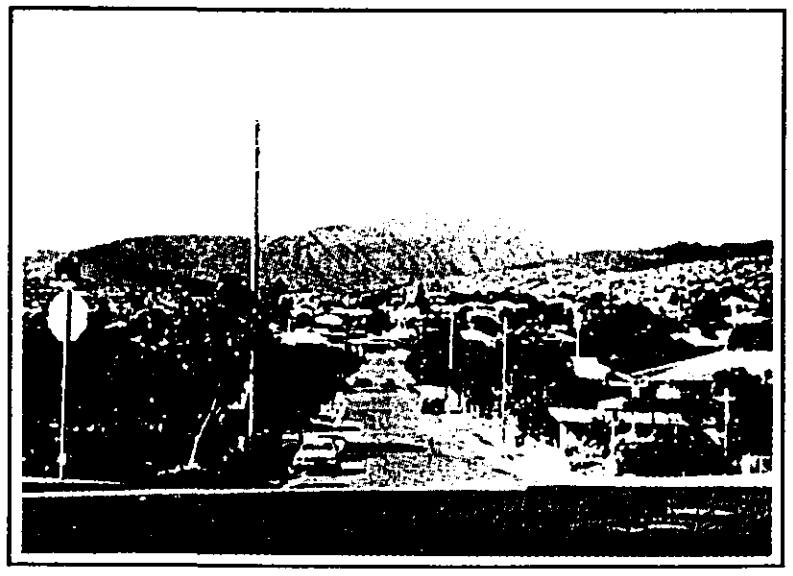


Photo H. Existing view of site from Monsarrat Avenue and Trousseau Street (near Fort Ruger).

Photo I. Existing view of site from King Street near the Hawaiian Humane Society, Moiliili.

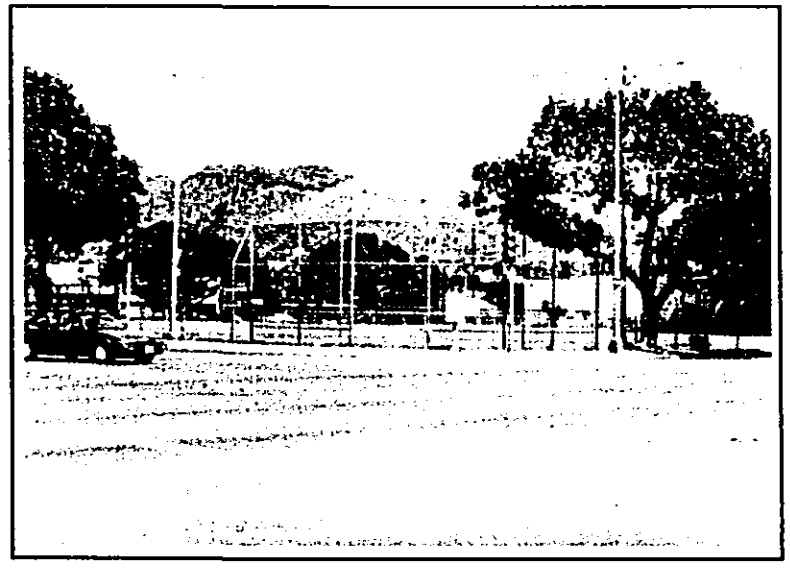


Photo J. Existing view of site from Honolulu Stadium Park at King and Isenberg, Moiliili.

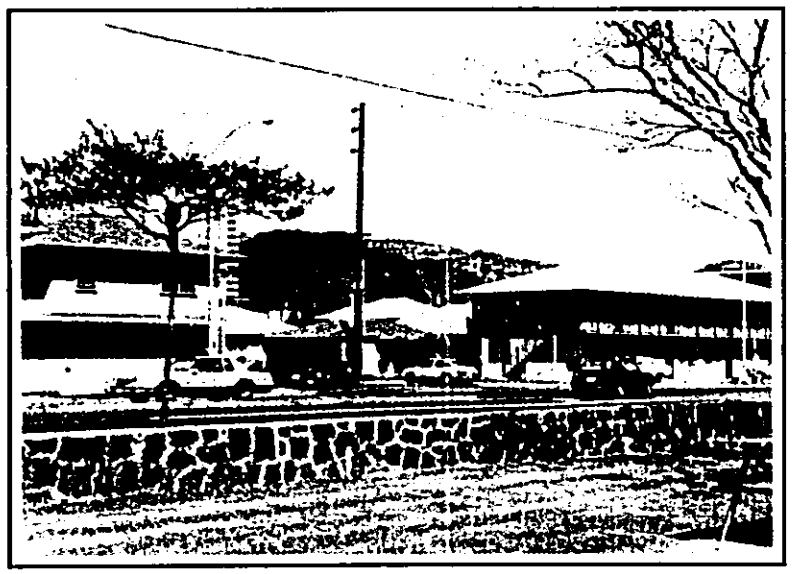


Photo K. Existing view of site from Ala Wai Park on Kapiolani Boulevard, Moiliili.

Photo L. Existing view of site from Ala Wai Boulevard and Wainani Street, Waikiki.

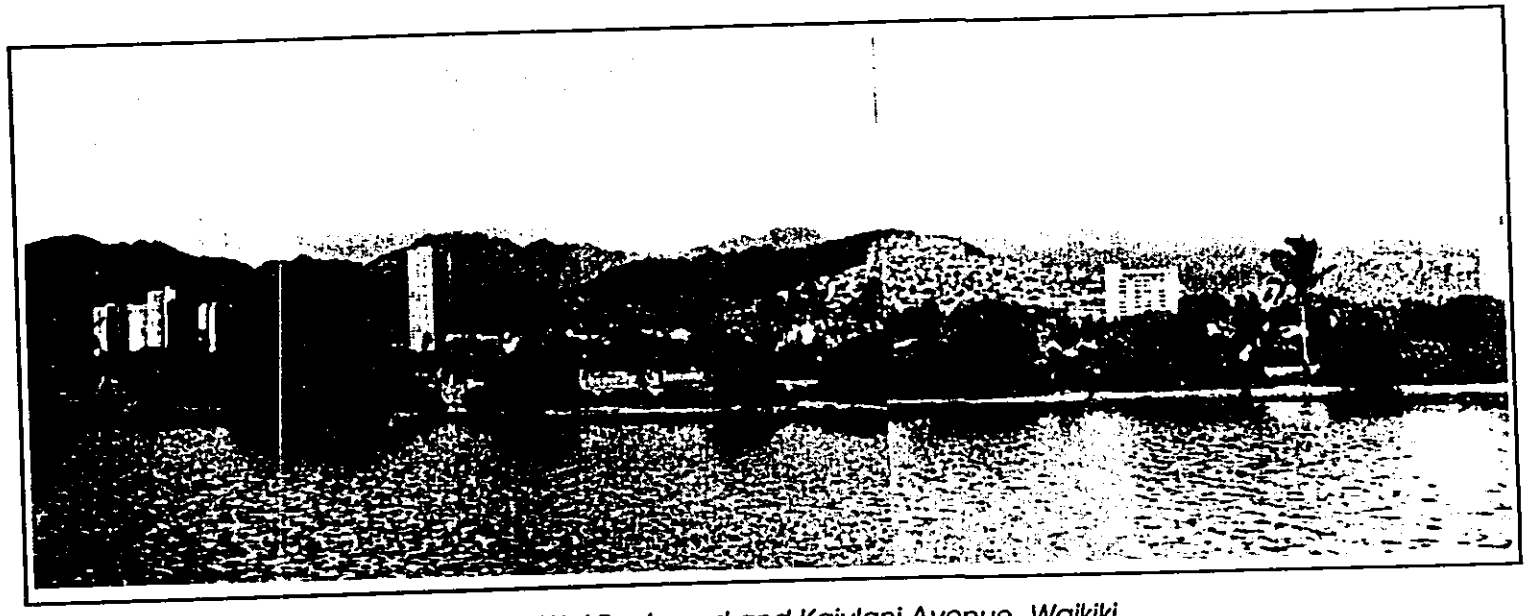


Photo M. Existing view of site from Ala Wai Boulevard and Kaiulani Avenue, Waikiki.

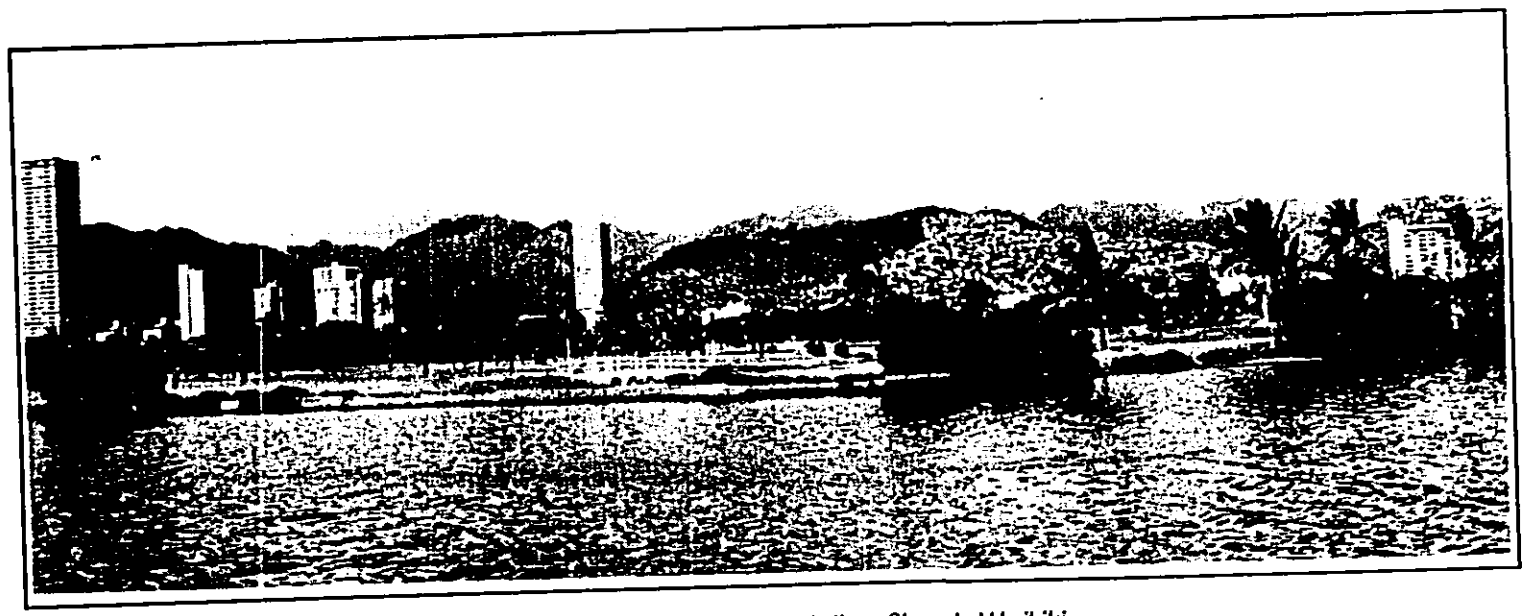


Photo N. Existing view of site from Ala Wai Boulevard and Walina Street, Waikiki.

Photo O. Existing view of site from Ala Wai Boulevard and Seaside Avenue, Waikiki.

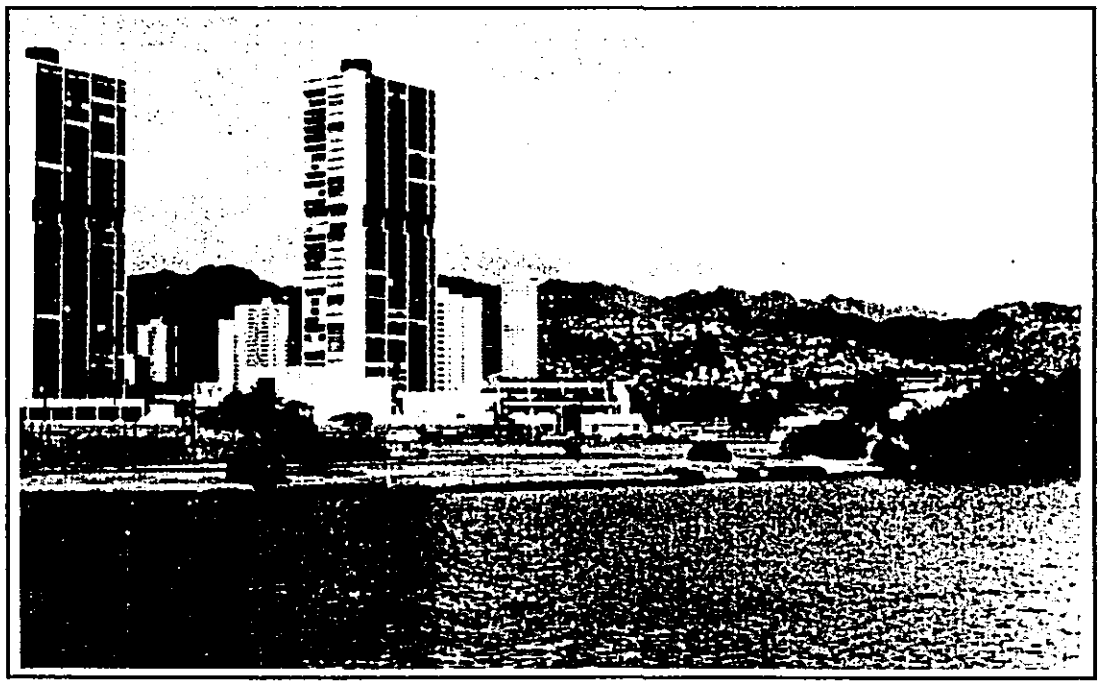


Photo P. Existing view of site from Ala Wai Boulevard and Lewers Street, Waikiki.

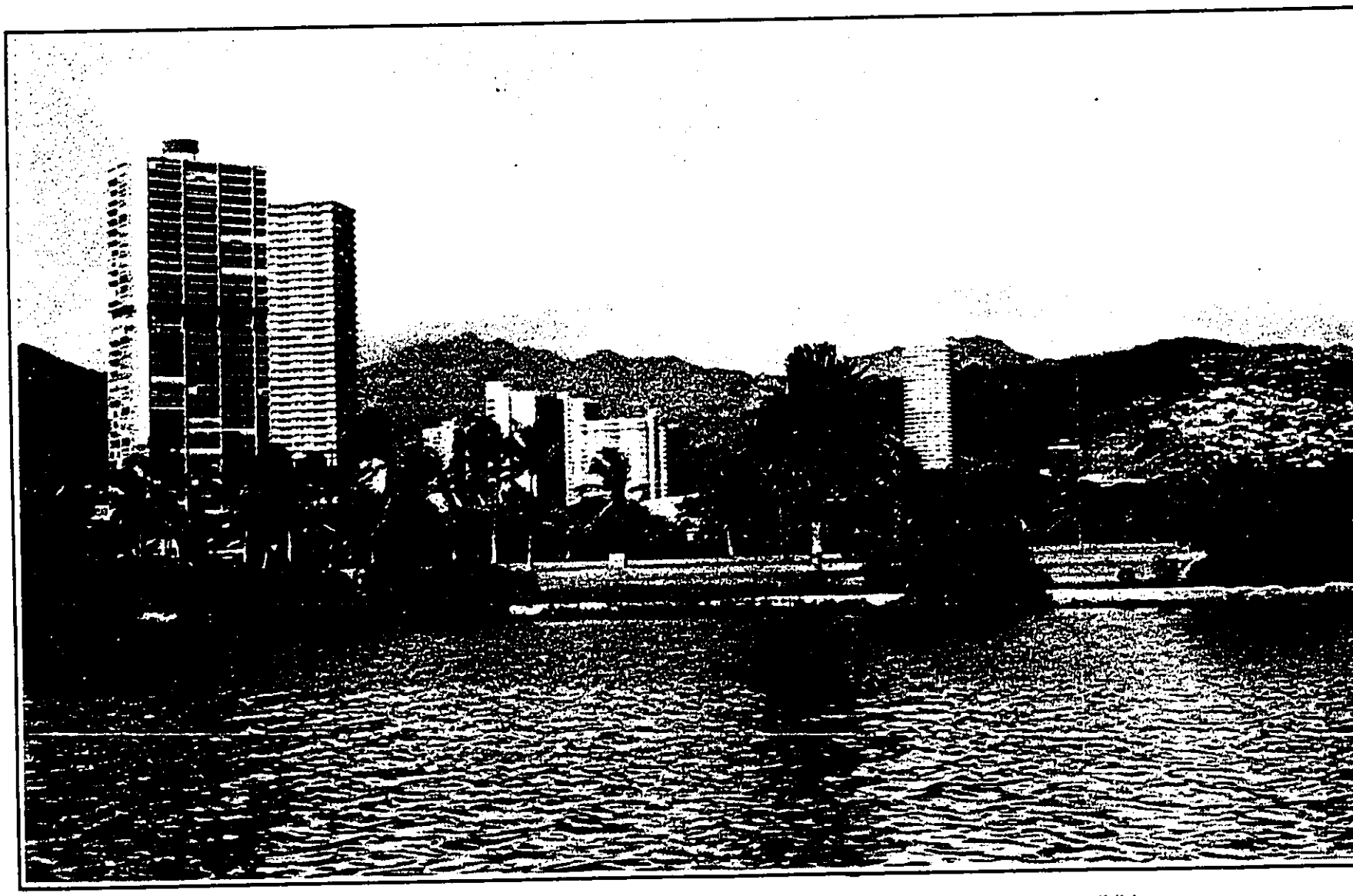
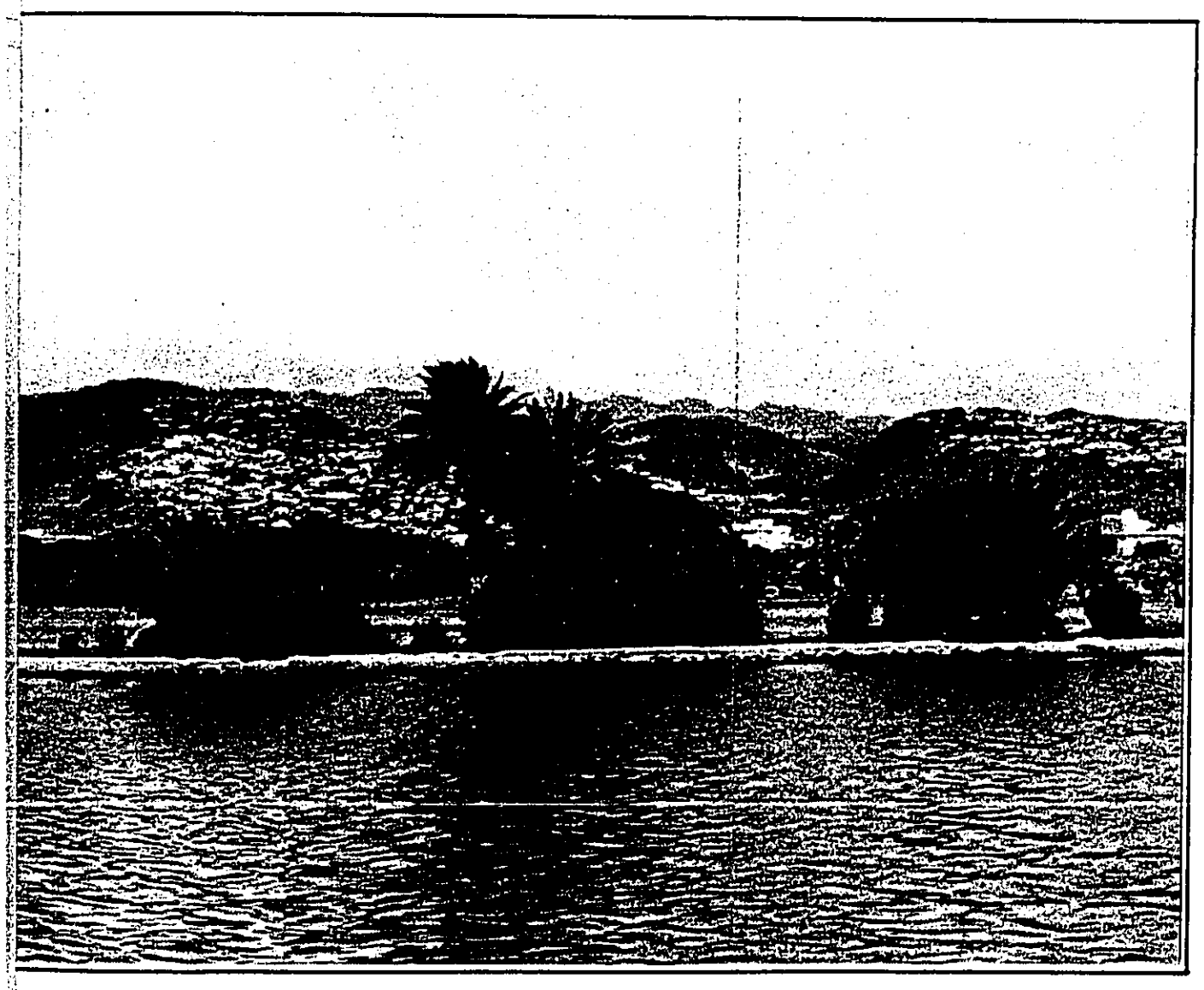


Photo Q. Expected view of reservoirs from Ala Wai Boulevard and Nohonani Street, Waikiki.



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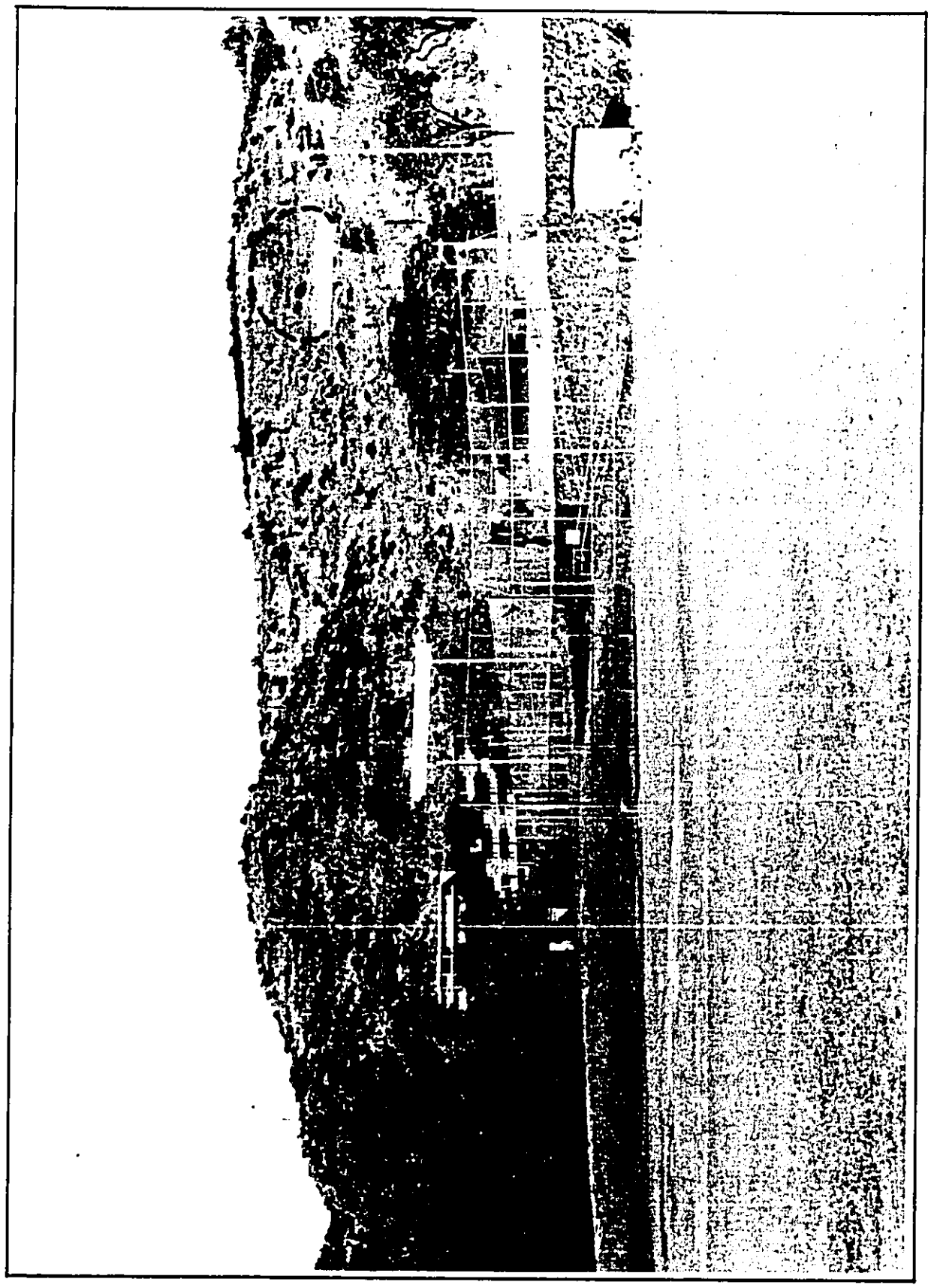

Photo R. Expected view of reservoirs from Kanewai Field, Dole Street.

3.9.3 VIEW ANALYSIS

It is recommended in the *Coastal View Study* prepared for the City and County of Honolulu, Department of Land Utilization (Chu and Jones, 1987) that view analyses performed for proposed projects should begin at a conceptual level, taking into account the following visual characteristics:

- Vividness - memorability of a view derived from contrasting landscape components combined to create striking and distinctive visual patterns. Form, line, texture, and color may integrate to form a highly vivid scene; e.g., the combination of landform, coastline, and ocean texture/color.

- Unity - the degree to which the visual elements of a landscape scene join together to form a coherent, harmonious visual pattern; a balanced composition between manmade and natural features. Views of buildings that encompass natural features or blend with natural surroundings possess high visual unity. Unity can be achieved without natural landscape elements through creation of a scene characterized by overall order and composition of the visual forms. Many urban scenes possess low visual unity because of their chaotic appearance.

- Intactness - the extent to which the landscape is free from visually encroaching features. Adding any manmade element to a predominantly natural environment would reduce the intactness of the view. In a suburban or urban environment, on the other hand, visual intactness is measured according to the consistency and order of the visual pattern.

More than one of these characteristics may be represented in a particular view. In the case of the proposed Waahila reservoirs, unity and intactness seem to be the more relevant visual characteristics. For example, the photos of the project site taken from Kapahulu and Moiliili reveal landscapes that are cluttered by buildings, power lines and poles, and other elements (see photos E, F, G, J, and K). It is especially difficult to see the Waahila hillside from many locations in Moiliili, where buildings block the view of the Koolaus. Someone driving toward Diamond Head on Kapiolani Boulevard or up University Avenue would catch only glimpses of the site. On the other hand, the view of the Waahila hillside is relatively unobstructed from Ala Wai Boulevard along the length of the Ala Wai Golf Course, but from Lewers Street to McCully Street, the view is generally blocked by tall buildings (see photo P).

The Special Provisions section of the Development Plan for the Primary Urban Center (PUC) identifies significant open spaces and public views. Under section 32-2.2, high priority is given to maintaining "the visibility, preservation, enhancement and accessibility of open space areas...in the design of adjacent and nearby developments in the PUC. These areas include, but are not limited to the steep slopes of valley and ridge areas..." This section of the Development Plan also identifies important views to be protected, including "Panoramic, mauka and makai, and continuous views of the Koolau and Waianae mountain ranges, ridges, valleys, and coastline and the sea."

The *Coastal View Study* designates the Waahila site as being within an "Important Coastal Landform." In the PUC, these designated areas include Diamond Head, Punchbowl, and the Koolaus. In addition, the *Coastal View Study* identifies cases in which view concerns are most critical; these are situations where:

- views of exceptional quality should remain unaltered;

- significant views may be lost or diminished due to future development; or

- views are limited or nonexistent, but where enhancement opportunities may be available.

The view of the Waahila site does not appear to fit the first two categories; by itself, it is neither exceptional nor significant. Enhancement opportunities may exist but are probably limited. The Koolau Mountains as a whole form a scenic backdrop for the city of Honolulu, but the small valley between Waahila and Kalaepohaku Ridges does not substantially affect the dominant view. This is evident from the panoramic views of the Koolaus as seen from Ala Wai Boulevard (see photos M, N, O, and Q).

3.9.4 VISUAL CHARACTER OF EXISTING BWS RESERVOIRS

In recent years, the Board of Water Supply has reinstituted its emphasis on the appearance and beautification of facilities, with increased attention given to landscaping. A systematic reservoir and building painting and repair program was started in fiscal year 1985-86 and is being implemented on a continuing basis. Landscape improvements have been made at various reservoirs and wells, and maintenance increased at the more highly visible booster stations.

This attention to aesthetics is evident in the design of several existing reservoir facilities. Examples of how these large structures can be integrated into their surroundings through landscaping and other means are shown on the following pages. A number of very large BWS reservoirs, such as Waialae Iki 180 (3.5 mg) and Pohakupu 272 #2 (6 mg), are good examples of how the visual impact of such facilities can be minimized (photos S and T). Both of these are located near very busy highways in residential neighborhoods, and yet each is barely noticeable to the people who pass by them daily. Bougainvilla and other plants have been cultivated around the Waialae Iki 180 reservoir so that its appearance is compatible with the Waialae Iki subdivision. The Pohakupu 272 reservoir in Kailua is surrounded by trees. Additional examples include Niu 170, a 1-mg reservoir virtually hidden by kiawe and other "natural" vegetation (photo U), and Koko Head 405, a 0.2-mg reservoir painted in the same color as the rock face of the cut (photo V). Other reservoirs on the island are not as well "hidden" from public view, and lessons can be learned from these as well.

3.9.5 MITIGATION MEASURES

The following suggestions are intended to maintain the unity and intactness of the view, i.e., to make the reservoirs and their cuts as unobtrusive as possible.

- Minimize visual impact by the use of landscaping around the tanks to soften the effect of the structures.
- Landscape the cuts, which would otherwise stand out as rock faces against the background of vegetation on the hillside. Any landscaping of the cuts will require placement of soil on the benches. An irrigation system will be required initially, but if plants adapted to arid conditions are selected, the system could be removed once the plants are established. Koa-haole and other species now covering the area could be planted. Both trees and vines planted on the benches would help to cover the cut slopes. The "unthirsty" Chinese banyan, which already exists on the site, is a good choice.
- Stain the walls of the structures to blend with the background. Use colored roof gravel so that the reservoirs are not as visible from Saint Louis Heights.
- Color the concrete road in a color that harmonizes with the background.
- Provide sufficient impediments to prevent the reservoir walls from being defaced with graffiti. Since the Waahila reservoirs will be in such a central location, they should be well maintained and repainted on a regular basis.

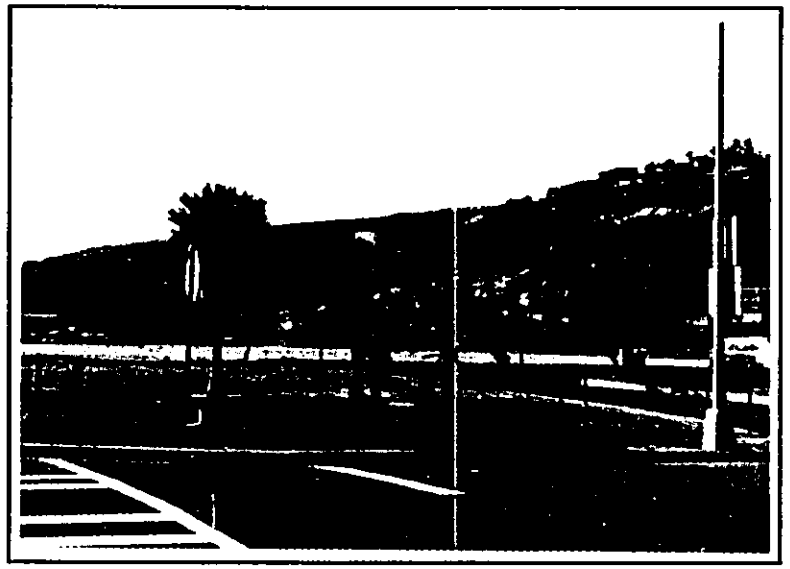

Photo S. Waialae Iki 180 Reservoir.

Photo T. Pohakupu 272 Reservoir.

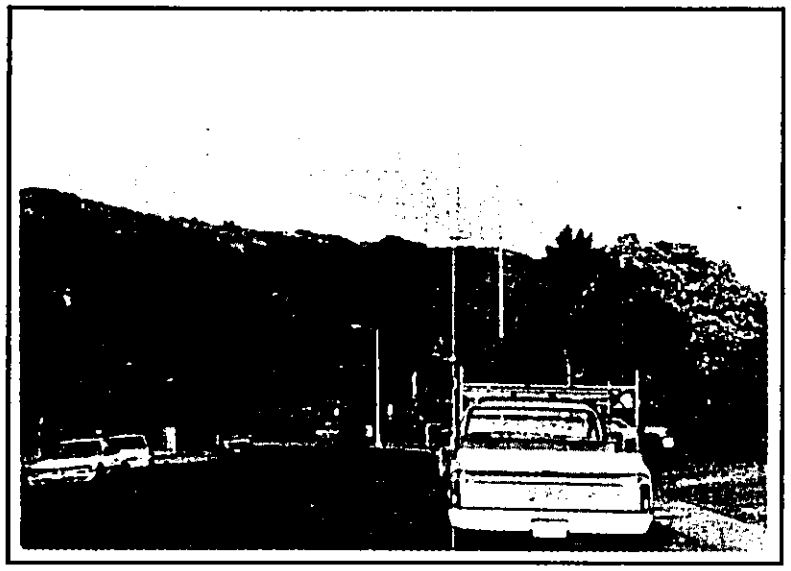

Photo U. Niu 170 Reservoir.

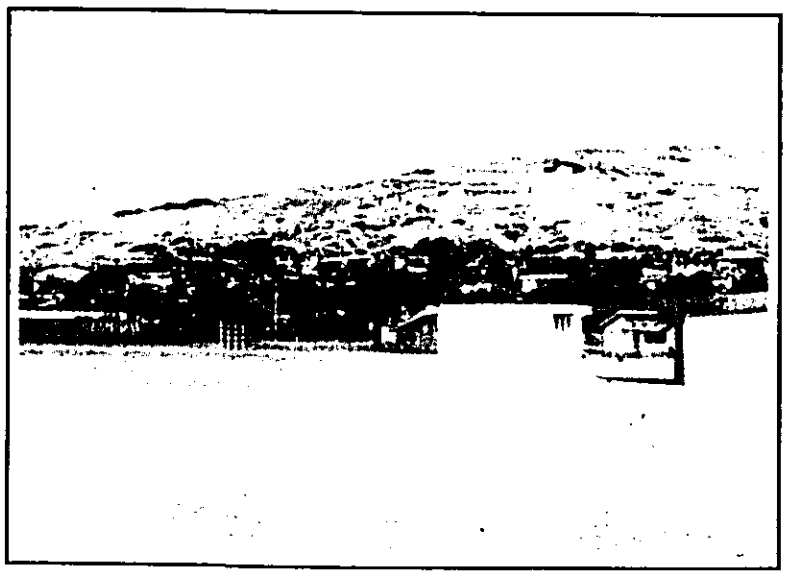

Photo V. Koko Head 170 and 405 Reservoirs.

3.10 SOCIOECONOMIC IMPACTS AND MITIGATION MEASURES

Two of the anticipated socioeconomic impacts of the proposed project are primarily consequences of the noise, air quality, and traffic impacts expected during construction. Hence, these socioeconomic impacts will be temporary, and their severity will range from minor inconveniences to an overall reduction in quality of life. Negative economic consequences are also possible. It has been determined that a third potential impact—the possibility that the presence of the reservoirs would constrain the University of Hawaii's future plans for the faculty apartments site—is unlikely.

3.10.1 IMPACTS ON THE WAAHILA FACULTY APARTMENTS

The Waahila Faculty Apartments are available as a benefit for newly hired University of Hawaii faculty members. Units ranging from studios to three-bedroom apartments are rented out for a maximum of one year. Rental rates are very reasonable—from about $250 a month for a studio apartment to under $600 for a three-bedroom unit. The University's purpose is to provide interim housing for newly arrived faculty, giving them time to look for something permanent. This is a valuable benefit, especially for faculty in the lower academic ranks who need some support when confronted by a tight, high-priced housing market. Just a short walk from the campus and conveniently close to the Kaimuki and Moiliili commercial areas, the Waahila facility is in an ideal location. Amenities for families with children include a public elementary school and a park within walking distance.

During construction of the reservoir project, the apartment tenants' quality of life will be diminished by noise, dust, and traffic. A number of mitigation measures have been proposed to minimize these impacts. but even with these measures, the tenants will still be affected. The University is concerned that it may not be able to rent out the units during construction of the reservoirs, resulting in a loss of revenue (estimated at $150,000 annually for Building E), as well as the loss of an important benefit and convenience for new faculty members.

In addition to the mitigation measures proposed in the previous chapter, which address each impact separately, other options have been considered as possible solutions to the cumulative impact of noise, dust, and traffic on the faculty apartment residents.

One proposal was to delay construction of the reservoirs so that it could be coordinated with the relocation of faculty housing to another site. The University's long range plans call for the construction of new faculty housing in the Woodlawn area of Manoa Valley and redevelopment of the Dole Street site for student housing. If the reservoir project was constructed after the faculty apartments were vacated, the potential impacts of the project would be greatly reduced. A problem with this proposal is that the Board of Water Supply is well along in its planning for the Waahila facilities, while the University of Hawaii has not yet begun its plans for the new faculty housing. Planning funds for the Woodlawn complex are included in the University's current budget request. Given the need for additional reservoir capacity, however, the Board of Water Supply cannot delay its project for the three to four years it will probably take to complete the Woodlawn housing.

Air conditioning of the apartments, particularly the units in Building E, was considered as a possible mitigation measure. However, this alternative is not feasible for two reasons. First, the cost would be prohibitive. The total estimated cost to install window air conditioning in Building E only, including the cost of a new transformer and other electrical work, is $181,800. In addition to this cost is the increase in the electricity costs. Second, and more critical, is the lead time required by Hawaiian Electric Company to arrange for and install the transformer. This is estimated to be about six to eight months.

The issue of reimbursement for lost revenues as a result of the construction activities has been resolved through discussions between the Board of Water Supply and the University of Hawaii. Should any vacancies occur in the faculty apartments during the construction period, the Board will reimburse the University for the loss of rental income.

3.10.2 IMPACT ON FUTURE UNIVERSITY OF HAWAII DEVELOPMENT PLANS

As mentioned above, the Dole Street site currently occupied by the Waahila Faculty Apartments is master planned for new multi-story student dormitories. The staff at the University responsible for facilities planning has voiced concern that once the reservoirs are constructed, their presence adjacent to the Dole Street site may preclude the use of explosives to carry out the substantial amount of cut earthwork anticipated for the dormitory project. The Board of Water Supply generally does not allow blasting to take place in close proximity to its reservoir structures, so this was recognized as a very real concern. At the request of the University, BWS authorized Geolabs-Hawaii to conduct a geotechnical engineering exploration to determine potential blasting impacts on the proposed 180 reservoir, which would be located closest to the dormitory site.

The scope of work included the drilling and sampling of four borings to depths ranging from 15 to 30 feet below the surface in the proposed dormitory area, as well four seismic refraction surveys. A surficial layer of very stiff brown clays with boulders, cobbles, and gravel was encountered, ranging in thickness from 1.0 to 8.0 feet. This layer represents either man-made fill or transported soil, or colluvium, commonly found on hillsides. Below this stratum, the field exploration revealed weathered basalt formation (Koolau Basalt) to the maximum depths explored in the borings. Both the core samples and seismic surveys indicate that the basalt rock formation underlying the proposed dormitory site seems to be more weathered than the formation underlying the reservoir sites. (Note: Geolabs-Hawaii also performed the geotechnical investigations for the reservoirs.) Geolabs has concluded, therefore, that the rock formation underlying the housing area will probably be rippable without the extensive use of explosives. However, blasting may be preferred to lower the construction cost and/or shorten the project duration; if this is the case, the following hazards should be considered:

- Flyrock. This term refers to flying rock or other debris resulting from open blasting by the force of detonating explosives. These projectiles often have tremendous kinetic energy and could possibly damage a reservoir structure. The hazard may be reduced and even eliminated by increasing the confinement or depth of the explosive charges and/or by using safety mats.

- Ground Vibration. This is the most critical potential impact relative to the reservoir structures. Upon detonation below ground, an explosive generates intense stress waves in the surrounding material, crushing the rock immediately adjacent to the explosion and permanently distorting and cracking the rock for some distance. When the intensity of the stress waves attenuates to the point that there is no longer any permanent deformation of the rock, the stress is propagated through the rock as elastic waves, which in turn create ground vibration. The potential of the ground vibration to damage a structure is a function of the intensity of the vibration and the natural frequency of the structure.

- Air Blast. The air blast from an explosion is a compressional wave in air; noise is the portion of the air blast with frequencies between 20 and 20,000 Hz, while concussion is the portion with frequencies below 20 Hz. In general, air blasts would not pose a problem for a reinforced concrete structure such as a reservoir.

Because the basalt rock formation underlying the area is rippable without the use of explosives, Geolabs recommends that blasting not be used for the earthwork of the proposed dormitory project unless it is absolutely necessary. If explosives are used, the following measures are recommended:

- Limit the scaled distances of the explosives charges to those that will generate peak particle velocities of 1.5 inches per second or less at the reservoir structure.
- Retain a qualified operator with a proven record, and assure that blasting is performed in accordance with applicable statutes, rules, and regulations.
- Carry out a program of test shots with instrumentation of the reservoir by seismographs or other appropriate means. Start with large scaled distances and gradually decrease to determine the lowest allowable scaled distances.
- Retain a geotechnical engineer to monitor the excavation phase of the work and carry out field changes in the event that subsurface conditions differ from that anticipated prior to the start of construction.

3.10.3 IMPACT ON BUSINESSES

Installation of the water transmission mains near the Saint Louis Drive-Waialae Avenue intersection will temporarily affect the three businesses located there. Consumer Tire Warehouse, located on the ewa-mauka corner of the intersection, will be affected because the transmission main will be installed on the ewa side of Saint Louis Drive. City Mill and Roger's Chevron, located on the Diamond Head side of Saint Louis Drive, may also be affected but to a lesser degree. Loss of some business is a possibility if potential customers avoid the area because of traffic congestion caused by the project.

Mitigation measures include the usual traffic control procedures, including signs, flagpersons, and barricades, to facilitate a smooth traffic flow. Entry and egress need to be assured and clearly identified so that motorists are not discouraged from patronizing these businesses. It is important that these businesses be notified in advance about the project.

3.11 IMPACT ON PUBLIC SERVICES AND FACILITIES

3.11.1 WATER SERVICE

As discussed earlier, the proposed reservoirs will improve the service provided by the Board of Water Supply to the Honolulu District.

Major water service in the vicinity will have to be cut off for several hours when the transmission mains are connected to existing mains on Dole Street and Waialae Avenue. To avoid any inconvenience, this work will probably be done at night or at other non-peak hours when water demand is very low. It usually takes from four to six hours to complete a connection of this type.

3.11.2 FIRE PROTECTION

Construction of the two reservoirs will have a positive impact on the City's fire protection services, assuring a reliable supply of water for fire fighting purposes.

During construction, the Board of Water Supply will provide advance notification to the Fire Department in the event of street closures or reduced access to hydrants. The Fire Department will

also be advised before water service is temporarily disrupted to connect the proposed transmission mains to the existing system.

3.11.3 ELECTRIC, GAS, AND TELEPHONE SERVICE

The Board of Water Supply will coordinate preparation of the construction drawings with the utility companies to assure that the project does not conflict with existing and planned utility lines and facilities. Coordination will also be established during construction.

3.11.4 RECREATIONAL RESOURCES AND FACILITIES

Two public parks are in the vicinity: Kanewai Playground, a City and County park on Dole Street that includes a swimming pool, playing courts, and a large baseball/softball field; and Waahila State Recreation Area, featuring picnic facilities and hiking trails in a forest reserve above the Saint Louis Heights residential area. Recreational opportunities at these parks will not be affected by the proposed project, either during construction or operation. The only inconvenience may be minor problems with vehicular access to the parks while the transmission main is being installed.

3.11.5 SCHOOLS

Educational institutions in the vicinity include Hokulani Elementary School, the University of Hawaii Manoa campus, Saint Louis High School, and Chaminade University. The impacts on the University of Hawaii have been discussed in earlier sections. Because of their relative distance from the project site, it is anticipated that Saint Louis High School and Chaminade University will not be adversely affected by the project during construction. There might be some minor traffic inconvenience on Waialae Avenue during installation of the transmission main.

Hokulani Elementary is closer to the reservoir sites, so construction noise will be a factor. Traffic congestion during installation of the transmission main may also affect ease of access to the school by students, parents, and staff. If the trucks hauling away excavated material leave the reservoir sites via Dole Street and Saint Louis Drive, in order to avoid the University traffic, the noise and traffic impacts of these trucks would be felt by the school. However, it has been recommended that the excavation and transmission main installation parts of the project should be confined to the summer months. With students on vacation during this period, the project would have no adverse impact on the school.

3.12 COMMUNITY RELATIONS

People who live and work in the vicinity of the project will have to be kept informed about construction activities. The following measures are suggested:

- Maintain communication throughout the construction period with the University of Hawaii, the Neighborhood Boards, the Saint Louis Heights Community Association.
- Publicize construction activities in the daily newspapers (*Honolulu Advertiser, Honolulu Star-Bulletin,* and the University's *Ka Leo)* and on radio, as well as through newsletters published by the Neighborhood Boards and the Saint Louis Heights Community Association.
- Maintain a procedure whereby complaints, concerns, and questions about the project can be handled quickly and effectively. For example, the phone number of the Board of Water Supply's Construction Section can be publicized.

- Inform the public about the project's benefits. It was evident from the community meetings that people are willing to tolerate inconveniences if they understand why the reservoirs are needed and how they fit in with the overall water system.

- Consider sending out a flyer or newsletter with the bimonthly water bill. This could be done as needed or on a regular basis, perhaps every six months or so.

CHAPTER 4

ALTERNATIVES TO THE PROPOSED PROJECT

Chapter 200 of Title 11, the Department of Health's Environmental Impact Statement Rules, states: "The draft EIS shall contain any known alternatives for the action. These alternatives which could feasibly attain the objectives of the action—even though more costly—shall be described and explained as to why they were rejected."

The Board of Water Supply's overall objective is to operate and maintain its systems in a manner which is economically sound and to public advantage. Specific project objectives are to: (1) significantly increase storage capacity in the Honolulu District to more closely with BWS standards, (2) provide uninterrupted water service to customers, and (3) stabilize pressures and supply water during peak demand periods and for fire fighting purposes. A number of alternatives to the planned project, described below, were considered.

4.1 NO ACTION

Under this alternative, water service to the area extending from Aliamanu to Hawaii Kai would continue to operate significantly below the Board of Water Supply's standards which call for reservoir capacity equal to 1.5 times the average daily use. The likelihood of some users being without water during extended power outages would still exist. Furthermore, the proposed reservoirs are needed for fire fighting, stabilizing system pressures, and meeting peak demand. Municipal water demand is expected to increase due to economic expansion, population growth, and an increasing per capita consumption rate (State of Hawaii DPED, December 1984), and additional storage is especially required to serve areas such as Waikiki and Kaka'ako, which is currently undergoing redevelopment. Since the Honolulu District's storage capacity is already significantly below standard, failure to act in a timely manner to remedy the shortage would not be an acceptable course of action.

4.2 DELAYED PROJECT

Delay of the project will initially have the same effect as the "no action" alternative. Given projected increases in water demand, a delay would further exacerbate the current situation. Construction at a later date will probably result in increased construction costs due to inflation, so the Board of Water Supply may not be able to meet its objective of developing facilities in the most economical manner.

4.3 ALTERNATE RESERVOIR CONFIGURATIONS AT THE WAAHILA SITE

4.3.1 CONSTRUCTION OF ONLY ONE RESERVOIR

One alternative is to construct a single reservoir at the Waahila site, thus reducing the scope of the project and its impacts. Under this alternative, the Board of Water Supply's reservoir capacity for the Honolulu District would be increased by only 4.0 mg rather than 8.0 mg. If only the 180 reservoir is constructed, another site would have to be found for a reservoir for the high level (450') system, and vice versa. Construction of two reservoirs at two separate sites would probably be more expensive in terms of requirements for processing of permits and approvals, field investigations, construction costs, and possibly land acquisition. It would also entail a delay due to the need to select and acquire a new site and carry out the required planning and engineering. This alternative was rejected since it would not enable the Board to attain its objectives.

4.3.2 CONSTRUCTION OF SMALLER RESERVOIRS

The significant impacts identified in the previous chapter are primarily due to the large diameter of the proposed reservoirs and the extensive cuts required for their construction. Therefore, smaller reservoirs could be considered in order to lessen these impacts. A tank with a 2.0-mg capacity would have a diameter of approximately 130 feet, compared with the 190-foot diameter of the proposed tanks, and require a smaller cut (75 feet rather than 100 feet in depth). However, if this alternative is to allow the Board of Water Supply to significantly increase its reservoir capacity in the Honolulu District by the same amount as the proposed project, it would be necessary to construct four 2.0-mg reservoirs. These reservoirs would actually cover a larger area than the two 4.0-mg reservoirs and, hence, have as much (and possible more) of a visual impact. Construction of only two 2.0-mg reservoirs on the site would not be in keeping with the Board's objective to significantly increase reservoir capacity in the District. Moreover, another site would have to be found to accommodate additional tanks.

4.3.3 CONSTRUCTION OF TALLER RESERVOIRS

The option of constructing taller reservoirs with smaller diameters was considered as a way to reduce the size of the cuts while maintaining the 4.0-mg capacities. This alternative is technically feasible (the base and sides of the tanks would have to be thicker), but it is undesirable from an operational standpoint. The reason for this is that the height of each reservoir needs to match that of other tanks in the same service zone. If the reservoir heights within the same service zone are unequal, the reservoir with the highest water level would be totally drained before the others are used. Reservoir water levels rarely get this low, so the lower reservoirs within the same service zone would go virtually unused. Hence, it would be difficult to use the additional ten feet of storage height that a 30-foot high configuration would provide in conjunction with the other 20-foot high reservoirs that contain the remainder of the BWS's High Service (450') and Low Service (180') storage capacity.

4.3.4 CONSTRUCTION OF UNDERGROUND RESERVOIRS

The option of underground reservoirs or partially buried reservoirs at the Waahila site was also rejected for operational reasons. This was proposed as a solution to resolve the critical environmental issues, but the difficulties in maintaining and repairing buried facilities outweigh the advantages. Board of Water Supply standards require storage tanks that are accessible around their entire perimeters.

4.3.5 CONSTRUCTION OF LINED RESERVOIRS

It has been suggested that a lined reservoir might ameliorate some of environmental concerns, specifically the potential visual impacts. This type of reservoir is a water storage area dug out of the earth and lined with a plastic or rubber membrane. The surface is covered to prevent contamination, and the reservoir looks like a huge bubble. A lined reservoir is less viable than a concrete tank for several reasons. At the proposed site, the excavated quantities for such a facility would be about equal to or greater than those for a concrete storage tank. Soil stability would be a problem; if cut and fill quantities are balanced, there would be difficulty in retaining the filled side under the weight of the reservoir water. Pond-like reservoirs are usually not constructed on such steep slopes. Additionally, the lining and covering do not last as long as concrete.

4.4 ALTERNATE RESERVOIR LOCATIONS

Other locations for additional reservoirs have been considered and rejected. Few potential sites are available in the Honolulu District due to the siting requirements for reservoirs and the shortage of land. As part of an integrated water system, a reservoir must be placed at a specific elevation. Hence, Waahila 180 will be part of the Honolulu District's Low Service System, with

spillway elevations of 170 and 180 feet; and Waahila 405 will be part of the District's High Service System, comprised of reservoirs with spillway elevations of 405 feet above sea level.

Diamond Head is one possibility, but its status as a Historic, Cultural and Scenic District (established in the City and County of Honolulu Land Use Ordinance) precludes any construction that would diminish prominent public views. Another alternative is Kalani-Iki Valley, but it is not close enough to Waikiki and Kaka'ako, where the growth is taking place. Virtually all of the ridges from Aliamanu to Hawaii Kai have been developed, leaving little land available for reservoirs without having to condemn existing homes, which would be difficult and expensive. The Waahila site is ideal since it is public land and can accommodate two reservoirs at the required elevations.

4.5 ELEVATED WATER TANKS

In flat areas of the mainland, elevated water tanks are often used for storage. This option is not viable for Honolulu because of the unacceptable visual impacts, potential hazards to planes flying overhead, dangers posed in case the tanks malfunction or are damaged, and more difficult maintenance.

4.6 ALTERNATE ACCESS ROAD ALIGNMENTS

Four alternate alignments were considered for the proposed access road (see section 2.3.2 and figure 2-4). Starting the roadway at the edge of the existing faculty housing playground was rejected for safety reasons. Starting it at the east end of the upper parking lot was rejected because it would have required a costly relocation and alteration of drainage facilities. Using an existing State easement which starts on Saint Louis Heights was not considered feasible because the road would have to cross the existing drainage way and have to be significantly longer. It was suggested that perhaps Hawaiian Electric Company has an access road into the valley from Waahila Ridge to get to the power lines located above the reservoir site, and that the Board of Water Supply might be able to extend it to the reservoirs. However, Hawaiian Electric confirmed that no access exists and that crews reach such areas on foot or by helicopter when needed.

4.7 ONSITE DISPOSAL OF EXCAVATED MATERIAL

The disposal of excavated material on the Waahila hillside was suggested as a way to avoid the impact of truck traffic and also possibly reduce construction costs. Space was thought to be available on University of Hawaii controlled land adjacent to the reservoir sites. It was proposed that an engineering feasibility study be conducted to determine the best location for disposal, site preparation requirements, how the material should be placed, cost, and drainage and other impacts. This alternative was rejected because of concerns about drainage and questions about the availability of land for this purpose. The University did not foresee any need for fill material, so the Board of Water Supply sent letters to other government agencies inquiring whether they anticipate such a requirement. The responses to the letters indicate no need for the fill material.

CHAPTER 5

RELATIONSHIP TO APPLICABLE LAND USE PLANS, POLICIES, AND CONTROLS

5.1 STATE LAND USE LAW

All lands in the State have been placed in one of four land use districts (Urban, Agriculture, Conservation, or Rural) by the State Land Use Commission (SLUC). State Land Use District Boundary Reviews are undertaken by the SLUC to update its Land Use District Maps. Besides this SLUC-initated review, provisions for applicant-initiated amendments to the district boundaries have been established in Section 205-4 of the Hawaii Revised Statutes (HRS), and further promulgated in the *State Land Use Commission: Rules of Practice and Procedure and District Regulations* (12-21-75 as amended).

The site of the proposed project is in Urban designated land.

5.2 HAWAII STATE PLAN

The *Hawaii State Plan* (State of Hawaii, Department of Planning and Economic Development, Revised, 1986) consists of a series of broad goals, objectives, and policies which are to act as the guidelines for the growth and development of the State. In general, the proposed project is consistent with the overall intent of the State Plan. Discussed below are the specific goals, objectives, and policies, and priority actions contained in Part I of the State Plan which are thought to be most directly related to the Waahila reservoirs, access road, and transmission lines. Excerpts from the relevant sections of the State Plan are shown in italics. None of the Priority Guidelines listed in Part III of the State Plan relate to the proposed project.

Section 226-4 State Goals

(2) A desired physical environment, characterized by beauty, cleanliness, quiet, stable natural systems, and uniqueness, that enhances the mental and physical well-being of the people.

The proposed Waahila reservoirs, access road, and transmission mains are consistent with the overall goals of the State Plan. These facilities will be located in the midst of an already heavily developed area. Steps will be taken during construction to reduce the temporary effects of noise, fugitive dust, and traffic congestion on the surrounding neighborhood.

Section 226-11 Physical Environment - Land-based, Shoreline, and Marine Resources.

(a) Planning for the State's physical environment with regard to land-based, shoreline, and marine resources shall be directed towards achievement of the following objectives:

(1) Prudent use of Hawaii's land-based, shoreline, and marine resources.

(2) Effective protection of Hawaii's unique and fragile environmental resources.

(b) To achieve the land-based, shoreline, and marine resources objectives, it shall be the policy of this State to:

(1) Exercise an overall conservation ethic in the use of Hawaii's natural resources.

(2) Ensure compatibility between land-based and water-based activities and natural resources and ecological systems.

(3) Take into account the physical attributes of areas when planning and designing activities and facilities.

(4) Manage natural resources and environs to encourage their beneficial and multiple use without generating costly or irreparable environmental damage.

(8) Pursue compatible relationships among activities, facilities, and natural resources.

The reservoirs, access road, and transmission mains will be compatible with existing activities, facilities, and resources in the area. Once construction is completed and the reservoirs are operational, there will be no noise, air quality, or traffic impacts, and no significant biological or archaeological resources will be affected. The physical attributes of the site make it a good location for the proposed reservoirs; adequate space is available at the required elevations. Construction of the proposed facilities will not bar other potential uses of the hillside, so multiple use could still be a possibility.

Section 226-12 Physical Environment - Scenic, Natural Beauty, and Historic Resources

(a) Planning for the State's physical environment shall be directed towards achievement of the objective of enhancement of Hawaii's scenic assets, natural beauty, and multicultural/historical resources.

(b) To achieve the scenic, natural beauty, and historic resources objective, it shall be the policy of this State to:

(3) Promote the preservation of views and vistas to enhance the visual and aesthetic enjoyment of mountains, ocean, scenic landscapes, and other natural features.

(5) Encourage the design of developments and activities that complement the natural beauty of the islands.

The issue of views and vistas is discussed in detail in Section 3.8 of this EIS. Because of the central location of the project, it is recognized that special mitigation measures will have to be implemented to minimize visual impacts.

Section 226-13 Physical Environment - Land, Air, and Water Quality

(a) Planning for the State's physical environment with regard to land, air, and water quality shall be directed towards achievement of the following objectives:

(1) Maintenance and pursuit of improved quality in Hawaii's land, air, and water resources.

(2) Greater public awareness and appreciation of Hawaii's environmental resources.

(b) To achieve the land, air, and water quality objectives, it shall be the policy of this State to:

(2) Promote the proper management of Hawaii's land and water resources.

(3) Promote effective measures to achieve desired quality in Hawaii's surface, ground, and coastal waters.

(6) Encourage design and construction practices that enhance the physical qualities of Hawaii's communities.

(8) Foster recognition of the importance and value of the land, air, and water resources to Hawaii's people, their cultures and visitors.

The Waahila site is unused hillside land under State jurisdiction. It is located in the Urban Land Use District, and the proposed use is consistent with the City and County's Land Use Ordinance and Development Plan for the Primary Urban Center. Construction of the reservoirs and access road is a beneficial use of the State's land resources, since it will enable the Board of Water Supply to improve its service to the Honolulu District. Adherence to the State's land, air, and water quality objectives will be assured through proper design and construction practices. For example, precautions will be taken to minimize sedimentation of Manoa Stream, and the grading and drainage design will be carried out to minimize runoff from the site. Steps will also be followed to control fugitive dust during construction.

Section 226-16 Facility Systems - Water

(a) Planning for the State's facility systems with regard to water shall be directed towards achievement of the objective of the provision of water to adequately accommodate domestic, agricultural, commercial, industrial, recreational, and other needs within resource capacities.

(b) To achieve the facility systems water objective, it shall be the policy of this State to:

(4) Assist in improving the quality, efficiency, service, and storage capabilities of water systems for domestic and agricultural use.

Construction of the Waahila reservoirs will add 8.0 mg of storage capacity to the Board of Water Supply's Honolulu District system, which presently serves more than 433,000 people. This added capacity will lessen the probability of interrupted service during periods of extended power outages and help to stabilize pressures and supply water during peak demand periods and for fire fighting purposes.

5.3 STATE FUNCTIONAL PLANS

State functional plans are intended to provide more detail to the *Hawaii State Plan* in 12 specific areas of concern—agriculture, conservation lands, education, higher education, energy, health, historic preservation, housing, recreation, tourism, transportation, and water resources development. As defined in the *Hawaii State Plan* (section 2-10), a functional plan sets forth "the policies, programs and projects designed to implement the objectives of a specific field of activity when such activity or program is proposed, administered, or funded by an agency of the State." The 12 State functional plans were examined to determine the relationship of the proposed Waahila reservoir project to each. Only one—the State Water Resources Development Functional Plan—was found to have any direct relevance. This functional plan, prepared by the Department of Land and Natural Resources (June 1984), primarily affects State operations. The proposed project is consistent with the State's objective to "assure adequate municipal water supplies for planned urban growth."

5.4 HAWAII COASTAL ZONE MANAGEMENT (CZM) PROGRAM

The Hawaii Coastal Zone Management Act (Act 188, SLH 1977), which became Chapter 205A, Hawaii Revised Statutes, established State policies for any actions affecting the coastal zone. Objectives and policies in seven broad categories are specified, and the relationship of the proposed project to two of these categories is discussed below.

5.4.1 SCENIC AND OPEN SPACE RESOURCES

The CZM program seeks to "protect, preserve, and, where desirable, restore or improve the quality of coastal scenic and open space resources." The Waahila hillside is visible from a wide area and is identified in the City and County of Honolulu's *Coastal View Study* as an "important coastal landform." A detailed view analysis was carried out to address this issue (see section 3.8), and mitigation measures have been suggested, including landscaping around the reservoirs and on the associated cuts.

5.4.2 COASTAL ECOSYSTEMS

Another CZM objective is to "protect valuable coastal ecosystems from disruption and minimize adverse impacts on all coastal ecosystems." The major concern here is with sediment runoff into streams and offshore waters due to erosion from the site during excavation. Erosion control measures are proposed in section 3.2.3.1.

5.5 OAHU GENERAL PLAN

The General Plan of the City and County of Honolulu is a statement of long-range social, economic, environmental, and design objectives and broad policies to facilitate the attainment of the stated objectives. Identified below in italics are the objectives and the respective policies which relate to the proposed reservoir project. Comments on how the proposed action relates to the objectives and policies are presented in plain text.

5.5.1 NATURAL ENVIRONMENT

Objective A: To protect and preserve the natural environment of Oahu.

- *Protect Oahu's natural environment, especially the shoreline, valleys, and ridges, from incompatible development.*
- *Require development projects to give due consideration to natural features such as slope, flood and erosion hazards, water-recharge areas, distinctive land forms, and existing vegetation.*
- *Design surface drainage and flood-control systems in a manner which will help preserve their natural settings.*
- *Protect the natural environment from damaging levels of air, water, and noise pollution.*

The site for the proposed reservoirs is shown on the Development Plan Public Facility Map for the Primary Urban Center. Hence, construction of the proposed reservoirs in the valley between Waahila and Kalaepohaku Ridges is compatible with the existing land use designation.

Due consideration will be given to slope, as well as flood and erosion hazards, in the design of the proposed reservoirs and access road. Surface drainage systems will be designed to lessen the impact of runoff. A detailed discussion of these issues is contained in sections 2.3, 2.4, and 3.2 of this document.

Existing vegetation on the site is comprised largely of exotic weeds, and no endemic species were encountered in the botanical survey conducted for the project (see section 3.3).

Mitigation measures will be carried out to protect the environment from potentially damaging levels of air, water, and noise pollution. Air quality impacts are discussed in section 3.7, and noise impacts in section 3.6. Water quality concerns are addressed in the sections dealing with drainage and erosion (3.2.1.5, 3.2.2, and 3.2.3).

Objective B: To preserve and enhance the natural monuments and scenic views of Oahu for the benefit of both residents and visitors.

- *Protect Oahu's scenic views, especially those seen from highly developed and heavily travelled areas.*
- *Locate roads, highways, and other public facilities and utilities in area where they will least obstruct important views of the mountains and the sea.*

A detailed view analysis has been conducted as part of this environmental impact study (see section 3.8). Objective B will be achieved through the implementation of mitigation measures such as landscaping around the reservoirs and on the cuts.

5.5.2 TRANSPORTATION AND UTILITIES

Objective B: To meet the needs of the people of Oahu for an adequate supply of water and for environmentally sound systems of waste disposal.

- *Develop and maintain an adequate supply of water for both residents and visitors.*

Construction of the proposed reservoirs will improve the Board of Water Supply's service to both residents and visitors in the Honolulu District, which includes more than 433,000 residents, tourists, and military personnel and dependents. Among other reasons, the Waahila site was selected because of its proximity to Waikiki. The added reservoir capacity will help to stabilize pressures and supply water during peak demand periods and for fire fighting purposes.

Objective C: To maintain a high level of service for all utilities.

- *Provide improvements to utilities in existing neighborhoods to reduce substandard conditions.*

The BWS is heavily dependent upon wells rather than storage capacity to meet daily demand in the Honolulu District. According to BWS standards, reservoir capacity should be 1.5 times the average daily use, but in 1987, reservoir capacity was only 0.5 times average daily use. Development of the new reservoirs is an attempt to bring the system closer to standard and provide improved service.

Objective D: *To maintain transportation and utility systems which will help Oahu continue to be a desirable place to live and visit.*

- *Give primary emphasis in the capital improvement program to the maintenance and improvement of existing roads and utilities.*

- *Evaluate the social, economic, and environmental impact of additions to the transportation and utility systems before they are constructed.*

The proposed project is part of the Board of Water Supply's Six-Year Capital Improvement Program for 1988-1993. Social, economic, and environmental impacts of the project are being evaluated as part of the EIS process.

5.5.3 PHYSICAL DEVELOPMENT AND URBAN DESIGN

Objective A: *To coordinate changes in the physical environment of Oahu to ensure that all new developments are timely, well-designed, and appropriate for the areas in which they will be located.*

- *Plan for the construction of new public facilities and utilities in the various parts of the Island according to the following order of priority: first, in the primary urban center; second, in Ewa; and third, in the urban-fringe and rural areas.*

The Waahila site is located in the Primary Urban Center and is designated on the Development Plan Public Facilities Map for the PUC.

Objective D: *To create and maintain attractive, meaningful, and stimulating environments throughout Oahu.*

- *Design public structures to meet high aesthetic and functional standards and to complement the physical character of the communities they will serve.*

The proposed facilities will be designed to meet high aesthetic and functional standards, especially since they will be located in a heavily populated urban environment. Landscaping and other mitigation measures will be carried out so that the reservoirs and their cuts are blended into the surroundings as much as possible.

Objective E: *To promote and enhance the social and physical character of Oahu's older towns and neighborhoods.*

- *Provide and maintain roads, public facilities, and utilities without damaging the character of older communities.*

The Board of Water Supply will construct the reservoirs, access road, and transmission mains in such a way that the character of the surrounding Saint Louis-Moiliili-Kaimuki community is not damaged.

5.5.4 GOVERNMENT OPERATIONS AND FISCAL MANAGEMENT

Objective A: *To promote increased efficiency, effectiveness, and responsiveness in the provision of government services by the City and County of Honolulu.*

- *Maintain City and County government services at the level necessary to be effective.*

As stated previously, the Board of Water Supply's overall objective is to operate and maintain its systems in a manner which is economically sound and to public advantage. The project is intended to assure reliable service to BWS customers.

5.6 DEVELOPMENT PLAN FOR THE PRIMARY URBAN CENTER

Both reservoir sites are designated on the Development Plan Public Facility Map for the Primary Urban Center. On the Development Plan Land Use Map, the 180 reservoir site is within an area designated for public facilities and the 405 reservoir is designated "Preservation"; however, the Department of General Planning will change this latter designation to Public Facilities after the project is completed.

The proposed project is consistent with the policies, guidelines, and standards set forth in the City and County of Honolulu Development Plan for the Primary Urban Center. Priority is given to public facilities that will correct recognized but previously unmet facility needs.

5.7 LAND USE ORDINANCE

The City and County of Honolulu's Land Use Ordinance (LUO) regulates land use in accordance with adopted policies, including the Oahu General Plan and Development Plans. The zoning provisions of the LUO provide development and design standards relating to location, height, and size of structures; yard areas; off-street parking; open space; and the use of structures and land for agriculture, industry, business, residences, or other purposes.

The 180 reservoir site is located in an area zoned "R-5 Residential" by the City and County of Honolulu; the route of the transmission main along Dole Street and Saint Louis Heights Drive is also in "R-5." The 405 reservoir site is on land zoned "P-2 Preservation." Reservoirs and other public uses and structures are "Principal Uses" within these districts. (Note: "Public Uses and Structures" are defined as those uses conducted by or structures owned or managed by government to fulfill a government function, activity or service for public benefit and in accordance with public policy.) Hence, the proposed facilities are consistent with the existing zoning.

5.8 OFFSETTING CONSIDERATIONS OF GOVERNMENTAL POLICIES

The Department of Health's Environmental Impact Statement Rules (Title 11, Chapter 200) require that an EIS "shall indicate what other interests and considerations of governmental policies are thought to offset the adverse environmental effects of the proposed action." As stated in other sections of this document, the countervailing benefit is the improved water service provided to the area between Aliamanu and Hawaii Kai. The extent to which the various benefits could be realized by following alternatives to the proposed action is limited. See Chapter 4 of this EIS for a detailed discussion of each alternative considered.

CHAPTER 6

UNRESOLVED ISSUES

Most of the issues relating to the project were resolved prior to preparation of the Draft Environmental Impact Statement. This has been done primarily through discussions with the University of Hawaii. For example, the decision to use blasting as an excavation method was made in response to a preference for this method stated by University facilities management staff. Two special studies were carried out to provide answers to questions about blasting impacts.

Continued discussions between the University and the Board of Water Supply have resolved the issue of reimbursement for lost revenues in the event of housing vacancies resulting from construction activities. No other unresolved issues remain.

CHAPTER 7

REFERENCES

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CHAPTER 8

CONSULTATION

8.1 ORGANIZATIONS AND INDIVIDUALS WHO ASSISTED IN PREPARATION OF THIS ENVIRONMENTAL IMPACT STATEMENT

The environmental impact statement was prepared for the Board of Water Supply by Belt Collins & Associates with input provided by subconsultants. The following were involved:

Belt Collins & Associates:

Perry J. White	Planner with a masters degree in regional planning; contributed to the organization and content of all sections; conducted the traffic impact analysis.
Susan S. Rutka	Planner with an M.A. in political science; contributed to the organization and writing of all sections; conducted the view analysis.
Leland Y. S. Lee, P.E.	Civil engineer with an M.S. in civil engineering and an M.B.A.; project engineer on the reservoir feasibility study.
Molly M. Kihara	Junior Civil Engineer with a B.S. in civil engineering; contributed to the reservoir feasibility study.
Gregory S. Fukumitsu, P.E.	Civil Engineer with a B.S. in civil engineering; contributed to the reservoir feasibility study.

Subconsultants:

Winona Char	Consultant with Char & Associates; conducted botanical survey; M.S. in botanical sciences.
Yoichi Ebisu	Consultant with Y. Ebisu & Associates; analyzed the noise and vibration impacts of blasting; M.S. in electrical engineering.
Bob Y. K. Wong, P.E.	President of Geolabs-Hawaii; principal engineer on the study of potential blasting impacts on the 180 reservoir; B.S. in civil engineering.
Clayton S. Mimura, P.E.	Vice President of Geolabs-Hawaii; principal engineer on the geotechnical engineering exploration for the reservoir project; M.S. in civil engineering
Dayton E. Fraim	Project Engineering Geologist with Geolabs-Hawaii; contributed to both geotechnical studies conducted for the project; B.S. in geology and geophysics;
Paul H. Rosendahl	President of Paul H. Rosendahl, Ph.D., Inc.; conducted the archaeological reconnaissance survey; Ph.D. in anthropology.

8.2 CONSULTATION ON THE DRAFT ENVIRONMENTAL IMPACT STATEMENT (DEIS)

8.2.1 OFFICIAL DOCUMENTS

The EIS Preparation Notice (EISPN) for the subject project was published in the *OEQC Bulletin* by the office of Environmental Quality Control on February 8, 1988. Copies of the EISPN and the Environmental Assessment (EA) are presented in this chapter. Also included is a sample of a letter that was sent, along with copies of the EISPN and EA, to various agencies, organizations, and individuals who were asked to comment on the project.

8.2.2 CONSULTED PARTIES

The following is a list of those who were sent copies of the Environmental Impact Statement Preparation Notice (EISPN) and asked to comment on the Waahila reservoir project. Everyone believed to have an interest in the project or who requested consulted party status was included in the mailing. Those who responded to the request for comments are marked with an asterisk (*).

Federal Government:

* U.S. Department of Agriculture, Soil Conservation Service
U.S. Army Engineer District, Honolulu
U.S. Department of Commerce, National Marine Fisheries Service
* U.S. Department of Interior, Fish & Wildlife Service
U.S. Department of Interior, Geological Survey, Water Resources Division

State Government:

* State Legislature:
President of the Senate and Senators from Districts 12 and 14
Speaker of the House and Representatives from Districts 25, 27, and 28
Department of Accounting and General Services, Division of Public Works
* Department of Agriculture
Department of Business and Economic Development
* Department of Commerce and Consumer Affairs
Department of Defense, Office Of Adjutant General
Department of Education
* Department of Hawaiian Home Lands
Department of Health, Environmental Protection and Health Services Division
Department of Land and Natural Resources
Department of Social Services and Housing, Hawaii Housing Authority
Department of Transportation
Office of Environmental Quality Control
Office of Hawaiian Affairs
* University of Hawaii, Environmental Center
* University of Hawaii, Faculty Housing Office
* University of Hawaii, Procurement and Property Management Office
* University of Hawaii, Student Housing Office
* University of Hawaii, University Housing Office
University of Hawaii, Water Resources Research Center

City and County Government:

City Council: Chairman of the City Council and Members from Districts IV and V
Building Department
* Fire Department
Department of General Planning
Department of Housing and Community Development
* Department of Land Utilization
Department of Parks and Recreation
* Police Department
Department of Public Works
Department of Transportation Services
Neighborhood Boards Nos. 5, 6, and 7

Others:

Chaminade University
* Hawaiian Electric Company, Inc.
* Hawaiian Telephone Company
* Oceanic Cablevision
* PRI Gasco, Inc.
Saint Louis Heights Community Association
Saint Louis High School

In addition, presentations on the project were given to the following groups:

Manoa Neighborhood Board No. 7
Palolo Neighborhood Board No. 6
McCully/Moiliili Neighborhood Board No. 8
Diamond Head/Kapahulu/St. Louis Heights Neighborhood Board No. 5
St. Louis Heights Community Association Executive Board
St. Louis Heights Community Association Annual Meeting

8.2.3 COMMENTS ON THE EIS PREPARATION NOTICE

Also presented in this chapter are reproductions of letters commenting on the EISPN, together with copies of letters written by the Board of Water Supply in response to the comments. The following is a list of agencies, organizations, and individuals who commented on the EISPN.

Responded with No Comments

Federal Government:
U.S. Department of Agriculture, Soil Conservation Service

State Government:
Department of Defense
Department of Transportation

Responded with Comments

Federal Government:
U.S. Department of Interior, Fish & Wildlife Service

State Government:
Department of Business and Economic Development
Department of Health
Representative Brian T. Taniguchi
Senator Ann H. Kobayashi
University of Hawaii, Environmental Center
Dr. Paul L. Hummel, Department of Civil Engineering
University of Hawaii, Procurement and Property Management Office
University of Hawaii, University Housing Office

City Government:
Fire Department
Department of Land Utilization
Police Department

Others:
Hawaiian Electric Company, Inc.
Hawaiian Telephone Company
PRI Gasco, Inc.

8.3 CONSULTATION ON THE FINAL ENVIRONMENTAL IMPACT STATEMENT

8.3.1 OFFICIAL DOCUMENTS

An announcement of the availability of the DEIS for the proposed project was first published in the *OEQC Bulletin* by the Office of Environmental Quality Control on April 23, 1989. A copy of the announcement is reproduced in this chapter.

8.3.2 CONSULTED PARTIES

The agencies, organizations, and individuals listed in section 8.2.2 were sent copies of the DEIS with a request for their comments on the project. In addition, copies of the report were sent to the following:

Federal Government:
East-West Center
Department of the Navy, Commander, Naval Base Pearl Harbor

State Government:
University of Hawaii
Auxillary Services
Campus Operations
Center for Hawaiian Studies
Facilities Planning and Management Office

8.3.3 COMMENTS ON THE DRAFT ENVIRONMENTAL IMPACT STATEMENT

Presented in this chapter are reproductions of letters commenting on the DEIS, together with copies of letters written by the Board of Water Supply in response to the comments. The Board responded to all letters, including those received after the June 7, 1989 deadline. The following is a list of agencies, organization, and individuals who commented on the DEIS.

Responded with No Comments

Federal Government:
- Department of the Army, U.S. Army Engineer District, Honolulu
- Department of the Interior, Fish and Wildlife Service
- Department of the Navy, Commander, Naval Base Pearl Harbor
- East-West Center

State Government:
- Department of Accounting and General Services
- Department of Agriculture
- Department of Business and Economic Development, Housing Fiance and Development Corporation
- Department of Defense, Office of the Adjutant General

Responded with Comments

State Government:
- Department of Health
- Department of Land and Natural Resources
- Office of Environmental Quality Control
- University of Hawaii
  - Center for Hawaiian Studies
  - Environmental Center
  - Procurement and Property Management Office

Others:
- The Rt. Rev. Wayne W. Gau
- Hawaiian Electric Company, Inc.

DRAFT ENVIRONMENTAL IMPACT STATEMENT

OFFICIAL DOCUMENTS

AND

COMMENTS ON THE EIS PREPARATION NOTICE

465 SOUTH KING STREET · KEKUANAOA BUILDING, #104 ! HONOLULU, HAWAII 96813 TELEPHONE (808)

OEQC BULLETIN

OFFICE OF ENVIRONMENTAL QUALITY CONTROL

JOHN WAIHEE
GOVERNOR

MARVIN T. MIURA, Ph.D.
DIRECTOR

Volume V February 8, 1988 No. 3

REGISTER OF CHAPTER 343, HRS DOCUMENTS

****

All Chapter 343, HRS documents submitted for publication in the OEQC Bulletin must be addressed to the Office of Environmental Quality Control, 465 South King Street, Room 104, Honolulu, Hawaii 96813. Documents addressed otherwise will not be considered for publication.

****

EIS PREPARATION NOTICES

The following proposed actions have been determined to require an environmental impact statement. Anyone can be consulted in the preparation of the EIS by writing to the listed contacts. 30 days are allowed for requests to be a consulted party.

WAAHILA 180 AND 405 RESERVOIRS, MANOA, OAHU. City and County of Honolulu Board of Water Supply

The proposed project involves the installation of two 4.0-million gallon reservoirs along Waahila Ridge on a 40-acre site (TMK: 3-3-56:por. 1 and 2) above the existing University of Hawaii faculty housing on Dole St. One reservoir will be sited at the 180-ft. elevation and the other at the 405-ft. elevation. Both reservoirs are needed to provide additional storage capacity to meet peak demand periods and provide a temporary source of water during brief power outages. In addition to the 2 tanks, other improvements will include an access road, transmission mains, instrument houses, landscaping, irrigation, and fencing. Approx. 5,400 linear ft. of 24-in. diameter transmission main will be installed to integrate the new reservoirs with the existing water mains on Dole St. and on Maialae Ave.

Contact: Mr. Lawrence Whang
Board of Water Supply
City and County of Honolulu
630 S. Beretania Street
Honolulu, HI 96843

Deadline: March 9, 1988.

CHINATOWN GATEWAY PLAZA PROJECT, HONOLULU, OAHU. City and County of Honolulu Dept. of Housing and Community Development

A negative declaration for the proposed project was previously published in the November 23, 1987 OEQC Bulletin. On January 21, 1988, based on concerns raised regarding public input, the Dept. of Housing and Community Development withdrew the Negative Declaration and indicated its intent to prepare an

ENVIRONMENTAL IMPACT ASSESSMENT
FOR THE
WAAHILA "180" AND "405" RESERVOIRS

MANOA, OAHU

Tax Map Key: 3-3-56: por. 1 & 2

Proposing Agency

HONOLULU BOARD OF WATER SUPPLY
City and County of Honolulu
630 South Beretania Street
Honolulu, Hawaii 96843
Contact: Lawrence Whang, Telephone 527-6138

Prepared by

BELT COLLINS & ASSOCIATES
606 Coral Street
Honolulu, Hawaii 96813

January 4, 1988

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INTRODUCTION AND SUMMARY

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Board of Water Supply, City and County of Honolulu

1.2 APPROVING AGENCY

Office of the Governor, State of Hawaii

1.3 AGENCIES CONSULTED IN MAKING THE ASSESSMENT

Department of General Planning, City and County of Honolulu
Department of Land Utilization, City and County of Honolulu
Soil Conservation Service, U.S. Department of Agriculture
Historic Sites Section, Department of Land and Natural Resources, State of Hawaii
Auxillary Services, University of Hawaii

1.4 PROJECT BACKGROUND AND OBJECTIVES

The City and County of Honolulu Board of Water Supply (BWS) proposes the construction of two 4.0-million gallon (mg) reservoirs to provide additional storage capacity to serve the Honolulu District, which extends from Aliamanu to Hawaii Kai. According to current BWS standards and given the average daily water use in the District, existing reservoir capacity is deficient by approximately 85 mg. Construction of the two proposed reservoirs would increase the storage capacity available to the Board of Water Supply in the Honolulu District by almost 18 percent--still short of the Board's standard but a substantial improvement nonetheless.

The Board of Water Supply's objective is to provide uninterrupted service. With its limited reservoir capacity, however, the BWS system is heavily dependent upon pumpage from wells rather than storage to meet daily demand. While this is normally not a problem, an extended power outage which prevents pumping from the wells can leave some users without water. Additional reservoir capacity would reduce the likelihood of this occurrence.

1.5 PROJECT AND SITE DESCRIPTION

The proposed Waahila 180 and Waahila 405 Reservoirs will be constructed on a 40-acre site above the existing University of Hawaii faculty housing on Dole Street (see Figures 1 and 2). (The numbers 180 and 405 indicate the spillway elevations, or the maximum design elevations of water level in the reservoirs measured in feet above sea level.) In addition to the two tanks, other improvements will include an access road, transmission mains, instrument houses, landscaping, irrigation, and fencing. Approximately 5,400 linear feet of 24-inch diameter transmission main will be installed to integrate the new reservoirs with the existing water mains on Dole Street and on Waialae Avenue. The routing of the underground pipeline is shown in Figure 2.

The site is characterized by steeply sloped lava rock covered with a dense growth of grasses, brush, and small trees. It is located in the Urban district on State-owned land under the jurisdiction of the University of Hawaii and the Department of Land and Natural Resources.

1.6 POTENTIAL IMPACTS, MITIGATION MEASURES, AND ALTERNATIVES

Significant temporary impacts are expected during construction of the project due to extensive earthwork and grading. Impacts will include noise from excavation and other activities, dust, runoff, and increased traffic congestion, especially during pipeline installation. Measures will be taken to minimize these impacts.

The proposed project will have several potentially significant long-term effects:

- Increased reservoir capacity will improve the Board of Water Supply's ability to reliably meet peak demand and fire flows.
- The cuts in the terrain and the reservoirs themselves will alter the appearance of the hillside.
- Steep ground will be exposed to rain and runoff, making erosion control and re-vegetation a critical issue.

The Board of Water Supply has considered several alternatives to the proposed project, including no action, delayed action, different facilities, and alternate locations. All of these were found to be less desirable.

1.7 GOVERNMENTAL PERMITS AND APPROVALS

The following permits/approvals would be required:

Building Permit	City Building Department
Grubbing, Grading and Stockpiling Permit	City Department of Public Works
Street Usage Permit	City Department of Transportation Services
Variance from Pollution Controls	State Department of Health

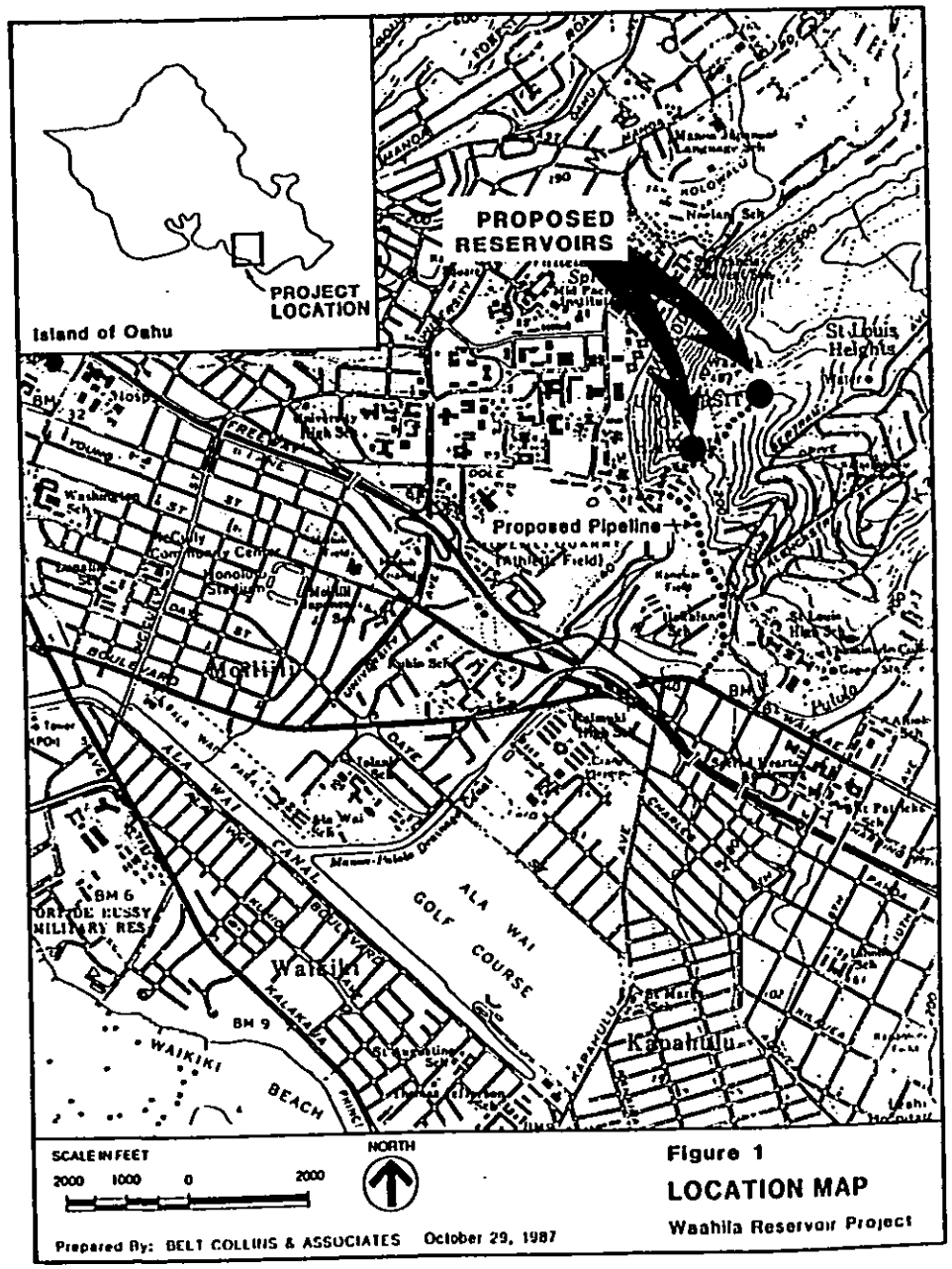

Figure 1
LOCATION MAP
Waahila Reservoir Project

Prepared By: BELT COLLINS & ASSOCIATES October 29, 1987

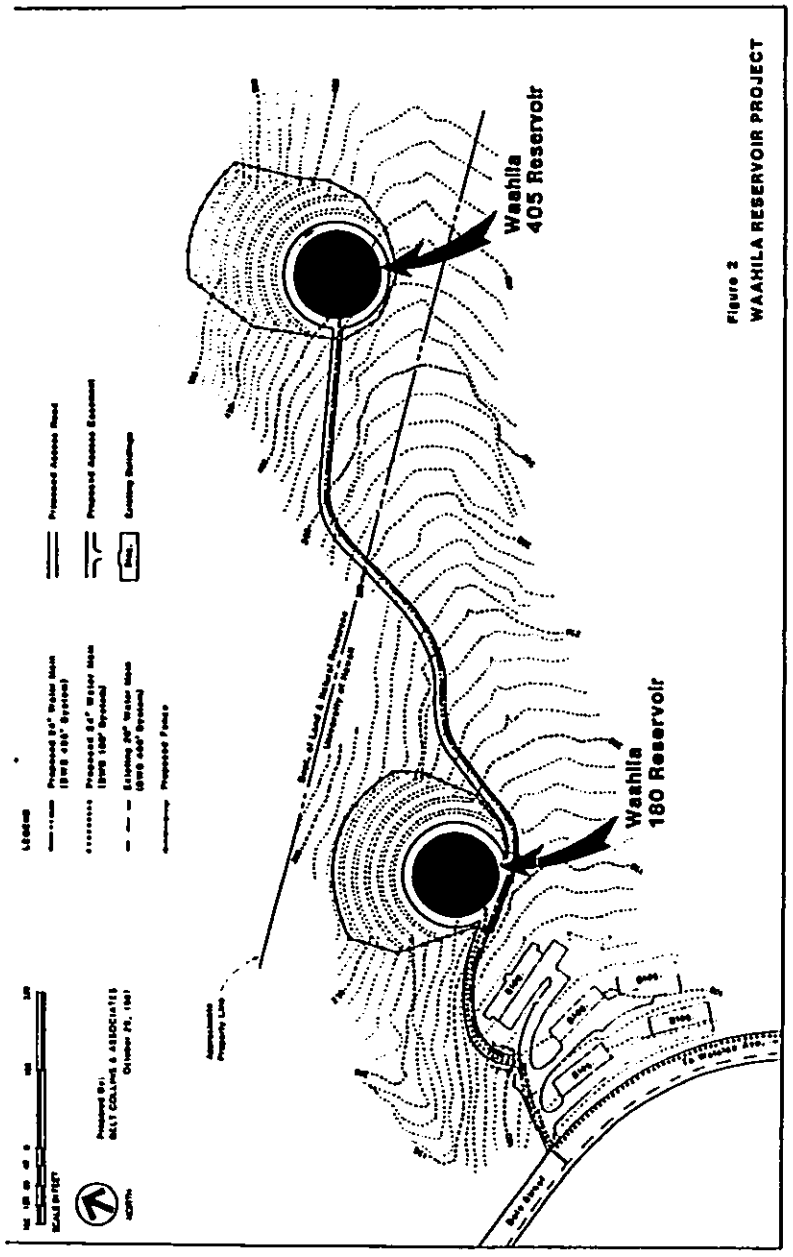

Figure 2
WAAHILA RESERVOIR PROJECT

CHAPTER 2

PROJECT DESCRIPTION

2.1 PROJECT SITE

2.1.1 Location

The proposed reservoirs are located above the University of Hawaii Waahila Faculty Housing complex on the western slopes of the valley separating Waahila and Kalaepohaku Ridges (TMK No. 3-3-56: por. 1 & 2). The Waahila 180 Reservoir will be situated about 500 feet northeast of (above) Dole Street, and the Waahila 405 Reservoir will be another 1,100 feet to the northeast (i.e., approximately 1,600 feet from Dole Street). Access to the site will be via Dole Street, the existing faculty housing driveway, and a proposed new access road as shown in Figures 1 and 2.

Each reservoir will be served by its own 24-inch diameter water main running beneath the access road. From the Waahila 405 Reservoir, a new main will be installed through the faculty housing entry road and connect to an existing 20-inch main on Dole Street. The Waahila 180 Reservoir water main will follow the same route through the housing area, turn southeast along Dole Street to its intersection with Saint Louis Drive, and then proceed one block south to the existing 24-inch transmission main beneath Waialae Avenue.

The project site lies between the Manoa campus of the University of Hawaii and the Saint Louis Heights residential area. In addition to the Waahila Faculty Housing complex, which is less than 200 feet from the Waahila 180 reservoir, single-family residences are located about 500 feet southeast of the reservoirs along the edge of Saint Louis Heights. Also nearby are Kanewai Park, University dormitories, Hokulani School, Saint Louis High School, and the Kaimuki Business District. Dole Street is heavily used by students, faculty, and staff bound to and from the University of Hawaii and by residents of the student housing located near the intersection of Dole Street and East-West Road.

2.1.2 Land Ownership

All of the land to be occupied by the reservoirs and access road is owned by the State of Hawaii. The lower portion, on which Waahila 180 will be constructed, is controlled by the University of Hawaii; the remainder is administered by the Department of Land and Natural Resources (DLNR). Use of the University of Hawaii parcel is being provided for under a land exchange, and arrangements to acquire use of the DLNR land is currently in progress.

2.1.3 Land Use Designation and Controls

The reservoir sites and routes of the access road and new transmission main linking the 180 reservoir with the existing transmission main on Waialae Avenue are all within the State "Urban" Land Use District. Both reservoir sites are designated on the Development Plan Public Facility Map for the Primary Urban Center. On the Development Plan Land Use Map, the 180 reservoir site is within an area designated for public facilities and the 405 reservoir is designated "Preservation"; however, the Department of General Planning will change this latter designation to Public Facilities after the project is completed.

The 180 reservoir is located in an area zoned "R-5 Residential" by the City and County of Honolulu; the 405 reservoir is on land zoned "P-2 Preservation." Reservoirs and other public uses and structures are "Principal Uses" within these districts. Hence, the proposed facilities are consistent with the existing zoning.

2.2 PROPOSED FACILITIES

The proposed project consists of the following elements (see Figures 1 and 2):

- Two 4.0-million gallon (mg) capacity concrete reservoirs, each 190 feet in diameter and 22 feet high.
- A 15-foot wide concrete access road, with 3-foot shoulders on each side and approximately 1,800 feet in length, between the existing University of Hawaii Waahila Faculty Housing complex and the two reservoirs. An alternative to the route shown in Figure 2 was considered (having the access road start at the east end of the upper parking lot), but it would have required the relocation of drainage facilities and hence, would have been too costly.
- Two 24-inch diameter underground pipelines. Approximately 2,050 feet of pipeline will run beneath the new access road and the faculty housing entry road and connect the 405 reservoir with an existing 20-inch water main beneath Dole Street. The other transmission main, approximately 3,350 feet in length, will run beneath the access road to Dole Street, along Dole Street to Saint Louis Drive, and down Saint Louis Drive to an existing 24-inch water main beneath Waialae Avenue.
- A chain-link gate across the access road near its intersection with the Waahila Faculty Housing parking area, fencing around each of the reservoirs and associated cut slopes, and gates where the reservoir fences cross the access road.
- Two instrument houses (about 10'x10') and other control equipment associated with the reservoirs.
- Landscaping and a landscape irrigation system.

2.3 CONSTRUCTION ACTIVITIES

Extensive grading will be required to prepare the area for the proposed facilities. Rough grading of the access road, the first step, will be followed either by installation of the pipelines beneath the roadway and paving of the roads, or by preparation of the reservoir sites. Because the two reservoirs will be constructed on steeply sloping terrain, large-scale excavation of the hillside will be required. Initial estimates place the height of the cut required for the 180 reservoir at 100 feet; the estimate for the 405 reservoir is 120 feet. A preliminary field survey indicates that the lava rock underlying the site is strong enough to support the structures without the use of special foundations such as piers or piles. The survey findings also suggest that 1:1 cut slopes with an 8-foot wide bench for every 20 feet of vertical rise will be stable. However, soil and rock borings, scheduled for completion by December 1987, are needed to confirm this.

Road grading can be accomplished using bulldozers and other heavy construction equipment. Due to the steepness of the roadway, it must be constructed of concrete. An absolute need for blasting cannot be determined until after the boring results have been analyzed, but the large quantity of material that must be moved, as well as the expected hardness of the material, make it likely that at least some blasting will be desirable to minimize the construction period and cost.

Based on very preliminary plans and topographical information, it is estimated that up to 200,000 cubic yards of excavated material will have to be removed from the reservoir sites and roadway alignment. Assuming an average of 8 cubic yards per truck load, about 25,000 trips by heavy trucks will be required to remove and dispose of the material.

Once the grading is completed, the reservoirs will be constructed. Reinforcing steel will be placed on the ground and forms placed around it; ready-mix concrete will then be trucked to the site and placed in several separate pours. After the pad is cured, the concrete pillars which support the roof and the walls will be erected, followed by installation of the reservoirs' concrete roofs. Finally, construction of the instrument houses (one for each reservoir) and installation of an irrigation system, landscaping, and fencing will be carried out.

2.4 PROJECT SCHEDULE AND CONSTRUCTION COST

The engineering feasibility study for the Waahila Reservoir Project should be completed by late December 1987. It is anticipated that the draft environmental impact statement will be submitted for public review in early February 1988, and the final environmental impact statement completed by mid-April 1988. Construction is expected to begin in early 1989, and to be completed in one-and-a-half to two years.

This project is included in the Board of Water Supply's six-year CIP budget for fiscal years 1988-1993. Total cost (including planning, engineering, and construction) is tentatively estimated at $15,000,000.

2.5 NEED FOR THE PROJECT

In fiscal year 1986, water use in the Board of Water Supply's Honolulu District (Aliamanu to Hawaii Kai) averaged 86.7 million gallons per day (City and County of Honolulu Board of Water Supply, 1987). The Board's 1987 reservoir listing shows that existing reservoirs in the Honolulu District have the following capacities:

Sub-Area	Reservoir Capacity (millions of gallons)
Low Service System (170'-180')	22.2
Boosted Low Service System	9.6
High Service System (405')	7.72
Boosted High Service System	2.42
Mountain Service	2.87
Total Reservoir Capacity	44.81 mg

Current Board of Water Supply standards call for reservoir capacity equal to 1.5 times the average daily use. Meeting this standard in FY 1986 would have required approximately 130 million gallons of storage capacity in the Honolulu District, or nearly three times the amount that was actually available.

Because of the limited reservoir capacity, the BWS system is heavily dependent upon operational sources (wells) rather than reservoir storage to meet daily demand. This is not a problem under normal circumstances, but if operation of the sources is interrupted for any reason (e.g., when a power failure prevents pumping from the wells), water levels in the reservoirs drop quickly. In the event of an outage lasting more than half a day, some users could be left without water. Additional reservoir capacity is desirable to reduce the likelihood of this occurrence.

Construction of the proposed Waahila 180 Reservoir would increase the storage capacity of the Low Service System by 18 percent. The Waahila 405 Reservoir would raise the storage capacity available in the High Service System by over 50 percent. Together, the two reservoirs would increase the storage capacity available to the Honolulu District by almost 18 percent. This would still leave the District with only 40 percent of the storage capacity needed to meet the Board's standards, but the improvement would be substantial.

CHAPTER 3

EXISTING CONDITIONS

3.1 PHYSICAL ENVIRONMENT

3.1.1 Physiography/Geology

The proposed reservoirs will be located in the small valley between Waahila Ridge and Kalaepohaku Ridge. The valley is an erosional feature on the southern flank of the Koolau Range. Construction of the reservoirs and access road will involve work at elevations between 90 and 550 feet above sea level, and on hillside slopes varying from 25 to 45 percent.

The Koolau Volcanic Shield consists of thinly-bedded basaltic lava, deeply dissected by streams. Portions of the eroded stream valleys may be filled with recent sediments. Observations indicate that the site will be excavated in basaltic lava flows, which generally average 10 feet or less in thickness. Both pahoehoe and a'a lava are common in the Koolau Formation, with a preponderance of the flows in the lower flanks of the mass. Lava tubes are commonly encountered in any deep excavation through the Koolau Formation; they may form in a'a flows, but far greater numbers are known to occur in pahoehoe lava. Inspections of clinker (basalt fragments) layers at the ground surface reveal that these highly fractured to granular layers may vary from six inches up to several feet thick, as observed in road cuts along Dole Street.

The Dole Street section of the proposed pipeline extending from the Waahila Faculty Housing entry road to Waialae Avenue is nearly level. The pipeline route then drops sharply beginning at Saint Louis Drive and crosses Palolo Stream just above Waialae Avenue.

3.1.2 Soils

According to the U.S. Department of Agriculture Soil Conservation Service (August 1972), the soils in the project site are of three types, which are described below. None are well suited for agriculture.

- Kaena Very Stony Clay, 12 to 20 percent slopes (KanE): very deep, poorly drained soils occuring on talus slopes and alluvial fans, with many stones on the surface and in the profile; medium to rapid runoff; moderate to severe erosion hazard; very sticky and plastic soils with high liquid limit and high shrink-swell potential; low shear strength.

- Pamoa Silty Clay, 5 to 20 percent slopes (PID): representative profile characterized by a thin silty clay surface layer, over a thick subsoil (about 55 inches) of clay and silty clay, and a substratum of soft, weathered rock. The clay is very sticky and very plastic when wet but friable when moist, with a low liquid limit, high shrink-swell potential, and low shear strength. Runoff is medium, erosion hazard is moderate to severe, and the soil is susceptible to gullying and piping.

- Rock Land (rRK): characterized by rock outcrops (covering 25 to 90 percent of the surface) mainly of basalt and andesite, as well as very shallow soils; typically very sticky and very plastic soils with high shrink-swell potential. This land type can be nearly level to very steep. On steep slopes, buildings constructed on soil covered areas are susceptible to sliding when the soil is saturated; foundations and retaining walls constructed on the soil pockets are susceptible to cracking.

3.1.3 Climate

Average annual rainfall at the 180 reservoir site is approximately 40 inches, with most of the rain occuring in the winter and early spring months. Rainfall is believed to be somewhat higher at the 405 reservoir site, probably on the order of 50 inches per year. Temperatures range from an average (mean) minimum in the mid 60s (Fahrenheit) in the winter to an average maximum in the mid- to high-80s during the summer and early fall. The prevailing wind throughout the year is the northeasterly trade wind; in general, the trades are more persistent in the summer than the winter. Because the ridges on either side of the narrow valley tend to block the prevailing winds, wind speeds at the site of the reservoirs tend to be lower.

3.1.4 Drainage

The valley in which the reservoirs and access road will be constructed forms a single drainage area. An analysis of the drainage patterns indicates that part of the Waahila 180 reservoir site lies at the edge of the floodway boundary (a small channel is located adjacent to the reservoir and road), whereas the Waahila 405 site is not within the boundary. The floodway is located parallel and to the southeast of the reservoirs and road. Storm runoff in the gulch and overland flow intercepted by concrete-lined ditches mauka of the faculty housing units is channeled into a culvert that carries it beneath the buildings. The runoff eventually discharges into Manoa Stream.

According to the National Flood Insurance Program Flood Insurance Rate Map, the reservoir and access road site is in "Other Areas, Zone X," defined as those areas determined to be outside the 500-year flood plain (Federal Emergency Management Agency, National Flood Insurance Program, September 4, 1987).

3.1.5 Flora and Fauna

Vegetation on the project site is largely grassland, with scrub and small tress where the soil permits. Grass cover is about 70 to 80 percent; the most prevalent plant is Guinea grass (*Panicum maximum* and its smaller form, var. *trichoglume*). Two species--kolomona (*Senna surratensis*) and koa-haole (*Leucaena leucocephala*)--form an open scrub over much of the site. In a botanical survey conducted in October 1987, a total of 46 vascular plant species were found on the site, of which 42 are exotic and only 4 are considered native or Polynesian introductions. Not a single Hawaiian endemic species was encountered, and none of the species are rare, threatened, or endangered. Those considered indigenous are questionably so, as they are widespread weedy species in the Pacific which may have accompanied early voyagers to Hawaii (Linney and Char, 1987).

Since the proposed reservoirs and access road will be constructed in the midst of an area that has been heavily developed for a long time, it is unlikely that the site provides a habitat for any significant bird or other wildlife species.

3.1.6 Archaeology

An archaeological reconnaissance survey of the site was conducted on October 13, 1987 by Paul H. Rosendahl, Ph.D., Inc. The purpose of the survey was to determine the presence or absence of any potentially significant archaeological sites within the project area. Survey field work consisted of a 100 percent coverage ground reconnaissance of both reservoir sites and the access road corridor, including all immediately adjacent areas to be affected by construction grading. No potentially significant archaeological sites or features of any kind were encountered. Based on the entirely negative results of the survey, it has been concluded that no further archaeological work of any kind is necessary. The granting of full archaeological clearance for the project has been recommended.

3.2 SOCIO-ECONOMIC ENVIRONMENT

The Waahila Reservoir Project is near Manoa Valley, Saint Louis Heights, Kaimuki, and Moiliili. Land uses within these neighborhoods, all of which are in the Urban District, include residential, commercial, park, and educational facilities.

Residential areas most likely to be affected by the proposed construction include the University of Hawaii Waahila Faculty Housing complex, the University dormitories on Dole Street between East-West Road and Manoa Stream, and portions of Saint Louis Heights along Dole Street and overlooking the reservoir site. The faculty housing complex is composed of five three-story buildings. The student housing closest to the project site are the four circular, multi-story dormitory buildings. Saint Louis Heights is a neighborhood of single-family homes. Other residential areas farther from the project site but still in the vicinity include Kaimuki (primarily single-family dwellings and low-rise apartment buildings with a fairly high density), Moiliili (a mix of all types of housing), and Manoa Valley (single-family units).

Commercial activities are generally found in Kaimuki and Moiliili, as well as in certain areas of Manoa Valley--along University Avenue adjacent to the campus and along East Manoa Road further up in the valley. However, the East Manoa business district is for all practical purposes outside the direct project impact area. Nearby schools include the Manoa campus of the University of Hawaii, Chaminade University, Hokulani Elementary School, and Saint Louis High School. Kanewai Field, a City and County park, is located across Dole Street from the faculty housing complex. Waahila State Recreation Area, featuring hiking trails in the forest reserve, is located above the Saint Louis Heights residential area, at about 1,100 feet.

The project impact area is potentially wider than the immediate neighborhood, since the reservoirs would be visible from other areas as well and would provide added water storage capacity for all Board of Water Supply Honolulu District customers who are seved by the high (405') and low service (180') systems.

CHAPTER 4

SUMMARY OF POTENTIAL IMPACTS AND POSSIBLE MITIGATION MEASURES

4.1 SUMMARY OF POTENTIAL IMPACTS

Preliminary analyses of the changes associated with the proposed project have been carried out during the preparation of this envionmental assessment. The following potential impacts have been identified:

4.1.1 Short-Term Impacts During Construction

Residents of the University of Hawaii Waahila Faculty Housing complex will be most affected by the impacts listed below. Other groups likely to be affected by the proposed project during construction include University of Hawaii student housing residents; members of the University community who gain access to the campus via Saint Louis Drive and Dole Street, including those who park along the stretch of Dole Street fronting the project; Saint Louis Heights residents; Kanewai Park users; and Hokulani School students, staff, and parents.

- Noise: Excavation of the reservoir sites will require blasting and removal of up to 200,000 cubic yards of excavated soil and rock. Temporary noise impacts will accompany this activity. In addition, there will be noise generated by construction equipment and by vehicular traffic (especially from trucks hauling excavated material from the site).

- Air: Air quality is likely to be affected due to the extensive earthwork, and to a lesser degree, emissions from construction equipment and vehicles. Unless the access road is paved before the pads for the reservoirs are constructed, large amounts of dust will be generated.

- Soil Erosion and Loose Rocks: Soil erosion potential is expected to increase during the site preparation phase of the work. In addition, there are potential hazards from loose rocks and boulders.

- Traffic: Installation of the proposed water main will affect traffic along Dole Street, Saint Louis Drive, and at the Saint Louis Drive-Waialae Avenue intersection.

4.1.2 Long-Term Impacts

- Physiographic Changes: Construction of the reservoirs will result in major, permanent changes to the existing landforms. The cuts in the hillside will be extensive; since the cuts will be in rock, the slopes will be stablized and erosion minimal. Natural drainage patterns will not be substantially altered by the project. Although one of the reservoirs will be at the edge of the existing floodway boundary, no significant drainage effects are anticipated as a result of the construction.

- Visual Impact: There will be an aesthetic impact since the reservoirs and their cuts will be visible from a fairly wide area. Preliminary observations indicate that the project will be visible from parts of Saint Louis Heights, Kaimuki, Kapahulu, and Moiliili, as well as the University faculty and student housing complexes.

- Benefits: By increasing storage capacity, the proposed project will improve the Honolulu District water system and reduce the likelihood of interruption of service during short power outages.

- Biological Impact: The impact on existing vegetation and wildlife is expected to be minimal, since no endangered or threatened species have been observed on the site. No significant archaeological or historic sites have been identified within the project boundaries.

4.2 POSSIBLE MITIGATION MEASURES

A number of measures can be implemented to minimize the impacts listed above. Since the faculty housing area will be most affected by the proposed project, open communication should be maintained with the residents throughout the construction period to keep them informed and to provide a way for any problems to be addressed and solved.

- Minimize noise impacts by limiting construction operations to daylight hours, generally between 7:30 a.m. and 4:30 p.m., Monday to Friday (excluding holidays).

- Reduce the need for blasting whenever possible, and when it is required, give ample warning to nearby residents via signs, newspaper articles, personal communication, etc.

- Minimize air pollution caused by air-borne dust by paving the access road at the earliest feasible stage of project development and by implementing other dust control measures.

- During installation of the pipeline, minimize impact on traffic flow through the use of proper signs, barricades, flagmen, etc. to insure ease and safety of motorists and pedestrians. Limit construction activity to non-peak hours, generally between 8:30 a.m. and 3:30 p.m., Monday to Friday (excluding holidays).

- Minimize the visual impact by the use of landscaping. Plantings around the tanks would soften the effect of the structures. In addition, landscaping of the cuts can also be considered, possibly with species such as koa-haole which now cover the area.

- Minimize visual impact of the reservoir by staining the walls of the structure to blend with the background and by using colored roof gravel.

- Alleviate any drainage impacts in the vicinity of the Waahila 180 reservoir by using fill and embankments, as required, to prevent water from flooding the roadway.

CHAPTER 5

POSSIBLE ALTERNATIVES

5.1 NO ACTION

Under this alternative, water service to the area extending from Aliamanu to Hawaii Kai would continue to operate significantly below the Board of Water Supply's standards. Under these conditions, some users could be left without water during extended power outages. Construction of the Waahila reservoirs would substantially increase the storage capacity available to the Honolulu District and thus help the Board meet its objective of providing uninterrupted service.

5.2 DELAYED PROJECT

Delay of the project will initially have the same effect as the "no action" alternative. Construction at a later date will probably result in increased construction costs due to inflation.

5.3 ALTERNATE RESERVOIR CONFIGURATIONS

5.3.1 Construction of Only One Reservoir

One alternative is to construct a single reservoir at the Waahila site, thus reducing the scope of the project and its impacts. Under this alternative, the Board of Water Supply's reservoir capacity for the Honolulu District would be increased by only 4.0 mg rather than 8.0 mg. If only the 180 reservoir were constructed, another site would have to be found for a reservoir for the high level (405') system, and vice-versa. Construction of two reservoirs at two separate sites would probably be more expensive in terms of requirements for processing of permits and approvals, field investigations, and engineering, as well as construction costs.

5.3.2 Construction of Smaller Reservoirs

The significant impacts identified in the previous chapter are primarily due to the large diameter of the proposed reservoirs and the extensive cuts required for their construction. Therefore, smaller reservoirs could be considered in order to lessen these impacts. A reservoir with, say, a 2.0-mg capacity, would have a diameter of approximately 130 feet (compared with the 190-foot diameter of the proposed tanks) and require a smaller cut. However, if this alternative is to allow the Board of Water Supply to significantly increase its reservoir capacity in the Honolulu District by the same amount as the proposed project, it would be necessary to construct four, rather than two, reservoirs.

5.3.3 Construction of Taller Reservoirs

The option of constructing taller reservoirs with smaller diameters was considered as a way to reduce the size of the cuts while maintaining the 4.0-mg capacities. This alternative is technically feasible (the base and sides of the reservoirs would have to be thicker), but it is undesirable from an operational standpoint since it would be difficult to use the additional ten feet of storage height that a 30-foot high configuration would provide in conjunction with the 20-foot high reservoirs that contain the remainder of the BWS's High Service (405') and Low Service (180') storage capacity.

5.4 ALTERNATE RESERVOIR LOCATIONS

Other locations for additional reservoirs have been considered and rejected (e.g., another reservoir on Diamond Head). Few potential sites are available in the Honolulu District due to the siting requirements for reservoirs and the shortage of land. As part of an integrated water system, a reservoir must be placed at a specific elevation. Hence, Waahila 180 will be part of the Honolulu District's Low Service System, with reservoirs located at elevations of 170 and 180 feet; and Waahila 405 will be part of the District's High Service System, comprised of reservoirs at 405 feet above sea level. Virtually all of the ridges from Aliamanu to Hawaii Kai have been developed, leaving little land available for reservoirs. The Waahila site is ideal since it can accommodate two reservoirs at these specific elevations.

In flat areas of the mainland, elevated water tanks are often used for storage. This option is not considered viable for Honolulu because of the unacceptable visual impacts.

CHAPTER 6

DETERMINATION

In accordance with Chapter 343, Hawaii Revised Statutes, it has been determined that an Environmental Impact Statement is required for the proposed Waahila Reservoir Project. The determination has been made based primarily on the project's detrimental impact on the physical environment. Several potentially significant impacts have been identified, most of them associated with the extensive cuts in the hillside required to construct the reservoirs.

CHAPTER 7

AGENCIES TO BE CONSULTED IN THE PREPARATION OF THE EIS

Federal Government:

U.S. Department of Agriculture, Soil Conservation Service
U.S. Army Engineer District, Honolulu
U.S. Department of Commerce, National Marine Fisheries Service
U.S. Department of Interior, Fish & Wildlife Service
U.S. Department of Interior, Geological Survey, Water Resources Division

State Government:

State Legislature:
President of the Senate and Senators from Districts 12 and 14
Speaker of the House and Representatives from Districts 25, 27, and 28
Department of Accounting and General Services, Division of Public Works
Department of Agriculture
Department of Business and Economic Development
Department of Commerce and Consumer Affairs
Department of Defense, Office Of Adjutant General
Department of Education
Department of Hawaiian Home Lands
Department of Health, Environmental Protection and Health Services Division
Department of Land and Natural Resources
Department of Social Services and Housing, Hawaii Housing Authority
Department of Transportation
Office of Environmental Quality Control
Office of Hawaiian Affairs
University of Hawaii, Environmental Center
University of Hawaii, Faculty Housing Office
University of Hawaii, Procurement and Property Management Office
University of Hawaii, Student Housing Office
University of Hawaii, Water Resources Research Center

City and County Government:

City Council: Chairman of the City Council and Members from Districts IV and V
Building Department
Fire Department
Department of General Planning
Department of Housing and Community Development
Department of Parks and Recreation
Police Department
Department of Public Works
Department of Transportation Services
Neighborhood Boards Nos. 5, 6, and 7

Others:

Chaminade University
Saint Louis Heights Community Association
Saint Louis High School
Selected Kaimuki businesses, e.g., City Mill

CHAPTER 8

REFERENCES

Federal Emergency Management Agency, National Flood Insurance Program. (September 4, 1987). Flood insurance rate map, City and County of Honolulu. Panel 120 of 135; community panel number 150001 0120 C.

Linney, G. K., and W. P. Char. (October 1987). Flora survey, Waahila reservoir project, Manoa, Island of Oahu. Prepared for Belt Collins & Associates.

Rosendahl, Paul H. (October 30, 1987). Archaeological reconnaissance survey, Waahila reservoirs project area, Waahila Ridge, Manoa, Honolulu, Island of Oahu (TMK:3-5-56:Por. 1, Por. 2). Letter report prepared for Belt Collins & Associates by Paul H. Rosendahl, Ph.D., Inc.

U.S. Department of Agriculture Soil Conservation Service. (August 1972). *Soil Survey of Islands of Kauai, Oahu, Maui, Molokai, and Lanai, State of Hawaii.*

Wong, B. Y. K. (October 4, 1987). Geotechnical field reconnaissance, preliminary feasibility study for EIS submittal, proposed Waahila "180" and "405" reservoirs, Manoa, Oahu, Hawaii. Letter report prepared for Belt Collins & Associates by C. W. Associates, Inc. dba Geolabs-Hawaii.

BOARD OF WATER SUPPLY
CITY AND COUNTY OF HONOLULU
630 SOUTH BERETANIA STREET
HONOLULU HAWAII 96843

SAMPLE

COPY

January 20, 1988

Mr. Richard N. Duncan
State Conservationist
Soil Conservation Service
U. S. Department of Agriculture
P. O. Box 50004
Honolulu, Hawaii 96850

Dear Mr. Duncan:

Subject: Environmental Impact Statement Preparation Notice for Waahila "180" and Waahila "405" Reservoirs, TMK: 3-3-56: Por. 1 and 2

We request your review and comments on the anticipated impacts that the proposed reservoirs will have on the community and the environment. A copy of the environmental assessment is attached.

Please submit your comments on the environmental assessment to us by February 20, 1988. If you have any questions, please contact Lawrence Whang at 527-6138.

Very truly yours,

KAZU HAYASHIDA
Manager and Chief Engineer

Attachment

cc: Belt, Collins & Associates

UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
P. O. BOX 50004
HONOLULU, HAWAII
96850

February 22, 1988

Mr. Lawrence Whang
Board of Water Supply
City and County of HOnolulu
630 South Beretania Street
Honolulu, HI 96843

Mar 2 4 53 PM '88

Dear Mr. Whang:

Subject: Environmental Impact Statement Preparation Notice for Waahila "180" and Waahila "405" Reservoirs, TMK: 3-3-56: Por. 1 and 2

We have no comments to offer at this time, but would appreciate the opportunity to review the final EIS on this project.

Sincerely,

RICHARD N. DUNCAN
State Conservationist

BOARD OF WATER SUPPLY
CITY AND COUNTY OF HONOLULU

COPY

March 9, 1988

Mr. Richard N. Duncan
State Conservationist
United States Department
of Agriculture
Soil Conservation Service
P. O. Box 50004
Honolulu, Hawaii 96850

Dear Mr. Duncan:

Subject: Your Letter of February 22, 1988 on the EIS Preparation Notice for Waahila "180" and "405" Reservoirs

Thank you for reviewing the environmental assessment for our proposed reservoir project. We shall be sending you a copy of the Draft EIS for your review and comment when it is completed.

If you have any questions, please contact Lawrence Whang at 527-6138.

Very truly yours,

KAZU HAYASHIDA
Manager and Chief Engineer

cc: Belt, Collins & Associates

Engineering Office

Mr. Kazu Hayashida
Manager and Chief Engineer
Board of Water Supply
630 South Beretania Street
Honolulu, Hawaii 96843

Dear Mr. Hayashida:

Environmental Impact Statement Preparation Notice for Waahila "180" and Waahila "405" Reservoirs, TMK: 3-3-56: Por. 1 and 2

Thank you for providing us the opportunity to review the above subject project.

We have no comments to offer at this time regarding this project.

Sincerely,

Jerry M. Matsuda
Major, Hawaii Air
National Guard
Contr & Engr Officer

Enclosure

cc:
Belt, Collins & Associates

JOHN WAIHEE
GOVERNOR

STATE OF HAWAII
DEPARTMENT OF TRANSPORTATION
869 PUNCHBOWL STREET
HONOLULU, HAWAII 96813

EDWARD Y. HIRATA
DIRECTOR

DEPUTY DIRECTORS
JOHN K. UCHIMA
RONALD M. HIRANO
DAN T. KOCHI
JEANNE K. SCHULTZ

IN REPLY REFER TO
STP 8.2799

RECEIVED
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April 22, 1988

Mr. Kazu Hayashida
Manager and Chief Engineer
Board of Water Supply
City and County of Honolulu
630 South Beretania Street
Honolulu, Hawaii 96813

Dear Mr. Hayashida:

Environmental Impact Statement Preparation Notice
Waahila "180" and Waahila "405" Reservoirs

We have no objections to the construction of the Waahila "180" and Waahila "405" Reservoirs as described in the preparation notice.

Thank you for this opportunity to provide comments.

Very truly yours,

Edward Y. Hirata
Director of Transportation

United States Department of the Interior

RECEIVED
BOARD OF WATER SUPPLY
FEB 4 9 03 AM '88

FISH AND WILDLIFE SERVICE
300 ALA MOANA BOULEVARD
P. O. BOX 50167
HONOLULU, HAWAII 96850

IN REPLY REFER TO:
ES
Room 6307

3 FEB 1988

Mr. Kazu Hayashida
Manager and Chief Engineer
Board of Water Supply
630 South Beretania Street
Honolulu, Hawaii 96843

Re: Environmental Impact Statement Preparation Notice
for Waahila "180" and Waahila "405" Reservoirs,
TMK: 3-3-56: Por. 1 and 2

Dear Mr. Hayashida:

We have reviewed the referenced material and find that due to its nature, the proposed project will have no significant deleterious impact on fish and wildlife resources. We recommend, however, that clearing and grading be done incrementally so as to avoid excessive soil erosion and sedimentation of Manoa Stream during periods of heavy rainfall.

We appreciate this opportunity to comment.

Sincerely yours,

John Engbring

for Ernest Kosaka, Field Supervisor
Office of Environmental Services
Pacific Islands Office

cc: NMFS - WPPO
DLNR
EPA, San Francisco

CONSERVE AMERICA'S ENERGY

Save Energy and You Serve America!

BOARD OF WATER SUPPLY
CITY AND COUNTY OF HONOLULU

COPY

February 11, 1988

Mr. Ernest Kosaka
Office of Environmental Services
Fish and Wildlife Service
U. S. Department of the Interior
P. O. Box 50167
Honolulu, Hawaii 96850

Dear Mr. Kosaka:

Subject: Your Letter of February 3, 1988 on the
Environmental Impact Statement Preparation Notice
for Waahila "180" and Waahila "405" Reservoirs,
TMK: 3-3-56: Por. 1 and 2

Thank you for your comments on the environmental impact assessment for our proposed reservoir projects.

We will require the contractor to take the necessary precautions to minimize or avoid sedimentation of Manoa Stream from the project sites.

If you have any questions, please contact Lawrence Whang at 527-6138.

Very truly yours,

KAZU HAYASHIDA
Manager and Chief Engineer

cc: Belt, Collins & Associates

JOHN WAIHEE
GOVERNOR

ROGER A. ULVELING
DIRECTOR

BARBARA KIM STANTON
DEPUTY DIRECTOR

LESLIE S. MATSUBARA
DEPUTY DIRECTOR

DEPARTMENT OF BUSINESS AND ECONOMIC DEVELOPMENT

KAMAMALU BUILDING 250 SOUTH KING ST. HONOLULU HAWAII
MAILING ADDRESS P.O. BOX 2359 HONOLULU HAWAII 96804 TELEX: 7409220 HIDPED

BD OF WATER SUPPLY
FEB 12 9 57 AM '88

Ref. No. P-8074

February 12, 1988

The Honorable Kazu Hayashida
Manager and Chief Engineer
Board of Water Supply
City and County of Honolulu
630 South Beretania Street
Honolulu, Hawaii 96843

Dear Mr. Hayashida:

Subject: Environmental Impact Statement Preparation Notice (EISPN)
for Waahila "180" and Waahila "405" Reservoirs, Manoa, Oahu

We have reviewed the subject application and do not have any objections to the project in general. However, we do have specific concerns about certain aspects of the project relative to the Hawaii Coastal Zone Management (CZM) Program.

Construction and site preparation activities such as grubbing, grading, and excavating can expose large land areas to climatic factors which can cause erosion and subsequent sedimentation of streams and coastal waters. The EISPN specifies that the project will involve extensive grading and states that "steep ground will be exposed to rain and runoff, making erosion control and re-vegetation a critical issue" (p.2). The assessment also indicates that runoff from the site will eventually discharge into Manoa Stream. It is a CZM objective to protect valuable coastal ecosystems from disruption and minimize adverse impacts on all coastal ecosystems. Relative to this, we are concerned that large quantities of sediment may enter streams and watercourses. The EIS should discuss the project's potential impacts upon streams, coastal waters, and coastal ecosystems due to anticipated sediment runoff.

According to the EISPN, there are potential hazards from loose rocks and boulders during the construction phase of the project. It is also a CZM objective to reduce hazard to life and property from erosion. In this regard, we are concerned that the project's erosion potential may pose hazard to residences located directly below the Waahila 180 Reservoir site. The EIS should address the erosion hazard potential and present measures to prevent the dislodging of rocks and boulders from the project site.

The applicant also indicates that the proposed reservoirs and their cuts will alter the appearance of the hillside and will be visible from a wide area. It is a CZM objective to protect coastal scenic and open space resources. Relative to this the Department of Land Utilization of the City

and County of Honolulu recently completed its Coastal View Study and identifies the subject area as an important coastal landform. In this regard, we agree with the applicant's plans to mitigate the visual impact of the tanks with landscaping. The applicant also indicates that landscaping of the cuts may also be considered. We felt that such landscaping should be implemented.

Thank you for the opportunity to review and comment on this EISPN. If you have any questions relative to this matter, please feel free to call our CZM office 548-5973.

Sincerely,

Roger A. Ulveling

Roger A. Ulveling

JOHN WAIHEE
GOVERNOR OF HAWAII

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STATE OF HAWAII
DEPARTMENT OF HEALTH
P. O. BOX 3378
HONOLULU, HAWAII 96801

JOHN C. LEWIN, M.D.
DIRECTOR OF HEALTH

In reply, please refer to:
EPHSD

February 17, 1988

MEMORANDUM

To: Mr. Kazu Hayashida, Manager and Chief Engineer
Board of Water Supply, City & County of Honolulu

From: Deputy Director for Environmental Health

Subject: Environmental Impact Statement Preparation Notice (EISPN) for Waahila "180" and Waahila "405" Reservoirs, Manoa, Oahu

Thank you for allowing us to review and comment on the subject EISPN. In preparation of an EIS of the subject project, the following concerns must be addressed:

1. The Environmental Impact Statement must address the stationary equipment noise from the reservoir that may adversely impact nearby residents.

2. Mitigative measures must be taken in order to minimize the adverse noise impacts resulting from possible blasting activities.

3. Construction activities must comply with the provisions of Title 11, Administrative Rules Chapter 43, Community Noise Control for Oahu.

   a. The contractor must obtain a noise permit if the noise levels from the construction activities are expected to exceed the allowable levels of the rules.

   b. Construction equipment and onsite vehicles or devices requiring an exhaust of gas or air must be equipped with a muffler.

   c. The contractor must comply with the conditional use of the permit as specified in the rules and conditions issued with the permit.

4. Traffic noise from heavy vehicles travelling to and from the construction site must be minimized near residential areas and schools, and must comply with the provisions of Title 11, Administrative Rules Chapter 42, Vehicular Noise Control for Oahu.

5. Should there be a baseyard located adjacent to residences or schools, mitigative measures, such as barriers or berms, must be developed in the event that noise complaints are received.

Bruce S. Anderson
BRUCE S. ANDERSON, Ph.D.

BOARD OF WATER SUPPLY
CITY AND COUNTY OF HONOLULU

COPY

March 8, 1988

Dr. Bruce S. Anderson
Deputy Director of
Environmental Health
Department of Health
State of Hawaii
P. O. Box 3378
Honolulu, Hawaii 96801

Dear Dr. Anderson:

Subject: Your Letter of February 17, 1988 on the EIS Preparation Notice for Waahila "180" and "405" Reservoirs

Thank you for commenting on the environmental assessment for our proposed reservoir projects.

Your concerns on various noise impacts and other pertinent impacts will be addressed in detail in the Draft EIS.

If you have any questions, please call Lawrence Whang at 527-6138.

Very truly yours,

KAZU HAYASHIDA
Manager and Chief Engineer

cc: Belt, Collins & Associates

BOARD OF WATER SUPPLY
CITY AND COUNTY OF HONOLULU

COPY

March 1, 1988

Mr. Roger A. Ulveling, Director
Department of Business and
Economic Development
State of Hawaii
P.O. Box 2359
Honolulu, Hawaii 96804

Dear Mr. Ulveling:

Subject: Your Letter of February 12, 1988 on the EIS Preparation Notice for Waahila "180" and "405" Reservoirs

Thank you for commenting on the environmental assessment for our proposed reservoir projects.

Your concerns on the various aspects that the project may have on the Hawaii Coastal Zone Management Program will be addressed in the EIS.

If you have any questions, please contact Lawrence Whang at 527-6138.

Very truly yours,

KAZU HAYASHIDA
Manager and Chief Engineer

cc: Belt, Collins and Associates

HOUSE OF REPRESENTATIVES
THE FOURTEENTH LEGISLATURE
STATE OF HAWAII
STATE CAPITOL
HONOLULU, HAWAII 96813

February 15, 1988

Mr. Lawrence Whang
Board of Water Supply
630 S. Beretania Street
Honolulu, HI 96813

RE: Environmental Impact Assessment for Manoa

Dear Mr. Whang:

My office is in receipt of your study on Waahila "180" and "405" Reservoirs for Manoa.

One of my concerns with regard to both of these proposed reservoirs is the current land movement problem which is occurring on Manoa's eastern hillside. Any additional strains placed on the land movement situation in the Woodlawn area would be devastating to the residents of the area. As Chairman of Higher Education and the Arts, I would also be concerned that there be no negative impact on the current faculty housing on Dole Street right below this project.

Thank you for allowing me the opportunity to comment on the proposed reservoirs. Please feel free to contact me at 548-6208 if I can be of further assistance to you.

Sincerely,

Brian T. Taniguchi
State Representative
27th District

cc: Marilyn Bornhorst

FEB 11 1 55 PM '88

BOARD OF WATER SUPPLY
CITY AND COUNTY OF HONOLULU

COPY

March 2, 1988

Honorable Brian T. Taniguchi
State Representative, 27th District
House of Representatives
State Capitol
Honolulu, Hawaii 96813

Dear Representative Taniguchi:

Subject: Your Letter of February 15, 1988 on the Environmental Impact Statement Preparation Notice for the Waahila "180" and "405" Reservoirs

Thank you for informing us of your concerns on our proposed reservoir project.

The reservoirs should not have any impact on the existing land movement in east Manoa or the faculty housing along Dole Street. The sites are within solid rock formation which shall be investigated thoroughly by our soil consultant during the design of the reservoirs.

If you have any questions, please contact Lawrence Whang at 527-6138.

Very truly yours,

KAZU HAYASHIDA
Manager and Chief Engineer

cc: Belt, Collins & Associates

RECEIVED
BOARD OF WATER SUPPLY
FEB 19 2 39 PM '88

The Senate
The Fourteenth Legislature
of the
State of Hawaii

STATE CAPITOL
HONOLULU, HAWAII 96813

February 19, 1988

Kazu Hayashida
Board of Water Supply
630 South Beretania Street
Honolulu, Hawaii 96843

SUBJECT: Environmental Impact Assessment for the Waahila "180" and "405" Resevoirs in Manoa, Oahu

Dear Mr. Hayashida:

I have reviewed the impact assessment results and conclusions. It appears that the anticipated impacts imposed by this project on the residents of Saint Louis Heights and the University of Hawaii dormitories and faculty housing have been adequately mitigated, in part due to the daytime work hours.

However, I fear that the noise from the construction activities (especially from the periodic blasting) that may disrupt the classes at Hokulani Elementary and the University of Hawaii (Holmes Hall, Oceanography Building) have not been sufficiently addressed in this report. These institutions are in the vicinity of Waahila Ridge and may be particularly susceptible.

As part of the future planning efforts of this project, please consider consultation with university and education officials on possible measures that would reduce the likelihood of this problem.

I appreciate the opportunity to comment on this report.

Sincerely,

Ann

Ann H. Kobayashi
Senator, 14th District

cc: Department of Education
University of Hawaii,
Vice-President of Student Affairs
Hokulani Elementary School

BOARD OF WATER SUPPLY
CITY AND COUNTY OF HONOLULU

COPY

March 1, 1988

Honorable Ann H. Kobayashi
Senator, 14th District
The Senate
State Capitol
Honolulu, Hawaii 96813

Dear Senator Kobayashi:

Subject: Your Letter of February 19, 1988 on the Environmental Assessment for the Waahila "180" and "405" Reservoirs .

Thank you for commenting on the environmental assessment for our proposed reservoir projects.

Your concerns on the possible disruption to classes at Hokulani Elementary and the University of Hawaii from periodic blasting will be addressed in the Environmental Impact Statement (EIS). The EIS will be coordinated with the University.

If you have any questions, please contact Lawrence Whang at 527-6138.

Very truly yours,

Kazu Hayashida

KAZU HAYASHIDA
Manager and Chief Engineer

cc: Belt, Collins & Associates

University of Hawaii at Manoa

Environmental Center
Crawford 317 • 2550 Campus Road
Honolulu, Hawaii 96822
Telephone (808) 948-7361

February 19, 1988
PN:0061

Mr. Kazu Hayashida
Board of Water Supply
City & County of Honolulu
630 South Beretania Street
Honolulu, Hawaii 96843

Dear Mr. Hayashida:

Preparation Notice
Environmental Impact Statement
Waahila Reservoirs
Waahila Ridge, Oahu

The proposed project involves the construction of two 4-million gallon (mg) reservoirs, an access road, transmission mains, instrument houses, landscaping, irrigation, and fencing on Waahila Ridge. The placement of reservoirs would require the removal of up to 200,000 cubic yards of rock and soil from a relatively steep hillside behind the University of Hawaii's faculty housing facility. The Environmental Center has conducted a review of this document with the assistance of Yu-Si Fok and Edwin Murabayashi, Water Resources Research Center; George Taoka and Paul Hummel, Civil Engineering; and Jennifer Crummer, Environmental Center.

Alternatives

Current Board of Water Supply standards require nearly 300% of the total reservoir capacity for Honolulu District that would be achieved upon completion of the proposed project. With the proposed new reservoirs, the total Honolulu District capacity would be 52.81 mg, or 77.19 mg short of the 130 mg capacity which represented standard equivalence in 1986. The cost estimate for construction of an additional 8 mg of capacity is $15,000,000. By extrapolation, the total cost of meeting the 1986 reservoir capacity standard would be on the order of $145,000,000. Furthermore, it is not apparent that sufficient suitable sites are available in order to construct the additional reservoirs that would be required to meet the BWS standards. Given these economic and logistic considerations, we question the degree of realism inherent in the BWS standards. If the substantive issue motivating the standard of reservoir capacity is concern over loss of electrical power, it would seem more cost effective to install auxiliary electrical generators at well sites than to undertake a massive reservoir construction program. In view of the substantial environmental impacts of noise, fugitive dust, traffic, and

risk of soil erosion generated by the proposed project, we would urge the Board of Water Supply to reconsider their strategy for water resource distribution during general power failures.

Traffic

Our reviewers have calculated that the proposed project will result in heavy trucks transiting the area at a rate of about 1 truck every 7 or 8 minutes. Given the normal daily traffic load in the region, it is certain that many complaints will arise from the community regarding the increased level of traffic.

Additionally, concerns have been raised concerning the road design from Dole Street to the reservoirs. A steep road may not be suitable for the hauling of excavated material. Perhaps a switch-back type of road would provide a safer and more stable route for transport.

As an alternative to transporting the ecavated material through the community, it may be more cost effective to replace the excavated soil and rock on the site in such a manner as to aid in slowing storm water runoff or as site preparation fill for additional faculty housing.

Water Pipelines

It appears 24-inch pipes of the reservoirs will be feeding existing 20-inch pipes of the main waterline. Would it not be sufficient to use pipes of matched diameter? Our concern here regards pressure and maintenance problems that may result from mismatched pipelines. It should be specified in the Draft Environmental Impact Statement (EIS) whether there are intentions to upgrade the existing 20-inch pipeline in the near future.

University Faculty Housing

Anticipated impacts upon the faculty housing units, specifically with regard to noise and traffic generated from the project, should be included in the Draft EIS.

We thank you for the opportunity to review this document. We look forward to your response and consideration of our comments in the Draft EIS.

Yours truly,

John T. Harrison, Ph.D.
Environmental Coordinator

cc: OEQC
L. Stephen Lau
Y.S. Fok
Paul Hummel
Edwin Murabayashi
George Taoka
Jennifer Crummer

BOARD OF WATER SUPPLY
CITY AND COUNTY OF HONOLULU

March 2, 1988

Dr. John T. Harrison
Environmental Coordinator
Environmental Center
University of Hawaii at Manoa
2550 Campus Road, Crawford 317
Honolulu, Hawaii 96822

Dear Dr. Harrison:

Subject: Your Letter of February 19, 1988 on the EIS Preparation Notice for Waahila "180" and "405" Reservoirs

Thank you for commenting on the environmental assessment for our proposed reservoir project.

A more detailed discussion will be provided in the Draft EIS on alternative actions such as installing auxiliary electrical generators at well sites. Besides providing water during power outages, reservoirs are also needed for firefighting and to stablize pressures and supply water during peak demand periods.

Additional discussion on traffic impacts, pipeline hydraulics, and impacts to the University Faculty Housing will be included in the Draft EIS.

If you have any questions, please contact Lawrence Whang at 527-6138.

Very truly yours,

KAZU HAYASHIDA
Manager and Chief Engineer

cc: Belt, Collins and Associates

CORY

February 11, 1988

Mr. John Harrison
Environmental Center
University of Hawaii

REFERENCE: Evaluation of the Environmental Impact Assessment for the Waahila "180" and "405" Reservoirs

Dear. Mr. Harrison:

The following evaluation and comments are presented within the confines of the charge that you have presented to me in your letter of February 3, 1988. These charges were "We would appreciate your evaluation of the adequacy of the attached assessment to describe the potential impacts of the project and the appropriateness of the negative determination. In this regard, assessments of the advisability of the action as well as potential environmental and socioeconomic impacts of the proposed action are warranted.

I have reviewed the above named document as well as the Geolab-Hawaii foundation reports prepared for this project. My evaluation and comments are as follows:

1. The recommendations for foundations are not only adequate but are probably very conservative. If built according to the recommendations, the structure would be very safe and functional over the period of service required of it.

2. The most notable aspect of this project is the projected removal of up to 200,000 cubic yards of rock and soil by an estimated 25,000 truck loads to dispose of it. (see Section 2.3, Page 7)

The value of the disposed material may range up to about ten dollars per yard. I seriously question the need for removal of this material from the site. I propose that more study be conducted to properly plan the placement of the excavated soil and rock on site. With but a fraction of the cost for removal, the excavated material can be placed in an attractive and beneficial manner.

For example, it could be placed to aid in slowing storm water runoff to contribute to flood control. Or, it could be placed in a manner to fit a master plan for development of faculty housing. As an aside, faculty housing (lack thereof) is perhaps the most neglected part of the development program for the University of Hawaii. It has the potential to yield the greatest cost-benefit ratio of any money invested in the University of Hawaii system and with enormous intangible benefits for faculty recruitment and retention.

I congratulate the Board of Water Supply for the vision and careful planning that has gone into this proposed development. Honolulu is truly blessed with one of the best water supply systems in the world. A few noisy, anti-development individuals should not be allowed to stop this development that has been and is being so carefully planned for the benefit of our total Honolulu population. These benefits include more reliable service, better fire protection, and more economical delivery of water for all of us.

Respectfully submitted by,

Paul L. Hummel

Paul L. Hummel, PhD.
Department of Civil Engineering
University of Hawaii

cc: Lawrence Whang, Honolulu Board of Water Supply
Belt Collins & Associates

UNIVERSITY OF HAWAII

Procurement and Property Management Office

February 17, 1988

Kazu Hayashida
Manager and Chief Engineer
Board of Water Supply
City and County of Honolulu
630 South Beretania Street
Honolulu, Hawaii 96843

Dear Mr. Hayashida:

Subject: Environmental Impact Statement Preparation Notice for Waahila "180" and Waahila "405" Reservoirs, TMK:3-3-56: Por. 1 and 2

In response to your January 20, 1988 request, the University of Hawaii has reviewed the environmental impact assessment for the proposed reservoirs. Based upon this review, we feel that all of the listed items (noise, air, soil erosion and loose rocks, traffic) in Section 4.1.1, "Short Term Impacts During Construction," need to be addressed in greater detail in the environmental impact statement. Furthermore, we submit the following comments:

1. An alternate route for the proposed construction access road should be explored. The length of the construction period and the projected construction traffic will create an unacceptable condition at the proposed location. The mixture of construction vehicles, faculty and staff vehicles will cause a potentially hazardous condition since the current roadway was not designed for this mix. If an alternate route is not feasible, the present roadway should be widened for construction purposes, adequate traffic control procedures should be instituted, and the roadway should be resurfaced/repaired after the completion of the project.

2. The effects of surface drainage during the construction phase need to be addressed to avoid flooding in the University's faculty housing complex. The temporary access road constructed during the study period caused some problems with water runoffs during the recent heavy rains.

1400 Lower Campus Road, Room 15 • Honolulu, Hawaii 96822 Cable Address: UNIHAW
An Equal Opportunity Employer

3. All air quality controls should be in effect 7 days per week, 24 hours per day. The lack of air conditioning in the faculty housing units will require that all dust be controlled to avoid problems with the faculty tenants.

4. The noise/dust/traffic impact of this project should not be permitted to cause the displacement of tenants in the faculty housing units.

5. Earlier studies done by the Board of Water Supply proposed a lined reservoir to address the aesthetic problems of a tank. There should be an explanation on why this alternative is not feasible at the present time.

6. The environmental impact statement should address whether these reservoirs will preclude or otherwise restrict the future development of the faculty housing site (e.g. the construction of highrise facilities).

7. The loss of parking spaces on Dole Street will have major impact on the surrounding neighborhood, especially if the effects are compounded with further losses of parking spaces on the main campus due to proposed building construction. The environmental impact statement should study this issue further.

Please send us a copy of the draft environmental impact statement for our further review and comment. If you have any questions concerning this matter, please contact me.

Very truly yours,

Edward Yuen
Director

EY:DZ:kh

BOARD OF WATER SUPPLY
CITY AND COUNTY OF HONOLULU

COPY

March 1, 1988

Mr. Edward Yuen, Director
Procurement and Property
Management Office
University of Hawaii
1400 Lower Campus Road,
Room 15
Honolulu, Hawaii 96822

Dear Mr. Yuen:

Subject: Your Letter of February 19, 1988 on the EIS Preparation Notice for Waahila "180" and "405" Reservoirs

Thank you for commenting on the environmental assessment for our proposed reservoir project.

Your concerns on traffic, surface drainage, air quality, parking, and other pertinent impacts will be discussed in more detail in the Draft EIS. A copy of the Draft EIS will be sent to you for your review and comments.

If you have any questions, please call Lawrence Whang at 527-6138.

Very truly yours,

KAZU HAYASHIDA
Manager and Chief Engineer

cc: Belt, Collins and Associates

University of Hawaii at Manoa

University Housing Office
Johnson Hall A Basement • 2555 Dole Street, Honolulu, Hawaii 96822 • Cable Address: UNIHAW

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BD. OF WATER SUPPLY
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February 11, 1988

Mr. Kazu Hayashida
Manager and Chief Engineer
Board of Water Supply
City and County of Honolulu
630 South Beretania Street
Honolulu, Hawaii 96843

Dear Mr. Hayashida:

This is being written in response to your letter of January 20, 1988, concerning the Environmental Impact Statement Preparation Notice for Waahila "180" and Waahila "405" Reservoirs, TMK: 3-3-56:. Por. 1 and 2.

Thank you for giving us the opportunity to review and comment on this proposed project.

Due to the location of this project, it is anticipated that there will be considerable impact upon residential facilities operated by the University. These include the Faculty Housing units and the Student Housing units. Our concern has to do with the increased vehicular and construction equipment traffic and the noise disturbance to students and faculty members of the University. This would be especially disturbing during the final exam study periods each semester during the project's construction. There are approximately 1,800 students residing in various dormitory/residence hall units that would be affected.

The impact on the traffic along Dole Street which is one of the major vehicular access routes to and from the Univerity's campus would be a major concern to many individuals not living on campus. This street is heavily used during daytime hours.

While other major projects have been and will be undertaken which impact the University community, there are few which must take two years to complete as is anticipated with this project. The need for the project which seems to involve extended power outages raises the question of the possibility of eliminating any such extended power outages by other methods (i.e., electrical safety measures, etc.) if at all feasible.

Your environmental impact assessment study is very well done and seems to take into account the various positive and negative factors for this project.

Sincerely yours,

James M. Burgoyne
Director

ds

cc: Vice President Doris Ching
Vice President Ralph Horii

BOARD OF WATER SUPPLY
CITY AND COUNTY OF HONOLULU

CORY

March 8, 1988

Mr. James M. Burgoyne, Director
University of Hawaii at Manoa
University Housing Office
Johnson Hall A Basement
2555 Dole Street
Honolulu, Hawaii 96822

Dear Mr. Burgoyne:

Subject: Your Letter of February 11, 1988 on the EIS Preparation Notice for Waahila "180" and "405" Reservoirs

Thank you for commenting on the environmental assessment for our proposed reservoir project.

Your concerns on traffic and noise impacts upon University facilities will be addressed in the EIS.

The reservoirs are required for firefighting, stabilizing system pressures, meeting peak demand, and providing water during power outages. The reference to power outages in the environmental assessment applies to only a part of the need for the reservoirs.

If you have any questions, please contact Lawrence Whang at 527-6138.

Very truly yours,

KAZU HAYASHIDA
Manager and Chief Engineer

cc: Belt, Collins and Associates

DEPARTMENT OF LAND UTILIZATION
CITY AND COUNTY OF HONOLULU
650 SOUTH KING STREET
HONOLULU, HAWAII 96813 ☎ (808) 523-4432

FRANK F. FASI
MAYOR

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JOHN P. WHALEN
DIRECTOR

LU1/88-465(BM)

February 12, 1988

MEMORANDUM

TO: KAZU HAYASHIDA, MANAGER & CHIEF ENGINEER
BOARD OF WATER SUPPLY

FROM: JOHN P. WHALEN, DIRECTOR

SUBJECT: ENVIRONMENTAL IMPACT STATEMENT PREPARATION NOTICE (EISPN)
FOR WAAHILA "180" AND WAAHILA "405" RESERVOIRS
TAX MAP KEY: 3-3-56: PORTION 1 AND 2

We have reviewed your January 20, 1988 request for review and consultation comments. In order for the EA or EIS to properly describe the environmental effects of the proposed action, we suggest the following:

1. Drainage

The volume (in cfs) of the runoff from the site should be compared to the volume of the runoff from the drainage basin that the project is located within. A plan showing the project site and the drainage basin that the project is located within would be appropriate.

2. View Analysis

A detailed view analysis would be appropriate. The City's Coastal View Study identifies the area that the project is located within as an "Important Coastal Landform." As such, it would be appropriate to determine the visual impact that the reservoirs and the cuts into the mountainside will have as they are viewed from Dole Street, St. Louis heights, and from other more distant areas such as Kaimuki, Kapahulu, and Moiliili. We suggest that photo-montage be used, overlaying the proposed project and associated cuts on photographs of the existing site.

Thank you for the opportunity to comment. If you have any questions, please contact Bennett Mark of our staff at 527-5038.

JOHN P. WHALEN
Director of Land Utilization

JPW:sl
1626B

BOARD OF WATER SUPPLY
CITY AND COUNTY OF HONOLULU

COPY

February 24, 1988

TO: JOHN P. WHALEN, DIRECTOR
DEPARTMENT OF LAND UTILIZATION

FROM: KAZU HAYASHIDA, MANAGER AND CHIEF ENGINEER
BOARD OF WATER SUPPLY

SUBJECT: YOUR LETTER DATED FEBRUARY 12, 1988 COMMENTING ON THE ENVIRONMENTAL IMPACT STATEMENT PREPARATION NOTICE (EISPN) FOR WAAHILA "180" AND "405" RESERVOIRS

Thank you for reviewing and commenting on the EISPN.

The Draft EIS will address runoff from the proposed construction site.

The use of photo-montage to analyze the view of the proposed reservoirs from various locations has already been initiated by our EIS consultant.

If you have any questions, please contact Lawrence Whang at 527-6138.

cc: Belt, Collins and Associates

FIRE DEPARTMENT
CITY AND COUNTY OF HONOLULU
1455 S. BERETANIA STREET, ROOM 305
HONOLULU, HAWAII 96814

FRANK F. FASI
MAYOR

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FRANK K. KAHOOHANOHANO
FIRE CHIEF

LIONEL E. CAMARA
DEPUTY FIRE CHIEF

February 29, 1988

TO: KAZU HAYASHIDA, MANAGER AND CHIEF ENGINEER
BOARD OF WATER SUPPLY

ATTN: LAWRENCE WHANG

FROM: FRANK K. KAHOOHANOHANO, FIRE CHIEF

SUBJECT: ENVIRONMENTAL IMPACT STATEMENT PREPARATION NOTICE
FOR WAAHILA "180" AND WAAHILA "405" RESERVOIRS
TMK: 3-3-56: POR. 1 AND 2

We have reviewed the materials provided and are in favor of the proposal. The improvement will have a positive impact on fire protection services now provided.

We request a Fire Department connection with either a 2-1/2" or 4-1/2" outlet be provided at each reservoir for firefighting capability within the surrounding area.

We also request immediate notification to the Fire Alarm Bureau, phone 523-4376, in the event of street closures or reduced access for fire apparatus during the construction and pipeline installation phase. Notification is also requested for hydrants placed out of commission within the project boundary.

We apologize for our delayed response and hope it has not inconvenienced you. Should you have any questions, please contact Battalion Chief Kenneth Word of our Administrative Services Bureau at 943-3838.

Frank K. Kahoohanohano
FRANK K. KAHOOHANOHANO
Fire Chief

FKK/KAH:lm

BOARD OF WATER SUPPLY
CITY AND COUNTY OF HONOLULU

COPY

March 15, 1988

TO: FRANK K. KAHOOHANOHANO, FIRE CHIEF
FIRE DEPARTMENT

FROM: KAZU HAYASHIDA, MANAGER AND CHIEF ENGINEER
BOARD OF WATER SUPPLY

SUBJECT: YOUR LETTER OF FEBRUARY 29, 1988 ON THE ENVIRONMENTAL IMPACT STATEMENT (EIS) PREPARATION NOTICE FOR WAAHILA "180" AND "405" RESERVOIRS

Thank you for commenting on the environmental assessment for our proposed project.

We will note in the Draft EIS the need for a standard fire hydrant at each reservoir site. The notification to the Fire Alarm Bureau will be noted on the construction drawings.

If you have any questions, please contact Lawrence Whang at 527-6138.

cc: Belt, Collins & Associates

POLICE DEPARTMENT
CITY AND COUNTY OF HONOLULU
1455 SOUTH BERETANIA STREET
HONOLULU, HAWAII 96814 - AREA CODE (808) 943-3111

FRANK F. FASI
MAYOR

DOUGLAS G. GIBB
CHIEF

MARVIN S. DANG
DEPUTY CHIEF

OUR REFERENCE JH-LK

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February 4, 1988

TO: KAZU HAYASHIDA, MANAGER AND CHIEF ENGINEER
BOARD OF WATER SUPPLY

FROM: DOUGLAS G. GIBB, CHIEF OF POLICE
HONOLULU POLICE DEPARTMENT

SUBJECT: ENVIRONMENTAL IMPACT STATEMENT PREPARATION NOTICE
FOR WAAHILA "180" AND WAAHILA "405" RESERVOIRS
TMK: 3-3-56: POR. 1 AND 2

We have reviewed the Waahila "180" and "405" environmental impact statement and have the following comment.

As stated, traffic along Dole Street, St. Louis Drive, and at the St. Louis Drive/Waialae Avenue intersection will be affected by the installation of the water main.

As Dole Street is traditionally busy due to University of Hawaii traffic, we would re-emphasize the need to use signs, barricades, and flagpersons to insure the ease and safety of motorists and pedestrians during construction.

for DOUGLAS G. GIBB
Chief of Police

BOARD OF WATER SUPPLY
CITY AND COUNTY OF HONOLULU

COPY

February 11, 1988

TO: DOUGLAS G. GIBB, CHIEF OF POLICE
HONOLULU POLICE DEPARTMENT

ATTN: KAZU HAYASHIDA, MANAGER AND CHIEF ENGINEER
BOARD OF WATER SUPPLY

SUBJECT: YOUR MEMORANDUM OF FEBRUARY 4, 1988 ON THE ENVIRONMENTAL IMPACT STATEMENT PREPARATION NOTICE FOR WAAHILA "180" AND WAAHILA "405" RESERVOIRS, TMK: 3-3-56: POR. 1 AND 2

Thank you for commenting on our environmental impact assessment for our proposed reservoirs and appurtenant pipelines.

The contractor will be required to install signs and barricades and to use flagpersons to insure the safety of motorists and pedestrians along the affected streets during construction.

If you have any questions, please contact Lawrence Whang at 527-6138.

cc: Belt, Collins & Associates

Hawaiian Electric Company, Inc. • PO Box 2750 • Honolulu, HI 96840 0001

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ENV 2-1
JA/G

Brenner Munger Ph D PE
Manager
Environmental Department
(808) 548 6880

February 23, 1988

Mr. Kazu Hayashida
Manager and Chief Engineer
City and County of Honolulu
Board of Water Supply
670 South Beretani St.
Honolulu, HI 96843

Dear Mr. Hayashida:

Subject: Environmental Impact Statement Preparation Notice for Waahila "180" and Waahila "405" Reservoirs, Manoa, Oahu, Hawaii

There are no existing HECO 138KV transmission lines crossing or in proximity to the proposed reservoirs and pipelines. However, the route for the proposed Pukele-Kamoku 138KV transmission line may be affected.

Sincerely,

Brenner Munger

BOARD OF WATER SUPPLY
CITY AND COUNTY OF HONOLULU

COPY

March 9, 1988

Dr. Brenner Munger
Manager, Environmental Department
Hawaiian Electric Company, Inc.
P. O. Box 2750
Honolulu, Hawaii 96840

Dear Dr. Munger:

Subject: Your Letter of February 23, 1988 on the Environmental Impact Statement Preparation Notice for Waahila "180" and "405" Reservoirs

Thank you for commenting on the environmental assessment for our proposed reservoir project.

We will coordinate the construction drawings with HECO to ensure that the proposed reservoir projects will not conflict with your Pukele-Kamoku 138 KV transmission line project.

If you have any questions, please contact Lawrence Whang at 527-6138.

Very truly yours,

KAZU HAYASHIDA
Manager and Chief Engineer

cc: Belt, Collins & Associates

HAWAIIAN TEL GTE

[illegible]
[illegible]
[illegible] 546-4511

RECEIVED
BOARD OF WATER SUPPLY
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February 25, 1988

Mr. Kazu Hayashida
Manager and Chief Engineer
Board of Water Supply
City and County of Honolulu
630 South Beretania Street
Honolulu, Hawaii 96843

Dear Mr. Hayashida:

Environmental Impact Statement Preparation
Notice for Waahila "180" and Waahila "405"
Reservoirs, TMK 3-3-56: Por. 1&2

We have reviewed the above-referenced EIS and anticipate no impact on the community or the environment.

To insure that Hawaiian Tel facilities do not conflict with the project, please submit construction plans to this office as telephone services or telemetering lines are identified. This information should be forwarded at the earliest possible date.

Thank you for the opportunity to comment on the project. Should there be any questions, please call Supervising Engineer Ron Tibayan at 834-6220.

Sincerely,

Walter M. Matsumoto
Oahu Engineering &
Construction Manager

BOARD OF WATER SUPPLY
CITY AND COUNTY OF HONOLULU

COPY

March 9, 1988

Mr. Walter M. Matsumoto
Oahu Engineering and
Construction Manager
Hawaiian Telephone Company
P. O. Box 2200
Honolulu, Hawaii 96841

Dear Mr. Matsumoto:

Subject: Your Letter of February 25, 1988 on the EIS Preparation Notice for Waahila "180" and "405" Reservoirs

Thank you for commenting on the environmental assessment for our proposed reservoir project.

We will submit for your review the construction drawings for the proposed project showing the telephone and telemetering lines.

If you have any questions, please contact Lawrence Whang at 527-6138.

Very truly yours,

KAZU HAYASHIDA
Manager and Chief Engineer

cc: Belt, Collins & Associates

PRI Gasco, Inc.
A Pacific Resources, Inc. Company

PRI Tower 733 Bishop Street
P.O. Box 3379 Honolulu, Hawaii 96842
Telephone 808 547-3333 Telex 7430292

February 19, 1988

RECEIVED
BD OF WATER SUPPLY
FEB 23 9 07 AM '88

Board of Water Supply
City and County of Honolulu
630 South Beretania Street
Honolulu, Hawaii 96813

Attention: Mr. Kazu Hayashida
Manager and Chief Engineer

Gentlemen:

Subject: Environmental Impact Statement
Preparation Notice for
Waahila "180" and Waahila "405" Reservoirs
Tax Map Key: 3-3-56: Por. 1 and 2

We refer to your letter of January 20, 1988, regarding our review and comment for the subject water system improvement project.

Gasco, Inc. currently has an underground gas utility system in the project area which serves the University area and is interconnected with the utility network in the bordering areas. We would appreciate the consideration of your planners and consultants during the project planning and design process to minimize the conflicts with the proposed water main and to establish the necessary coordination during construction.

Thank you for the opportunity to comment on the proposed water system improvements project. Should there be any questions, or if additional information is desired, please call me at 547-3574.

Very truly yours,

David Y. Morikawa
Supervisor,
Engineering and Projects

DYM:nsd

BOARD OF WATER SUPPLY
CITY AND COUNTY OF HONOLULU

COPY

March 1, 1988

Mr. David Y. Morikawa
Supervisor, Engineering and Projects
PRI Gasco, Inc.
P.O. Box 3379
Honolulu, Hawaii 96842

Dear Mr. Morikawa:

Subject: Your Letter of February 19, 1988 on the EIS Preparation Notice for Waahila "180" and "405" Reservoirs

Thank you for commenting on the environmental assessment for our proposed reservoir projects.

We will note in the Draft EIS that Gasco, Inc. has underground gas utility lines within the project and surrounding areas. Our construction plans will be coordinated with you to minimize conflicts with Gasco's system.

If you have any questions, please contact Lawrence Whang at 527-6138.

Very truly yours,

KAZU HAYASHIDA
Manager and Chief Engineer

cc: Belt, Collins and Associates

FINAL ENVIRONMENTAL IMPACT STATEMENT

OFFICIAL DOCUMENTS

AND

COMMENTS ON THE DRAFT EIS

mauka edge of the Alii Highway right-of-way adjacent to the Holua side. The Royal Holua Slide is listed on the National Register of Historic Places. A retaining wall would be constructed below the Holua Slide for stabilization along the cut embankment of the Alii Highway right-of-way.

The existing golf pro shop in the clubhouse located makai of the Alii Highway would be expanded by approximately 690 sq. ft. of floor area.

The estimated cost is $5.1 million.

KAUAI

FINDING OF NO SIGNIFICANT IMPACT (FONSI) PILOT TEST TO ERADICATE THE MEDITERRANEAN FRUIT FLY. Kauai and Niihau; U.S. Department of Agriculture

A pilot test is planned for the islands of Kauai and Niihau to eliminate the Mediterranean fruit fly by use of the sterile insect technique (SIT).

The objectives of the test will be to (1) determine whether a 50 to 1 overflooding ratio of sterile to wild flies is adequate to initiate and maintain a theoretically projected downward rate in the reproductive potential of the medfly, and (2) demonstrate eradication of an entrenched population of the medfly with the SIT.

The flies will be reared on Oahu and shipped as sterile pupae to Kauai where they will be held for eclosion and aerial distribution. Preliminary marked release-recapture studies will be carried out beforehand to estimate the size of the medfly population on Kauai which at present is known to be small.

Fixed wing aircraft will be used for sterile fly distribution because of economics; however, if necessary, distribution will be supplemented by use of ground releases or even by helicopter where warranted.

DRAFT ENVIRONMENTAL IMPACT STATEMENTS

EISs listed in this section are available for review at the following public depositories: Office of Environmental Quality Control; Legislative Reference Bureau; Municipal Reference and Records Center (Oahu EISs); Hamilton Library; State Main Library and the Kaimuki, Kaneohe, Pearl City, Hilo, Wailuku and Lihue Regional Libraries. Statements are also available at State Branch Libraries that are in proximity to the site of a proposed action (indicated by project description).

Comments on the following EISs should be sent to: 1) the accepting authority; and 2) the proposing agency. Please note the deadline date for submitting written comments on the EIS.

OAHU

WAAHILA 180 AND WAAHILA 405 RESERVOIRS Honolulu, Oahu; Board of Water Supply, City and County of Honolulu/ Governor, State of Hawaii (TMK: 3-3-56: Por. 1 & 2)

The proposed Waahila 180 and Waahila 405 Reservoirs will be constructed on the hillside above the University of Hawaii Waahila Faculty Apartments on Dole Street.

The proposed project includes the construction of two 4.0 million gallons concrete reservoirs, 190 feet in diameter by 22 feet in height.

The reservoir access road and two 24-inch pipelines, one to connect the upper reservoir to the high service line on Dole Street, and the second to connect to the low service line on Wailalae Avenue are also included in the project.

Reservoirs are used to meet fire flow requirements, peak demands, and to provide water during power outages.

The Board of Water Supply standard calls for a total storage capacity of 1.5 times average daily use. Eighty-five (85) million gallons of additional storage is still required of which the proposed 8 million gallons of storage will help to alleviate this shortage.

Contact: Lawrence Whang
Board of Water Supply
City & County of Honolulu
630 So. Beretania St.
Honolulu, Hawaii 96843

Deadline: June 7, 1989

LANIKAI FLOOD CONTROL PROJECT, Koolaupoko, Oahu; Dept. of Public Works, City & County of Honolulu/ Dept. of Land Utilization, City & County of Honolulu (TMK: 4-3-01 thru 05)

Previously published March 23, 1989

Contact: Mr. Chew Lun Lau
Dept. of Public Works
City & County of Honolulu
650 So. King Street
Honolulu, Hawaii 96813

Deadline: May 8, 1989

WAIKIKI LANDMARK, Waikiki, Oahu; Bel-Landmark, Inc./ Dept. of Land Utilization, City & County of Honolulu (TMK: 2-16-14: Parcels 39,41,43,44,49,50,52-56,59)

Previously published March 23, 1989

Contact: DHM, Inc.
Diane E. Borchardt
1188 Bishop St., Suite 2405
Honolulu, Hawaii 96813

Deadline: May 8, 1989

HAWAII

WAILUKU RIVER HYDROELECTRIC PROJECT, South Hilo, Hawaii; Kahala Energy Development/ State Dept. of Land & Natural Resources (TMK: 2-6-18;2-5-8;2-5-9)

Previously published April 8, 1989

Contact: Mrs. Jacqueline Parnell
KRP Information Services
320 Ward S. 106
Honolulu, Hawaii 96814

Deadline: May 23, 1989

WEST HAWAII LANDFILL, North Kona, Hawaii; Dept. of Public Works, County of Hawaii/Mayor, County of Hawaii (TMK: 7-1-02:01)

Previously published March 23, 1989

Contact: Colette M. Sakoda
Senior Planner
R. M. Towill Corporation
420 Waiakamilo Road, S. 411
Honolulu, Hawaii 96817

Deadline: May 8, 1989

P-476/89

DEPARTMENT OF THE ARMY
U.S. ARMY ENGINEER DISTRICT, HONOLULU
BUILDING 230
FT SHAFTER, HAWAII 96858-5440

REPLY TO ATTENTION OF:

May 24, 1989

Planning Branch

Dr. Marvin T. Miura
Director
Office of Environmental Quality Control
465 South King Street, Room 104
Honolulu, Hawaii 96813

Dear Dr. Miura:

Thank you for the opportunity to review the Draft Environmental Impact Statement (DEIS) for the proposed Waahila 180 and Waahila 405 Reservoirs, Manoa, Oahu. As noted in our review comments on the Environmental Assessment (letter dated February 12, 1988), a Department of the Army permit is not required for this project. We have no additional comments on the DEIS.

Sincerely,

Clarence Fujii
Acting Chief
Engineering Division

Copy furnished:

Mr. Lawrence Whang
Honolulu Board of Water Supply
City and County of Honolulu
630 South Beretania Street
Honolulu, Hawaii 96813

JUN 5 8 27 AM '89

United States Department of the Interior
FISH AND WILDLIFE SERVICE
300 ALA MOANA BOULEVARD
P O BOX 50167
HONOLULU, HAWAII 96850

RECEIVED
BD OF WATER SUPPLY
MAY 8 11 46 AM '89

IN REPLY REFER TO:
ES
Room 6307
MAY 05 1989

PE

Dr. Marvin T. Miura
Director, Office of Environmental Quality Control
465 South King Street, Room 104
Honolulu, Hawaii 96813

Re: Draft Environmental Impact Statement, Waahila "180" and Waahila "405" Reservoirs, Honolulu, Hawaii

Dear Dr. Miura:

We have reviewed the referenced Environmental Impact Statement, and have no additional comments at this time.

We appreciate this opportunity to comment.

Sincerely yours,

Ernest Kosaka
Ernest Kosaka
Field Office Supervisor
Environmental Services

cc: Honolulu Board of Water Supply

MAY 5 / 55 AM '89

CONSERVE AMERICA'S ENERGY

Save Energy and You Serve America!

DEPARTMENT OF THE NAVY
COMMANDER
NAVAL BASE PEARL HARBOR
BOX 110
PEARL HARBOR, HAWAII 96860-5020

P-359/89
IN REPLY REFER TO

5090 (1488)
Ser 032/1075
28 Apr 1989

MAY 4 8 17 AM '89

Dr. Marvin T. Miura
Office of Environmental Quality Control
465 S. King St., Room 104
Honolulu, HI 96813

Dear Dr. Miura:

WAAHILA 180 AND WAAHILA 405 RESERVOIRS, MANOA, OAHU

The Draft Environmental Impact Statement (DEIS) for the Waahila 180 and Waahila 405 Reservoirs, Manoa, Oahu, has been reviewed, and we have no comments to offer. Since we have no further use for the DEIS, it is being returned.

Thank you for the opportunity to review the draft.

Sincerely,

W. R. IRU
Assistant Base Civil Engineer
By direction of
the Commander

Encl
DEIS

Copy to:
Honolulu Board of Water Supply

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PE

East-West Center

Office of the Vice President for Administration

1777 EAST-WEST ROAD HONOLULU, HAWAII 96848 CABLE EASTWEST TELEX 723572

May 30, 1989

Mr. Kazu Hayashida
Manager and Chief Engineer
Board of Water Supply
City & County of Honolulu
630 South Beretania Street
Honolulu, HI 96813

Dear Mr. Hayashida:

Subject: Draft Environmental Impact Statement for
The Waahila 180 and Waahila 405 Reservoirs
TMK: 3-3-56:por. 1 & 2

We have no objections to the construction of the Waahila 180 and Waahila 405 Reservoirs as described in the Draft Environmental Impact Statement.

Thank you for the opportunity to provide comments.

Sincerely,

Wesley T. Park
Vice President for Administration

890930

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(P)1394.9

MAY 2 1989

Dr. Marvin Miura
Director
Office of Environmental
Quality Control
465 South King Street, Room 104
Honolulu, Hawaii 96814

Dear Dr. Miura:

Subject: Waahila "180" & Waahila "405" Reservoirs
Draft Environmental Impact Statement

Thank you for the opportunity to review the subject document. We have no comments to offer.

Should there be any questions, please have your staff contact Mr. Cedric Takamoto of the Planning Branch at 548-7192.

Very truly yours,

T. Tominaga

TEUANE TOMINAGA
State Public Works Engineer

CT:jnt
cc: Board of Water Supply

P-537/89

JUN 14 7 37 PM '89

June 8, 1989

Dr. Marvin T. Miura, Director
Office of Environmental Quality Control
465 South King Street
Suite 104
Honolulu, Hawaii 96813

Dear Dr. Miura:

Subject: Draft Environmental Impact Statement (DEIS)
Waahila "180" and Waahila "405" Reservoirs
TMK: 3-3-56: por. 1 & 2
Manoa, Oahu

The Department of Agriculture has reviewed the subject DEIS and has no comments to offer.

Thank you for the opportunity to comment.

Sincerely,

Yukio Kitagawa

YUKIO KITAGAWA
Chairperson, Board of Agriculture

cc: Honolulu Board of Water Supply

P-410/89

89:PLNG/1614B JT

May 3, 1989

Mar 16 11 10 AM '89

MEMORANDUM

TO: Dr. Marvin T. Miura, Director
Office of Environmental Quality Control

FROM: Joseph K. Conant

SUBJECT: Draft EIS for the Waahila "180" and "405" Reservoirs

Thank you for the opportunity to review the enclosed draft EIS. We have no comments to offer.

ORIGINAL SIGNED

JOSEPH K. CONANT
Executive Director

cc: Honolulu Board of Water Supply

P-444/89

STATE OF HAWAII
DEPARTMENT OF DEFENSE
OFFICE OF THE ADJUTANT GENERAL
3949 DIAMOND HEAD ROAD, HONOLULU, HAWAII 96816-4495

Mar 23 9 32 AM '89

May 1, 1989

HIENG

Dr. Marvin T. Miura, Director
Office of Environmental Quality Control
465 South King Street, Room 104
Honolulu, Hawaii 96813

Dear Dr. Miura:

Waahila "180" and Waahila "405"
Honolulu, Hawaii

Thank you for providing us the opportunity to review the above subject project.

We have no comments to offer at this time regarding this project.

Sincerely,

Jerry M. Matsuda
Major, Hawaii Air
National Guard
Contracting & Engineering Officer

cc:
Mr. Lawrence Whang
Honolulu Board of Water Supply

NATIONAL GUARD

P-452/89

JOHN WAIHEE
GOVERNOR OF HAWAII

STATE OF HAWAII
DEPARTMENT OF HEALTH
P. O. BOX 3378
HONOLULU, HAWAII 96801

JOHN C. LEWIN, M.D.
DIRECTOR OF HEALTH

In reply, please refer to:
EPHSO

May 15, 1989

MAY 24 8 27 AM '89

MEMORANDUM

To: Dr. Marvin T. Miura, Director
Office of Environmental Quality Control

From: Deputy Director for Environmental Health

Subject: Draft Environmental Impact Statement (DEIS) for the Waahila 100 and Waahila 405 Reservoirs, Manoa, Oahu, TMK 3-3-56: Por. 1 & 2

Thank you for allowing us to review and comment on the subject DEIS. The following concern addressed on the earlier comments was not included in the DEIS:

Noise from stationary equipment at the reservoir, such as generators, pumps, and air conditioning/exhaust fans, which may adversely impact nearby residents.

BRUCE S. ANDERSON, PH.D.

cc: Honolulu Board of Water Supply ✓

June 14, 1989

Bruce S. Anderson, Ph.D.
Deputy Director
Environmental Health
Department of Health
State of Hawaii
P. O. Box 3378
Honolulu, Hawaii 96801

Dear Dr. Anderson:

Subject: Your Letter Dated May 15, 1989 Commenting on the Draft Environmental Impact Statement (DEIS) for the Waahila "180" and "405" Reservoirs, Manoa, Oahu, TMK: 3-3-56: Por. 1 and 2

Thank you for reviewing and commenting on our DEIS. We shall address your concerns in the Final EIS.

If you have any questions, please contact Lawrence Whang at 527-6138.

Very truly yours,

for KAZU HAYASHIDA
Manager and Chief Engineer

cc: Sue Rutka (Belt, Collins & Associates)

LHYW:eva
cc: K. Hayashida
L. Whang

P-452/89

RECEIVED
ENVIRONMENTAL QUALITY CONTROL
'89 JUN 5 12 02 PM

891208

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
P. O. BOX 621
HONOLULU, HAWAII 96809

REF: OCEA-sor

JUN 1 1989

FILE NO.: 89-604
DOC. NO.: 5794E

PE

MEMORANDUM

TO: The Honorable Marvin T. Miura, Director
Office of Environmental Quality Control

FROM: William W. Paty, Chairperson
Board of Land and Natural Resources

SUBJECT: Waahila "180" and Waahila "405" Reservoirs
Draft Environmental Impact Statement
Honolulu, Hawaii

Thank you for giving our Department the opportunity to comment on this matter. We have reviewed the materials you submitted and have the following comments:

Our Department's Historic Sites Section indicates that as no previous archaeological survey had been done in the project area, a survey was commissioned by BWS in connection with this project. The results were negative. Therefore, we believe that the project will have "no effect" on significant historic sites.

The Department's Forestry and Wildlife Division comments that although there may be no direct impact on DOFAW activities, the proximity to the high density urban/residential area poses a high visual impact to the hillside. Figure I-2 on the General Site Plan shows a deep site "cut" for both reservoir sites, but no "berm" on the downhill side of the reservoirs to place them in defilade, nor is there any indication of plantings to further "hide" these structures and enhance their blending with the terrain and flora of the hillside in order to reduce their negative visual impact. This is especially true of the upper Waahila 405 reservoir on DLNR lands. Other reservoirs on Oahu have been placed in defilade by berms and plantings and have greatly negated the otherwise high visual impact.

Therefore, we recommend that the construction and engineering of both those reservoirs include berms and plantings and that site and construction plans be forwarded to DLNR for review and approval.

Our Aquatic Resources Division has no overriding objection to the proposal. We endorse the proposed erosion control measures (incremental grading of reservoir sites, installation of sediment basin before grading, limiting grading to the drier months of the year and seeding of the area after grading, diversion of runoff from areas above the slopes to minimize water from flowing across the slope face, and installation of check dams, containment dikes, sediment traps and filter inlets) and drainage improvements (diversion of water away from the reservoir foundations and edges of cut slopes, and drainage swales and other structures on the access road). Such measures should minimize impact, if any, in Manoa Stream which will continue to receive runoff from the project area.

Please feel free to call me or Roy Schaefer of our Office of Conservation and Environmental Affairs, at 548-7837, if you have any questions.

WILLIAM W. PATY

cc: Honolulu Board of Water Supply

June 21, 1989

Mr. William W. Paty, Chairperson
Board of Land and Natural
Resources
State of Hawaii
P. O. Box 621
Honolulu, Hawaii 96809

Dear Mr. Paty:

Subject: Your Letter Dated June 1, 1989 Commenting on the Draft Environmental Impact Statement (DEIS) for the Waahila "180" and Waahila "405" Reservoirs

Thank you for reviewing and commenting on the DEIS.

We would like to clarify the mitigation measures addressed in the DEIS on the visual impact of the two reservoirs. Our landscape architects have been selecting plantings that match or are compatible with the existing vegetation at each reservoir site. As an example, new trees will not be massed around the sites because the existing forests are on the ridge overlooking the hillside where the reservoirs are to be located.

We also would like to note that our reservoir sites do not normally contain berms, whether natural or man-made to place them in defilade. For reservoirs sited in heavily vegetated areas, we have been able to further enhance the vegetation by judicious landscaping. In the case of the Waahila Reservoirs, the benches on the cut slopes will be landscaped with plantings to reduce their visual impact.

If you have any questions, please contact Lawrence Whang at 527-6138.

Very truly yours,

KAZU HAYASHIDA
Manager and Chief Engineer

cc: Sue Rutka
(Belt, Collins and Associates)
LHYW/GH:do
cc: K. Hayashida, Engineering, D. Ching, E. Shiraishi,
L. Whang
89-1208

P-372/89

JOHN WAIHEE
GOVERNOR

STATE OF HAWAII
OFFICE OF ENVIRONMENTAL QUALITY CONTROL
465 SOUTH KING STREET, ROOM 104
HONOLULU, HAWAII 96813

MARVIN T. MIURA, PH.D.
DIRECTOR

TELEPHONE NO.
548-6915

May 2, 1989

Mr. Lawrence Whang
Honolulu Board of Water Supply
City and County of Honolulu
630 South Beretania Street
Honolulu, Hawaii 96843

Dear Mr. Whang,

Our main concern regarding the Waahila 180 and 405 Reservoirs EIS is that erosion control measures are implemented, and that any blasting be coordinated with the University of Hawaii.

Thank you for the opportunity to review this EIS.

Sincerely,

MARVIN T. MIURA, PH.D.
Director, Office of Environmental Quality Control

ROY SAKAMOTO
Environmental Technical Specialist

nnh

11AM J 1 39TH '89

June 2, 1989

Harvin T. Miura, Ph.D.
Director
Office of Environmental Quality Control
State of Hawaii
465 South King Street, Room 104
Honolulu, Hawaii 96813

Dear Dr. Miura:

Subject: Your Letter Dated May 2, 1989 Commenting on the Waahila "180" and "405" Reservoirs Draft EIS

Thank you for reviewing and commenting on our Draft Environmental Impact Statement (EIS).

The University of Hawaii (UH) Dole Street Faculty Housing is located just below our proposed Waahila "180" reservoir. We have, therefore, met with the various UH operation and engineering staff to discuss their concerns and mitigation measures. The mitigative measures on erosion and the blasting work discussed in the Draft EIS were the result of these meetings. For example, blasting was preferred by the UH over a hoe ram operation because of the shorter time to complete the site evacuation work and the precautions which the contractor will have to undertake.

If you have any questions, please call Lawrence Whang at 527-6138.

Very truly yours,

KAZU HAYASHIDA
Manager and Chief Engineer

cc: Sue Rutka (Belt, Collins and Associates)
(with incoming letter)

LHYW/HHM:jj
cc: K. Hayashida, Engineering, D. Ching, L. Whang

P-372/89

University of Hawai'i at Mānoa

Center for Hawaiian Studies
1890 East-West Road • Moore Hall 428
Honolulu, Hawai'i 96822
Telephone: (808) 948-6825
Facsimile: (808) 948-6345

8 June 1989

Mr. Lawrence Whang, Head
Environmental Section
Board of Water Supply
630 S. Beretania Street
Honolulu, Hawai'i 96843

Dear Mr. Whang:

Mahalo for your helpful telephone conversation today.

I enclose a copy of our comments sent to Mr. Kazu Hayashida to meet the 7 June deadline.

I understand from you that you and your staff have been in communication with Mr. Keoni Fairbanks and Mr. Ronald Fenstemacher regarding the four concerns cited in our 6 June letter to Mr. Hayashida.

We look forward to your responses after your receipt of our comments.

Tnank you in advance for your kind consideration.

Sincerely,

Kekuni Blaisdell, M.D.
Acting Interim Director

Encl.

cc: Mr. Keoni Fairbanks
Mr. Roland Fenstemacher
Mr. Charles Kupa

JUN 21 10 33 AM '89

University of Hawai'i at Mānoa

Center for Hawaiian Studies
1890 East-West Road • Moore Hall 428
Honolulu, Hawai'i 96822
Telephone (808) 948-6825
Facsimile (808) 948-6345

6 June 1989

Mr. Kazu Hayashida, Manager and Chief Engineer
Board of Water Supply
City and County of Honolulu
630 South Beretania Street
Honolulu, Hawai'i 96843

Dear Mr. Hayashida:

RE: Draft EIS for Wa'ahila 180 and 405 Reservoirs

Mahalo for inviting the University of Hawai'i at Mānoa Center for Hawaiian Studies (UHM-CHS) to comment on your draft of 20 April 1989. We have four (4) primary areas of concern regarding the proposed reservoir project:

1. Erosion and s'l+ .ion effects on the gully and spring that bisect the UHM-CHS site between the low-ground Kapapa Lo'i 'O Kānewai and the high-ground site of the future CHS building.
2. Implications of drainage improvements for sub areas "M" and "N".
3. Construction impacts of two 24" transmission lines, and connection to the existing 20" line along Dole Street.
4. Visual and botanical impacts of proposed landscaping around reservoir sites.

A sketch is enclosed for your reference.

1. Section 3.2 The Project Impact Area fails to refer to Kapapa Lo'i 'O Kānewai and the site of the future CHS building as located directly across Dole Street from UH Faculty Housing (see enclosure). The natural gully that drains the impacted watershed, completely bisects the Hawaiian Studies site, thus making (UHM-CHS) the most directly affected facility after Faculty Housing. Also a small spring is located in the gully makai of Dole Street. These factors should be considered in the final EIS.

In Section 3.3.2.3 Drainage Impacts, we are informed that run off during a 100-year storm would rise only 1 inch. What is the increased velocity of the run off? What is the change in volume and velocity during an annual winter storm? The usual winter

storms are our primary concern, and we are not convinced that such heavy construction will have no impact on the convergence point of the watershed drainage area.

What is the projected increase in the sediment load of the run off? What impact will this, as well as the increased volume and velocity, have on scouring the spring, as well as the channel of the gully that bisects the CHS property? What mitigation measures are appropriate for the projected impacts?

2. Another drainage issue is the discharge from sub areas "M" and "N" discussed in Section 3.3.2.1 Drainage Impacts. We are seriously concerned over the route the drain pipe will take. Many rare and endangered native species are planted in Kapapa Lo'i 'O Kānewai, right up to the makai sidewalk of Dole Street. Our vital 'auwai ditch runs along the Mānoa Stream base of Wa'ahila Ridge, crossing under the Dole Street bridge. What exactly will be the alignment of the discharge drain in relation to our plantings and our 'auwai?

Section 3.3.2.2 Drainage Improvements refers to a route "on the makai side of Dole Street outside of the Hawaiian Studies lo'i property." This is a physical impossibility since the lo'i site begins makai of Dole Street, unless you mean the alignment is directly under the sidewalk or side strip. This description also appears to contradict the description in Section 3.6 SUMMARY OF PROPOSED MITIGATION MEASURES, EROSION CONTROL, where the drain alignment is described as mauka of Dole Street. Which alignment is being proposed? What are the projected impacts on the Lo'i garden?

3. Of equally critical concern is the construction of two 24" transmission mains: one connecting the proposed 405 reservoir with an existing 20" line running along Dole Street (within the Lo'i property), and a second running from the proposed 180 reservoir "along" Dole Street to Wai'alae Avenue. Where exactly will the 405 transmission line tie into the existing 20" main? What impact is this expected to have on existing plantings and buildings at Kapapa Lo'i 'O Kānewai? What will be the alignment of the 180 transmission main along Dole Street in relation to the existing 20" main? What impact will this have on the Kapapa Lo'i property, which borders the sidewalk on the makai side of Dole Street?

4. Our last concern is the visual and botanical impact of landscaping the proposed reservoir sites. The location of the planned CHS building is directly down-hill from the project site makai of Dole Street. The mauka views from this building, intended to be emphasized in the building's design, will be highly affected by the proposed Wa'ahila Reservoir Project.

The Center for Hawaiian Studies (CHS) strongly suggests that plantings blend with the existing light green/yellow mountain viewscape. Also we encourage the re-introduction of native species to the area. Dry forest native species are, by natural evolution, well adapted to the site and drought tolerant. We oppose the use of Chinese banyan mentioned in Section 3.9.5 Mitigation Measures. This is not a good choice. Chinese banyans are a noxious, introduced weed that have been spreading steadily along the Wa'ahila ridge over the past several years. Their dark green leaves and large bulk stand out conspicuously from the surrounding light green scrub vegetation. We would recommend enhancing the existing native species present (pili, 'ilima, etc.) with other similarly-colored, drought-resistant native vegetation such as wiliwili, kolomona, ma'o, u'ulei and others, that were present in the area historically.

Has the Board of Water Supply explored native species as an option for the landscaping program? We would like to cooperate with you to accomplish this. We can offer planting stock, greenhouse facilities and expertise. We are eager to participate in such a program in order to enhance our mauka views and surrounding environment.

Thank you again for the opportunity to comment. We look forward to your response.

Sincerely,

Kekuni Blaisdell
Acting Interim Director

Encl.

cc: Mr. Allan AhSan, Campus Operations
Mr. Clyde Akita, UH Facilities Planning
Dean Thomas W. Gething, SHAPS
Mr. Charles Kupa, Kapapa Lo'i 'O Kānewai
Mr. Nahoa Lucas, Ho'okahe Wai Ho'oulu 'Aina
Dr. Jacqueline Miller, Enviromental Center
Center for Hawaiian Studies Facilities Committee
UH Hawaiian Studies Council

BOARD OF WATER SUPPLY
CITY AND COUNTY OF HONOLULU

July 7, 1989

Dr. Kekuni Blaisdell, Director
Center for Hawaiian Studies
University of Hawaii
1890 East-West Road
Moore Hall 428
Honolulu, Hawaii 96822

Dear Dr. Blaisdell:

Subject: Your Letter Dated June 6, 1989 Commenting on the Draft Environmental Impact Statement (DEIS) for the Waahila "180" and "405" Reservoirs

Thank you for reviewing and commenting on the DEIS.

We have been working with Mr. Keoni Fairbanks on the concerns and some of the mitigative measures that may have an effect on the Ka Papa Loi 'O Kanewai complex. We shall also reference the proposed Center for Hawaiian Studies in the Final EIS.

We want to assure you that the proposed drainage plan should not affect the gully and spring makai of Dole Street. The additional runoff due to the reservoirs will be insignificant and will be handled by the drainage improvements which will be constructed as part of the reservoir projects.

For the drainage issue in item 2, the discharge from sub areas "M" and "N" will be collected in a drain pipe running down the faculty housing access roadway, across Dole Street to the makai side of the road, continue along Dole Street towards the drainage gully, and then make a 45 degree turn into the makai sidewalk area ending at the rock wall of the existing drainage culvert. The drain line will, therefore, have no effect on the plantings or auwai.

The existing 20-inch water line on Dole Street is located in the sidewalk area adjacent to Ka Papa Loi 'O Kanewai. To prevent any detrimental effect on the complex, the

24-inch water line will come down the faculty housing access roadway, cross over to the makai side of Dole Street, turn and continue in the paved road area to Manoa Bridge, and connect to the existing 20-inch water line near the bridge itself.

Landscape plantings for a reservoir site are generally the same as the existing surrounding plantings or comparable in appearance. We will have the landscape architect contact you to see if we can mutually benefit from such a joint effort.

If you have any questions, please contact Lawrence Whang at 527-6138.

Very truly yours,

KAZU HAYASHIDA
Manager and Chief Engineer

cc: Sue Rutka (Belt, Collins and Associates)

P-510/89

University of Hawaii at Manoa

Environmental Center
Crawford 317 • 2550 Campus Road
Honolulu, Hawaii 96822
Telephone (808) 948-7361

June 7, 1989
RE:0534

Dr. Marvin T. Miura, Director
Office of Environmental Quality Control
465 South King Street, Room 104
Honolulu, Hawaii 96813

Dear Dr. Miura:

Draft Environmental Impact Statement
Waahila "180" and Waahila "405" Reservoirs
Honolulu, Oahu

The proposed project involves the construction of two 4-million gallon (mg) reservoirs, an access road, transmission mains, instrument houses, landscaping, irrigation, and fencing on Waahila Ridge. The placement of reservoirs would require the removal of up to 200,000 cubic yards of rock and soil from the hillside behind the University of Hawaii's faculty housing facility. The Environmental Center has conducted a review of this Draft Environmental Impact Statement (EIS) with the assistance of Paul Hummel, Civil Engineering; Yu-Si Fok and Edwin Hurabayashi, Water Resources Research Center; and Randall Rush, Environmental Center.

During the Preparation Notice stage we thoroughly reviewed the above referenced project and had the following comments. First, we questioned the degree of realism inherent in the Board of Water Supply's (BWS) goal to attain a standard reservoir capacity of 130 mg. Second, we noted transportation-related impacts including increased traffic and steep road design. Third, we suggested utilizing the excavated material for site preparation for much needed additional faculty housing at the location and to aid in slowing storm water runoff. Fourth, we expressed reservations about connecting 24-inch pipes to the existing 20-inch waterline.

Presently, the Draft EIS only partially addresses our earlier concerns. Although there is some discussion of the configuration of the access road, alternative means of disposal of excavated materials seem to have been largely dismissed without further significant study. In view of the extensive traffic impacts posed by removal of the excavated material, there would appear to be reasonable justification to seriously consider alternative disposal options. Finally, the Draft EIS fails to consider the concerns raised over the interconnection of pipes with divergent diameters.

Jun 9 8 19 AM '89

Outside we offered material to O.H. and other governmental agencies and none offered the material

AN EQUAL OPPORTUNITY EMPLOYER

We thank you for the opportunity to review this document. We look forward to your response to our comments.

Yours truly,

John Harrison
Environmental Coordinator

cc: L. Stephen Lau
Honolulu BWS
Paul Hummel
George Taoka
Randall Rush

June 27, 1989

Dr. John Harrison
Environmental Coordinator
Environmental Center
University of Hawaii
Crawford 317
2550 Campus Road
Honolulu, Hawaii 96822

Dear Dr. Harrison:

Subject: Your Letter Dated June 7, 1989 Commenting on the Draft Environmental Impact Statement (DEIS) for the Waahila "180" and Waahila "405" Reservoirs

Thank you for reviewing and commenting on the DEIS.

Numerous meetings were held with the University of Hawaii (UH) representatives regarding our proposed Waahila Reservoirs. Among the people we met with were: Edward Yuen and Duff Ewald of the Procurement and Property Management Office; Alan Ah Sam of Campus Operations; Michael Yano of Faculty Housing; James Burgoyne of (Student) Housing Office; Michael Yoneda of Facilities Planning and Management Office; and Keoni Fairbanks, Ka Papa Lo'i 'O Kanewai.

Some of the major discussion issues centered on construction activities; closeness of the lower reservoir to the existing faculty housing; land exchange; possible construction effects on rare and endangered native species, including many varieties of Hawaiian taro; the proposed center for Hawaiian Studies; and the UH master plan to relocate the faculty housing and replace them with high-rise student dormitories. Many of the mitigation measures that were worked out as a result of these discussions are noted in the DEIS. Other mitigative measures that have only been recently agreed upon will be noted in the Final EIS (FEIS).

Reservoirs are an important part of the system. They help to meet peak demand and fire flow. In addition, they along with tunnel gravity sources, are the only sources of supply during an electrical outage.

As you are probably aware, undeveloped lands at the required 405' and 180' elevations are scarce in the metropolitan Honolulu area. Since we do not have many alternatives for siting new reservoirs within metropolitan Honolulu, our storage standard of 1.5 times the average daily use may be unattainable in the Honolulu system. However, our standard for storage reservoirs is a goal that we strive to attain. The closer we come to it, the greater will be the reliability of the system.

Two of the absolute elements for the siting of a reservoir are sufficient elevation and suitable ground conditions. These key elements dictate where reservoirs may be constructed. Access to the reservoirs by roads with steep slopes and several curves are often unavoidable due to elevation and terrain factors.

On the matter of utilizing the estimated 130,000 cubic yards of excavated material, we offered the material to UH and other government agencies, but none of them were interested in it. The UH Faculty Housing indicated they are concerned with runoff, including silt or boulders, causing damage to the faculty housing if the use of the excavated material caused changes in the existing drainage patterns. The possibility of excessive sediment build up, if the excavated material is used in the area, is a concern of the Center for Hawaiian Studies and the Ka Papa Lo'i 'O Kanewai complex makai and across Dole Street from the faculty housing.

The water lines which connects the reservoir to the system is designed to minimize head loss and to promote flow in and out of the reservoir. We are not aware of any problems in connecting a 24" main to a 20" main.

If you have any questions, please contact Lawrence Whang at 527-6138.

Very truly yours,

KAZU HAYASHIDA
Manager and Chief Engineer

cc: Sue Rutka (Belt, Collins and Associates)

LHYW/GH:do
cc: K. Hayashida, Engineering, D. Ching, E. Shiraishi, L. Whang

P-510

U91223

RECEIVED

PE

UNIVERSITY OF HAWAII

Procurement and Property Management Office

June 6, 1989

Kazu Hayashida
Manager and Chief Engineer
Board of Water Supply
630 South Beretania Street
Honolulu, Hawaii 96843

Dear Mr. Hayashida:

Subject: Comments on Draft Environmental Impact Statement for the Waahila "180" and Waahila "405" Reservoirs, Manoa Tax Map Key: 3-3-56: Por. 1 and 2

Based on our review of the subject draft EIS, we would submit the following comments:

1. In Section 1.6 (Summary of Proposed Mitigation Measures - Erosion Control), we believe that a mandatory requirement should be imposed on the contractor to remove rocks and boulders to reduce the possibility of rock slides. Accordingly, this provision should be re-drafted to specify that "the contractor shall remove all visible rocks and boulders after grading is completed to reduce the hazard of rock slides."

2. In Section 3.10.2 (Impact on Future University of Hawaii Development Plans), there is a discussion concerning the use of blasting by the University in the future development of the area adjoining the reservoir site. If such blasting would be prohibited or otherwise restricted, the University believes that it should be compensated by the Board of Water Supply for the additional construction costs incurred.

3. References are made in Section 1.6 (Summary of Proposed Mitigation Measures - Socioeconomic Impacts) and Section 3.10.1 (Impacts on the Waahila Faculty Apartments) concerning the provision of subsidies to the University regarding those apartments impacted by reservoir construction. It continues to be the University's position, as addressed in Section 1.11 (Unresolved Issues), that the Board of Water Supply should provide full reimbursement for revenues lost from the faculty housing units due to construction activities.

4. There is no discussion in the draft EIS on whether the Board of Water Supply will require the use of any University parking areas to serve as construction staging areas for the project. If such use is required, the University would insist that it receive reimbursement for all parking revenues lost as a result of such use.

5. The University believes that the EIS should include a discussion concerning the potential impact on surrounding areas and the safety measures implemented regarding possible breakage of the reservoirs to be constructed.

We appreciate the opportunity to review the draft EIS and to offer our comments.

Very truly yours,

Edward Yuen
Director

EY:DZ:kh

cc: Director Ah San

June 22, 1989

Mr. Edward Yuen, Director
Procurement and Property
Management Office
University of Hawaii
1400 Lower Campus Road,
Room 15
Honolulu, Hawaii 96822

Dear Mr. Yuen:

Subject: Your Letter Dated June 6, 1989 Commenting on the Draft Environmental Impact Statement (DEIS) for the Waahila "180" and Waahila "405" Reservoirs

Thank you for reviewing and commenting on the DEIS.

We have the following response to your comments:

1. We shall redraft the provision covering the removal of visible rocks and boulders. This revision has also been included in the requirements to the contractor and as an item for the proposed right-of-entry.

2. We shall provide the services of a geotechnical engineer should you go ahead with the proposed student dormitory project. We, however, cannot be responsible for any additional construction costs.

3. We have made a commitment to reimburse the UH for any loss of revenue from any vacant faculty housing apartment during the construction of the Waahila "180" reservoir.

4. Staging areas for our construction projects are the responsibility of the contractor who makes his own arrangements with the landowners.

5. Our reinforced concrete reservoirs are designed for seismic loading or to resist lateral movements generated by earthquakes. The steel reinforcing in the concrete makes it almost impossible for the reservoir to collapse like a dammed-up surface water reservoir.

If you have any questions, please contact Lawrence Whang at 527-6138.

Very truly yours,

KAZU HAYASHIDA
Manager and Chief Engineer

cc: Sue Rutka (Belt, Collins and Associates)

LHYW:do
cc: K. Hayashida, Land (with incoming letter), Engineering, D. Ching, E. Shiraishi, L. Whang

89-1223

COMMUNITY OF ST. COLUMBA
The Celtic Evangelical Church
The Rt. Rev. Wayne W. Gau
P. O. Box 90850
Honolulu, HI 96835-0850 U.S.A.

001142

PE

26 May 89

Mr. Kazu Hayashida
Manager and Chief Engineer
Board of Water Supply
630 South Beretania Street
Honolulu, HI 96843

Dear Sir:

Thank you for your letter of 26 Apr 89 and the opportunity to review the Draft Environmental Impact Statement for the Waahila 180 and Waahila 405 Reservoirs, Manoa, Oahu, Tax Map Key: 3-3-56:por. 1 & 2, dated 20 Apr 89.

I would like to draw your attention to Section 3.6.1.1 of the aforementioned document, entitled "Site Preparation Phase," on p. 3-9. This section indicates that trucks carrying debris from the excavation site will move eastward along Dole Street to St. Louis Drive, in order to reach Wailalae Avenue. You should be aware that since 1982, there has been continuous, unabated construction of one type or another along or on Dole Street itself, between the Manoa Stream bridge and Kanewai Street. Even now there is a sewer relief construction project between Kanewai Park and the lower University of Hawaii campus and vehicles related to that project are already impeding traffic along that stretch of Dole Street. Having the trucks from the Waahila construction site drive eastward on Dole Street to reach St. Louis Drive will bring traffic along that part of Dole Street to a virtual standstill as well as present a major problem to the residents of all of St. Louis Heights, whose access to and exit from the hill are limited to Frank Street and lower St. Louis Drive.

Therefore I urge you to reconsider the plan to have trucks removing excavation material from Waahila drive eastward along Dole Street to St. Louis Drive. I suggest that the trucks leave the excavation site by driving west on Dole Street to University Avenue. Motorists entering or leaving the University of Hawaii Manoa campus have a number of roads and options available to them. But in the case of St. Louis Heights, all traffic comes to a bottleneck at the foot of the hill, i.e., the intersections of Dole and Frank Streets and St. Louis Drive and Wailalae Avenue. Furthermore, the intersection of Dole Street and St. Louis Drive

is already an overused and hazardous point in the roadway due to

1. the volume of traffic,
2. the speed of the traffic, especially that of vehicles coming down the hill, and
3. the impaired visibility for vehicles on Dole Street trying to enter St. Louis Drive due to the curve of the roadway on St. Louis Drive immediately above Dole Street.

Your reconsideration of this matter will be greatly appreciated and could avert a potentially serious inconvenience to the residents of St. Louis Heights. Thank you.

Yours truly,

Wayne W. Gau

The Rt. Rev. Wayne W. Gau

BOARD OF WATER SUPPLY
CITY AND COUNTY OF HONOLULU

June 8, 1989

The Rt. Rev. Wayne W. Gau
Community of St. Columba
The Celtic Evangelical Church
P. O. 90880
Honolulu, Hawaii 96835-0880

Dear Rt. Rev. Gau:

Subject: Your Letter Dated May 26, 1989 Commenting on the Draft Environmental Impact Statement (DEIS) for the Waahila "180" and "405" Reservoirs

Thank you for reviewing the DEIS and informing us of your concerns.

Our consultant studied the traffic pattern on University Avenue, Dole Street, and St. Louis Drive as recorded in Figures 3-2, 3-3, and 3-4 on pages 3-12 to 3-14 and find that the traffic is heavier on University Avenue and Dole Street between University Avenue and the East-West Road on the University of Hawaii (U.H.) campus. The U.H. has, therefore, requested that due to the heavy student traffic, our contractors exit eastward on Dole Street towards St. Louis Drive.

The contractors will be required to obtain a traffic permit from the City's Department of Transportation Services before they can start their construction work. Conditions to safely move vehicles and pedestrians are incorporated as part of the approval for the traffic permit. Furthermore, our contractors will be restricted to off-peak hours to minimize the traffic impact to residents in that area.

If you have any questions, please contact Lawrence Whang at 527-6138.

Very truly yours,

Kazu Hayashida

KAZU HAYASHIDA
Manager and Chief Engineer

cc: Sue Rutka
(Belt, Collins and Associates)

P-442/89

Hawaiian Electric Company, Inc. • PO Box 2750 • Honolulu, HI 96840 000

ENV 2-1
JA/G

William A Bonnet
Manager
Environmental Department

May 18, 1989

Mar 23 9 31 AM '89

Marvin T. Miura, Ph.D., Director
State of Hawaii
Office of Environmental Quality Control
465 South King Street, Room 104
Honolulu, Hawaii 96813

Dear Dr. Miura:

Subject: Draft Environmental Impact Statement (EIS) for Waahila "180" and Waahila "405" Reservoirs

We have reviewed the subject EIS and have the following comments:

1. Our review of the proposed project indicates that HECO has existing overhead and underground electrical facilities along most of the project route (see Attachment 1). However, until more detailed project drawings are available, possible conflicts with the project and our facilities cannot be determined.

2. Since HECO's facilities are energized, the following construction notes are to be included in the EIS.

   a. The Contractor shall exercise extreme caution whenever construction crosses or is in proximity to HECO underground lines and is to maintain a minimum 13'-0" clearance for his equipment while working close to and/or under the overhead facilities.

   b. The Contractor shall comply with the State of Hawaii's Occupational Safety and Health Law (DOSH).

   c. The Contractor shall obtain an excavation permit from HECO's Mapping and Records Division located at 820 Ward Avenue, Fourth Floor, two weeks prior to starting construction.

 C/y to Engr. Br.

   d. When trench excavation is adjacent to or beneath existing HECO structures or facilities, the Contractor is responsible for:

      1. Sheeting and bracing the excavation to prevent slides, cave-ins and settlements, and

      2. Protecting existing structures or facilities with beams, struts, or under-pinning.

   e. If pole bracing is required, the Contractor shall call the HECO District Construction Superintendent at Ward Avenue at 543-7745, a minimum of 72 hours in advance.

   f. For verification of underground lines or for assistance in supporting and protecting these lines, the Contractor shall call HECO's Underground Division at 543-7395 a minimum of 72 hours in advance.

   g. Any work required to relocate HECO facilities shall be done by HECO, and the Contractor shall be responsible for all coordination and costs incurred. In addition, should it become necessary for the Contractor to temporarily relocate any HECO facilities, these temporary locations will be done by HECO or by the Contractor under HECO's supervision, and all costs will be borne by the Contractor.

   h. Any damage to HECO's facilities will be reported immediately to HECO's Trouble Dispatcher at 543-7838. The Contractor shall be liable for any damages to HECO's facilities.

Sincerely,

William A Bonnet

Attachment

cc: Honolulu Board of Water Supply
City & County of Honolulu

ATTACHMENT 1

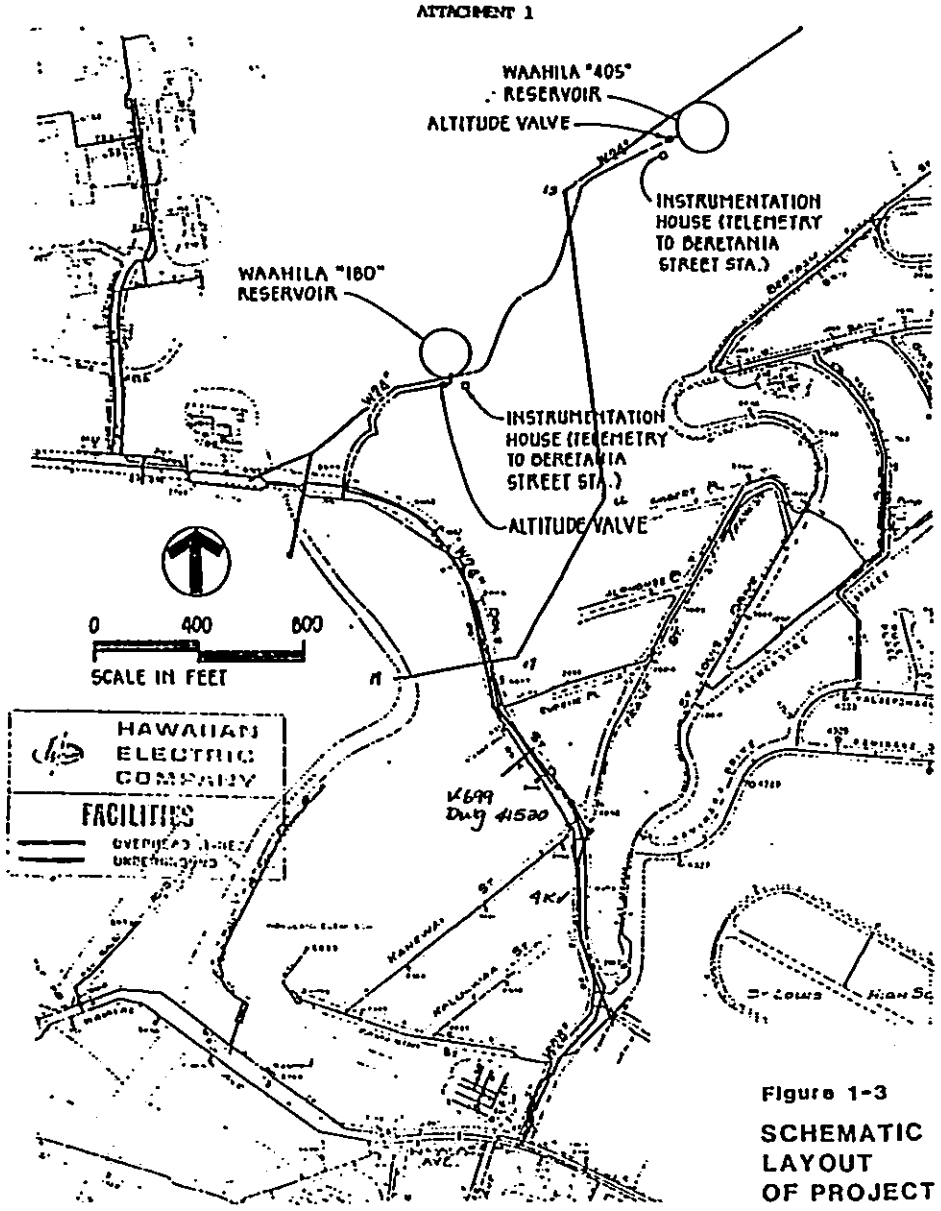

Figure 1-3
SCHEMATIC LAYOUT OF PROJECT

June 15, 1989

Mr. William A. Bonnett
Manager
Environmental Department
Hawaiian Electric Company, Inc.
P. O. Box 2750
Honolulu, Hawaii 96840-0001

Dear Mr. Bonnett:

Subject: Your Letter Dated May 18, 1989 Commenting on the Draft Environmental Impact Statement (DEIS) for Waahila "180" and Waahila "405" Reservoirs

Thank you for reviewing and commenting on our DEIS. Our design plans and construction work shall be coordinated with your firm. We shall also include your construction notes in the Final EIS.

If you have any question, please contact Lawrence Whang at 527-6138.

Very truly yours,

KAZU HAYASHIDA
Manager and Chief Engineer

cc: Sue Rutka (Belt, Collins and Associates)

LHYW:eva
cc: K. Hayashida
Engineering
D. Ching
E. Shiraishi
L. Whang

P-442

APPENDIX A

GEOTECHNICAL ENGINEERING REPORT
PROPOSED WAAHILA "180" AND "405"
4.0 M.G. RESERVOIRS
MANOA, OAHU, HAWAII

W.O. 1884-00 DECEMBER 4, 1987

PREPARED FOR

BELT, COLLINS & ASSOCIATES

C.W. ASSOCIATES INC.
dba GEOLABS-HAWAII
2006 KALIHI STREET
HONOLULU, HAWAII 96819

CW ASSOCIATES, INC. dba
GEOLABS-HAWAII
Geology Soils and Foundation Engineering

December 4, 1987
W.O. 1884-00
(Dk. No. 46)

Belt, Collins & Associates
606 Coral Street
Honolulu, Hawaii 96813

Attention: Mr. Paul Hirota

Gentlemen:

Submitted herewith is our report entitled "Geotechnical Engineering Report, Proposed Waahila "180" and "405", 4.0 M.G. Reservoirs, Manoa, Oahu, Hawaii".

Our work was performed in general accordance with the scope of services outlined in our proposal of April 3, 1987.

Detailed discussions and recommendations are contained in the body of the report. If there is any point that is not clear, please feel free to contact us.

Very truly yours,

C.W. ASSOCIATES INC.
dba GEOLABS-HAWAII

Clayton S. Mimura

Clayton S. Mimura, P.E.
Vice-President

CSM:lf

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GEOTECHNICAL ENGINEERING REPORT

PROPOSED WAAHILA "180" and "405"

4.0 M.G. RESERVOIRS

MANOA, OAHU, HAWAII

W.O. 1884-00 DECEMBER 4, 1987

SUMMARY OF RECOMMENDATIONS

Our field exploration disclosed that the project site is underlain by thin layers of very stiff to hard bouldery clays over weathered to relatively unweathered basalt formation which could provide adequate foundation support for the proposed reservoirs.

An allowable bearing capacity of 5000 p.s.f. may be used for the design of foundations bearing on the undisturbed weathered to relatively unweathered basalt formation.

A 0.5H:1V slope ratio is recommended for cut slopes with slope benches provided at maximum vertical height intervals of 30 feet. The upper 15 feet of cut should be flattened to a ratio of 1H:1V.

The text of this report should be referred to for detailed recommendations.

INTRODUCTION

This report presents the results of our geotechnical engineering exploration performed for the design of the proposed Waahila 4.0 M.G. reservoirs at Manoa, Oahu, Hawaii.

PURPOSE AND SCOPE

The purpose of our study was to explore the subsurface soil conditions at the proposed reservoir sites and along a portion of the alignment of the proposed access road in order to provide recommendations for use in the design of the site grading, reservoir tank foundations and trench excavation of the proposed facility.

The scope of work was revised from the scope outlined in our proposal of April 3, 1987 due to limited site accessibility and the unavailability of water for drilling.

The scope of our work included the excavation of seven (7) test pits at the reservoir sites and along the proposed access road alignment, the drilling and sampling of three (3) borings to depths ranging from 31.0 to 37.0 feet below the existing ground surface at the lower reservoir site and performing seven (7) geophysical (seismic) surveys at the two reservoir sites. Also included were engineering evaluation of the field data, the development of design recommendations and report preparation.

A detailed description of our field exploration is presented in the appendix of this report.

SITE DESCRIPTION

The project site is situated in a minor valley along the axis of Waahila Ridge in the Manoa-Saint Louis Heights area of Honolulu, Hawaii. The general location of the site and its vicinity is shown on the Project Location Map, Plate 1.

The reservoir sites are located adjacent to and upslope of the University of Hawaii-Manoa Faculty Housing. The site slopes steeply above the housing and is covered with dense dryland vegetation, e.g., haole koa and grasses. The existing ground surface elevation of the site varies from approximately 100 to 560 feet above Mean Sea Level.

PROJECT CONSIDERATIONS

It is proposed to construct two 4.0-million gallon capacity reinforced concrete reservoir structures on the site. The reservoirs will be approximately 190 feet in diameter and 20 feet in height.

The exact details of the proposed site grading were not known at the time of our exploration. However, it is anticipated that cuts of up to approximately 90 to 100 feet will be required to create level pads for the reservoirs.

SUBSURFACE CONDITIONS

Regional Geology

The island of Oahu is composed of two (2) shield volcanoes, Waianae and Koolau, built by the extrusion of basaltic lavas during the late Pliocene and Pleistocene epochs. Preliminary reconnaissance of the site and its vicinity indicates that the area is underlain by thin residual and transported soils over Koolau lavas.

Koolau basalts are typically thin-bedded primitive lavas with a large percentage of "pahoehoe" flows. Cavities or voids, such as lava tubes, are common in "pahoehoe" lava flows and are frequently encountered in cuts or excavations.

Subsurface Exploration

The subsurface conditions at the lower reservoir site were explored by drilling and sampling three (3) borings to depths ranging from 31.0 to 37.0 feet below the existing ground surface. In addition, a total of seven (7) test pits were excavated throughout the project area to explore near-surface conditions at both reservoir sites and along the proposed alignment of the access road between the two reservoirs. A total of seven (7) seismic refraction surveys were also performed to geophysically explore the subsurface conditions at the reservoir sites. The approximate locations of the borings, test pits and seismic surveys are shown on the Site Plans, Plates 2 and 3.

In general, the field exploration encountered a surficial layer of very stiff brown clays with boulders, cobbles and gravel, ranging in thickness from 0 to 3.5 feet, which represents the transported soil, or

slopewash, commonly found on hillside sites. Below this stratum, the field exploration encountered weathered basalt formation (Koolau Basalt) ranging in thickness between 5.0 and 10.0 feet.

Groundwater was not encountered during the time of our exploration.

DISCUSSIONS AND RECOMMENDATIONS

Reservoir Foundations

The exploration indicates that, at the proposed finished grades, the site is underlain by moderately to slightly weathered basalt formation which could provide adequate foundation support for the proposed reservoirs.

An allowable bearing capacity of 5000 p.s.f. may be used for the design of foundations bearing on undisturbed basalt formation. This value may be increased by one-third when temporary wind and seismic loads are considered.

Exterior wall footings should be embedded a minimum of 18 inches below the lowest adjacent finished grade. Interior spread footings should be embedded a minimum of 12 inches below the reservoir floor. Footings located next to utility trenches should extend down to a grade equal to or deeper than the trench. Alternatively, the trench backfill could be backfilled with concrete or compacted to 95% of its maximum dry density, as established by ASTM D-1557-78, to minimize footing settlement.

Due to the frequent occurrence of cavities and voids in Koolau "pahoehoe" lava flows, we recommend that the footing construction portion of the project include a program of probing and grouting to detect potential voids below the reservoir foundations. The wall footing excavation should be probed at approximately 10 feet on centers. One probe should be drilled at each individual spread footing. The probe holes should have a minimum diameter of 2 inches and extend below the

bottom of footing, a depth of 15 feet. The probe holes should be grouted from the bottom of the hole using low pressures. If a cavity is suspected below a footing, additional probe holes should be made to delineate the horizontal extent of the cavity. The probing and grouting operations should be monitored by the soils engineer to see that these recommendations are carried out properly and to locate potential voids near the footing excavations.

The site grading should be designed to divert surface water away from the reservoir foundations.

Settlements

Based upon the available data from the field exploration and the anticipated reservoir loads, we estimate that the total and differential settlements would be negligible.

Lateral Resistance

For passive earth pressure, an equivalent fluid pressure of 500 p.s.f. per foot of depth may be used. A friction factor of 0.5 may be utilized to determine the sliding resistance of the structure and the foundations.

Retaining Walls

It is our understanding that retaining walls are anticipated for the lower portions of the access road. The guidelines for retaining wall design are listed below.

1. For lateral earth pressures, the following can be used:

Walls unrestrained at the top (active condition, level backfill)	-	35 p.s.f. equivalent fluid pressure per foot of depth
Wall restrained at the top (at-rest condition, level backfill)	-	55 p.s.f. equivalent fluid pressure per foot of depth

An allowable bearing value of up to 5000 p.s.f. is recommended for foundations bearing on the rock formation.

2. A passive earth resistance of 300 p.s.f. per foot of depth may be used for the wall footing on level areas. The passive pressure should be reduced for walls on slopes.

3. A base friction factor of 0.5 may also be used to determine the resistance against sliding of the wall.

4. The wall foundations on relatively flat areas should be embedded a minimum of 18 inches below the lowest adjacent finished grade.

5. The wall foundations on or near sloping ground should be embedded deeper to provide a 10-foot minimum horizontal set-back distance from the toe of the wall to the existing sloping ground surface.

6. Backfills directly behind the retaining wall should consist of granular material, such as select borrow, crusher waste or #38 Fine gravel. The top 12 inches of backfill should consist of non-expansive, impervious material to reduce water infiltration behind the wall.

7. A subsurface drainage system (subdrains or weepholes) should be utilized behind the walls. Subdrains should be properly constructed to drain water away from the wall.

Site Grading

Site Preparation

Prior to the commencement of earthwork, the area within the grading limits should be cleared and grubbed of all vegetation, organic material, debris and other deleterious material.

Excavation

The field exploration indicates that the two reservoir sites and most of the roadways are underlain at fairly shallow depths by dense basalt.

Relatively hard ripping is anticipated in the basalt formation. The more massive basalt in the deeper reservoir cut slopes will likely require special excavation procedures, such as hoe ram equipment or blasting, to make the proposed cut.

The above discussions regarding the rippability of the subsurface materials are based on our visual observations of the existing rock outcrops in the area and interpretation of the boring and seismic data.

We recommend that all prospective contractors bidding on this site should examine the rock outcrops and the boring and seismic data, and make their own interpretation.

Fill Placement & Compaction Requirements

It is anticipated that no fill placement will be required at the site of the reservoir structure. However, some minor amounts of fill may be required for the access road.

Where the existing ground is steeper than 5 horizontal to 1 vertical, any fill placed should be keyed and benched into firm existing ground to properly bond the new fill to the slope. For details, refer to Plate 4. The fill placement should begin at the lowest point and continue upwards in level compacted lifts.

Fills should be moisture conditioned to near-optimum moisture content, placed in horizontal lifts not exceeding ten (10) inches in loose thickness and compacted to 95% of its maximum dry density as determined by ASTM D-1557-78.

Slopes

It is anticipated that the site grading for the reservoir structures will require cuts of up to approximately 90 to 100 feet in depth. Cut slope ratios of 1/2 horizontal to 1 vertical may be used in competent slightly weathered basalt formation. The upper 15 feet of the cut slopes should be flattened to 1 horizontal to 1 vertical to accommodate the less competent highly weathered basalt formation and thin layer of slopewash. Slope benches should be provided at maximum vertical height intervals of 30 feet.

To reduce the potential of damage due to rock falls from the steep cut slope, the toe of slope should be set-back a minimum of 10 feet from the edge of pavement to create a catchment area.

If layers of soil or extremely weathered rock are exposed in the 0.5 to 1 slope, it is recommended that these layers be cut back into the slope approximately two (2) feet and faced with grouted riprap. Alternately, the cut back could be faced with lean concrete or masonry grout. A detail of this recommendation is shown on Plate 5.

Near the finished grade of the slope faces, cutting should be done with extreme care. Overcutting beyond the design slope should be avoided as attempts to backfill and compact overcut areas would be highly impractical in basalt formation.

Surface water from areas above the slope should be diverted away from the cut and prevented from flowing across the slope face.

Due to the relatively high rainfall occurring in the vicinity of the project site and the nature of the geologic materials encountered, it would not be wholly unexpected to encounter zones of seepage, particularly intermittent seepage, in the cut faces. If encountered, special provisions such as horizontal drains or toe drains may be required to stabilize the slopes.

Waterline Trench

Based upon the limited exploration performed for the access road between the reservoir sites, it is anticipated that the excavation for the proposed waterline trench will be in weathered basalt and may require hard excavation techniques, e.g., hoerams or ripping. Shoring should be at the discretion of the contractor and should conform to the applicable health and safety regulations and statutes.

Trench Backfill

A suitable pipe cushion material, such as sand or S4C, should be used to backfill the trench to a height of 12 inches above the top of the pipe. This cushion material should be tamped as it is placed so that it is in full contact with the periphery of the pipe.

From the top of the cushion to finished subgrade, on-site soils excavated from the trench, or select imported material, may be used as backfill. The soil used should be less than three (3) inches in diameter, non-expansive and free of vegetation, organic matter and any other deleterious material. The soils should be moisture conditioned to near-optimum moisture content, placed in level lifts not exceeding six (6) inches in loose thickness and compacted to a minimum of 90% of the maximum dry density established by ASTM D-1557-78.

Road-way Pavements

Asphaltic concrete and concrete pavements are planned for the access roads and replacement of the pavement in the currently paved portions of the waterline alignment. Based upon the results of our exploration, the preliminary pavement design is as follows:

2 Inches Asphaltic Concrete
6 Inches Base Course
8 Inches Total Pavement Thickness

or 6 Inches of Concrete Pavement

CBR tests should be performed on the actual subgrade soils encountered during construction and the above design section revised, if necessary. The preliminary recommended section considers light traffic and is based upon the assumption that good drainage will be provided adjacent to paved areas.

Design Review

Plans and specifications for the proposed construction should be forwarded to the geotechnical engineer for review and written comment prior to construction. This review is needed to determine adherence to the earthwork and foundation recommendations given herein. If this review is not made, the geotechnical engineer can assume no responsibility for misinterpretation of the recommendations.

Construction Monitoring

It is recommended that the geotechnical engineer be retained to provide geotechnical engineering services during construction of the excavation and foundation phases of the work. This is to observe compliance with the design concepts, specifications or recommendations and to allow design changes in the event that subsurface conditions differ from that anticipated prior to start of construction. The recommendations given in this report are contingent upon such observations.

Any imported material required should be non-expansive, tested and approved by the geotechnical engineer prior to hauling to the site.

If actual exposed rock/soil conditions encountered during construction are different from those assumed or considered in this report, then appropriate modifications to the design should be made.

LIMITATIONS

The analyses and recommendations submitted in this report are based in part upon information obtained from field data points, such as borings, probes, test pits and/or seismic surveys. Variations of conditions between the field data points may occur; and the nature and extent of these variations may not become evident until construction. If variations then appear evident, it will be necessary to re-evaluate the recommendations given in this report.

The location of the field data points were approximately determined by scaling from the topographic survey map. Elevations of the data points were approximately determined from the topographic survey map. The physical locations and elevations of the field data points should be considered accurate only to the degree implied by the method used.

The stratification lines shown in graphic representations of the field data points depict the approximate boundaries between soil types, and, as such, may denote a gradual transition. The strata lines shown on profiles or cross-sections are based upon interpolation between field data points and may not represent actual subsurface conditions.

Water level data from the field data points was collected at the times given on the graphic representations and/or in the text of this report. This data has been reviewed and interpretations made in the formulation of this report. However, it must be noted that fluctuations may occur due to variations in rainfall, tides, temperature and other factors.

This report had been prepared for the exclusive use of Belt, Collins and Associates, Inc. for specific application to the site grading and foundation design of the project in accordance with generally accepted geotechnical engineering principles and practices. No other warranty, expressed or implied, is made.

This report has been prepared solely for the purpose of assisting the engineer in the preliminary design evaluation of the proposed project. Therefore, this report may not contain sufficient data, or the proper information, for use in contract bid estimation. A contractor wishing to bid on this project is urged to retain a competent geotechnical engineer to assist in the interpretation of this report and/or in the performance of additional site specific exploration for bid estimating purposes.

The owner/client should be aware that unanticipated soil conditions are commonly encountered. Unforeseen soil conditions, such as perched groundwater, soft deposits, hard layers or cavities, may occur in localized areas and may required additional probing or connections in the field (which may result in construction delays) to attain a properly constructed project. Therefore, sufficient contingency fund is thus recommended to accommodate these possible extra costs.

The following plates and appendices are attached and complete this report:

Appendix A	-	Field Exploration
Plates A-1.1 thru A-10	-	Boring Logs and Test Pit Logs
Plates A-11 thru A-17	-	Seismic Refraction Survey Results
Plate 1	-	Project Location Map

Plate 2	-	Site Plan-1
Plate 3	-	Site Plan-2
Plate 4	-	Sketch of Keying and Benching
Plate 5	-	Slope Facing Detail

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Respectfully submitted,

C.W. ASSOCIATES INC.
dba GEOLABS-HAWAII

By Clayton S. Mimura
Clayton S. Mimura, P.E.

CSM:DEF:lf

CLAYTON S. MIMURA
REGISTERED PROFESSIONAL ENGINEER
No. 4176
HAWAII, U.S.A.

APPENDIX A

Field Exploration

The subsurface conditions at the site were explored by drilling three (3) borings to depths between 31.0 and 37.0 feet and by excavating seven (7) test pits to depths between 3.0 and 9.0 feet below the existing ground surface at the approximate locations shown on the Site Plans, Plates 2 and 3. A portable hand-carried drill rig was used to drill the borings and a track-mounted backhoe was used to excavate the test pits.

The soils encountered in the borings and test pits were classified by visual and textural examination in the field by our engineer who continuously monitored the exploratory operations. All soils were classified in general conformance with the Unified Soil Classification System. A summary of the materials encountered are presented on the Boring Logs, Plates A-1.1 through A-3.1, and the Test Pit Logs, Plates A-4 through A-10.

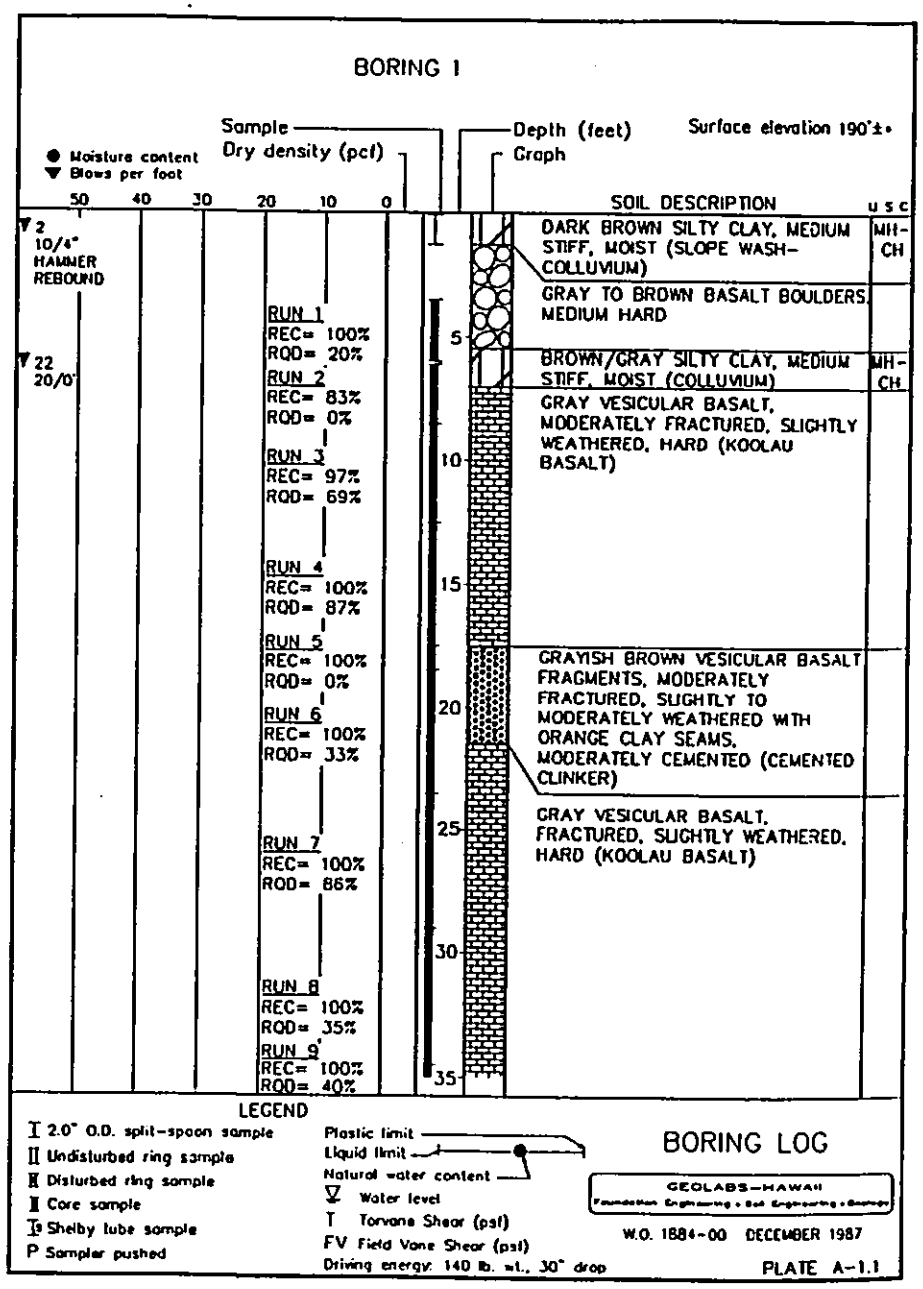
Soil samples were obtained from the borings by driving a 2-inch standard split-spoon sampler or a 2.4-inch I.D. split barrel sampler with a 140-pound hammer free falling 30 inches. The blow counts to drive the sampler the last 12 inches are shown on the Boring Logs at the appropriate sample depths.

Rock core samples were obtained by using a rotary wash "NX" core barrel. The core recovery and rock quality designation (RQD) are presented on the Boring Logs.

The data obtained from the test pits and borings was supplemented by the performance of geophysical surveys at the approximate locations shown on the Site Plans, Plates 2 and 3. These surveys consisted of seismic refraction seismograph to receive signals generated by the impact of a sledge hammer. The results and interpretations of these surveys are shown on the Seismic Refraction Survey Results, Plates A-11 through A-17.

W.O. 1884-00 DECEMBER 1987

(dk/no/46)



BORING 1 (CONTINUED)

Sample: ● Moisture content, ▼ Blows per foot; Dry density (pcf): 50 40 30 20 10 0

Depth (feet)	Graph	SOIL DESCRIPTION	U S C
		RUN 9 REC= 100% RQD= 40%	
40		GRAY VESICULAR BASALT, FRACTURED, SLIGHTLY WEATHERED, HARD (KOOLAU BASALT)	
		GRAYISH BROWN BASALT FRAGMENTS, MODERATELY CEMENTED (CEMENTED CLINKER)	
		BORING TERMINATED AT 37.0 FEET ON DECEMBER 23, 1987	
		GROUNDWATER NOT ENCOUNTERED	
		*ELEVATIONS ESTIMATED FROM POINTS SURVEYED BY TOWILL, SHIGEOKA & ASSOCIATES, INC. SEPTEMBER 1987.	

LEGEND

I 2.0" O.D. split-spoon sample
II Undisturbed ring sample
H Disturbed ring sample
X Core sample
Ⅲ Shelby tube sample
P Sampler pushed

Plastic limit
Liquid limit
Natural water content
▽ Water level
T Torvane Shear (psf)
FV Field Vane Shear (psf)
Driving energy: 140 lb. wt., 30" drop

BORING LOG

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PLATE A-1.2

BORING 2

Sample: ● Moisture content, ▼ Blows per foot; Dry density (pcf): 50 40 30 20 10 0

Depth (feet) Graph — Surface elevation 215'±

	SOIL DESCRIPTION	U S C
▼ 20/0" REFUSAL		
	RUN 1 REC= 63% RQD= 100%	
5	BROWNISH GRAY VESICULAR BASALT, MODERATELY FRACTURED, SLIGHTLY WEATHERED, MEDIUM HARD (KOOLAU BASALT)	
	RUN 2 REC= 100% RQD= 33%	
10	GRAY VESICULAR BASALT, MODERATELY FRACTURED, SLIGHTLY TO MODERATELY WEATHERED, HARD (KOOLAU BASALT)	
	RUN 3 REC= 98% RQD= 54%	
15	REDDISH GRAY VESICULAR BASALT, INTENSELY FRACTURED, MODERATELY WEATHERED, MEDIUM HARD (KOOLAU BASALT)	
	RUN 4 REC= 98% RQD= 23%	
	GRAYISH BROWN VESICULAR BASALT, MODERATELY FRACTURED, HIGHLY WEATHERED, MEDIUM SOFT TO MEDIUM HARD (KOOLAU BASALT)	
20	RUN 5 REC= 98% RQD= 53%	
	GRAY VESICULAR BASALT, MODERATELY FRACTURED, SLIGHTLY WEATHERED, MEDIUM HARD	
	GRAY DENSE BASALT, WIDELY FRACTURED, WEATHERED, HARD	
	RUN 6 REC= 98% RQD= 28%	
25	REDDISH GRAY VESICULAR BASALT, MODERATELY FRACTURED, SLIGHTLY TO MODERATELY WEATHERED, MEDIUM HARD (KOOLAU BASALT)	
	GRAYISH RED BASALT FRAGMENTS, MODERATELY TO HIGHLY WEATHERED MEDIUM DENSE (CLINKER)	
	RUN 7 REC= 100% RQD= 70%	
30	GRAY DENSE BASALT, WIDELY WEATHERED, HARD (KOOLAU BASALT)	
	RUN 8 REC= 100% RQD= 17%	
35	GRAYISH BROWN BASALT FRAGMENTS, MEDIUM DENSE (CLINKER)	

LEGEND

I 2.0" O.D. split-spoon sample
II Undisturbed ring sample
H Disturbed ring sample
X Core sample
Ⅲ Shelby tube sample
P Sampler pushed

Plastic limit
Liquid limit
Natural water content
▽ Water level
T Torvane Shear (psf)
FV Field Vane Shear (psf)
Driving energy: 140 lb. wt., 30" drop

BORING LOG

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PLATE A-2.1

BORING 2 (CONTINUED)

Sample — Depth (feet) — Surface elevation

● Moisture content
▼ Blows per foot
Dry density (pcf) — Graph

50 40 30 20 10 0

SOIL DESCRIPTION	U S C
RUN 8 REC= 100% ROD= 17%	
GRAYISH BROWN BASALT FRAGMENTS, MEDIUM DENSE (CLINKER)	
BORING TERMINATED AT 37.0 FEET ON DECEMBER 12, 1987	
GROUNDWATER NOT ENCOUNTERED	

40

LEGEND

I 2.0" O.D. split-spoon sample
II Undisturbed ring sample
III Disturbed ring sample
IX Core sample
IS Shelby tube sample
P Sampler pushed

Plastic limit
Liquid limit
Natural water content
▽ Water level
T Torvane Shear (psf)
FV Field Vane Shear (psf)
Driving energy: 140 lb. wt., 30" drop

BORING LOG

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PLATE A-2.2

BORING 3

Sample — Depth (feet) — Surface elevation 160'±

● Moisture content
▼ Blows per foot
Dry density (pcf) — Graph

50 40 30 20 10 0

SOIL DESCRIPTION	U S C
BROWN SILTY CLAY WITH GRAVEL, COBBLES AND BOULDERS, STIFF, DAMP (COLLUVIUM)	MH-CH
GRAY VESICULAR BASALT, MODERATELY FRACTURED, MODERATELY WEATHERED, MEDIUM HARD (KOOLAU BASALT)	
GRAY VESICULAR BASALT, MODERATELY TO SEVERELY JOINTED, MODERATELY TO HIGHLY WEATHERED, SOFT TO MEDIUM HARD (KOOLAU BASALT)	
GRAY DENSE BASALT, SLIGHTLY TO MODERATELY FRACTURED, MODERATELY WEATHERED, HARD (KOOLAU BASALT) GRADES TO SEVERELY FRACTURED WITH CLAY SEAMS AT 13.5 FEET	
GRAYISH BROWN VESICULAR BASALT, MODERATELY TO INTENSELY FRACTURED, MODERATELY TO HIGHLY WEATHERED, SOFT TO MEDIUM HARD (KOOLAU BASALT)	
GRAY DENSE BASALT, MODERATELY TO WIDELY FRACTURED, SLIGHTLY WEATHERED, HARD (KOOLAU BASALT)	
GRAYISH BROWN VESICULAR BASALT, MODERATELY FRACTURED, MODERATELY TO HIGHLY WEATHERED, SOFT TO MEDIUM HARD	
BORING TERMINATED AT 31.0 FEET ON DECEMBER 14, 1987	
GROUNDWATER NOT ENCOUNTERED	
RUN 1 REC= 100% ROD= 55%	
RUN 2 REC= 100% ROD= 62%	
RUN 3 REC= 100% ROD= 0%	
RUN 4 REC= 96% ROD= 13%	
RUN 5 REC= 100% ROD= 69%	
RUN 6 REC= 100% ROD= 87%	

5 10 15 20 25 30

LEGEND

I 2.0" O.D. split-spoon sample
II Undisturbed ring sample
III Disturbed ring sample
IX Core sample
IS Shelby tube sample
P Sampler pushed

Plastic limit
Liquid limit
Natural water content
▽ Water level
T Torvane Shear (psf)
FV Field Vane Shear (psf)
Driving energy: 140 lb wt., 30" drop

BORING LOG

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PLATE A-3.1

TEST PIT LOG

LOCATION OF TEST PIT	WORK ORDER	TEST PIT NO.	DATE	LOGGED BY
WAAHILA RESERVOIRS	1884-00	TP-1	11-25-87	D.P. FORD

DEPTH (FEET)	SOIL DESCRIPTION (TYPE, COLOR, MOISTURE, DENSITY, CONSISTENCY, BEDDING, JOINTS, GROUNDWATER)
	DARK GRAYISH BROWN CLAY (CH), MEDIUM STIFF, MOIST (ADOBE-SLOPEWASH)
2	GRAY TO REDDISH BROWN VESICULAR BASALT, SOFT TO MEDIUM HARD, MODERATELY TO HIGHLY WEATHERED (KOOLAU BASALT)
4	
6	
△	TEST PIT TERMINATED AT 7.0 FEET ON NOVEMBER 25, 1987
8	GROUNDWATER NOT ENCOUNTERED

SCALE:
H: 1" = 2'
V: 1" = 2'

TEST PIT ORIENTATION: PERPENDICULAR TO SLOPE

NATURAL SLOPE:

SURFACE ELEVATION: 389'±*

*ELEVATIONS ESTIMATED FROM PROPOSED BORING LOCATIONS SURVEYED BY TOWILL, SHIGEOKA & ASSOCIATES (UNDATED)

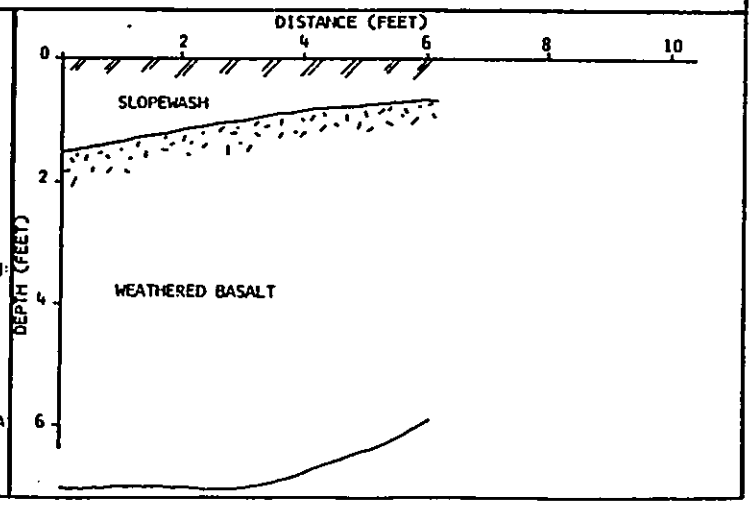

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PLATE A-4

TEST PIT LOG

LOCATION OF TEST PIT	WORK ORDER	TEST PIT NO.	DATE	LOGGED BY
WAAHILA RESERVOIRS	1884-00	TP-2	11-25-87	D.P. FORD

DEPTH (FEET)	SOIL DESCRIPTION (TYPE, COLOR, MOISTURE, DENSITY, CONSISTENCY, BEDDING, JOINTS, GROUNDWATER)
	GRAY VESICULAR BASALT WITH CLAY FILLED VESICLES, SOFT TO MEDIUM HARD, MODERATELY TO HIGHLY WEATHERED (KOOLAU BASALT)
2	
4	
6 △	GRAY DENSE BASALT, HARD, SLIGHTLY TO MODERATELY WEATHERED (REFUSAL)
	TEST PIT TERMINATED AT 6.0 FEET ON NOVEMBER 25, 1987
	GROUNDWATER NOT ENCOUNTERED

SCALE:
H: 1" = 2'
V: 1" = 2'

TEST PIT ORIENTATION: PERPENDICULAR TO SLOPE

NATURAL SLOPE: 2:1 (H:V)

SURFACE ELEVATION: 435'±*

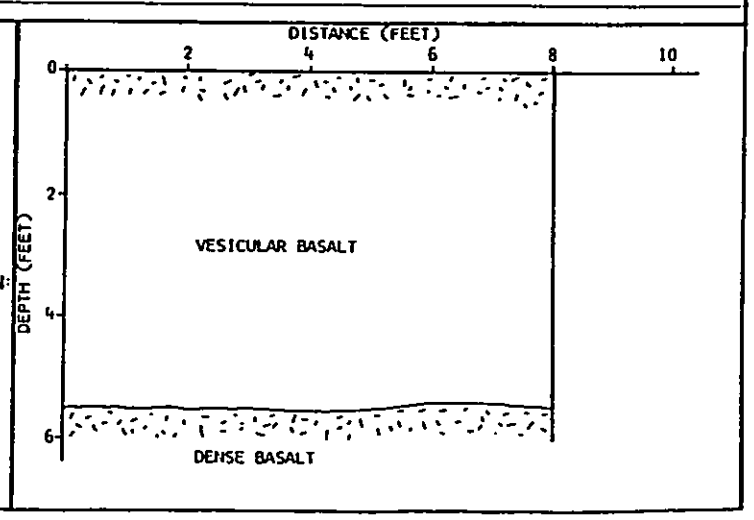

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PLATE A-5

TEST PIT LOG

LOCATION OF TEST PIT	WORK ORDER	TEST PIT NO.	DATE	LOGGED BY
WAAHILA RESERVOIRS	1884-00	TP-3	11-27-87	D.P. FORD

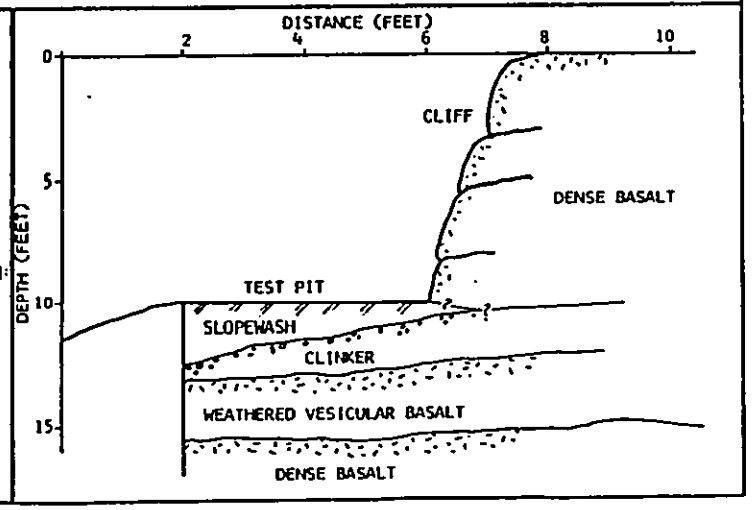
DEPTH (FEET)	SOIL DESCRIPTION (TYPE, COLOR, MOISTURE, DENSITY, CONSISTENCY, BEDDING, JOINTS, GROUNDWATER)
	BROWN CLAYEY SILT (MH-CH) WITH GRAVEL, COBBLES AND BOULDERS,
	STIFF, DAMP (SLOPEWASH)
2	GRAY TO REDDISH BROWN COARSE GRAVEL (GP), LOOSE TO MEDIUM DENSE,
	HIGHLY WEATHERED (KOOLAU BASALT CLINKER)
4	BROWN TO GRAY VESICULAR BASALT, SOFT TO MEDIUM HARD, MODERATELY
	TO HIGHLY WEATHERED (KOOLAU BASALT)
6	GRAY DENSE BASALT, HARD (REFUSAL)
△	TEST PIT TERMINATED AT 6.5 FEET ON NOVEMBER 27, 1987
	GROUNDWATER NOT ENCOUNTERED

SCALE:
H: 1" = 2'
V: 1" = 5'

TEST PIT ORIENTATION: PERPENDICULAR TO SLOPE

NATURAL SLOPE:

SURFACE ELEVATION: 247'±"



GEOLABS-HAWAII PLATE A-6

TEST PIT LOG

LOCATION OF TEST PIT	WORK ORDER	TEST PIT NO.	DATE	LOGGED BY
WAAHILA RESERVOIRS	1884-00	TP-4	11-27-87	D.P. FORD

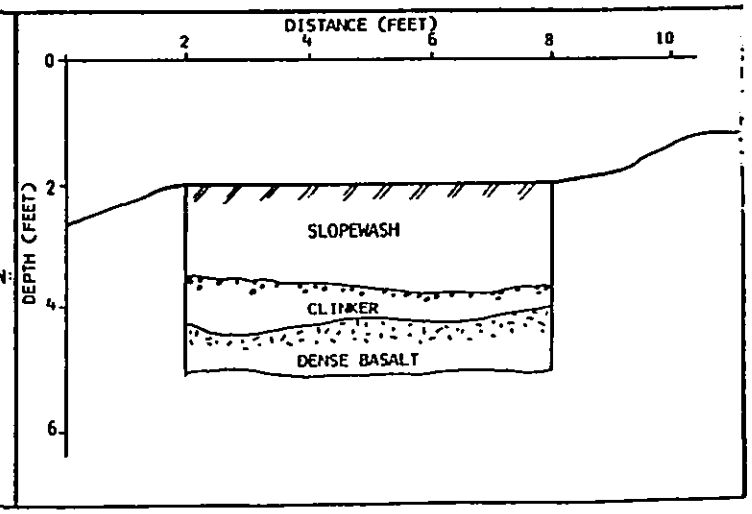
DEPTH (FEET)	SOIL DESCRIPTION (TYPE, COLOR, MOISTURE, DENSITY, CONSISTENCY, BEDDING, JOINTS, GROUNDWATER)
	BROWN CLAY (CH) WITH TRACES OF ROOTS, STIFF, MOIST (ADOBE-SLOPEWASH)
2	REDDISH BROWN COARSE GRAVEL (GP), LOOSE TO MEDIUM DENSE,
	HIGHLY WEATHERED (KOOLAU BASALT CLINKER)
	GRAY DENSE BASALT, HARD, SLIGHTLY WEATHERED (REFUSAL)
△	TEST PIT TERMINATED AT 3.0 FEET ON NOVEMBER 27, 1987
4	GROUNDWATER NOT ENCOUNTERED

SCALE:
H: 1" = 2'
V: 1" = 2'

TEST PIT ORIENTATION:

NATURAL SLOPE: RELATIVELY FLAT

SURFACE ELEVATION: 358'±"



GEOLABS-HAWAII PLATE A-7

TEST PIT LOG

LOCATION OF TEST PIT	WORK ORDER	TEST PIT NO.	DATE	LOGGED BY
WAAHILA RESERVOIRS	1884-00	TP-5	11-27-87	D.P. FORD

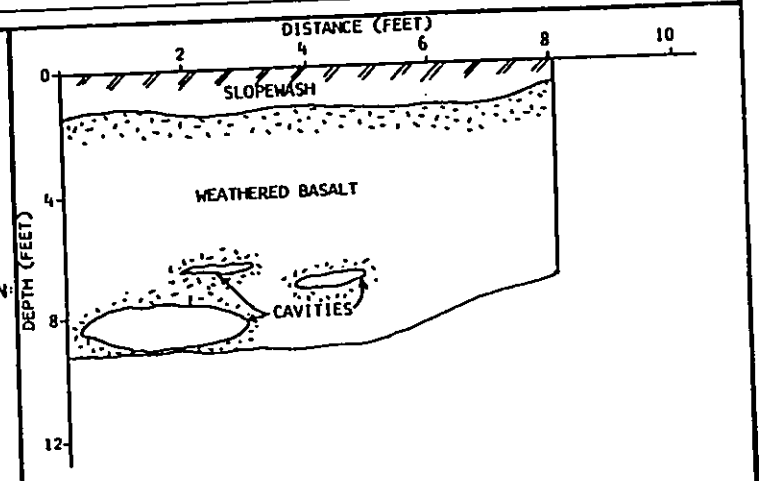
DEPTH (FEET)	SOIL DESCRIPTION (TYPE, COLOR, MOISTURE, DENSITY, CONSISTENCY, BEDDING, JOINTS, GROUNDWATER)
	GRAYISH BROWN CLAY (CH) WITH GRAVEL, COBBLES AND BOULDERS, STIFF, SLIGHTLY MOIST (ADOBE-SLOPEWASH)
2	GRAY VESICULAR BASALT, MODERATELY JOINTED, SOFT TO MEDIUM HARD, MODERATELY TO HIGHLY WEATHERED (KOOLAU BASALT)
4	
6	(SMALL LAVA TUBES AND CAVITIES FROM 6.0 - 9.0 FEET)
8	HARD, REFUSAL AT 9.0 FEET
△ 10	TEST PIT TERMINATED AT 9.0 FEET ON NOVEMBER 27, 1987
	GROUNDWATER NOT ENCOUNTERED

SCALE:
H: 1" = 2'
V: 1" = 4'

TEST PIT ORIENTATION:

NATURAL SLOPE: RELATIVELY LEVEL

SURFACE ELEVATION: 212'±



GEOLABS-HAWAII

PLATE A-8

TEST PIT LOG

LOCATION OF TEST PIT	WORK ORDER	TEST PIT NO.	DATE	LOGGED BY
WAAHILA RESERVOIRS	1884-00	TP-6	12-8-87	D.P. FORD

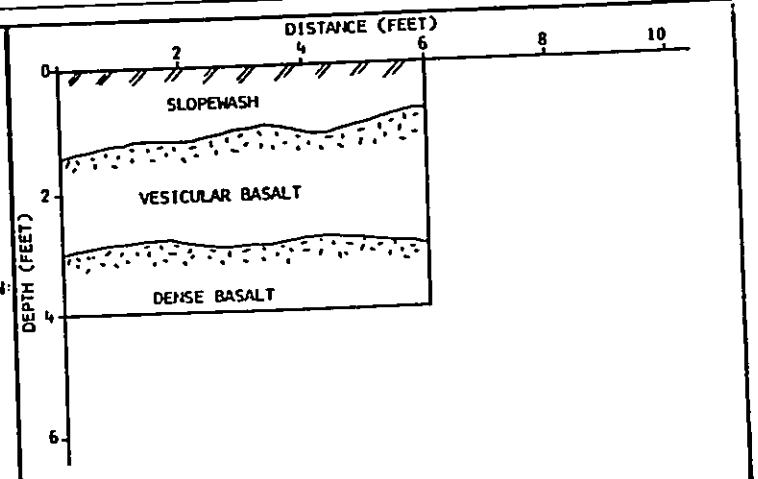
DEPTH (FEET)	SOIL DESCRIPTION (TYPE, COLOR, MOISTURE, DENSITY, CONSISTENCY, BEDDING, JOINTS, GROUNDWATER)
	BROWN CLAY WITH GRAVEL (MH-CH), COBBLES AND BOULDERS, STIFF, DAMP (ADOBE-SLOPEWASH)
2	GRAY TO REDDISH BROWN VESICULAR BASALT, MEDIUM HARD, MODERATELY TO HIGHLY WEATHERED (KOOLAU BASALT)
	GRAY DENSE BASALT, HARD, SLIGHTLY WEATHERED (KOOLAU BASALT)
△ 4	TEST PIT TERMINATED AT 4.0 FEET ON DECEMBER 8, 1987
	GROUNDWATER NOT ENCOUNTERED

SCALE:
H: 1" = 2'
V: 1" = 2'

TEST PIT ORIENTATION: PERPENDICULAR TO SLOPE

NATURAL SLOPE:

SURFACE ELEVATION: 165'±



GEOLABS-HAWAII

PLATE A-9

TEST PIT LOG

LOCATION OF TEST PIT	WORK ORDER	TEST PIT NO.	DATE	LOGGED BY
WAAHILA RESERVOIR	1884-00	TP-7	11-27-87	D.P. FORD

DEPTH (FEET)	SOIL DESCRIPTION (TYPE, COLOR, MOISTURE, DENSITY, CONSISTENCY, BEDDING, JOINTS, GROUNDWATER)
2	BROWN SILTY CLAY (MH-CH) WITH BOULDERS, COBBLES AND GRAVEL,
	STIFF, DAMP (ADOBE-SLOPEWASH)
4	
	GRAY TO REDDISH BROWN COARSE GRAVEL, LOOSE TO MEDIUM DENSE,
6	WEATHERED (KOOLAU BASALT CLINKER)
	GRAY TO REDDISH BROWN DENSE BASALT, SOFT TO MEDIUM HARD,
8	MODERATELY WEATHERED (KOOLAU BASALT)
	HARD, REFUSAL AT 9.0 FEET
△ 10	TEST PIT TERMINATED AT 9.0 FEET ON NOVEMBER 27, 1987
	GROUNDWATER NOT ENCOUNTERED

SCALE:
H: 1" = 2'
V: 1" = 4'

TEST PIT ORIENTATION: PERPENDICULAR TO SLOPE

NATURAL SLOPE:

SURFACE ELEVATION: 187'±

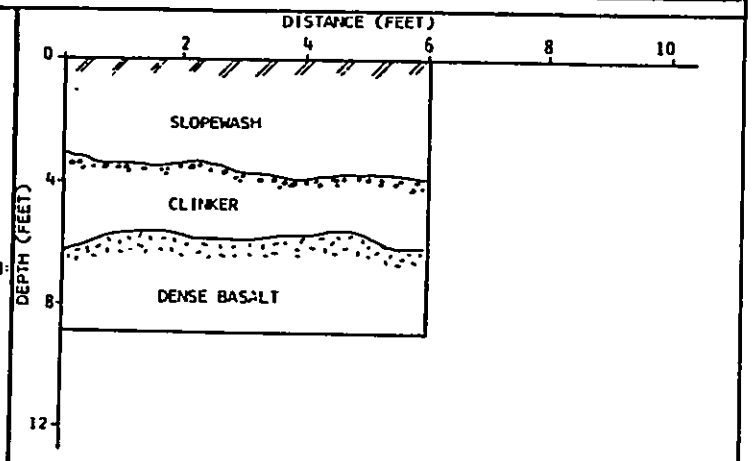


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PLATE A-10

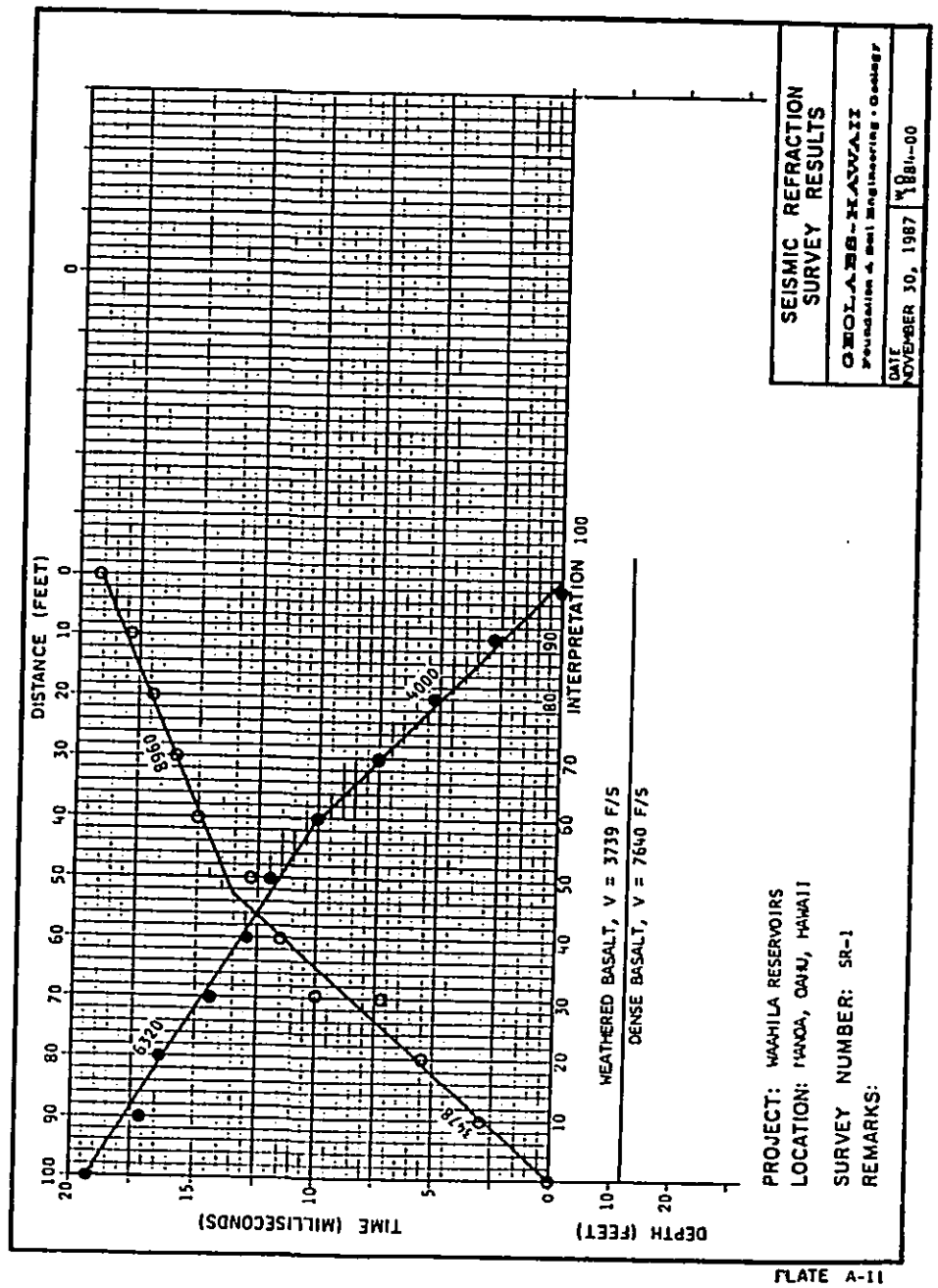


PLATE A-11

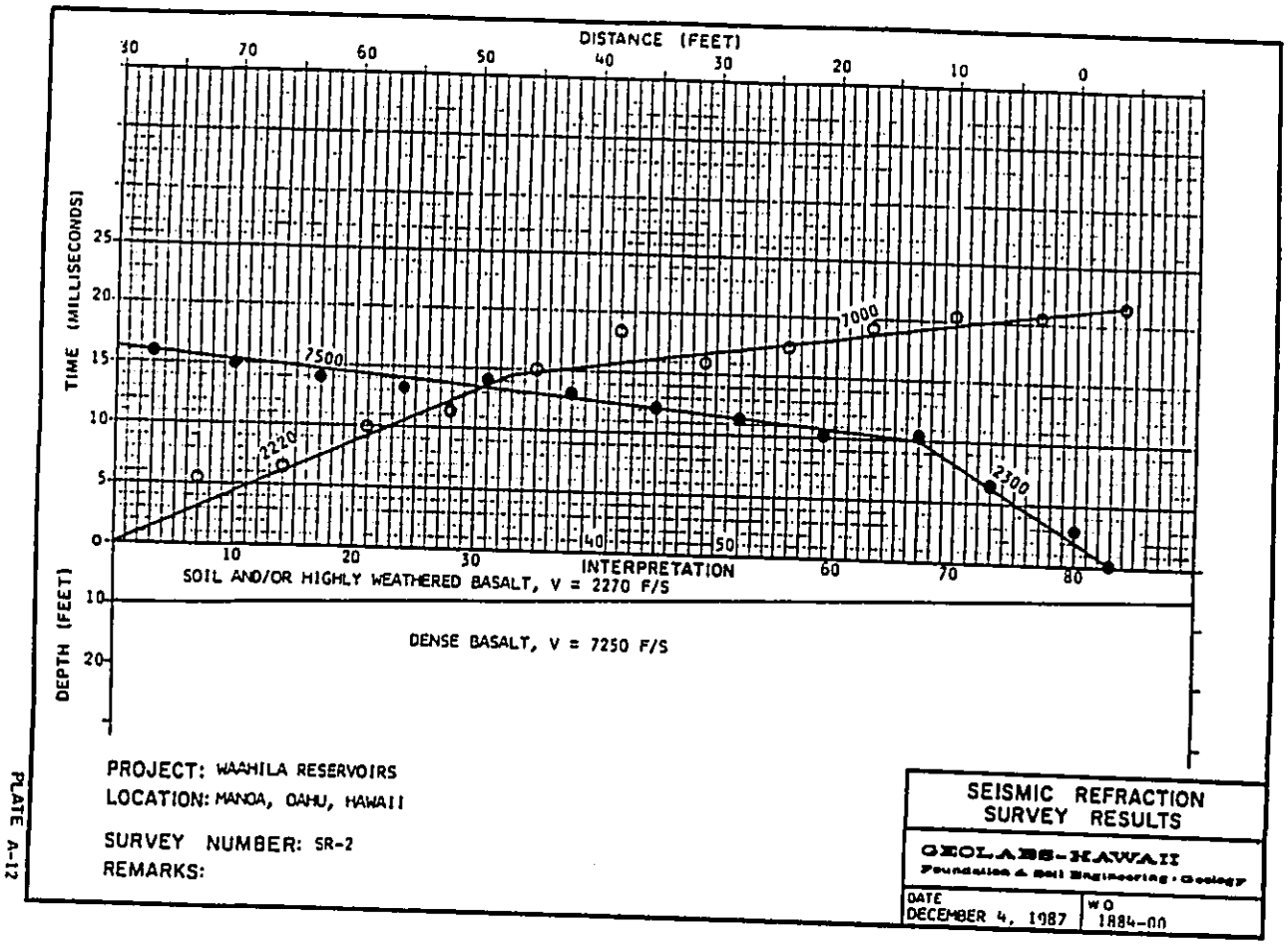


PLATE A-12

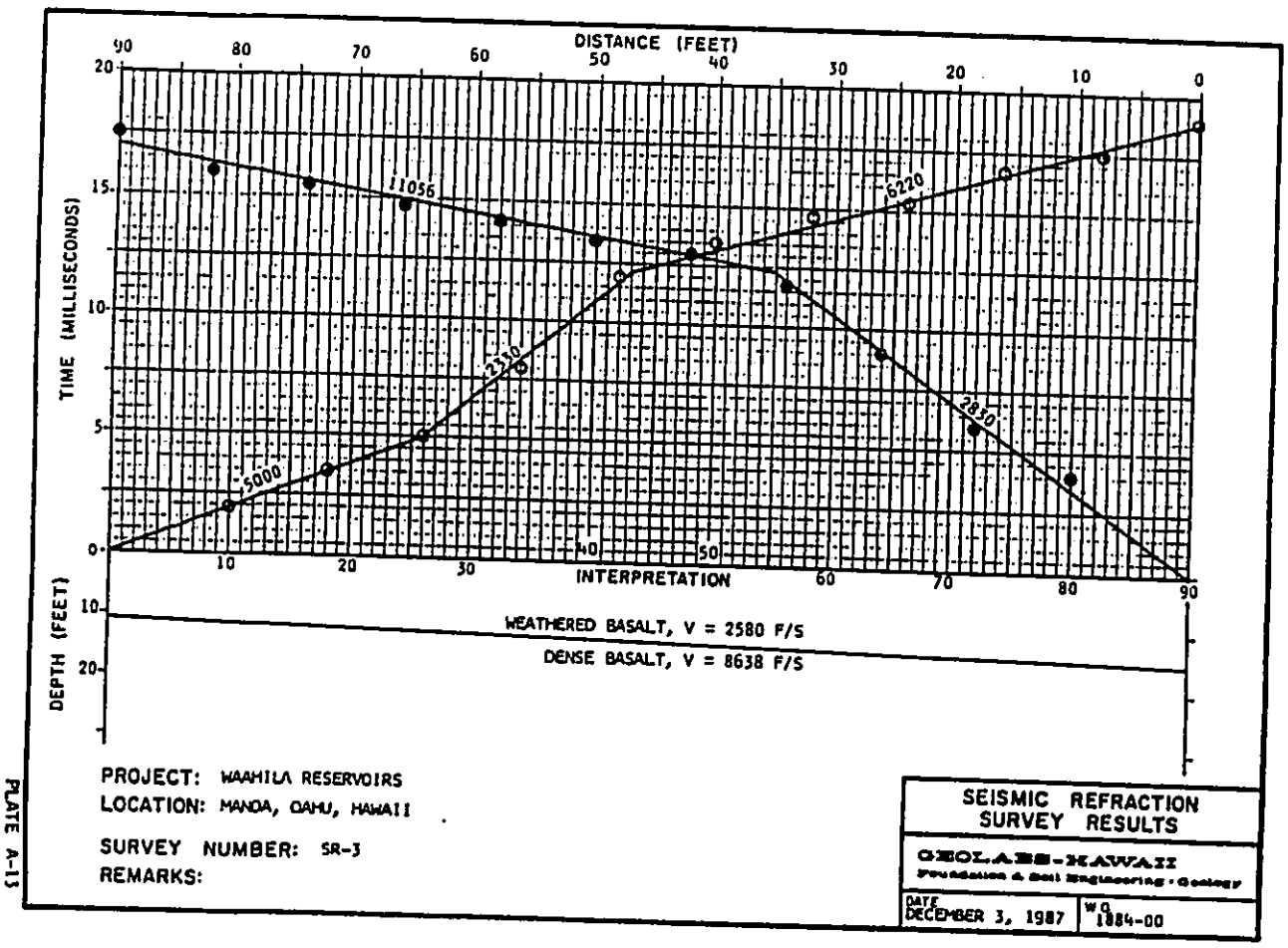
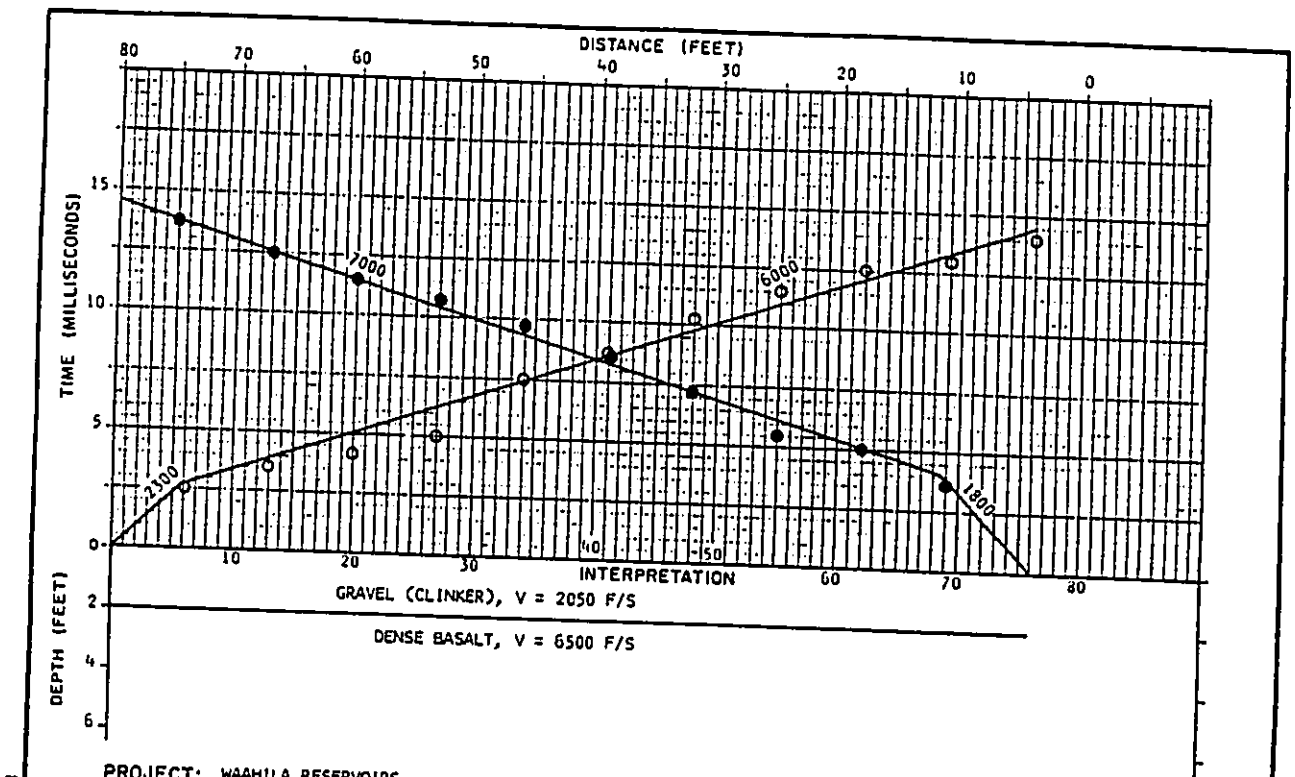


PLATE A-13

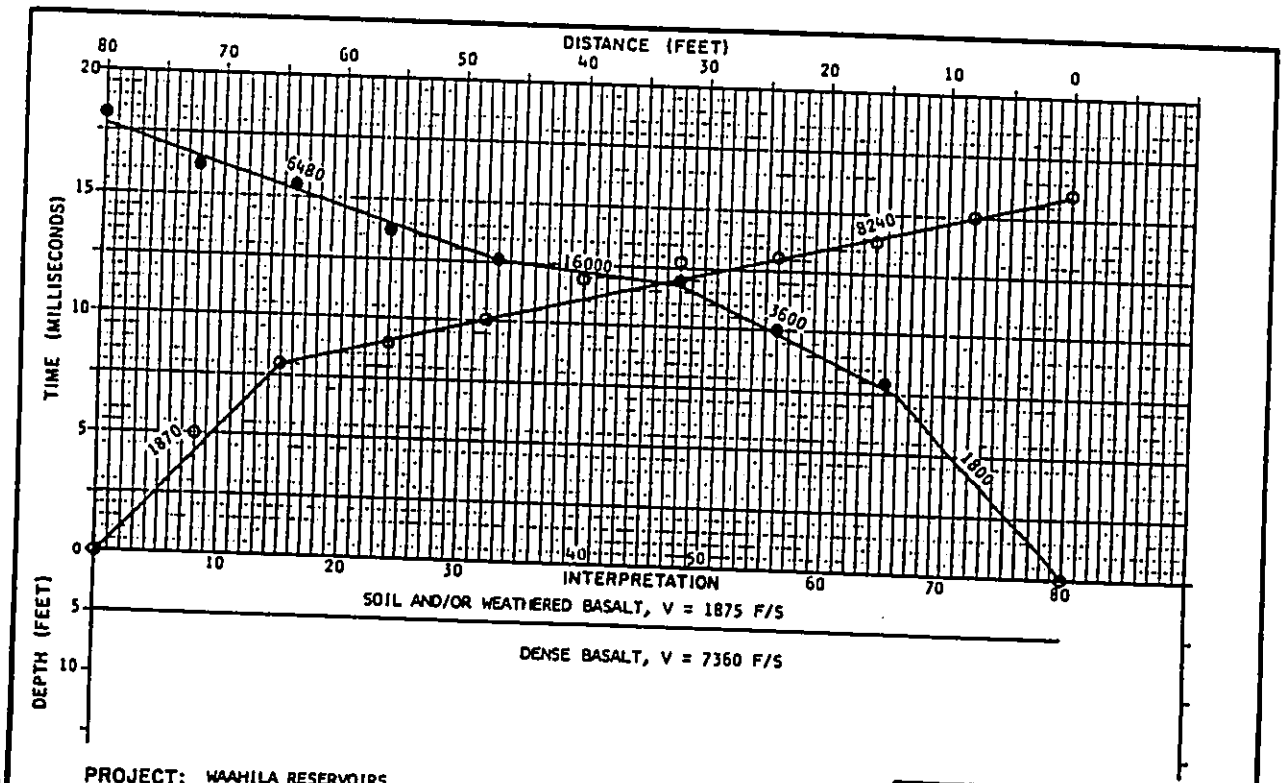


PROJECT: WAAHILA RESERVOIRS
LOCATION: MANOA, OAHU, HAWAII

SURVEY NUMBER: SR-4
REMARKS:

SEISMIC REFRACTION SURVEY RESULTS	
GEOLABS-HAWAII Foundation & Soil Engineering · Geology	
DATE DECEMBER 4, 1987	W.O. 1884-00

PLATE A-14

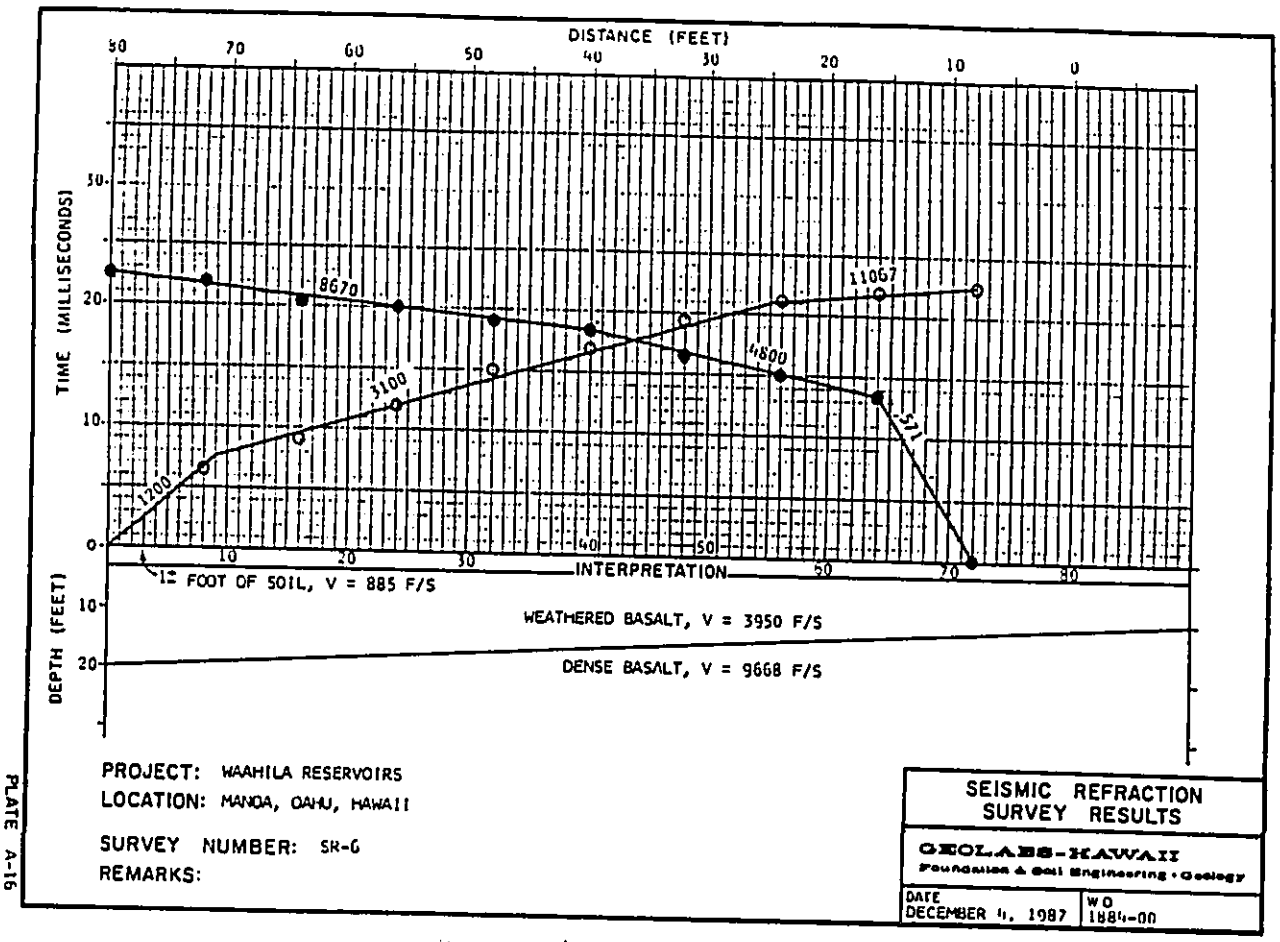


PROJECT: WAAHILA RESERVOIRS
LOCATION: MANOA, OAHU, HAWAII

SURVEY NUMBER: SR-5
REMARKS:

SEISMIC REFRACTION SURVEY RESULTS	
GEOLABS-HAWAII Foundation & Soil Engineering · Geology	
DATE DECEMBER 4, 1987	W.O. 1884-00

PLATE A-15


DISTANCE (FEET)
TIME (MILLISECONDS)
DEPTH (FEET)
1200
3100
8670
4800
11067
571
INTERPRETATION
12 FOOT OF SOIL, V = 885 F/S
WEATHERED BASALT, V = 3950 F/S
DENSE BASALT, V = 9668 F/S
PROJECT: WAAHILA RESERVOIRS
LOCATION: MANOA, OAHU, HAWAII
SURVEY NUMBER: SR-6
REMARKS:
SEISMIC REFRACTION SURVEY RESULTS
GEOLABS-HAWAII
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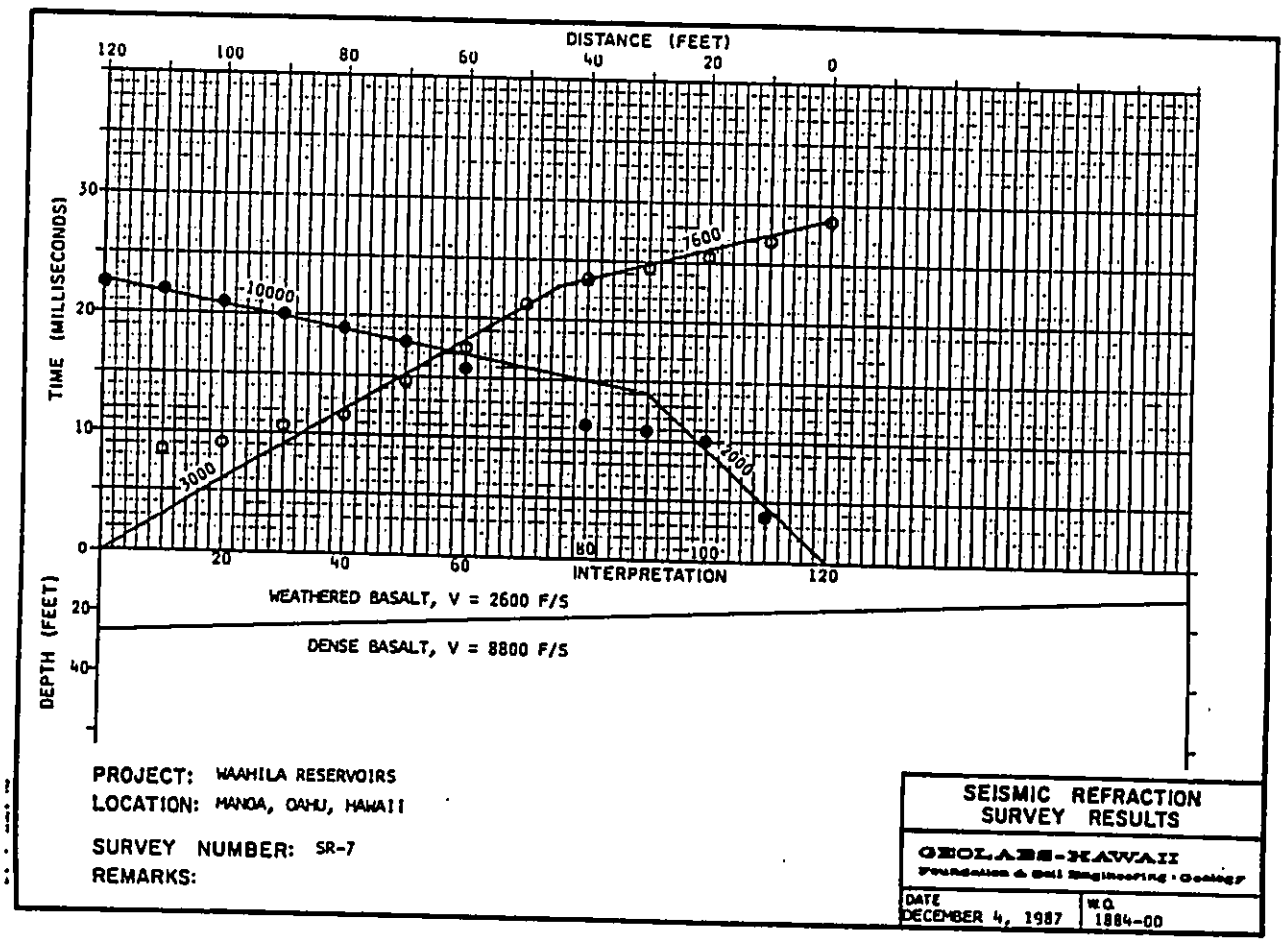
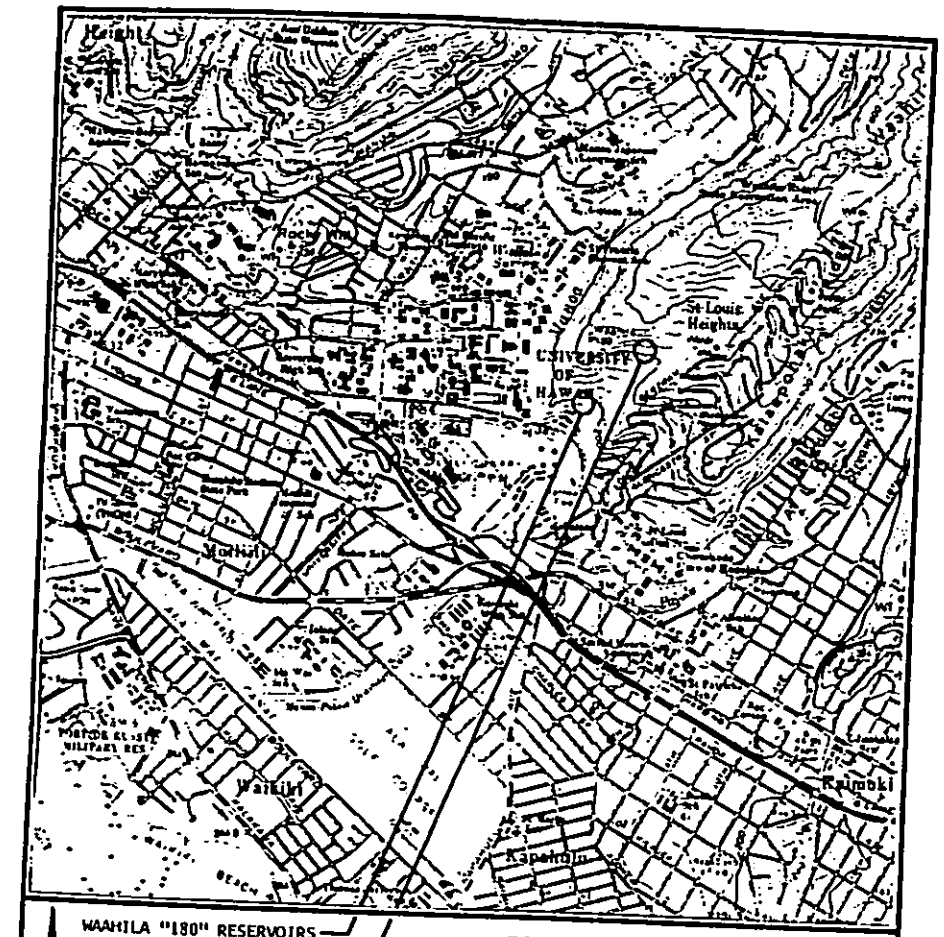
W.O. 1884-00

PLATE A-16


DISTANCE (FEET)
TIME (MILLISECONDS)
DEPTH (FEET)
3000
10000
7600
1000
INTERPRETATION
WEATHERED BASALT, V = 2600 F/S
DENSE BASALT, V = 8800 F/S
PROJECT: WAAHILA RESERVOIRS
LOCATION: MANOA, OAHU, HAWAII
SURVEY NUMBER: SR-7
REMARKS:
SEISMIC REFRACTION SURVEY RESULTS
GEOLABS-HAWAII
DATE DECEMBER 4, 1987
W.O. 1884-00



PROJECT LOCATION MAP

PROPOSED WAAHILA "180" AND "405"
4.0 M.G. RESERVOIRS
MANOA, OAHU, HAWAII

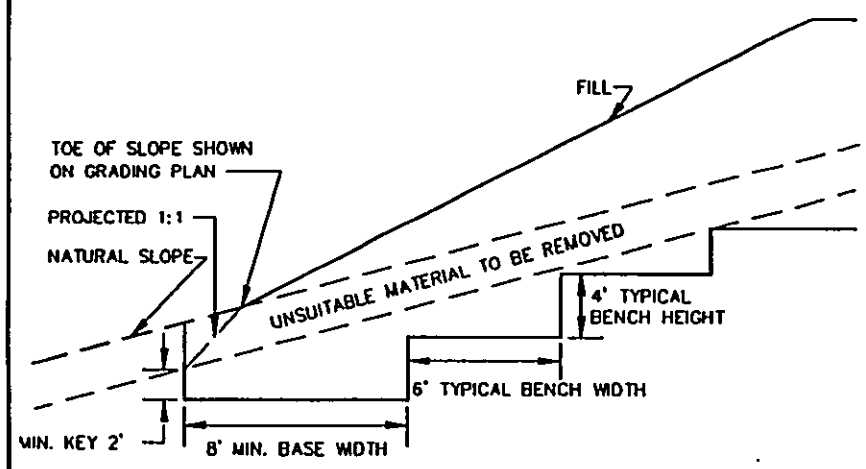
REFERENCE: U.S.G.S. QUADRANGLE MAP; HONOLULU, OAHU, HAWAII (1983)

PLATE 1

GEOLABS-HAWAII
Foundation & Soil Engineering • Geology

DATE	DRAWN BY
JANUARY 1988	KHN
SCALE	W.O.
1" = 2,000'	1884-00

GENERAL GRADING RECOMMENDTIONS
TYPICAL FILL ON NATURAL SLOPE



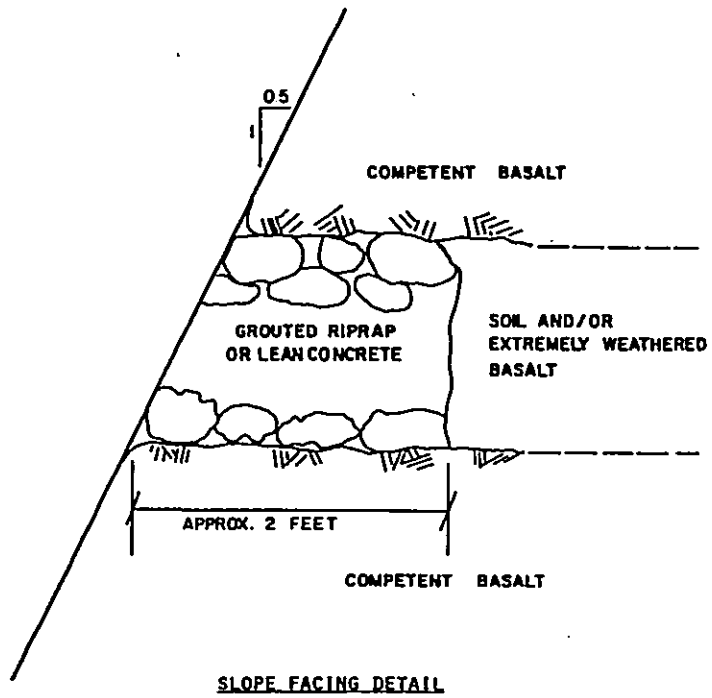
NOTE:

WHERE NATURAL SLOPE IS 5:1 OR FLATTER, BENCHING IS NOT NECESSARY. HOWEVER FILL SHOULD NOT BE PLACED ON COMPRESSIBLE OR UNSUITABLE MATERIAL.

NOT TO SCALE

PLATE 4

SKETCH OF KEYING & BENCHING	
GEOLABS–HAWAII Foundation & Soil Engineering Geology	
DATE 12/4/87	W.O. 1884-00



SLOPE FACING DETAIL

WAAHILA "180" & "405"
4.0 M.G. RESERVOIRS

GEOLABS-HAWAII Foundation & Soil Engineering • Geology	
DATE DECEMBER 1987	W.O. 1884-00

PLATE 5

APPENDIX B

FLORA SURVEY
WAAHILA RESERVOIR PROJECT
MANOA, ISLAND OF OAHU

by

George K. Linney
Winona P. Char

CHAR & ASSOCIATES
Botanical/Environmental Consultants
Honolulu, Hawaii

Prepared for BELT COLLINS & ASSOCIATES
October 1987

SUMMARY

On 17 October 1987, a botanical survey was made of lower Waahila Ridge above the University of Hawaii faculty housing. A total of 46 vascular plant species were found on the site, of which 42 are exotic, and only 4 are considered native or Polynesian-introductions. Not a single Hawaiian endemic species was encountered, and none of the species are rare, threatened, or endangered. There does not seem to be any botanical impediment to developing the area.

INTRODUCTION

Lower Waahila Ridge is largely a boulder-field with a SW-NE-trending rise of about 1 foot per 6 feet of horizontal distance, and with occasionally higher rock ledges. To the NW and SE there are steeper hillsides, and the rock ledges predominate. Soil is relatively deep except on top of the ledges. The vegetation is largely grassland, with scrub and small trees where the soil permits. From adjacent to the present faculty housing at an elevation of about 96 feet to an elevation of about 550 feet, a site has been selected for the construction of two reservoirs and their service road. This is a report of the vegetation in and adjacent to this site.

Char (1986) has prepared a survey of the vegetation on the steeper slope above Manoa stream, just a short distance to the west of the present site. Some 27 of the 59 species in her report were not found on the present site, while some 12 species found on the present site were not reported by her. Most of these discrepancies represent single specimens or seasonal differences. In addition there are a number of taxonomic and nomenclatural differences, reflecting changes in taxonomic opinion in the intervening 17 months. Most of this is attributable to the availability of a manuscript of the forthcoming flowering plant manual (Wagner et al., in prep.) Otherwise, there is a close congruence of the two sites, despite significant differences in slope and exposure. In general, the present site is more homogeneous than that studied by Char, with little of the rainfall-gradient-based variation observed by her.

METHODS

A walk-through survey method was employed on this site. For the most part, the center of the walk-through followed the surveyors' flagging. Species were mostly sight-identified in the field, though plants of unknown identity were collected and identified later by reference to standard literature and known specimens. Taxonomy of ferns follows Wagner and Wagner (1987, unpublished), while taxonomy of flowering plants is based largely on Wagner et al. (in prep.)

Also, note was made of the structure and composition of the vegetation type. As the work was done at the very end of the dry season, the species encountered may be slightly less than actually present. A number of characteristic weedy annuals were missing, and there was only the slightest evidence that germination of the season's seeds was beginning. Later in the season, after significant rain, a number of additional annual species should be expected to appear on the site. Because they are exotic weeds, their being undetected in this survey is not considered a serious limitation.

DESCRIPTION OF THE VEGETATION

The most prevalent plant on the site is Guinea grass (Panicum maximum and its smaller form, var. trichoglume). Grass-cover is about 70-80%, with the grass reaching heights of 2 meters or more. Two woody species form an open scrub over much of the site, but probably with not much more than 30-40% coverage. These small trees, generally less than 4 meters tall, are kolomona (Senna surratensis) and koa-haole (Leucaena leucocephala); and though they appear to favor patches of boulders where the Guinea grass is excluded, there is some overlap of grass and scrub. Patches of scrub often have an undergrowth of Chinese violet (Asystasia gangetica), again perhaps due to the exclusion of the grass by the boulders. On top of rocky ledges, the soil is too thin to support Guinea grass, and sour grass (Digitaria insularis) predominates instead. In a few places, where the soil is too thin to support any significant cover, the rather sparse layer of grasses is mostly Natal redtop (Rhynchelytrum repens), finger grass (Chloris barbata), foxtail (Setaria gracilis), and pili (Heteropogon contortus). In addition some

escaped exotic ornamentals, well adapted to the harsh conditions, have become established on almost bare rock. These include carrion flower (Stapelia gigantea) and pedilanthus (Pedilanthus padifolius).

A number of trees were found widely scattered on the site, with little evident pattern or trend, including kiawe (Prosopis pallida), silk-oak (Grevillea robusta), Chinese banyan (Ficus microcarpa), and logwood (Haematoxylum campechianum). Several trees are represented on the site by a single specimen: octopus tree (Schefflera actinophylla), autograph tree (Clusia rosea), monkey pod (Samanea saman), and Java plum (Syzygium cumini). Minor elements of the scrub are klu (Acacia farnesiana), lantana (Lantana camara), Christmas berry (Schinus terebinthifolius), guava (Psidium guajava), and panini (Opuntia ficus-indica). Vines are not a major component of the vegetation, but two morning glories (Ipomoea obscura and Ipomoea cairica), and a weedy passionflower (Passiflora suberosa) are occasional. A single potato vine (Solanum seaforthianum) seedling was encountered. Relatively minor components of the undergrowth are comb hyptis (Hyptis pectinata), Abutilon incanum, Stachytarpeta jamaicensis, 'uhaloa (Waltheria indica var. americana), Phyllanthus debilis, partridge pea (Chamaecrista nictitans), indigo (Indigofera suffruticosa), and cliffbrake (Pellaea viridis), the sole fern on the site.

DISCUSSION

The proposed project is not expected to have any significant negative impact on the flora of the site, as it is composed almost exclusively of exotic weedy species. Moreover, they are found throughout the islands in similar habitats. Not a single Hawaiian endemic species was found on the site, and those considered indigenous are questionably so, as they are widespread weedy species in the Pacific, and may have accompanied man here fairly early. None of the plants are listed, proposed, or candidate as rare, threatened, or endangered species. The only noteworthy plant is an unknown jasmine (Jasminum sp.) represented by a single specimen. This aggressive weed was first encountered at Lahilahi Pt. (Makaha, Oahu) earlier this year. It is very weedy, with a tendency to form dense tangles, and its seeds are readily dispersed by birds. The species appears to have been at Lahilahi Pt. for many

years, and at Waahila Ridge for at least a few. Seeds have surely been spread beyond the known locations already, and the plants can be expected to appear elsewhere in the future.

LITERATURE CITED

Char, W. P. 1986. Flora survey of Manoa Hillside Estates HELCO transmission route realignment. Prepared for Environmental Communications, Inc., Honolulu, May 1986.

Wagner, W. H., Jr., and F. S. Wagner. 1987. Revised checklist of Hawaiian pteridophytes. (unpublished).

Wagner, W. L., D. Herbst, and S. Sohmer. (in prep.) Manual of the flowering plants of the Hawaiian Islands.

APPENDIX 1. Plant Species List

Plants are divided into ferns and flowering plants, with the latter further divided into monocots and dicots. Within each group, they are arranged in alphabetical order by family. The following symbols are used:

SCIENTIFIC NAME
s.l. - in a very broad sense
sp. - species not yet determined

BIOGEOGRAPHICAL STATUS
I - indigenous, native to the Hawaiian islands and elsewhere
P - Polynesian introduction, not native here
X - exotic, not native here, but introduced since the arrival of Western man

SPECIES LIST

SCIENTIFIC NAME	COMMON NAME	BIOGEOGRAPHIC STATUS
FERNS		
Adiantaceae		
Pellaea viridis (Forsk.) Prantl	cliffbrake	X
FLOWERING PLANTS		
MONOCOTS		
Gramineae		
Chloris barbata (L.) Sw.	finger grass	X
Digitaria insularis (L.) Mez ex Ekman	sour grass	X
Eragrostis tenella (L.) Beauv. ex R. & S.	Japanese love-grass	X
Heteropogon contortus (L.) Beauv. ex R. & S.	pili	P
Panicum maximum Jacq.	Guinea grass	X
Panicum maximum Jacq. var. *trichoglume* Eyles ex Robyns	green panic grass	X
Rhynchelytrum repens (Willd.) C. E. Hubb.	Natal redtop	X
Setaria gracilis Kunth. in Humb. & Bonpl.	foxtail	X
Liliaceae s.l.		
Agave sisalana Perrine ex Englem.	sisal	X
Sansevieria trifasciata Prain	sansevieria	X

SCIENTIFIC NAME	COMMON NAME	STATUS
DICOTS		
Acanthaceae		
Asystasia gangetica (L.) T. Anders.	Chinese violet	X
Amaranthaceae		
Amaranthus spinosus L.	spiny pigweed	X
Anacardiaceae		
Schinus terebinthifolius Raddi	Christmas berry	X
Araliaceae		
Schefflera actinophylla (Endl.) Harms	octopus tree	X
Asclepiadaceae		
Stapelia gigantea N. E. Brown	carrion flower	X
Cactaceae		
Opuntia ficus-indica (L.) Mill.	panini	X
Convolvulaceae		
Ipomoea cairica (L.) Sw.	koali	I
Ipomoea obscura (L.) Ker-Gawl.	yellow bindweed	X
Euphorbiaceae		
Pedilanthes padifolius (L.) Poit.	pedilanthes	X
Phyllanthus debilis Klein ex Willd.	phyllanthus	X

SCIENTIFIC NAME	COMMON NAME	STATUS
Guttiferae		
Clusia rosea Jacq.	autograph tree	X
Labiatae		
Hyptis pectinata (L.) Poit.	comb hyptis	X
Leguminosae		
Acacia farnesiana (L.) Willd.	klu, huisache	X
Chamaecrista nictitans (L.) Moench.	partridge pea, lau-ki	X
Desmanthus virgatus (L.) Willd.	virgate mimosa	X
Indigofera suffruticosa Mill.	indigo	X
Haematoxylum campechianum L.	logwood	X
Leucaena leucocephala (Lam.) de Wit	koa-haole	X
Prosopis pallida (Humb. & Bonpl. ex Willd.) H.B.K.	kiawe	X
Samanea saman (Jacq.) Merr.	monkeypod	X
Senna surattensis (N. L. Burm.) Irwin & Barneby	kolomona	X
Malvaceae		
Abutilon incanum (Link) Sw.	hoary abutilon	I?
Sida rhombifolia L.	sida	X
Moraceae		
Ficus microcarpa L. f.	Chinese banyan	X

SCIENTIFIC NAME	COMMON NAME	STATUS
Myrtaceae		
Psidium guajava L.	guava	X
Syzygium cumini (L.) Skeels	Java plum	X
Oleaceae		
Jasminum sp.	jasmine	X
Passifloraceae		
Passiflora suberosa L.		X
Portulacaceae		
Portulaca oleracea L.	common purslane	X
Portulaca pilosa L.		X
Proteaceae		
Grevillea robusta A. Cunn. ex R. Br.	silk-oak	X
Solanaceae		
Solanum seaforthianum Andr.	potato vine	X
Sterculiaceae		
Waltheria indica L. var. americana (L.) R. Br. ex Hosaka	'uhaloa, hi'aloa	I?
Verbenaceae		
Lantana camara L.	lantana	X
Stachytarpheta jamaicensis (L.) Vahl	stachytarpheta	X

APPENDIX C

PAUL H. ROSENDAHL, Ph.D., Inc.
Consulting Archaeologist

Report 311-103087

October 30, 1987

Mr. Perry J. White
Belt, Collins & Associates
606 Coral Street
Honolulu, Hawaii 96813

Subject: Archaeological Reconnaissance Survey
Waahila Reservoirs Project Area
Waahila Ridge, Manoa, Honolulu, Island of Oahu
(TMK:3-5-56:Por.1, Por.2)

Gentlemen:

At the request of Mr. Perry J. White of Belt, Collins & Associates, for their client, the Honolulu Board of Water Supply, Paul H. Rosendahl, Ph.D., Inc. (PHRI) conducted an archaeological reconnaissance survey of the proposed Waahila Reservoirs project area, located on the slope of Waahila Ridge, in the Land of Manoa, Honolulu District, Island of Oahu. The primary objective of the survey was to determine the presence or absence within the project area of sites/features of potential archaeological significance. The information provided by the survey is intended to be appropriate to and sufficient for an Environmental Impact Statement (EIS) being prepared in conjunction with the proposed construction of two reservoirs, an associated access road, and transmission lines.

Reconnaissance survey field work was carried out on October 13, 1987, by PHRI Principal Archaeologist Dr. Paul H. Rosendahl and PHRI Supervisory Archaeologist Ms. Victoria K. Kai. Approximately ten labor-hours were expended in conducting the field work. Field work findings were discussed with Dr. Joyce Bath, State Department of Land and Natural Resources-Historic Sites Section (DLNR-HSS) staff archaeologist for Oahu, on October 14, 1987, and were orally reported to Mr. Perry J. White of Belt, Collins & Associates on October 15. The present letter report constitutes the final report on the reconnaissance survey.

The goal of the reconnaissance survey was to identify--to discover and locate on available maps--sites and features of potential archaeological significance. A reconnaissance survey comprises the initial level of archaeological investigation. It is extensive rather than intensive in scope, and is conducted basically to determine the presence or absence of archaeological resources within a specified project area. A reconnaissance survey indicates the general nature of and variety of archaeological remains present, and the general distribution and density of such remains. A reconnaissance survey permits a general significance assessment of archaeological resources, and facilitates formulation of realistic recommendations and estimates for further work that might be necessary or appropriate. Further work could include intensive survey--data collection involving detailed recording of sites and features, and selected test excavations; and possibly subsequent mitigation--data recovery research excavations, construction monitoring, interpretive

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planning and development, and/or preservation of sites and features with significant scientific research, interpretive, and/or cultural values.

The specific objectives of the reconnaissance survey of the Waahila Reservoirs project area were (a) to identify (find and locate) sites or features present within the project area, (b) to evaluate the potential general significance of identified archaeological remains, (c) to determine the impact of proposed development upon identified remains, and (d) to define the general scope of subsequent data collection or mitigation work that might be necessary or appropriate.

Based on a preliminary review of available background literature and records, and based on discussions with Mr. White and Dr. Bath, the following specific tasks were determined to constitute an adequate scope of work for the present project:

1. To review and evaluate available archaeological and historical literature relevant to the project area;
2. To conduct a 100% ground coverage field inspection of the project area and determine the presence or absence of any potentially significant archaeological sites;
3. To determine physical conditions in the project area that would influence the conduct of subsequent archaeological field work, should any be necessary; and
4. To prepare an appropriate scope of work (including specific field work and other non-field tasks) and accurate man-hour estimates for subsequent archaeological work that might be necessary.

The Waahila Reservoirs project area consists of roughly 8.9 acres (see attached map) situated on the south-southeast slope of Waahila Ridge, immediately adjacent to and upslope from the University of Hawaii Residential Housing Complex on Dole Street. It is comprised of two reservoir sites, their surrounding construction areas, and a transmission lines/access road corridor connecting the two sites. The project area rises in elevation, from c. 95 ft AMSL (above mean sea level) along the housing complex access road, to c. 550 ft AMSL at the higher-elevation reservoir construction area. For the most part, the project area terrain is steep and rocky; ground cover varies in density and is comprised primarily of introduced shrubs and grasses, scattered stands of koa-haole (Leucaena glauca [L.] Benth.), and klu (Acacia farnesiana [L.] Willd.).

Reconnaissance survey field work consisted of 100% ground coverage of the transmission lines/access road corridor, the two reservoir sites, and all immediately adjacent areas to be affected by construction grading. Field work was facilitated by (a) a topographic map of the project area (scale 1"=40', 10-ft contours; Towill, Shigeoka & Assoc., Inc.) upon

which the access road corridor, reservoir sites, construction grading limits, and geological testing bore-hole locations were plotted, and (b) the bore hole locations--which were physically marked on the ground. Systematic pedestrian sweeps of the project area covered 20 ft on each side of the approximate centerline of the proposed 20-ft wide transmission lines/access road corridor, and also covered areas extending c. 20 ft beyond the proposed reservoir construction areas.

The potential general significance of archaeological remains identified during the reconnaissance survey was to be evaluated in terms of the National Register criteria contained in the Code of Federal Regulations (36 CFR Part 60.4). The State Department of Land and Natural Resources-Historic Sites Section (DLNR-HSS) uses these criteria to evaluate eligibility for both the Hawaii State and National Register of Historic Places. It was anticipated that the potential significance of any identified remains would most likely relate to National Register criterion "(d)," which refers to remains "...that have yielded, or may be likely to yield, information important in prehistory or history." Once potential significance had been tentatively evaluated, DLNR-HSS was to be consulted (a) to determine and fix formally the significance of the remains, and (b) to determine appropriate mitigation to be undertaken.

In order to facilitate future cultural resource management decisions regarding site treatments, significant sites identified within the project area were also to be evaluated in terms of three value modes--scientific research value, interpretive value, and cultural value--derived from the previously mentioned State and National Register eligibility criteria. Research value refers to the potential of archaeological resources to produce information useful in the understanding of culture history, past lifeways, and cultural processes at the local, regional, and interregional levels of organization. Interpretive value refers to the potential of archaeological resources for public education and recreation. Cultural value refers to the potential of archaeological resources to preserve and promote cultural and ethnic identity and values.

No previously identified archaeological sites are known to exist within or immediately adjacent to the present project area. Likewise, the present reconnaissance survey encountered no potentially significant archaeological sites or features of any kind within the project area. A short segment (c. 5.0 m) of irregularly spaced small boulders was noted along the edge of a natural bedrock outcrop in the transmission lines/access road corridor near the 335-ft elevation contour, but it could not be determined whether the segment was natural or cultural in origin.

Based on the essentially negative results of the reconnaissance survey, it is concluded that no further archaeological work of any kind is necessary in the project area; it is recommended that the project area be granted full archaeological clearance.

The above recommendation is based on a surface reconnaissance of the project area, and is made with the general qualification that during construction activity involving extensive land surface modification, there

is always the possibility--however remote--that unknown or unexpected subsurface cultural features or deposits might be encountered. In such a situation, immediate archaeological consultation should be sought.

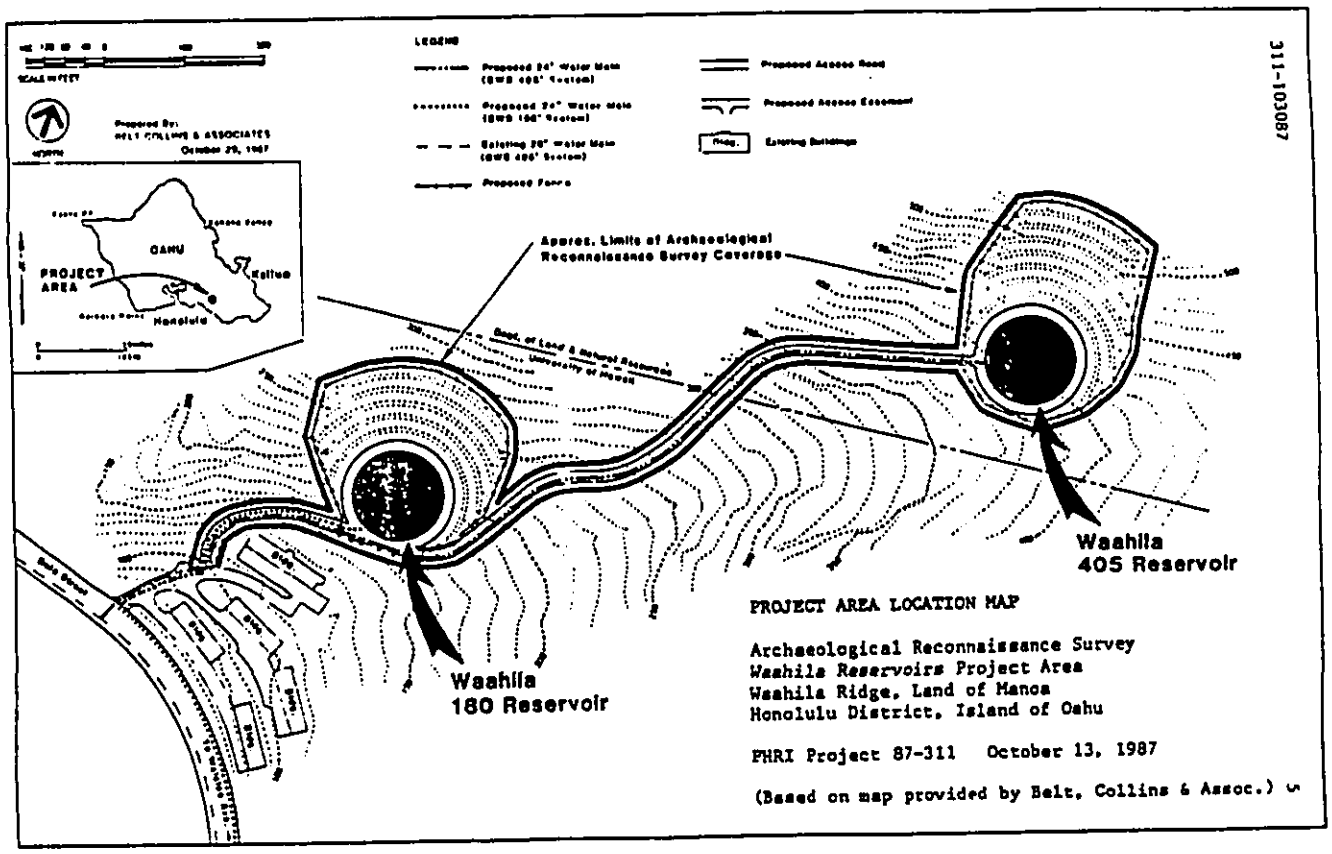
If you have any questions, please contact me at our Hilo office.

Sincerely yours,

Margaret K. Rosendahl

for Paul H. Rosendahl, Ph.D.
President and Principal
Archaeologist

Attachment: Project Area Location Map


LEGEND
Proposed 24" Water Main (BWS 405' System)
Proposed 24" Water Main (BWS 180' System)
Existing 20" Water Main (BWS 405' System)
Proposed Force
Proposed Access Road
Proposed Access Easement
Bldg.
Existing Buildings
311-103087
Prepared By:
HELT COLLINS & ASSOCIATES
October 29, 1987
OAHU
PROJECT AREA
Kailua
Honolulu
Approx. Limits of Archaeological Reconnaissance Survey Coverage
Waahila 405 Reservoir
Waahila 180 Reservoir
PROJECT AREA LOCATION MAP
Archaeological Reconnaissance Survey
Waahila Reservoirs Project Area
Waahila Ridge, Land of Manoa
Honolulu District, Island of Oahu
PHRI Project 87-311 October 13, 1987
(Based on map provided by Belt, Collins & Assoc.)

APPENDIX D

CHAPTER 4. SUMMARY OF POTENTIAL IMPACTS AND MITIGATION MEASURES

4.1 Short Term Impacts During Construction

4.1.1 Noise and Vibration from Blasting

Blasting will probably be used to fragment rock during the excavation phase of the construction project in order to reduce the total time required to complete the project. Blast induced ground and air vibrations have the potential to startle or annoy surrounding residents, and to also cause damage to structures.

The airblasts associated with blasting are concussion type, low frequency vibrations, which are of relatively short duration (or impulsive) and generally described in terms of peak overpressure in psi, or in dBL. The dominant sources of the airblast are the Air Pressure Pulse, which is caused by the large displacement of the ground surface near the charge, and the Stemming Release Pulse, which is caused by gas pressure ejecting the stemming (fill) material from the hole bored for the explosive charge. When exposed to high peak overpressure levels exceeding 141 dBL, large plate glass windows may break. At peak overpressure levels of 171 dBL, most windows can be expected to break. For these reasons, airblast levels during blasting are generally limited to levels below the 141 dBL level in order to minimize risks of damage to structures.

The low frequency characteristic (usually referred to bass sounds) of airblast noise tends to induce vibrations in structures (and subsequent complaint reactions) due to the low resonant frequency (10 to 25 Hz) of buildings. High frequency sounds of equal amplitude to blast noise generally do not induce vibrations and cause physical damage to structures. Although the human ear has an opposite characteristic (i.e., the ear is less sensitive to low frequency sounds), structures which vibrate can produce secondary audible effects such as rattling sounds (of fixtures, doors, etc.), and effects which are sensitive to touch (or feelable). Sound levels at which these secondary effects occur vary with the weight (and probably stiffness) of the structure. In general, the inception point of sound induced vibration is difficult to establish, but may occur at levels as low as 80 dBL. These levels are significantly below the peak levels of 120 to 136 dBL which have been associated with low risk of damage to structures.

Ground vibrations, or seismic waves, are also generated during blasting operations, and are generally described in terms of peak particle velocity in inches/second. Most of the seismic energy remains trapped in the ground, but some energy is released as an overpressure pulse into the air (or Rock Pressure Pulse). In general, the ground vibrations as well as the airborne Rock Pressure Pulse are expected to be less intrusive than the Air Pressure and Stemming Release Pulses. As an example, the current tunneling work along Dole Street for a sewer project generated some initial airblast complaints from nearby residents during

blasting of the surface entrance to the tunnel. However, once the entrance to the tunnel was formed and blasting was confined to tunneling underground, complaints stopped. Maximum ground vibration levels during the current tunneling work is limited to 2 inches/second, but blasting is conducted during all hours of the day and night (approximately 5 blasts per day). A total of 6 delays are typically used, with fixed delays of approximately 200 milliseconds, and with a maximum charge weight per delay of approximately 8.6 pounds.

Predictions of peak overpressure or ground vibration levels vs. scaled distance from the blast are not precise, with initial uncertainties for a given location in the order of 20 to 30 dBL. For this reason, it is standard practice to employ seismograph monitoring of air and ground vibrations during blasting operations with a 3-axis geophone (for ground vibrations) and a microphone (for air vibrations). The construction specifications for blasting operations generally require seismograph monitoring at the structure(s) closest to the bore holes. Based on the monitoring data, explosive charge sizes (or weights) are adjusted in order to limit peak overpressures of the airblasts to levels below the threshold of possible damage to structures. Based on standard practices, it is expected that, without special mitigation measures, maximum vibration levels at structures closest to the bore holes will be approximately 136 dBL for the airblasts and 2 inches/second for the seismic vibrations.

4.2 Possible Mitigation of Impacts During Construction

4.2.1 Mitigation of Blast Noise and Vibration

Since complaints resulting from airblast noise levels may occur at levels considerably below those necessary to cause damage to structures (120 to 136 dBL), additional mitigation measures will probably be required to minimize risks of antagonizing nearby residents. These recommended mitigation measures are described as follows:

- For initial blasts, prior to establishment of a data base of airblast levels vs. scaled distance, use a maximum charge weight (in equivalent pounds of TNT) per delay of less than (D/70)**2 pounds (or distance divided by 70, and quantity squared), where D is the distance in feet between the charge and the nearest noise sensitive residence or structure.

- If practical, reduce maximum airblast levels to less than 110 dBL at the nearest noise sensitive residences in response to airblast complaints. Possible methods of accomplishing this are: reducing charge sizes; increasing delay intervals; increasing hole depth; orienting bore holes to direct the Stemming Release Pulse away from noise sensitive properties; trucking in high quality stemming material to minimize stemming blow- outs; and filling (sandbagging) over the area to be blasted and the detonating chord.

- Schedule actual blasting during the warm periods of the day to minimize the possibility of thermal ducting and focusing of airblast noise at large distances from the blast. If possible, schedule blasting during fixed time periods which are publicized and made known to area residents.

- Restrict blasting operations which exceed 95 dBL at residences or apartments to the hours of 9:00 AM to 5:30 PM of the same day, and to weekdays (excluding holidays). For other noise sources associated with excavation operations, follow State Department of Health permit procedures and requirements for construction activities.

- Monitor airblast and ground vibration levels simultaneously at both the U.H. faculty housing and the St. Louis Heights homes which are closest to the bore holes.

APPENDIX E

GEOTECHNICAL ENGINEERING EXPLORATION
POTENTIAL BLASTING IMPACTS
PROPOSED WAAHILA "180" 4.0 M.G. RESERVOIR
MANOA, OAHU, HAWAII

W.O. 1884-10 DECEMBER 4, 1988

PREPARED FOR:

BELT COLLINS & ASSOCIATES

C.W. ASSOCIATES INC.
BD GEOLABS-HAWAII
2006 KALIHI STREET
HONOLULU, HAWAII 96819

C W ASSOCIATES, INC. dba
GEOLABS-HAWAII
Geology Soils and Foundation Engineering

December 4, 1988
W.O. 1884-10

Belt Collins & Associates
680 Ala Moana Boulevard, Suite 200
Honolulu, Hawaii 96813

Attention: Ms. Sue Rutka

Gentlemen:

Submitted herewith is our report entitled "Geotechnical Engineering Exploration, Potential Blasting Impacts, Proposed Waahila "180" 4.0 M.G. Reservoir, Manoa, Oahu, Hawaii".

Our work was performed in general accordance with the scope of services outlined in our proposal of April 29, 1988.

Detailed discussion of findings and recommendations are contained in the body of this report. If there is any point that is not clear, please feel free to contact us.

Very truly yours,

C.W. ASSOCIATES INC.
dba GEOLABS-HAWAII

Bob Y.K. Wong, P.E.
President

BYKW:DEF:as

(dk/508/as - 188410co)

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Telex 7431732 GEOHI • Facsimile 847-1749 • Phone (808)841-5064

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GEOTECHNICAL ENGINEERING EXPLORATION

POTENTIAL BLASTING IMPACTS

PROPOSED WAAHILA "180" 4.0 M.G. RESERVOIR

MANOA, OAHU, HAWAII

W.O. 1884-10 DECEMBER 4, 1988

INTRODUCTION

This report represents the results of our geotechnical engineering exploration performed to aid in the evaluation of potential blasting impacts to the subject reservoir during the construction of proposed University of Hawaii dormitory housing adjacent to the reservoir site in Manoa, Oahu, Hawaii.

PURPOSE AND SCOPE

Previously, we had performed a geotechnical engineering exploration of the proposed reservoir site as part of the feasibility and design studies for the subject project. Subsequent to our initial exploration, it was learned that part of the University of Hawaii - Manoa master plan proposes the construction of new dormitory type housing at the site of the existing Waahila Faculty Housing which is immediately adjacent to the site of the proposed reservoir. The plans for this proposed housing development are in the conceptual stage, however, it is anticipated that a substantial amount of cut earthwork may be involved in the site improvements. It may be necessary or desirable to use explosives in the earthwork operations. There is a concern that the use of explosives could potentially impact the reservoir structure if it is constructed and in service prior to the site grading of the proposed dormitory housing.

The purpose of our study was to explore the subsurface soil conditions in the vicinity of the reservoir site, where it is anticipated that the University of Hawaii intends to construct dormitory housing at some future date, to develop subsurface soils and rock data for analyses

to formulate geotechnical engineering assessment and recommendations pertinent to the future blasting which may be required for the earthwork portions of the proposed dormitory construction and its potential impacts on the reservoir.

The scope of our work included the drilling and sampling of four (4) borings to depths ranging from 15.0 to 30.0 feet below the existing ground surface in the accessible areas below the reservoir site and performing four (4) geophysical (seismic) surveys in the inaccessible areas to the southeast of the reservoir site. Also included were engineering evaluation of the field data, discussions of findings, the development of recommendations and report preparation.

A detailed description of our field exploration is presented in the appendix of this report.

SITE DESCRIPTION

The project site is situated in a minor valley along the axis of Waahila Ridge in the Manoa-St. Louis Heights area of Honolulu, Hawaii. The general location of the site and its vicinity is shown on the Project Location Map, Plate 1.

The proposed dormitory housing development site is located at and easterly of the existing Waahila Faculty Housing complex above Dole Street. The area within the existing housing complex has been previously developed and graded and is occupied by several low-rise apartment type buildings. The area easterly of the complex is undeveloped land covered with dryland vegetation, e.g., haole koa and grasses.

The reservoir site is located adjacent to and upslope of the existing Faculty Housing. The site slopes steeply above the existing housing and is covered with dense dryland vegetation.

SUBSURFACE CONDITIONS

Regional Geology

The island of Oahu is composed of two (2) shield volcanoes, Waianae and Koolau, built by the extrusion of basaltic lavas during the late Pliocene and Pleistocene epochs. Our exploration of the site and its vicinity indicates that the area is underlain by man-made fill and transported soils derived from the weathering of Koolau lavas.

Koolau basalts are typically thin-bedded primitive lavas with a large percentage of "pahoehoe" flows. Cavities or voids, such as lava tubes, are common in "pahoehoe" lava flows and are frequently encountered in cuts or excavations.

Subsurface Exploration

The subsurface conditions at the proposed housing area below the reservoir site were explored by drilling and sampling four (4) borings to depths ranging from 15.0 to 30.0 feet below the existing ground surface. In addition, a total of four (4) seismic refraction surveys were also performed to geophysically explore the subsurface conditions in the vicinity of the proposed housing area. The approximate locations of the borings and seismic surveys are shown on the Site Plan, Plate 2.

In general, the field exploration encountered a surficial layer of very stiff brown clays with boulders, cobbles and gravel, ranging in thickness from 1.0 to 8.0 feet, which represents either man-made fill or the transported soil, or colluvium, commonly found on hillside sites. Below this stratum, the field exploration encountered weathered basalt formation (Koolau Basalt) to the maximum depths explored by our borings.

Groundwater was encountered, in a perched condition, in Boring Nos. B-2 and B-3 during our exploration. These perched water tables drained as the borings were advanced and no groundwater was noted in the drilled borings upon completion.

DISCUSSIONS OF FINDINGS

General

Our previous exploration at the reservoir site indicated that, at the proposed finished grades, the site is underlain by moderately to slightly weathered basalt formation.

The current exploration indicates that the proposed housing area is underlain by fill and colluvial soils ranging in thickness from 1.0 to 8.0 feet below the existing ground surface. These surface soils are underlain by weathered basalt formation to the maximum depths explored. The seismic surveys performed for the current exploration indicate shear wave velocities ranging from 1100 to 6176 feet per second. The core samples and seismic surveys generally indicate that the basalt rock formation underlying the proposed housing area seems to be more weathered than the formation underlying the reservoir site. The evidence from our current exploration also tends to indicate that the rock formation underlying the proposed housing area will probably be rippable without the extensive use of explosives.

Potential Blasting Impacts

Although our limited scope of exploration indicates that the rock formation underlying the proposed housing area will probably be rippable, it may be deemed preferable or necessary to use explosives for excavation on the basis of economic and construction time factors. If blasting is to be used for the earthwork of the proposed housing, there could be potential impacts on the adjacent reservoir structure if it is constructed and in service prior to the construction of the proposed housing.

Hazards or objectionable impacts from blasting operations generally originate from one or more of the following:

1) Flyrock.
2) Ground Vibration.
3) Air Blast.

Flyrock

Flyrock is the blaster's term for flying rock or other debris which is launched into the air during open blasting by the force of the detonating explosives. These projectiles often have tremendous kinetic energy and can damage objects in their flight path or at their point of impact.

Flyrock generated during the earthwork for the proposed housing development could potentially strike the reservoir structure. If the flyrock has sufficient kinetic energy, it could damage the structure.

The occurrence of flyrock may be reduced and possibly eliminated by increasing the confinement or depth of the explosive charges and/or by using safety mats.

Ground Vibration

With respect to the subject project, ground vibration is probably the most critical potential impact. When an explosive detonates below ground, it generates intense stress waves in the surrounding material. These waves crushes the rock immediately adjacent to the explosion and permanently distorts and cracks the rock for some distance.

When the intensity of the stress waves attenuates to the point that there is no longer any permanent deformation of the rock, the stress is propagated through the rock as elastic waves. These elastic waves create ground vibration.

The potential of the ground vibration to damage a structure is a function of the intensity of the vibration and the natural frequency of the structure. According to the Du Pont "Blaster's Handbook", a formula has been developed to relate the intensity of ground

vibration at a given point, in terms of particle displacement, velocity and acceleration, to the weight of the explosive charge and the distance between the explosion and the point of interest.

The equation to determine the peak particle velocity is in the form of:

$V = K W^m R^{-n}$, where;

V is the the peak particle velocity (how fast the ground moves),

K is the ground transmission constant, which is empirically determined based on the rock surrounding the explosives and at the point of interest,

W is the weight of explosives used,

m and n are geologically controlled empirical constants, and

R is the distance between the explosion and the point of interest.

Work by the U.S. Bureau of Mines and others indicate that the equation may be reduced to:

$V = 160 (R/W^{1/2})^{-1.6}$, where;

W is the maximum charge weight, in pounds, per delay period of eight milliseconds or more.

Air Blast

The air blast from an explosion is a compressional wave in air. Noise is the portion of the air blast with frequencies between 20 and 20,000 Hz; and, concussion is the portion with frequencies below 20 Hz. The Du Pont "Blaster's Handbook" also sets forth a scaled

distance relationship for air blast. Generally speaking, air blast is not considered to be a problem for a reinforced concrete structure such as a reservoir.

RECOMMENDATIONS

Based on our limited exploration of the site, it is our opinion that in general, the basalt rock formation underlying the area of the proposed housing development is rippable without the use of explosives. Therefore, we recommend that blasting not be used for the earthwork portion of the proposed dormitory housing project unless it is absolutely necessary.

If blasting is to be used for the earthwork, we recommend that the scaled distances of the explosive charges be limited to those that will generate peak particle velocities of 1.5 inches per second or less at the reservoir structure. Blasting should be performed in accordance with the applicable statutes, rules and regulations and only by a qualified operator with a proven record. We recommend the prequalification of contractors and blasting operators bidding on the project.

If blasting is to be utilized for the earthwork portion of the proposed dormitory project, we recommend a program of test shots with instrumentation of the reservoir by seismographs or other appropriate means. The program should start with large scaled distances and gradually decrease to determine the lowest allowable scaled distance.

It is recommended that a geotechnical engineer be retained to provide geotechnical engineering and monitoring services during construction of the excavation phase of the work. This is to observe compliance with our concepts or recommendations and to allow field changes in the event that subsurface conditions differ from that anticipated prior to start of construction. The recommendations given in this report are contingent upon such observations.

If actual exposed rock/soil conditions encountered during construction are different from those assumed or considered in this report, then appropriate modifications to the design should be made.

ACKNOWLEDGMENT

We would like to acknowledge and thank Mr. Lawrence Fisher for his review and comments on the portion of this report pertaining to potential blasting impacts.

LIMITATIONS

The analyses and recommendations submitted in this report are based in part upon information obtained from field data points, such as borings, probes, seismic and/or observation wells. Variations of conditions between the field data points may occur; and the nature and extent of these variations may not become evident until construction. If variations then appear evident, it will be necessary to re-evaluate the recommendations given in this report.

The location of the field data points were approximately determined by taping from reference points shown on the "Topographic Survey" by Towill, Shigeoka & Assoc. Inc., dated September 17, 1987. Elevations of the data points were approximately determined by estimation from the same plan. The physical location and elevation of the field data points should be considered accurate only to the degree implied by the method used.

The stratification lines shown in graphic representations of the field data points depict the approximate boundaries between soil types, and, as such, may denote a gradual transition. The strata lines shown on profiles or cross-sections are based upon interpolation between field data points and may not represent actual subsurface conditions.

Water level data from the field data points was collected at the times given on the graphic representations and/or in the text of this report. This data has been reviewed and interpretations made in the

formulation of this report. However, it must be noted that fluctuation may occur due to variations in rainfall, tides, temperature and other factors.

This report had been prepared for the exclusive use of Belt Collins and Associates for specific application to the proposed Waahila "180" 4.0 M.G. Reservoir in accordance with generally accepted geotechnical engineering principles and practices. No other warranty, expressed or implied, is made.

This report has been prepared solely for the purpose of assisting the engineer in the preliminary design evaluation of the proposed project. Therefore, this report may not contain sufficient data, or the proper information, for use in contract bid estimation. A contractor wishing to bid on this project is urged to retain a competent geotechnical engineer to assist in the interpretation of this report and/or in the performance of additional site specific exploration for bid estimating purposes.

The owner/client should be aware that unanticipated soil conditions are commonly encountered. Unforeseen soil conditions, such as perched groundwater, soft deposits, hard layers or cavities, may occur in localized areas and may required additional probing or connections in the field (which may result in construction delays) to attain a properly constructed project. Therefore, sufficient contingency fund is thus recommended to accommodate these possible extra costs.

The following appendix and plates are attached and complete this report:

Appendix A	-	Field Exploration
Plates A-1 thru A-4	-	Boring Logs
Plates A-5 thru A-8	-	Seismic Survey Results

Plate 1 - Project Location Map

Plate 2 - Site Plan

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Respectfully submitted,

C.W. ASSOCIATES INC.
dba GEOLABS-HAWAII

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APPENDIX A

Field Exploration

The subsurface conditions at the site were explored by drilling four (4) borings to depths of 15.0 to 30.0 feet, utilizing truck-mounted drilling equipment. The approximate locations of the borings are shown on the Site Plan, Plate 2.

The soils/rock encountered were classified by visual and textural examination in the field by our engineer who continuously monitored the drilling operations. The classifications were reviewed by visual inspection in our laboratory. All soils were classified in accordance with the Unified Soil Classification System.

A graphic presentation of the soils and rock encountered in the borings is presented on the Boring Logs, Plates A-1 through A-4. Rock core samples were obtained by using a rotary wash HQ wireline core barrel. The core recovery and rock quality designation (RQD) are presented on the boring logs.

Seismic refraction surveys were conducted at various locations at the project site in order to evaluate the range of seismic velocities in the rock formation; which can generally be correlated to the rock hardness. The results of the seismic surveys are presented on Plates A-5 through A-8. The approximate locations of the surveys are shown on the Site Plan, Plate 2.

(dk/508/as - 188410AP)

BORING 1

● Moisture content
▼ Blows per foot

Sample Dry density (pcf) — 50 40 30 20 10 0

Depth (feet) Graph — Surface elevation 118'±*

SOIL DESCRIPTION	U S C
2-INCH ASPHALT CONCRETE	
3-INCH BASE COURSE	
REDDISH BROWN AND GRAY MOTTLED SILTY CLAY WITH SAND, GRAVEL, COBBLES AND BOULDERS, STIFF, MOIST TO WET (COLLUVIUM/ ALLUVIUM)	CH
GRAY DENSE BASALT, WEATHERED, HARD (KOOLAU BASALT)	
BROWN CLAYEY SILT WITH MUCH SAND AND GRAVEL, STIFF TO VERY STIFF, MOIST (DECOMPOSED CLINKER)	MH
BROWNISH GRAY VESICULAR BASALT, SEVERELY JOINTED, WEATHERED, SOFT TO MEDIUM HARD (KOOLAU BASALT)	
GRAY SANDY GRAVEL, MEDIUM DENSE, MOIST (DECOMPOSED CLINKER)	GW
GRAY/BROWN VESICULAR BASALT, SEVERELY JOINTED, HIGHLY WEATHERED, SOFT (KOOLAU BASALT	
GRAY DENSE BASALT, MODERATELY TO SEVERELY JOINTED, SLIGHTLY WEATHERED, HARD (KOOLAU BASALT)	
BORING TERMINATED AT 30.0 FEET ON NOVEMBER 4, 1988	
GROUNDWATER NOT ENCOUNTERED	
*ELEVATIONS ESTIMATED FROM "TOPOGRAPHIC SURVEY" BY TOWILL, SHIGEOKA & ASSOCIATES, INC., DATED SEPTEMBER 17, 1987	

RUN 1 REC= 41% RQD= 11%
RUN 2 REC= 100% RQD= 20%
RUN 3 REC= 79% RQD= 40%
RUN 4 REC= 97% RQD= 57%
RUN 5 REC= 98% RQD= 25%
RUN 6 REC= 45% RQD= 15%

5 10 15 20 25 30

LEGEND
I 2.0" O.D. split-spoon sample
II Undisturbed ring sample
III Disturbed ring sample
IV Core sample
Ts Shelby tube sample
P Sampler pushed

Plastic limit
Liquid limit
Natural water content
▽ Water level
T Torvane Shear (psf)
FV Field Vane Shear (psf)
Driving energy 140 lb. wt., 30" drop

BORING LOG

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W.O. 1884-10 DECEMBER 1988

PLATE A-1

BORING 2

● Moisture content
▼ Blows per foot

Sample Dry density (pcf) — 50 40 30 20 10 0

Depth (feet) Graph — Surface elevation 113'±*

SOIL DESCRIPTION	U S C
DARK GRAYISH BROWN SANDY CLAY WITH GRAVEL, STIFF, MOIST TO WET (FILL)	CH-SC
DARK BROWN/GRAY MOTTLED SILTY CLAY WITH MANY COBBLES AND BOULDERS, STIFF, MOIST TO WET (COLLUVIUM)	CH
GRAY VUGULAR BASALT WITH CLAY SEAMS, MODERATELY JOINTED, WEATHERED, HARD (KOOLAU BASALT)	
GRAYISH BROWN SILTY CLAY WITH GRAVEL, STIFF, MOIST (DECOMPOSED CLINKER)	CH
GRAY VESICULAR BASALT, SLIGHTLY JOINTED, WEATHERED, HARD (KOOLAU BASALT)	
GRAYISH BROWN SILTY CLAY WITH SAND AND GRAVEL, STIFF, MOIST (DECOMPOSED CLINKER)	CH
GRAY DENSE BASALT, SLIGHTLY FRACTURED, SLIGHTLY WEATHERED, HARD (KOOLAU BASALT)	
GRAYISH BROWN SANDY SILT WITH CLAY AND GRAVEL, STIFF, MOIST (DECOMPOSED CLINKER)	MH
RED AND GRAY VESICULAR BASALT, MASSIVE, SLIGHTLY WEATHERED, MEDIUM HARD (KOOLAU BASALT)	
BORING TERMINATED AT 30.0 FEET ON NOVEMBER 9, 1988	
GROUNDWATER ENCOUNTERED AT 4.5 FEET ON 11/7/88 IN PERCHED CONDITION- NO GROUNDWATER LEVEL IN BORING AT COMPLETION	

RUN 1 REC= 33% RQD= 0%
RUN 2 REC= 100% RQD= 45%
RUN 3 REC= 87% RQD= 17%
RUN 4 REC= 78% RQD= 33%
RUN 5 REC= 100% RQD= 48%
RUN 6 REC= 89% RQD= 30%
RUN 7 REC= 94% RQD= 72%

5 10 15 20 25 30

LEGEND
I 2.0" O.D. split-spoon sample
II Undisturbed ring sample
III Disturbed ring sample
IV Core sample
Ts Shelby tube sample
P Sampler pushed

Plastic limit
Liquid limit
Natural water content
▽ Water level
T Torvane Shear (psf)
FV Field Vane Shear (psf)
Driving energy 140 lb. wt., 30" drop

BORING LOG

GEOLABS—HAWAII
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PLATE A-2

BORING 3

● Moisture content
▼ Blows per foot

Sample
Dry density (pcf)
50 40 30 20 10 0

Depth (feet)
Graph

Surface elevation 118'±.

SOIL DESCRIPTION	U S C
2-INCH ASPHALT CONCRETE	
3-INCH BASE COURSE	
DARK GRAY CLAY WITH GRAVEL, STIFF, MOIST (FILL ?)	CH
GRAY VESICULAR BASALT, MODERATELY TO SEVERELY JOINTED, SLIGHTLY WEATHERED, MEDIUM HARD (KOOLAU BASALT)	
RED/BROWN VESICULAR BASALT, SLIGHTLY JOINTED, WEATHERED, SOFT TO MEDIUM HARD (WELDED/ CEMENTED CLINKER)	
GRAY DENSE BASALT, MASSIVE, MODERATELY WEATHERED, HARD (KOOLAU BASALT)	
RED/GRAY VESICULAR BASALT, MODERATELY TO SEVERELY JOINTED, SLIGHTLY TO MODERATELY WEATHERED, MEDIUM HARD (KOOLAU BASALT)	

RUN 1
REC= 87%
ROD= 22%

RUN 2
REC= 100%
ROD= 97%

RUN 3
REC= 100%
ROD= 74%

RUN 4
REC= 94%
ROD= 60%

RUN 5
REC= 100%
ROD= 50%

RUN 6
REC= 100%
ROD= 36%

5 10 15 20 25 30

BORING TERMINATED AT 30.0 FEET ON NOVEMBER 8, 1988

GROUNDWATER ENCOUNTERED AT 2.0 FEET AT 0840 ON 11/8/88 IN PERCHED CONDITION- NO GROUNDWATER ENCOUNTERED UPON COMPLETION OF BORING

LEGEND

I 2.0" O.D. split-spoon sample
II Undisturbed ring sample
III Disturbed ring sample
IV Core sample
V Shelby tube sample
P Sampler pushed

Plastic limit
Liquid limit
Natural water content
∇ Water level
T Torvane Shear (psf)
FV Field Vane Shear (psf)
Driving energy: 140 lb. wt., 30" drop

BORING LOG

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PLATE A-3

BORING 4

● Moisture content
▼ Blows per foot

Sample
Dry density (pcf)
50 40 30 20 10 0

Depth (feet)
Graph

Surface elevation 117'±.

SOIL DESCRIPTION	U S C
2-INCH ASPHALT CONCRETE	
3-INCH BASE COURSE	
GRAYISH BROWN SILTY CLAY WITH BOULDERS AND COBBLES, STIFF, MOIST (FILL/COLLUVIUM)	CH
RED/GRAY VESICULAR BASALT, SEVERELY JOINTED, MODERATELY TO HIGHLY WEATHERED, SOFT (KOOLAU BASALT)	

RUN 1
REC= 70%
ROD= 19%

RUN 2
REC= 100%
ROD= 29%

5 10 15

BORING TERMINATED AT 15.0 FEET ON NOVEMBER 8, 1988

GROUNDWATER NOT ENCOUNTERED

LEGEND

I 2.0" O.D. split-spoon sample
II Undisturbed ring sample
III Disturbed ring sample
IV Core sample
V Shelby tube sample
P Sampler pushed

Plastic limit
Liquid limit
Natural water content
∇ Water level
T Torvane Shear (psf)
FV Field Vane Shear (psf)
Driving energy: 140 lb. wt., 30" drop

BORING LOG

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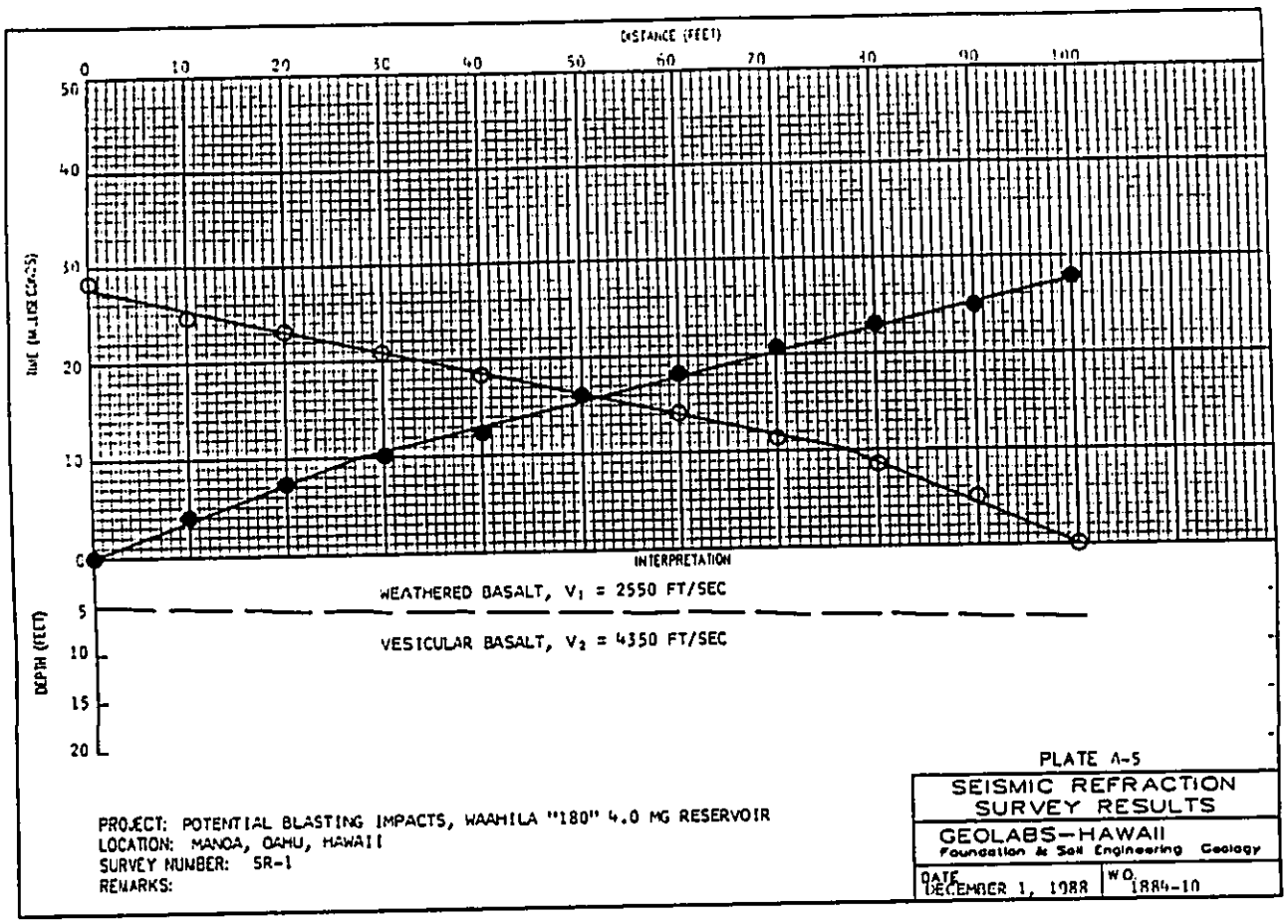
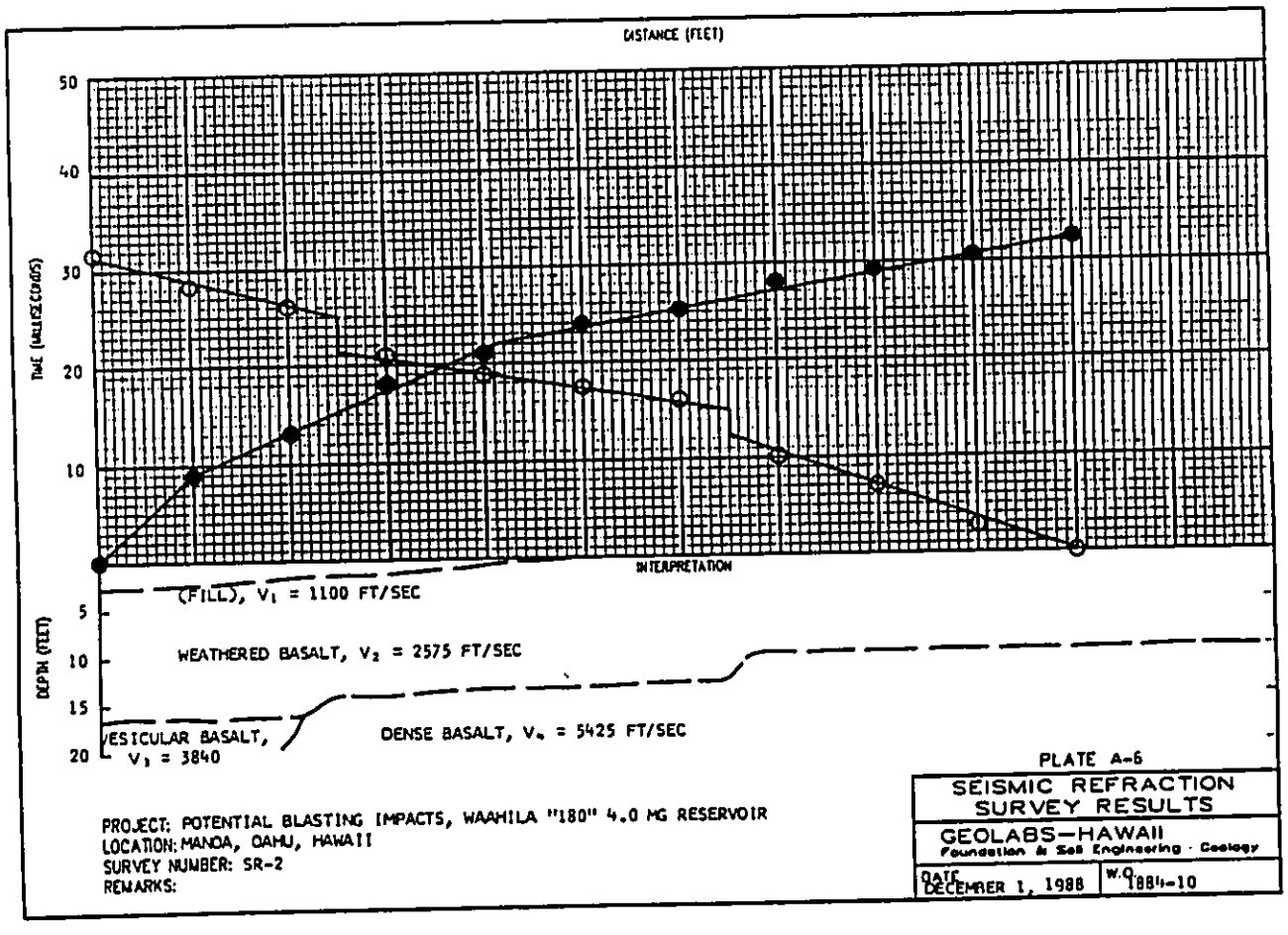
PLATE A-4


DISTANCE (FEET)
0
10
20
30
40
50
60
70
80
90
100
50
40
30
20
10
0
TIME (MILLISECONDS)
INTERPRETATION
WEATHERED BASALT, V1 = 2550 FT/SEC
VESICULAR BASALT, V2 = 4350 FT/SEC
DEPTH (FEET)
5
10
15
20
PROJECT: POTENTIAL BLASTING IMPACTS, WAAHILA "180" 4.0 MG RESERVOIR
LOCATION: MANOA, OAHU, HAWAII
SURVEY NUMBER: SR-1
REMARKS:
PLATE A-5
SEISMIC REFRACTION SURVEY RESULTS
GEOLABS—HAWAII
Foundation & Soil Engineering Geology
DATE DECEMBER 1, 1988
W.O. 1884-10


DISTANCE (FEET)
50
40
30
20
10
TIME (MILLISECONDS)
INTERPRETATION
(FILL), V1 = 1100 FT/SEC
WEATHERED BASALT, V2 = 2575 FT/SEC
VESICULAR BASALT, V3 = 3840
DENSE BASALT, V4 = 5425 FT/SEC
DEPTH (FEET)
5
10
15
20
PROJECT: POTENTIAL BLASTING IMPACTS, WAAHILA "180" 4.0 MG RESERVOIR
LOCATION: MANOA, OAHU, HAWAII
SURVEY NUMBER: SR-2
REMARKS:
PLATE A-6
SEISMIC REFRACTION SURVEY RESULTS
GEOLABS—HAWAII
Foundation & Soil Engineering · Geology
DATE DECEMBER 1, 1988
W.O. 1884-10

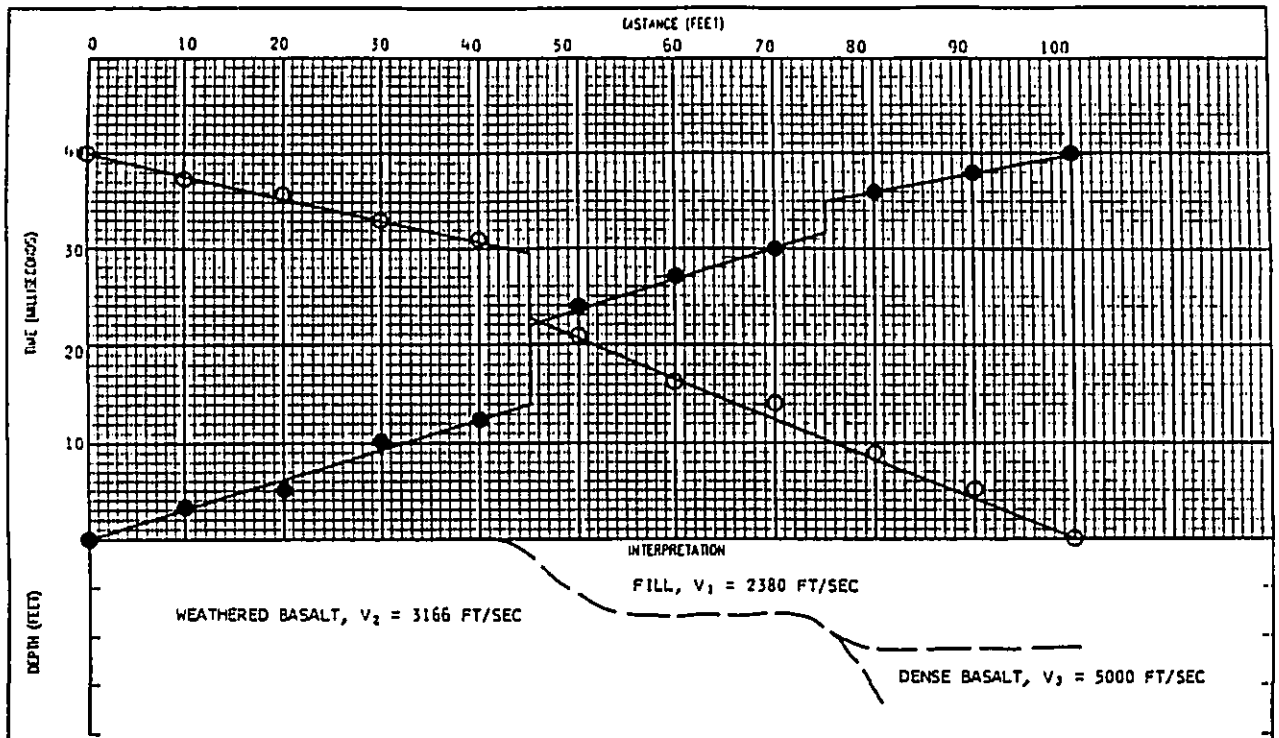


PLATE A-7

PROJECT: POTENTIAL BLASTING IMPACTS, WAAHILA "180" 4.0 MG RESERVOIR
LOCATION: MANOA, OAHU, HAWAII
SURVEY NUMBER: SR-3
REMARKS:

SEISMIC REFRACTION SURVEY RESULTS	
GEOLABS—HAWAII Foundation & Soil Engineering · Geology	
DATE DECEMBER 1, 1988	W.O. 1884-10

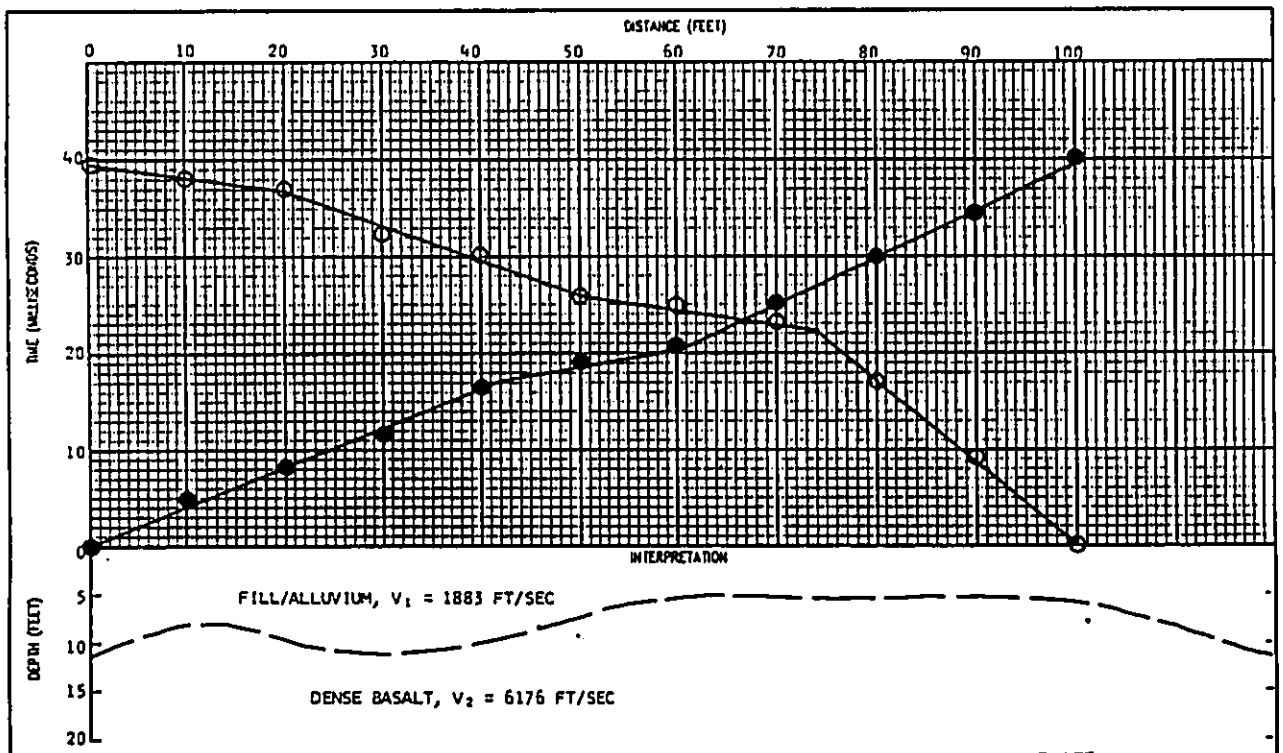


PLATE A-8

PROJECT: POTENTIAL BLASTING IMPACTS, WAAHILA "180" 4.0 MG RESERVOIR
LOCATION: MANOA, OAHU, HAWAII
SURVEY NUMBER: SR-4
REMARKS:

SEISMIC REFRACTION SURVEY RESULTS	
GEOLABS—HAWAII Foundation & Soil Engineering · Geology	
DATE DECEMBER 1, 1988	W.O. 1884-10

PROJECT LOCATION MAP

PROPOSED WAAHILA "180" 4.0 M.G. RESERVOIR
MANOA, OAHU, HAWAII

PLATE 1

REFERENCE: U.S.G.S. QUADRANGLE MAP; HONOLULU, OAHU, HAWAII (1983)

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DATE	DRAWN BY
DECEMBER 1988	KHN
SCALE	WO
1" = 2,000'	1884-10