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STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
P. O. BOX 621
HONOLULU, HAWAII 96809

REF. NO.: CPO-792
FILE NO.: HA-6/22/83-1554

Mr. Norman Oss, President
Hawaii Electric Light Company, Inc.
1200 Kilauea Avenue
P. O. Box 1027
Hilo, Hawaii 96720

Dear Mr. Oss:

We have completed our review of the Final Environmental Impact Statement (EIS) for the proposed Kaumana-Keamuku 138 Kv Transmission Line, Island of Hawaii, filed with this Department October 25, 1983.

We wish to state that acceptance of an EIS means that the document fulfills the definition of an Environmental Impact Statement, adequately describes identifiable environmental impacts and satisfactorily responds to comments received during the review process.

An EIS is an informational document prepared in compliance with the rules and regulations as stated in Chapter 343 of the Hawaii Revised Statutes which fully discloses environmental, social and economic effects of the proposed action, as well as measures proposed to minimize adverse effects and alternatives to the action and their environmental effects.

Sections 1:71 and 1:42 of the EIS Regulations enumerate criteria for EIS procedural, review process and content requirements.

A review of the procedure followed in the preparation, review, and revision of the document indicates the following did occur:

1. An EIS Preparation Notice was filed with the Environmental Quality Commission (EQC) and published in their Bulletin on July 23, 1983.

2. The Draft Environmental Impact Statement was officially filed with the EQC on September 8, 1983 and published in the EQC Bulletin on that date.

CPO-792

3. Comments regarding the Draft EIS were appended to the Final EIS. Responses were made and incorporated into the Final EIS.

Procedural requirements have therefore been met.

During the review process, comments were solicited from agencies and interested parties at all levels; comments were received and responded to adequately. Comments received and responses to assessment and draft EIS documents have been appended to the Final EIS.

With respect to the document content requirements as enumerated in Sections 1:42 of the EIS regulations, the Department finds these requirements have been satisfactorily met.

As such, the Department has determined that the revised or final EIS for the proposed Kaumana-Keamuku 138 Kv Transmission Line, Island of Hawaii has adequately disclosed and described all identifiable environmental impacts and represents an informational document as required by Chapter 343, Hawaii Revised Statutes. The document is therefore deemed acceptable. If you have any further questions please contact Mr. Roger C. Evans, of our Planning Office at 548-7837.

Very truly yours,

SUSUMU ONO, Chairperson
Board of Land and Natural Rescources

cc: Alva Nakamura, HELCO
EDAW, Inc.
Land Board Members
OEQC/EQC
COH Planning Department

ENVIRONMENTAL IMPACT STATEMENT

Kaumana to Keamuku 138 KV Transmission Line

HELCO

Revised

ENVIRONMENTAL IMPACT STATEMENT

Kaumana to Keamuku
138 KV Transmission Line

Prepared for:

Hawaii Electric Light Company, Inc.

Prepared by:

EDAW inc.

Submitted pursuant to Chapter 343, Hawaii Revised Statutes

Accepting Authority: State of Hawaii
Department of Land and Natural Resources

August 1983

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EXHIBITS

Chapter

CHAPTER I. SUMMARY

Hawaii Electric Light Company, Inc., proposes to construct a 138 Kv cross-island transmission line on the Island of Hawaii to connect substations at Kaumana, on the east, and Keamuku, on the west. The proposed line is the first of a series of planned transmission system improvements over the next two decades which are required to maintain reliable electric power service. The analysis used in defining the need for this project and the process involved in selecting the alignment for the proposed transmission line is described in a report titled Transmission Line Routing Study: Kaumana to Keamuku 138 Kv Line, (hereafter called "Routing Study") which is included in its entirety in the latter portion of this document.

Part of the proposed transmission line easement will cross the State Conservation District. The project will therefore require the approval of a Conservation District Use Application (CDUA) by the Hawaii State Board of Land and Natural Resources. The Department of Land Natural Resources (DLNR) has determined that an Environmental Impact Statement (EIS) under the provisions of Chapter 343, Hawaii Revised Statutes, is required as part of the CDUA review process. This document was prepared to fulfill that requirement. The DLNR is the "accepting authority" for the EIS, as defined by Chapter 343.

Many of the potentially adverse environmental impacts of the proposed transmission line have been avoided or minimized due to the method of project and route selection. Various alternatives to the proposed action were studied and project selection was based on an analysis of socio-economic and physical environmental considerations as well as cost-effectiveness. Route selection was also based on analysis of socio-economic, physical environmental and cost factors, in consultation with public agency representatives and Island residents through a series of public and individual meetings.

Additional mitigation measures, primarily to minimize land disturbance during construction and maintenance operations, are proposed to reduce the probability of adverse effects on the environment. The hauling and setting of transmission poles, for example, will most likely be done with the assistance of a heavy-lift helicopter. This will eliminate the need for a continuous construction road and thereby greatly reduce land disturbance. In addition, this construction method is more cost-effective, less time-consuming and will result in less inconvenience to motorists using Saddle Road when compared to a ground-only method of construction.

There will be unavoidable short-term impacts on air quality and noise levels during construction, but these adverse effects are not expected to be perceived by a large number of people. Construction will also create localized, short-term impacts on wildlife habitats and the rate of soil erosion. The long-term adverse effects on natural habitats, if any, are not expected to be significant. Long-term visual effects of the proposed transmission line are a matter of subjective judgement. By and large, the proposed alignment avoids areas where the line would be exposed to frequent viewing. In cases where it is likely to be prominently in view from vantage points such as Saddle Road and urbanized areas, the proposed line will be adjacent to an existing 69 Kv transmission line. Thus, visual intrusion into new view areas is avoided.

The project will require an irreversible commitment of resources such as capital, labor, construction materials and fossil fuels. In exchange, the project will enhance the public health, safety and welfare for the Island of Hawaii by providing reliable electric power and providing for future load growth.

CHAPTER II. DESCRIPTION OF PROPOSED ACTION

A. BACKGROUND

Hawaii Electric Light Company, Inc. (HELCO), the sole public utility company on the Island of Hawaii, is a subsidiary of Hawaiian Electric Company, Inc., (HECO), based in Honolulu. A System Planning Committee, made up of technical staff representing both HECO and HELCO, has determined, after thorough analysis of alternatives for meeting system reliability needs, that improvements to HELCO's transmission system will be required, consisting most immediately of a new 138 kilovolt (Kv) cross-island line connecting substations at Kaumana and Keamuku. A summary of this analysis can be found in Chapter I of the Routing Study report.[1]

Numerous references to the Routing Study report will be made in the following discussion of environmental setting, potential impacts, mitigation measures and alternatives to the proposed action. The bulk of the Routing Study describes the rationale for selecting the alignment of the proposed cross-island transmission line. The study process resulted in an alignment through the "saddle" area of the island, between the Mauna Kea and Mauna Loa volcanoes. (See Exhibit II-1.)

Route selection proceeded in two phases. The first phase was an islandwide analysis which identified potential transmission corridors, including a submarine route, by means of overlay mapping of various geophysical, biological, socio-economic and cost constraint factors. The entire island was mapped so that no potential corridor would be arbitrarily eliminated. The corridors varied in width, but in all cases were wide enough to permit the consideration of several alternative detailed alignments. The second phase of routing selection involved more detailed mapping of the selected study corridor, based largely on field surveys and aerial photo interpretation. Alternative alignments were delineated and evaluated. During both phases, rounds of meetings with the public, affected landowners and government agency representatives played a key role in the review of project need, constraint criteria and route selection. Additional explanation of the study methodology is contained in Chapter II of the Routing Study.

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[1] The report titled Transmission Line Routing Study: Kaumana to Keamuku 138 Kv Line is contained between the rust-colored cover pages in the latter portion of this document.

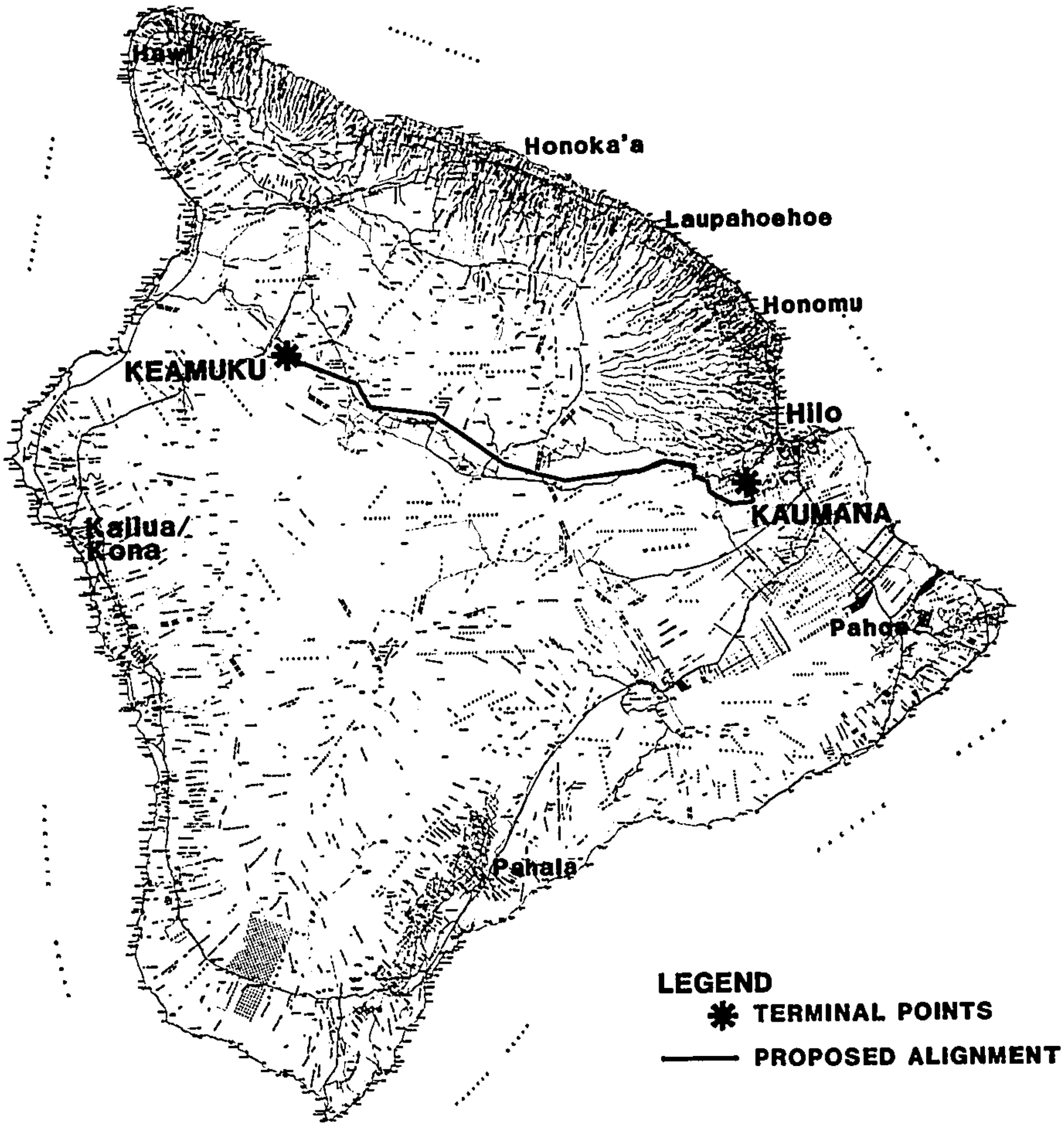


EXHIBIT II -1
PROJECT LOCATION

B. SYSTEM IMPROVEMENTS AND PHASING

The proposed 138 Kv cross-island line and a 69 Kv radial line of much shorter length are the first of a series of actions which are planned to maintain system reliability and to provide for future growth. These planned improvements are listed chronologically below. (Refer to Exhibit II-2 for locations.)

- Installation of the proposed fourth cross-island line

  This line is scheduled to be operational in 1987 and will connect existing substations at Kaumana and Keamuku. The line will have a design capacity of 138 Kv but will initially be energized at 69 Kv. Additional equipment will have to be installed at the existing substations to accommodate the line.

- Install radial 69 Kv lines

  In about 1987 the existing 69 Kv line connecting the substations at Keamuku and Waikaloa will be extended to connect the Waikaloa substation with the Anaeho'omalu substation. In about 1991, a new 69 Kv line will be required between substations at Keamuku and Keahole.

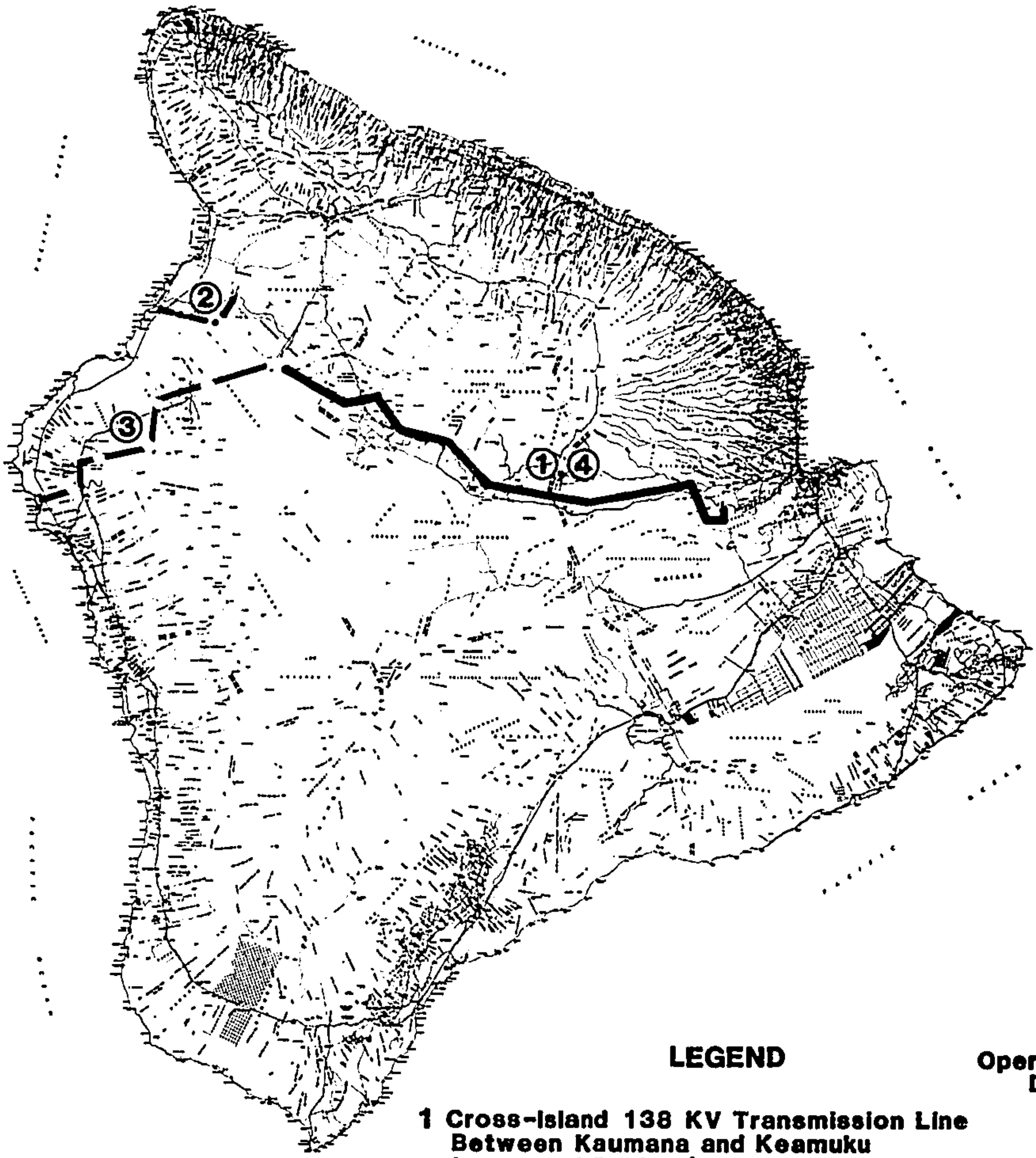
- Install a fifth cross-island line

  Scheduled to be operational in 1995, this line will parallel the proposed transmission line between the substations at Kaumana and Keamuku. As with the proposed line, this line will be constructed at 138 Kv and initially energized at 69 Kv.

- Construct new substations at Kaumana and Keamuku

  New substations at the terminal points of the two 138 Kv cross-island transmission lines will be needed before both lines can be energized 138 Kv, which is expected to occur at the turn of the century. These substations will measure approximately 185 feet by 215 feet in plan and will be similar in design to 138 Kv stations which have been constructed on Oahu. (See Exhibit II-3.) The new 138 Kv substations will be connected to the existing 69 Kv substations by tie lines.

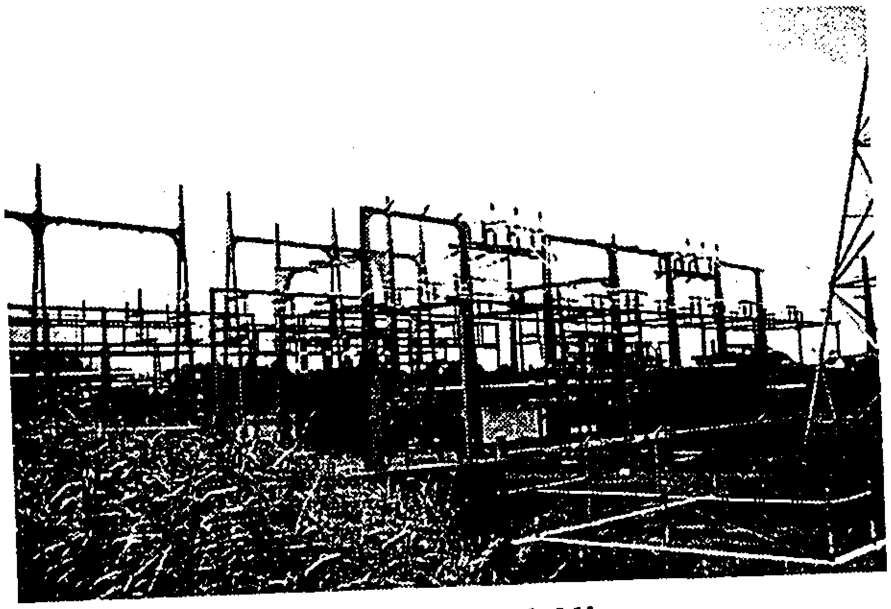
The dates for completion of system improvements are tentative, particularly for the elements scheduled for a decade or more in the future. The timetables for future improvements will be reviewed and adjusted periodically in light of load growth forecasts. Likewise, the design of future system improvements may be influenced by technological innovations. Nevertheless, a reasonable projection of future system needs is essential in order to provide for orderly and



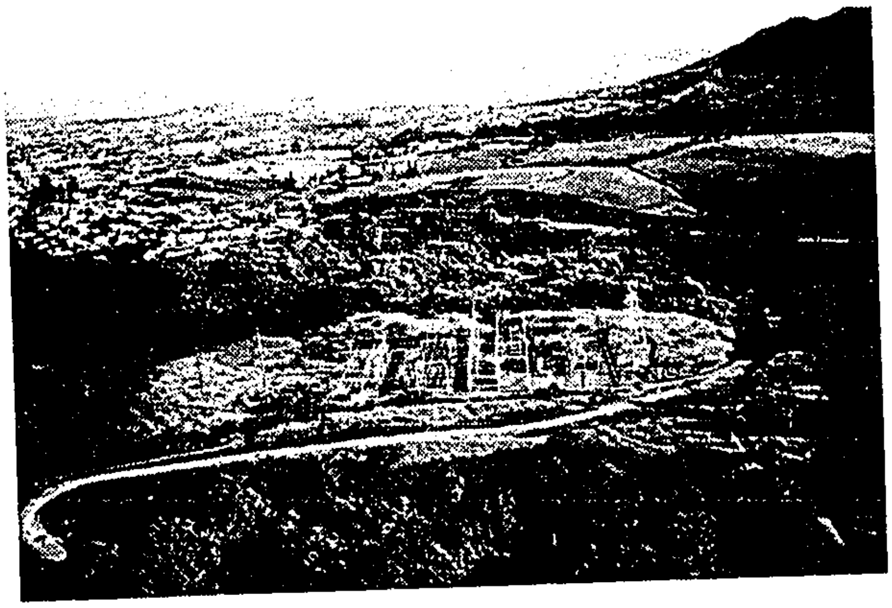
LEGEND

		Operation Date
1	Cross-Island 138 KV Transmission Line Between Kaumana and Keamuku (Proposed Project)	1987
2	Radial 69 KV Transmission Line Between Waikoloa and Anaeho'omalu	1987
3	Radial 69 KV Transmission Line Between Keamuku and Keahole	1991
4	Second Cross-Island 138 KV Transmission Line Between Kaumana and Keamuku	1995

EXHIBIT II-2: PROPOSED TRANSMISSION SYSTEM IMPROVEMENTS



Ground-level View



Aerial View

EXHIBIT II-3:
TYPICAL 138 KV SUBSTATION

rational expansion of facilities. For example, the alignment and width of the easement for the proposed 138 Kv transmission line should take into account the anticipated need to install an additional 138 Kv cross-island line later in this century. The placement of both cross-island lines within the same easement will create an "energy corridor" which will minimize environmental disruption, adverse possession of property and costs to the utility company and, ultimately, the consumer. Moreover, the route of the proposed cross-island line should consider logical locations for the 138 Kv substations which eventually will be required.

Since a portion of the proposed cross-island route passes through the State Conservation District, the proposed action is subject to environment assessment by the Department of Land and Natural Resources (DLNR) under Chapter 343, Hawaii Revised Statutes. The DLNR determined that an Environmental Impact Statement (EIS) was required and this document was prepared to fulfill that requirement.

This EIS addresses the probable environmental effects of the proposed initial 138 Kv cross-island transmission line in the context of future proposed improvements to HELCO's transmission system in order to present a comprehensive view of planning decisions. These other improvements, however, are separate projects and do not constitute cumulative impacts of the proposed action. While the first of the two proposed radial 69 Kv lines will be constructed at about the same time as the first cross-island line, it is not tied directly to the proposed cross-island line. Its route is short, adjacent to an existing 69 Kv line, and entirely outside of the State Conservation District. Its probable environmental effects are expected to be minimal and they are not discussed in the this EIS.[2] The second cross-island 138 Kv transmission line, while mentioned at this time to provide a frame of reference for the reader, is also a separate action which will be subject to separate permit review and environmental assessment procedures in the future.

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[2]Information on the routing considerations for the 69 Kv radial line can be found on pp. 149-152 of the Routing Study. Also, the route for this line was surveyed by biologists, archaeologists and geologists, who refer to this area in their field survey reports, which are included at the end of this document.

C. PROJECT FEATURES

The proposed 138 Kv transmission line will consist of three conductors approximately 0.856 inches in diameter and a 0.375 inch shield wire at pole top for protection against lightning. These conductors will be supported by single wooden poles at approximately 600-foot spans. The precise distance of the span will depend upon physical conditions in the vicinity of pole sites and various structural factors, such as tension or weight on the conductors caused by changes in the direction of the alignment, high wind velocities and other climatic or atmospheric conditions. The poles will average 90 feet in height, approximately 8 feet of which will be imbedded in the ground. At angles, where the alignment changes direction, 100-foot high poles will be required, of which about 10 feet will be buried. By comparison, wooden poles for 69 Kv lines are about 15 to 20 feet shorter than this. To insure stability, guy wires and anchors will be installed at angles and dead ends. The poles will have diameters of about 1.5 feet at their base, tapering to about 0.75 feet at the top. The wood will be fully treated against termite damage and rot. Conductors will be supported by post insulators or strings of suspension insulators. Where required, special insulators will be used to minimize maintenance costs for insulator damage caused by gunshots or contamination. (See Exhibit II-4.)

HELCO will acquire a 150-foot wide easement for the new cross-island line. This will be wide enough to accommodate an additional 138 Kv line at a later date. A 50-foot wide easement for an existing 69 Kv line will run directly next to the new 150-foot easement for much of the distance between Kaumana and Keamuku.

D. CONSTRUCTION

Construction of the proposed line will entail the following steps:

- Preparation of staging areas where materials and equipment are stored and assembled.
- Hauling of poles and other materials to staging areas.
- Preparation of pole sites.
- Hauling of poles to their sites and setting the poles.
- Framing of the poles.
- Stringing the conductors on the poles.

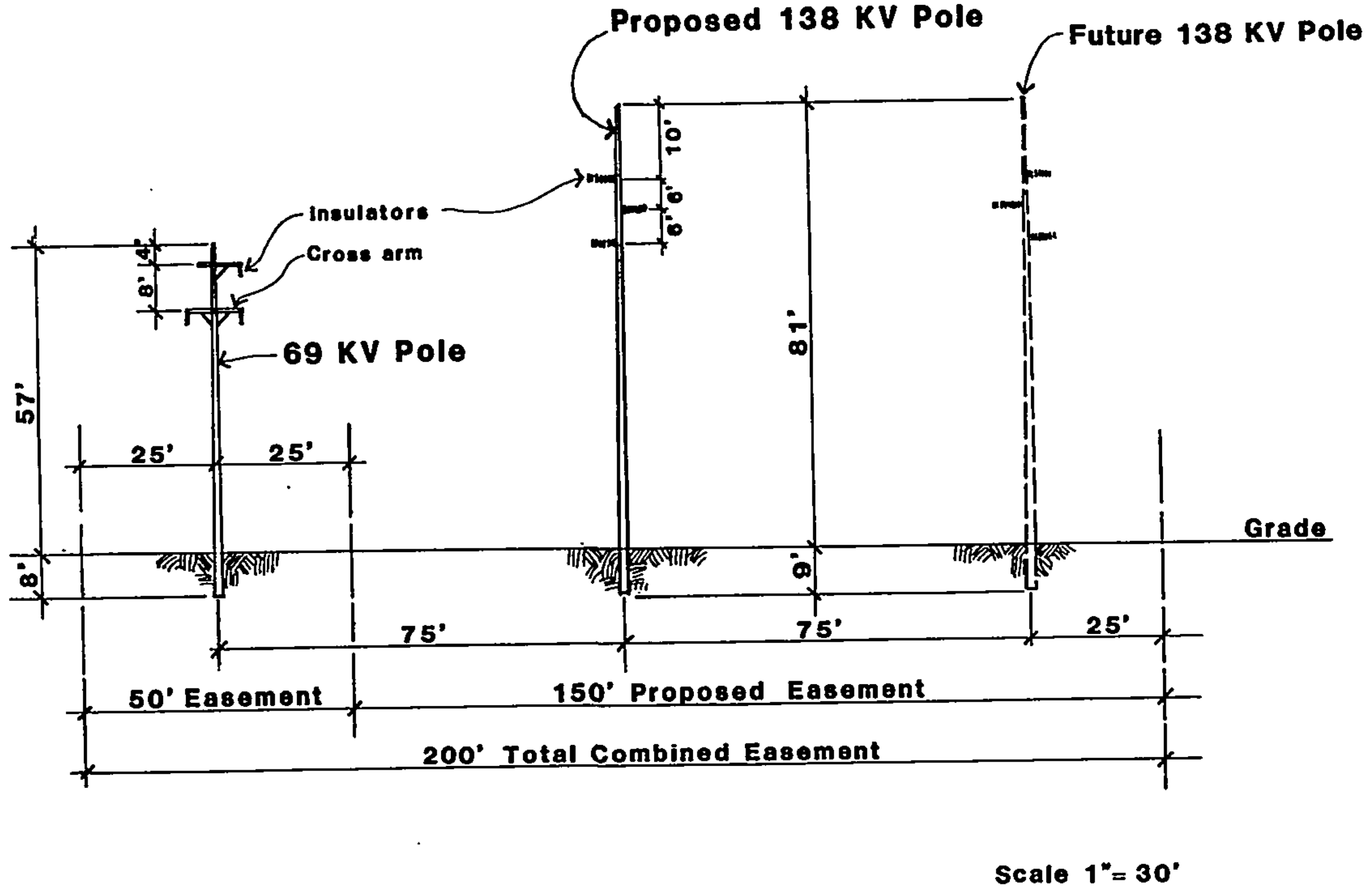

EXHIBIT II-4:
TRANSMISSION POLE CONFIGURATION

A heavy-lift helicopter is planned to be used for the hauling and setting of poles. Conventional helicopters will be used for stringing the conductors. The alternative method of using ground equipment only would be more costly, time consuming and environmentally disruptive. The following are some comparative advantages of utilizing a heavy-lift helicopter to haul and set the poles:

- The use of ground equipment only would require numerous small (100' x 100') staging areas along Saddle Road, whereas construction by helicopter would require only two large (300' x 500') staging areas. The two staging areas must be located so that all pole sites are within 30 minutes flying time, or about 20 miles. The two proposed sites are adjacent to HELCO substations at Kulani and Keamuku, both in the State Agriculture District. (See Exhibit III-5.) Neither site has sensitive environmental features; the Keamuku site is on open, rocky grassland and the Kulani site is on barren *a'a* lava flow. Moreover, neither is near an urbanized area. In contrast, several of the staging areas for the ground method would probably be in the State Conservation District. Some of these may contain or be located near relatively sensitive environmental zones. In addition, a staging area near Kaumana may be an inconvenience to nearby residents.

- The ground method would require the closing of Saddle Road for several periods during construction to haul poles to the staging areas along the road. In contrast, the helicopter method would avoid the closure of Saddle Road by using Stainback Highway to reach the Kulani staging area and Mamalahoa Highway to reach the Keamuku staging area.

- Continuous construction roads will not be needed for the helicopter method. This will mean a cost savings of at least $100,000 and far less environmental disturbance as compared to the ground method. The construction road would be about 20 feet wide and, while paving is not required, a gravel surface may be necessary in wet areas. The archaeologist and the biologists who conducted field studies during the route selection process and prepared impact assessment reports on the proposed

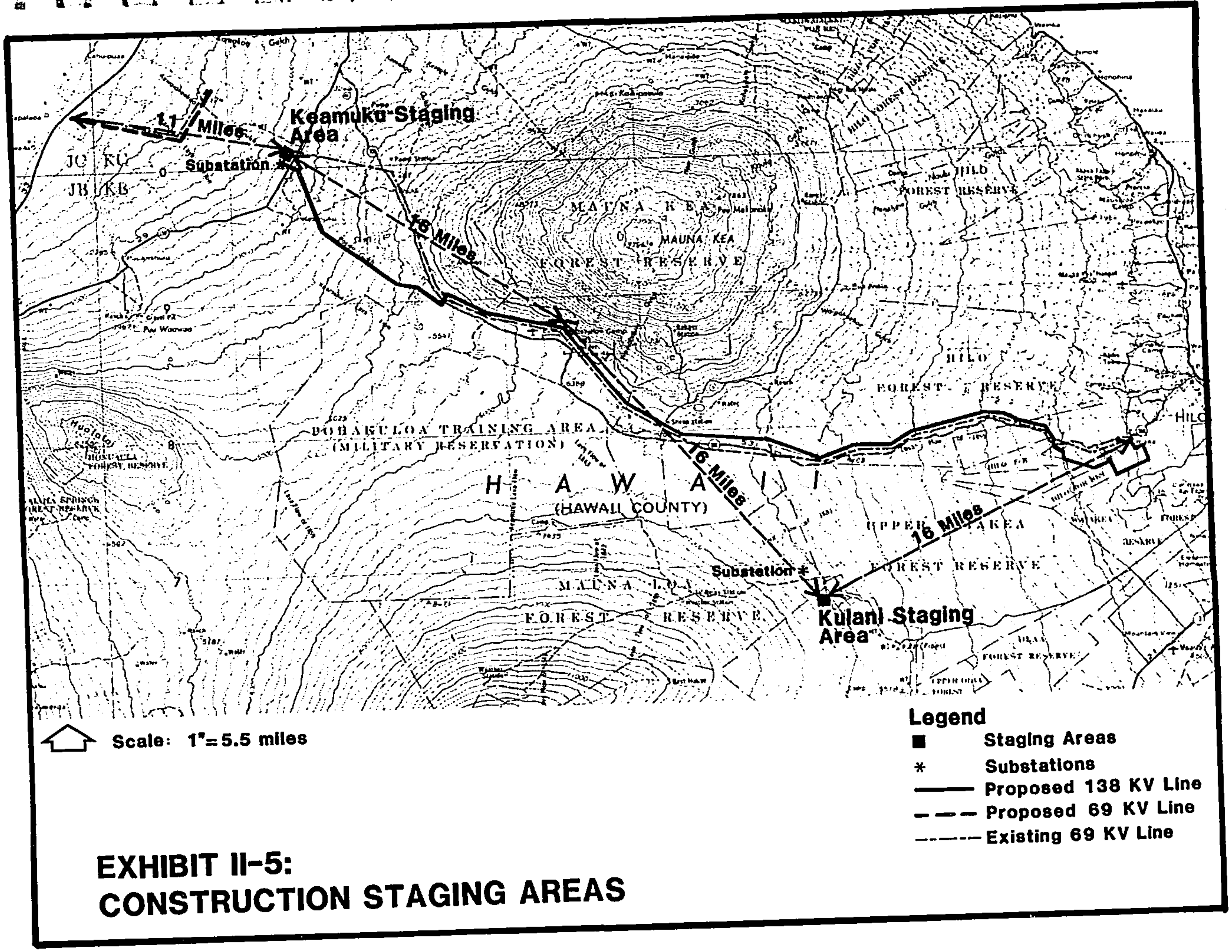

EXHIBIT II-5:
CONSTRUCTION STAGING AREAS

Chapter 11

project commented that major potential concerns would be minimized if the helicopter method of construction were used and no continuous construction road were built.[3]

- The hauling of poles to and from staging areas to the individual pole sites and the setting of poles will proceed nearly seven times faster with the use of a helicopter. The ground method would require an estimated 4,047 additional man-days for the hauling and setting of poles. The use of heavy-lift helicopter will therefore shorten the timetable for construction and result in a savings of over $1 million.

Transmission poles and other materials will be hauled to the two staging areas by truck. The poles will be the largest and heaviest materials to be transported over ground. A trailer rig can carry about 5 poles per trip. Since a total of about 420 poles will be required, this would mean about 84 round-trips between HELCO's baseyard and or Kawaihae Harbor and the staging areas for the hauling of poles.

The staging areas will be used concurrently for a period of about one year. Transmission poles, guy wires, insulators and hardware such as nuts, bolts and washers will be stored there. The conductors will most likely be kept in HELCO's base yard until the stringing operation commences. On the average, there may be anywhere from 5 to 10 people working in each staging area performing the following kinds of tasks:

- Unloading poles from the trailer rigs and moving them around with forklifts.
- Pre-drilling holes in the poles.
- Installing nuts, bolts and washers and mounting insulators on the poles.

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[3]See William Barrera, Jr. "Saddle Road, Hawaii Island: Archaeological Reconnaissance," February, 1983. pp. 2-3; W.L. Wagner, et. al., Bernice P. Bishop Museum, "Biological Reconnaissance and Environmental Impact Assessment of HECO/HELCO Proposed Cross-Island 138 Kv Transmission Line: Botanical, Entomological and Malacological Report," January 3, 1983. pp. 21-22.

- Mounting guy wires and tag lines on the poles. (Tag lines are used to guide the poles into the pole holes from the ground as they are being lowered by the helicopter.)

- Installing pole numbers on poles.

With the heavy-lift helicopter, approximately 8 to 10 poles per day can be installed in good weather.

While a continuous construction road will not be built along the alignment, there will be need for temporary vehicular access to each of the pole sites from Saddle Road to allow a ground crew to assist the helicopter operation. Existing trails or unpaved roads, such as the maintenance road for the present 69 Kv line, will be used to the greatest extent possible. Where accessible by vehicle, a truck-mounted drill rig (auger) can be brought to the pole site to bore a hole about 3 feet in diameter and 8.5 to 10 feet deep. However, soil conditions at many of the sites, particularly those covered by recent lava flows, may preclude the use of an auger to drill the holes. In such cases, the use of air hammers and explosives may be necessary. After the pole has been set, the hole will be backfilled with excavated material. Installation of anchors will be performed in a similar manner.

Upon acceptance of the EIS and approval of the CDUA, detailed surveying and design will take about 18 months, and construction another 24 months. These two phases may overlap somewhat. The design and construction of the transmission line is expected to cost about $10 million by the time it is completed in 1987.

Chapter III

CHAPTER III: ENVIRONMENTAL SETTING AND IMPACT ANALYSIS

A. INTRODUCTION

The latter part of Chapter VI in the Routing Study (pp. 118-148) contains a narrative and maps describing the physical, land control and visual conditions in the study corridor which influenced the selection of the proposed alignment for the 138 Kv cross-island transmission line between Kaumana and Keamuku. The 45-mile alignment of the proposed cross-island line is depicted in six map segments (Sections 1 through 6). Reference will be made to these map sections in the following descriptions of the physical setting of the transmission line route and the potential environmental effects of constructing and operating a transmission line along this route.

B. EXISTING CONDITIONS

As the proposed alignment leaves the Kaumana substation and travels westward, toward the "saddle" area between Mauna Loa and Mauna Kea volcanoes, ground elevations rise gradually to a high point of about 6,800 feet above sea level near the Humu'ula Sheep Station in Section 4. The alignment then descends gradually toward the Keamuku substation. (See Exhibit III-1.) The Humu'ula Sheep Station represents an approximate dividing point between two rather distinct physiographic zones.

The geology east of that point (towards Hilo) is dominated by the younger Mauna Loa slopes. Therefore, much of this area shows evidence of relatively recent lava flows and soil is generally classified as rocky muck. The western half of the alignment (towards Kona) is geologically composed of ash from Mauna Kea. The absence of recent lava flows in this area has allowed water erosion to form numerous intermittent stream beds and gulches, some of which intersect the proposed alignment. While the entire Island of Hawaii is highly susceptible to earthquake activity and damage, the eastern half of the alignment is somewhat more exposed to risk than the western half because of the greater volcanic activity of Mauna Loa as compared to Mauna Kea.[4]

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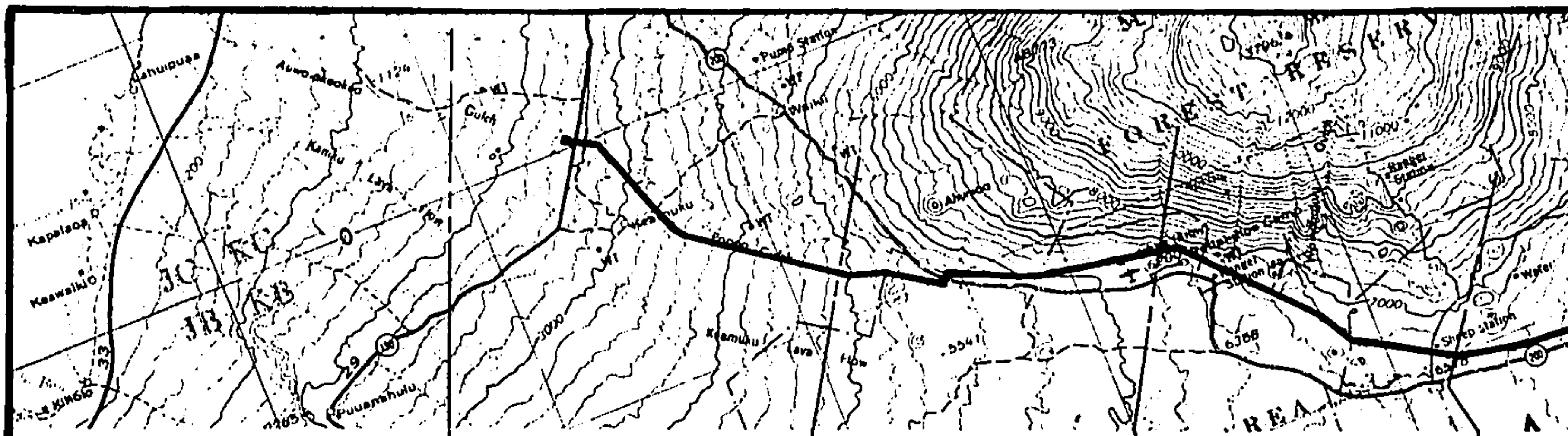
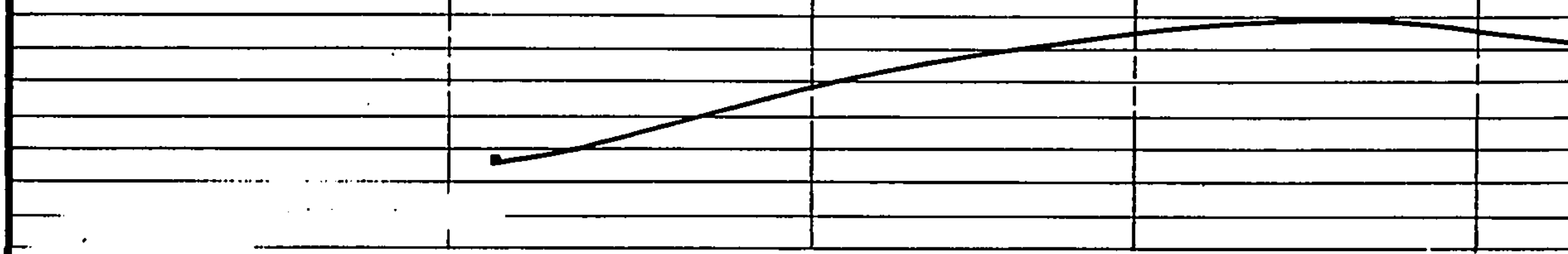
[4]Walter Lum Associates, Inc., "HELCO Transmission Line Routing Study: Geotechnical Factors," December 9, 1982. Full report is contained in the latter part of this document.



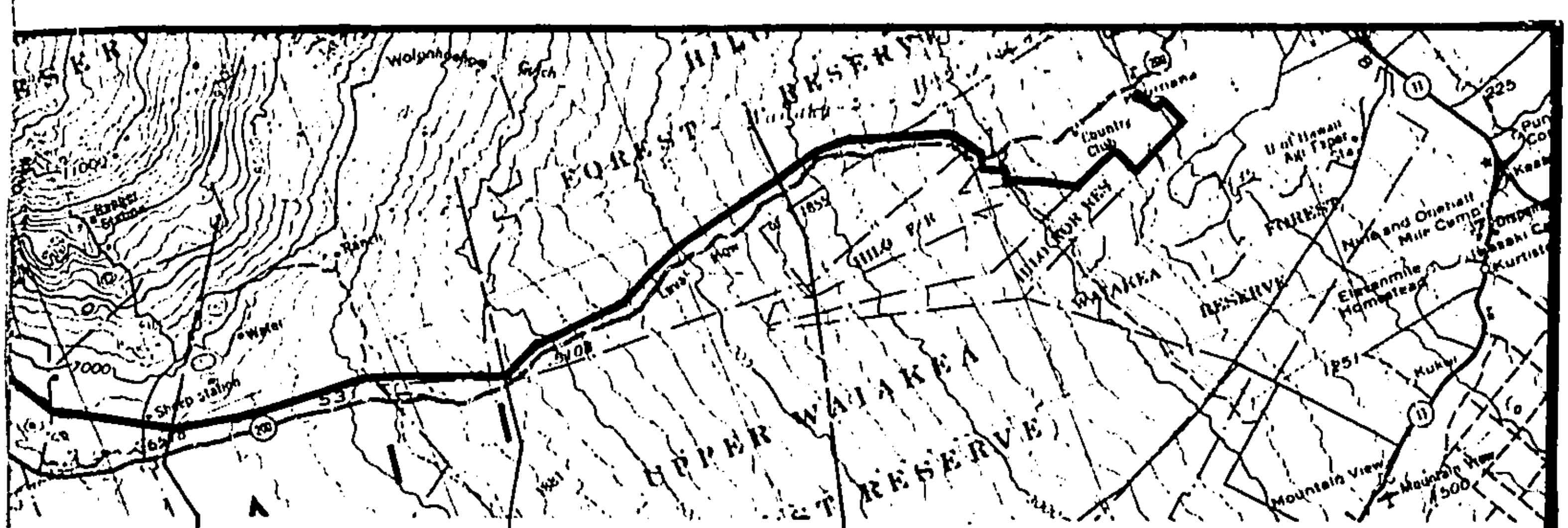
Proposed 138 KV Alignment



Section Along Proposed Alignmen

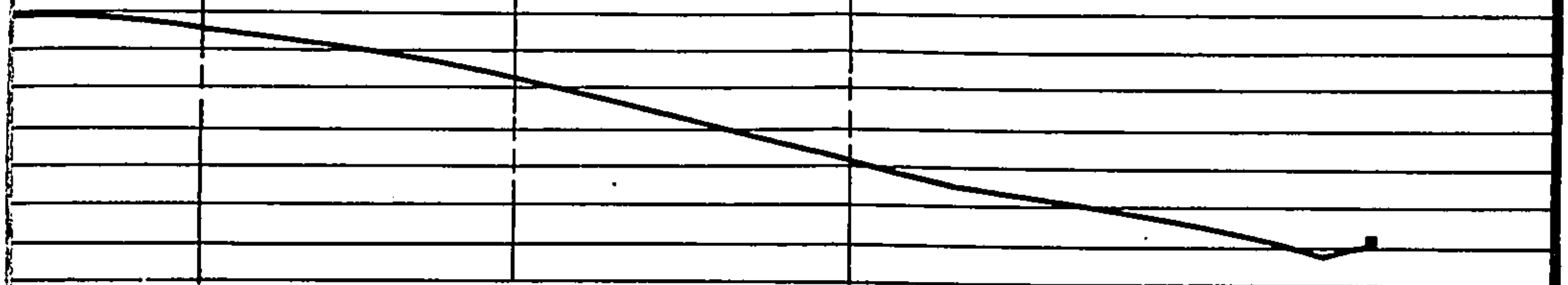
Description	**Section 6**	**Section 5**	**Section 4**	**Secti**
AVERAGE ANNUAL RAINFALL	20"	under 20"	50-75"	75-150
MAJOR GULCH CROSSINGS	2	0	0	0
SOILS	Soil is generally ash formation of Mauna Kea.			Mostly in kip
	Waikoloa very fine sandy loam	Kilohana loamy fine sand	Ke'eke'e loamy sand	Laumai stony
VEGETATION	Grasses and shrubs; pasture	Grasses and shrubs, scattered mamane-naio	Mamane-naio forest, pasture	Ohia-k (open and ba (a'a)
BIRDS AND MAMMALS	Game birds, cattle	Palila critical habitat; game birds	Palila critical habitat; game birds	Some e forest sheep

EXHIBIT III-1 SHEET 1: INVENTORY OF EXISTING CONDITIONS



XV Alignment

Scale 1:250,000

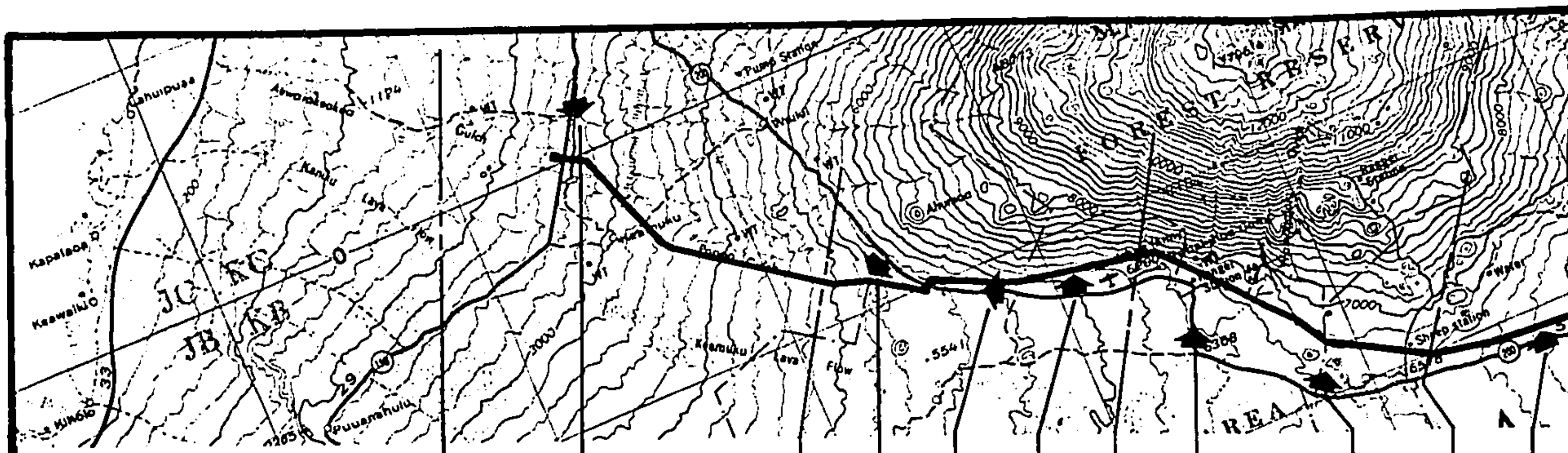


posed Alignment

Scales: Horizontal 1:250,000, Vertical 1" 5000'

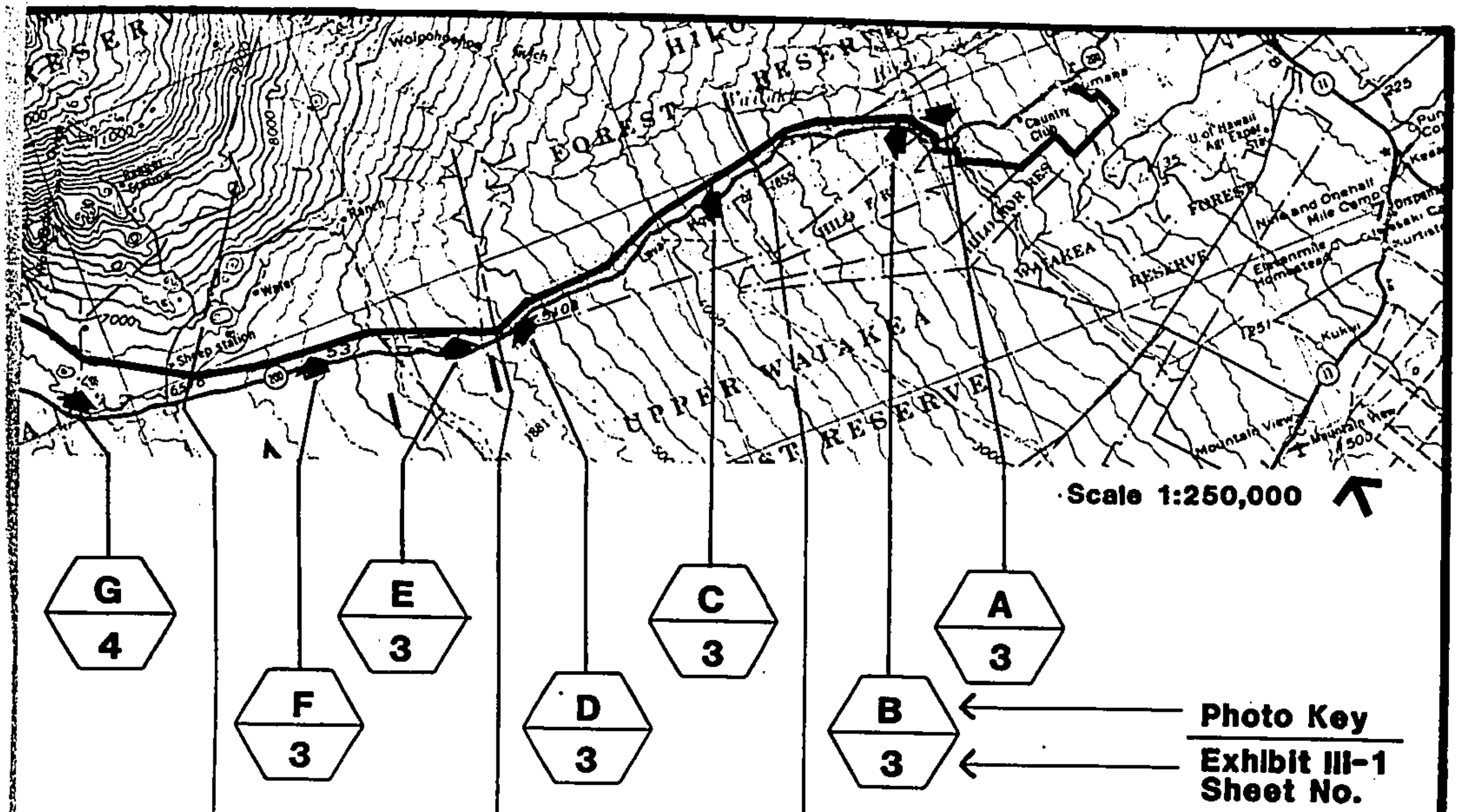
	Section 3	Section 2	Section 1
	75-150"	150-250"	250"
	0	0	0
	Mostly lava rock, but specific soil types are found in scattered areas, such as in kipuka.		
amy sand	Laumaia extremely stony silt loam	Ke'ei extremely	Ke'ei extremely rock muck
forest,	Ohia-koa forest (open and closed); and barren lava (a'a) and pasture	Ohia-koa forest (mostly closed); kipuka and collapsed lava tube nearby	Urban; introduced grassland; Ohia-koa forest, (open and closed); kipuka nearby
ical me	Some endemic forest birds; sheep	Endemic forest birds	Introduced birds and native forest birds

ITIONS



Photograph Location	L 4	K 4, J 4, I 4	H 4, G 4	F 3
Description	**Section 6**	**Section 5**	**Section 4**	**Sectio**
HISTORIC SITES	Parker Ranch District		Humuula Sheep Station	
VISUAL SCREENS	Solid and partial building and vegetation screens	No screens, some Pu'u	Pu'u, berms and solid and partial vegetation screens	Almost
LAND USE	Grazing and recreation (hunting)	Mostly military, some recreation (hunting)	Grazing, recreation (hunting) and military	Recreat (huntin grazing
LAND OWNERSHIP	Private (Parker Ranch)	State (mostly Federal lease)	State; Hawaiian Home Lands. (partly Federal lease, partly Parker Ranch lease)	State; Home L (mostl Ranch
LAND REGULATION	Agriculture	Mostly Conservation-Resources Subzone, some Agriculture	Agriculture; Conservation-General, Resource and Protective Subzones	Agricu Conser Resour Subzon

EXHIBIT III-1 SHEET 2: INVENTORY OF EXISTING CONDITIONS



4	Section 3	Section 2	Section 1
eep Station			
s and solid l vegetation	Almost none	Solid and partial vegetation screens	Partial and solid building and vegetation screens
ecreation and military	Recreation (hunting) and grazing	Recreation (hunting)	Recreation (hunting), some urban (residential) uses
aiian Home rtly Federal tly Parker e)	State; Hawaiian Home Lands (mostly Parker Ranch lease)	State	Private (various) and State
e; Conserva- al, Resource tive Sub-	Agriculture; Conservation-Resource Subzone	Conservation-Resource Subzone	Urban; Agriculture; Conservation-Protective and Resource Subzones

DITIONS

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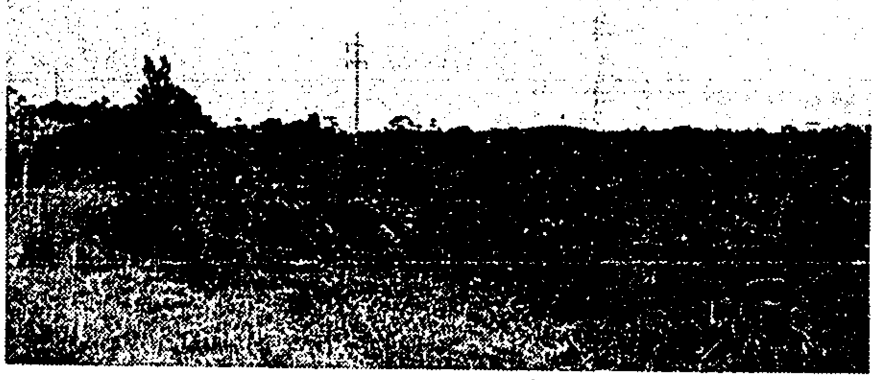

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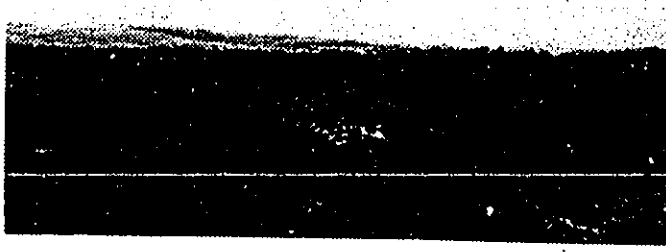

EXHIBIT III-1, SHEET 3: INVENTORY OF EXISTING CONDITIONS


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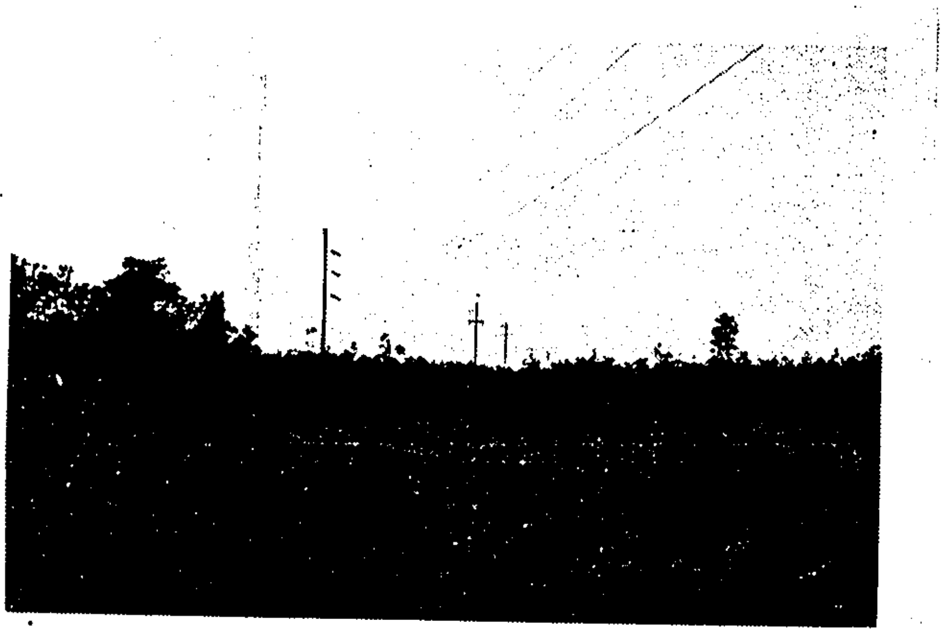
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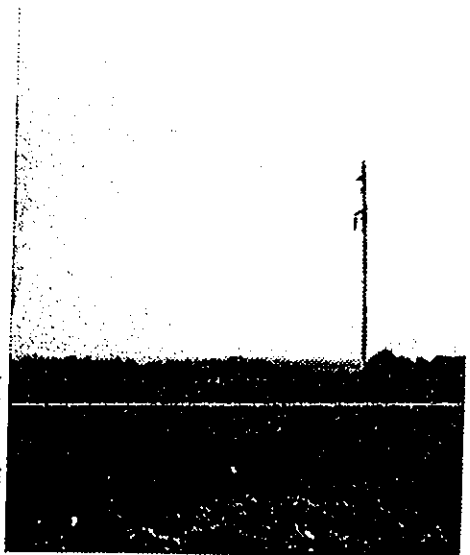
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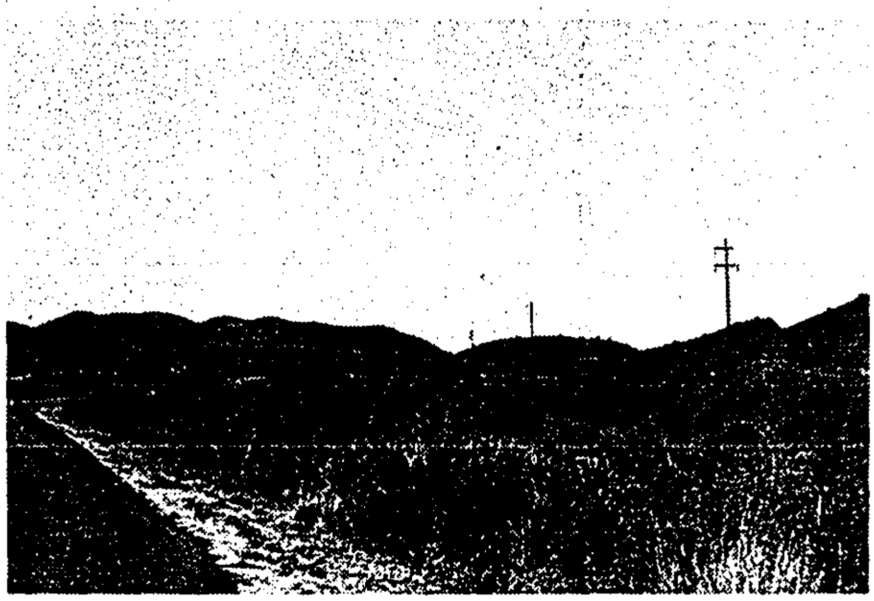

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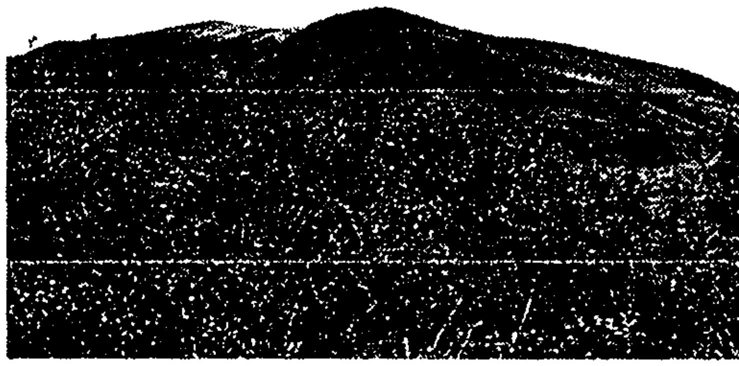
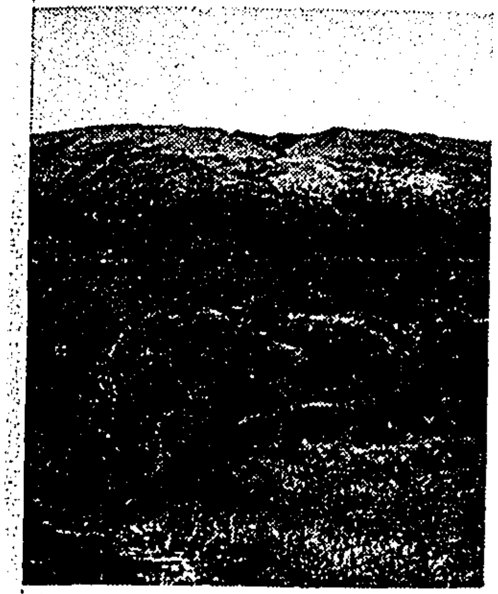


EXHIBIT III-1, SHEET 4: INVENTORY OF EXISTING CONDITIONS



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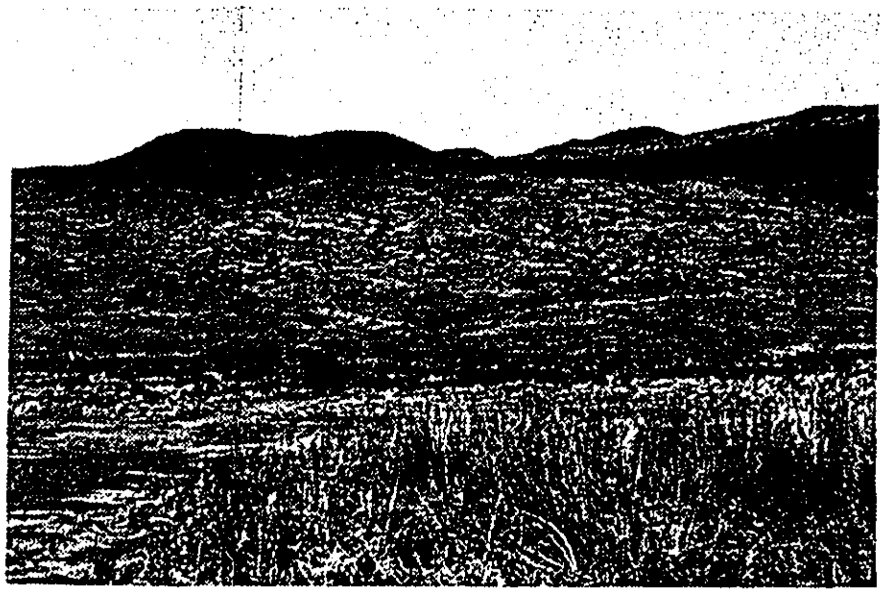

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The eastern half of the alignment is quite wet, with average annual rainfalls generally in excess of 75 inches. The western half, in the "rain shadow" of Mauna Kea, is much drier, with average annual rainfall in some areas less than 15 inches. Air temperatures are warm to moderate throughout the year all along alignment, with a notably cooler climate at higher elevations. Measurements at the U.S. Army's Pohakuloa Training Area (PTA) in Section 5, for example, indicate an average annual high temperature of 70°F and an average annual low of 45°F.

The "saddle" area experiences sea-mountain breezes in which cold air drains down slope at night. Fog in the morning hours are generally caused by the condensation which occurs when heat emanating from the land meets overlying cold air. In the afternoons fog is produced when the cold coastal breezes from the west meet the warmer air in the saddle area.

Average annual wind speeds measured at PTA are four to six knots or five to seven miles per hour. There are no areas along the alignment when average annual wind speeds are much in excess of that range, since there is little direct exposure to ocean-borne winds.

Vegetative cover and wildlife habitats along the alignment reflect geologic and climatic conditions. The wetter eastern section is dotted with native Ohia-Koa forests, ranging from dense growths with canopy heights of 50 feet or more to sparsely-covered younger growths on relatively recent lava fields.[5] Some of the older forest areas have been classified as kipuka, which are pockets of relatively pristine ecosystems that have been surrounded by lava flows occurring in the past couple of centuries. Kipuka are of considerable interest to evolutionary biologists because of their older successional stage and relative isolation from other natural habitats. The alignment comes close to only one of the many kipuka that were identified in the field investigations.[6] Mysterious "die-backs" have occurred in scattered portions of

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[5]W.L. Wagner, et. al., Bernice P. Bishop Museum, "Biological Reconnaissance and Environmental Impact Assessment of HECO/HELCO Proposed Cross-Hawaii Island 138 kv Transmission Line: Botanical, Entomological and Malacological Report," Honolulu, January 3, 1983. Full report is contained in the latter part of this document.

[6]This kipuka, identified as K-2300, is located in Section 1. See Physical Conditions map for Section 1 on page 123 of the Routing Study.

the Ohia-Koa forests. Scientists have not precisely identified the causes of Ohia decline, but it is apparently not due to human disturbance.[7]

The importance of these Ohia-Koa forests as habitats for native species of arthropods (i.e., insects, arachnids and crustaceans), snails and birds depends largely on the degree to which these areas have previously been disturbed. Relatively unperturbed kipuka provide habitat for plant-feeding anthropods and land snails dependent on various species of native trees, shrubs and ferns which are found in abundance in these areas.[8] The population of endemic forest birds likewise varies according to the degree to which the forest area has been disturbed by lava flows, human activity or other causes.[9] These endemic species, primarily members of the Hawaiian honeycreeper family, are most common between elevations 4,000 and 6,500 feet. They are therefore most likely to be found in the denser Ohia-Koa forest areas of Sections 2 and 3.

Collapsed lava tubes formed in pahoehoe flows constitute another type of important habitat in wetter areas. Surface vegetation provides the main energy source to the caves via root penetration. The cave-adapted arthropods which subsist in these environments are highly sensitive to surface alteration or destruction. One such cave, however, whose entrance is located adjacent to a pole for the existing 69 Kv line in Section 3, was found to have been relatively undisturbed.[10] The proposed alignment does not parallel this portion of the existing 69 Kv line and does not pass through or near any other identified lava tube habitats.

Between the higher reaches of the scattered Ohia-Koa forests and the middle of Section 4 of the alignment is pasture land interspersed with a'a lava flows. The pasture use has removed what was probably once a transition forest habitat between the wet Ohia-Koa forests and the dry scrub forests on the lee side of Mauna Kea.

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[7]Personal communication with Dr. Charles Hodges, Institute of Pacific Forestry, State of Hawaii Department of Land and Natural Resources.

[8]W.L. Wagner, et. al., op. cit., pp. 5, 6, 7, 11, 12, 13.

[9]Andrew J. Berger, "HECO/HELCO Transmission Line Routing and EIS/CDUA: Bird and Mammal Report," Honolulu, no date. Full report is contained in the latter part of this document.

[10]W.L. Wagner, et. al., op. cit., p. 11.

Beginning in the western portion of Section 4, where elevations are above 6,500 feet and rainfall is less plentiful, the proposed alignment crosses through Mamane-Naio forest. This is a dry, low-lying scrub forest with canopy heights no more than about 15 feet. There are several endemic host-specific species of pomace fly associated with Naio, several other species of native seed bug and at least three native species of land snail in this area.[11] The Mamane-Naio ecosystem provides nesting and foraging habitat for five species of endemic forest bird - Pueo, Elepaio, Amakilu, Palila and Akiapola'au. The latter two are on both the Federal and State lists of endangered species. The Palila is very rarely seen at elevations as low as the proposed alignment's, however, and has never been found nesting in this area. Similarly, there are no published records of the Akiapola'au being seen at elevations this low.[12] Despite infrequent sightings of Palila in the area, much of proposed alignment through Sections 4 and 5 are within the lower portion of the designated Palila Critical Habitat. Its path is immediately adjacent to the existing 69 Kv line. There is a jeep road following this route which serves the multiple purposes of ranching operations, hunting access and utility line maintenance access.

When the proposed alignment crosses Saddle Road in the extreme western portion of Section 5, it continues southwest through Section 6, crossing dry grasslands and open scrub forest consisting mostly of exotic plant species, particularly in areas which have been grazed or destroyed by fire. There are a few relatively undisturbed areas, mostly on hilltops, where some native grasses and ferns can be found. A native species of mint on the Federal list of endangered species (Haplostachys haplostachya) may occur in this area, but was not evident when the botanical survey of the alignment was conducted because of the lack of recent rainfall.[13] As the transmission line route approaches the Keamuku substation, it crosses more frequently grazed pasture land, covered almost entirely with exotic grasses and scattered, introduced olive and Eucalyptus trees. Section 6 provides habitat for very few species of birds, primarily the Pueo, the Skylark and various game birds such as the California Quail, Gambel's Quail, Chukar, North Indian Gray

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[11] W.L. Wagner, et. al., op cit., p. 14.

[12] W.L. Wagner, et. al., op. cit., p. 14.

[13] W.L. Wagner, et. al., op. cit., p. 18; and personal communication on May 3, 1983.

Francolin, Indian Black Francolin, Erckel's Francolin, Ring-necked Pheasant and Rio Grande Turkey.[14] In fact, the alignment passes directly through the Pu'u Ke'e Ke'e Game Management Area.

Ambient air quality data have never been kept in the "Saddle" area or anywhere along the proposed alignment. The air is generally free of pollutants generated by vehicular emissions and industrial discharges because of the low level of human activity in the area. Vehicular counts along Saddle Road in 1980 indicate an Average Daily Traffic (ADT) volume of only 358 vehicules near the intersection with Mamalahoa Highway (Section 6). The highest traffic volumes near the proposed alignment occur in the more urbanized end of Saddle Road, at Kaumana, where the ADT was 2,580 vehicles in 1980.[15]

The U.S. Army's Pohakuloa Training Area (Section 5) is sometimes dusty due to the combination of dry climatic conditions and the movement of military vehicles along unpaved roads or across rugged terrain. Explosives used in the PTA impact zone also create particulate emissions, although the affected areas are located several miles from the proposed alignment. Emissions from brush fires, particularly in the dry zones of Sections 5 and 6, can deteriorate air quality on an incidental basis. There is also a far less likely potential for air-borne emissions resulting from volcanic eruptions and sugar-cane burning.

Because of the relative absence of urban uses and highway traffic, noise levels throughout most of the proposed alignment are quite low, probably in the range of 30 to 50 dBA.[16] Major noise events are undoubtedly due to aircraft and artillery operations in the PTA. A noise survey of PTA's environs found that noise levels in the range of 75 to 90 dBA, caused by helicopters flying overhead and howitzer firing and shell burst, occurred less than 25 percent of the time. These levels would no doubt be lower and less frequent along the proposed alignment, since it is only on the periphery of military lands in Sections 5 and 6.

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[14] Andrew J. Berger, op. cit., pp. 2-7.

[15] Records of the Highway Planning Branch, State of Hawaii Department of Transportation.

[16] Ronald A. Darby & Associates for U.S. Army, "Noise Survey of the Environs of Pohakuloa Training Area, Pohakuloa, Hawaii," June, 1977.

The proposed cross-island transmission line would not pass directly over any existing buildings, but would cross Saddle Road at two points, in Sections 1 and 5, and Mauna Kea Access Road, in Section 4. It also crosses the existing 69 Kv line twice in Sections 1 and 5. The route of the proposed 138 Kv cross-island line is immediately adjacent to an existing 69 Kv transmission line for nearly two-thirds of its length.

Starting from the Kaumana substation, the alignment passes within several hundred feet of a residential subdivision, but circumvents most existing residential areas and undeveloped Urban District land. Approximately 5 miles from Kaumana substation, still in Section 1, the alignment passes within a few hundred feet of the site of a proposed radio transmitter station. There are no other nearby structures until Section 4, where the alignment runs just south of Humu'ula Sheep Station, next to the existing 69 Kv line. Toward the western end of Section 4, the proposed alignment, again following the route of the existing 69 Kv line, passes within two thousand feet of Pohakuloa State Park, remaining out of sight of the cabin area. About a mile west of this the alignment comes within a couple hundred feet of two water tanks perched on a ledge above the base camp for Pohakuloa Training Area. There are no other nearby structural improvements anywhere along the remainder of the route for the proposed 138 Kv line and there are virtually no buildings at all near the alignment for the proposed 69 Kv radial line.

Two marginally significant historic buildings are found in the urban area of Kaumana (Section 1), both a thousand feet or more from the proposed alignment.[17] The Humu'ula Sheep Station, considered a "valuable" historic site, lies adjacent to the proposed route in Section 4. The Parker Ranch District, also considered a "valuable" site, encompasses virtually the entire alignment in Section 6. However, the only physical feature of any historic significance in Section 6 is the cluster of buildings at Waiki'i, located several miles away from the proposed alignment. None of these sites are currently listed on the Hawaii State Register of Historic Places.

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[17] William Barrera, Jr. "Saddle Road, Hawaii Island: Archaeological Reconnaissance," February, 1983. Full report is contained in the latter part of this document.

Because of the proposed alignment's proximity to Saddle Road along much of its length, this highway is the vantage point from which the transmission line potentially has the most significant impact on public views. Vegetation and topographic features can sometimes screen the proposed alignment from view, even when the route parallels the road at a range of a couple hundred feet or so.[18] An indication of potential impact can be seen in the visibility of the existing 69 Kv line which lies adjacent to much of the proposed route.

Beginning in the middle of Section 1, where the alignment first approaches Saddle Road, solid and partial vegetation screens lie between the proposed alignment and the roadway. The existing 69 Kv line is intermittently visible in this area. This condition continues through Section 2, with occasional openings to views of the 69 Kv line, until Section 3, where the existing 69 Kv line is directly exposed to view and crosses the road twice. The proposed alignment, however, would be set back about 2,000 feet from the road along this same stretch. In Section 4, a series of pu'u lie between the proposed alignment and Saddle Road, effectively screening the adjacent 69 Kv line. The 69 Kv line remains generally out of obvious sight from the road until after it passes Bradshaw Airfield in Section 5, where it begins to reapproach Saddle Road. There are virtually no vegetative or topographic screens in this area, so the transmission line becomes increasingly visible as it comes to within a hundred feet or so of the road. The proposed alignment crosses over to the south side of Saddle Road at this point and its path departs steadily and out of sight from the alignment of Saddle Road and the paralleling 69 Kv line.

Major landowners along the proposed alignment include Parker Ranch, the State of Hawaii, the Department of Hawaiian Home Lands and the Federal government. There are also a few smaller private properties in Section 1. (See Exhibit IV-2.) Most of the land owned by the State is undeveloped and used for passive recreation, hunting and resource conservation. The land held or leased by the Federal government, in Sections 4 and 5, is part of the U.S. Army's Pohakuloa Training Area, but the proposed alignment is not in the immediate area of military operations. The Department of

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[18] A more detailed description of screens and views is provided on pages 111 and 116 of the Routing Study. Visual Resources maps for each of the sections of the study corridor are included in the same chapter of the Routing Study.

Hawaiian Home Lands leases most of its property in Sections 3 and 4 to Parker Ranch, which uses this land, together with its own extensive holdings in Section 6, for sheep and cattle ranching.

The proposed alignment runs near a small area of existing residences in Kaumana (Section 1) and continues along the periphery of an undeveloped parcel in the State Urban District, where there is potential for expanding the residential land use pattern. Otherwise, the proposed alignment is entirely within the State Agriculture and Conservation Districts. (See Exhibit III-2.) Much of the Agriculture District land is fallow. Parts of Sections 3, 4 and 6 are used for pasture, but none of the Agriculture District land anywhere along the proposed alignment is used for crop cultivation orchards or other more intensive uses.

C. POTENTIAL IMPACTS AND PROPOSED MITIGATION

The potential environmental impacts of the proposed action can be seen in several different ways, depending upon when they would occur, how long they would last, where their effects would be felt and how significant their effects might be. Each of these considerations can be taken individually.

- When the impact might occur: The impact might be induced during either construction of the proposed transmission line or after it is put into operation.

- How long the effect would last: Many of the impacts which occur during the construction phase would be expected to have short-term effects. Some others, however, might have longer lasting effects. For example, the removal of a colony of rare plants during construction of the transmission line could irreversibly destroy a unique habitat, as well as species of insects or other animals that are dependent upon the habitat for their survival.

- Where their effects would be left: Some of the impacts may localized, such as the disturbance of land areas during construction, while others have regional or larger-scale implications, such as the effects on energy supplies and consumption.

- How significant their effects might be: Potential impacts range in their degree of importance, depending largely on the qualities of the physical, social or economic resource being affected. For example, a prominent view of the proposed transmission line in a major scenic areas which receives

EXHIBIT III-2

EASEMENT FOR
KAUMANA-KEAMUKU 138 Kv TRANSMISSION LINE,
BY LAND USE DISTRICT

	LENGTH (FT)	SQ FT	ACRES
CONSERVATION DISTRICT			
Sec 1, 2, 3, 4, 5	124,550	18,682,500	428.89
Protective Subzone*			
Sec 1	2,500		
Sec 4	6,000		
Total	8,500	1,275,000	29.27

*All immediately adjacent to existing 69 kv line at the subzone boundary.

	LENGTH (FT)	SQ FT	ACRES
Resource Subzone			
Sec 1	22,200		
Sec 2	38,000		
Sec 3	2,000		
Sec 4	17,850		
Sec 5	36,000		
Total	116,050	17,407,500	399.62
AGRICULTURE DISTRICT			
Sec 1, 3, 5, 6	124,500	18,675,000	428.72
URBAN DISTRICT			
Sec 1	3,000	450,000	10.33

frequent exposure would be a more significant impact than the visual effect of the line in an area which is hidden from frequent viewing.

The beneficial as well as adverse effects of the proposed action should be considered in an analysis of potential impacts so that planning and permit decisions can be based on a balanced view of the project. There are, in addition, various ways to minimize or mitigate potentially adverse impacts which should play a major part in the planning and review process.

Mitigation of potential environmental impacts has been incorporated into the planning process for the proposed transmission line from the initial stages, as documented in the enclosed Routing Study. The first chapter of that report describes the various considerations of system reliability, past and forecasted load growth, energy resource policies and cost-effectiveness that led to project selection. Consideration of these factors is expected to minimize or avoid potential socio-economic impacts of the proposed project, such as induced population growth and increases in utility costs and energy consumption. HELCO's long-range, system wide transmission plans identified the need for a second cross-island 138 Kv line by the year 2000. By assuming during route selection that a second transmission line will eventually be built adjacent to the proposed line, the cumulative impacts of HELCO's systemwide plans are addressed and minimized.

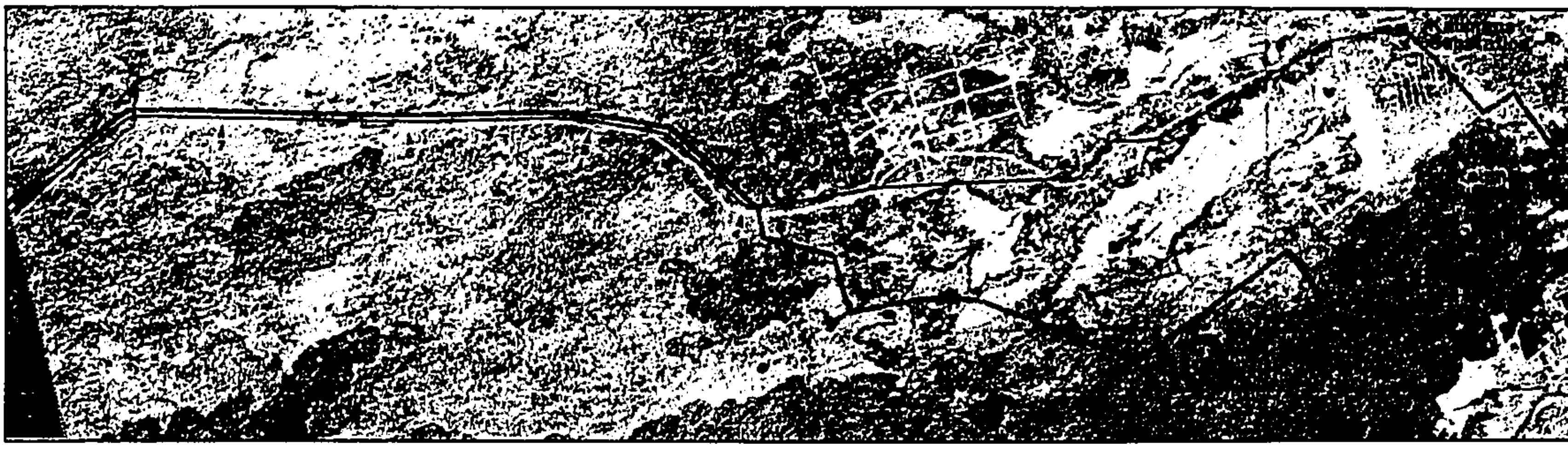
Route selection for the proposed transmission line easement took into account a wide range of socio-economic, physical, environmental and land use control factors in order to avoid potential adverse impacts. The effects of construction and maintenance of the proposed line were taken into account during both the broadscale analysis and the detailed alignment phases of route selection and assisted in the development of the proposed project design and construction methods. As a result of this planning approach, the probability of significant adverse effects from the proposed project is low. The table in Exhibit III-3 summarizes each potential impact in terms of when, how long, and where it is expected to occur, how significant its effects might be and whether there will be beneficial effects. The impact sensitivity analysis for each of the six route map section sheets in Exhibit III-4 is keyed to categories of potential impacts. Where additional mitigation measures are appropriate, they are included at the end of the discussion of each of the following categories of potential impact.

1. <u>Soil erosion</u>

There is some potential for soil erosion during the construction phase in areas which are cleared for the pole sites and pole anchors, but long-term effects on

IMPACT CATEGORY	WHEN		HOW LONG		WHERE		HOW MUCH			BENEFICIAL EFFECTS
	Construction Phase	Operation Phase	Short-term	Long-term	Route-specific	Regional or Large scale	High Potential	Moderate Potential	Low Potential	
Soil Erosion	●		●		●			●		
Unique or Native Ecosystems	●	●	●	●	●		●			
Wildlife	●	●	●	●	●		●			
Air Quality and Noise Levels	●	●	●	●	●			●		
Archaeological and Historic Resources	●			●	●				●	
Use of Surrounding Properties		●		●	●				●	●
Public Health and Safety		●		●	●			●		●
Aesthetics		●		●	●		●			
Employment and Population Growth	●	●	●	●		●			●	●

EXHIBIT III-3:
IMPACT ASSESSMENT MATRIX, BY IMPACT CATEGORY



SOIL EROSION

UNIQUE OR NATIVE ECOSYSTEMS

WILDLIFE

ARCHAEOLOGICAL AND HISTORIC RESOURCES

USE OF SURROUNDING PROPERTIES

PUBLIC HEALTH AND SAFETY

AESTHETICS

EXHIBIT III-4, SECTION 1

HELCO
ENVIRONMENTAL IMPACT STATEMENT

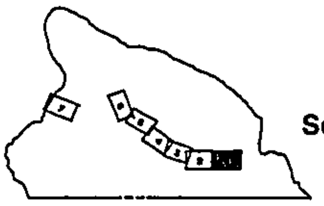
LEGEND

PLAN DATA

- Proposed 138 KV alignment
- Existing 69 KV line
- Proposed substation
- Existing substation
- Matchline

DEGREE OF SENSITIVITY

- High
- Moderate
- Low
- Not in section



Section 1

Impact Sensitivity Analysis

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0 500 1000 1500 METERS 3000

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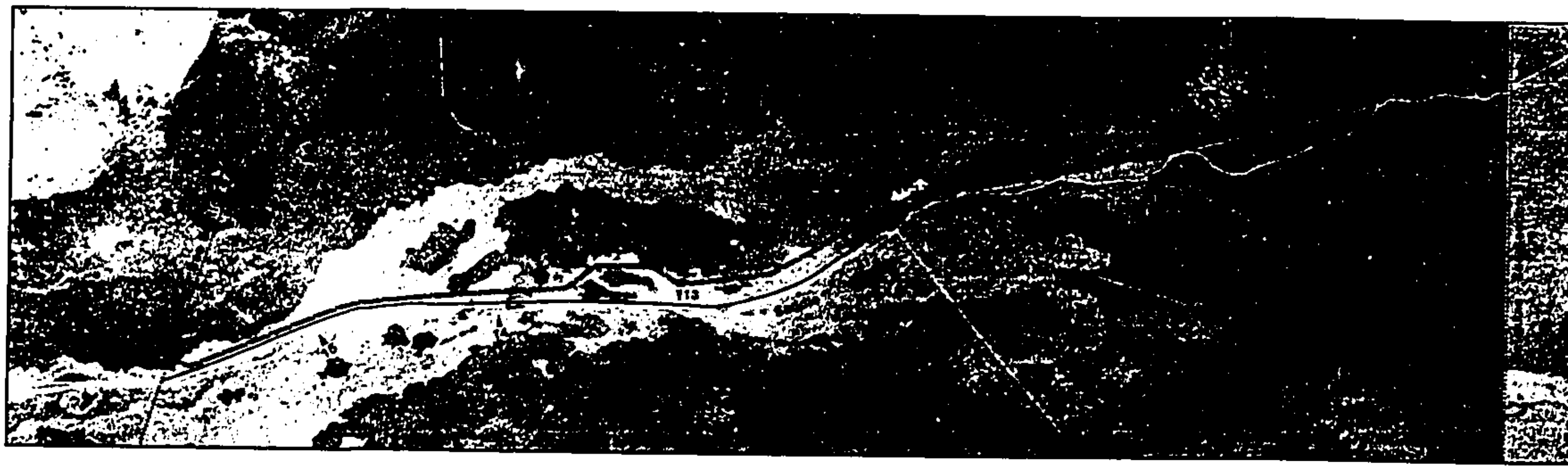


SOIL EROSION

UNIQUE OR NATIVE ECOSYSTEMS

WILDLIFE

ARCHAEOLOGICAL AND HISTORIC RESOURCES

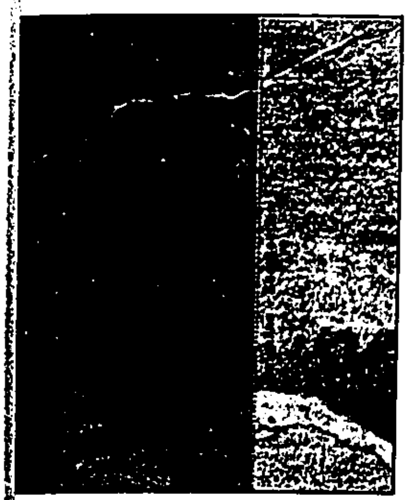
USE OF SURROUNDING PROPERTIES

PUBLIC HEALTH AND SAFETY

AESTHETICS

EXHIBIT III-4, SECTION 2

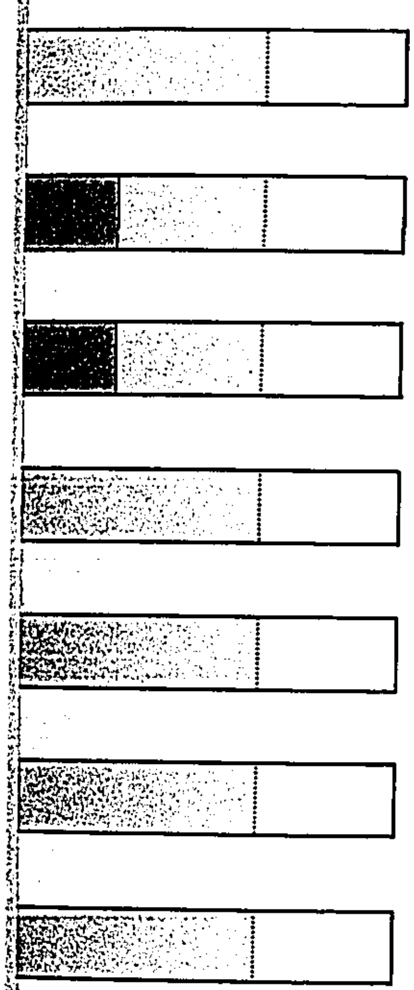
HELCO ENVIRONMENTAL IMPACT STATEMENT



LEGEND

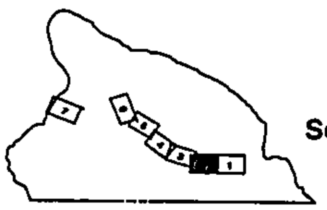
PLAN DATA

Proposed 138 KV alignment
Existing 69 KV line
Proposed substation
Existing substation
Matchline



DEGREE OF SENSITIVITY

High
Moderate
Low
Not in section



Impact Sensitivity Analysis

TEMENT ○ EDAW inc.

SOIL EROSION

UNIQUE OR NATIVE ECOSYSTEMS

WILDLIFE

ARCHAEOLOGICAL AND HISTORIC RESOURCES

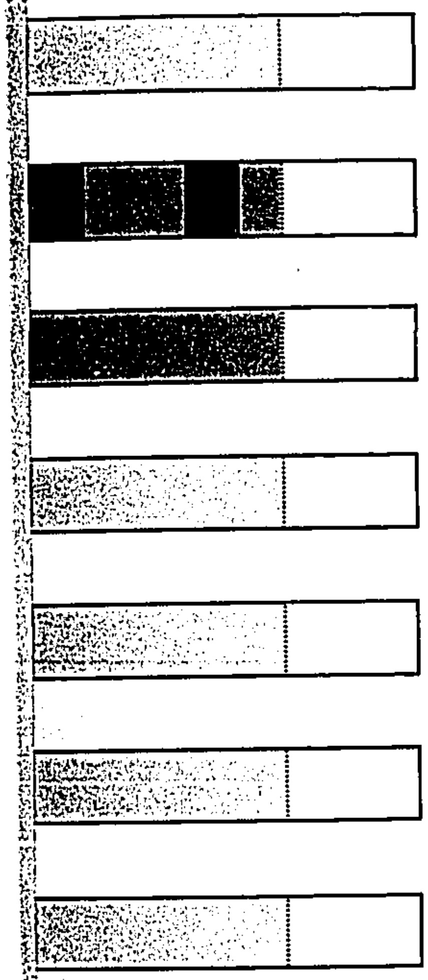
USE OF SURROUNDING PROPERTIES

PUBLIC HEALTH AND SAFETY

AESTHETICS

EXHIBIT III-4, SECTION 3

HELCO ENVIRONMENTAL IMPACT STATEMENT



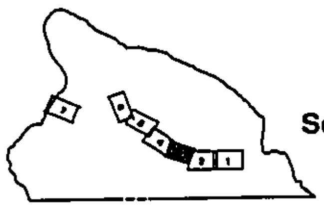
LEGEND

PLAN DATA

Proposed 138 KV alignment
Existing 69 KV line
Proposed substation
Existing substation
Matchline

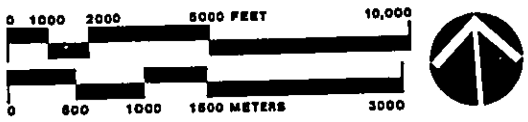
DEGREE OF SENSITIVITY

High
Moderate
Low
Not in section



Section 3

Impact Sensitivity Analysis



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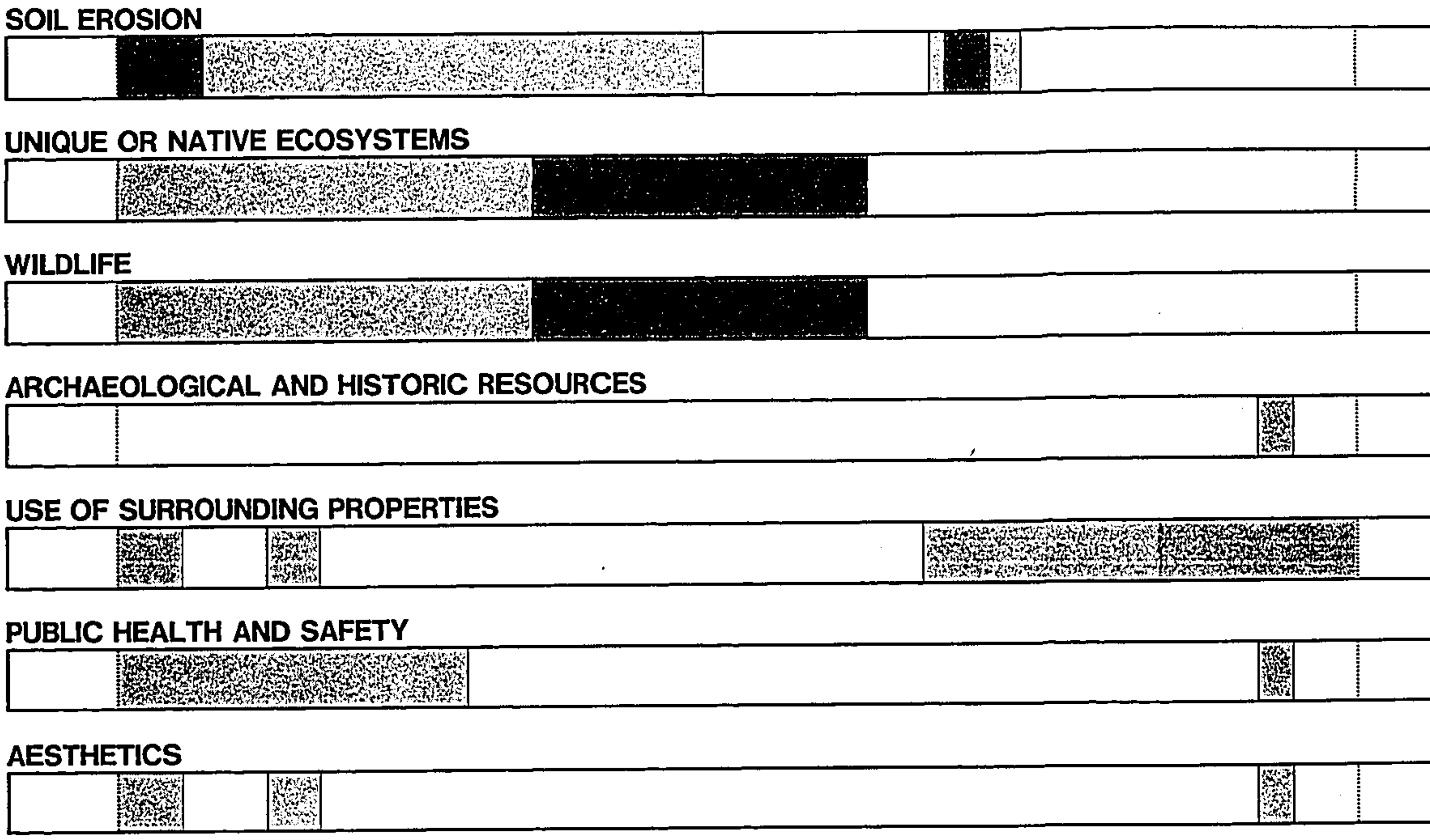


EXHIBIT III-4, SECTION 4

HELCO ENVIRONMENTAL IMPACT STATEMENT

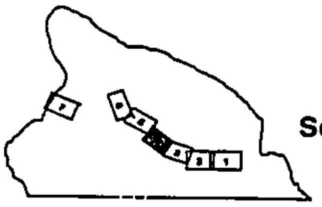
LEGEND

PLAN DATA

- Proposed 138 KV alignment
- Existing 69 KV line
- Proposed substation
- Existing substation
- Matchline

DEGREE OF SENSITIVITY

- High
- Moderate
- Low
- Not in section



Section 4

Impact Sensitivity Analysis

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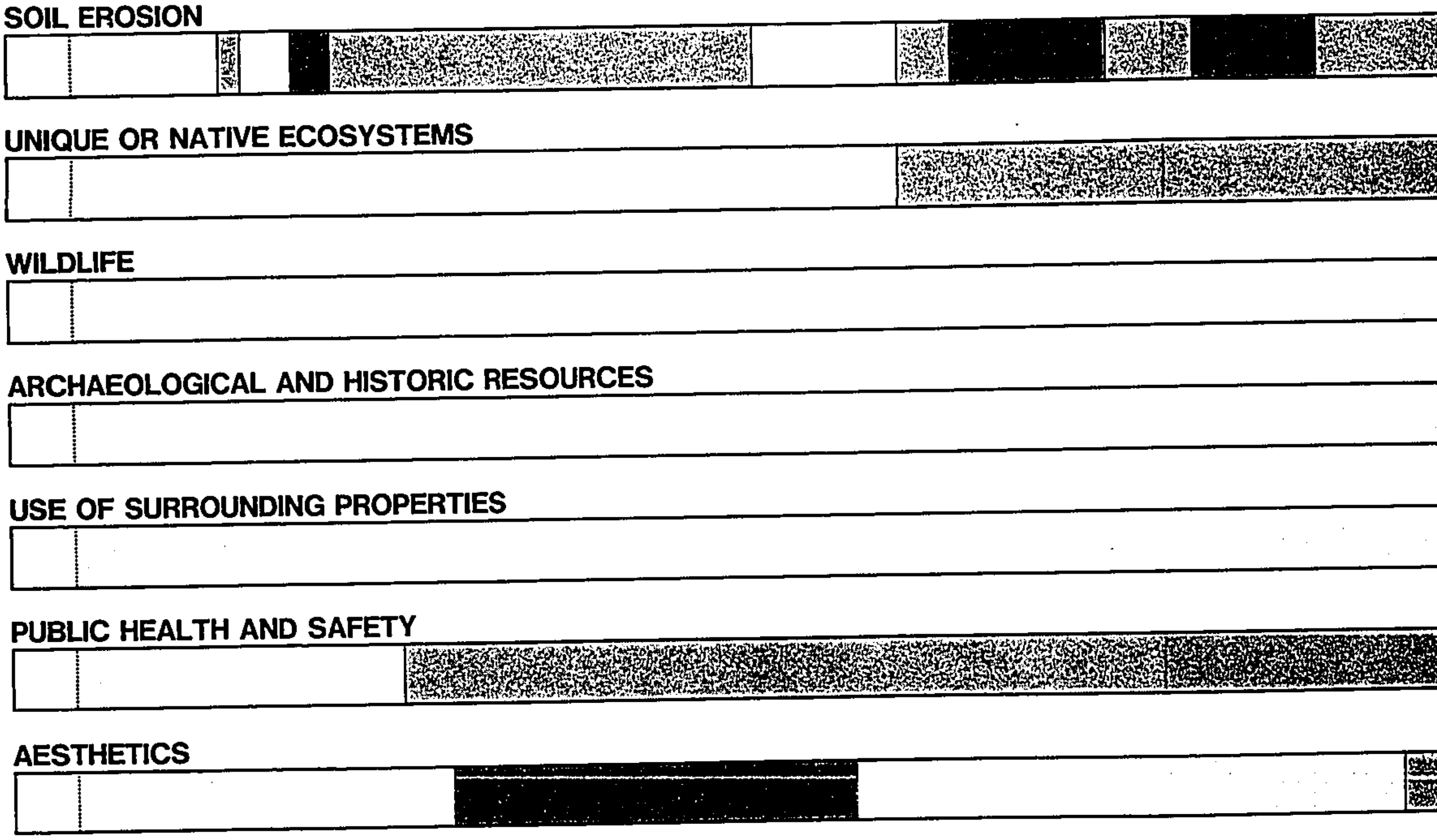


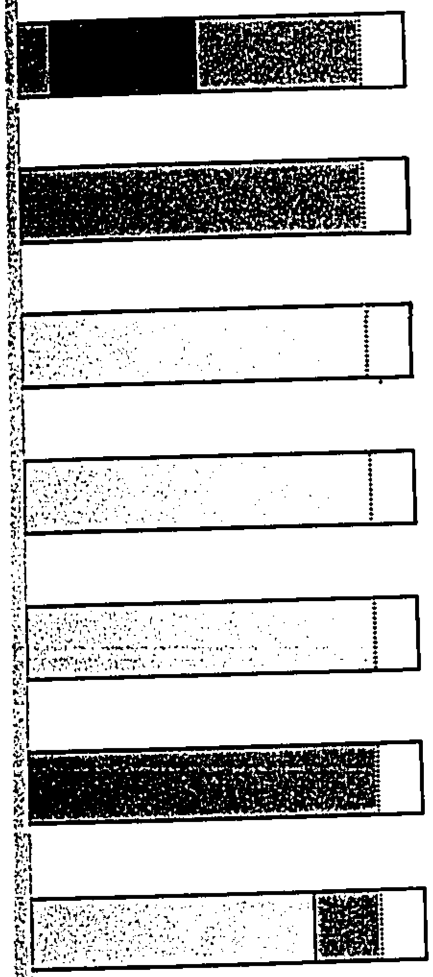
EXHIBIT III-4, SECTION 5

HELCO
ENVIRONMENTAL IMPACT STATEMENT

LEGEND

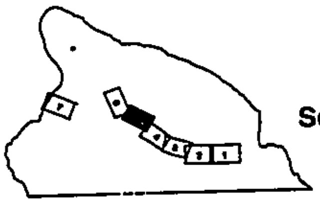
PLAN DATA

- Proposed 138 KV alignment
- Existing 69 KV line
- Proposed substation
- Existing substation
- Matchline



DEGREE OF SENSITIVITY

- High
- Moderate
- Low
- Not in section



Section 5

Impact Sensitivity Analysis

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SOIL EROSION

UNIQUE OR NATIVE ECOSYSTEMS

WILDLIFE

ARCHAEOLOGICAL AND HISTORIC RESOURCES

USE OF SURROUNDING PROPERTIES

PUBLIC HEALTH AND SAFETY

AESTHETICS

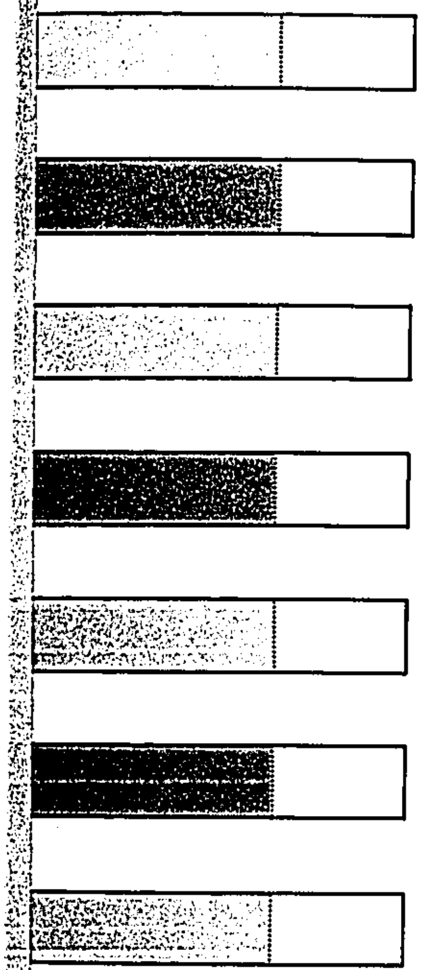
EXHIBIT III-4, SECTION 6

HELCO ENVIRONMENTAL IMPACT STATEMENT

LEGEND

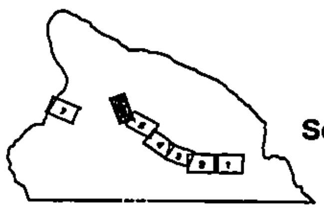
PLAN DATA

Proposed 138 KV alignment
Existing 69 KV line
Proposed substation
Existing substation
Matchline



DEGREE OF SENSITIVITY

High
Moderate
Low
Not in section



Section 6

Impact Sensitivity Analysis

TEMENT ○ EDAW inc.

soil erosion are expected to be minimal. Soil erosion was one of the constraint factors considered in the selection of a detailed alignment for the transmission, so areas of high erosion hazard potential and steep slope have generally been avoided.

Approximately 48 poles in Sections 4 and 5 of the alignment will be sited on soils rated by the U.S. Soil Conservation Service as having "high erosion hazard potential." Perhaps one or two of the poles will be on slopes of 20% or greater.[19] Since this area gets little rainfall, wind erosion tends to be a more important factor than water erosion.[20] Nevertheless, the alignment will cross several small gullies created by runoff from the slopes of Mauna Kea. The following steps will be taken to minimize soil erosion and slope stability problems in sensitive areas:

- In areas where erosion hazard potential is highest, there is an existing jeep trail along the proposed alignment which can be used for access by necessary ground crews and equipment during construction and maintenance of the line. Since the poles will be transported by helicopter, no large hauling vehicles will be travelling this route. Thus, disturbance to soils and their vegetative cover will be confined to the pole sites.

- Peripheral areas where vegetation has been destroyed during construction will be re-planted. Species to be used in re-planting will be indigenous to the area and subject to the approval of the State Division of Forestry.

- Poles will be sited only at the toe of slopes in steeper areas and away from gulches to avoid short-term and long-term erosion and stability problems. Detailed field surveys will be conducted by geological and soils engineers to determine optimum sites for poles in sensitive areas.

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[19] The locations of high erosion hazard soils and steep slopes can be seen in the Physical Conditions maps for Sections 4 and 5 on pages 137 and 141 of the Routing Study.

[20] Walter Lum Associates, Inc., _op. cit._, p. 10.

2. Unique or native ecosystems

A major criterion for route selection was the avoidance of unique or native ecosystems which might be adversely affected by the construction and operation of a transmission line. Nevertheless, there are areas along the proposed alignment which are ecologically sensitive and deserve special attention. (See Exhibit III-3.) Disturbance of these areas may promote the growth of invasive, exotic species of plants and disrupt the ecological balance.

There are three stretches of older forest area of the Ohia-Koa type, each about 1000 to 2000 feet in length, which could be adversely affected by removal of plant material during construction and periodic maintenance to replace damaged equipment and provide adequate clearance for transmission line conductors. The first of these three areas, a kipuka in Section 1, has been described as "somewhat disturbed" by the biological survey team for the Routing Study, probably due to its proximity to Saddle Road. Construction activity within the kipuka could accelerate its deterioration. The other two areas, along the edges of closed-canopied forest interspersed among lava flows of 1935 in Section 3, while not identified as kipuka, are separated from areas of previous construction activity and may therefore be sensitive to this type of disturbance.[21] Other Ohia-Koa forests along the alignment are less sensitive to potential impacts because they consist of young, pioneer vegetation on relatively recent lava flows or are adjacent to previously disturbed areas, such as the existing 69 Kv line or Saddle Road.

The Mamane-Naio scrub forest in Section 4 may also be sensitive to impacts from construction and maintenance of the proposed alignment. The removal of native plant material may encourage exotic species to take root. Periodic tree trimming for transmission conductor clearance is not likely to be a significant factor because the plants in this area are generally under 30 feet in height. Botanical surveys of this area indicate the presence of exotic species throughout this section

[21] W.L. Wagner, et. al., p. 7.

of forest, particularly in areas which have previously been disturbed.[22] The proposed alignment is alongside the existing 69 Kv transmission line and a jeep trail which is used by ranchers and hunters. This is no doubt the area of greatest prior disturbance. In addition, there are a number of open patches in the forest where transmission poles might be placed without requiring the removal of large plants. The adverse impact of an additional transmission line is not likely to be significant if adequate precautionary measures are taken.

A final area of ecological sensitivity occurs in Section 6, where an endangered species of mint is thought to occur.[23] If it is present, it is most likely located on rocky hilltops which are inaccessible to grazing animals that range throughout this area.[24] If transmission poles are placed near colonies of this endangered species,the disturbance may encourage the growth of competing plant species and threaten the continued existence of the colony.

Other than the effects of direct physical disturbance to areas along the proposed alignment during construction and maintenance activities, the transmission line's probable impact on nearby ecosystems is expected to be negligible. The possibility of fire due to arcing or spark discharge from conductors is extremely remote. Periodic tree trimming clears all vegetation within 10 feet of energized conductors. In drier areas of the proposed alignment, where the chances of fire hazard are greater, the height of vegetation is naturally limited to about 30 feet, which is about 10 feet below the lowest point of the conductor sag. Any damage or disturbance to the line, such as downing of a conductor, will cause the system to "trip out." The breakers will open at Kaumana and Keamuku substations, stopping the flow of electricity. The existing 69 Kv line has tripped out three times since it was built nearly 30 years ago. On all three occasions, the conductor made contact with plant material but did not cause a fire. The relay mechanism sensed a fault on the line and immediately caused the breakers to open at Kaumana and

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[22] W.L. Wagner, et. al., p. 15.

[23] ibid., p. 18.

[24] Personal communication with Warren L. Wagner, Bernice P. Bishop Museum, May 16, 1983.

Keamuku substations. The relay mechanism for the proposed 138 Kv line will operate even faster, with trip-out occurring within about 17 cycles or 0.33 seconds.

The maintenance of an access road alongside the transmission line in Sections 4, 5 and 6 will, in fact, reduce existing hazards to unique dry climate ecosystems by acting as a fire break and providing access for fire-fighting personnel and equipment.

To avoid or minimize potential impacts of the proposed project on unique, native ecosystems, the following steps will be taken:

- A qualified botanist will survey the proposed alignment through the areas described above as ecologically sensitive in order to identify pole sites which will minimize ecosystem disruption and to recommend appropriate site-specific mitigation, such as re-planting of exposed areas with indigenous vegetation.

- No herbicides will be used to clear pole sites or to maintain clearance within the transmission line easement.

- Where additional clearance is required for conductors, trees in the areas described above as being ecologically sensitive will be "feathered back" and trimmed approximately once every two years rather than uprooted and removed from the easement.

- Existing jeep trails will be used to the extent possible for access to the poles site by construction and maintenance personnel.

- Continuous access roads within the proposed transmission line easement will be provided and maintained in Sections 4, 5 and 6 for fire protection purposes.

- No continuous access roads will be provided in Sections 1, 2 and 3. Instead, ground crew access to the pole sites will be gained directly from Saddle Road, using existing jeep trails whenever possible.

3. Wildlife

There are several endemic species of birds, insects and land mollusks (snails) which are dependent upon the habitats described in the previous section. Since the route selection process and the mitigation measures listed above will avoid the removal or degradation of important habitat, adverse effects on wildlife populations are expected to be temporary. Bird populations may retreat from the area surrounding the pole sites during construction but will return after poles are set and conductors are placed. It is highly improbable that any endangered species will be affected even on a temporary basis. No endangered birds are known to nest in the vicinity of the proposed alignment where it crosses through the officially designated Palila Critical Habitat. According to the ornithologist who headed the Palila Recovery Team, the proposal to include Pohakuloa Flats in the Critical Habitat was made at a time when feral sheep were destroying the Mamane-Naio forest on Mauna Kea. The thought was to include the entire forest, even though it was known that Palila does not nest in Pohakuloa Flats area and that the Palila population moves upslope during the non-breeding season rather than downward to the Flats.[25]

The possibility of birds and bats colliding with the transmission conductors while in flight is also extremely remote. Only migratory birds and large birds of prey would be subject to collision hazard, and these species would be very unlikely to fly across the proposed alignment. The Hawaiian bat, which may be found in the area, can avoid transmission conductors and other obstacles during nocturnal flights by using its excellent echolocation system.[26]

Because potential impacts on wildlife are related mainly to probable effects on habitat and several means have been and will be employed to minimize adverse impacts on habitat, no additional mitigation measures for the protection of wildlife are believed to be necessary.[27]

4. Air quality and noise levels

Construction activities, including the use of helicopters and the blasting and drilling of holes for poles and anchors, will lower air quality and increase noise levels in limited areas for temporary periods.

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[25] Andrew J. Berger, op. cit. pp. 22-23.

[26] Andrew J. Berger, op. cit., pp. 30-32.

[27] See conclusion in ibid., p. 31.

A hovering helicopter generates approximately 93 dBA at a distance of about 100 feet and blasting will probably generate levels of up to 95 dBA at the same distance.[28] This is substantially higher than ambient noise levels along the major portion of the alignment, except for sections near Pohakuloa Training Area which are subjected to equivalent noise levels on an occasional basis. The outdoor noise levels will be loud enough to interfere with human speech (60 dBA or greater) within approximately a half-mile of each construction site.

Air quality impacts will result primarily from dust generated by blasting, the movement of construction vehicles over unpaved trails and rotating helicopter blades, particularly in Sections 4, 5 and 6, where the climate is dry. It has been estimated that construction activity of this sort can generate small-size particulates (less than 30 microns in diameter) at a rate of 1.2 tons per acre per month of activity if there is no mitigation.[29]

Neither the noise nor air quality impacts during construction will have significant effect on populated areas and will most probably be perceived by few people other than construction workers. Perhaps 3 or 4 poles sites near the Kaumana substation are close enough to a small residential area to result in construction noise which will be audible to occupants.

After construction, noise and air quality impacts will be minor. It is possible that corona discharge[30] from the transmission conductors will produce a barely audible (less than 30 dBA) hissing and crackling sound at the edge of the easement in higher elevations during foggy or rainy frequent.

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[28] Bolt, Beranek and Newman, Noise from Construction Equipment and Operations, Building Equipment and Appliances, 1971.

[29] U.S. Environmental Protection Agency, Compilation of Air Pollutant Emission Factors AP-42, Third Edition, August, 1977.

[30] The corona is a discharge of electrical energy from the transmission conductors into the atmosphere, where it is dissipated.

Corona discharge also breaks down the air near the conductor surface, causing the formation of small quantities of ozone (O_3) and nitrogen oxides (NOx). Based on measurements which have been taken around transmission lines of much higher voltage capacity, the proposed project is expected to produce insignificantly small concentrations of these substances, even under the most adverse weather conditions. Scientific study of corona discharge effects has concentrated on facilities with voltage capacities of 345 Kv or more because the effects of lower capacity facilities, such as the proposed 138 Kv transmission line are considered negligible.[31]

To reduce air quality and noise impacts during construction, the following procedures will be followed:

- o Travelling speeds along unpaved trails will be restricted to 20 mph. This will reduce dust generation by 65 to 80 percent.

- o Work hours at construction sites within 1 mile of human habitation (i.e., portions of Sections 1 and 4) will be limited to the hours of 7 am to 6 pm.

5. <u>Archaeological and historic resources</u>

The proposed transmission line is not expected to have any adverse effect on sites which have been placed on the Hawaii State Register of Historic Places or any other areas which have been identified as having historic value. The only known historic site which the alignment would actually cross, the extensive Parker Ranch District, contains no apparent remains or structures within or near the alignment itself.

While it is highly improbable that any undiscovered archaeological remains exist within the proposed alignment,[32] the destruction of unknown sites will be avoided as follows:

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[31] John Dunlop, Electric Power Research Institute, personal communication; July 20, 1983.

[32] William Barrera, Jr. op. cit. See conclusion on pp. 2-3.

- Proposed pole sites and any other surface areas that will be disturbed by construction activities will be surveyed by an archaeologist, who will locate and describe any historic remains within the areas affected by construction. Suitable means to protect or remove significant remains will be determined in consultation with the archaeologist and the Hawaii State Historic Preservation Office.

6. Use of surrounding properties

Since HELCO will acquire an easement rather than a fee simple right-of-way for the proposed transmission line, owners of property along the alignment will retain limited rights to the use of the property. The use will be restricted by safety requirements applying primarily to buildings and structures.[33] Uses such as parking lots and small sheds are permitted within the easement but no dwellings are allowed, nor are any structures which would encroach into the minimum clearance for transmission conductors.

These limitations on use obviously have greater potential effect on properties in the State Urban District than on lands in the State Agriculture and Conservation Districts. Overhead transmission lines through urban areas are often perceived as nuisances which can detract from the use and enjoyment of adjoining properties. Many people object to the appearance of transmission lines and believe that they lower property values in residential areas, although there is no evidence that this is the case.[34] There is also a common perception that transmission lines through an urban area pose a hazard to public health and safety. This concern, discussed in the following section, also has little basis in fact. Sparking and corona discharge from transmission lines and insulators can, however, cause interference with AM radio and television reception under certain conditions, which may be an annoyance to residents in nearby areas. Proper design and maintenance can eliminate this problem.

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[33]Public Utilities Commission, State of Hawaii, General Order No. 6: Rules for Overhead Electric Line Construction in the State of Hawaii.

[34]See M & E Pacific, Inc., for Hawaiian Electric Company, Revised Environmental Impact Statement for the Proposed Halawa to Kamoku 138 kv Transmission Lines; February, 1979. pp. 89-90.

Because of both the real and perceived nuisance factors, the avoidance of urban areas was one of the principal criteria in selecting the route for the proposed transmission line. Only 10.33 acres, or slightly more than 1%, of the total easement area will be in or alongside Urban District land, and none of this area is presently urbanized. While some of the Agriculture and Conservation District land crossed by the proposed easement may someday be urbanized, it is highly improbable that a significant amount of this land will be developed within the next several decades due to a combination of major physical constraints and remoteness from existing urban areas. In areas more likely to be urbanized, such as in the eastern portion of Section 1 near Kaumana, the route of the proposed transmission line avoids or minimizes conflicts with potential urban uses by following property lines.

Owners of Agriculture and Conservation District property within and alongside the proposed easement will be limited little more than they already are by existing land use controls. The potential for agriculture use, for example, will be largely unaffected. Easements for 138 Kv transmission lines can and have been used in Hawaii for grazing and the cultivation of sugar cane, pineapple and other crops without discernible adverse effect. The easement will cross through two areas which Parker Ranch uses for sheep and cattle pasture. A 69 Kv transmission line has been present in these same areas for more than 30 years and has not impeded ranching operations. In fact, the access trails through these areas serve both ranchers and transmission line maintenance crews to mutual benefit. Landowners may apply for special or conditional use permits for certain types of development projects outside the range of specified permitted uses in the Agriculture and Conservation Districts, but it is not likely that the proposed transmission line would preclude many such potential uses. As an example, there are plans to build an FM radio station transmitter on Conservation District land within a few hundred feet of the proposed easement in Section 1. The detailed plans for the proposed transmission line and radio transmitter can and will be coordinated so that the two uses can co-exist compatibly.

In addition to the method of route selection for the transmission line, which has already avoided many potential impacts on the use and enjoyment of property, the following measures are proposed to minimize conflicts with surrounding land uses and property rights:

- To reduce the incidence of sparking and potential interference with radio and television reception, particular care will be given to the installation and maintenance of the transmission line near urbanized areas to prevent loose hardware, insufficient tension on suspension insulators and insulation contamination.

- The compensation paid to landowners for the transmission line easement will be based on a fair market appraisal of the existing and potential use of the property.

7. <u>Public health and safety</u>

In recent years, there has been increasing interest in the long-term biological effects which are believed to be associated with the electromagnetic field generated by extra high voltage transmission lines (345-765 Kv). Although research in this area is still in its formative years, it is clear that potential biological effects are related to the electrical field gradient, measures in kilovolts per meter (kv/m), and the frequency of the alternating current, measured in Hertz (Hz). The exact nature and extent of potential health effects on humans from chronic exposure to very strong electromagnetic fields has still not been determined.

There are currently no State of Hawaii or Federal standards based on health effects for exposure to electromagnetic fields produced by transmission lines. The New York Public Service Commission, after extensive hearings in 1978, adopted an interim standard of 1.0 kv/m measured at a height of 1 meter at the right-of-way edge for new 345 and 765 Kv lines, and placed a moratorium on transmission lines of higher voltage until definitive health effect information becomes available.[35] The government of the Soviet Union, after a study conducted in that country in 1972, set limits on the exposure to electric fields for personnel at high voltage substations.[36] (See Exhibit III-5.) The Soviet standards

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[35]New York Public Service Commission, <u>Opinion No. 78-13, Case 26529 and 26559: Common Record Hearings on Health and Safety of Extra-High Voltage Transmission Lines</u>; June 19, 1978.

[36]V.P. Korobkova, Yu A. Morozov, M.D. Stolarov and Yu A. Yakub, "Influence of the Electric Field in 500 and 750 KV Switchyards on Maintenance Staff and Means for Its Protection," CIGRE 23-06, 1972.

EXHIBIT III-5

RUSSIAN EXPOSURE STANDARDS FOR SUBSTATION WORK

Electric Field Intensity kv/m (50 Hz)	Electric Field Intensity kv/m (60 Hz)	Permissible Stay in Field in 24-hour Period minutes
5	4.2	Unlimited
10	8.3	180
15	12.5	90
20	16.7	10
25	20.8	5

are considered quite conservative, since they apply to continuous, long-term exposures in workplaces. The Soviet research is not generally accepted by the U.S. scientific community or regulatory agencies because of inadequate control conditions and unspecified variables which were used in their experiments.[37] Several subsequent tests in the U.S. and Western Europe, using careful experimental controls, did not find conclusive evidence of health effects on humans and laboratory animals resulting from extended exposure to high electric field gradients.[38] In any case, the electric field gradients for the proposed transmission line will be substantially lower than the conservative Soviet standard for unlimited exposure. Electric field gradients are calculated to be no more than 0.47 kv/m anywhere within the proposed easement. As the graph in Exhibit III-6 illustrates, electric field gradients drop significantly as one moves a short distance from a transmission line. At the edge of the easement, the electromagnetic field exposure will be comparable to that which results from normal use of household appliances. (See Exhibit III-7.)

People wearing cardiac pacemakers may be potentially at risk from exposure to electromagnetic fields. Electric fields may cause the hearts of persons wearing synchronous pacemakers to receive asynchronous artificial stimulation along with biological stimulation, creating a phenomenon known as competitive pacing. There is no agreement among cardiovascular specialists about the seriousness (or even the existence) of problems associated with competitive pacing.[39] Regardless, electric

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[37] B. Scott-Walton, K.M. Clark, B.R. Holt, D.C. Jones, S.D. Kaplan, J.S. Crebs, P. Poulson, R.A. Shepherd, J.R. Young, *Potential Environmental Effects of 765 Kv Lines*, prepared by SRI for the U.S. Department of Energy, Report No. DOE/EV-0056; November, 1979.

[38] J.E. Bridges, "Environmental Considerations Concerning the Biological Effects of Power Frequency (50 or 60 Hz) Electric Fields," *IEEE Transactions on Power Apparatus and Systems*, Vol. PAS-97, #1, Jan./Feb., 1978.

[39] J.E. Bridge and M.J. Frazier, for the Electric Power Research Institute, *The Effects of 60-Hertz Electric and Magnetic Fields on Implanted Cardiac Pacemakers*, EIA-1174, Final Report; September, 1979. pp. 5-8.

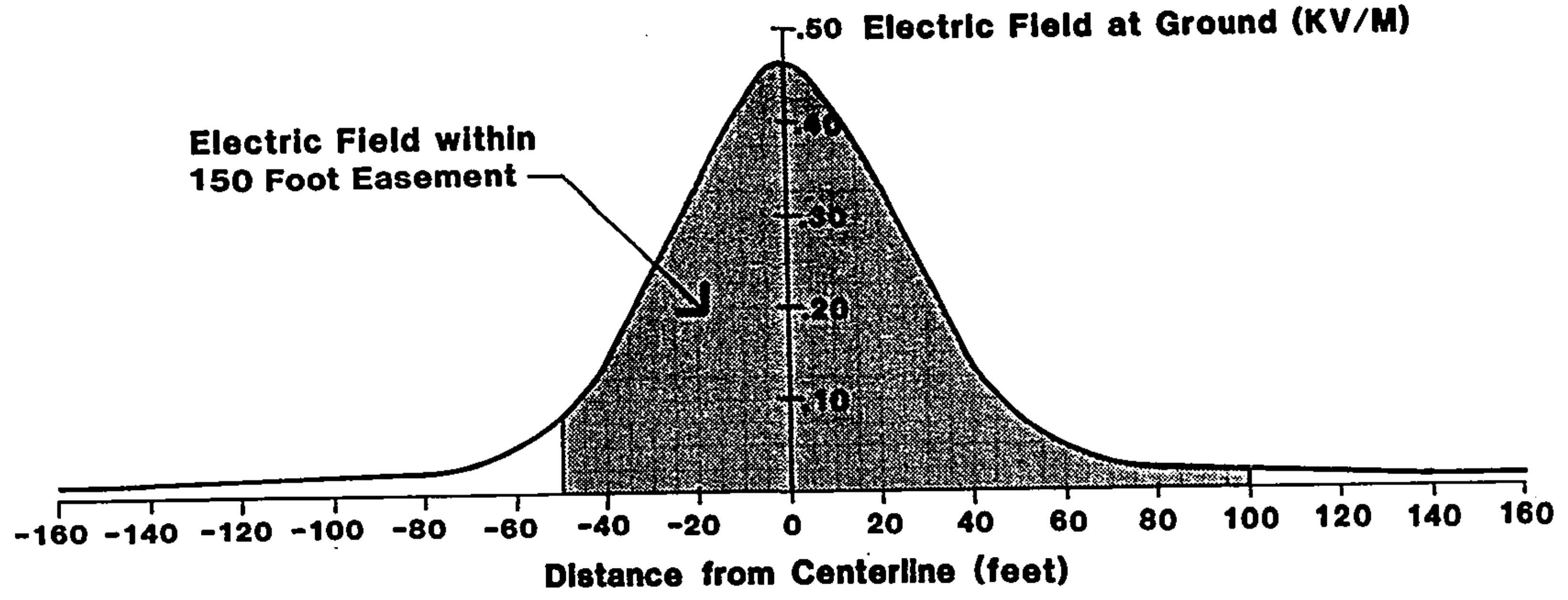

EXHIBIT III-6:
ELECTRIC FIELD GRADIENT PROFILE FOR SINGLE POLE 138 Kv TRANSMISSION LINE

EXHIBIT III-7

ELECTRIC FIELDS (60 Hz)
GENERATED BY APPLIANCES

Item	Electric Field (kv/m)*
Electric blanket	0.25
Broiler	0.13
Stereo	0.09
Iron	0.06
Refrigerator	0.06
Hand mixer	0.05
Toaster	0.04
Vaporizer	0.04
Color TV	0.03
Coffee pot	0.03
Vacuum cleaner	0.016
Clock	0.015
Fluorescent light (office)	0.01
Electric range	0.004
Incandescent light bulb	0.002

*Measurements made 30 cm from appliance.

field gradients sufficient to cause competitive pacing (3.4 kv/m) in the most sensitive pacemaker users will not be present anywhere within the easement at ground level.

Because a portion of the proposed easement passes through the approach and departure zone of Bradshaw Airfield in Sections 4 and 5, the transmission line's effect on aircraft safety is a potential concern. Throughout the zone, the proposed transmission line would be adjacent to the existing 69 Kv line on the site opposite the airfield. Army aviation officers commented that this alignment would be preferable to various alternative alignments because the existing 69 Kv line is a readily identifiable feature to pilots using the airfield, so a new adjacent line should not pose a hazard to military aircraft operations.[40] The height of the proposed transmission poles will be at least 40 feet under the maximum height restrictions set by the Federal Aviation Administration (FAA) for structures within the approach/departure zone itself; however, a portion of the easement running parallel to the airfield on the slopes above the runway will require a notice to the FAA.[41]

Highway crossings present certain safety considerations. The proposed transmission line will cross Saddle Road twice, and Mauna Kea access road and Old Mamalahoa Highway once each. The route will avoid two additional crossings of Saddle Road which are taken by the existing 69 Kv line. It should be noted that all three roads, even the Old Mamalahoa Highway, are lightly travelled, so the probability of a significant interruption to traffic due to a fallen pole or conductor is extremely small. No traffic counts are available for the points where the proposed line will cross Saddle Road and Mauna Kea access road, but the average daily traffic along Old Mamalahoa Highway near Keamuku was only 1245 vehicles in 1980. Based on visual observation, traffic on the other two roads is much lighter than this. The State of Hawaii Department of Transportation and County of Hawaii

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[40] Personal communications with Captains Mitchell and Paulson, Pohakuloa Training Area, on November 17 and 18, 1982, and with Captain James Morrill, U.S. Army Support Command, Schofield Barracks, November 24, 1982.

[41] U.S. Department of Transportation, Federal Aviation Administration, Federal Aviation Regulations, Part 77, Subchapter B.

Department of Public Works will have an opportunity to review the design plans for the transmission line for traffic safety considerations.

Other forms of effects on public health and safety could result from the project's impacts on air quality, noise levels and fire hazard potential. As pointed out in previous sections, however, these factors are not expected to be significant.

On balance, the proposed project's effect on public health and safety will be beneficial. It will improve the reliability of electric power service on the Island of Hawaii and thereby prevent potentially dangerous conditions, such as traffic light failures, which can lead to traffic accidents, and darkened residential and commercial areas, which can lead to higher levels of criminal activity and personal injuries.

There are relatively minor steps which can and will be taken to insure public safety within the vicinity of the transmission line:

- A Notice of Proposed Construction or Alteration will be filed with the Federal Aviation Administration (FAA) for the portion of the proposed transmission line near Bradshaw Airfield. HELCO will comply with safety requirements of the FAA.

- Design plans for the proposed transmission line where it crosses Saddle Road, Mauna Kea access road and Old Mamalahoa Highway will be reviewed by the Hawaii State Department of Transportation and County of Hawaii Department of Public Works. HELCO will comply with the safety recommendations of these agencies.

8. Aesthetics

One of the criteria for selecting the proposed route for the transmission line was the avoidance of adverse visual impact.[42]

Because the proposed line roughly parallels Saddle Road, the potential for continuous view exposure along this road is the primary concern, particularly since this route includes areas of major scenic interest, such as the Mauna Kea and Mauna Loa volcanoes.

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[42] See pp. 116-120 of the Routing Study.

Several means were used in route selection to minimize adverse visual impacts. First, the proposed alignment follows the route of the existing 69 Kv line for nearly two-thirds of the distance between the Kaumana and Keamuku substations. This confines the potential visual impact to an area already affected. Where the proposed alignment is adjacent to the existing 69 Kv line, it runs along the side opposite Saddle Road. Since this will place the proposed line farther from the road, the 138 Kv transmission poles will appear to be approximately the same height as the existing poles when viewed from the road even though they will actually be about 15 feet higher.

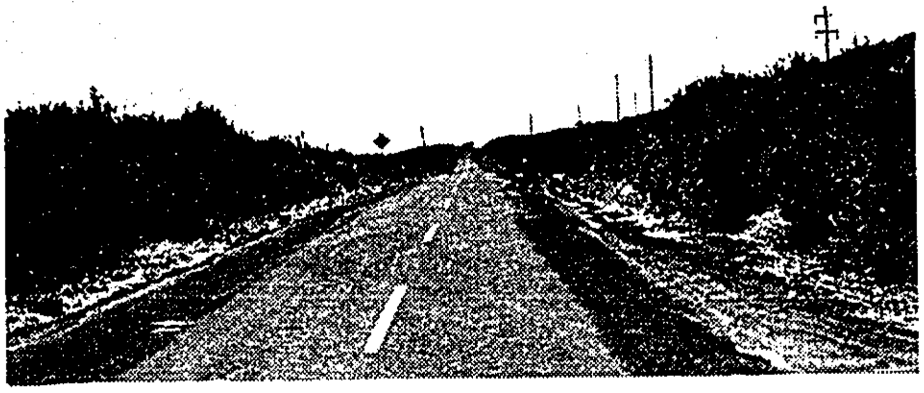
For the remaining one-third of the proposed alignment, the new transmission line will be less visible than the existing 69 Kv line is because it will avoid two additional road crossings, be placed farther from Saddle Road and make use of visual screens and distant backdrops to avoid direct exposure or sharp contrast to views from the road. For example, in Section 6 and the eastern portion of Section 1, the proposed line will disappear almost entirely from sight, due to a combination of distance from the road, visual screens and elevation changes. In Section 3, where the proposed alignment remains 2000 to 3000 feet north of Saddle Road, the transmission conductors will virtually disappear and the poles will be barely visible against the dark and mottled background of a'a lava flows and the grass-and scrub-covered lower slopes of Mauna Kea. The existing 69 Kv line, by comparison, tends to be visually prominent along these same stretches of Saddle Road. Note that the "after project" condition for this route segment (see bottom right photograph in Exhibit III-8) does not include the existing poles for the telephone distribution line, which is scheduled for removal.

There are two stretches along Saddle Road where the proposed line will be visually prominent. The first is in Section 1 between Reference Markers 4 and 7, where the proposed alignment parallels the road and the 69 Kv line on the north side. The proposed line will be intermittently visible here from the road, depending on the height and density of vegetation and topographic changes. The second is an approximately 2.5 mile stretch in Section 5, where the proposed line runs adjacent to the existing 69 Kv line as it converges toward Saddle Road. (See Exhibit III-8.) The proposed line, like the existing line, will be highly visible in this area because of the lack of visual screens and ground elevations along the alignment which are higher than the elevation of the road, which tends to exaggerate the apparent height of the transmission poles to viewers along the road. The visual impact of the 138 Kv

BEFORE PROJECT **A**

Along Saddle Road heading west, near Reference Marker 6 in Section 1

Along Saddle Road heading west, near Reference Marker 36 in Section 5



Along Saddle Road heading west, near Reference Marker 37 in Section 5

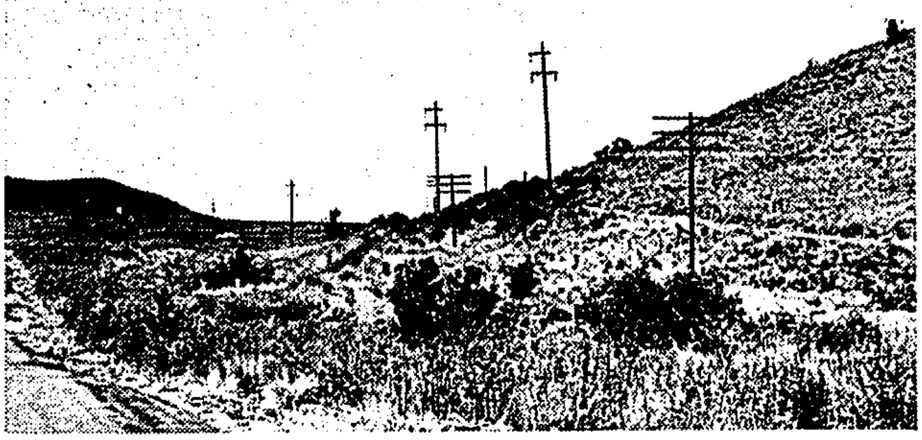
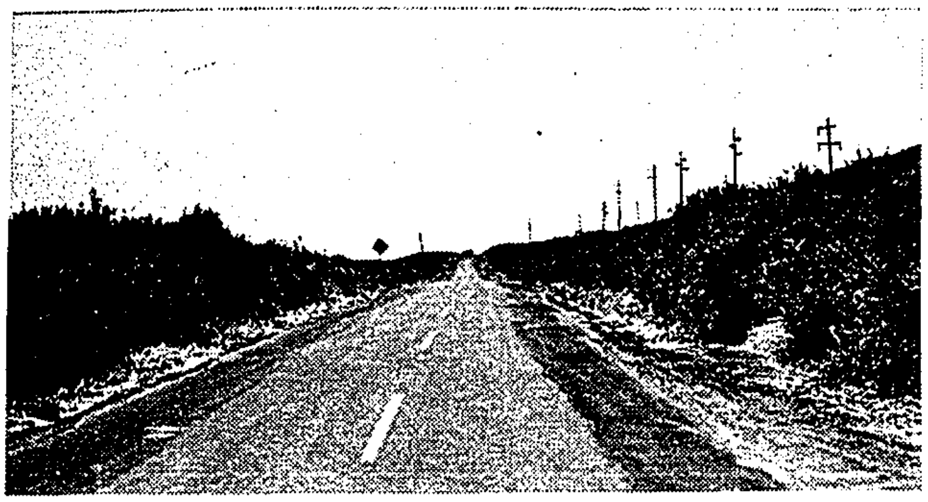
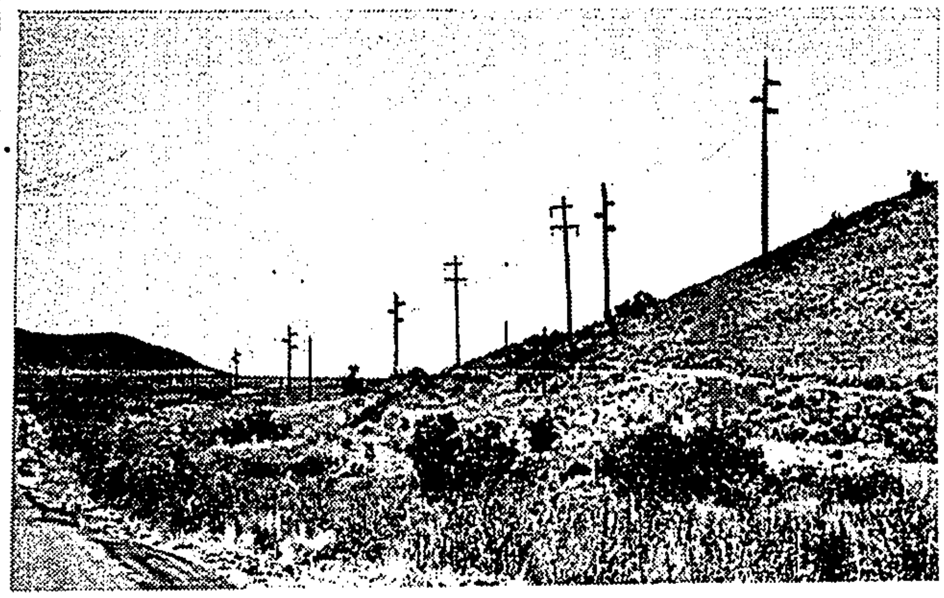


EXHIBIT III-8: PROMINENT VIEWS OF PROPOSED LINE

AFTER PROJECT





line will essentially end just after the proposed alignment crosses over to the south of Saddle Road between Reference Markers 37 and 38. The existing 69 Kv line remains visible beyond this point as it continues to follow Saddle Road.

There are vantage points other than Saddle Road from which the proposed transmission line will probably have occasional and limited view exposure. A few hundred feet of the line, as it leaves the Kaumana substation, may be visible from the back or side yards of a few residences. In Section 4, travellers along Mauna Kea access road will be able to see the proposed line as it crosses the road just north of the existing 69 Kv line. One or two of the proposed transmission poles may be visible along the northern edge of Pohakuloa State Park, where 69 Kv pole can now be seen, but not in the cabin area. The line may also be visible from the base camp of Pohakuloa Training Area as it runs adjacent to the existing 69 Kv line. In Section 6, travellers along Old Mamalahoa Highway will be able to see the line as it crosses the road to connect with the Keamuku substation. Travellers heading north will see only the short span of conductor across the road, since the approach will be screened by a stand of *Eucalyptus* trees. Heading south, travellers will see the line against the backdrop of trees, which will tend to mask the appearance of the poles and conductors.

Overall, the proposed transmission line will be visually unobtrusive from almost all areas where frequent view exposure is likely. In the areas mentioned above where visual sensitivity is greater, the proposed line either will seldom be noticed because of its placement outside typical view ranges or will minimize impacts on views by running adjacent to the existing 69 Kv line. Furthermore, the rustic appearance, texture and color of the wooden poles will blend well with the varied natural landscape, which includes forests, grass lands and barren lava flows.

9. Employment and population growth

While most of the design and some of the construction work for the proposed transmission line will be done by personnel from HELCO and its parent company, HECO, certain tasks requiring specialized skills may be contracted to outside companies and individuals. At this time, it is dificult to ascertain how many temporary jobs will be created or what proportion of these would be held by residents of the Island of Hawaii. Outside contractors, who will be responsible for hiring their own personnel, have not yet been selected. A company based on the Mainland will need to be hired for helicopter lifts and installation of poles, since there are no companies in Hawaii with the necessary equipment or specialized experience to perform this task. Otherwise, it is probable that all other outside contractor jobs will go to State residents. The creation of these temporary jobs will generate income and excise tax revenues accruing to the State government. Both the creation of direct jobs and the purchase of supplies and materials for construction will support jobs locally through the multiplier effect. After construction, the project will have little direct or indirect effect on employment levels, since the maintenance requirement for a transmission line are not substantial. Nevertheless, by providing reliable electrical energy service, the project will help maintain the viability of the Island's various economic sectors.

Since the objective of the project is to provide reliable power to existing service areas rather than to extend service to previously undeveloped areas, the proposed transmission line will not have a "growth inducing" effect. As explained in Chapter I of the Routing Study, the need for the project was determined on the basis of line outage studies. The voltage capacity and location of terminal points for the transmission line were based on an analysis of past and projected population and load growth. The projected load growth used in this analysis is quite conservative when compared to the official population forecast adopted by the State of Hawaii, as illustrated graphically in Exhibit I-7 (page 11) of the Routing Study.

HELCO monitors load growth on a regular basis by means of readings at its various substations. Should load grow faster or slower than projected, the timing of the conversion of proposed line from 69 Kv to 138 Kv can be advanced or deferred as necessary.

D. ADVERSE ENVIRONMENTAL EFFECTS WHICH CANNOT BE AVOIDED

Construction of the project will create localized and temporary adverse impacts on air quality and noise levels. The movement of construction equipment, drilling and blasting will increase the amount of air-borne dust and particulate emissions. Noise will be increased above ambient levels along most of the proposed alignment. It is expected these impacts will be perceived by few people other than construction workers because of the remoteness of most of the proposed activities from urbanized areas.

The disturbance to land areas during construction and occasional maintenance operations will have an adverse effect on native plants and animals and possibly on the rate of soil erosion, despite efforts to avoid the most sensitive areas through the route selection process and additional mitigation measures which were described in the previous section. Due to the precautions which have and will be taken, the adverse impacts are not expected to be significant over the long term.

The proposed transmission line may also have an adverse visual impact, depending upon one's subjective opinion regarding the quality of views and the appearance of the proposed transmission poles and conductors as seen within those views. The significance of this impact is also dependent upon the probable frequency of view exposure. By and large, areas where the proposed line will be exposed to frequent viewing are avoided. In cases where the proposed line will be exposed to relatively frequent viewing, it will be adjacent to the existing 69 Kv line to avoid visual intrusion into new areas. Furthermore, the proposed wooden pole design will have less visual impact than alternative structural configurations and materials for transmission line supports, such as a steel lattice tower.

The risk of other potentially adverse effects described in the previous section, such as effects on public health and safety and archaeological resources, is expected to be so low that the proposed mitigation measures should be more than adequate to address these concerns.

E. IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES

Construction of the proposed project will require an irreversible commitment of capital, labor, construction materials and fossil fuels. The facilities, once installed, will remain there for the life of the project and will require periodic maintenance. Some of the construction materials could be recycled if the facilities were dismantled, such as the copper and aluminium used for conductors, the steel used for guy wires and anchors and the wood poles used for supports. The vegetation which would be cleared to provide for pole sites, access roads and safety clearances for the energized lines will be irretrievably lost. However, much of this vegetation can be expected to regenerate over the long term. While it is conceivable that the transmission line could be removed or relocated, and the land restored to resource or some other use, HELCO intends to acquire a perpetual easement wherever possible in anticipation that the affected land area will be committed to transmission line use for an indefinite period.

F. UNRESOLVED ISSUES

The potential impacts of the proposed action are generally known and appropriate mitigation measures have been developed to address these impacts. There are no significant unresolved issues.

Chapter IV

CHAPTER IV. RELATIONSHIP OF THE PROPOSED ACTION TO PLANS, POLICIES AND CONTROLS FOR THE AFFECTED AREA

A. FEDERAL

1. Wildlife protection

Since a portion of the proposed easement crosses land which is leased to the U.S. Army for the Pohakuloa Training Area, the granting of an easement will require the consent of the Department of the Army, which in turn will trigger a review of the proposed action under the Endangered Species Act and Fish and Wildlife Coordination Act (16 U.S.C. 661-666c). Early coordination with the Regional Director of the Fish and Wildlife Service is necessary to determine if any listed endangered or threatened species or species proposed for listing or their critical habitat may be present in the area of the proposed easement across the land leased by the Army. Representatives of the U.S. Fish and Wildlife Service were, in fact, consulted during the route selection for the proposed line. Although the transmission line crosses the Palila Critical Habitat, there is no evidence of this bird's nesting in the area. The ornithologist who headed the Palila Recovery Team stated that the proposed transmission line should have no adverse impact on officially recognized endangered species or their habitat.[43] U.S. Fish and Wildlife officials have informally concurred with this opinion. Mitigation measures proposed to avoid removal or destruction of habitat are outlined at the end of the discussion regarding potential impact on unique or native ecosystems (Chapter III, C.2.).

2. Aircraft safety

Notice must be submitted to the Federal Aviation Administration (FAA) since the proposed transmission line is within the approach/departure zone of Bradshaw Airfield. Aviation officials were consulted during the routing selection process to assure that the location and heights of the proposed line would not adversely affect air traffic.

---

[43] Andrew J. Berger, op. cit.

3. Military operations

While a portion of proposed easement will be within the area leased by the Army for Pohakuloa Training Area, the alignment is well outside of the designated "impact area," where structures such as transmission lines are prohibited because of the danger posed by explosive material and military training exercises.

4. National parks and monuments

The proposed transmission line will stay completely out of the Hawaii Volcanoes National Park and all other areas under the jurisdiction of the National Park Service.

B. STATE

1. State planning documents

The proposed project complies with the following objective of the adopted Hawaii State Plan:

- To protect rare and endangered plant and animal species and habitats native to Hawaii. (The selected route for the transmission line seeks to avoid important habitats and proposed additional mitigation measures will avoid or minimize impacts on these resources.)

- To preserve and restore significant natural and historic resources. (The route selection process and proposed mitigation measures avoid potential adverse impacts on these resources.)

- To reduce threat to life and property from erosion, flooding, tsunami, earthquake and other natural or man-induced hazards and disasters. (The routing selection process identified these high hazard areas and sought to avoid them.)

- To provide dependable, efficient and economical energy systems capable of supporting the needs of the people. (The objective of the proposed project is to provide reliable electric power for the Island of Hawaii.)

- To increase energy self sufficiency. (Project selection is based on the premise that the development of alternate energy sources will be encouraged.)

- To ensure that the development or expansion of power systems and sources adequately consider environmental, public health and safety concerns and resource limitations. (This objective was built into the project and route selection process from the outset.)

Functional plans have been prepared as part of the State planning process. While not adopted by the State Legislature at this time, these documents serve as policy guidelines for State administrative agencies. The following functional plans are pertinent to the proposed project.

- State Agriculture Plan: The proposed transmission line would not cross any "prime" or "unique" agricultural lands and would not interfere with or adversely affect any existing agricultural operations.

- State Conservation Lands Plan: The routing selection process for the proposed transmission line respects the policies to protect and preserve valuable natural resources and wildlife habitats.

- State Energy Plan: The proposed project is part of HELCO's overall strategy to encourage the development of renewable, indigenous energy sources.

A portion of the proposed transmission line route, in Sections 4 and 5, pass through the lower reaches of the area covered by The Mauna Kea Plan, which was adopted by the State Board of Land and Natural Resources in 1977. This plan sets forth development and management guidelines for Mauna Kea, particularly the summit and mid-level areas. It specifically prohibits the installation of overhead powerlines to serve "the observatories and support facilities on Mauna Kea." The proposed transmission line, which is unrelated to the development of observatories or support facilities on Mauna Kea, would be adjacent to an existing overhead transmission line in The Mauna Kea Plan area at a point more than 6,000 feet lower in elevation than the summit and 3,500 feet lower than the Hale Pohaku mid-level facility. Nevertheless, an amendment to The Mauna Kea Plan is being sought which would explicitly allow the proposed overhead line. The amendment would be concurrent with Conservation District Use Application approval.

2. State land use controls

Most of the route is within the State Agriculture and Conservation Districts. A small portion is in the State Urban District. According to Chapter 205, Hawaii Revised Statutes, (HRS), utility lines are allowed in the Agriculture and Urban Districts. Although transmission lines are not expressly allowed in the Conservation District, an approved Conservation District Use Application will allow such use if it can be shown that the public benefits outweigh any impact on the Conservation District. The Conservation District, which is under the jurisdiction of the State Board of Land and Natural Resources, is divided into subzones, as authorized by Chapter 183, HRS. The Board's Regulation No. 4 establishes four subzones and sets forth objectives and permitted uses for each, in varying degrees of restrictiveness. As shown in Exhibit III-2, most of the proposed easement through the Conservation District is in the Resource (R) subzone, which is one of the two most permissive subzones. Approximately 29.27 acres, or 2% of the total easement area, is in the Protective (P) subzone, which is the most restrictive of the four subzones as to permitted uses. Where the proposed easement is within the P subzone, it is adjacent to the existing 69 Kv at the subzone boundary. Therefore, the encroachment into the P subzone is minimal and will not adversely affect the natural resource values which the P subzone is intended to protect. On the contrary, alternative alignments were found to have greater potential impact on the environment, landowners, aircraft safety. In Section 1, the two landowners requested that the proposed alignment remain to the north of Saddle Road, which would provide them more flexibility in the future should these lands be redesignated to Agriculture or Urban. In Section 5, routing of the proposed alignment outside of the P subzone would place the alignment within the approach/departure zone of Bradshaw Airfield, which would have an impact on aircraft safety.

3. Environmental impact statements

Under the provisions of Chapter 343, HRS, all proposed actions in the State Conservation District are subject to an assessment by the State Department of Land and Natural Resources (DLNR) to determine whether or not an Environmental Impact Statement (EIS) is required. DLNR determined that an EIS is required for the proposed project and this document was prepared to fulfill that requirement. The DLNR, as "approving agency" under Chapter 343, will be the accepting authority for this EIS.

C. COUNTY

1. General Plan

The County of Hawaii General Plan was adopted in 1971, with revisions in 1979 and 1980. The proposed transmission line is not in conflict with planned land uses, since the General Plan designates most of the easement area for extensive agriculture, such as pasture and range land, and conservation. The proposed project is consistent with the County policy to strive for energy self-sufficiency, since the transmission line is part of HELCO's strategy to encourage the development of alternate energy sources.

2. Other land use controls

The proposed easement is not in conflict with County zoning and is not within any special districts administered by the County.

D. PRIVATE

1. Easements

HELCO will seek to acquire a perpetual 150-foot wide easement for the transmission line for all private and public landowners along the proposed alignment. (See Exhibit IV-2.) The easement will allow the landowner to retain limited use of the property. Acquisition of the easement will be based on an appraisal of fair market value and the landowner will be compensated a percentage of that value, to be determined by negotiation. HELCO prefers to negotiate a settlement with property owners rather than exercise its power of eminent domain. The latter approach is used only as a last resort. Normally, the acquisition of an easement is a two-step process. The first step is a Right-of-Entry, which allows HELCO to conduct surveying necessary to stake the precise boundaries of the easement. Some of the proposed mitigation to avoid sensitive areas will be carried out at this stage. Once the boundaries are determined, formal documentation for the easement is drawn up.

EXHIBIT IV-1

LIST OF NECESSARY PERMITS AND APPROVALS

TYPE OF APPROVAL	ISSUING AGENCY	STATUS
Conservation District Use Application and Mauna Kea Plan Amendment	Hawaii State Board of Land and Natural Resources	Application filed and accepted 6/83
Notice of Proposed Construction or Alteration	Federal Aviation Administration	Notice to be filed upon completion of design drawings
Section 7 Review (under Endangered Species Act and *Fish and Wildlife* Coordination Act)	U.S. Fish and Wildlife Service (via the U.S. Army Support Command)	Completed
Construction Permit (for crossing State and County highways)	Hawaii State Department of Transportation and Hawaii County Department of Public Works	Application to be filed upon completion of design drawings
Right-of-Entry and Easement	Various landowners (see Exhibit IV-2)	Right-of-Entry granted: Hawaiian Home Lands (5/83); Hawaii Conference of the United Church of Christ (4/83); Mauna Kea Sugar Company (4/83). Right-of-Entry for State land requested concurrently with CDUA approval; remaining Rights-of-Entry to be requested incrementally, as needed.

EXHIBIT IV-2

PROPERTIES CROSSED BY
PROPOSED EASEMENT FOR 138 Kv
TRANSMISSION LINE

TAX MAP KEY	STATE LAND USE	OWNER(S) & LESSEE(S)
2-4-08-02	Agr	J. T. Trading Co., Ltd., et. al.
2-5-01-01	Cons	Mauna Kea Sugar Company, Inc.
2-5-01-07	Cons	Mauna Kea Sugar Company, Inc.
2-5-01-12	Cons	Hawaii Conference of the United Church of Christ
2-5-01-02,06	Cons	State of Hawaii
2-5-01-08	Cons	State of Hawaii
2-5-01-11	Cons	Hawaii Conference of the United Church of Christ
2-5-01-13	Cons	Hawaii Conference of the United Church of Christ
2-5-02-01	Agr	State of Hawaii
2-5-02-14	Cons	State of Hawaii
2-5-02-17	Agr	Wallace H. K. Young, et. al.
2-5-05-80	Urb	State of Hawaii
2-5-05-86	Urb	State of Hawaii
2-5-05-89	Urb	State of Hawaii
2-5-06-02	Agr	Brilhante-Hawaii, Inc.
2-5-44-04	Agr	Joseph R. Silva
2-5-45-10	Agr	Joseph R. Silva
2-5-46-01	Urb	Foremost-Hawaiiana Associates

TAX MAP KEY	STATE LAND USE	OWNER(S) & LESSEE (S)
2-6-18-04	Cons	State of Hawaii
3-8-01-07	Agr	Hawaiian Home Lands (Le: Richard Smart)
3-8-01-13	Cons	Hawaiian Home Lands (Le: US Army Pohakuloa Training Area)
4-4-15-08	Cons	State of Hawaii (G/L to USA Pohakuloa Training Area
4-4-16-03	Cons	State of Hawaii
4-4-16-05	Cons	State of Hawaii (Le: US Army for Pohakuloa Training Area)
4-4-16-10	Cons	State of Hawaii (Le: US Army Pohakuloa Training Area)
6-7-01-03	Agr	Richard Smart Trust

Chapter V

CHAPTER V: ALTERNATIVES TO THE PROPOSED ACTION

A. NO PROJECT

The "no project" alternative would mean doing nothing to improve system reliability and reduce the risk of power failures in areas which are presently vulnerable to line outages.[44] This is an unacceptable alternative because reliable electric power is important for the maintenance of public health and safety and economic well-being. Moreover, HELCO is legally required to provide reliable electric power by the State of Hawaii Public Utilities Commission.[45]

B. PROJECT ALTERNATIVES

A wide range of alternatives was considered during project and routing selection. They are discussed in various sections of the Routing Study. The following are the basic categories of alternatives which were studied.

1. Generation on west side

Since the areas currently vulnerable to transmission line outages are located on the west side of the island, particularly in the Kona region, and this is also the region of greatest recent and projected load growth, the alternative of constructing a new generating plant on the west side was considered. As indicated in Chapter I of the Routing Study, the new generating plant would have to be fired by fossil fuels because there is no known potential for the development of a significant alternate energy resource on this side of the island in the near term.[46] Because this would run counter to HELCO's policy to reduce its dependence on fossil fuels to generate electric energy and because the cost of constructing and operating a new generating plant would be significantly greater than the cost of a new cross-island transmission line of comparable voltage capacity,

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[44]These areas are depicted in Exhibit I-4 (page 7) of the Routing Study.

[45]Standards for electric utility service in the State of Hawaii are contained in Appendix A of the Routing Study.

[46]See analysis in Chapter I of the Routing Study, pp. 10-14.

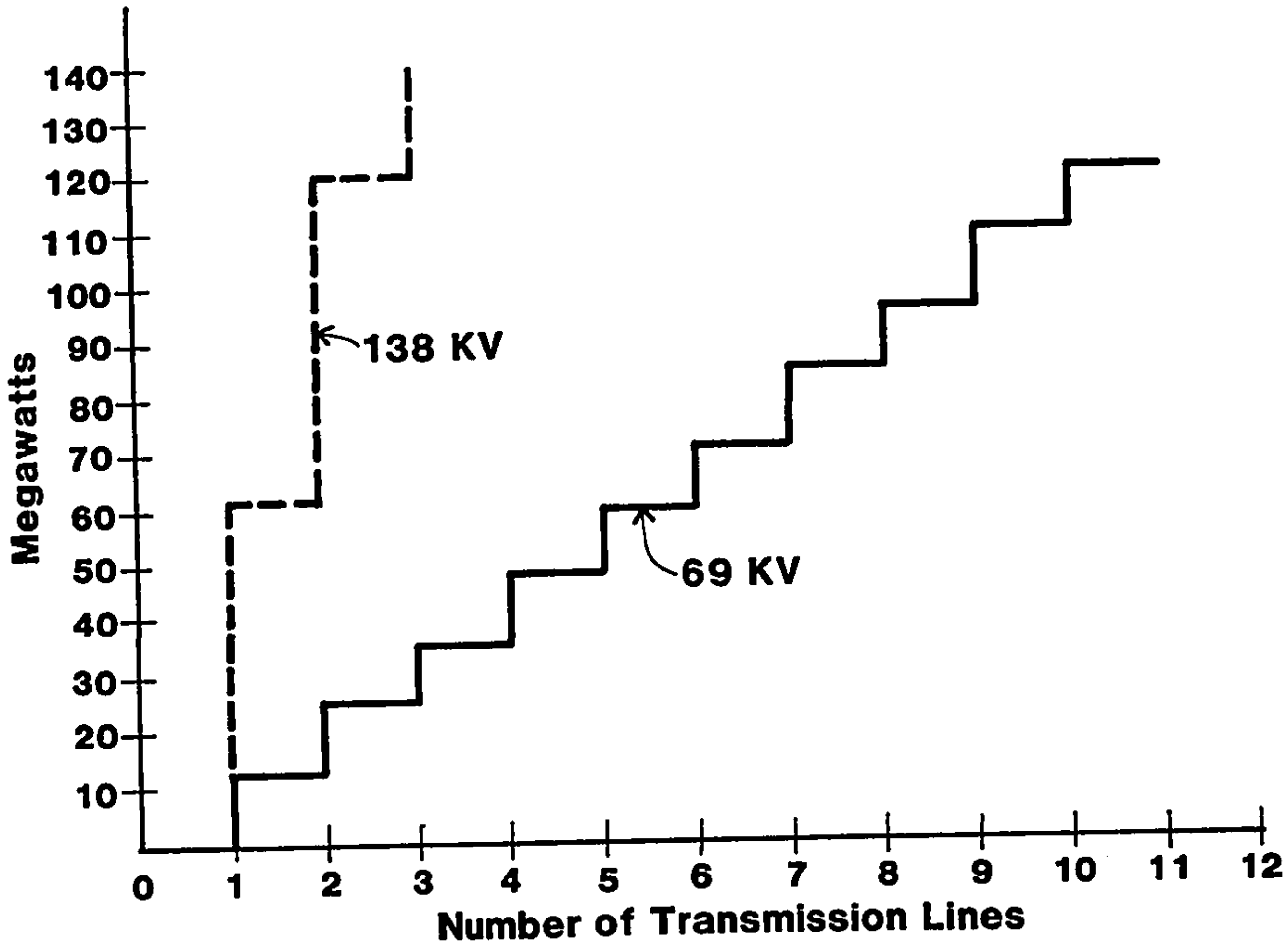
the alternative of a new plant on the west side is unattractive.[47] This is not to say that small additions to the capacities of existing generating plants on the west side are not necessary as a short-term means to accommodate peak loads. The point is that a new base load fossil fuel generating facility on the west side is an unsatisfactory means to improve system reliability because it is not cost-effective and would not be available to supply power continuously.

2. Voltage alternatives

The voltage capacity for the cross-island transmission line is determined by evaluating the costs and benefits of different voltage alternatives. During the review meetings for the route selection process, several people asked why the reliability problem could not be solved by converting an existing 69 Kv line to a higher voltage capacity; namely, 138 Kv. This would not solve the immediate low voltage condition problems. True, the 69 Kv line converted to 138 Kv would be able to supply adequate voltage to areas which are vulnerable to low voltage conditions in the event of a line outage elsewhere in the transmission system, but if the converted line itself were to be taken out of service, low voltage conditions would occur. Therefore, at least two of the three existing 69 Kv cross-island lines must be converted to a higher voltage. Furthermore, taking one of the existing 69 Kv lines out of service to perform conversion or maintenance work would create low voltage conditions in the vulnerable areas over extended periods of time. Conversion cannot be accomplished merely be stringing new higher voltage conductors on existing transmission poles. All existing support poles would have to be replaced with larger poles capable of supporting 138 Kv conductors.

In the near term, the proposed fourth cross-island transmission line, constructed at 138 Kv but initially energized at 69 Kv, would provide sufficient voltage capacity for system reliability needs. As load growth increases, a fifth cross-island transmission line, will be installed and also constructed for 138 Kv. At the proper time, both the fourth and fifth cross-island transmission lines will be energized at 138 Kv. As shown in Exhibit V-1, each 138 Kv line will have the same capacity as five 69 Kv lines. Therefore, one of the 138 Kv lines can be taken out of service for

[47] See pp. 14-19 of the Routing Study.



69 KV Line Capacity --12 Megawatts

138 KV Line Capacity --62 Megawatts

EXHIBIT V-1:
COMPARATIVE CAPACITIES OF 138 KV AND 69 KV TRANSMISSION LINES

maintenance or sustain an outage condition, and the remaining 138 Kv line will still be able to carry the West Hawaii load. More important, this will enable HELCO to shut down any of the first three cross-island 69 Kv lines for long needed maintenance, or even convert them to 138 Kv as the need arises. One immediate concern is that the two proposed 138 Kv lines will be located relatively close to each other as shown in Exhibit II-4. A major disaster such as a lava flow or hurricane could theoretically shut down both 138 Kv lines. Converting either the northern or southern 69 Kv to 138 Kv once the two 138 Kv lines are in service would improve system reliability. This would also preclude the need for any more cross-island transmission lines within the foreseeable future. Thus, utilizing a voltage level of 138 Kv will eliminate the need for several additional 69 Kv lines. Multiple 69 Kv lines would not only be very costly to construct and maintain, but would also create a greater impact on the environment due to the large easement area required and the probability of several separate corridors.

While a line with a 138 Kv voltage capacity would be preferable to additional 69 Kv lines, lines with voltage capacities greater than this, from 230 Kv and up, would not be practical or desirable. The initial cost of such a line would be high and not justifiable in light of forecasted load growth. Moreover, too much reliance would be placed on a single high voltage line, raising the problem of reliability once again as load increases in the future.

3. Marine and underground cables

Marine and underground transmission cables were considered as generic alternatives to an overhead transmission line. The marine cable alternative would have an obvious influence on the selection of the route. An underground cable would also affect route selection, but in a less apparent way. The features, advantages and disadvantages of marine and underground cable systems are discussed in Chapter III of the Routing Study. The table in Exhibit V-2, on the following page, provides a summary comparison of the three system in terms of the four basic categories used in route selection. The marine and underground cable alternatives are not cost-effective when compared to an overhead transmission line and they would probably not result in less environmental impact. Furthermore, the difficulties and delays involved in repairing these cable systems make them less reliable than an overhead line for the transmission of power.

EXHIBIT V-2

COMPARATIVE CONSTRAINTS FOR OVERHEAD TRANSMISSION LINE, MARINE CABLE, UNDERGROUND CABLE

FACTORS	OVERHEAD	MARINE	UNDERGROUND
GEOPHYSICAL	1. Possible collapse of poles or lines due to earthquake or volcanic activity.	1. Possible burial or rupture of cable due to earthquakes and slides. 2. Turbulence in ocean waters during construction and maintenance. 3. Possible oil leakage in ocean waters.	1. Possible burial or rupture of cable due to earthquakes and lava flows. 2. Soil erosion and alteration of land form due to extensive grading.
BIOLOGICAL	1. Potential damage to vegetation and wildlife habitat due to fire hazard. 2. Potential bird collisions.	1. Potential damage to marine habitat due to oil leakage. 2. Possible entanglement of deep-feeding marine organisms with cable.	1. Potential damage to wildlife habitat and vegetation due to oil leakage. 2. Extensive removal of vegetation and wildlife habitat.
SOCIO-ECONOMIC	1. Visibility of the poles and lines in areas exposed to public view. 2. Dense urban areas where high land values, fragmented ownership patterns, restrictive land regulation and potential interference with human activities are probable.	1. Visibility and regulatory restrictions with respect to terminal stations near the shoreline. 2. Potential conflicts with commercial and sport fishing. 3. Regulatory controls on use of ocean.	1. Visibility of right-of-way in forested areas or other uniform landscapes. 2. Potential disturbance of archaeological sites.
COST	1. Areas which are inaccessible by land. 2. Areas subject to high wind or salt spray and low rainfall.	1. High cost of construction (3 times as much per mile as overhead line). 2. Difficulty of access for repair. 3. Uncertainties involving technology. 4. Energy loss through the cable. 5. Specializing equipment and crew required.	1. High cost of construction (6 times as much per mile as overhead line). 2. Difficulty of access for repair. 3. Uncertainties involving technology. 4. Energy loss through the cable. 5. Specialized equipment and crew required.

4. Routing alternatives

Virtually every possible overhead route between Kaumana and Keamuku substations was considered in the routing selection process. The methodology, described in Chapter II of the Routing Study, included an island-wide analysis of constraints and opportunities for a transmission line route. Through a narrowing-down process, described in Chapters IV and V of the Routing Study, a study corridor was identified. Chapter VI describes conditions in the study corridor, potential alignments and the criteria for selecting the "preferred" alignment, which is the proposed easement.

No other kinds of project alternatives are possible. The location of the terminal points for the proposed transmission line, for example, are fixed by the relationship of HELCO's infrastructure (e.g., its Kaumana and Keamuku substations) to present and future loads and generating resources. Much of the project design is determined by engineering safety criteria and regulatory standards.

Comments and Responses During Consultation Phase

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

IN REPLY REFER TO:
ES
Room 6307

SEP 3 0 1983

Mr. Susumu Ono
Chairman
Board of Land and Natural Resources
P. O. Box 621
Honolulu, Hawaii 96809

Dear Mr. Ono:

The Service has reviewed the Environmental Impact Statement (EIS) for the Kaumana-Keamuku 138 KV Transmission Line which was forwarded to us with your letter of September 6, 1983. The EIS adequately addresses Service concerns and impacts to significant plants and animals.

Section 7 consultation with the Army regarding the portion of the project which will traverse Pohakuloa Training Area, vis-a-vis Palila and Palila Critical Habitat, has determined that the action will not jeopardize the continued existence of this bird or adversely modify its critical habitat. Thank you for this opportunity to comment.

Sincerely,

William R. Kramer
Acting Project Leader
Office of Environmental Services

cc: HELCO
EDAW

RECEIVED
OCT 4 1983
EDAW Inc.

CONSERVE AMERICA'S ENERGY

Save Energy and You Serve America!

October 5, 1983

Mr. William R. Kramer,
Acting Project Leader
Office of Environmental Services
U. S. Fish and Wildlife Service
P. O. Box 50167
Honolulu, Hawaii 96850

Dear Mr. Kramer:

Subject: Environmental Impact Statement
Kaumana-Keamuku 138 Kv Transmission Line

Thank you for the copy of your letter to Mr. Susumu Ono regarding the above. Your comment about the Section 7 consultation is noted. If you should have any further comments or questions on this project, please feel free to call me.

Sincerely,

EDAW inc.

John P. Whalen, AICP
Project Manager

JPW:lt

EDAW Inc.
Environmental Planning Urban Design Landscape Architecture
San Francisco Alexandria Irvine Honolulu Fort Collings New Orleans Atlanta Seattle
1121 Nuuanu Avenue, Suite 203, Honolulu, Hawaii 96817 Telephone (808) 536-1074

DEPARTMENT OF THE ARMY
PACIFIC OCEAN DIVISION, CORPS OF ENGINEERS
FT. SHAFTER, HAWAII 96858

September 28, 1983

RECEIVED
OCT 3 1983
EDAW Inc.

Mr. Susumu Ono, Chairman
Board of Land and Natural Resources
P.O. Box 621
Honolulu, Hawaii 96809

Dear Mr. Ono:

Thank you for the opportunity to review and comment on the environmental impact statement for Kaumana-Keamuku 138 KV Transmission Line. The following comments are offered:

a. A Department of the Army permit is not required.

b. The proposed routing for the transmission line does not traverse any regulatory flood plain areas, but rather in areas of minimal flooding of Zone C designation. This information was obtained from the flood hazard maps prepared under the Flood Insurance Study for the County of Hawaii by the Federal Insurance Administration.

Sincerely,

Kisuk Cheung
Chief, Engineering Division

Copies Furnished:

Mr. Alva Nakamura
Hawaii Electric Light Co., Inc.
P.O. Box 1027
Hilo, Hawaii 96720

✓Mr. Norman Oss, President
EDAW, Inc.
1121 Nuuanu Avenue, Suite 203
Honolulu, Hawaii 96817

October 6, 1983

Mr. Kisuk Cheung, Chief
Engineering Division
Department of the Army
Pacific Ocean Division,
Corps of Engineers
Fort Shafter, HI 96858

Dear Mr. Cheung:

Subject: Environmental Impact Statement
Kaumana-Keamuku 138 Kv Transmission Line

Thank you for the copy of your comment letter on the above.

The avoidance of flood-prone areas was one of the criteria used in route selection. As stated in the EIS, transmission pole sitings will be outside of drainage gullies and other depressions which may be subject to localized flooding.

If you should have any further comments or questions on this project, please call me.

Sincerely,

EDAW inc.

John P. Whalen, AICP
Project Manager

JPW:lt

EDAW inc.
Environmental Planning Urban Design Landscape Architecture
San Francisco Alexandria Irvine Honolulu Fort Collings New Orleans Atlanta Seattle
1121 Nuuanu Avenue, Suite 203, Honolulu, Hawaii 96817 Telephone (808) 536-1074

DEPARTMENT OF THE ARMY
HEADQUARTERS, UNITED STATES ARMY WESTERN COMMAND
FORT SHAFTER, HAWAII 96858

REPLY TO ATTENTION OF:

September 26, 1983

Directorate of Facilities Engineering

RECEIVED
SEP 29 1983
EDAW Inc.

Mr. Susumu Ono, Chairman
Board of Land and Natural Resources
P.O. Box 621
Honolulu, Hawaii 96809

Dear Mr. Ono:

The Draft Environmental Impact Statement (DEIS) for the Kaumana to Keamuku 138 KV Transmission Line, Island of Hawaii has been reviewed. Army concerns regarding possible impacts on training activities and sensitive resources at the Pohakuloa Training Area have been provided to Hawaiian Electric Company, Inc., Hawaii Electric Light Company, Inc., and EDAW Inc. in earlier correspondences and meetings.

Thank you for the opportunity to comment on the DEIS.

Sincerely,

Ronald A. Borrello
Colonel, Corps of Engineers
Director of Facilities Engineering

Copies Furnished:
Mr. Alva Nakamura
Hawaii Electric Light Co., Inc.
P.O. Box 1027
Hilo, HI 96720

✓ Mr. Norman Oss, President
EDAW Inc.
1121 Nuuanu Ave., Suite 203
Honolulu, HI 96817

October 3, 1983

Col. Ronald A. Borrello
Director of Facilities Engineering
Department of the Army
Headquarters, U. S. Army Western Command
Fort Shafter, HI 96858

Dear Col. Borrello:

Subject: Environmental Impact Statement
Kaumana-Keamuku 138 Kv Transmission Line

Thank you for the copy of your comment letter on the above.

We have appreciated your cooperation on this project. If any additional comments or questions should arise, please give me a call.

Sincerely,

EDAW inc.

John P. Whalen, AICP
Project Manager

JPW:lt

EDAW Inc.
Environmental Planning Urban Design Landscape Architecture
San Francisco Alexandria Irvine Honolulu Fort Collings New Orleans Atlanta Seattle
1121 Nuuanu Avenue, Suite 203, Honolulu, Hawaii 96817 Telephone (808) 536-1074

UNIVERSITY OF HAWAII

Vice-President for Administration

September 23, 1983

RECEIVED
SEP 28 1983
EDAW Inc.

Mr. Susumu Ono, Chairman
Board of Land and Natural Resources
Department of Land and Natural Resources
State of Hawaii
State Office Building
Honolulu, Hawaii 96813

Dear Mr. Ono:

SUBJECT: Environmental Impact Statement
Kaumana to Keamuku, 138 KV Transmission Line

The University of Hawaii has no major comments to offer on the EIS for the HELCO 138 KV transmission line. We suggest that the need for an amendment to the Mauna Kea Plan, which is noted on Page 60, be included in the Summary, Page 1, along with the discussion on the CDUA approval.

Thank you for the opportunity to review the document.

Sincerely yours,

Harold S. Masumoto
Vice President for
Administration

cc Mr. Alva Nakamura
Mr. Norman Oss
Mrs. Mae Nishioka/H. Tanaka

2444 Dole Street · Room 201 · Honolulu, Hawaii 96822
An Equal Opportunity Employer

October 6, 1983

Mr. Harold S. Masumoto
Vice President for Administration
University of Hawaii
2444 Dole Street, Room 201
Honolulu, Hawaii 96822

Dear Mr. Masumoto:

Subject: Environmental Impact Statement
Kaumana-Keamuku 138 Kv Transmission Line

Thank you for the copy of your comment letter on the above.

The need for an amendment to the Mauna Kea Plan was not mentioned in the Summary because it is being considered concurrently with the Conservation District Use Application (CDUA). It was the CDUA which triggered the environmental assessment under Chapter 343, HRS. A request for an amendment to the Mauna Kea Plan is not defined per se as a "class of action" under Chapter 343, HRS, so it would not be quite accurate to include it in the second paragraph on page 1 of the EIS.

Sincerely,

EDAW inc.

John P. Whalen, AICP
Project Manager

JPW:lt

EDAW inc.
Environmental Planning Urban Design Landscape Architecture
San Francisco Alexandria Irvine Honolulu Fort Collings New Orleans Atlanta Seattle
1121 Nuuanu Avenue, Suite 203, Honolulu, Hawaii 96817 Telephone (808) 536-1074

COPY

COUNTY OF HAWAII
DEPARTMENT OF PUBLIC WORKS
HILO, HAWAII 96720

RECEIVED
SEP 23 1983
EDAW Inc.

September 21, 1983

Mr. Susumu Ono, Chairman
Environmental Quality Commission
550 Halekauwila Street, Room 301
Honolulu, HI 96813

SUBJECT: DRAFT EIS
KAUMANA TO KEAMUKU 138 KV TRANSMISSION LINE

Thank you for the opportunity to review the subject document.

The Saddle Road is on route FAS 200. It is a County-maintained road on the Federal-Aid Secondary system. We wish to inform you that any work along or across the Saddle Road right-of-way should be planned toward confomance to Chapter 22, Article 4 of the County Code which prescribes policies and procedures for accommodating and installing utility facilities on the right-of-ways of Federal-Aid Secondary County Highways.

Will poles and wiring along the Saddle Road that are presently abandoned be removed?

Edward Harada

EDWARD HARADA
Chief Engineer

cc: HELCO
EDAW Inc.

October 5, 1983

Mr. Edward Harada, Chief Engineer
Department of Public Works
County of Hawaii
25 Aupuni Street
Hilo, Hawaii 96720

Dear Mr. Harada:

Subject: Environmental Impact Statement (EIS)
Kaumana-Keamuku 138 Kv Transmission Line

Thank you for your review comments on the above.

Hawaii Electric Light Company, Inc. (HELCO) will comply with Chapter 22, Article 4 of the County Code and coordinate detailed plans for the proposed transmission line with your department during the design phase. It is anticipated that the proposed line will be within the Saddle Road right-of-way only at the two points where it would cross the road in the Kaumana and Pohakuloa areas. (Refer to the Sections 1 and 5 alignment maps in the EIS and Routing Study.)

HELCO has no abandoned poles and wiring in the Saddle Road area. The proposed project would supplement the existing 69 Kv transmission line, so present facilities will remain in service. Perhaps your comment refers to the Hawaiian Telephone Company's distribution lines. We understand that the telephone company has abandoned these lines along Saddle Road and we expect that they eventually will be removed. During field studies for the proposed transmission line project last year, we observed that portions of the telephone line were being removed in the Pi'ihonua area.

If you should have any further comments or questions on this project, please feel free to contact either me, at 536-1074, or Mr. Alva Nakamura of HELCO at 935-1171.

Sincerely,

EDAW inc.

John P. Whalen

John P. Whalen, AICP
Project Manager

EDAW Inc.
Environmental Planning Urban Design Landscape Architecture
San Francisco Alexandria Irvine Honolulu Fort Collings New Orleans Atlanta Seattle
1121 Nuuanu Avenue, Suite 203, Honolulu, Hawaii 96817 Telephone (808) 536-1074

GEORGE R. ARIYOSHI
GOVERNOR

STATE OF HAWAII
ENVIRONMENTAL QUALITY COMMISSION
550 HALEKAUWILA ST.
ROOM 301
HONOLULU, HAWAII 96813

ROY R. TAKEMOTO
CHAIRMAN

TELEPHONE NO.
(808) 548-6915

SEP - 8 1983

RECEIVED
SEP 22 1983
EDAW Inc.

September 6, 1983

Dear Reviewer:

Attached for your review is an Environmental Impact Statement (EIS) that was prepared pursuant to Chapter 343, Hawaii Revised Statutes and the Rules and Regulations of the Environmental Quality Commission:

Title: Kaumana-Keamuku 138 KV Transmission Line

Location: Kaumana to Keamuku, Island of Hawaii

Classification: Applicant Action

Your comments or acknowledgement of no comments on the EIS are welcomed. Please submit your reply to the accepting authority or approving agency:

Mr. Susumu Ono, Chairman
Board of Land and Natural Resources
P.O. Box 621
Honolulu, Hawaii 96809

Please send a copy of your reply to the proposing party:

Mr. Alva Nakamura	AND	✓Mr. Norman Oss, President
Hawaii Electric Light Co., Inc.		EDAW Inc.
P.O. Box 1027		1121 Nuuanu Avenue, Suite 203
Hilo, Hawaii 96720		Honolulu, Hawaii 96817

Your comments must be received or postmarked by: October 8, 1983

If you have no further use for this EIS, please return it to the Commission.

Thank you for your participation in the EIS process.

Sept. 20, 1983
No comments.
Takeshi Yoshihara
Energy Program Adm.
Energy Div. - DPED

September 23, 1983

Mr. Takeshi Yoshihara
Energy Division
Department of Planning and
Economic Development
State of Hawaii
P. O. Box 119
Honolulu, Hawaii 96810

Dear Mr. Yoshihara:

Subject: Kaumana-Keamuku 138 Kv Transmission Line
Environmental Impact Statement

Thank you for the copy of your correspondence in reference to the above. On behalf of the Hawaii Electric Light Company, Inc., we appreciate your review of the document and prompt response.

Sincerely,

EDAW inc.

John P. Whalen
John P. Whalen, AICP
Project Manager

JPW:lt

EDAW Inc.
Environmental Planning Urban Design Landscape Architecture
San Francisco Alexandria Irvine Honolulu Fort Collins New Orleans Atlanta Seattle
1121 Nuuanu Avenue, Suite 203, Honolulu, Hawaii 96817 Telephone (808) 536-1074

GEORGE R. ARIYOSHI
GOVERNOR OF HAWAII

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

CHARLES G. CLARK
DIRECTOR OF HEALTH

In reply, please refer to:
EPHSD-88

September 19, 1983

RECEIVED
SEP 23 1983
EDAW Inc.

Mr. Susumu Ono, Chairman
Board of Land & Natural Resources
P. O. Box 621
Honolulu, Hawaii 96809

Dear Mr. Ono:

Subject: Request for Comments on Proposed Environmental Impact Statement (EIS) for Kaumana-Keamuku 138 KV Transmission Line, Kaumana to Keamuku, Island of Hawaii

Thank you for allowing us to review and comment on the subject proposed EIS. Please be informed that we do not have any comments or objections to this project at this time.

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

Sincerely,

CHARLES G. CLARK
Director of Health

cc: Mr. Alva Nakamura
Mr. Norman Oss

September 26, 1983

Mr. Charles G. Clark, Director
Department of Health
State of Hawaii
P. O. Box 3378
Honolulu, Hawaii 96801

Dear Mr. Clark:

Subject: Kaumana-Keamuku 138 Kv Transmission Line
Environmental Impact Statement

Thank you for the copy of your correspondence in reference to the above. On behalf of the Hawaii Electric Light Company, Inc., we appreciate your review of the document and prompt response.

Sincerely,

EDAW inc.

John P. Whalen, AICP
Project Manager

JPW:lt

EDAW Inc.
Environmental Planning Urban Design Landscape Architecture
San Francisco Alexandria Irvine Honolulu Fort Collings New Orleans Atlanta Seattle
1121 Nuuanu Avenue, Suite 203, Honolulu, Hawaii 96817 Telephone (808) 536-1074

COPY

DEPARTMENT OF WATER SUPPLY • COUNTY OF HAWAII

25 AUPUNI STREET • HILO, HAWAII 96720

September 19, 1983

RECEIVED

SEP 23 1983

EDAW Inc.

Board of Land and Natural Resources
P.O. Box 621
Honolulu, HI 96809

ENVIRONMENTAL IMPACT STATEMENT (EIS)
KAUMANA-KEAMUKU 138 KV TRANSMISSION LINE

We have no comments on the EIS inasmuch as the proposed action will not have any adverse effects on our water facilities.

H. William Sewake
Manager

CS

cc - Hawaii Electric Light Company, Inc.
✓EDAW, Inc.
Environmental Quality Commission (w/Enc. - EIS)

... Water brings progress...

September 26, 1983

Mr. H. William Sewake, Manager
Department of Water Supply
County of Hawaii
25 Aupuni Street
Hilo, Hawaii 96720

Dear Mr. Sewake:

Subject: Kaumana-Keamuku 138 Kv Transmission Line
Environmental Impact Statement

Thank you for the copy of your correspondence in reference to the above. On behalf of the Hawaii Electric Light Company, Inc., we appreciate your review of the document and prompt response.

Sincerely,

EDAW inc.

John P. Whalen

John P. Whalen, AICP
Project Manager

JPW:lt

EDAW Inc.
Environmental Planning Urban Design Landscape Architecture
San Francisco Alexandria Irvine Honolulu Fort Collings New Orleans Atlanta Seattle
1121 Nuuanu Avenue, Suite 203, Honolulu, Hawaii 96817 Telephone (808) 536-1074

GEORGE R. ARIYOSHI
GOVERNOR

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

RYOKICHI HIGASHIONNA, Ph.D.
DIRECTOR

DEPUTY DIRECTORS
WAYNE J. YAMASAKI
JONATHAN K. SHIMADA, Ph.D.
CHERYL D. SOON

IN REPLY REFER TO:
STP 8.9385

September 19, 1983

RECEIVED
SEP 23 1983
EDAW Inc.

MEMORANDUM

TO: The Honorable Susumu Ono, Chairman
Board of Land and Natural Resources

FROM: Director of Transportation

SUBJECT: ENVIRONMENTAL IMPACT STATEMENT
KAUMANA-KEAMUKU 138 KV TRANSMISSION LINE,
ISLAND OF HAWAII

Thank you for the opportunity to comment on the subject EIS.

We have no comments to offer which could improve the statement.

Ryokichi Higashionna
Ryokichi Higashionna

cc: Mr. Norman Oss

September 26, 1983

Mr. Ryokichi Higashionna, Director
Department of Transportation
State of Hawaii
869 Punchbowl Street
Honolulu, Hawaii 96813

Dear Mr. Higashionna:

Subject: Kaumana-Keamuku 138 Kv Transmission Line
Environmental Impact Statement
Ref. #: STP 8.9385

Thank you for the copy of your correspondence in reference to the above. On behalf of the Hawaii Electric Light Company, Inc., we appreciate your review of the document and prompt response.

Sincerely,

EDAW inc.

John P. Whalen
John P. Whalen, AICP
Project Manager

JPW:lt

EDAW Inc.
Environmental Planning Urban Design Landscape Architecture
San Francisco Alexandria Irvine Honolulu Fort Collings New Orleans Atlanta Seattle
1121 Nuuanu Avenue, Suite 203, Honolulu, Hawaii 96817 Telephone (808) 536-1074

GEORGE R. ARIYOSHI
GOVERNOR

JACK K. SUWA
CHAIRMAN, BOARD OF AGRICULTURE

SUZANNE D. PETERSON
DEPUTY TO THE CHAIRMAN

State of Hawaii
DEPARTMENT OF AGRICULTURE
1428 So. King Street
Honolulu, Hawaii 96814

Mailing Address:
P. O. Box 22159
Honolulu, Hawaii 96822

September 19, 1983

RECEIVED
SEP 20 1983
EDAW Inc.

MEMORANDUM

To: Mr. Susumu Ono, Chairman
Board of Land and Natural Resources

Subject: Draft Environmental Impact Statement (EIS) for
Kaumana-Keamuku 138KV Transmission Line
Hawaiian Electric Light Company, Inc.
Kaumana to Keamuku, Island of Hawaii

The Department of Agriculture has reviewed the subject draft EIS and does not foresee any significant adverse impacts upon agricultural activities as a result of the development of the proposed transmission line.

Thank you for the opportunity to comment.

JACK K. SUWA
Chairman, Board of Agriculture

cc: HELCO
EDAW

"Support Hawaiian Agricultural Products"

September 20, 1983

Mr. Jack K. Suwa, Chairman
Board of Agriculture
P. O. Box 22159
Honolulu, Hawaii 96822

Dear Mr. Suwa:

Subject: Kaumana-Keamuku 138 Kv Transmission Line
Environmental Impact Statement

Thank you for the copy of your correspondence in reference to the above. On behalf of the Hawaii Electric Light Company, Inc., we appreciate your review of the document and prompt response.

Sincerely,

EDAW inc.

John P. Whalen, AICP
Project Manager

JPW:lt

EDAW inc.
Environmental Planning Urban Design Landscape Architecture
San Francisco Alexandria Irvine Honolulu Fort Collings New Orleans Atlanta Seattle
1121 Nuuanu Avenue, Suite 203, Honolulu, Hawaii 96817 Telephone (808) 536-1074

HEADQUARTERS
NAVAL BASE PEARL HARBOR
BOX 110
PEARL HARBOR, HAWAII 96860

IN REPLY REFER TO:
002B:WKL:jam
Ser 2030
14 SEP 1983

RECEIVED
SEP 15 1983
EDAW Inc.

Mr. Susumu Ono, Chairman
Board of Land and Natural Resources
P. O. Box 621
Honolulu, Hawaii 96809

Dear Mr. Ono:

Environmental Impact Statement
Kaumana-Keamuku 138 KV Transmission Line

The EIS for the Kaumana-Keamuku 138 KV Transmission Line has been reviewed and the Navy has no comments to offer. As this command has no further use for the EIS, the EIS is being returned to the Environmental Quality Commission, by copy of this letter.

Thank you for the opportunity to review the EIS.

Sincerely,

M. M. DALLAM
CAPTAIN, CEC, U. S. NAVY
FACILITIES ENGINEER
BY DIRECTION OF THE COMMANDER

Enclosure

Copy to:
Environmental Quality Commission
Hawaii Electric Light Co., Inc.
EDAW Inc.

September 16, 1983

Captain M. M. Dallam
Facilities Engineer
Headquarters Naval Base
Box 110
Pearl Harbor, Hawaii 96860

Dear Captain Dallam:

Subject: Kaumana-Keamuku 138 Kv Transmission Line
Environmental Impact Statement

Thank you for the copy of your correspondence in reference to the above. On behalf of the Hawaii Electric Light Company, Inc., we appreciate your review of the document and prompt response.

Sincerely,

EDAW inc.

John P. Whalen, AICP
Project Manager

JPW:lt

EDAW Inc.
Environmental Planning Urban Design Landscape Architecture
San Francisco Alexandria Irvine Honolulu Fort Collings New Orleans Atlanta Seattle
1121 Nuuanu Avenue, Suite 203, Honolulu, Hawaii 96817 Telephone (808) 536-1074

GEORGE R. ARIYOSHI
GOVERNOR

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

ALEXIS T. LUM
MAJOR GENERAL
ADJUTANT GENERAL

DANIEL K. C. AU
COLONEL
DEPUTY ADJUTANT GENERAL

HIENG

12 SEP 1983

RECEIVED
SEP 13 1983
EDAW Inc.

Mr. Susumu Ono, Chairman
Board of Land and Natural Resources
P. O. Box 621
Honolulu, Hawaii 96809

Dear Mr. Ono:

Thank you for providing us the opportunity to review the proposed project, "Kaumana-Keamuku 138 KV Transmission Line" Environmental Impact Statement.

We have completed our review and have no comments to offer at this time.

Yours truly,

JERRY M. MATSUDA
Major, HANG
Contr & Engr Officer

cc: Mr. Alva Nakamura
Hawaii Electric Light Co., Inc.
Mr. Norman Oss, President
EDAW Inc.
Env. Quality Commission w/EIS

September 16, 1983

Mr. Jerry M. Matsuda
Major, HANG
Contr & Engr Officer
State of Hawaii
Department of Defense
Office of the Adjutant General
3949 Diamond Head Road
Honolulu, Hawaii 96816

Dear Mr. Matsuda:

Subject: Kaumana-Keamuku 138 Kv Transmission Line
Environmental Impact Statement

Thank you for the copy of your correspondence in reference to the above. On behalf of the Hawaii Electric Light Company, Inc., we appreciate your review of the document and prompt response.

Sincerely,

EDAW inc.

John P. Whalen, AICP
Project Manager

JPW:lt

EDAW inc.
Environmental Planning Urban Design Landscape Architecture
San Francisco Alexandria Irvine Honolulu Fort Collings New Orleans Atlanta Seattle
1121 Nuuanu Avenue, Suite 203, Honolulu, Hawaii 96817 Telephone (808) 536-1074

U.S. Department of Transportation
United States Coast Guard

Commander
Fourteenth Coast Guard District
(dpl)

Prince Kalanianaole
Federal Building
300 Ala Moana Blvd.
Honolulu, Hawaii 96850
Phone: 546-2861

11000
Serial 588
9 September 1983

RECEIVED
SEP 13 1983
EDAW Inc.

Mr. Susumu Ono, Chairman
Board of Land and Natural Resources
P.O. Box 621
Honolulu, Hawaii 96809

Dear Mr. Ono:

The Fourteenth Coast Guard District has reviewed the Draft Environmental Impact Statement (EIS) for the Kaumana-Keamuku 138 KV Transmission Line and has no objection or constructive comments to offer at the present time.

Sincerely,

J. E. SCHWARTZ
Commander, U. S. Coant Guard
District Planning Officer
By direction of
Commander, Fourteenth Coast Guard District

Copy: Hawaii Electric Light Co., Inc.
✓EDAW Inc.

September 16, 1983

Mr. J. E. Schwartz
Commander, U. S. Coast Guard
District Planning Officer
U. S. Department of Transportation
United States Coast Guard
Prince Kalanianaole
Federal Buidling
300 Ala Moana Boulevard
Honolulu, Hawaii 96850

Dear Mr. Schwartz:

Subject: Kaumana-Keamuku 138 Kv Transmission Line
Environmental Impact Statement

Thank you for the copy of your correspondence in reference to the above. On behalf of the Hawaii Electric Light Company, Inc., we appreciate your review of the document and prompt response.

Sincerely,

EDAW inc.

John P. Whalen, AICP
Project Manager

JPW:lt

EDAW Inc.
Environmental Planning Urban Design Landscape Architecture
San Francisco Alexandria Irvine Honolulu Fort Collings New Orleans Atlanta Seattle
1121 Nuuanu Avenue, Suite 203, Honolulu, Hawaii 96817 Telephone (808) 536-1074

DEPARTMENT OF THE AIR FORCE
HEADQUARTERS 15TH AIR BASE WING (PACAF)
HICKAM AIR FORCE BASE, HAWAII 96853

RECEIVED
SEP 13 1983
EDAW Inc.

9 SEP 1983

REPLY TO ATTN OF: DEEV (Mr Yamada, 449-1831)

SUBJECT: Draft Environmental Impact Statement for the Kaumana to Keamuku 138 KV Transmission Line

TO: Ms Letita N. Uyehara, Interim Director
Office of Environmental Quality Control
550 Halekauwila Street, Room 301
Honolulu, HI 96813

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

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

ROBERT M. OKAZAKI
Chief, Engrg & Envmtl Plng Div
Directorate of Civil Engineering

1 Atch
Draft EIS

cc: Mr Susumu Ono, Chairman
Board of Land & Natural Resources
P. O. Box 621
Honolulu, HI 96809

Mr Alva Nakamura
Hawaii Electric Light Co., Inc.
P. O. Box 1027
Hilo, HI 96720

Mr Norman Oss, President
EDAW, Inc.
1121 Nuuanu Avenue, Suite 203
Honolulu, HI 96817

September 16, 1983

Mr. Robert M. Okazaki
Chief, Engineering &
Environmental Planning Division
Directorate of Civil Engineering
Department of the Air Force
Headquarters 15th Air Base Wing (PACAF)
Hickam Air Force Base, Hawaii 96853

Dear Mr. Okazaki:

Subject: Kaumana-Keamuku 138 Kv Transmission Line
Environmental Impact Statement

Thank you for the copy of your correspondence in reference to the above. On behalf of the Hawaii Electric Light Company, Inc., we appreciate your review of the document and prompt response.

Sincerely,

EDAW inc.

John P. Whalen, AICP
Project Manager

JPW:lt

EDAW Inc.
Environmental Planning Urban Design Landscape Architecture
San Francisco Alexandria Irvine Honolulu Fort Collins New Orleans Atlanta Seattle
1121 Nuuanu Avenue, Suite 203, Honolulu, Hawaii 96817 Telephone (808) 536-1074

Written responses to the draft Environmental Impact Statement were received from the following persons and agencies. Comments postmarked after the review period deadline on October 8, 1983, are indicated by an asterisk beside the reviewer's name. A double asterisk indicates no substantive comments.

Federal

U. S. Fish and Wildlife Service
U. S. Army Support Command, Hawaii
U. S. Army Corps of Engineer
U. S. Soil Conservation Service
**U. S. Navy, Pearl Harbor, Facilities Engineer
**U. S. Coast Guard, District Planning Officer
**U. S. Air Force, Hickam, Directorate of Civil Engineering

State

**Department of Transportation
**Department of Defense
**Department of Health
Department of Land and Natural Resources
Department of Accounting and General Services
**Department of Agriculture
**Department of Planning and Economic Development, Energy Coordinator
University of Hawaii
*Environmental Center
**Water Resources Research Center
* Vice President for Administration

County of Hawaii

Planning Department
Department of Public Works
**Department of Research and Development

Others

*Winona P. Char

These review letters and responses to them are contained in the following pages.

Comments and Responses During Review Period

August 26, 1983

Ms. Ann Yoklavich
Preservation Planning Committee
Historic Hawai'i Foundation
119 Merchant Street
Honolulu, Hawai'i 96813

Dear Ms. Yoklavich:

This is to confirm our recent telephone conversation in which you indicated that you will not be submitting written comments on the Environmental Impact Statement (EIS) Preparation Notice for the proposed Kaumana-Keamuku 138 Kv transmission line. Thank you for your oral comments, which we will address in the EIS. We expect to file the document with the Environmental Quality Commission (EQC) on September 5th. A copy will be sent to you by EQC for your review and comment.

Sincerely,

EDAW inc.

John Whalen

John P. Whalen
Project Manager

JPW:lt

EDAW Inc.
Environmental Planning Urban Design Landscape Architecture
San Francisco Alexandria Newport Beach Honolulu Fort Collins New Orleans Portland Atlanta Seattle
1121 Nuuanu Avenue, Suite 203, Honolulu, Hawaii 96817 Telephone (808) 536-1074

HISTORIC HAWAI'I FOUNDATION

RECEIVED
AUG . 4 1983
EDAW Inc.

August 3, 1983

Mr. Fred S. Johnson
c/o EDAW, Inc.
1121 Nuuanu Avenue, Suite 203
Honolulu, Hawaii 96817

Dear Mr. Johnson:

Please send Historic Hawai'i Foundation a copy of the Environmental Impact Statement Preparation Notice for the Kaumana-Keamuku 138 Kv Transmission line project.

Thank you.

Sincerely yours,

Ann Yoklavich
Ann Yoklavich
Preservation Planning Committee

AY:rk

cc: Gerald Takano
Phyllis G. Fox

119 Merchant Street Honolulu, Hawai'i 96813 • Telephone (808) 537-9564 • PO Box 1658 Honolulu, Hawai'i 96806

August 5, 1983

Ms. Ann Yoklavich
Preservation Planning Committee
Historic Hawai'i Foundation
119 Merchant Street
Honolulu, Hawai'i 96813

Dear Ms. Yoklavich:

Enclosed, per your request to Mr. Fred S. Johnson, is the environmental assessment for the proposed Kaumana-Keamuku 138 Kv Transmission Line. It serves as the basis for an Environmental Impact Statement currently in preparation.

The submittal of the Conservation District Use Application for this project was preceded by a route selection process which involved several community and public agency workshops on the Island of Hawai'i and O'ahu. Its also involved biological surveys by Dr. Andrew Berger and staff of the Bishop Museum; a visual inventory by EDAW inc.; an archaeological reconnaissance survey by Chiniago, Inc.; and a geological and soils survey by Walter Lum & Assoicates, Inc. The full text of the Routing Study report, as well as field surey reports, will be included in the Environmental Impact Statement.

If you would like any additional information at this time, please call me.

Sincerely,

EDAW inc.

John Whalen
John Whalen, AICP
Project Manager

JW:va

EDAW Inc.
Environmental Planning Urban Design Landscape Architecture
San Francisco Alexandria Newport Beach Honolulu Fort Collins New Orleans Portland Atlanta Seattle
1121 Nuuanu Avenue, Suite 203, Honolulu, Hawaii 96817 Telephone (808) 536-1074

August 26, 1983

Ms. Winoma P. Char
4471 Pu'u Panini Avenue
Honolulu, Hawai'i 96816

Dear Ms. Char:

This is to confirm our recent telephone conversation in which you indicated that you will not be submitting written comments on the Environmental Impact Statement (EIS) Preparation Notice for the proposed Kaumana-Keamuku 138 Kv transmission line. Thank you for your oral comments, which we will address in the EIS. We expect to file the document with the Environmental Quality Commission (EQC) on September 5th. A copy will be sent to you by EQC for your review and comment.

Sincerely,

EDAW inc.

John Whalen

John P. Whalen
Project Manager

JPW:lt

EDAW Inc.
Environmental Planning Urban Design Landscape Architecture
San Francisco Alexandria Newport Beach Honolulu Fort Collins New Orleans Portland Atlanta Seattle
1121 Nuuanu Avenue, Suite 203, Honolulu, Hawaii 96817 Telephone (808) 536-1074

Winona P. Char
4471 Puu Panini Avenue
Honolulu, Hawaii 96816

RECEIVED
AUG . 4 1983
EDAW Inc.

Fred S. Johnson
c/o EDAW, Inc.
1121 Nuuanu Avenue
Honolulu, Hawaii 96817

02 August 1983

Dear Mr. Johnson:

SUBJECT: KAUMANA-KEAMUKU 138 KV TRANSMISSION LINE

I would like a copy of the proposed HELCO Kaumana-Keamuku Transmission Line Project proposal.

Thank you for your courtesy in this matter.

Sincerely,

Winona P. Char
Winona P. Char

August 5, 1983

Ms. Winona P. Char
4471 Puu Panini Avenue
Honolulu, Hawaii 96816

Dear Ms. Char:

Enclosed, per your request to Mr. Fred S. Johnson, is the environmental assessment for the proposed Kaumana-Keamuku 138 Kv Transmission Line. It serves as the basis for an Environmental Impact Statement currently in preparation.

The submittal of the Conservation District Use Application for this project was preceded by a route selection process which involved several community and public agency workshops on the Island of Hawai'i and O'ahu. Its also involved biological surveys by Dr. Andrew Berger and staff of the Bishop Museum; a visual inventory by EDAW inc.; an archaeological reconnaissance survey by Chiniago, Inc.; and a geological and soils survey by Walter Lum & Assoicates, Inc. The full text of the Routing Study report, as well as field surey reports, will be included in the Environmental Impact Statement.

If you would like any additional information at this time, please call me.

Sincerely,

EDAW inc.

John Whalen
John Whalen, AICP
Project Manager

JW:va

EDAW inc.
Environmental Planning Urban Design Landscape Architecture
San Francisco Alexandria Newport Beach Honolulu Fort Collins New Orleans Portland Atlanta Seattle
1121 Nuuanu Avenue, Suite 203, Honolulu, Hawaii 96817 Telephone (808) 536-1074

The approach/departure zone for Bradshaw Airfield, the Palila Critical Habitat and the Protective Subzone of the State Conservation District were the three principal constraints which were considered in the proposed alignment through the northernmost extent of Pohakuloa Training Area. Often these three constraints are in competition, so we have had to consult with a total of 19 technical personnel in the U.S. Army, U.S. Air Force, Federal Aviation Administration, U.S. Fish and Wildlife Service and State of Hawaii Department of Land and Natural Resures to select an alignment which would satisfy the concerns of all sides. We believe that the selected alignment, adjacent to the existing 69 Kv transmission line, accomplishes this. We have had no indication to the contrary from any of the people who were consulted in the route selection process.

The Environmental Impact Statement (EIS) will address these issues, as well as archaeological, fire protection and future use concerns. Based on archeaological studies which have been conducted in the area (Hommon, 1982; Barrera, 1983) no historic sites within the proposed easement are anticipated. However, pole sites will be inspected prior to construction to confirm the absence of archaeological remains. If remains are present, the pole site will be relocated.

If you have any further comments prior to receiving a copy of the EIS, please call me.

Sincerely,

EDAW inc.

John Whalen

John Whalen, AICP
Project Manager

JW:ac

DEPARTMENT OF THE ARMY
HEADQUARTERS UNITED STATES ARMY SUPPORT COMMAND, HAWAII
FORT SHAFTER, HAWAII 96858

June 21, 1983

REPLY TO ATTENTION OF:
Directorate of Facilities Engineering

Mr. John Whalen
EDAW, Inc.
1121 Nuuanu Avenue, Suite 203
Honolulu, Hawaii 96817

Dear Mr. Whalen:

Reference Hawaii Electric Light Company letter, dated June 15, 1983, subject: Environmental Impact Statement, Kaumana-Keamuku 138KV Transmission Line. As you are aware, the proposed transmission line route passes through parts of the Army's Pohakuloa Training Area (PTA) on the Big Island. Continued use of PTA by the Army is essential to the readiness and efficiency of the 25th Infantry Division. Request that the EIS address any potential impact on military training activities and aviation safety. Coordination with Army aviation elements and the Federal Aviation Administration is suggested.

Furthermore, the proposed transmission line route passes through that part of PTA designated as critical habitat for the Palila (*Psittirostra bailleui*). Army consent for the easement is a Federal agency action requiring consultation with the Fish and Wildlife Service (FWS), US Department of the Interior under the Endangered Species Act of 1973, as amended. We are in the process of initiating Section 7 consultation with FWS and will provide their findings to you for possible inclusion in the EIS.

Additional considerations at PTA include impacts of the transmission line on archaeological sites, fire protection, and future development plans.

We appreciate the opportunity to comment on your notice of intent to prepare an EIS and look forward to reviewing the draft document.

Sincerely,

Ronald A. Borrello
Colonel, Corps of Engineers
Director of Facilities Engineering

July 14, 1983

Col. Ronald A. Borrello
Directorate of Facilities Engineering
Headquarters, U.S. Army Support Command Hawaii
Fort Shafter, HI 96858

Dear Col. Borrello:

Environmental Impact Statement
Kaumana-Keamuku 138 kv Transmission Line
Island of Hawaii

Thank you for your letter dated June 21, 1983, in reference to the above.

We have consulted with several Army and Air Force personnel on the relationship of this project to operations at Bradshaw Airfield:

Mr. Alvin Char	Capt. Robert L. Mitchell (PTA)
Mr. Fred Nakahara	Lt. Col. John Horalek (PTA)
Ms. Natalie Hiroto	Capt. Kenneth Paulson (PTA)
Capt. James Morrill	

After reviewing the proposed route, none of the aviation officers have expressed concern about potential impacts on aircraft safety, inasmuch as the proposed transmission line will be on the Mauna Kea side of the existing 69 Kv line in the Pohakuloa area. We have also consulted with Mr. Al Loo of the Federal Aviation Administration (FAA). A Notice of Proposed Construction or Alteration will be filed with FAA upon completion of design drawings for the project. Hawaii Electric Light Company, Inc., will comply with any safety requirements of the FAA.

We are aware that the proposed route passes through a portion of the designated Palila Critical Habitat. We have consulted with Mr. Lucien Kramer of the U.S. Fish and Wildlife Service at various stages of the route selection process and he has had the opportunity to review the proposed alignment. We understand that your office has forwarded to him a copy of the Routing Study report. We have also sent him copies of the biological surveys which were conducted along the proposed route.

EDAW Inc.
Environmental Planning Urban Design Landscape Architecture
San Francisco Alexandria Newport Beach Honolulu Fort Collins New Orleans Portland Atlanta Seattle
1121 Nuuanu Avenue, Suite 203, Honolulu, Hawaii 96817 Telephone (808) 536-1074

GEORGE R. ARIYOSHI
GOVERNOR

RECEIVED
AUG 1 1983
EDAW Inc.

State of Hawaii
DEPARTMENT OF AGRICULTURE
1428 So. King Street
Honolulu, Hawaii 96814

JACK K. SUWA
CHAIRMAN, BOARD OF AGRICULTURE

SUZANNE D. PETERSON
DEPUTY TO THE CHAIRMAN

Mailing Address:
P. O. Box 22159
Honolulu, Hawaii 96822

July 28, 1983

Mr. John Whalen
EDAW, Inc.
1121 Nuuanu Ave., Suite 203
Honolulu, Hawaii 96817

Dear Mr. Whalen:

Re: Environmental Impact Statement: Kaumana-Keamuku 138KV Transmission Line

The Department of Agriculture has reviewed the Conservation District Use Application (CDUA) for the above project and understands that the transmission line will pass through grazing lands of the Parker Ranch and the Humu'ula Sheep Station. The CDUA further states that the proposed project will not interfere with these operations and other landowners' future plans.

We do not foresee any significant impacts upon agricultural activities as a result of the development of the proposed transmission line.

Sincerely,

JACK K. SUWA
Chairman, Board of Agriculture

cc: DLNR

"Support Hawaiian Agricultural Products"

August 3, 1983

Mr. Jack K. Suwa, Chairman
Department of Agriculture
State of Hawaii
1428 South King Street
Honolulu, Hawaii 96814

Dear Mr. Suwa:

Environmental Impact Statement
Kaumana-Keamuku 138 Kv Transmission Line
Island of Hawaii

Dear Mr. Suwa:

Thank you for your July 28th letter in reference to the above. We appreciate your concurrence with our assessment with respect to agricultural activities. Your department will receive a copy of the Environmental Impact Statement during the review period in September.

Sincerely,

EDAW inc.

John P. Whalen, AICP
Project Manager

JPW:lt

EDAW Inc.
Environmental Planning Urban Design Landscape Architecture
San Francisco Alexandria Newport Beach Honolulu Fort Collins New Orleans Portland Atlanta Seattle
1121 Nuuanu Avenue, Suite 203, Honolulu, Hawaii 96817 Telephone (808) 536-1074

University of Hawaii at Manoa

Hawaii Institute of Geophysics
2525 Correa Road • Honolulu, Hawaii 96822
Cable Address: UNIHAW

Office of the Director

June 23, 1983

RECEIVED
JUN 30 1983
EDAW Inc.

Mr. John Whalen
EDAW, Inc.
1121 Nuuanu Avenue, Suite 203
Honollu, HI 96817

Dear Mr. Whalen:

I received the earlier plans for the 138KV transmission line between Kaumana and Keamuku and saw no reason that the project should not proceed. It is very unlikely that this project could have any significant long-term environmental impact, and I am surprised that an EIS is being required. This is a totally unnecessary process in this case and is a totally unwarranted cost that will have to be passed on to the consumers on the Big Island.

Sincerely,

Charles E. Helsley
Director

cc: Mr. Fred S. Johnson

AN EQUAL OPPORTUNITY EMPLOYER

July 14, 1983

Mr. Charles E. Helsley, Director
Hawaii Institute of Geophysics
2525 Correa Road
Honolulu, HI 96822

Dear Mr. Helsley:

Environmental Impact Statement
Kaumana-Keamuku 138 kv Transmission Line
Island of Hawaii

Thank you for your comments on the above project and your concern for the impact of regulatory processes on utility rate payers.

Environmental Impact Statement (EIS) was required by the Department of Land and Natural Resources because the proposed transmission line unavoidably will cross the State Conservation District.

We believe that the EIS will clearly show that there will be no significant adverse environmental effects from the construction and operation of this line.

Sincerely,

EDAW inc.

John Whalen
Project Manager

JW:ac

EDAW Inc.
Environmental Planning Urban Design Landscape Architecture
San Francisco Alexandria Newport Beach Honolulu Fort Collins New Orleans Portland Atlanta Seattle
1121 Nuuanu Avenue, Suite 203, Honolulu, Hawaii 96817 Telephone (808) 536-1074

University of Hawaii at Manoa

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

RECEIVED
JUL 1 1983
EDAW Inc.

July 1, 1983

Mr. John Whalen
EDAW, Inc.
1121 Nuuanu Avenue, Suite 203
Honolulu, Hawaii 96817

Dear Mr. Whalen:

Environmental Impact Statement
138 KV Transmission Line
Kaumana-Keamuku, Hawaii

Your letter of June 15, 1983 requested our input as to specific information which we would like covered in the forthcoming DEIS for the 138 KV transmission line from Kaumana to Keamuku, Hawaii. Since we have no background information as yet for this project, we can only comment in general terms as to potential impact assessment needs of power projects with the understanding that more site specific concerns must await our receipt of the environmental assessment.

Complete documentation of both above and below ground impacts may be needed if the work to be done may involve both types of transmission line installation and depending on the terrain to be crossed. If poles are to be placed, archaeological impact assessment may be necessary at each pole cite. Weed and soil erosion control methods should be addressed and revegetation of the pole sites should be considered as a mitigation measure for soil erosion. The species of plants that will be used in any revegetation effort should be indicated.

Previous reviewers of power line projects have expressed concern over corona discharge. A discussion of this possiblity and the potential impacts of corona discharge on the enviornment should be presented. Other impacts include possible noises that may effect local residences such as the loud "humming" noises that have been reported from wind created vibrations. A clear documentation of what residences (if any) will be effected by noise as well as asthetic impacts would also be helpful in the evaluation of the impacts of the proposed power line installation.

We hope these comments and concerns are helpful in the preparation of the DEIS. If you have any further questions please contact me or Mark Ingoglia at 948-7361.

Yours truly,

Doak C. Cox
Director

cc: Jacquelin Miller
Mark Ingoglia

AN EQUAL OPPORTUNITY EMPLOYER

July 14, 1983

Dr. Doak C. Cox, Director
Environmental Center
Univeristy of Hawaii
Crawford 317
2550 Campus Road
Honolulu, HI 96822

Dear Dr. Cox:

Environmental Impact Statement
Kaumana-Keamuku 138 kv Transmission Line
Island of Hawaii

Thank you for your letter dated July 1, 1983 in reference to the above.

All of the concerns you mention have been addressed in the project and route selection process for the proposed transmission line, so many of the potential adverse environmental impacts have been avoided or minimized. A report documenting this process will be included in the Environmental Impact Statement (EIS). The EIS will discuss probable impacts along specific segments of the transmission line route and more generic issues, such as corona discharge. While field surveys of biological and archaeological resources along the proposed route have been conducted, and the reports of these surveys will be included in the EIS, we expect that follow-up inspections at pole sites will be necessary during the design phase. At this point in project planning, specific pole sites have not been determined.

Enclosed is a copy of the environmental assessment in case you have not yet received one from the Department of Land and Natural Resources. Please feel free to call me if you have any additional comments.

Sincerely,

EDAW inc.

John Whalen
Project Manager

JW:ac

EDAW inc.
Environmental Planning Urban Design Landscape Architecture
San Francisco Alexandria Newport Beach Honolulu Fort Collins New Orleans Portland Atlanta Seattle
1121 Nuuanu Avenue, Suite 203, Honolulu, Hawaii 96817 Telephone (808) 536-1074

DEPARTMENT OF THE ARMY
PACIFIC OCEAN DIVISION, CORPS OF ENGINEERS
FT. SHAFTER, HAWAII 96858

RECEIVED
JUN 24 1983
EDAW Inc.

June 22, 1983

Mr. John Whalen
EDAW, Inc.
1121 Nuuanu Ave., Suite 203
Honolulu, Hawaii 96817

Dear Mr. Whalen:

Thank you for the opportunity to provide preliminary input to the Environmental Impact Statement for a 138KV transmission line between Kaumana and Keamuku, Island of Hawaii.

Flood hazard potential should be addressed in the EIS. Most likely, flooding is not a problem in the conservation areas where development is sparse and runoff does not pose a problem.

Sincerely,

Kisuk Cheung
Chief, Engineering Division

July 14, 1983

Mr. Kisuk Cheung, Chief
Engineering Division
Pacific Ocean Division, Corps of Engineer
U.S. Department of the Army
Port Shafter, HI 96858

Dear Mr. Cheung:

Environmental Impact Statement
Kaumana-Keamuku 138 kv Transmission Line
Island of Hawaii

Thank you for your letter dated June 22, 1983, in reference to the above.

Please be advised that the proposed transmission line route does not pass through any identified flood hazard areas. Care has been taken to minimize the crossing of streams and gullies. Pole sites will not be placed in areas where runoff and ponding could undermine the stability of the structure. This mitigation measure will be included in the Environmental Impact Statement.

Sincerely,

EDAW inc.

John Whalen
Project Manager

JW:ac

EDAW inc.
Environmental Planning Urban Design Landscape Architecture
San Francisco Alexandria Newport Beach Honolulu Fort Collins New Orleans Portland Atlanta Seattle
1121 Nuuanu Avenue, Suite 203, Honolulu, Hawaii 96817 Telephone (808) 536-1074

DEPARTMENT OF PLANNING AND ECONOMIC DEVELOPMENT
KAMAMALU BUILDING, 250 SOUTH KING ST, HONOLULU, HAWAII • MAILING ADDRESS: P.O. BOX 2359 HONOLULU, HAWAII 96804

GEORGE R. ARIYOSHI, Governor
KENT M. KEITH, Director
FRANK SKRIVANEK, Deputy Director

July 19, 1983

Ref. No. 7720

RECEIVED
EDAW Inc.

Mr. John Whalen
EDAW, Inc.
1121 Nuuanu Avenue, Suite 203
Honolulu, Hawaii 96817

Dear Mr. Whalen:

Subject: Kaumana-Keamuku 138KV Transmission Line, County of Hawaii

During your preparation of the environmental impact statement (EIS) for the proposed 138KV transmission line, Kaumana-Keamuku, County of Hawaii, we recommend that you review Parts I and III of the Hawaii State Plan and address applicable objectives, policies and priority directions in the EIS.

We would also appreciate the opportunity to review the draft EIS when it is available.

Very truly yours,

Kent M. Keith

July 25, 1983

Mr. Kent M. Keith, Director
Department of Planning and
Economic Development
State of Hawaii
Kamamalu Building
P. O. Box 2359
Honolulu, Hawaii 96804

Dear Mr. Keith:

Environmental Impact Statement
Kaumana-Keamuku 138 Kv Transmission Line
Island of Hawaii

Thank you for your letter of July 19, 1983 in reference to the above.

The Environmental Impact Statement (EIS) will address the provisions of the Hawaii State Plan, as you recommend, as well as applicable functional plans adopted by Executive Order.

We expect that you will receive a copy of the draft EIS in the latter part of August, when the formal review period will begin.

Sincerely,

EDAW inc.

John P. Whalen, AICP
Project Manager

JPW:lt

EDAW inc.
Environmental Planning Urban Design Landscape Architecture
San Francisco Alexandria Newport Beach Honolulu Fort Collins New Orleans Portland Atlanta Seattle
1121 Nuuanu Avenue, Suite 203, Honolulu, Hawaii 96817 Telephone (808) 536-1074

United States Department of Agriculture

Soil Conservation Service

P.O. Box 50004
Honolulu, Hawaii
96850

Mr. Oss

October 6, 1983

RECEIVED
OCT 7 1983
EDAW Inc.

Mr. Susumu Ono, Chairman
Board of Land and Natural Resources
Department of Land and Natural Resources
P.O. Box 621
Honolulu, Hawaii 96809

Dear Mr. Ono:

Subject: Draft EIS for the Kaumana-Keamuku 138 KV Transmission Line
Kaumana to Keamuku, Island of Hawaii

We reviewed the subject environmental impact statement and feel that the erosion and sediment control aspect have been adequately addressed, considering the harsh climatic factors along most of the proposed route.

Thank you for the opportunity to review the document.

Sincerely,

Francis C.H. Lum

FRANCIS C.H. LUM
State Conservationist

cc:
Mr. Alva Nakamura
Hawaii Electric Light Co., Inc.
P.O. Box 1027
Hilo, Hawaii 96720

Mr. Norman Oss, President
EDAW, Inc.
1121 Nuuanu Avenue, Suite 203
Honolulu, Hawaii 96817

October 11, 1983

Mr. Francis C. H. Lum,
State Conservationist
U. S. Department of Agriculture
Soil Conservation Service
P. O. Box 50004
Honolulu, Hawaii 96850

Dear Mr. Lum:

Subject: Environmental Impact Statement
Kaumana-Keamuku 138 Kv Transmission Line

Thank you for the copy of your letter to Mr. Susumu Ono regarding the above. If you should have any further comments or questions on this project, please do not hesitate to call me.

Sincerely,

EDAW inc.

John P. Whalen

John P. Whalen, AICP
Project Manager

JPW:lt

HERBERT T. MATAYOSHI, MAYOR
H. STUART KEARNS, JR.
Director

DEPARTMENT OF RESEARCH AND DEVELOPMENT

COUNTY OF HAWAII • 25 AUPUNI STREET • HILO, HAWAII 96720 • TELEPHONE (808) 961-8366

RECEIVED
OCT 13 1983
EDAW Inc.

October 4, 1983

Mr. Susumu Ono, Chairman
Board of Land and Natural Resources
P. O. Box 621
Honolulu, Hawaii 96809

SUBJECT: Kaumana-Keamuku 138 KV Transmission Line

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

The proposed project will up grade and provide needed additional electrical service to the western part of the island of Hawaii. It should be noted that the western part of the island is destined to develop as the major resort/recreational center of the island.

H. STUART KEARNS, JR.
DIRECTOR

cc: Mr. Alva Nakamura
HELCO

Mr. Norman Oss, President
EDAW, Inc.

October 13, 1983

Mr. H. Stuart Kearns, Jr., Director
Department of Research and Development
County of Hawaii
25 Aupuni Street
Hilo, Hawaii 96720

Dear Mr. Kearns:

Subject: Environmental Impact Statement
Kaumana-Keamuku 138 Kv Transmission Line

Thank you for the copy of your review comments on the above. On behalf of the Hawaii Electric Light Company, Inc., we appreciate your recognition of the need for reliable electric power service for the western part of the Island of Hawaii.

Sincerely,

EDAW inc.

John P. Whalen, AICP
Project Manager

JPW:lt

EDAW inc.
Environmental Planning Urban Design Landscape Architecture
San Francisco Alexandria Irvine Honolulu Fort Collings New Orleans Atlanta Seattle
1121 Nuuanu Avenue, Suite 203, Honolulu, Hawaii 96817 Telephone (808) 536-1074

University of Hawaii at Manoa

Department of Botany
St. John Plant Science Laboratory
Room 101 • 3190 Maile Way • Honolulu, Hawaii 96822
Telephone (808) 948-8369 • Cable Address: UNIHAW

RECEIVED
OCT 17 1983
EDAW Inc.

07 October 1983

Mr. Susumu Ono, Chairman
Board of Land and Natural Resources
P. O. Box 621
Honolulu, Hawaii 96809

Dear Mr. Ono:

SUBJECT: Environmental Impact Statement
Kaumana to Keamuku 138 KV Transmission Line

The biological section was well-written and the potential environmental impacts on the native biota are well addressed in the EIS. The rationale for mitigating measures are well-thought out and I hope the steps for minimizing potential impacts of the project on the native ecosystems (page 39) are carried out in full.

Employing helicopters for the set-up of the transmission lines will definitely minimize disturbance to the native ecosystems. A botanist should definitely be involved in the final pole site location decisions in Section 6 to insure that no plants of the endangered Haplostachys are disturbed.

The access roads in Section 6 pose somewhat of a problem in that although they facilitate greater access into the area for fire control, they also increase human traffic in the area. The chances for fire occurring increases with human activity. Perhaps access can be restricted by chaining the road entrances.

Sincerely,

Winona P. Char
Winona P. Char

cc: A. Nakamura
N. Osa ✓

AN EQUAL OPPORTUNITY EMPLOYER

October 18, 1983

Professor Winona P. Char
Department of Botany
University of Hawaii
3190 Maile Way, Room 101
Honolulu, Haaii 96822

Dear Professor Char:

Subject: Enviromental Impact Statement
Kaumana-Keamuku 138 Kv Transmission Line

Thank you for the copy of your letter to Mr. Susumu Ono regarding the above.

Your point about the double-edged effect of the proposed access road through Section 6 is well taken. The access road was recommended by staff of the State's Division of Forestry and Wildlife, reasoning that the advantages of such a road outweigh the disadvantages. The proposed road will have locked gates. This has been discussed with both the State and Parker Ranch, the property owner. It was my oversight not to mention it in the EIS.

Sincerely,

EDAW inc.

John P. Whalen
John P. Whalen, AICP
Project Manager

JPW:lt

EDAW Inc.
Environmental Planning Urban Design Landscape Architecture
San Francisco Alexandria Irvine Honolulu Fort Collings New Orleans Atlanta Seattle
1121 Nuuanu Avenue, Suite 203, Honolulu, Hawaii 96817 Telephone (808) 536-1074

University of Hawaii at Manoa

Water Resources Research Center
Holmes Hall 283 • 2540 Dole Street
Honolulu, Hawaii 96822

RECEIVED
OCT 17 1983
EDAW Inc.

12 October 1983

Mr. Susumu Ono, Chairman
Board of Land and Natural Resources
P. O. Box 621
Honolulu, Hawaii 96809

Dear Mr. Ono:

SUBJECT: Environmental Impact Statement, Kaumana to Keamuku, 138 KV Transmission Line, August 1983

We have reviewed the subject EIS and have no comment to offer. Thank you for the opportunity to comment. This material was reviewed by WRRC personnel.

Sincerely,

Edwin T. Murabayashi
Edwin T. Murabayashi
EIS Coordinator

ETM:jm

cc: Alva Nakamura, HELCO
Norman Oss, EDAW

AN EQUAL OPPORTUNITY EMPLOYER

October 18, 1983

Mr. Edwin T. Murabayashi
Water Resources Research Center
University of Hawaii
2540 Dole Street, Room 283
Honolulu, Hawaii 96822

Dear Mr. Murabayashi:

Subject: Environmental Impact Statement (EIS)
Kaumana-Keamuku 138 Kv Transmission Line

Thank you for the copy of your letter to Mr. Susumu Ono regarding the above. We appreciate your review of the EIS.

Sincerely,

EDAW inc.

John P. Whalen
John P. Whalen, AICP
Project Manager

JPW:lt

EDAW Inc.
Environmental Planning Urban Design Landscape Architecture
San Francisco Alexandria Irvine Honolulu Fort Collings New Orleans Atlanta Seattle
1121 Nuuanu Avenue, Suite 203, Honolulu, Hawaii 96817 Telephone (808) 536-1074

RECEIVED

OCT 7 1983

EDAW Inc.

(P)1786.3

OCT 5 1983

Honorable Susumu Ono
Chairman
Department of Land and
Natural Resources
State of Hawaii
Honolulu, Hawaii

Dear Mr. Ono:

Subject: Draft Environmental Impact Statement
Kaumana to Keamuku 138 KV Transmission Line

We have reviewed the subject draft EIS and have the following comments:

1. The Stainback Highway, which is paved, provides access to the Kulani Correctional Facility (KCF) and terminates at the boundary of the KCF site.

2. Except for the short section of roadway from Stainback Highway to the main camp, the roads within KCF are considered to be jeep trails that generally require 4-wheel drive vehicles to traverse.

3. The proposed Kulani Construction Staging Area, as shown on Exhibit II-5, is deep within the KCF site. Therefore, to transport poles and materials to the Staging Area, the roads within the KCF to the Staging Area may have to be graded and paved.

4. All construction activities within the KCF should be coordinated with the Corrections Division and the administrator of the KCF.

If there are any questions or additional information is required, please have your staff call Mr. Norman Sahara of the Division of Public Works at 548-7660.

Very truly yours,

HIDEO MURAKAMI
State Comptroller

NS:jm
Attachment

cc: Mr. Franklin Sunn
Mr. Alva Nakamura
✓Mr. Norman Oss

October 19, 1983

Mr. Hideo Murakami,
State Comptroller
Department of Accounting
and General Services
State of Hawaii
Division of Public Works
P. O. Box 119
Honolulu, Hawaii 96810

Dear Mr. Murakami:

Subject: Environmental Impact Statement (EIS)
Kaumana-Keamuku 138 Kv Transmission Line

Thank you for the copy of your letter to Mr. Susumu Ono regarding the above. We are responding on behalf of Hawaii Electric Light Company, Inc. (HELCO).

Your information and advice regarding the proposed Kulani staging area was very helpful, particularly with respect to road conditions. In follow-up to your comments, we visited the area and discussed the matter with Mr. Jack Sakamoto of the Kulani Correctional Facility (KCF) staff. With his guidance, we travelled the road that leads through KCF to the Kulani substation. While we were able to get through with no difficulty, a couple of the curves may be too sharp for the truck hauling the poles to negotiate. Mr. Sakamoto pointed out three additional sites within KCF that would be nearer the paved portion of Stainback Highway and well-suited for a staging area. All three sites have previously been leveled, cleared of major vegetation and are presently unused by KCF. One of the sites is near the abandoned Boy's School, the second is near the piggery and the third is next to the entrance to KCP from Stainback Highway. HELCO is very interested in the possible use of one or more of these three sites for the staging area and will pursue this matter with KCF and the Corrections Division. If these sites are not available, then permission will be requested to make any necessary improvements to the road through KCF. This would have no direct bearing on the CDUA for the proposed transmission line because the three potential staging area sites and the access road are all in the Agriculture District.

EDAW Inc.
Environmental Planning Urban Design Landscape Architecture
San Francisco Alexandria Irvine Honolulu Fort Collings New Orleans Atlanta Seattle
1121 Nuuanu Avenue, Suite 203, Honolulu, Hawaii 96817 Telephone (808) 536-1074

Your comments on the EIS are appreciated. Please feel free to call me if I can provide any additional information.

Sincerely,

EDAW inc.

John P. Whalen

John P. Whalen, AICP
Project Manager

JPW:lt

University of Hawaii at Manoa

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

RECEIVED
OCT 13 1983
EDAW Inc.

October 7, 1983

RE:0388

Mr. Susumu Ono
Board of Land and Natural Resources
P.O. Box 621
Honolulu, Hawaii 96809

Dear Mr. Ono:

Draft Environmental Impact Statement
Kaumana-Keamuku 138 KV Transmission Line
Kaumana to Keamuku, Hawaii

The Environmental Center review of the above cited document has been prepared with the assistance of Sheila Conant, General Science; Joseph Halbig, Geology-UH Hilo; Bertil Granborg, Electrical Engineering; Matthew Spriggs, Anthropology; and Jacquelin Miller and Pamela Bahnsen, Environmental Center.

The basic format of the DEIS document and the extensive use of graphics in combination with explantory text certainly facilitates the readers understanding of the project and the evaluation of the potential impacts. There are two areas however, identified by our reviewers, that require additional information. One we would conclude is so inadequate as to preclude acceptance of the document without extensive revision and expansion.

Wildlife

We are pleased to note that a Section 7 Review by the U.S. Fish and Wildlife Service (USFWS) was requested in August 1983 (p. 63). Will the results of the Section 7 review be incorporated into the Revised EIS? It would seem appropriate and necessary to include these results since the project will involve the critical habitat of endangered species. We also understand that a Forest Bird Survey was recently completed by the USFWS. It would be helpful if the findings of this survey were also included in the Revised EIS.

Archaeology

Our most serious concern lies with the adequacy of the archaeological studies. We find the two-page Archaeological report concerning the 55 miles for the primary route and 54 miles for the alternatives to be inadequate and unacceptable. Contrary to what is stated in the introduction, the report does not include a "literature search". The only literature apparently consulted were the National and State historic sites registers on which are placed certainly less than 1 percent of the recorded sites in the state. Conspicuous

by its absence is reference to R.J. Mommon and H.M. Ahlo Jr. "Research Design for Archaeological Studies at the Pohakuloa Training Area, Island of Hawaii (August 1982), which is a reasonable summary of archaeological and historical information for the Saddle Road area, with a consideration of research questions which need to be addressed. This report also contains a good bibliography for the area.

In relation to the field reconnaissance it is not clear why inspection of the total length of right of way was not envisaged, or alternatively why a systematic survey design was not implemented. There is reference to "terrain features" and "already known cultural features" as the basis for examination of particular areas but no explicit research design. On what basis were the four areas chosen? Is it really a valid point that one need only look where previous sites have been located, particularly if no intensive survey of any of the areas except the Anaehoomalu stretch has ever been attempted? There are numerous examples in Hawaiian archaeology where the "extremely rough nature of the terrain" did not deter the Hawaiians from utilization of resources. Without any explicit model of ancient Hawaiian exploitation of the different zones the power line will pass through, it would seem difficult to frame a meaningful survey design. We find it most disturbing to read of "the lack of precise location data for the rights of way": if this was the case then one can not even be sure that the few sections that were surveyed have anything to do with where the power-line will be placed!

No details have been provided as to the amount of time spent on the reconnaissance or the methods used. Were 150-foot wide sections covered or just a general area? How many people were involved, walking how far apart? No survey of the proposed large staging areas appears to have been included. These staging areas will have a major impact on any sites which may be present.

The omission of published archaeological information and the superficial treatment of the archaeological and cultural resources relative to the proposed transmission lines is so significant as to render suspect any conclusions promulgated by this report. There is no evidence presented to support the conclusions expressed in the DEIS of a "strong probability that significant archaeological or historical sites are absent from the proposed right of way". A systematic archaeological survey of a defined right of way is needed in order to identify the environmental impacts associated with the construction of the proposed transmission line. The survey should concentrate on the pole sites, the sub-stations, and the areas/roads that will be subject to grading or construction and it should be completed prior to land disturbance activities.

We appreciate the opportunity to comment on this DEIS and hope that you will find our comments useful in the preparation of the revised document.

Sincerely,

Doak C. Cox
Director

cc: OEQC
Hawaii Electric Light Co., Inc.
EDAW Inc.
Sheila Conant
Joseph Halbig
Bertil Granborg
Matthew Spriggs
Jacquelin Miller
Pamela Bahnsen

October 19, 1983

Dr. Doak Cox, Director
Environmental Center
University of Hawaii
2550 Campus Road
Honolulu, Hawaii 96822

Dear Dr. Cox:

Subject: Environmental Impact Statement
Kaumana-Keamuku 138 Kv Transmission Line

Thank you for the copy of your review comments on the above. I am responding to your comments on behalf of Hawaii Electric Light Company, Inc.

The U. S. Fish and Wildlife Service (USFWS) has completed its Section 7 review and has concluded that the proposed transmission line will have no significant adverse impact on the palila or its critical habitat. The USFWS letter is included in the revised EIS. The Forest Bird Survey was underway when Dr. Andrew Berger and the Bishop Museum team were conducting the field assessments for the proposed transmission line route. Both consulted the USFWS biologists working on the recovery plan and incorporated their preliminary work products and findings in their analyses. I recently consulted the USFWS biologists who reviewed the EIS. They felt that the analysis in the EIS is consistent with the findings and recommendations of the Forest Bird Survey and Recovery Plan.

The comments on the archaeological studies were significant enough to warrant a direct reply from Mr. William Barrera, Jr., the consulting archaeologist. His response is enclosed and will be included in the revised EIS.

There is no disagreement on the need for detailed, site-specific archaeological investigations prior to disturbance of land areas. This, in fact, is explicitly proposed as a mitigation measure on page 43 of the EIS. It was also recommended in Mr. Barrera's report. The reviewer, however, has apparently misunderstood the scope of land disturbance activities. The only areas of excavation will be at the pole sites themselves. Each pole will consume a land area of only 2.36 square feet, resulting in a combined total of

less than 1,000 square feet for all 420 or so poles. The excavated area will be as close as possible to the actual dimension of the pole bases so that surrounding solid material will act as a support. It would be pointless at this stage to attempt an archaeological study based on predetermined pole spacings. A CDUA is normally required to conduct the detailed land surveying and to take the test bores and other samples necessary to locate pole sites in the field. There is a fair amount of flexibility in the siting of poles. The sites can be shifted within the easement a distance of about 10 feet laterally and several hundred feet lengthwise, so responsiveness to specific site constraints is both possible and desirable. The State Historic Preservation Office is in agreement with the proposed mitigation program and has expressed no objection to the analysis or conclusions of the archaeological impact analysis in the EIS.

If you should have any additional comments or questions on this matter, please feel free to call me.

Sincerely,

EDAW inc.

John P. Whalen, AICP
Project Manager

JPW:lt

CHINIAGO INC.
Archaeological Consulting
1040-B SMITH STREET • HONOLULU, HAWAII 96817 • TELEPHONE: (808) 521-2785

October 17, 1983

RECEIVED
OCT 17 1983
EDAW Inc.

Mr. John Whalen
EDAW, Inc.
1121 Nuuanu Avenue
Honolulu, Hawaii 96817

Dear Mr. Whalen:

Thank you for the opportunity to respond to the comments from the University of Hawaii Environmental Center regarding the HECO powerline report.

Firstly, the reviewer's comment that we did not refer to the Hommon and Ahlo report on the Pohakuloa area is accurate. I have since inspected this report, and there is nothing about it that would cause us to change any of our recomendations.

As for the rest of his criticisms, the major point which I would like to make is that the reviewer has both misunderstood and misrepresented our report. For example, he asks "Is it really a valid point that one need only look where previous sites have been located, particularly if no intensive survey of any of the areas except the Anaehoomalu stretch has ever been attempted?" In the first place, the "Anaehoomalu stretch" has never been intensively surveyed. Secondly, we never said that we had looked only where previous sites had been located, so this point accomplishes nothing more than the setting up of a straw man for the sole purpose of knocking it down.

Next is the comment:

"Without any explicit model of ancient Hawaiian exploitation of the different zones the power line will pass through, it would seem difficult to frame a meaningful survey design."

First, "explicit models" are indeed useful devices for generating hypotheses for areas about which something is known, but I find ludicrous the thought that it would be useful to spend even the least amount of time attempting to discern the possible relationships between unknown sites in an unsurveyed area. It is also insulting to suggest that the act of making such a research design explicit, in and of itself, somehow confirms the validity of the work. Is the reviewer unaware that people are capable of misrepresenting their work?

Another comment ["There is reference to 'terrain features' and 'already known cultural features' as the basis for examination of particular areas but no explicit research design"] entirely misses the point that the purpose of the fieldwork was not to do archaeological research, but to generate recommendations regarding future actions. This goal was accomplished, as can be seen by our final comment.

The reviewer states:

"The omission of published archaeological information and the superficial treatment of the archaeological and cultural resources relative to the proposed transmission lines is so significant as to render suspect any conclusions promulgated by this report."

He then proceeds to present virtually the same conclusion as we did, as can be seen by comparing his conclusion with ours and with the commitments made in the Draft Environmental Impact Statement:

"A systematic archaeological survey of a defined right of way is needed in order to identify the environmental impacts associated with the construction of the proposed transmission line. The survey should concentrate on the pole sites, the sub-stations, and the areas/roads that will be subject to grading or construction and it should be completed prior to land disturbance activities."

"In order to accurately ascertain the impact of the powerline construction on such sites it will be necessary for an archaeologist to inspect the exact proposed pole sites as well as any construction areas or other areas to be disturbed as direct or indirect results of powerline installation."

"Proposed pole sites and any other surface areas that will be disturbed by construction activities will be surveyed by an archaeologist, who will locate and describe any historic remains within the areas affected by construction. Suitable means to protect or remove significant remains will be determined in consultation with the archaeologist and the Hawaii State Historic Preservation Office."

Since the ulimate purpose of a reconnaissance survey of this type is to present recommendations for future actions, any criticism should at least suggest ways in which the report being criticised might have been different had the reviewer's suggestions been incorporated into the investigation process. In this case the reviewer has failed to do so, and indeed has even gone so far as to confirm our recommendations. One wonders why any comments at all were necessary, if he agrees with all of the conclusions presented anyway. This is especially so since his conclusions were not based on "explicit models," "explicit research designs," or "precise location data,", but rather on the very report which he claims is inadequate.

In sum, I see no need to alter any of the recommendations that were made in our report. If you need any further assistance, please don't hesitate to call.

Sincerely yours,

William Barrera, Jr.
President

COPY PLANNING DEPARTMENT COUNTY OF HAWAII
25 AUPUNI STREET HILO, HAWAII 96720

October 7, 1983

Mr. Susumu Ono, Chairman
Board of Land and Natural Resources
P. O. Box 621
Honolulu, HI 96809

Dear Mr. Ono:

Comments to Draft EIS
Kaumana to Keamuku 138 Kv
<u>Transmission Line</u>

Thank you for the opportunity to comment on this EIS especially as it relates to the pending CDUA for this project. In addition to affecting lands within the Conservation District, the project will also affect lands within the Agricultural and Urban Districts. In both the Agricultural and Urban Districts the proposed project would be a "permitted use" and only ministerial permits would be required.

HELCO proposes a 138 Kv cross-island transmission line from Kaumana to Keamuku as the first in a long-range series of actions to maintain system reliability and to provide for future growth. The eventual installation of a second 138 Kv cross-island transmission line, new substations at the terminal points, a 69Kv radial line, and conversion of the existing 69 Kv lines to 138 Kv lines are also planned.

Several of these actions affect lands within the Conservation District thus requiring compliance with Chapter 343, HRS. The level of specificity needed to evaluate the potential impacts cannot be found in this document as it is primarily a corridor study. Page 14 in Chapter II is concluded with the following statement: "Upon acceptance of the EIS and approval of the CDUA, detailed surveying and design will take about 18 months, and construction another 24 months." The biological, archaeological, and geological impacts, especially, cannot be evaluated until specific pole locations have been determined and surveyed by a biological, archaeological and geotechnical team.

Greater discussion should be devoted to the two new proposed substations at Kaumana and Keamuku. These substations are vital and must be in place before the 138 Kv line can be energized. Details should include site specific information on biology, archaeology, access, soil condition/characteristics, etc. These substation sites would need to be subdivided and will require access from new or existing roads.

Included in this document's Appendix are the reports prepared by specialized survey teams. These survey teams provided several recommendations which have neither been discussed nor discounted in the EIS. Thus, the "preferred alignment" appears to have been pre-selected and little or no adjustments made even after receiving recommendations from the special survey teams to deviate from the "preferred alignment." The preparer implies that further site specifics will surface as the project enters into the design and construction phases and that the necessary mitigation measures will be taken to minimize conflicts. Environmental impacts are difficult to weigh without site specific considerations.

Approximately 420 poles will be required (EIS, page 13), however, neither the number that will be situated within the fourteen (14) parcels listed as being within the Conservation District on Exhibit IV-2 on page 64 nor the number to be situated within the Agricultural and Urban Districts have been discussed. Is the reviewer being led to believe that a CDUA for the corridor may be followed by a CDUA for each pole site? The proposed staging areas also need to be evaluated as the Fulani Staging Area in particular also appears to be in the Conservation District.

We in the County of Hawaii are aware of the generation and transmission problems encountered by HELCO. Meeting West Hawaii's demand for electrical power is a high priority, however, it cannot be met at the sacrifice of biologically, archaeologically, or geologically, etc. sensitive resources. Until more details have been presented in a revised EIS, it is difficult to recommend a favorable position to the Board of Land and Natural Resources on the CDUA.

Again thank you for the opportunity to comment. Should you have any questions, please feel free to contact us at 961-8288.

Sincerely,

Sidney M Fuke

SIDNEY FUKE
Planning Director

RN/GU:gs

cc: Alva Nakamura
✓Norman Oss
Roland Higashi

October 19, 1983

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

Dear Mr. Fuke:

Subject: Environmental Impact Statement (EIS)
Kaumana-Keamuku 138 Kv Transmission Line

Thank you for the copy of your letter to Mr. Susumu Ono regarding the above. We are replying on behalf of Hawaii Electric Light Company, Inc.

By no means was the proposed route "pre-selected" or the recommendations of technical subconsultants ignored. Chapter II of the Routing Study clearly explains the step-by-step procedure for route selection. Technical subconsultants were given a tentative "preferred" alignment and several alternative alignments, developed on the basis of mapped data, for their reference in doing field work. They needed and requested this guidance. Major changes were made to the "preferred" alignment as the result of the field work and recommendations of the subconsultants and meetings with regulatory agency personnel. This can be checked by comparing the alignment maps which were displayed at the routing study workshops in November, 1982, with those which appear in the EIS and Routing Study.

All routing recommendations made by technical staff in regulatory agencies were followed. Only two of the subconsultant teams recommended specific alignments along portions of the corridor. An alternative alignment in Sections 5 and 6, due in part to the recommendation on page 13 of the report by Walter Lum and Associates. Numerous adjustments to the proposed alignment were made in Sections 1 through 3 in response to recommendations made by the Bishop Museum field team. In two instances, in Sections 3 and 4, the alignments recommended by Bishop Museum were not selected. Specific reasons for this are provided on pages 130 and 135 of the Routing Study. In Section 4, the proposed alignment was recommended by the State Division of Forestry and Wildlife. Both Dr. Andrew Berger, who headed the Palila

Recovery Team and served as the other biological subconsultant on the transmission line routing study, and the U. S. Fish and Wildlife Service, which has jurisdiction over the Palila Critical Habitat, agree that the proposed transmission line will have no significant adverse effect on the palila or its critical habitat. The Palila Critical Habitat was the primary concern of the Bishop Museum team in suggesting an alternative route in Section 4.

It is important to note that the construction method for the proposed transmission line was not determined until after the preparation of Bishop Museum's report. Their report concludes, on pages 21 and 22, that "minimum damage to native ecosystems would occur from construction and maintenance of the 138 Kv line by helicopter. This method would produce 'islands' of site-specific disturbance with more extensive disruption from additional construction of access and maintenance roads, with their subsequent negative indirect impacts." This, as well as a similar statement by the archaeological consultant, was a major factor in the decision to use the helicopter method of construction. Many of the other mitigation measures proposed in the EIS were developed directly from the recommendations of the technical subconsultants. EDAW provided a number of additional mitigation measures.

Conditions at specific pole sites are not a significant consideration in the evaluation of the CDUA. Each pole would consume a land area of only 2.36 square feet, so that all 420 poles in combination would cover a total of less than 1,000 square feet. As can be surmised from the table in Exhibit III-2 of the EIS (page 27), less than half this area - and fewer than half the poles - would be in the Conservation District. Moreover, the placement of poles is flexible. The sites can be shifted within the proposed easement a distance of up to 10 feet laterally and several hundred feet lengthwise. This is adequate allowance for any sensitive resources or difficult conditions which may be present in the area, since major areas of sensitivity or adverse conditions have already been avoided through the route selection process and method of construction. There is a practical difficulty, as well, in determining site-specific conditions at this stage. Normally, a CDUA is required for the detailed land surveying necessary to identify specific pole sites in the field and to take test bores and other samples. Pole sites could be pre-determined on the basis of standard spacing, but this would not be responsive to site conditions. The Board of Land and Natural Resources always attaches conditions to use permits for projects such as the proposed transmission line. It is expected that various technical staff in DLNR, principally in the Divisions of Forestry and Wildlife, State Parks and Historic Sites, Land and Water Development, and Land Management, will be involved in the review of detailed design plans to ensure that proposed mitigation measures are properly executed. All of these divisions have been consulted in the planning process and all concur with the proposed mitigation measures.

As indicated in the EIS and Routing Study, the new substations are not required until the proposed transmission line is energized to higher voltage in about 1995. They are not part of this CDUA. The survey of environmental conditions along the proposed alignment indicates no resources or conditions of unusual value or sensitivity at either location. The two proposed staging areas are described on page 11 of the EIS. The Keamuku staging area is also the site of the future 138 Kv substation and is adjacent to the existing substation on rocky grass lands which have previously been disturbed. The Kulani staging area is on barren a'a lava flow. Through comments by the Department of Accounting and General Services during the EIS review period, it came to our attention that three potential staging area sites may be available on the grounds of the Kulani Correctional Facility, within two miles of the Kulani substation. All three sites are in the Agriculture District, have previously been leveled and cleared of vegetation, and are presently unused. HELCO will ask permission from the State to use one or more of these sites in preference to the site near Kulani substation because of the easier road access. Given the temporary use of the staging areas and their low resource values, a detailed inventory of site conditions would not yield any information which would be useful in evaluating the CDUA. As a precaution, however, an archaeologist will inspect the staging areas prior to any land disturbance including the placement of temporary structures, heavy equipment and materials storage areas.

If you have any additional comments or questions on this matter, please feel free to call me.

Sincerely,

EDAW Inc.

John P. Whalen

John P. Whalen, AICP
Project Manager

JPW:lt

GEORGE R. ARIYOSHI
GOVERNOR OF HAWAII

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
P. O. BOX 621
HONOLULU, HAWAII 96809

SUSUMU ONO, CHAIRMAN
BOARD OF LAND & NATURAL RESOURCES
EDGAR A. HAMASU
DEPUTY TO THE CHAIRMAN

DIVISIONS:
AQUACULTURE DEVELOPMENT PROGRAM
AQUATIC RESOURCES
CONSERVATION AND RESOURCES ENFORCEMENT
CONVEYANCES
FORESTRY AND WILDLIFE
LAND MANAGEMENT
STATE PARKS
WATER AND LAND DEVELOPMENT

OCT 1983

REF. NO.: CPO-624
FILE NO.: HA-6/22/83-1554

Mr. Norman Oss, President
Hawaii Electric Light Co., Inc.
1200 Kilauea Avenue
P. O. Box 1027
Hilo, Hawaii 96720

RECEIVED
OCT 7 1983
EDAW Inc.

Dear Mr. Oss:

We have completed our review of the Draft Environmental Impact Statement submitted to the Environmental Quality Commission on September 6, 1983, relating to the proposed Kaumana to Keamuku 138 kv transmission line, Hawaii. Our comments are as follows:

1. A review of our records indicates that the proposed transmission line will not adversely affect any sites listed on the Hawaii or National Registers of Historic Places, or that have been declared Eligible for Inclusion on the National Register of Historic Places.

   We concur with the subject document's statement which proposes the following action:

   > "Proposed pole sites and any other surface areas that will be distributed by construction activities will be surveyed by an archaeologist, who will locate and describe any historic remains within the areas affected by construction. Suitable means to protect or remove significant remains will be determined in consultation with the archaeologist and the Hawaii State Historic Preservation Office." (Subject Document, 1983: 43)

2. With reference to Dr. Andrew J. Berger, it is stated that "according to the ornithologist who headed the Palila Recovery Team, the proposal to include Pohakuloa Flats in the Critical Habitat was made at a time when feral sheep were destroying the Mamane-Naio forest on Mauna Kea. The thought was to include the entire forest, even though it was known that Palila does not nest in Pohakuloa Flats area and that the Palila population moves upslope during the non-breeding season rather than downward to the Flats."

   To further clarify this statement, we wish to have it noted that the recommendation to include Pohakuloa Flats in the critical habitat is based on the fact that the area is a part of the palila's historic range and is essential for the expansion of the present Mauna Kea population, which is necessary for getting the palila off the endangered list.

3. Although the absence of endangered birds nesting in the vicinity of the alignment near Pohakuloa Flats is mentioned (p. 40), the Endangered Species Captive Rearing Facility (ESCRF) is overlooked as being in the vicinity. The ESCRF is mentioned by Dr. Berger on page 24 of the Bird and Mammal Report and it is his feeling that the presence of the new line would not bother the project. This is true, however, the disturbance caused by the "heavy lift helicopter" operating nearby during alala reproductive seasons could be devastating. Consideration must be given to doing the work by other means if alala nesting season (April through August) is in progress when the nearby segment of the transmission line is to be built.

4. Statements made in the EIS and Dr. Berger's report discount the probability of in-flight collisions between birds and the new transmission line. Nene geese were found dead along the Powerline Road transmission line as many as three years after it was built. The Keauhou-Puu O'o flyway was traveled by nene at night as well as daylight hours. Although the new transmission line will be near enough to an existing line the birds already are aware of, the new line will be 15 feet higher (page 52). A new flyway has developed for nene between pastures in Humuula, Kipuka Ainahou and Puu 6677. Although mitigation may not be possible, the corridor should be monitored for fallen nene.

5. Prevention of soil erosion is a primary concern. This is addressed and mitigation measures proposed. Use of heavy lift helicopters in place of ground transportation should minimize impacts. We note a continuous construction road will not be required; however, temporary vehicular access for construction crews will be necessary. Although existing roads and trails are to be used where possible, the number, location and length of new access roads should be discussed.

6. Blasting or use of air hammers will be required in areas where soil conditions preclude augering. This also appears to be necessary at sites which are not accessible to the truck mounted drilling equipment. The number and location of sites requiring blasting or use of air hammers should be discussed as well as the various impacts anticipated from their use. Public safety measures in blasting areas should also be considered, i.e., media announcements and posting of areas where blasting is to occur.

CPO-624
HA-1554

7. Review of the EIS has served to clarify the proposal especially in the context of the long range plans. However, we note that HELCO apparently intends to maintain the existing 69 kv line even after the future 138 kv line (fifth cross-island line) scheduled to be operational in 1995 is completed. Is this indeed what is intended? A justification for the need to maintain three parallel lines should be presented.

8. Although placement of the transmission line underground is discussed under alternatives (pg. 69), further discussion of underground placements, impacts, and mitigation measures may be advisable since a portion of the route crosses through the area covered under the Board of Land and Natural Resources' Mauna Kea Plan, which prohibits overhead transmission lines. Full disclosure of anticipated impacts would enable the Board of Land and Natural Resources to fully consider the required underground placement and the applicant's requested amendment to allow an overhead line through this area.

For your records, review and response, we are attaching a copy of comments received by DLNR to date, to ensure that responses are provided for all comments received.

We hope that the foregoing comments will enable you to revise the draft EIS where appropriate. We further hope that our suggestions will be reflected in the revised document.

Very truly yours,

SUSUMU ONO, Chairperson
Board of Land and Natural Resources

Attachments

cc: Alva Nakamura, HELCO
OEQC
EDAW, Inc.

October 19, 1983

Mr. Susumu Ono, Chairman
Board of Land and Natural Resources
P. O. Box 621
Honolulu, Hawaii 96809

Dear Mr. Ono:

Subject: Environmental Impact Statement (EIS)
Kaumana-Keamuku 138 Kv Transmission Line

Thank you for the copy of your letter to Mr. Norman Oss, Hawaii Electric Light Company, Inc., (HELCO), regarding the above. We are responding directly to your comments on behalf of HELCO. The following responses are numbered in the sequence of your comments.

1. Your concurrence with the proposed mitigation program for possible archaeological sites is noted.

2. Your clarification regarding the inclusion of Pohakuloa Flats in the Palila Critical Habitat is noted. This is not inconsistent with Dr. Berger's comment. A letter from the U. S. Fish and Wildlife Service, contained in these pages, states that it has determined, through Section 7 consultation, that the proposed transmission line will have no significant adverse effect on the palila or its critical habitat.

3. The Endangered Species Captive Rearing Facility (ESCRF) is approximately 1,400 feet from the nearest point along the proposed transmission line alignment. Since sound is reduced by 6 decibels for each doubling of the distance from the source, the noise from a hovering helicopter would generate a maximum of about 70 dBA. This is within the range of ambient noise levels in a typical urban environment. The ESCRF is located directly underneath the approach/departure zone of Bradshaw Airfield and is therefore exposed to noise from overhead helicopters and jets on a long-term basis. For this reason, the helicopter noise during construction of the proposed transmission line was not given special attention in the EIS. Thank you for

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1121 Nuuanu Avenue, Suite 203, Honolulu, Hawaii 96817 Telephone (808) 536-1074

pointing out this concern. HELCO is willing to schedule helicopter operations to avoid the nesting season of the alala and will coordinate this activity with your Division of Forestry and Wildlife.

4. Most of the normal range of the nene is south of Saddle Road. The Powerline Road transmission line is south of Saddle Road in the vicinity of the nene breeding area and transects the new flyway described in your letter. The potential for in-flight collision is therefore probably greater in this area than along the proposed transmission line, which is north of Saddle Road. While the new flyway includes the Humu'ula pastures, this area is at the northern edge of the nene's normal range. This matter was discussed further with both Dr. Berger and Mr. Ronald Bachman, DLNR biologist on the Island of Hawai'i, subsequent to receiving your comments. Both agree that the potential collision hazard is substantially reduced by locating the proposed transmission line adjacent to the existing 69 Kv transmission line through the Humu'ula pasture and that the height difference of 15 feet would not create a significant additional hazard. HELCO's maintenance personnel will be made aware of the concern about in-flight collisions and instructed to report any incidents they may discover to your Division of Forestry and Wildlife.

5. Since the proposed transmission line will be adjacent to the existing 69 Kv line for two-thirds of the route and the existing transmission poles are already accessible by vehicle, no new access roads are anticipated along this portion of the route. The remaining third of the route, where the alignments of proposed and existing lines diverge, is primarily in Section 1 (near Kaumana) and Section 6 (near Keamuku). For the first two miles of the alignment in Section 1, it is possible to take advantage of an existing street and a firebreak to gain access to the pole sites. From Mile 2 to Mile 4, a new access road is necessary. The land cover in this portion, mostly in the State Agriculture District, consists of a mix of grasslands and young ohia growth. Soils are rated by the U. S. Soil Conservation

Service (USSCS) as having low erosion hazard potential. In Section 5 and 6, a new 10.2 mile alignment is proposed. A new access road will be necessary to construct approximately 3 miles of this portion, which crosses pasture owned by Parker Ranch and the scrub-covered Pu'u Ke'e Ke'e Game Management Area. State game management personnel favor the construction and maintenance of an access road, as noted on page 166 of the Routing Study. Soils through the alignment of the new access road are rated by the USSCS as having low erosion hazard potential. In Section 3, there is a stretch of about 2.1 miles where the proposed alignment is north of the existing line at a range of 2000 to 3500 feet and there is not adjacent access road. Other means of ground access will be necessary in this portion. It appears that a four-wheel drive vehicle can traverse the open-canopied ohia forest in this stretch, which is in the State Agricultural District and contains soils rated by the USSCS as having low erosion hazard potential.

6. The exact number of pole sites which will require blasting cannot be determined without a soil sample and analysis of each of the approximately 420 pole sites. This normally follows the issuance of a CDUA. Based on preliminary soil reconnaissance studies by Walter Lum and Associates, Inc., and the experience of HELCO personnel in constructing the adjacent 69 Kv line, it is assumed that a majority of the pole sites, certainly all of those on recent lava flows, may have to be excavated with the use of blasting or air hammers. The air quality and noise impacts of blasting activities are described on page 41 of the EIS. The remoteness of most of the proposed blasting sites and the rather limited extent of blasting required to imbed the 1.5-foot diameter poles a depth of about 9 feet will preclude the creation of a major public nuisance or safety hazard. The objective is to excavate a hole as close as possible to the pole dimensions so that the surrounding material can act as a solid support for the pole base. This type of operation is fairly common on the Island of Hawaii, even in residential areas. In many sections, for example, blasting is done on residential lots to excavate cesspools of larger dimension than the proposed pole holes. The typical procedure for excavating a hole of this type is to drill a hole

large enough for a shaped charge. The excavation site is covered by a "blast blanket" to prevent flying debris and muffle the sound. The contractor will be licensed to do blasting and be required to carry out additional precautions as necessary, such as publishing notices of proposed blasting work, the marking of blasting areas, and the control of traffic along roadways near blasting sites.

7. As noted on pages 67 through 69 of the EIS, under the section titled "Voltage Alternatives", once the fourth and fifth cross-island lines are energized at 138 Kv, it would be possible to shut down any of the first three cross-island lines for maintenance. Nevertheless, these three lines, including the existing 69 Kv line near Saddle Road, will be needed to accommodate anticipated load growth. In addition, there are several customers at Waiki'i, Pohakuloa and Mauna Kea who are presently served by the 69 Kv line. If this line were removed, at least one additional 138 Kv substation would be required along the proposed route to serve these customers, which is undesirable for operations and cost reasons.

8. Written testimony regarding the underground requirement in the Mauna Kea Plan area was submitted to the Board of Land and Natural Resources on July 7 and August 25, 1983. A consolidated statement is attached for incorporation into the EIS.

If there are any additional comments or questions on this matter, please feel free to call me.

Sincerely,

EDAW, inc.

John P. Whalen

John P. Whalen, AICP
Project Manager

JPW:lt

Attachment

SUMMARY ANALYSIS OF THE UNDERGROUND ALTERNATIVE THROUGH THE MAUNA KEA PLAN AREA

The proposed alignment for the 138 Kv transmission line is immediately adjacent to an existing overhead 69 Kv transmission line for the entire distance through the Mauna Kea Plan area. The existing line, which is sited more than 3000 feet lower than the Hale Pohaku mid-level facility and 6000 feet lower than the summit, has been in place for 30 years. During that time, the operation of the line has had no discernible adverse effect on the surrounding environment. This has been confirmed in a report by Dr. Andrew Berger, a prominent biologist who headed the Palila Recovery Team and is very knowledgeable about the ecology of the Mauna Kea area. The U. S. Fish and Wildlife Service has concurred that the proposed overhead 138 Kv transmission line would have no significant adverse effect on the palila or its critical habitat.

If the proposed 138 Kv line were to be undergrounded, it would have far greater impact on the surrounding environment than an overhead line would. Undergrounding would require the clearing and grading of the entire length and width of the proposed easement and the excavation of a trench in which to bury an oil-filled cable. (See attached photo exhibits.) The general characteristics of underground cable systems and their potential environmental impacts are discussed in Chapter III of the Routing Study. In this particular case, the consequences of clearing, grading and excavation would be especially severe, for the following reasons:

- The proposed alignment passes through stretches of native mamane-naio forest. Clearing of vegetation along the entire easement would significantly reduce the habitat of endemic insects and birds. It would also promote the introduction of exotic species, and therefore have adverse biological impact over the long term. Moreover, it would be necessary to keep the easement free of major vegetative growth in order to permit access to the underground cable and prevent damage from root penetration. This would require frequent maintenance, thereby increasing the degree of disturbance to the area. In contrast, an overhead line would entail disturbance to much more limited areas, essentially confined to pole sites, and maintenance would be much less frequent and extensive. Even mature mamane trees, which are the tallest vegetation in the area, could remain within the easement because there would still be sufficient clearance for the overhead conductors.

- Most of proposed alignment through this area cuts laterally across the slope of Mauna Kea. Consequently, earthwork for the construction of an underground cable would have to be quite extensive. As shown in the attached exhibits, the area adjacent to the trench for the underground cable must be graded to a relatively level cross section to allow safe and efficient operation of the excavation and cable installation equipment. Thus, not only the vegetation would be uprooted and removed with the cut and fill, but the landform itself would change. Since the alignment crosses several gullies, some of these drainageways may even need to be reinforced with rock and concrete to stabilize the slopes where soil has been exposed. In contrast, the construction of an overhead line would not require this extensive grading and leveling, particularly if a heavy-lift helicopter is used. Pole sites can be placed to avoid gullies and soil erosion hazards.

- The excavation of a trench in this area may be quite difficult because of the preponderance of hard volcanic rock. A reconnaissance of this area by Walter Lum and Associates found only a shallow soil and ash cover over the rock. Blasting will be required for the placement of transmission poles. If an underground cable were installed, blasting would probably be required to excavate most of the trench. This would create high noise levels and air quality impacts in the form of particulate emissions and dust over a sustained period.

Two possible environmental advantages might be claimed for the underground cable alternative. First, that the underground cable would have less visual impact and, second, that it would eliminate the possibility of fire hazard. On closer examination, however, these are at best marginal advantages.

While the cable itself would not be visible, its path would be quite obvious due to the extensive clearing and alteration of the land form. Most the present overhead transmission line through Mauna Kea Plan area is not visible from Saddle Road or from higher vantage points on Mauna Kea, such as Hale Pohaku or the summit. At a distance, the poles and conductors tend to disappear against the backdrop. Photos G, H and I in Exhibit III-1, Sheet 4, of the EIS show views from Saddle Road looking toward Mauna Kea and the existing 69 Kv line. There is no evidence of the existing 69 Kv in these views through the Mauna Kea Plan area. The proposed line would be equally unobtrusive. A cleared easement for the underground cable, on the other hand, would create a visible swath on the landscape.

Reduced fire hazard is likewise not a clear benefit. There has never been a fire incident caused by any of HELCO's 69 Kv transmission lines. Any damage or disturbance to a transmission line, such as the downing of a conductor, causes the system to "trip out". The breakers open at the substations at either end of the line, stopping the flow of electricity. The relay mechanism for

the proposed 138 Kv line will cause the breakers to open within a third of a second, which would be well before any possible contact between a fallen conductor and flammable plant material. An underground cable, while not really offering substantial fire protection benfits, raises the possibility of another kind of hazard; namely, oil leakage from a rupture in the cable. Subsurface oil see page could be very difficult to detect and repair, and could have significant long-term impacts on the ecology of an area such as lower Mauna Kea.

Thorough consideration has been given to routing alternatives for the proposed 138 Kv transmission line, as documented in the Routing Study report. All of the alternative detailed alignments described in Chapter VI of the Routing Study pass through the Mauna Kea Plan area. Alignments on the south side of Saddle Road, avoiding the Mauna Kea Plan area, are not possible because of the U.S. Army's highly restrictive "impact zone" and the flight patterns for Bradshaw Airfield. Even an underground cable would not be possible through the "impact zone". In addition, the south side of Saddle Road is generally more susceptible to lava flows from an eruption of Mauna Loa, which is clearly a possible occurrence, and contains several areas of environmental sensitivity. A large area just south of Saddle Road is in the Protective Subzone.

In conclusion, the route crossing the Mauna Kea Plan area was selected after exhaustive study of various environmental, cost and regulatory constraints, with broad agency and community participation in the planning process. The decision to build an overhead line rather than underground cable was made at an early stage in the process, by November of 1982, with general concurrence expressed at both public agency and community workshops. The costs of installing an underground cable through the Mauna Kea Plan area would be prohibitively high, approximately six to twelve times higher than those of an overhead line. Undergrounding the alignment through the Mauna Kea Plan area would therefore add approximately \$12 to \$24 million to the project cost. Moreover, undergrounding would not be desirable for a transmission line whose primary purpose is to provide system reliability. The costs to ratepayers cannot be justified, particularly when the environmental disadvantages, as has been shown, outweigh any conceivable advantages of an underground cable.

Figure 4-36. Vegetation may be disposed of by burning in pipeline installations. Cleared right-of-way is about twice as wide as is necessary for a single-circuit underground transmission line.

Figure 4-37. Grading is required in cleared areas to remove stumps and prepare the surface for trench excavating equipment as shown in this petroleum pipeline construction.

Figure 4-38. Extensive grading is required to create a level working area in steep terrain as shown in this example of a natural gas pipeline construction project.

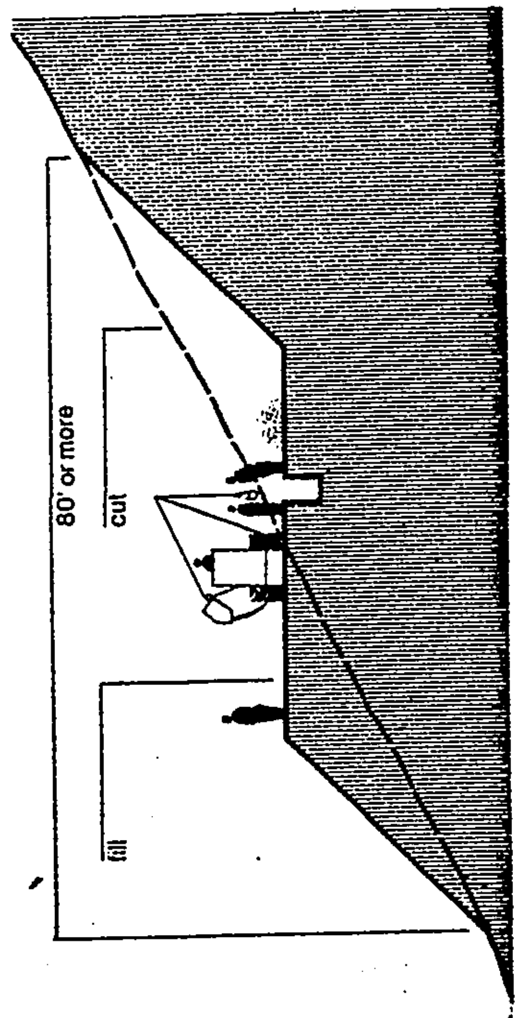

Figure 2-34. Right-of-way requirements during construction on steep slopes

TRANSMISSION LINE ROUTING STUDY

Kaumana to Keamuku

138 KV Line

HELCO

TRANSMISSION LINE ROUTING STUDY

Kaumana to Keamuku

138 KV Line

Prepared for:

Hawaii Electric Light Company, Inc.

Prepared by:

EDAW inc.

February 1983

PREFACE

This report represents a new approach for the planning of Hawaii Electric Light Company's (HELCO) major facilities. It documents a study process which begins with an analysis of HELCO's system requirements, establishing the need for transmission system improvements, and concludes with the selection of a transmission line route. Route selection is based on an analysis of environmental, social and economic factors, including an extensive review process in which a large number of public agencies, all affected landowners and virtually every resident on the Island of Hawaii was invited to participate.

A portion of the selected route crosses the State Conservation District, which requires the issuance of a conditional use permit by the Hawaii State Board of Land and Natural Resources. This, in turn, requires the preparation of an Environmental Impact Statement (EIS), describing the potential environmental effects of a 138 Kv transmission line along the selected route and the measures which will be taken to reduce or avoid adverse effects on the environment. Careful route selection is an effective way to avoid adverse effects on the physical and social environment from the outset. This report on the route selection process is, therefore, an important precursor to the environmental and permit review process and serves essentially as an appendix to the EIS.

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EXHIBITS

Glossary

TERM	DEFINITION
A'a (lava flow)	A rough-surfaced lava flow consisting of layers of jagged fragments of clinker. Pahoehoe lava flows often change to a'a as they advance downhill.
Alignment	The route of a proposed transmission line as depicted on detailed maps.
Archaeological site	Physical evidence of human habitation in Hawaii prior to the first recorded contact with Western explorers (i.e., A.D. 1778).
Circuit	A conductor or system of conductors through which electric current is intended to flow.
Coastal high hazard area	Areas which are susceptible to inundation due to storm waves, tsunamis, subsidence and continuous erosion on a frequency greater than once in every 100 years.
Conductor	The wire or cable suitable for carrying electric current.
Constraint	A condition which discourages, but not necessarily precludes, a transmission line route.
Corridor	A broad, linear area which provides ample space for delineating and studying several alternative alignments for a proposed transmission line.
Critical habitat	Areas with a special combination of altitude, climate, plant material and other conditions constituting an ecosystem which is essential to the survival of certain species of animals or plants.
De facto population	The number of people physically present in area, regardless of usual place of residence; it includes visitors present but excludes residents temporarily absent.

TERM	DEFINITION
Diadromous fish	Fresh water fish which migrate to salt water to spawn.
Distribution	The act or process of delivering electrical energy from the generation and transmission system to the consumer.
Easement	An interest in land that entitles its holder to a specific land use, such as a transmission line.
Endemic species (of plants or animals)	Plants and animals which are restricted to a particular area or region and are found nowhere else.
Flashover	An abnormal electrical discharge from the transmission conductors through the air to the ground or to other conductors.
Flood zone, 100-year	An area where the probability of inundation of stormwaters is greater than one percent in any given year.
Fossil fuel	A deposit of organic material containing stored solar energy that can be used as fuel. The most important are coal, natural gas, and petroleum.
Geothermal energy	The internal energy of the earth, available as heat from heated rocks or water.
Generation capacity	The nominal power output of a production facility, often measured in watts or megawatts.
Groundwater aquifer	A saturated underground body of rock or similar material capable of storing water and transmitting it to wells or springs.
Instantaneous peak load	The maximum power output of a generating unit in any given year.

TERM	DEFINITION
Intermittent stream (or water body)	Definite depressions, basins or channels where water is present on a periodic or seasonal basis, usually after a period of high rainfall.
Kilovolt (or Kv)	One thousand volts; a volt is a unit of electrical potential difference and electromotive force.
Kipuka	Hawaiian term for an area of older vegetation which is surrounded by relatively recent lava flows.
Load	The amount of electric power delivered or required at any specified point or points on a system. Load originates primarily at the power consuming equipment of the consumers.
Mauka	Hawaiian word for inland.
Megawatt (or mw)	One million watts; a watt is the absolute unit of electrical power equal to the rate of work represented by a current of one ampere under a pressure of one volt.
Native species (of plants or animals)	Plants and animals which are present in an environment and were not introduced to that type of environment by humans.
Nominal capacity (of a transmission line)	The load which a line is expected to carry under normal conditions. Transmission lines are designed for a higher than nominal capacity in order to carry higher loads under emergency conditions.
Opportunity	A favorable juncture of conditions for a transmission line route.

TERM	DEFINITION
Pahoehoe (lava flow)	A smooth-surfaced lava flow, often with wrinkles formed by the movement of liquid lava beneath a cooler but still-plastic crust. The liquid lava sometimes leaves subsurface hollow tubes with diameters of up to 50 feet.
Peak load	The highest portion of demand, usually that occurring less than 10% of that time.
Perrenial stream (or water body)	Depressions, basins or channels where water is present year round in a volume sufficient to sustain aquatic animal and plant life on a continuous basis.
Prime agricultural land	Land which is best suited for the sustained high-yield production of food, feed, forage and fiber crops.
Pu'u	Hawaiian term for a hill, peak, or mound.
Radial circuit (of transmission circuits)	A branch line of the transmission system, usually carrying lower voltages.
Rare and endangered species	Rare species or subspecies are animals or plants which are in such limited numbers throughout their range that they may become endangered if their environment worsens. Endangered species are threatened with extinction. Both terms have a legal definition and are used here in that sense.
Registered historic site	The legal recognition of an historic property. The National and Hawaii Registers of Historic Places are planning tools used to assess, but not necessarily prevent, the potential impact of a publicly funded, licensed or permitted activity on the cultural resources or heritage of the State.

TERM	DEFINITION
Rift zone	A system of fractures and faults in the earth's crust.
Seismic	Pertaining to an earthquake or earth vibration, including those that are artificially induced.
Substation	A subsidiary station in which electric energy is transformed. It is often combined with a switching station. (See below)
Subtransmission line	A conductor which transmits electric energy from a transmission substation or switching station to a distribution substation.
Switching station	A subsidiary station in which electrical energy is switched from one circuit to another. It is often combined with a substation. (See above)
Transmission	The act or process of transporting electrical energy in bulk.
Unique agricultural land	Land other than prime agricultural land which has the special combination of conditions that favor the production of specific high-value good crops such as coffee, taro, rice, watercress and non-irrigated pineapple.
Viewshed	The area which can be seen from a given point of view.
Watershed (critical)	Areas at higher elevations with dense tree cover which extract from the moist trade winds that pass over them much more rainfall than would otherwise fall, thus contributing to stream flow and groundwater recharge.

TERM	DEFINITION
Wetland	Land area where water is the major factor in controlling the development of soils and the development of the vegetative cover, if any.

Chapter

CHAPTER I: SYSTEM REQUIREMENTS

A. LOAD GROWTH

Energy consumption on the Island of Hawaii grew significantly in the fifteen years between 1965 and 1980. The Hawaii Electric Light Company (HELCO), which is the sole public utility company and the major provider of electric energy for the island, recorded a system load growth of over 175 percent during this period.[1] Today, HELCO's system load is about 90 megawatts (mw).

HELCO's service area is divided into the following six regions: Hamakua (North); Hilo (East); Puna (Southeast); Ka'u (South); Kona (West); and Kohala (Northwest). The recorded load in megawatts between 1965 and 1980 for each of these service regions is depicted in Exhibit I-1. Although the Hilo region has consistently had the largest load, the Kona region has experienced a much higher rate of load growth.

B. SYSTEM DESCRIPTION

HELCO generates power at several locations and connects these generating resources to its customer loads via transmission lines and distribution lines. Exhibit I-2 illustrates how HELCO's system evolved between 1965 and 1980 in response to customer load growth over this period. Exhibit I-3 shows the generation and transmission system as it exists today.

HELCO's generation system presently has a total firm capacity of 124 megawatts. Although HELCO owns most of the generating resources in this system, some are privately owned, such as the bagasse-burning generators at the Puna (Amfac), Hamakua (T. H. Davies) and Pepe'ekeo (Hilo Coast Processing) plantations. About 60% of HELCO's total energy is generated from fossil fuels; i.e. industrial fuel oil and diesel oil. The remainder is generated from renewable energy resources, which at this time include geothermal, hydroelectric and bagasse. Most of the system's generating resources

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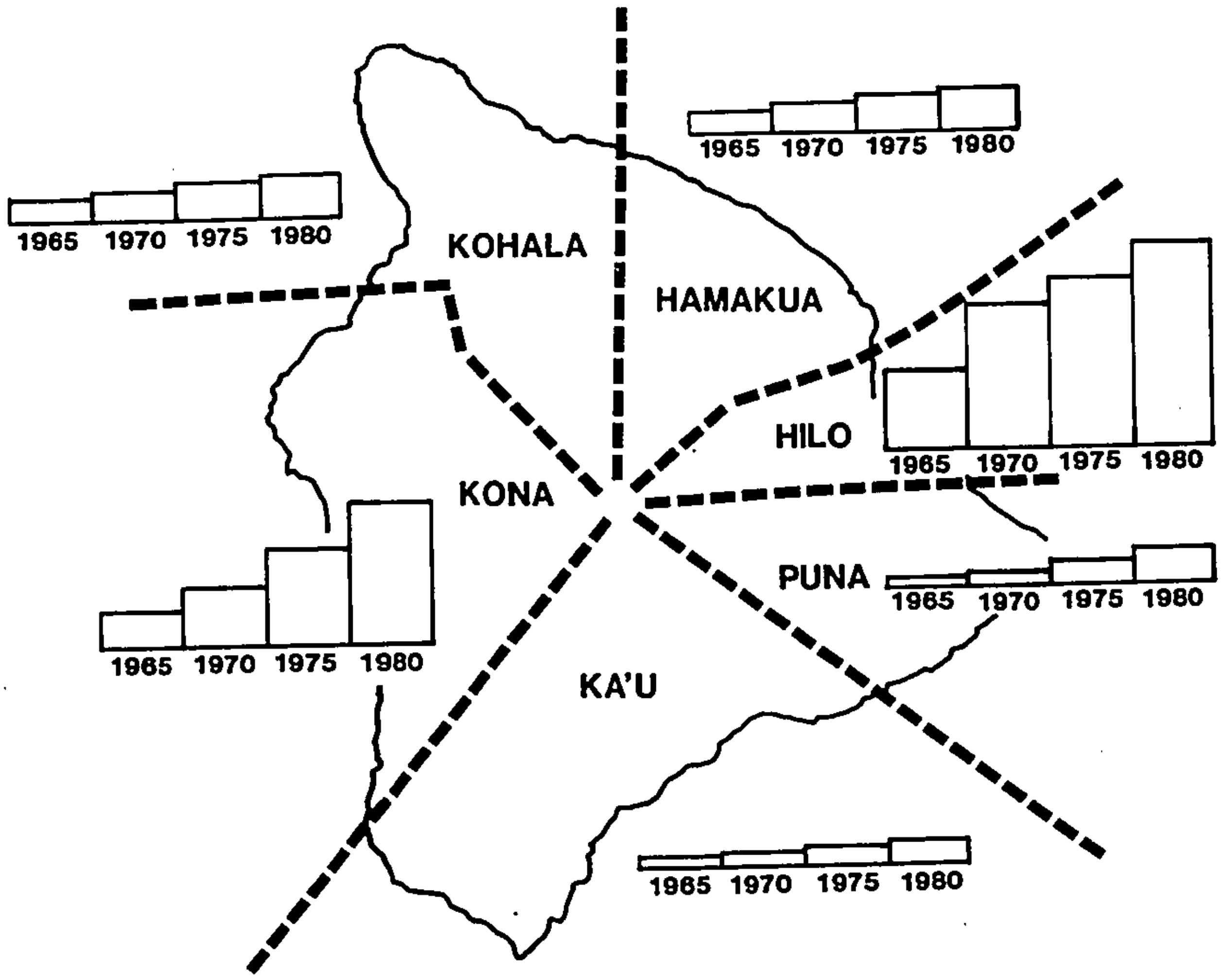
[1]Load, as used here, means instantaneous peak load. Total system load is recorded continuously at each generation unit, and the maximum recorded each year is reported as the instantaneous peak load. Peak loads at each substation also are recorded so that regional loads can be calculated.



REGION	LOAD IN MEGAWATTS 1965	1970	1975	1980	RATE OF GROWTH 1965-1980	1975-1980
HAMAKUA	3.826	4.889	6.424	6.632	73.3%	3.2%
HILO	14.213	26.886	33.150	37.383	163.0%	12.8%
PUNA	1.256	1.832	4.483	6.254	398.1%	39.5%
KA'U	1.812	2.048	2.397	2.886	59.3%	20.0%
KONA	6.179	10.400	17.987	25.770	317.1%	43.3%
KOHALA	3.974	4.845	6.559	7.375	85.6%	12.4%
TOTAL LOAD	31.260	50.900	71.000	86.300	176.1%	21.6%

EXHIBIT I-1:
LOAD GROWTH BY REGION, 1965-1980

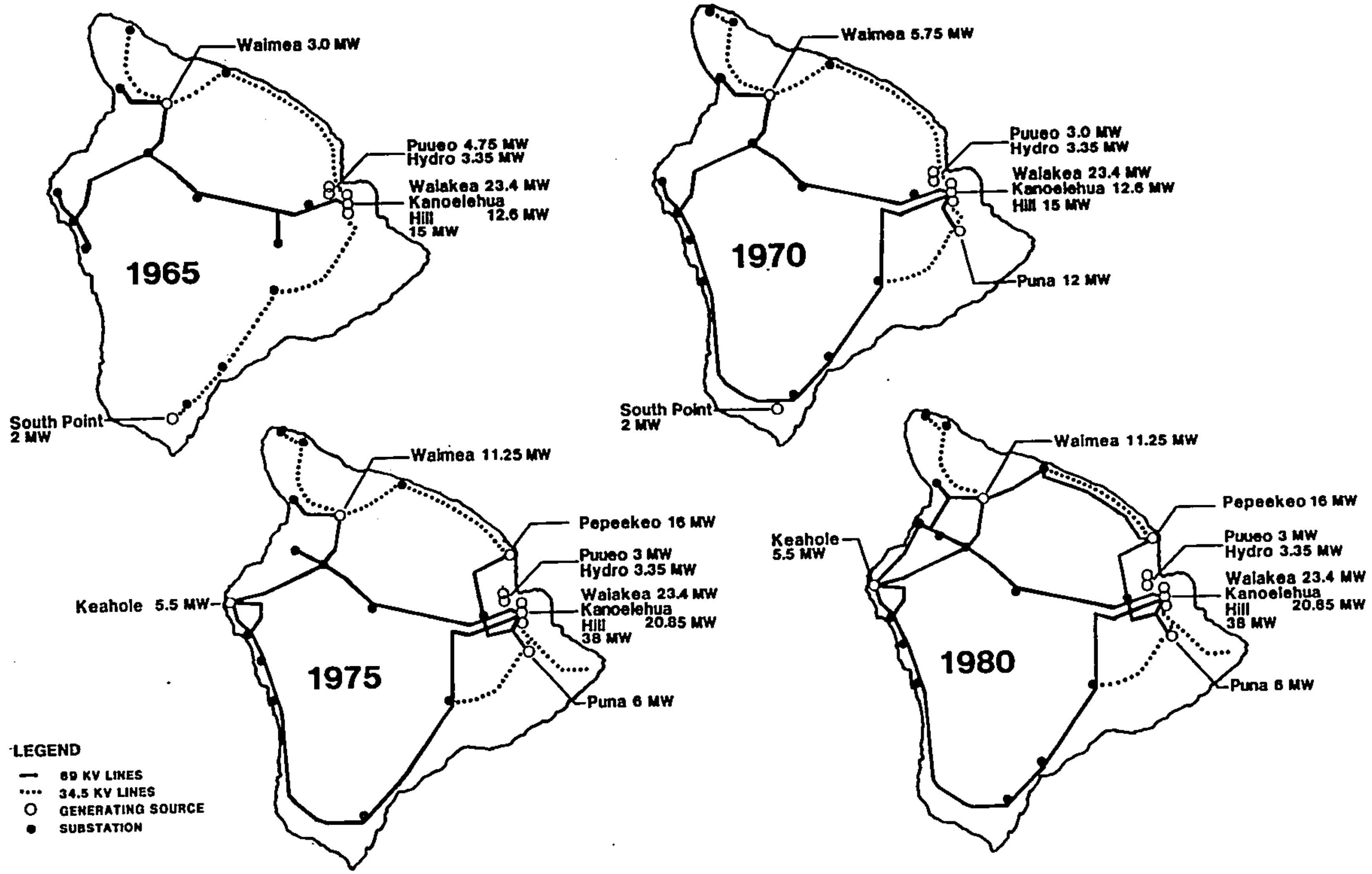


EXHIBIT I-2:

GENERATION AND TRANSMISSION SYSTEM, 1965-1980

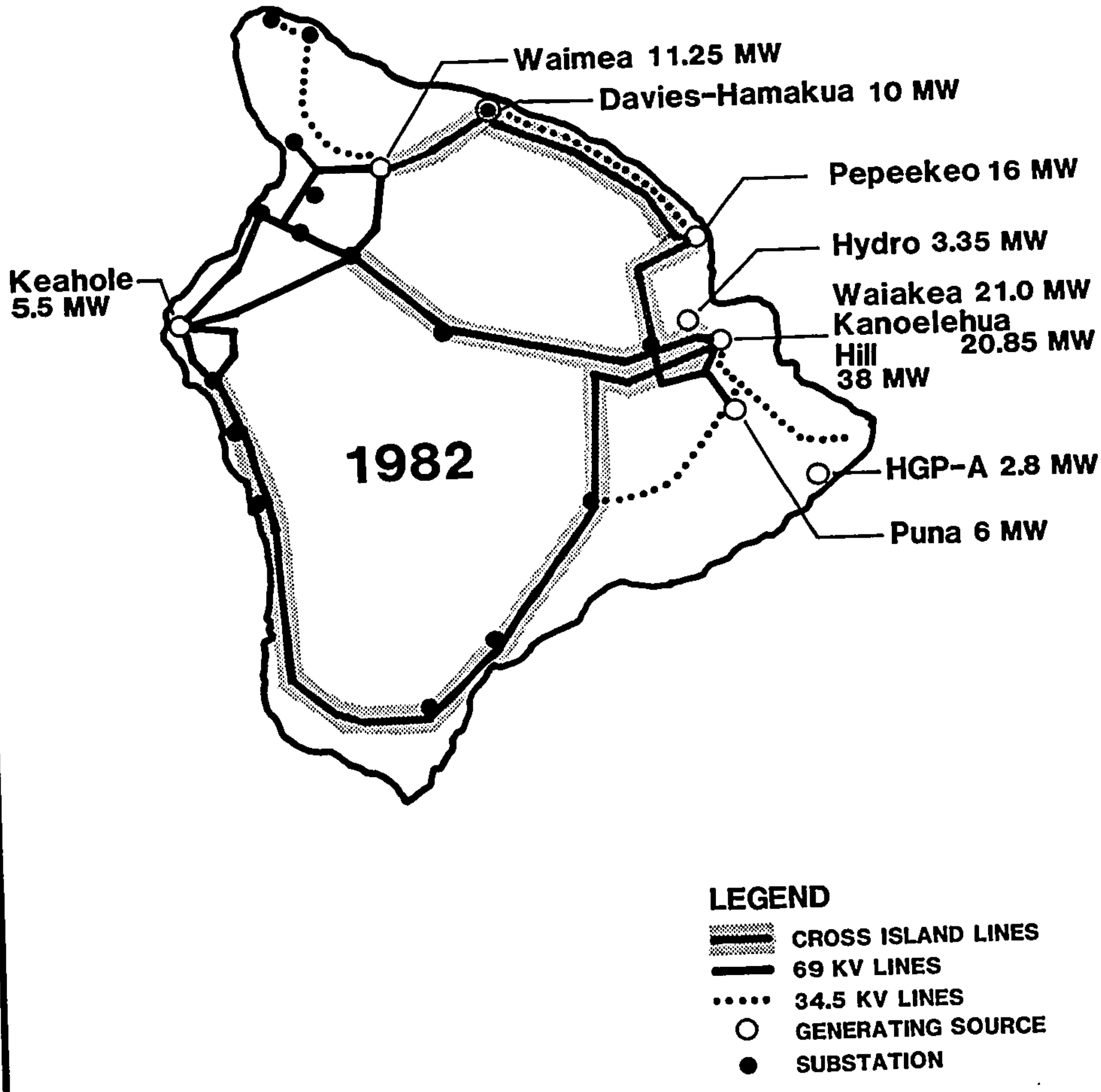


**EXHIBIT I-3:
GENERATION AND TRANSMISSION SYSTEM, 1982**

are located on the east (Hilo) side of the island, whereas load has grown faster on the west (Kona) side.

Connecting today's loads and resources is a 2,800 mile long system of transmission and distribution lines. There are three existing cross-island transmission lines, all energized at 69 kilovolts (Kv). The cross-island lines were added incrementally between 1965 and 1980 as load increased on the west side of the island. The cross-island line along the northern part of the island connects Pepe'ekeo to Waimea via Honoka'a and has a nominal capacity of 12 mw.[2] Crossing the middle of the island along Saddle Road is a line with a nominal capacity of 12 mw connecting Kaumana with Keamuku. Along the southern end of the island is a line with a nominal capacity of 8 mw connecting Kanoelehua to Keauhou via South Point. These lines are interconnected with a network of 69 Kv lines, as shown in Exhibit I-3. The 34.5 Kv subtransmission lines are radial or deadend lines serving loads for small communities located some distance from the routes of the 69 Kv lines.

C. SYSTEM RELIABILITY

The State of Hawaii Public Utilities Commission has standards for electric utility service, some of which are contained in Appendix A. HELCO establishes criteria for transmission system planning which assure reliable electric service meeting these State standards.

To meet the requirements for reliability, HELCO seeks to maintain delivery of energy at proper voltage from the generating resources to the loads even with the loss of a major transmission line during peak loads. When all or a portion of a major transmission line goes out, the event is referred to as a single contingency outage. HELCO must guard against two potential consequences of a single contingency outage: (1) it must carry the load without exceeding the emergency rating[3] of the line, and (2) it must maintain voltage within 10% of normal. Failure to do either of these may cause an interruption of service. The length and

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[2]"Nominal capacity" means the load which the line is expected to carry under normal conditions.

[3]"Emergency rating" refers to the overload which a line can carry without creating permanent damage to the line or the electrical system.

extent of service interruption depends on the location and severity of the single contingency outage.

Using latest substation readings, HELCO routinely analyzes whether or not the system will meet the requirements for reliability. Although there is sufficient transmission capacity when all lines are in operation, a single contingency outage at several locations within the present system would cause low voltage (i.e., less than 90 percent of normal voltage) conditions as illustrated in Exhibit I-4. When an outage occurs along the southern line between the Kilauea and Honuapo Substations, low voltages in Kealia, Keauhou, and Kam Development result, and if between Kilauea Substation and Junction B, low voltages in Kilauea, Kealia, Keauhou, and Kam Development result, as illustrated in Appendix B. Low voltages in Kealia, Keauhou, Kam Development, Kailua, Kawaihae and Waimea result when an outage occurs along the northern line between Waimea Power Plant and Honoka'a Substation.

This analysis shows that improvements to HELCO's system are needed now to prevent these low voltage situations from occurring and to meet requirements for reliability. In order to determine the proper system improvement, HELCO takes future needs into account by anticipating how much, when and where additional amounts of electric energy will be required and produced.

D. FUTURE LOADS AND RESOURCES

Factors considered in making a load forecast are the past records of load and population growth plus whatever is known about future plans such as new developments or new industries. Uncertainties make accurate forecasting difficult. What is the future of large industries such as sugar and macadamia nuts? How will the tourist industry develop, especially in the Kona region? Will industries with large loads be attracted if large geothermal reserves prove feasible for development? These are some questions for which there are no definite answers. In its most recent forecast, HELCO has estimated a range of future loads, from the least to the most which might be expected, as shown in Exhibit I-5. The most likely scenarios for 1985 and 1990 are based on an estimated annual load growth rate of two percent, which is lower than the rate of growth over the past 15 to 20 years. Also shown in Exhibit I-5 is a breakdown of the projected load by region. These data are represented as rates of load growth by region in Exhibit I-6. As in the recent

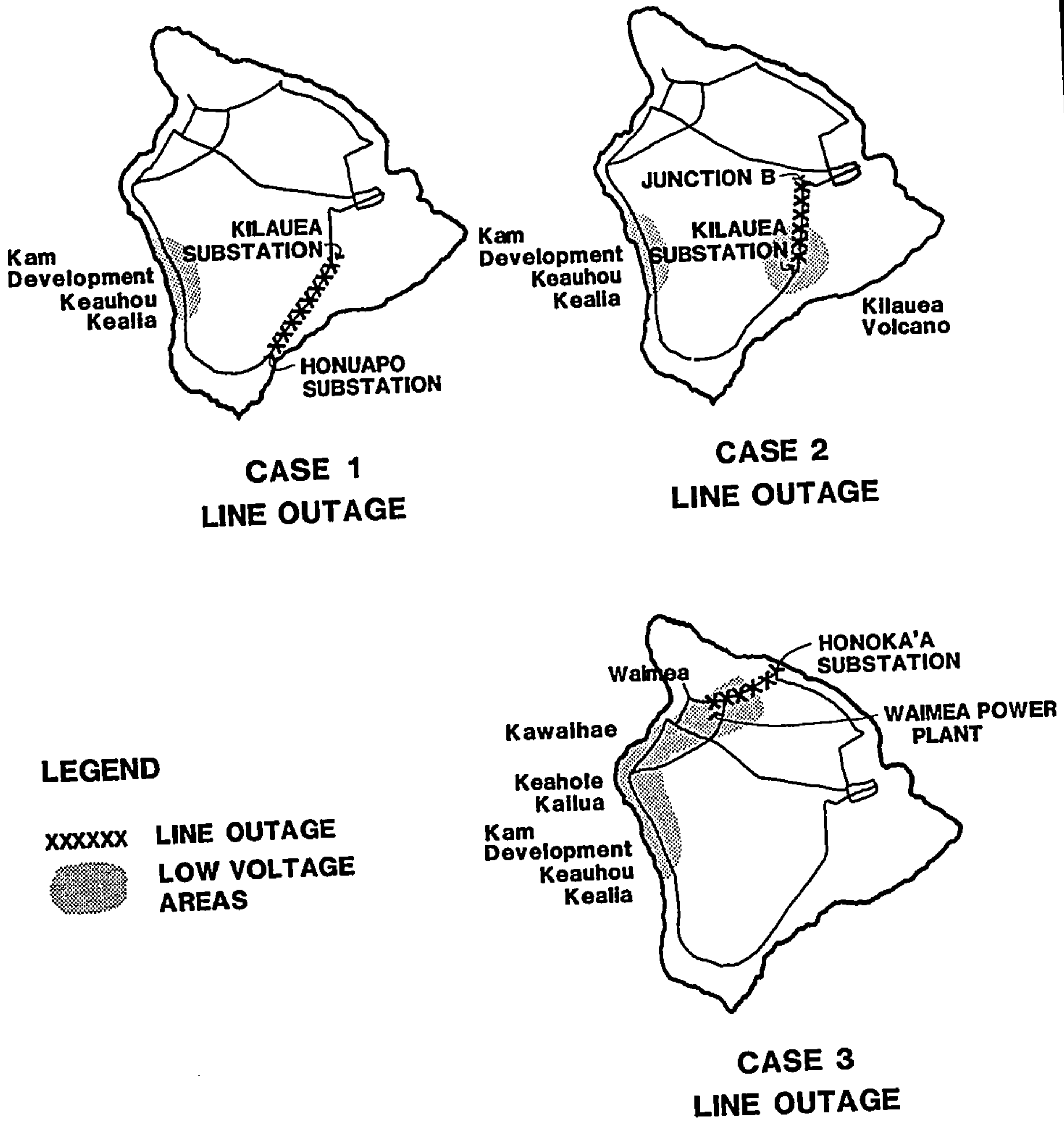

EXHIBIT I-4:
EFFECTS OF LINE OUTAGE, 1982 STUDY

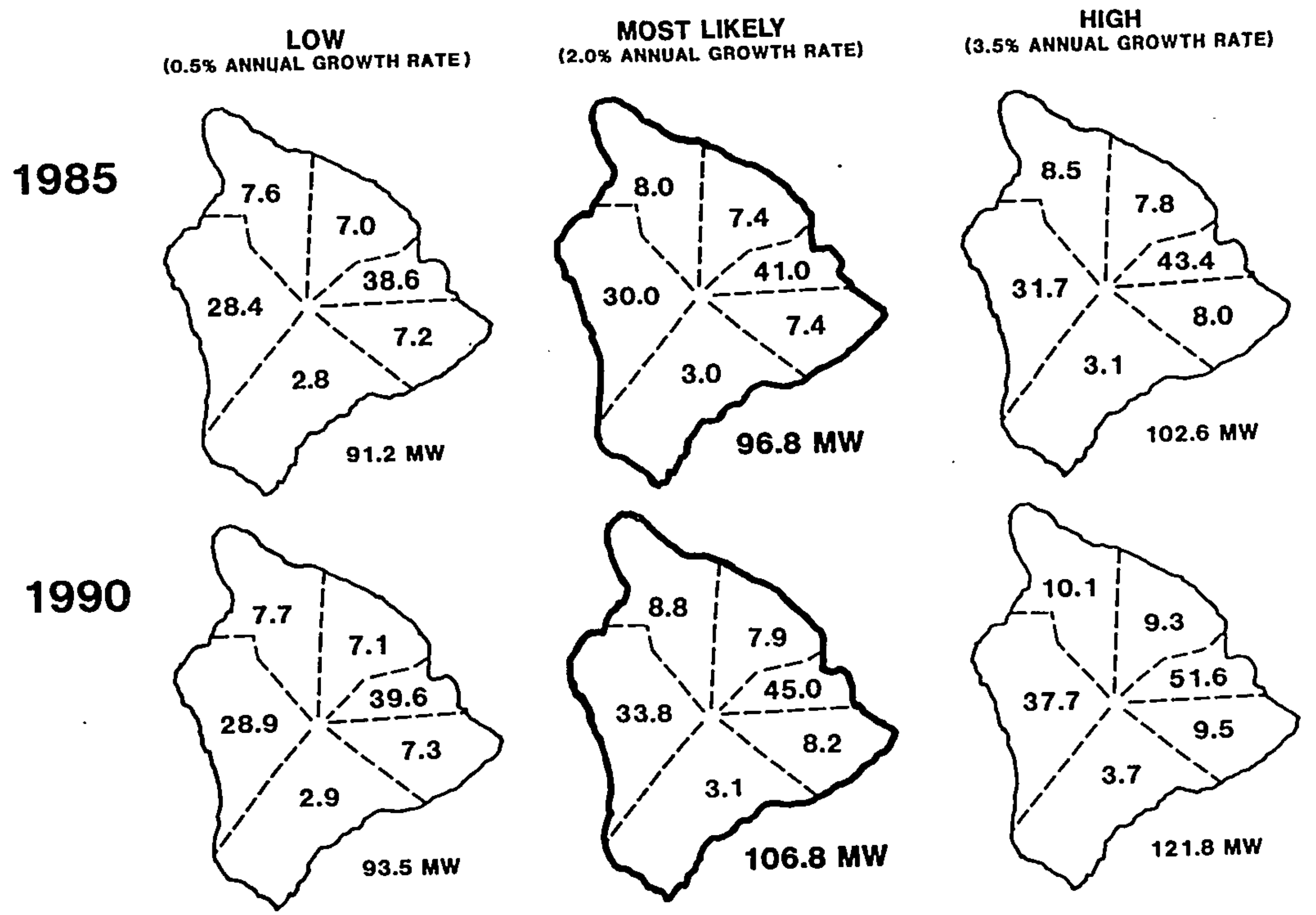

EXHIBIT I-5:
PROJECTED REGIONAL LOAD GROWTH SCENARIOS, 1985 and 1990

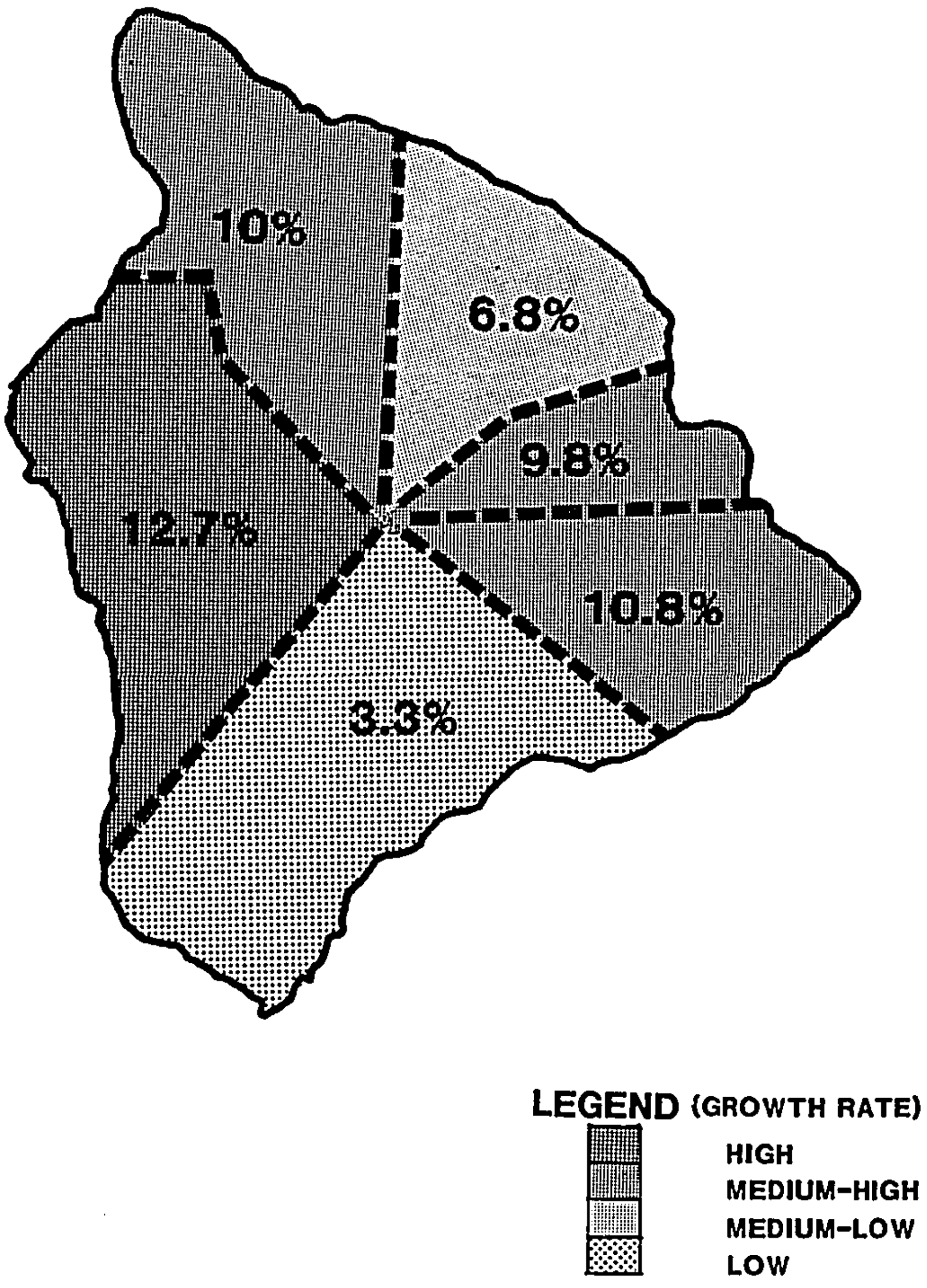

EXHIBIT I-6:

PROJECTED RATE OF LOAD GROWTH BY REGION, 1985 TO 1990

past, the Kona service area is expected to have the highest rate of load growth.

The population projections prepared and adopted by the State of Hawaii's Department of Planning and Economic Development serve as a useful benchmark for HELCO's load forecasts.[4] These population projections are based on a complex model representing the most comprehensive data available on the future economic conditions of the Island of Hawaii. They, therefore, address the questions raised above. In addition, the State's projections have an official sanction. Virtually all public agencies use them for planning facilities, programs and land use policies. HELCO, therefore, refers to these projections in making load forecasts.

In Exhibit I-7, actual population and load growth from 1965 to the present are shown on the left hand side of the graph and projected population and loads are indicated on the right side. Note that load grew somewhat faster than population until the early 1970's, when the high prices and shortages of fuel oil raised the cost of producing electric energy and encouraged conservation practices. The 1970's saw load and population growing at approximately parallel rates. In light of this record, HELCO's load growth forecast is quite conservative, since it assumes that electric energy consumption per capita will decline in future years as the consequence of a conservation trend.[5]

Having estimated future loads, HELCO must develop generating resources to meet them. Similar uncertainty surrounds the quantity and types of generating resources that will meet these loads. HELCO's long-term goal is to reduce its dependence upon fossil fuels to generate electric energy. The map in Exhibit I-8 indicates the general locations of existing and potential alternate energy sources.

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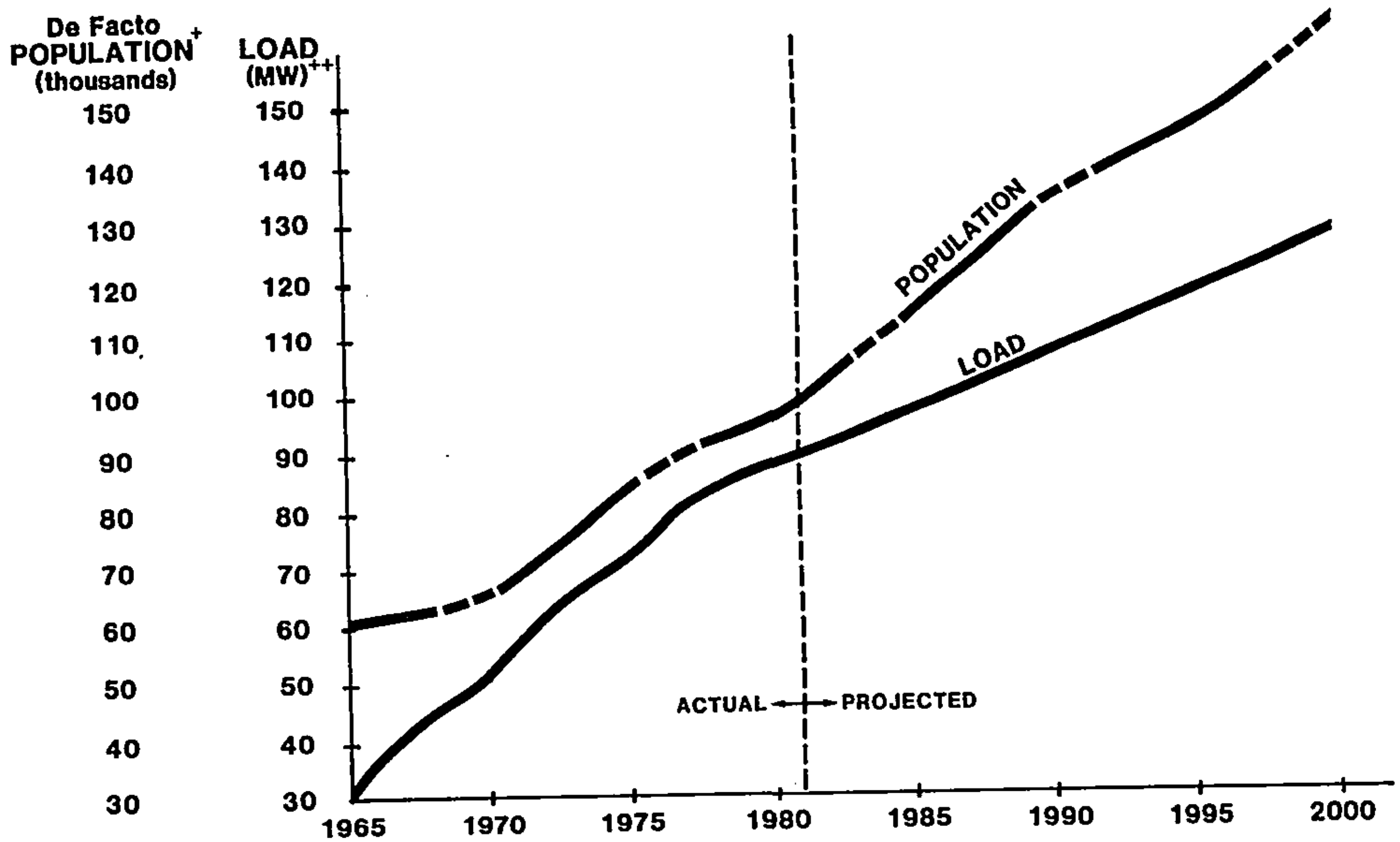
[4]Hawaii State Department of Planning and Economic Development, Revised Population and Economic Projections, 1975-2000 (March 1, 1978) and De Facto Population Projections for Counties, 1978-2000 (Statistical Memorandum 79-5, April 26, 1979).

[5]The Hawaii State Department of Planning and Economic Development projects a slightly higher average annual energy demand growth rate between now and the year 2000 in its State Energy Plan and Technical Reference Document, September, 1980, p. III-55.



+ Hawaii State Department of Planning and Economic Development, Revised Population and Economic Projections, 1975-2000, (March 1, 1978), p. 4; DeFacto Population Projection for Counties, 1978-2000 (Statistical Memorandum 79-5, April 26, 1979) and Hawaii County Department of Research and Development, County of Hawaii Data Book, (1980), p. 5.

++ Megawatts

EXHIBIT I-7:

PAST AND PROJECTED POPULATION AND LOAD GROWTH, 1965-2000

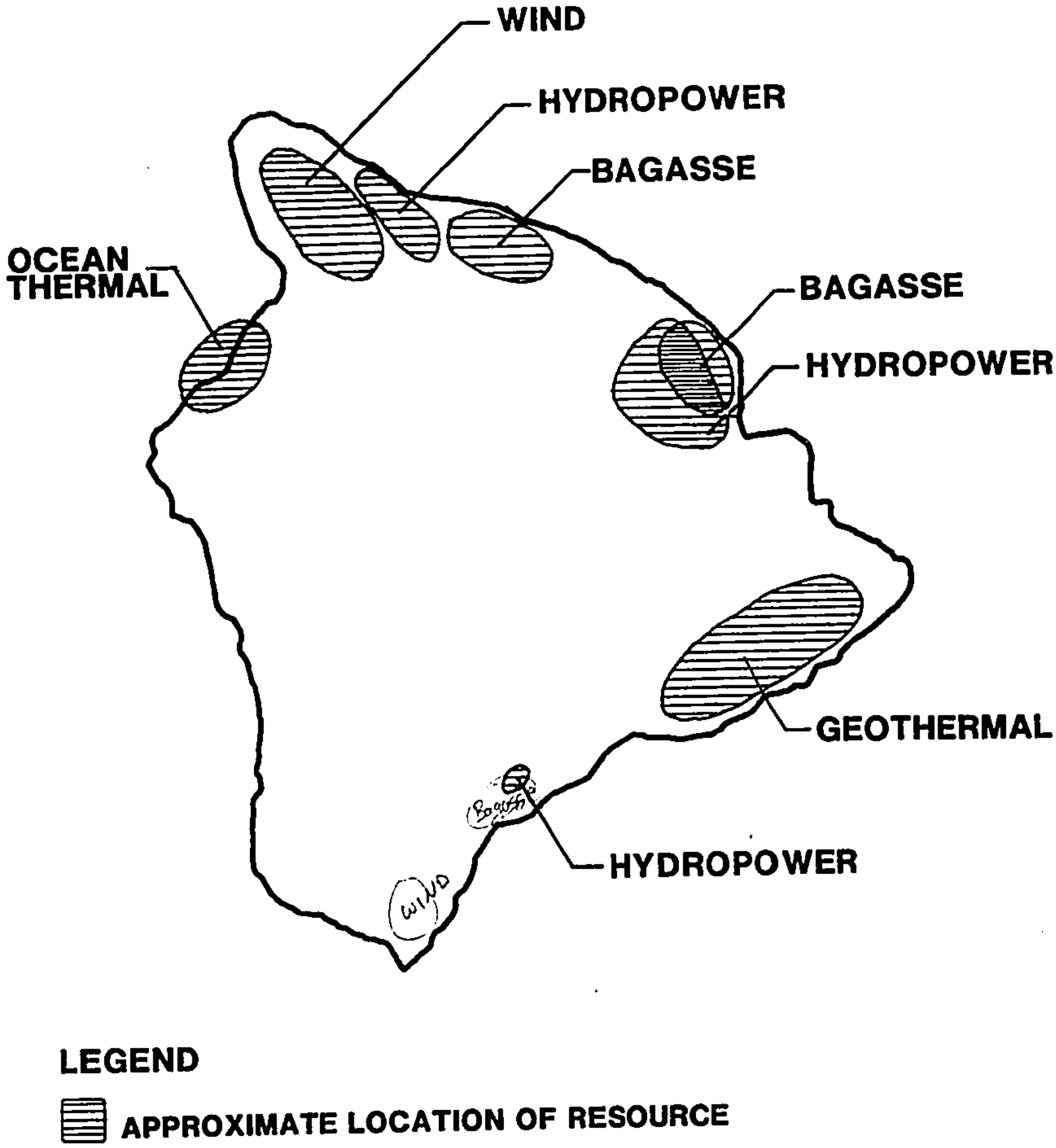


EXHIBIT I-8:

EXISTING AND POTENTIAL SITES FOR ALTERNATE ENERGY GENERATION

Various economic conditions, including fluctuations in the price and supply of fossil fuel relative to other resources, will affect the timing and type of generating resources which are added or removed. For example, the availability of bagasse-fired generation depends upon the survival of the sugar industry. The closing of Puna Plantation will reduce system resources by 6 mw or about 5 percent in early 1985.

The four other alternate resources shown in Exhibit I-8 are ocean thermal, wind energy conversion, hydropower and geothermal. The potential for ocean thermal energy conversion (OTEC) is being studied at a government-funded laboratory based at Keahole Point on the western coast of the island. Due to a number of technical risks and high capital costs at the present time, a significant commercial OTEC project for the Island of Hawaii is highly improbable within the next couple of decades.[6]

An excellent wind regime in the Kohala Mountains area of the island offers good technical potential for the development of wind energy conversion systems (WECS). While some interest has been expressed in the development of a WECS project in this area, the estimated return on the high capital investment has not been attractive enough to encourage large-scale commercialization of this resource. Furthermore, wind speed is variable and, therefore, will not provide a source of firm power as will geothermal or OTEC. The potential development of additional hydroelectric resources on the island is restricted to small run-of-the river plants that have no storage capacity, so this resource, too, is unable to provide firm power.[7]

Of all the existing and potential alternate energy sources, the outlook for development on a significant scale is most favorable for geothermal power. A pilot geothermal plant, with a capacity of 2.8 mw, is presently operating in the Puna area. The ultimate

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[6]A federally-funded pilot project in Hawaii is being planned for a location near Kahe Point, Oahu. This project is not expected to be operational before the end of the decade. Hawaii State Department of Planning and Economic Development, State Energy Plan and Technical Reference Document, September, 1981; p. III-75.

[7]W. A. Hirai Associates, Inc. Hydroelectric Power in Hawaii: A Reconnaissance Survey, Hawaii State Department of Planning and Economic Development, February, 1981.

size of the resource in this region may be as much as 1,000 mw. In the near term, however, HELCO is seeking only to acquire 25 mw to meet the energy needs on the island itself. Three prospective developers have responded to HELCO's request for proposals and an operating geothermal plant is planned for 1987.

The most likely scenario for the location and size of generating resources in HELCO's system for 1985 and 1995, based on a policy emphasizing alternate energy resource development, is shown in Exhibit I-9. By combining the generation scenario with the regional load scenario (Exhibit I-6), it can be seen that the island is most likely to witness an increase in load in the Kona (West) region and an increase in generation by geothermal power in the Puna (Southeast) region.

E. ALTERNATIVES FOR MEETING THE NEED

There are two general types of alternatives for providing reliable electric power to the west side of the island. The first is to transmit power from HELCO's present generating resources, which are located mostly on the east side and have a sufficient combined capacity to meet the forecasted energy needs of the island through the next several years.

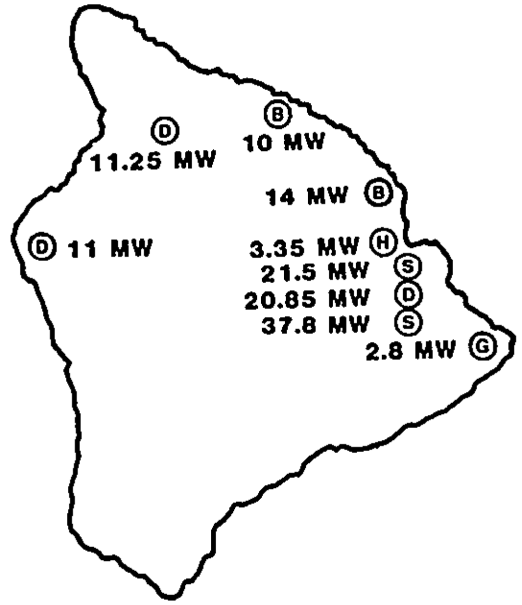
The second alternative is to construct a new or expanded generating facility on the west side. Since, as noted in the previous section, the development of an alternate energy resource of sufficient scale on this side of the island is highly unlikely in the next couple of decades, the new generating resource would have to be fired by fossil fuels.

Each alternative should have adequate capacity to meet the additional loads which are forecasted for the west side over the next 15 to 20 years. For comparison, a minimum capacity of 12 mw is used.

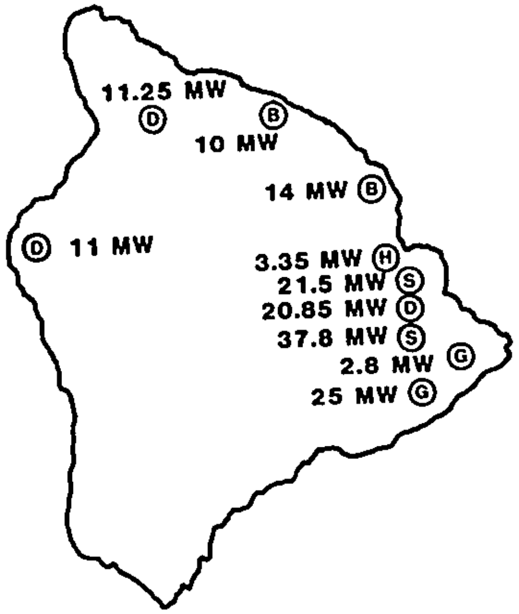
The future load growth and generation scenarios described in the previous section also help determine the location of the terminal points for the 138 Kv transmission line. Within HELCO's electric power transmission system, the terminal points would need to be Kaumana Switching Station (or Substation) on the east side of the island and Keamuku Substation on the west side. (See Exhibit I-10)

Additional power can be transmitted by either building a new 138 Kv transmission line or upgrading the voltage capacity of an existing line. The latter, however, does not satisfy the need for system reliability.

1985



1990



KEY TO GENERATING RESOURCES

	FACILITY	TYPE	OWNER
Ⓢ	Waiakea	Steam	HELCO
Ⓢ	Hill	Steam	HELCO
Ⓓ	Kanoelehua	Gas & Diesel	HELCO
Ⓓ	Waimea	Diesel	HELCO
Ⓓ	Keahole	Diesel	HELCO
Ⓑ	Pepeekeo	Bagasse	Private
Ⓑ	Davies-Hamakua	Bagasse	Private
Ⓗ	Hydro	Hydro	HELCO
Ⓖ	HGP-A	Geothermal	State
Ⓖ	Puna	Geothermal	Private

EXHIBIT I-9:
PROJECTED GENERATING RESOURCES, 1985 and 1990

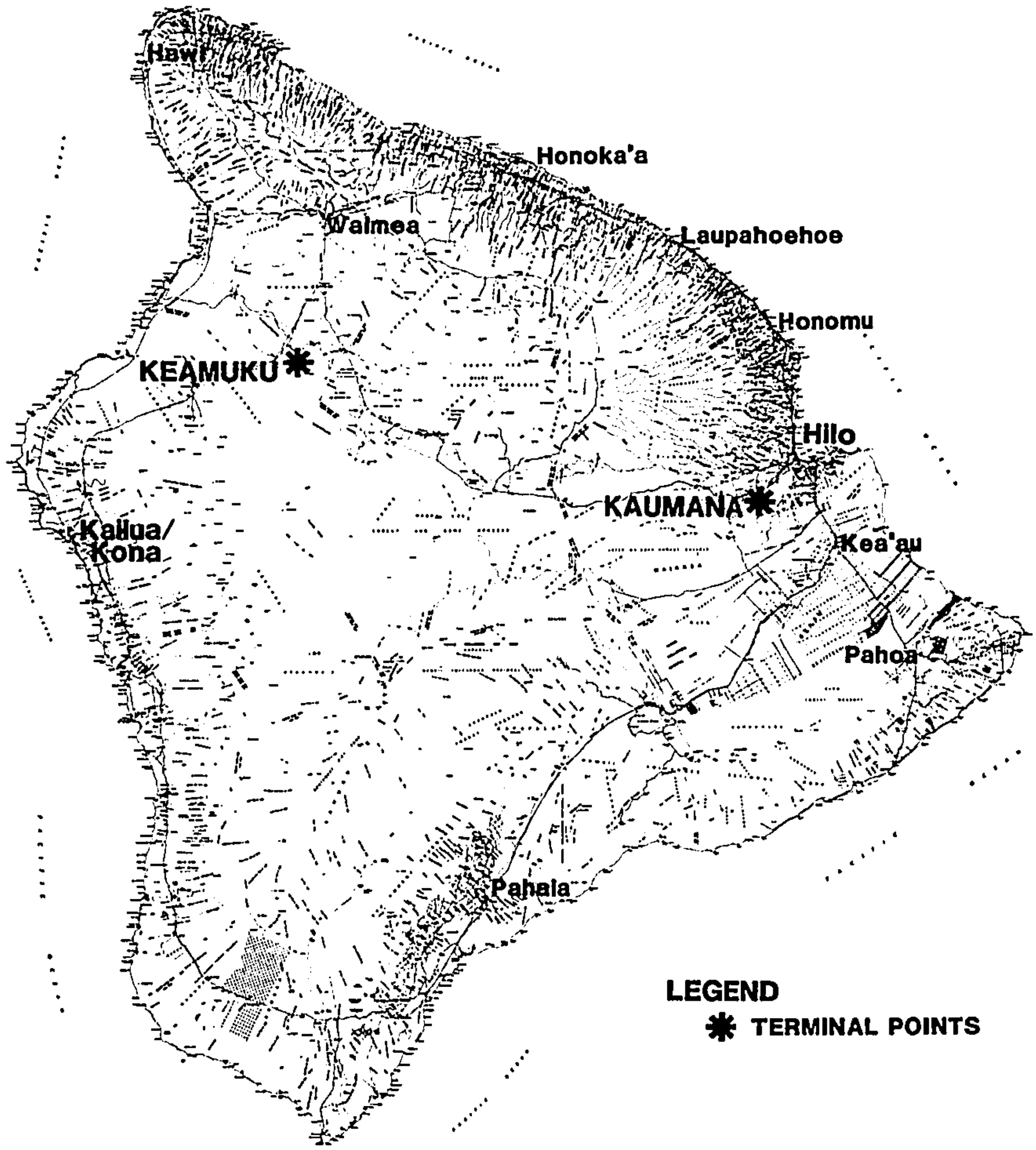


EXHIBIT I-10:

TERMINAL POINTS OF PROPOSED CROSS-ISLAND TRANSMISSION LINE

If any of the existing cross-island transmission lines are taken out of service to perform this conversion work, the low voltage conditions depicted in Exhibit I-4 will occur over an extended period of time. All of the supporting poles would have to be replaced since they were not designed to support higher voltage (138 Kv) conductors. Moreover, if the line converted to 138 Kv suffered an outage after installation due to damage or maintenance needs, the remaining two cross-island lines would not have sufficient voltage capacity to sustain reliable service, leaving a vulnerability in HELCO's transmission system. Consequently, the need for system reliability requires the building of a new 138 Kv line rather than the upgrading of an existing cross-island line if the transmission alternative is selected.

The alternative of an additional fossil-fuel generating resource on the west side can be provided by either increasing the generating capacity of HELCO's diesel plant at Keahole or building a new steam generator on the west side. In addition to increasing and prolonging HELCO's dependence on fossil fuels to generate electric power, which is contrary to the utility company's policy, the cost of constructing and maintaining a new or expanded generating resource on the west side would be substantially higher than that of a new transmission line of similar capacity.

The graph in Exhibit I-11 compares the costs (in 1982 dollars) of building a transmission line capable of carrying at least 12 mw versus installing a diesel or steam unit of comparable size. The cost of the transmission line includes the work necessary to upgrade the substations at Keamuku and Kaumana.[8] The cost of fuel oil is not included in the annual operation and maintenance expenses represented for either type of generating resource. Uncertainty about the price and supply of fossil fuel in the future and the environmental and social costs involved in locating and operating a plant which is fueled by this nonrenewable resource are clearly additional factors favoring a transmission line. It should be noted that

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[8]This, as well as the two types of generating resource alternatives, will also require radial 69 Kv lines of relatively shorter length. They are not included in the cost comparison because the length of the 69 Kv line(s) associated with a steam generator would depend upon the location of this new facility, which is unknown. Nevertheless, this is a cost which can be considered roughly equivalent for all three alternatives.

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[8]This, as well as the two types of generating resource alternatives, will also require radial 69 Kv lines of relatively shorter length. They are not included in the cost comparison because the length of the 69 Kv line(s) associated with a steam generator would depend upon the location of this new facility, which is unknown. Nevertheless, this is a cost which can be considered roughly equivalent for all three alternatives.

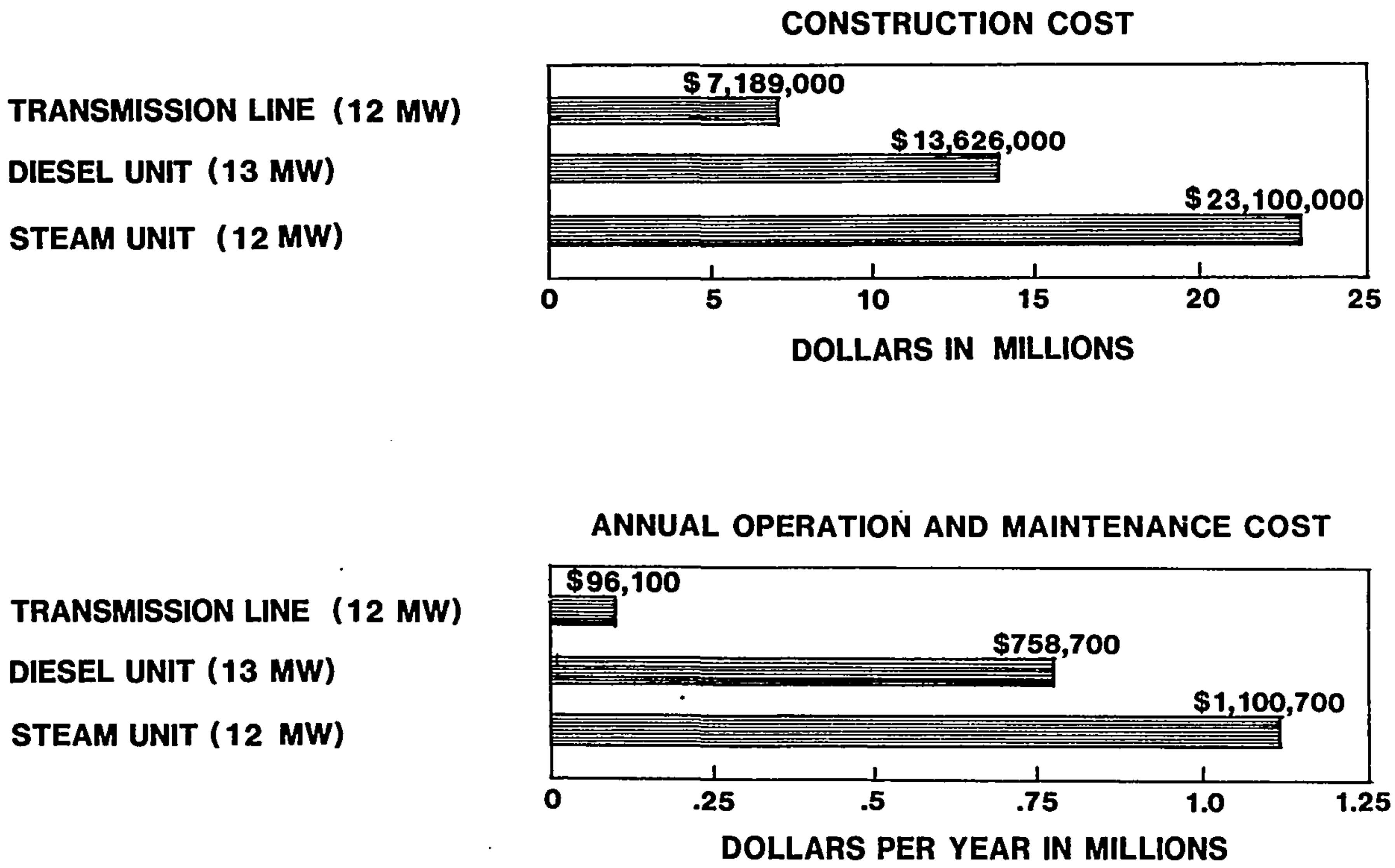


EXHIBIT I-11:
COSTS FOR SYSTEM IMPROVEMENT ALTERNATIVES (1982 Dollars)

installation of a new transmission line at this time will not require additional generating resources in East Hawaii, as the line is required for reliability and not for load purposes.

F. PROJECT OBJECTIVES AND DESCRIPTION

As stated earlier, project objectives are 1) to maintain system reliability and 2) to provide for future load growth. The transmission system will be improved incrementally, as the need arises. The immediate need is to construct a new cross-island line between Kaumana and Keamuku. It will have a voltage capacity of 138 Kv in order to accommodate anticipated loads several years from now, but initially will be energized at 69 Kv. On the west side of the island, new radial 69 Kv lines serving as auxiliaries to the new 138 Kv line, will be needed between the Waikaloa (Boise Cascade) and Anaeho'omalu Substations and between the Keamuku and Keahole Substations by 1987 and 1991, respectively. By 1995, according to load forecasts, another transmission line - the fifth cross-island line - will be required in order to maintain system reliability. Like the fourth cross-island line, it will have a voltage capacity of 138 Kv, connect Keamuku with Kaumana and be energized initially at 69 Kv. By 1999, both 138 Kv lines will be energized at full capacity. This will require new 138 Kv substations at Keamuku and Kaumana.

These proposed transmission system improvements are sufficient only to accommodate future load growth on the island itself. While there have been well-known proposals to export bulk power to Oahu and to introduce new industries with high energy requirements, dependent upon large scale and relatively rapid development of the geothermal resource, there are too many uncertainties surrounding these proposals to serve as a basis for transmission planning at this time.

Chapter 11

CHAPTER II: TRANSMISSION LINE ROUTING METHODOLOGY

A. OVERVIEW

There is a wide range of geographic alternatives for routing a transmission line between Kaumana and Keamuku. In addition to routes over land, some alternatives might include a marine cable. HELCO's objective is to select the route which has the least environmental and capital cost, and minimal impact on land use along the route.

The methodology used for the selection of the route is a sequence of steps organized in two phases. Phase 1 narrows down the large number of possibilities by identifying an optimum corridor for further study based upon a broadscale analysis of opportunities and constraints for a transmission line route. The width of the study corridor may vary, depending upon the type and number of constraining factors in any particular vicinity, but will be ample enough to permit several alternative alignments. Phase 2 leads to the selection of a specific route alignment, based upon a detailed analysis of conditions within the study corridor and the development of measures to mitigate the potential adverse effects of the line.

During each phase a comprehensive set of data factors is used to structure the analysis. For Phase 1, the factors are grouped under five general categories: Exclusion Areas, Geophysical Factors, Biological Factors, Socio-Economic Factors and Cost Factors. The data categories span a wide range of considerations that might be applied to the evaluation of almost any type of major construction project. The data factors, while still general, begin to identify considerations that relate more specifically to construction projects which cover a fairly substantial area and are linear in character.

Exhibit II-1 outlines the data categories and data factors used in Phase 1. They are defined briefly as follows:

<u>Exclusion areas</u> are those where regulatory controls are so restrictive that they essentially preclude a transmission line route.

<u>Geophysical factors</u> relate to the physical properties and processes of the earth. The specific factors which affect the location of transmission lines are:

EXHIBIT II-1

DATA CATEGORIES AND FACTORS

PHASE 1: IDENTIFICATION OF STUDY CORRIDOR

	DATA CATEGORY		DATA FACTOR
A.	Exclusion Areas		
B.	Geophysical Factors	1.	Slope and Soils
		2.	Geologic Hazards
		3.	Hydrology
C.	Biological Factors	1.	Vegetation
		2.	Wildlife
D.	Socio-Economic Factors	1.	Recreation
		2.	Land Use
		3.	Transportation and Utilities
		4.	Land Ownership
		5.	Visual Quality
		6.	History and Archaeology
		7.	Land Regulation
E.	Cost Factors	1.	Land Value
		2.	Route Length
		3.	Access
		4.	Maintenance

- Topographic features, particularly slopes and soils.

- Geologic characteristics, including seismic, volcanic and other types of foundation hazard.

- Hydrologic characteristics, including surface water, groundwater and rainfall.

Biological factors include both plant life and animal life. The specific factors are:

- Vegetation zones and their susceptibility to construction activity and possible fire hazards from transmission lines.

- Wildlife habitats, particularly for species which are susceptible to hazards from transmission lines.

Socio-economic factors relate to the human use of land and the effect which a transmission line might have upon the use value of land. Specific factors are:

- Recreational resources, such as parks, hiking and hunting trails.

- Urban and non-urban land uses of various catergories.

- The easements which make up the transportation and utilities network.

- Land ownership patterns.

- Visual quality, particularly scenic landmarks and areas with low visual absorption capability and substantial exposure to the public.

- Historic and archaeological resources.

- Regulatory controls over land use, other than Exclusion Areas.

Cost factors are those which the utility company, and eventually the utility customers, pay for the acquisition of an easement and the construction and maintenance of a transmission line. These factors are:

- The relationship between the market value of land and the cost of acquiring an easement.

- The effect of route length on easement, construction and maintenance costs.

- The relationship between site accessibility and construction and maintenance costs.

- Physical conditions which affect the maintenance and operation of the line.

The data factors are further defined by criteria which have for the most part been developed in previous scientific and planning studies sponsored by government agencies. The criteria deal with conditions on a general level. They are evaluated in light of constraints or opportunities for the location of a transmission line and then displayed in map form.

Phase 2 involves a similar analytical framework. However, the analysis is much more detailed, relying on first-hand field observations as well as secondary sources, and covers only conditions within the study corridor. Along with a change in level of analysis and map scale comes a revised description of data categories and factors. Exclusion Areas, for example, are no longer a data category because these highly restrictive areas have been excluded from the study corridor. Costs Factors can also be eliminated as a data category because the major determinants of cost, such as route length, access, maintenance and land value, are important considerations in the identification of a study corridor, but are far less significant in Phase 2 because of the relatively limited range of potential alignments. In any case, factors such as existing land use and terrain conditions, which have cost implications, are mapped and taken into account under other data categories.

Certain factors in the geophysical, biological and socio-economic data categories begin to play a more significant role in Phase 2. For example, land ownership and regulation, biological habitats, and visual resources become much more meaningful influences on the location of the transmission line because these are factors which require a relatively detailed scale of analysis. Due to the elimination or altered significance of data categories and factors in Phase 2, the analytical framework is restructured as shown in Exhibit II-2.

EXHIBIT II-2

DATA CATEGORIES AND FACTORS

PHASE 2: SELECTION OF DETAILED ALIGNMENT

DATA CATEGORY		DATA FACTOR	
A.	Physical Conditions	1.	Land Use
		2.	Biological Factors
		3.	Geophysical Factors
B.	Land Control	1.	Land Ownership
		2.	Land Regulation
C.	Visual Resources	1.	Visual Screens
		2.	Views

B. STEP-BY-STEP PROCEDURE

The following is a description of the sequence of steps leading to route selection. The procedure is illustrated in Exhibit II-3. More specific descriptions of the data sources and methods used can be found in the texts of Chapters IV through VI.

PHASE I: Identification of Study Corridor

Step 1: Define Data Categories and Factors

This is to provide a structure for analyzing and evaluating physical, social and economic conditions which create constraints or opportunities for the routing of a transmission line. The data categories and factors are defined in the preceding pages.

Step 2: Describe and Analyze Transmission Line Alternatives

The three basic options are overhead line, underground cable and marine cable. The design features of the latter two and their limitations and advantages relative to an overhead line are analyzed in Chapter III.

Step 3: Develop Evaluation Criteria for Broadscale Analysis

Criteria for evaluating the relative constraints and opportunities for the transmission line route within each data category are described in Chapter IV. These evaluations rely almost entirely on secondary source material, particularly data and planning maps prepared by government agencies.

Step 4: Identify Potential Corridors for Future Study

Broadscale evaluation criteria are displayed through an overlay mapping process which highlights the areas of opportunity. Potential corridors are identified by linking the areas of opportunity to provide a continuous connection

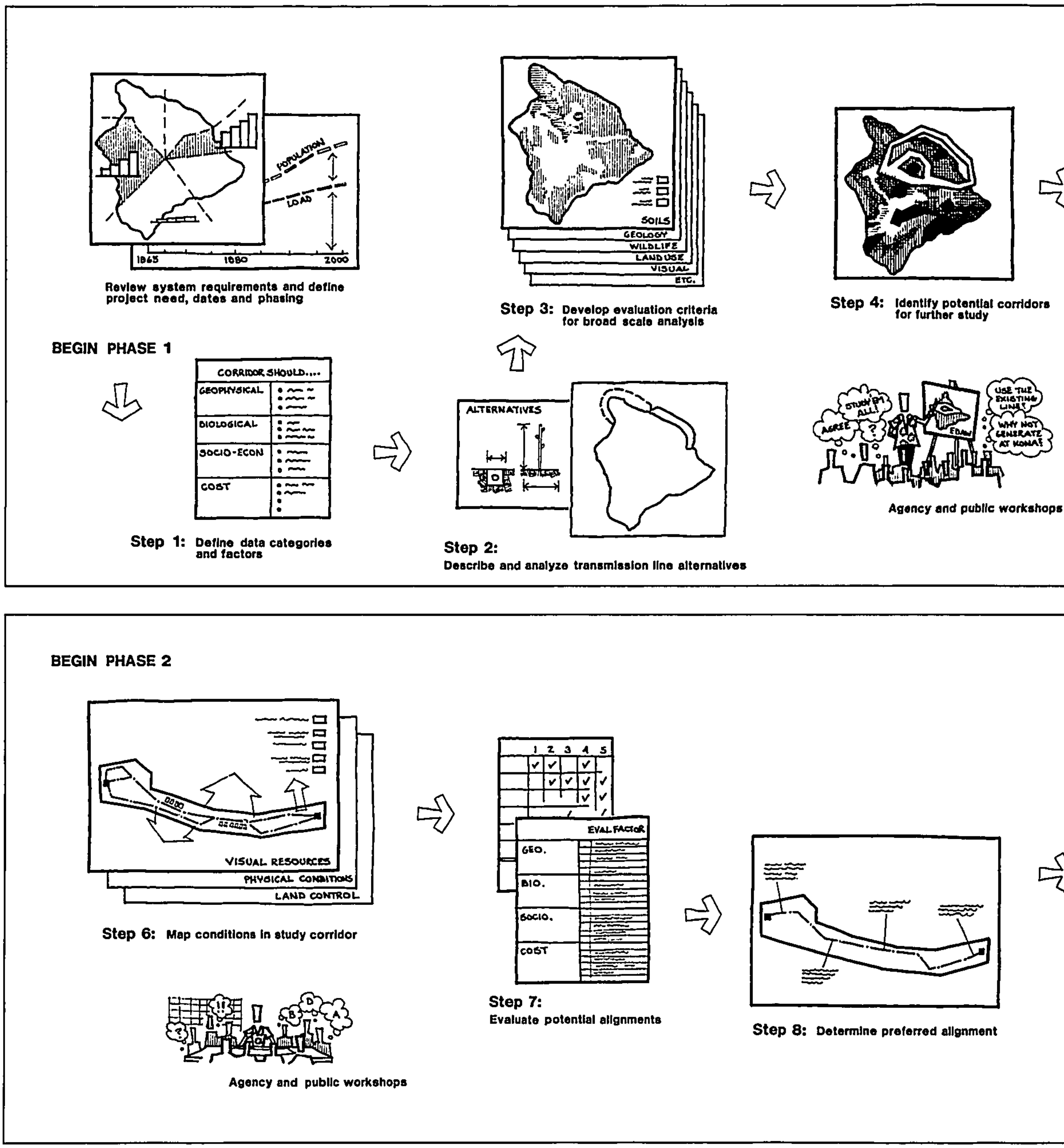
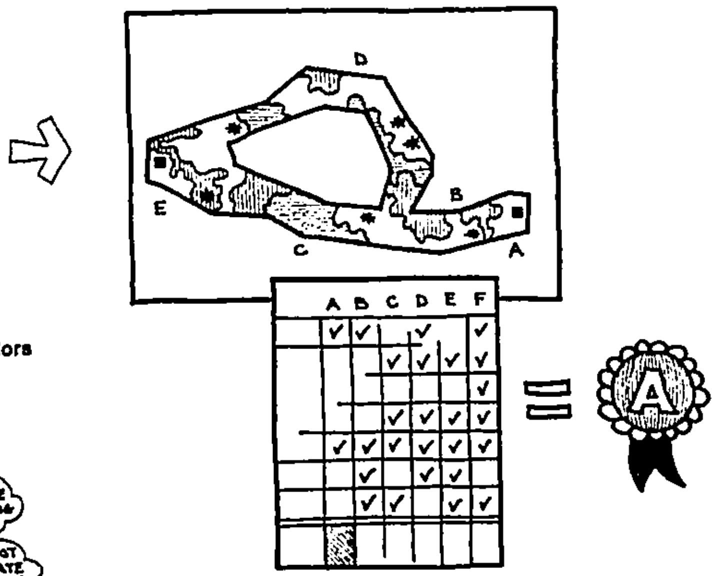


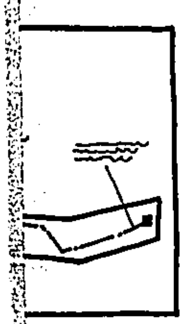
EXHIBIT II-3: TRANSMISSION LINE ROUTING STUDY PROCESS

ntify potential corridors
further study

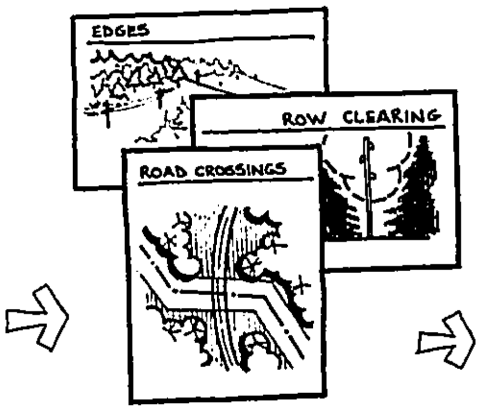
ncy and public workshops



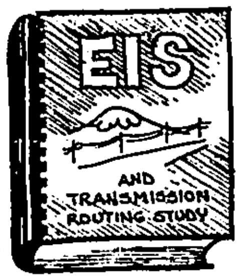
Step 5: Evaluate and select a study corridor



erred alignment



Develop mitigation measures and . . .



Document routing process in a report, included as an appendix to an EIS

CESS

between Keamuku and Kaumana.[1] The areas of opportunity are more extensive along some portions of the corridor than along others, so the corridor width varies accordingly.

<u>Step 5: Evaluate and Select a Study Corridor</u>

The potential corridors are rated quantitatively by measuring the type and extent of constraint area crossed by a hypothetical "best alignment" through each of the corridor segments. This rating, combined with a narrative description, leads to the selection of the study corridor. Steps 4 and 5 are included in Chapter V.

PHASE 2: Selection of Detailed Alignment

<u>Step 6: Map Conditions in Study Corridor</u>

Conditions in the study corridor which will influence the routing of the transmission line are defined and then mapped. The types of conditions correspond to the data factors for the broadscale analysis, but more detailed criteria and information sources are used for this phase. Secondary sources are used, when available. These are supplemented with aerial photo interpretation, field surveys and consultation with technical specialists, resource managers and land agents.

<u>Step 7: Evaluate Potential Alignments</u>

Based on an analysis of constraints in the mapped data, preliminary potential alignments are delineated. Along some sections of the corridor, particularly where there are trade-offs between the types of constraints which are encountered, more than one potential alignment may be shown. The potential alignments are used as a basis for conducting field surveys of geological, biological and archaeological conditions along the corridor and for consulting with various government regulatory agency representatives and landowners who would be affected by the proposed easement. The surveys and consultations take place within the same time period.

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[1]An exception would be the overland portions of a marine route, which would be connected by a submarine cable at the shoreline.

Step 8: Determine Preferred Alignment

Adjustments to the potential alignments are made as the result of field observations and consultations in Step 7. A rationale for the selection of the preferred alignment is then elaborated. This is based on a hierarchy of selection criteria.

C. PUBLIC REVIEW

Government agencies and residents of the Big Island were kept informed of the progress of this study from its outset and their opinions and concerns were actively solicited. There were two rounds of public workshops held in Hilo and Kailua-Kona during the course of study. The first round was held in the middle of September, 1982, just after completion of Step 4, and the second round was in mid-November, 1982, during the completion of Step 8. The workshops are announced in local newspapers, radio broadcasts and in a newsletter (Consumer Lines)[2] which was inserted in monthly billings sent to all of HELCO's customers. HELCO sent over 200 direct invitations to individuals and leaders of community organizations who were thought to have some interest in participating in the study.

There were also two rounds of information workshops for representatives of government agencies. The first was in September, 1982, one week prior to the public workshops. This was attended by Federal and State officials based in Honolulu, who reviewed the material on project need, the methodology for route selection, the criteria for the broadscale analysis and the preliminary results of Step 4. The second round was held in mid-October, 1982, and dealt with more specific results of the study, marking the completion of Phase 1. This round consisted of two sessions: one for government officials based in Honolulu and the other for agency representatives on the Big Island.

Summaries of these workshops are found in Appendix C of this report. It was originally intended to conduct a final round of workshops after individual consultation meetings with government agency representatives and landowners were held and the preferred alignment was selected. Based on the attendance and favorable commentary at the second round of workshops, however, it appeared that there was no need for an additional

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[2]Notices from Consumer Lines are contained in Appendix C.

workshop. Notice of the alignment selection was in the January, 1983, edition of Consumer Lines and sent to all HELCO customers.

Chapter

CHAPTER III: TRANSMISSION LINE ALTERNATIVES

A. TYPES OF ALTERNATIVES

Transmission lines come in three basic forms: overhead lines, underground lines and marine cables. A marine cable could cover only a portion of the route since the terminal points are located several miles inland.

Electric power can be transmitted through a cable or conductor via either alternating current (AC) or direct current (DC). The major difference between these two is the need for converter and inverter equipment for the DC system. This equipment converts the AC power to DC at the sending end, and from DC power to AC at the receiving end.

HELCO's need for system reliability can best be met by the AC system. DC systems are expensive, due in large part to the added costs of the converter and inverter equipment. As a result, their use in public utility networks has been limited to two kinds of situations: (1) the points to be connected are separated by distances of several hundred miles or more, or (2) a linkage between two or more incompatible AC systems is required. Since neither of these conditions applies to the case at hand, only an AC system is considered appropriate for HELCO's new cross-island transmission lines. The following analysis discusses generic issues related to the underground and marine alternatives as compared to an overhead transmission line and considers factors which would influence the routing of an underground or marine cable.

B. UNDERGROUND CABLE

The basic components of an underground transmission system include the cable, terminal stations, pumping stations and manholes.[1]

1. Cables

At the present time, high pressure oil-filled (HPOF) pipe systems are the most widely used

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[1]Discussion of underground cable components and impact analysis is based primarily on EDAW inc., Study of Environmental Impact of Underground Electric Transmission Systems, Washington, D. C., Energy Research and Development Administration, May 1975.

underground systems in the United States. This system encases conductors within a steel pipe, which provides mechanical protection and prevents moisture from entering. The pipe is also the housing for pressurizing oil which fills the remaining space in the pipe and acts as a coolant. This system's exceptionally good operating record and physical ruggedness tends to reduce maintenance and repair requirements.

2. Terminal Stations

The buried pipe system must eventually be brought above ground at terminal stations so that it may be electrically connected to overhead equipment or lines. The cable terminations are usually porcelain devices that provide the necessary control of voltage stress and external leakage. The typical height of a terminal frame for an underground 138 Kv cable is approximately 16 feet. Terminal stations require relatively little space and can be installed within the fenced area of a substation.

3. Pumping Stations

Where there are significant elevation changes between two substations, as is the case between the Kaumana and Keamuku substations, an underground cable between the two points would probably require pumping stations along the route in order to maintain proper oil pressure within the cable pipe. The number, location and sizes of these pumping stations will depend upon the specific terrain conditions along the route.

4. Manholes

Most underground systems require manholes or subsurface vaults at intervals along the cable routes. These manholes are used for installing, jointing, splicing and maintaining the cable system. The maximum spacing between manholes is limited by the amount of tension which can be used to pull the cable into the pipe. In some cases, the maximum length of cable that can be transported to the job site may also have a bearing on the manhole spacing. The usual spacing is 2000 to 4000 feet.

There are certain inherent technical problems associated with underground systems. A primary consideration in the design, manufacture, installation and operation of these systems is the insulation and cooling of conductors. Overhead conductors are cooled and insulated naturally by the air which surrounds them. However, underground cables must be insulated artificially to prevent electric charge from flowing through metallic materials, moisture and other potential conductors which are imbedded in the earth. The artificial insulating material also tends to trap heat, thereby reducing power capacity. The resulting heat build-up impairs the electrical insulating properties of the insulating material itself. Technological solutions designed to balance the needs for insulation and cooling are expensive and still in the development stage.

As an overall point of comparison, an underground cable has a more extensive effect on conditions at the earth's surface than does an overhead transmission line along the same route. This is because the construction of the underground system requires excavation and backfill along the entire length of the cable, whereas the overhead line requires only the installation of poles spaced several hundred feet apart. The area between poles remains relatively undisturbed. Generic impacts of constructing and operating an underground system, as compared to an overhead line, are discussed below. This analysis would apply to any route on the Island of Hawaii.

Geophysical Factors

In general, the construction of an underground transmission system would have more extensive impacts on topography and soils than an overhead system would because greater alteration to surface and subsurface conditions is involved. Impacts on the physical characteristics of soil include:

- Compaction of surface soils from movement of equipment and personnel.

- Disruption from earthwork, excavation and backfill.

- Changes in grain size and chemical make-up from accelerated soil weathering caused by earthwork and excavation and soil warming from cable operations.

- Visible changes in soil color and texture at the ground surface, especially in off-road barren areas.

A related impact is the rate of soil erosion, which would be increased in the following ways:

- the soil compaction noted above causes increased rainfall runoff, resulting in greater erosion.

- Protective vegetative cover is removed during construction and maintenance. After cleaning, a different type of vegetation, often less effective at retaining soil, may take root within the easement boundaries.

Alterations to land forms from construction of the underground line include:

- Grading within the easement, particularly on sidehills in steep terrain.

- Grading for access roads.

- Excavation and filling of ditches.

An underground line would be subject to seismic hazards. Special engineering design measures would have to be used to mitigate potential damage to the cable from earthquakes. There is also a possibility of inundation of the cable corridor by lava flows. Some of the area along the route between Kaumana and Keamuku has been covered by flows within the past two centuries. Burial of the cable by a lava flow could seriously hinder or prohibit repair operations.

Surface water runoff could be altered in a number of ways, including:

- Changes in runoff rates due to changes in soil characteristics and vegetative cover.

- Changes in surface runoff patterns due to surface grading and excavation or the presence of cables in surface installations.

<u>Biological Factors</u>

Vegetation is more directly impacted by an underground line than by an overhead line because removal of the vegetative cover is required for construction and maintenance of the cable. Vegetative cover tends to re-establish after an area has been disturbed through a gradual succession or change in vegetation types; e.g., from grasses and herbs to shrubs to a final cover of trees. This succession will stop at the dominant or climax vegetation type of the region in which the construction is taking place. Therefore, in areas of grass and shrub, the recovery to original conditions will be relatively rapid. Native forests, however, could take many years to fully recover from construction impacts. The linear nature of an underground transmission system has the potential to impact a variety of vegetation types, over the entire distance of the corridor. It would be very difficult to locate a reasonably direct route which affects very little forest area.

Wildlife is affected by underground transmission systems mostly by the direct impact on wildlife habitats. For example, vegetation removal indirectly impacts wildlife by changing cover and food supply. Direct impacts could occur to microorganisms or insect communities which are found at or near the surface.

A rupture in the underground pipe due to seismic activity, mechanical flaws or other origins will result in oil leakage, which in turn has the potential for causing biological damage. The degree of impact will depend upon the extent of leakage and the biological sensitivity of the affected area. In remote areas, which are often those likely to have high biological resource value, the leakage could become quite significant before it is detected.

In general, an underground system could have at least as much, if not more, impact on vegetation and wildlife than an overhead line would. The impact would be greater in areas which have been relatively less disturbed.

Socio-Economic Factors

In many respects, the generic socio-economic impacts of an underground cable and an overhead transmission line are similar. Considerations such as land use and regulation, transportation and utility easements, land ownership and recreation areas are dependent upon the route rather than the type of system which is selected.

In areas where the transmission corridor is exposed to public view, the underground cable would be perceived as having less adverse impact on visual quality than an overhead line would. However, the extent of the overhead line's impact varies according to the closeness of view range, the character of the visual background, the configuration of the overhead line and its supporting structures and the subjective preferences of the viewer.

Transmission line routes through densely developed urban settings receive a great deal of potential view exposure. This consideration, in combination with other socio-economic factors, such as high land values, fragmented ownership patterns, restrictive land regulation and potential interference with a wide variety of human activities, sometimes makes undergrounding the transmission cable beneath public streets, along with other utility lines, an attractive option.

The potential impacts of an underground system on historic and archaeologic sites are relatively greater than those of an overhead line due to the greater degree of disturbance to surface and subsurface areas. More extensive surveys of the route would be necessary to determine the location of archaeological remains.

Cost Factors

Costs specific to the underground system, including the cable material, associated equipment, installation (trenching, backfill, manholes, joint bays) and operation (energy losses, pumps, heat exchangers), are very high compared to the capital costs of an overhead line. Conservatively, an underground system is six to twelve times more expensive to construct than an overhead line.[2]

Normal maintenance and repair costs are somewhat lower for an underground line because it is not exposed to the elements, such as high wind and airborne residue from cane burning and salt spray, which can cause damage or impair the efficiency of the line. However, when something does go wrong with the underground cable, it is more expensive and time-consuming to repair than an overhead line because of the difficulty in locating the cause of cable failure and getting access for repair crews and equipment.

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[2]Hwang, H. H., A Study of The Feasibility of Linking Maui, Molokai and Lanai with Submarine Electric Power Cables, Honolulu: Hawaii Natural Energy Institute, University of Hawaii; January, 1979.

C. MARINE CABLE

The components of a marine cable system are as follows:[3]

1. Cable

There are basically four types of submarine cables: gas filled, oil filled, solid type paper insulated and polyethylene insulated. A review of literature on submarine cables indicates that the oil filled cable has a history of good performance in the transmission of 138Kv/110mw power, and would most likely be the type of cable used for this kind of project.

2. Terminal Stations

In addition to the cable itself, a submarine cable system requires terminal stations. These stations are similar in size to small substations and would be located close to the shoreline. Their purpose is to act as a transition from overhead to underwater. These terminal stations, therefore, represent an additional capital cost.

Submarine cables have been used in Japan, British Columbia, Spain and New York. The life expectancy of a submarine cable is estimated at 40, years although none has been in operation that long. Marine cables share with underground systems the technical problems of insulation and cooling. In addition, there are other difficulties posed by the marine environment.

Some principal causes of submarine cable failure have been as follows:[4]

Impact Damage

Ships dropping anchor have damaged existing submarine cables. The Long Island Lighting Company operates seven 11.6-mile long cables across the Lond Island Sound from Connecticut. They have reported six cases of damage between 1969 and 1977. The 1974 and 1977 emergency repair costs amount to $2.4 million each year. The 1974 damage required half capacity transmission for nine months. The 1977 damage required half capacity transmission for 5-1/2 months.

The 14.6 mile Vancouver-Mainland Intertie has experienced three cases of such damage between 1956 and

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[3] Discussion of marine cable components and impact analysis is based primarily on H. H. Hwang, *op. cit.*

[4] Hwang, *op. cit.*, pp. 43-50.

1978. The best method of preventing external damage is to bury the cables in the ocean bed. This practice, however, is costly and aggravates heat build-up in the cable.

Rock and Coral

When cables are laid on the uneven surfaces of the ocean floor, rocks and coral could, over time, chafe and wear away the protective cover. This chafing action could also be experienced in areas of high ocean bottom currents or surge action. A hydrographic survey could assist in the identification of hazardous areas, and areas where additional armouring of the cable may be necessary.

Seismic

Damage to submarine cables by earthquake activity is possible. The Hawaiian Telephone Company, which has had experience with submarine cables in the islands, notes it is often not possible to avoid rifts or fractures and other irregularities on the ocean bottom which can damage and bury the cable.[5] It is necessary to conduct thorough surveys of the ocean bottom and devise a cable laying plan to take anomalies into account.

Marine Life

Occasionally, a deep feeding whale may entangle itself in a cable causing an infrequent type of cable damage. This would be more prevalent during breeding and migration periods.

There are two potential marine routes for this project. One of the alternative routes would enter the ocean at Hilo Bay and parallel the coast in a northerly direction. It would come on-shore at Honoka'a and continue overland to the Keamuku substation. The other route would enter the ocean at Hilo Bay, travel parallel to the Hamakua Coast and round Upolu Point. It would then parallel the Kohala Coast in a southerly direction and come on shore at Kawaihae. The connection to the Keamuku substation would continue overland (see Exhibit III-1). For practical reasons, this second corridor does not deserve a full discussion of potential impacts. It is economically unfeasible due to route length. The distance of this corridor,

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[5]Letter to the Hawaii Natural Energy Institute, University of Hawaii at Manoa, 21 July 1978.

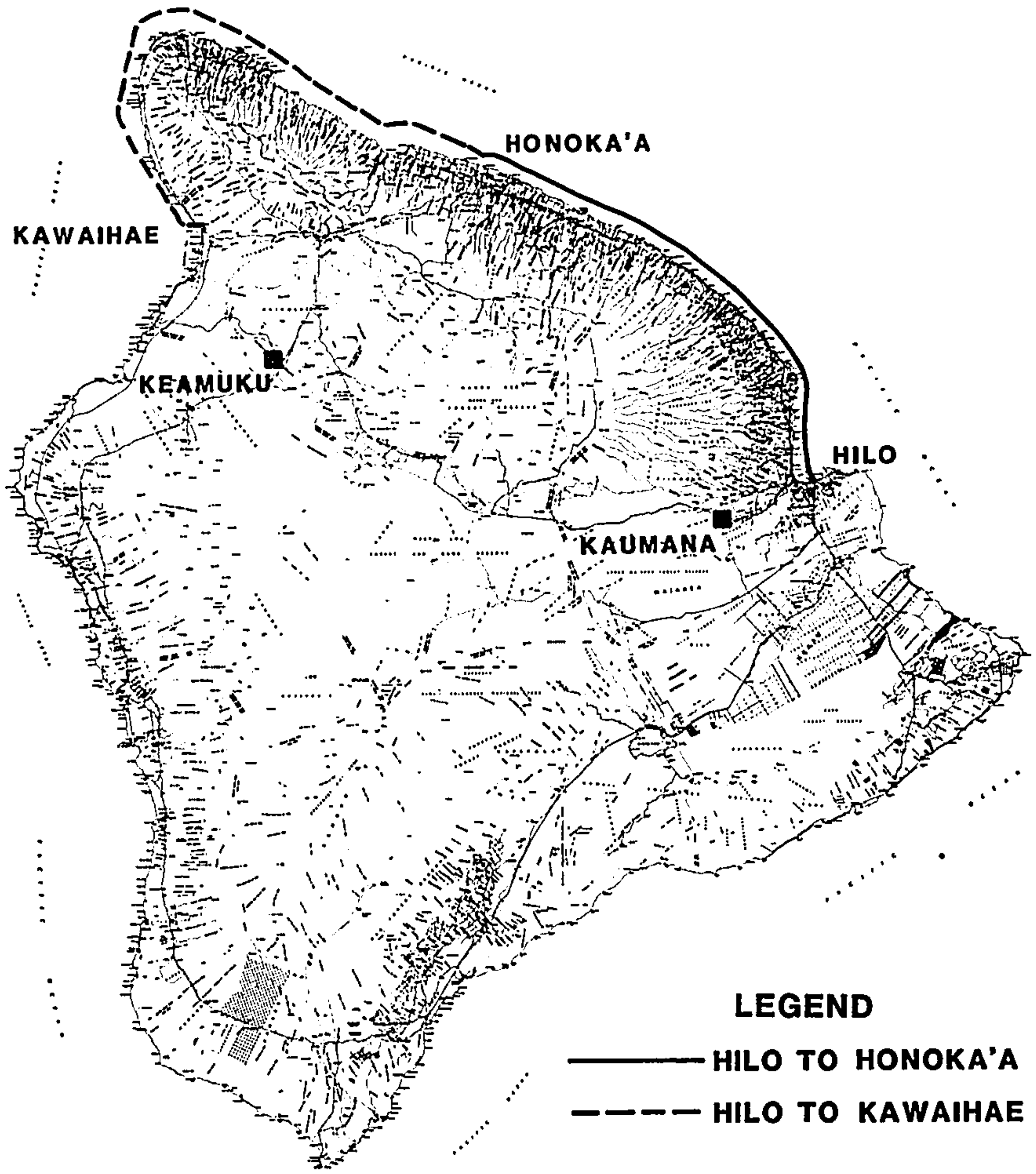

EXHIBIT III-1:

POTENTIAL MARINE CABLE ROUTES

about the long-term impacts of these cables, this would not be easy to show conclusively.

The marine route would still require a significant length overland in order to connect the two substations. The constraints for these land portions will be analyzed in Chapter IV. However, the terminal stations which are required at the points where the marine cable enters and leaves the water are unique to the marine alternative.

The shoreline area in the vicinity of Honoka'a, where the cable would come on-shore, is situated within the Limited (L) subzone of the Conservation District. Regulation No. 4 states, "the objective of this subzone is to limit uses where natural conditions suggest constraint on human activities."[9] The L subzone consists of areas susceptible to tsunamis, floods and soil erosion, "where human activities are necessarily restricted."[10] A submarine cable terminal station in the L subzone would be vulnerable to these natural hazards.

<u>Cost Factors</u>

The major cost factor is related to route length. A submarine corridor would be an indirect and lengthy route between the Kaumana and Keamuku substations. Installation proceeds much more quickly than with an overhead line because the cable is laid directly on the ocean bottom by a cable-laying barge. However, this savings in labor costs is more than off-set by the expense of the cable material and use of a cable-laying barge. The cost of installing a submarine cable, including the terminal stations, is, conservatively, three to six times the cost of overhead lines.[11] In addition, there still remains the cost of the overland portion of the marine route. The cost of regular maintenance of a submarine cable is minimal. Emergency repair to the cable, however, represents a significant cost. Adverse weather and sea conditions can seriously impede access to the cable. In 1977, for example, a crew from the Long Island Lighting Company had to abandon its repair barges due to a storm.

Related to delay in repairs is the interruption of service in the event of cable damage. To account for

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[9]State of Hawaii, Board of Land and Natural Resources Administrative Rules, Title 13, Chapter 2, May 1981.
[10]Ibid.
[11]Hwang, <u>op</u>. <u>cit</u>., p. 20.

this possibility, the Long Island Lighting Company provided a spare cable in its submarine crossing of the Long Island Sound. Even with the use of the spare cable, service had to be reduced to half capacity during both the 1974 and 1977 repairs, since the spare cable itself sustained damages.

Indirectly related to cost is the function of energy loss, which is directly proportional to the submarine cable's length. The amount of energy losses makes an AC submarine system economically unfeasible for lengths beyond approximately 45 miles.[12] The distance from Hilo Bay to Honoka'a is approximately 40 miles.

D. SUMMARY

The foregoing analysis indicates that the cost per mile to construct submarine and underground cables is substantially higher than the construction cost of an overhead line. A marine route, including its overland portions, would be about twice as long as a reasonably direct overland route between Keamuku and Kaumana.

The high cost of these two alternatives to an overhead line is a strong factor counting against their feasibility.

The environmental constraints of submarine and underground cables are in many respects just as great or greater than those of an overhead line. There are some types of environmental concerns which are unique to an overhead line because of its exposure to public view and the potential of conductor contact with plants and animals. It is difficult to weigh the value of scenic and biological resources in terms of capital cost, yet there are several areas along potential overland routes between Keamuku and Kaumana which clearly have high value in terms of natural beauty and as habitats for rare and endangered species of animals and plants. Nevertheless, adverse impact on these resources can be avoided or minimized by careful routing of the line and various design, construction and operations measures.

The following chapter describes criteria for routing a transmission line in a way which responds to sensitive environmental factors.

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[12]Hwang, op. cit., p. 17

approximately 137 miles, is beyond the capacity of an AC system. Therefore, the following analysis relates only to the potential impacts of a submarine route from Hilo to Honoka'a. Even this route, measuring approximately 40 miles, is longer than any presently operating AC marine cable.

Geophysical Factors

Benthic conditions along the Hamakua Coast tend to be rocky and sandy with possible canyons and muds. The insulating quality of mud may cause heat build-up in the cable. The ocean currents generally parallel the coast from Hilo Bay towards Upolu Point at the island's northernmost point. Due to the exposure to the northeast trade winds, surge action is also possible. Surge action is caused by storm activity at sea and is recognized as wave action toward shore. This activity could potentially cause chafing of the cable along the ocean bottom, resulting in cable wear.

The rift zone underlying Mauna Kea continues out to sea just north of Hilo Bay. Earthquakes of Richter magnitude 6.0 and greater have been recorded along this rift zone. Movement along the rift could cause undetermined damage to a submarine cable situated across this area. Seismic events could trigger underwater landslides which could bury or undermine the submarine cable. In addition, the Honoka'a terminal station would be vulnerable to inundation in the event of a tsunami triggered elsewhere within the Pacific ring.

Biological Factors

The Hamakua Coast is seasonally visited by migrating whales.[6] There is a remote possibility of deep feeding whales becoming injured or killed by entanglement with the cable. Energy loss through the cable, as a result of resistance in the cable itself, will be dissipated as heat. This discharged heat poses a potential impact to benthic organisms in the immediate area of the cable. The extent of potential impact on whales and benthic organisms would require further study.

As in the case of an underground cable system, there is potential for adverse biological impact on marine organisms due to leakage of oil from the submarine

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[6] Hwang, op. cit.; See also, A. A. Wolman and C. M. Juarez, "Humpback Whale Distribution in Hawaii", Marine Fisheries Review, Vol. 39, No. 7 (Paper 1254), 1977.

cable. The degree of impact, once again, will depend on the extent of the leakage and sensitivity of the local marine environment, particularly benthic organisms. The leakages may become fairly significant before the cable flaw or rupture is detected, located and repaired.

Socio-Economic Factors

Depending on the depth of the cable, commercial and sport fishing activities and shipping in and out of Hilo Bay may constrain a marine cable alternative. Eighty-one percent of reported damage to existing submarine cables over the past six years is attributed to external damage.[7] Of this percentage, 45 percent of the damage was caused by fishing and trawling gear, and 22 percent was caused by anchors. Because the Hamakua Coast is the windward side of the Island, fishing vessels working off-shore may drop anchor, as would ships awaiting entry into Hilo Bay, or ships in distress. A cable may be damaged from the direct impact of a dropped anchor or the snagging of the cable by an anchor as it is moved.

Installation of a marine cable would come under the review of both Federal and State agencies. The U. S. Army Corps of Engineers would base its review of an application to do work in navigable waters on an evaluation of the probable impact of a marine cable on the public interest, which the Corps defines with a wide range of physical, environmental and socio-economic criteria.

The State government's review of a marine cable proposal would be coordinated by the Department of Land and Natural Resources (DLNR), which administers the State Conservation District. The entire marine route is in the Resource (R) subzone of this District, so the cable would require a permit from DLNR's Board. The R subzone is less restrictive than two of the three other Conservation District subzones.[8] Nevertheless it would be necessary to demonstrate that the cable would not adversely affect the "sustained use of the natural resources" of the subzone. Given the uncertainties

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[7] Sumitomo Electric Technical Review, Number 21, January 1982, "Studies on Submarine Cables with High Resistance to External Damage", Mitsuru Takada, Kusuo Sanjo and Minoru Kameda.

[8] The Protective (P) and Limited (L) subzones are more restrictive than the R subzone as to use. The fourth subzone, the least restrictive, is the General (G) subzone.

Chapter IV

CHAPTER IV: BROADSCALE ANALYSIS

A. INTRODUCTION

As described earlier, the first step in the overhead line route selection process is the identification and definition of criteria for broadscale analysis. These criteria consist of data factors that have a bearing on the location of a transmission line. The evaluation of criteria relies essentially upon information which is already available in mapped form without having to do field surveys. This forms a sufficient data base for the broadscale analytical objectives of Phase 1.

This chapter discusses each of the data factors with respect to conditions on the Island of Hawaii. Under each factor, with the exception of "Exclusion Areas", the conditions are evaluated in terms of degrees of constraint for the location of transmission lines. These constraints range in three degrees from "high" to "low" for each factor, with a description of the criteria used to rate the conditions. Low constraint areas represent opportunities for transmission corridor locations. "Exclusion Areas" are those where transmission lines are essentially precluded by government regulation because of either the desire to protect natural or cultural resources from encroachment or the pre-emptive use of land for such purposes as military training exercises.

Each data factor is evaluated separately. The objective is to analyze the constraints for each factor as if all other factors were equal. No single factor is a determinant of the route. Instead, the routing opportunities are identified through a composite view of the data factors provided by an overlay mapping process.

A constraint map accompanies the analysis of each data factor. To produce these maps, a mylar sheet representing areas of either high constraint or medium constraint for each factor was prepared. A mylar sheet was also prepared for the exclusion areas. No mylar sheet was prepared for the remaining areas, which are designated low constraint.

Color films were then generated from these master sheets. For every medium constraint sheet, one color film was produced. For every high constraint sheet, four color films were produced. These color films are then overlayed to display relative constraint areas for each factor. Low constraint areas remain clear. The Exclusion areas appear as a heavy gray tone.

darker the intensity of color in any given area, the more significant the constraint. Initially, only two high constraint sheets are overlayed for each data factor. This makes the high constraint areas twice as dark as the medium constraint areas. Two additional high constraint sheets were made for each data factor in order to permit the "weighting" of data factors which are considered to play a more significant role in the selection of a preferred transmission corridor. There is no pre-judgment as to what data factors are more "significant" considerations. This is determined by means of the public and agency review process described in Chapter II. As we will see in Chapter IV, it was decided not to weight the relative significance of the data factors.

B. EXCLUSION AREAS

There are certain regulatory restrictions on land use which influence the location of transmission lines. For the most part, these regulations are considered under various physical and socio-economic data factors. In their most restrictive form, however, regulatory measures preclude rather than merely constrain the location of the transmission lines. As a result, these areas should be excluded from consideration as a potential route. The exclusion areas are as follows:

1. Mauna Kea Science Reserve - The summit area of Mauna Kea was established as a Science Reserve by the Board of Land and Natural Resources. A cross-island transmission line would not be permitted in this area according to the policies of the Mauna Kea Plan.

2. National Parks - The National Park Service has jurisdiction over Hawaii Volcanoes National Park and City of Refuge National Park. Because of their status and National Park Service regulations, these are considered exclusion areas.

3. Natural Area Reserves - These are relatively pristine environmental zones designated by the Board of Land and Natural Resources and established by Executive Order for natural preservation in perpetuity under the provisions of Chapter 195, Hawaii Revised Statutes. Even the removal of plants or rocks from these areas is prohibited. Eight such Natural Area Reserves have been designated, including Kipahoehoe, Laupahoehoe, Manuka, Mauna Kea Ice Age, Pu'u Maka'ala, Pu'u O Umi, Waiakea Lava Flow and Wao Kele O Puna.

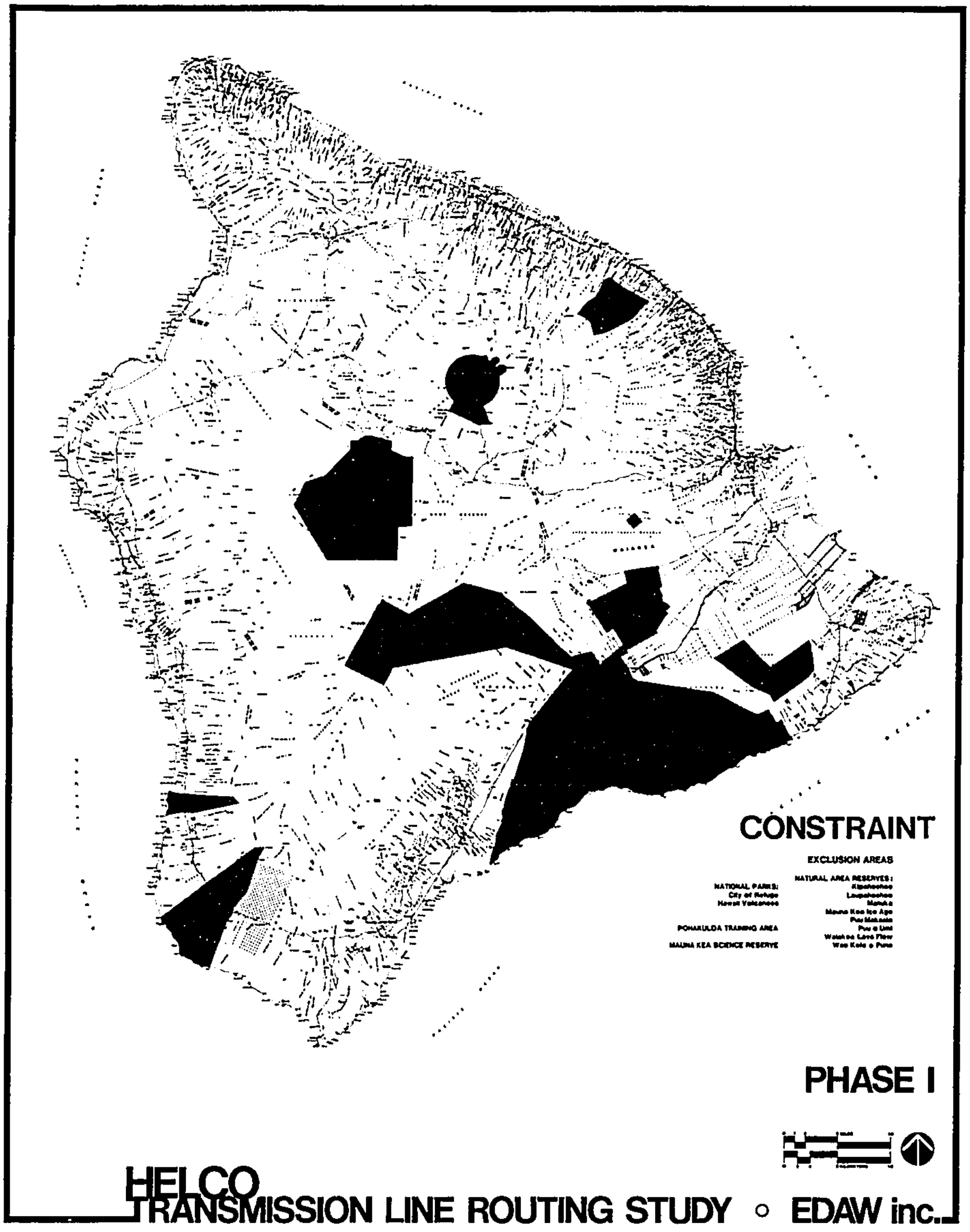

EXHIBIT IV-1:

EXCLUSION AREAS

4. Pohakuloa Training Area - The U. S. Army has defined an "impact area" within its Pohakuloa Training Area, where structures such as transmission lines are prohibited because of the danger posed by explosive materials and military training exercises.

There are other jurisdictional areas where transmission lines would be precluded or severely constrained, but the areas affected are too small to merit consideration as a broadscale factor. An example would be the area near airports where the height of structures, including transmission poles, is restricted to establish "clear zones" within the flight paths of approaching and departing aircraft. Restrictions covering limited areas such as these will be considered in the next planning phase, dealing with the specific alignment of the transmission line within the selected corridor.

C. GEOPHYSICAL FACTORS

1. Slope and Soils

Slope and soil characteristics, particularly erosion hazard potentials, are two related factors which should be considered when locating a transmission corridor.

Slope substantially affects the length of transmission lines, location of the line, positions of utility poles and substation, length of access roads, construction methods required for access roads, the amount of earth movement for road and utility pole construction and vegetation removal. Gentler slopes are more suitable then steeper slopes for pole construction and access road location because road and line distances are shorter and necessary earth movement and vegetation removal are minimal. A common threshold used to distinguish "steep" from "gentle" slopes for land use suitability analysis is 20 percent.[1] This is a standard which is appropriate for identifying "high" constraint areas for transmission corridors. About 85 percent of the Island of Hawaii has a

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[1]EDAW, inc., State of Hawaii Land Use Districts and Regulations Review, Honolulu, Hawaii, 1969. Plate 10, page 44, Potential Hazard Areas.

slope of less than 20 percent.[2] Slopes between 0 to 20 percent are not given a constraint rating. A more significant topographic data factor for areas with slopes in this range is the characteristics of the soils.

The clearing of vegetation and placement of structures is less desirable in an area whose soils are subject to considerable wind and water erosion than in areas where this hazard is not as significant. While the utility poles would not occupy a large area, the stability of these structures may be either undermined by erosion or stressed by accumulated soil deposits at their base. In addition, the presence of man-made structures, including access roads, tends to aggravate natural erosion hazards. Thus, soils with severe erosion hazard potential should be avoided, if possible. The U. S. Soil Conservation Service has rated the erosion hazard potential as "slight," "moderate" or "severe" for each of the soil classifications which they have identified and described for the Island of Hawaii.[3] These ratings correspond to "low", "medium" and "high" constraints respectively.

DEGREE OF CONSTRAINT	CRITERIA
High	Erosion hazard potential rated "severe" and/or slope greater than 20 percent.
Medium	Erosion hazard potential rated "moderate."
Low	Erosion hazard potential rated "slight."

[2]Federal Emergency Management Agency, Flood Insurance Study, Hawaii County, Hawaii (Unincorporated Areas). February 1, 1982, p. 4.

[3]U. S. Department of Agriculture, Soil Conservation Service, Inventory of Hawaii Type IV River Basin Survey, Honolulu, July, 1975. Figure 4.1, pp. 4-2, 3.

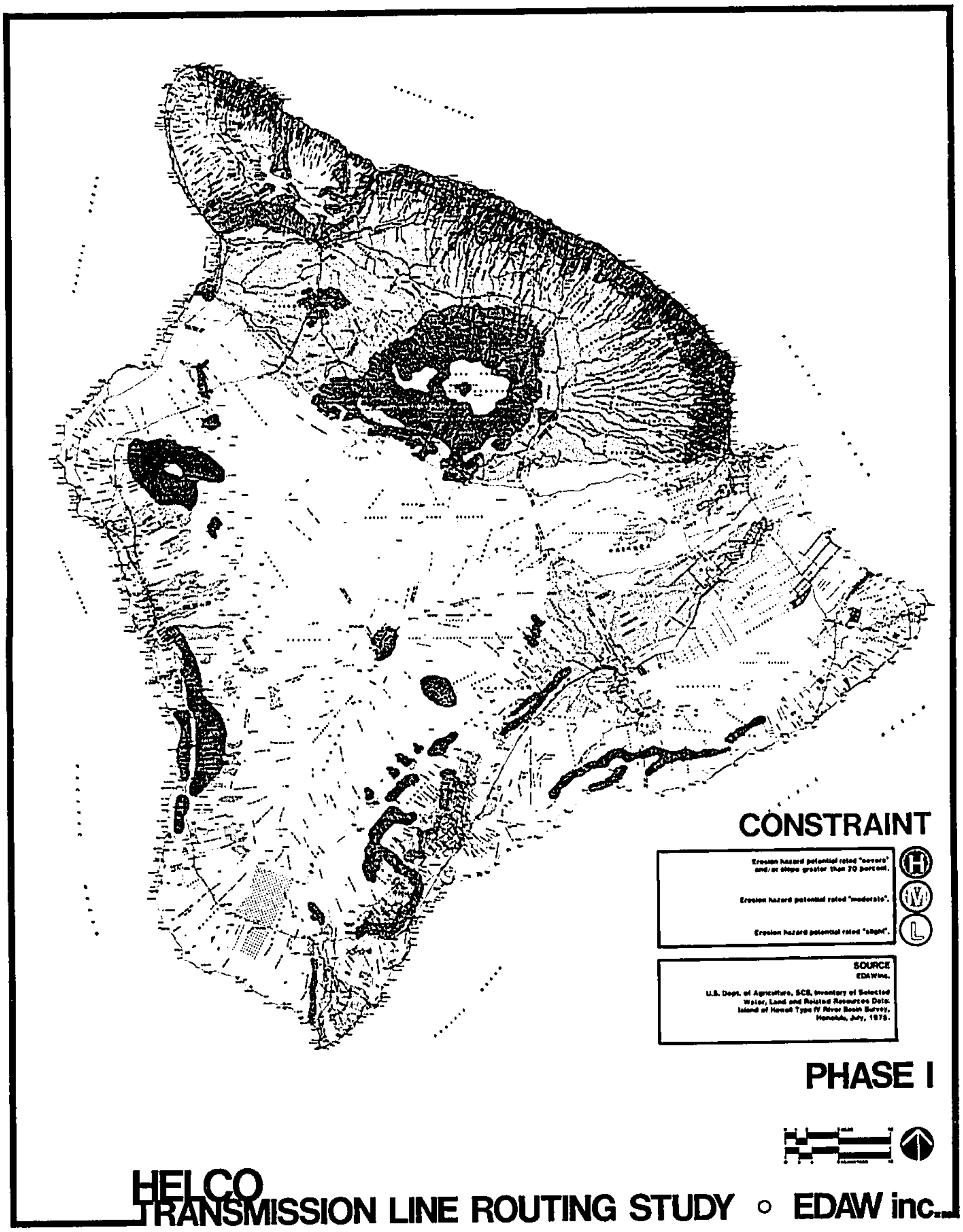

EXHIBIT IV-2:

SLOPE AND SOILS

2. Geologic Hazards

The Island of Hawaii is geologically the most active in the Hawaiian archipelago. Many volcanic eruptions and earthquakes on this island have been recorded in historic times. Several faults and rift zones are present, as well as lava flows, tubes and vents from volcanic activity. These hazards pose an obvious physical constraint for the location of transmission lines. While the entire island is considered a hazard area in this respect, there are various degrees of risk according to location. Historical records of lava flows and seismic events provide some indication of the relative risk in various geographic areas of the island.[4] The risk of seismic and volcanic hazard in these areas has been rated as "high", "medium" and "low".

The characteristics of these constraint areas are as follows:

DEGREE OF CONSTRAINT	CRITERIA
High	Rift zones; area covered by lava flows since 1800.
Medium	Other areas which have been covered by lava flows within past 5000 years.
Low	All remaining areas.

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[4] U. S. Department of the Interior/Geological Survey, Natural Hazards on the Island of Hawaii, Washington, D. C.: U. S. Government Printing Office, 1977. Figures 2 and 4, pages 7 and 11; and Donal R. Mullineaux and Donald W. Peterson, Volcanic Hazards on the Island of Hawaii, U. S. Geological Survey Open File Report 74-239, 1974.

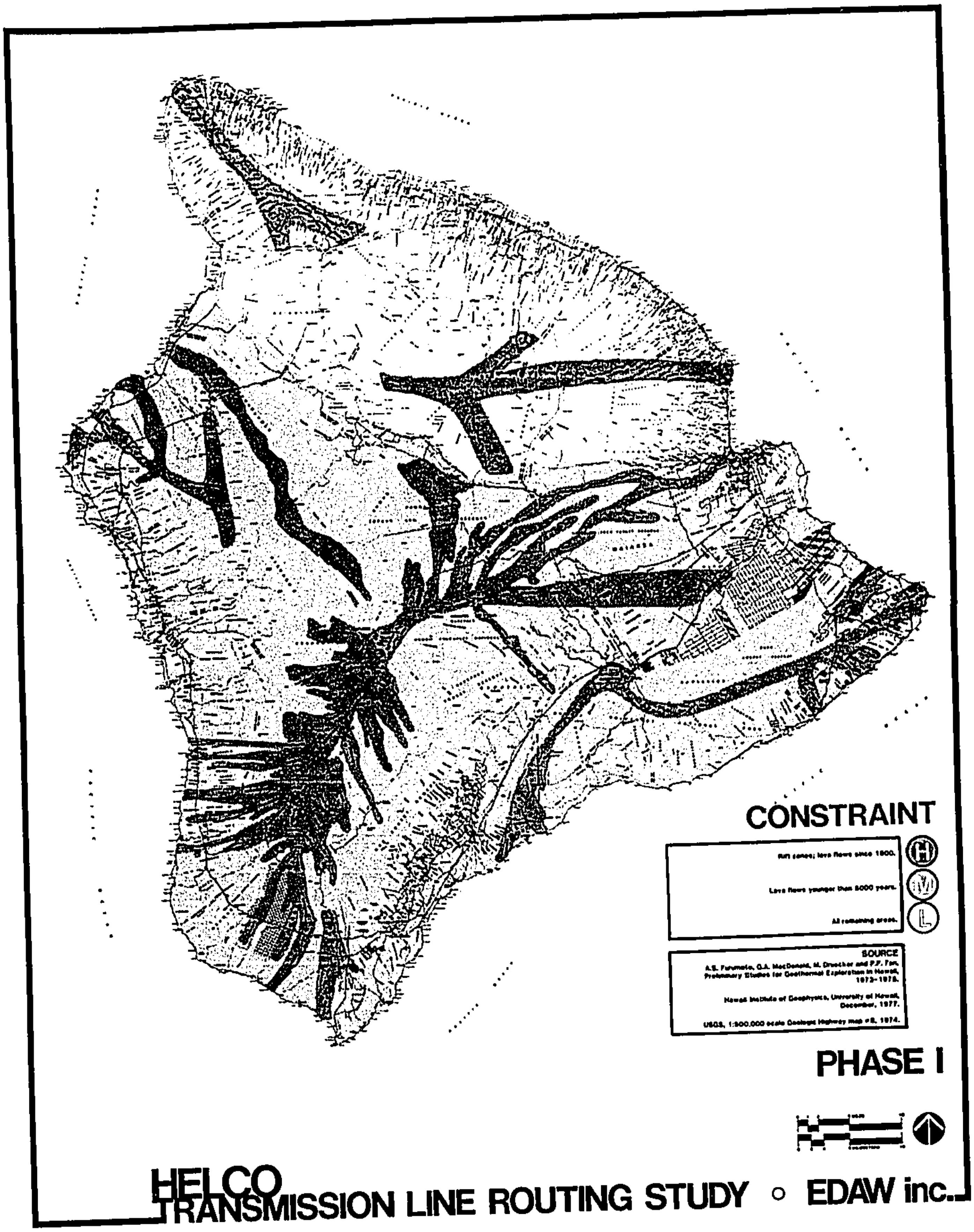

EXHIBIT IV-3:
GEOLOGIC HAZARDS

3. <u>Hydrology</u>

Hydrological features include surface waters of both a perennial and intermittent nature, groundwater areas and rainfall patterns. A factor related to hydrology is coastal and riverine flooding. Storm waves, tsunamis and stream flooding are constraints for transmission corridors because of the lateral force which the high velocity waters exert on the transmission poles. However, the 100-year flood and coastal high hazard boundaries encompass a very small portion of the island.[5] These are areas which in any case would be avoided for the routing of a transmission line due to consideration of other factors, such as the location of major water bodies.

Perennial surface waters encompass streams, lakes, wetlands and ponds. Intermittent surface waters occur in stream beds, gulches and stormwater retention basins on an incidental basis following periods of high rainfall.

Intermittent streams are not a significant constraint as a broadscale factor. They can be avoided by considering them as a constraint criterion during the selection of a precise alignment within a transmission corridor. However, perennial water bodies are a significant constraint because the continuous presence of water makes them more important as biological resource areas and as a source of potable water, both direclty and through the recharge of groundwater aquifers.

The turbulence and other forms of disturbance caused by the construction and maintenance of a cross-water cable or nearby transmission pole adversely affects water quality. This is in turn, affects aquatic life, as noted in a following description of biological factors.

Since a stream course is linear, just as a transmission corridor, the potential impact is less significant if the transmission corridor simply crosses the stream rather than runs parallel to it at close range. Thus, the constraint areas for streams are "regimes" which include the land area on either side of the stream bed. The State's

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[5]See U. S. Department of Housing and Urban Development, Federal Insurance Administration, <u>Flood Boundary and Floodway Map: County of Hawaii</u>, no date.

Water Resources Development Plan has identified such a regime along the Hamakua Coast.[6]

Potable groundwater areas are another hydrologic consideration. These groundwater resources are replenished primarily by rainfall in forest reserves, which act as watersheds.[7] The protection of forest cover in high rainfall areas is important not only to prevent long-term soil erosion and sedimentation, but also to extract rainfall from the moist trade winds that pass over them. Because of the importance of the forest reserve watersheds, they do pose a constraint for a transmission corridor. Nevertheless, it is not necessary to clear the entire transmission easement or even trim the tops of the trees if there is adequate clearance for the power lines. In other words, there is an opportunity to mitigate the potential impacts on forest reserves without avoiding the area altogether. Thus, watershed areas are considered a "medium" constraint.

The final hydrologic element is the rainfall pattern.[8] Since rainfall affects both soil and water resources, the potential impacts on these resources are intensified in areas subject to high rainfall. Thus, areas with an average annual rainfall of 75 inches and over are categorized as "medium" constraint areas and areas with less rainfall than this in an average year are "low" constraint areas.

In summary, the hyrdologic constraints can be described as follows:

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[6]See Department of Land and Natural Resources, <u>State Water Resources Development Plan and Technical Reference Document</u>, Honolulu: September, 1980; Figure 2, page III-11.

[7]State Department of Land and Natural Resources, <u>Conservation District Inventory</u>, Honolulu, July, 1977. Map 4: Water Resources.

[8]<u>Ibid</u>.

DEGREE OF CONSTRAINT	CRITERIA
High	Regimes of perennial fresh water bodies, wetlands and streams.
Medium	Watersheds; areas with average annual rainfall of 75 inches or more.
Low	All remaining areas.

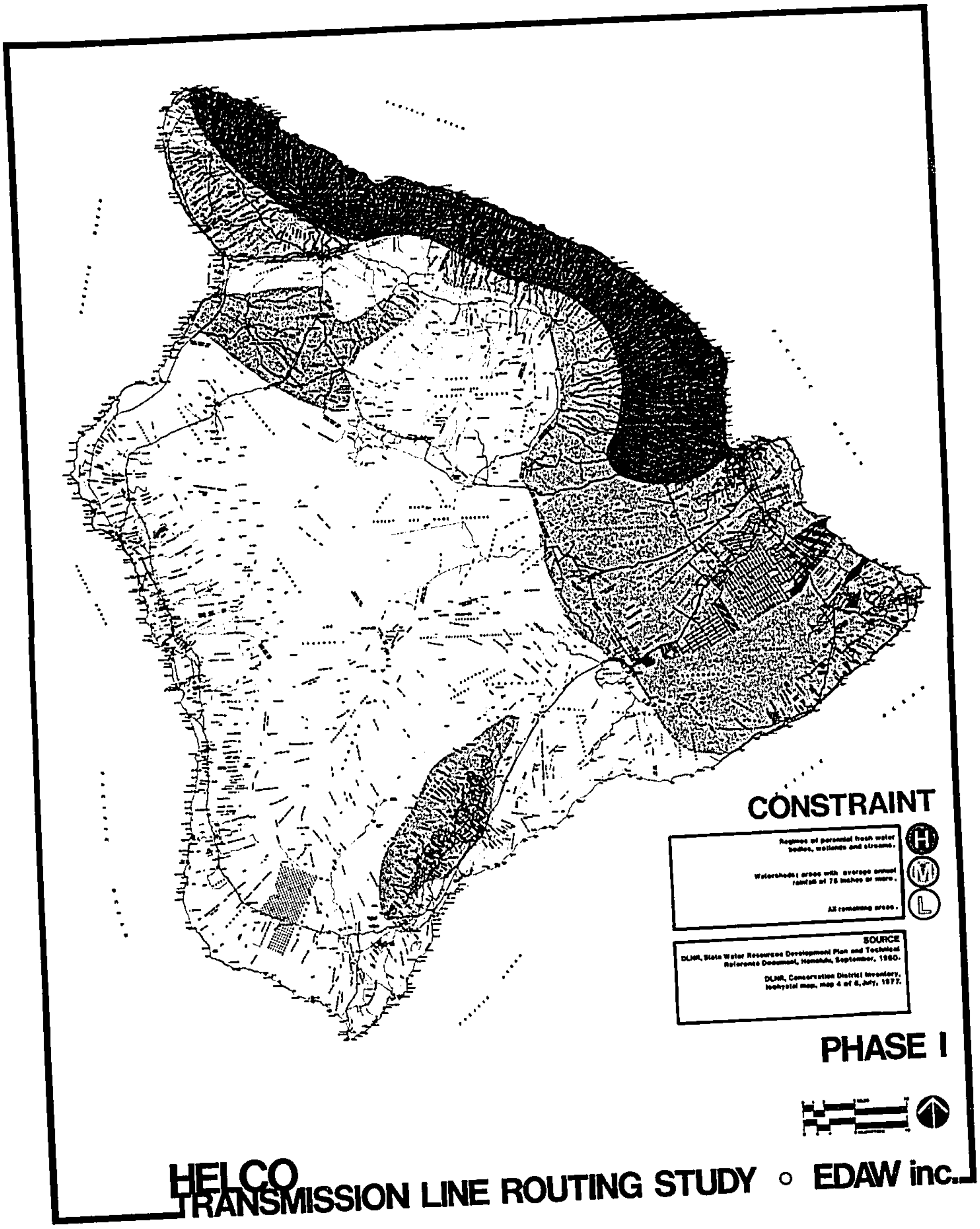

EXHIBIT IV-4:
HYDROLOGY

D. BIOLOGICAL FACTORS

1. Vegetation

Transmission lines can adversely affect plant life, primarily as the result of a potential fire hazard in the event a line is downed. The necessity of keeping transmission lines clear of vegetation often requires the removal of some foliage in forest areas. Sometimes the vegetative growth is kept at a very low height within the easement for ease of access and maintenance. This can disrupt the ecological balance in native forest areas which serve as critical habitats for rare and endangered species of animal life, particularly forest birds. It is possible to mitigate this by feathering down the tree tops in forest areas so that an adequate clearance for the circuits can be maintained without removing all trees and shrubs from the easement. However, maintenance must be more frequent under this method. In addition, a clear area underneath the transmission line can act as a fire break and provide access for fire-fighting vehicles and personnel.

The threat of fire is greater in dry zones with highly flammable vegetative cover, such as shrubs, ferns and high grasses. Therefore, while native forests are an important botanical resource, many such areas are wet almost the entire year with an average annual rainfall of 75 inches or more. The potential of a serious fire from a fallen transmission line is less here than in an area such as the Puna District where a low-lying cover of ferns and other highly flammable plant material have ignited during dry spells.[9] Fires that start in such areas could rage out of control and spread to forest areas.

Fortunately, there have been no recorded instances of fires having been caused by HELCO transmission lines. However, the more fire-prone areas expose transmission lines themselves to the hazard of fires caused by other sources, so the constraint is reciprocal.

In summary, the areas of "high" constraint are native forests with an average annual rainfall of less than 75 inches or other vegetation zones with

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[9] Records in the Department of Land and Natural Resources, Division of Forestry and Wildlife.

highly flammable plant material and/or less than 20 inches of average annual rainfall. The wetter native forests and other vegetation zones are considered "medium" constraint areas. All water bodies, urbanized areas and land areas covered by barren lava fields and cinders are "low" constraint areas with respect to potential impacts on vegetation.

DEGREE OF CONSTRAINT	CRITERIA
High	Native forests with less than 75 inches of average annual rainfall; other areas with highly flammable cover and/or less than 20 inches of average annual rainfall.
Medium	Native forests with 75 inches or more of average annual rainfall; other areas with vegetative cover and 20 inches or more of average annual rainfall.
Low	Barren lava and cinder lands; urbanized land.

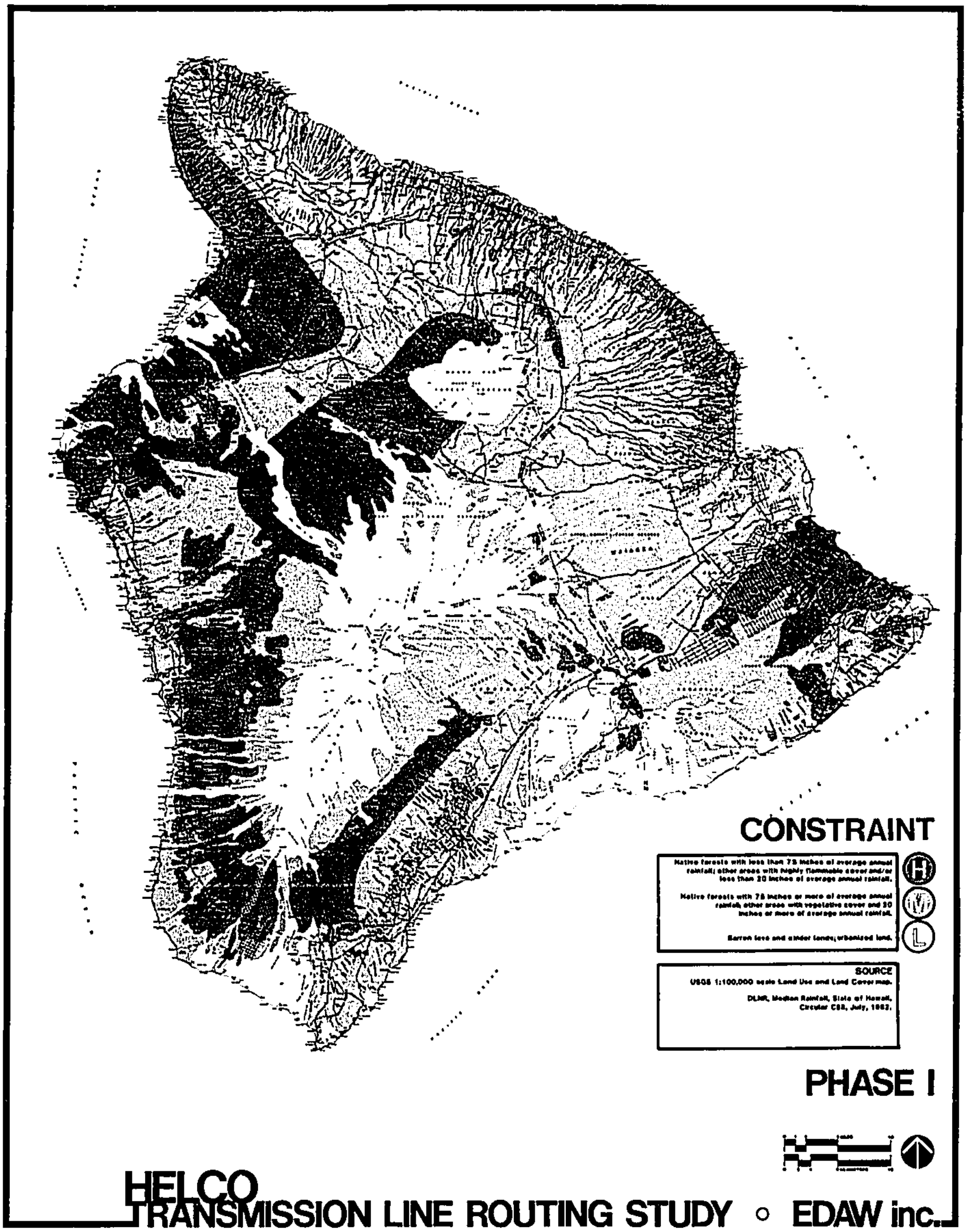

EXHIBIT IV-5:

VEGETATION

2. Wildlife

In general, a transmission line's presence is more significant to avifauna than to other wildlife populations because there is a potential for collision with towers and conductors where transmission lines cross bird migration routes, flyways and use areas. The incidence of mortality depends upon several factors, including the number of birds present, weather conditions and individual species behavior.

A principal concern is the habitat and nesting areas for rare and endangered forest birds, of which there are several species, including the 'Io (Buteo solitarius), 'Alala (Corvus tropicus), Hawaii 'Akepa (Loxops coccinea), 'Akiapola'au (Hemiguathus wilsoni), 'O'u (Psittirostra psittacea), and Palila (Psittirostra bailleui).

The Nene (Branta sandvicencis), which is the State bird of Hawaii, has adapted to life on rugged lava flows. It nests at elevations of about 5,000 to 8,000 feet on the slopes of Mauna Loa. Similarly, the 'Ua'u (Pterodroma phaeopygia sandwichensis), an endangered species of marine bird, has nesting areas on volcanic slopes at elevations between 7,000 and 10,000.[10]

Wetlands, streams and ponds are also important habitats and feeding areas for certain types of birds, some of which are endangered species, such as the Koloa (Anas wyvilliana), the Gallinule (Gallinula chloropus sandvicencis), the Coot (Fulica americana alai), and the Black-necked Stilt (Himantopus himantopus knudseni). There is a further reason why streams, particularly the areas near the mouth of perennial streams are important: they serve as habitats for aquatic species such as diadromous fishes.[11]

Critical terrestrial and aquatic habitats and nesting areas, as defined by the U. S. Fish and Wildlife Service, are considered "high" constraint

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[10] U. S. Fish and Wildlife Service, Hawaii's Endangered Forest Birds, (no date) and Department of Geography, University of Hawaii, Atlas of Hawaii, Honolulu: The University Press of Hawaii, 1973, pp. 70-73.

[11] Diadromous fishes mature in fresh water, spawn in salt water, then return to fresh water. An example is the O'opu, a native Hawaiian goby.

areas. The geographic area identified as the normal range of native avifauna is a "medium" constraint zone.

Transmission corridors pose only a very limited impact to habitats for land-based mammals. Potential adverse impacts on insect and snail populations are localized and can be mitigated by siting utility poles to avoid major colonies and habitats. The most interesting insect and land snail species, from a biological point of view, are found in relatively pristine environments, such as native forests, or in marginal habitats, such as high altitude zones or lava tubes. Since these areas would be avoided anyway, because of their inherent characteristics, the existence of localized populations of insects and snails is not considered, in itself, a broadscale constraint for a transmission corridor.

DEGREE OF CONSTRAINT	CRITERIA
High	Critical habitats for endangered birds and for aquatic species.
Medium	Normal range of native avifauna, other than critical habitats.
Low	All remaining areas.

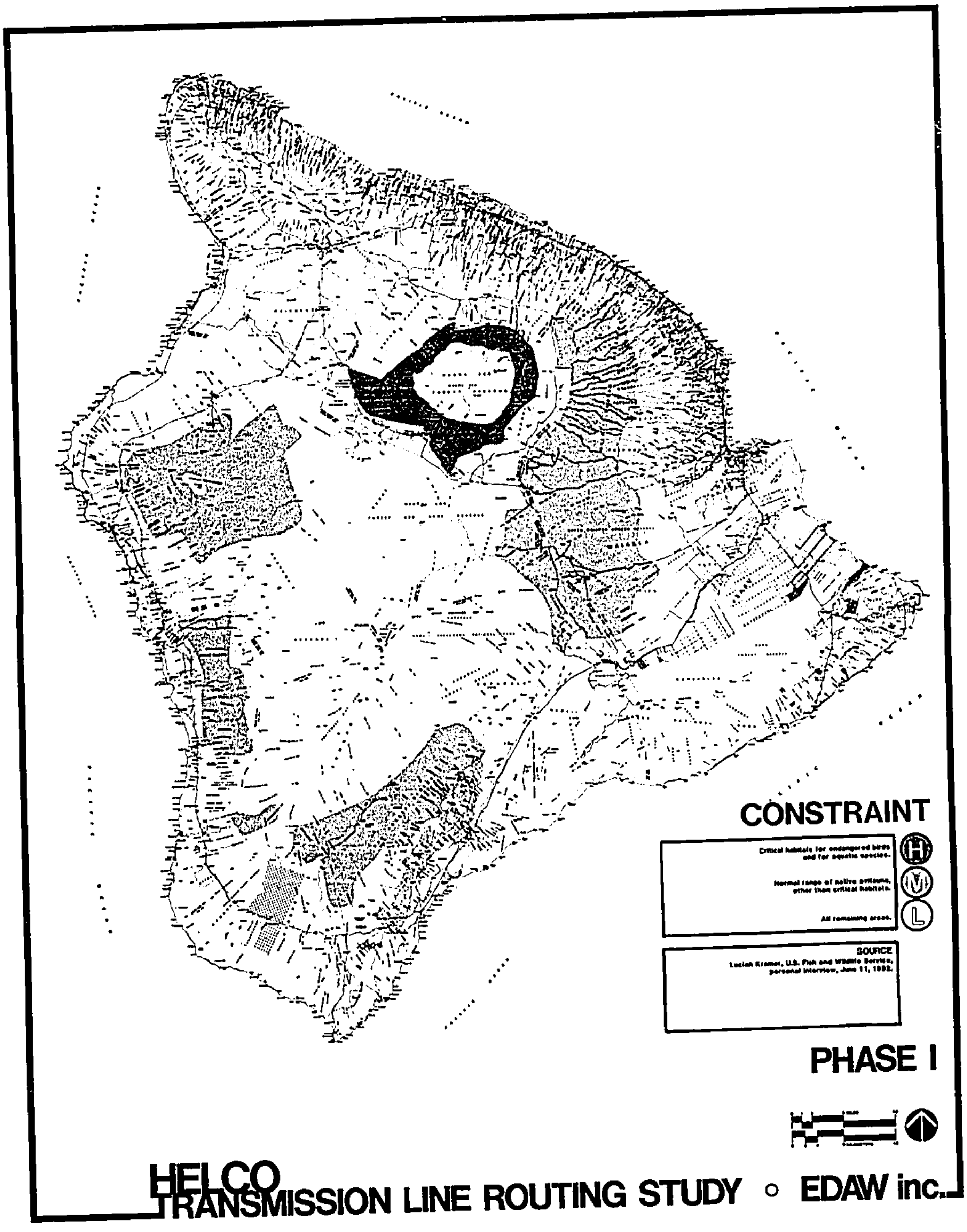

EXHIBIT IV-6:

WILDLIFE

E. SOCIO-ECONOMIC FACTORS

1. Recreation

While transmission lines can and often do co-exist quite compatibly with nearby recreational areas, they are perceived as a potential encumbrance. This may tend to constrain the recreational value of an area underneath and to either side of the transmission line. This is a greater constraint for beach parks and playgrounds designed for active recreation use, such as organized games and sporting events, than for wilderness parks, since the former are usually smaller in size and exposed to more frequent and intensive use.

Existing and proposed public recreation areas have been identified in the State Recreation Plan.[12] This document also rates the intensity of use for these recreation areas. For the purposes of this analysis, high and moderate use areas are considered a "high" constraint and medium and low use areas are classified as "medium" constraints. Areas with no identifiable recreational value are "low" constraints.

DEGREE OF CONSTRAINT	CRITERIA
High	High and moderate recreation use.
Medium	Medium and low recreation use.
Low	All remaining areas.

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[12] See State Department of Land and Natural Resources, State Recreation Plan Technical Reference Document, Honolulu, September, 1980; pp. 215-226.

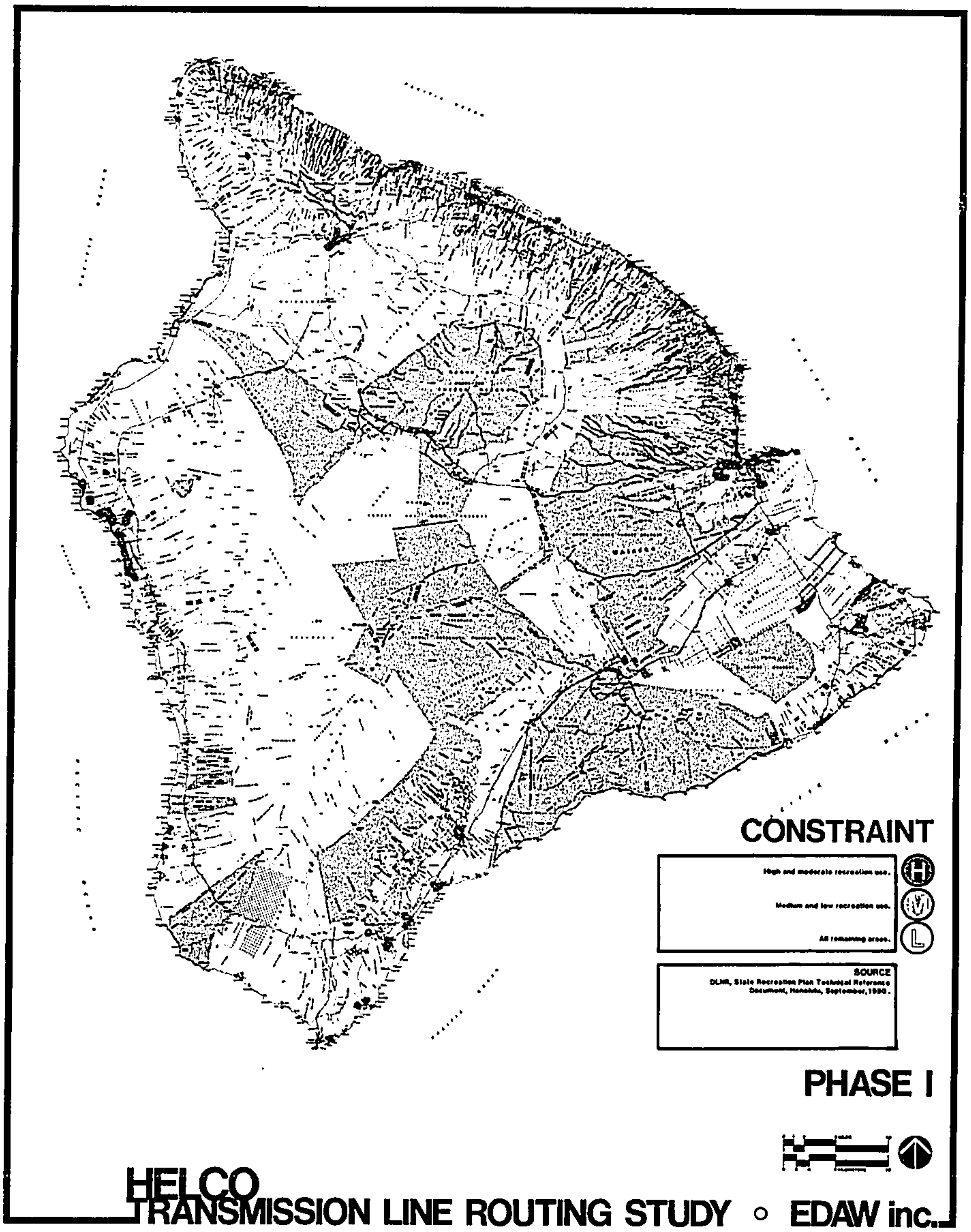

EXHIBIT IV-7:
RECREATION

2. Land Use

Transmission line easements can be maintained so as to avoid possible harm or interference with the human use of land. Nevertheless, while safeguards can be provided, transmission lines are generally perceived as an unsightly and potentially hazardous intrusion in areas which are more intensively exposed to human activity. Indeed, experience in Hawaii and elsewhere has shown that opposition to a transmission line is usually strongest when the proposed alignment crosses through such areas.

Urban and urbanizing areas receive the greatest human exposure and are, therefore, classified as a "high" constraint for the location of a transmission line. However, industrial areas are of somewhat less concern than other types of urban use, such as residential neighborhoods and resort areas, because the perceived hazards and nuisances of industrial activity are often as great or greater than those of a transmission line. Therefore, industrial use zones are considered a "medium" constraint. The various categories of existing and planned urban use areas are identified in the County's General Plan.[13]

Agricultural areas, while not as intensively exposed to human activity, are important to the support of this activity. There is a wide range of the quality of agricultural land in terms of productive capability. The State Department of Agriculture has described, classified and located what are considered to be the most important agricultural lands on the Island of Hawaii.[14] With respect to the siting of transmission corridors, the lands classified as "prime" and "unique" are considered to be "high" constraints and those areas designated "other agricultural land" are "medium" constraints.

Resource conservation areas can be considered a passive land use, but are undeniably important to the support of human activity. Nevertheless, the values which make these areas important, for purposes such as groundwater recharge and wildlife

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[13]County of Hawaii, The General Plan, (Adopted by Ordinance No. 439 on December 15, 1971).

[14]State Department of Agriculture, State Agriculture Plan and Technical Reference Document, Honolulu, September, 1980, Appendix B.

habitats, have been considered as constraint factors in themselves. Therefore, no additional constraint evaluation is necessary from the standpoint of land use, per se.

DEGREE OF CONSTRAINT	CRITERIA
High	Areas designated for non-industrial urban use on General Plan; prime and unique agricultural land.
Medium	Other agricultural lands; industrial land.
Low	All remaining areas.

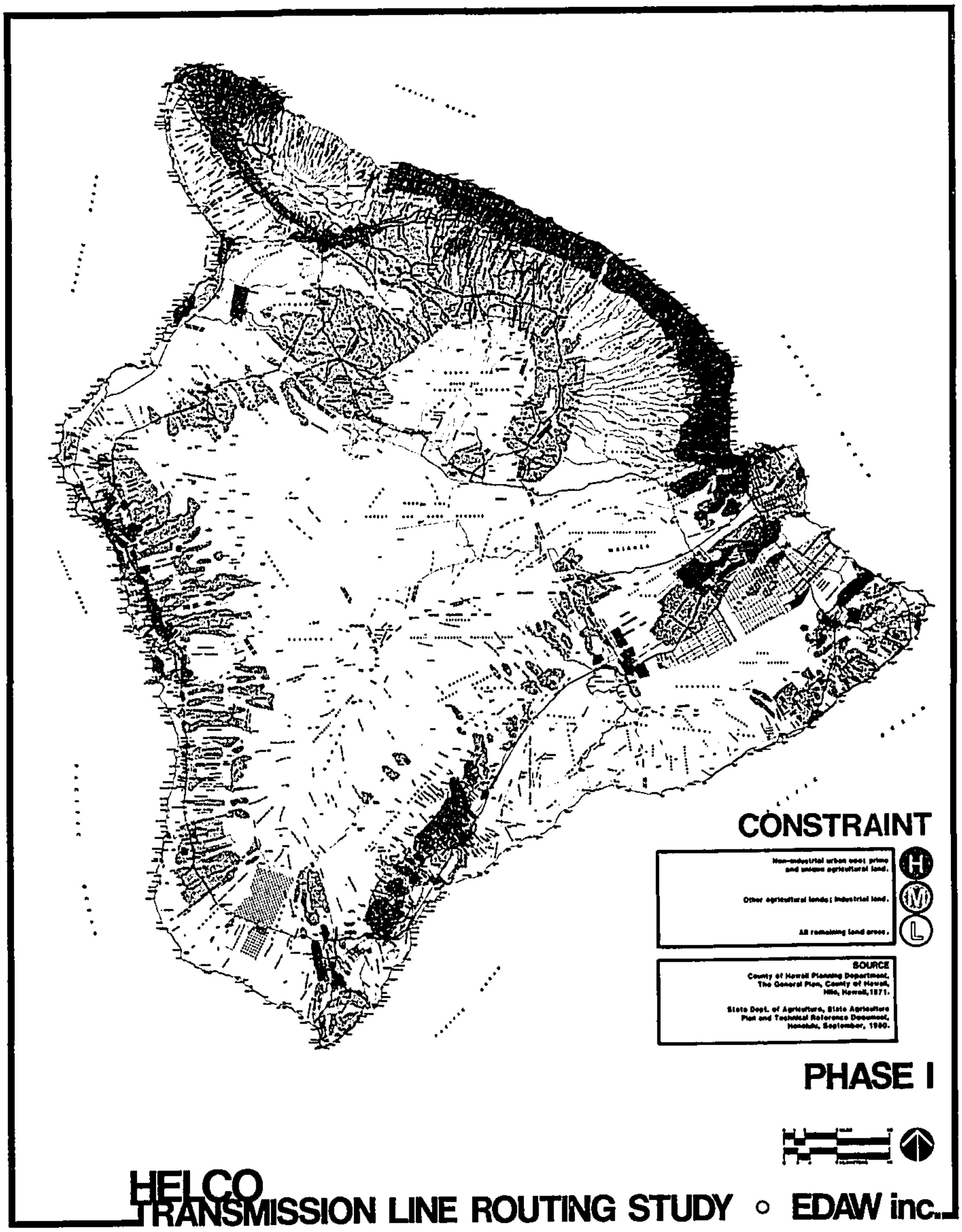

EXHIBIT IV-8:

LAND USE

3. Transportation and Utilities

The island's present network of public roadways and utility lines represents an opportunity for the location of a transmission line because they are existing easements which could conceivably allow for additional poles or circuits on poles already in place. Utilities include sewer, water and gas mains as well as overhead telephone and electric power lines. In most cases these utilities are located within road easements or closely parallel major highways. The major advantage of conforming to this alignment pattern is that it avoids the disruption which a transmission line easement might create in "new" territory and it tends to minimize the cost of construction and maintenance. In a sense, it relates to almost all of the other data factors.

Because of the importance of this factor, all areas within near range of existing major public roadways and utility easements are considered a "low" constraint and all areas beyond this are assigned a "high" constraint.

DEGREE OF CONSTRAINT	CRITERIA
High	More than 1/2 mile from a major public road or utility line.
Medium	Not applicable.
Low	Areas within 1/2 mile of a major public road or utility line.

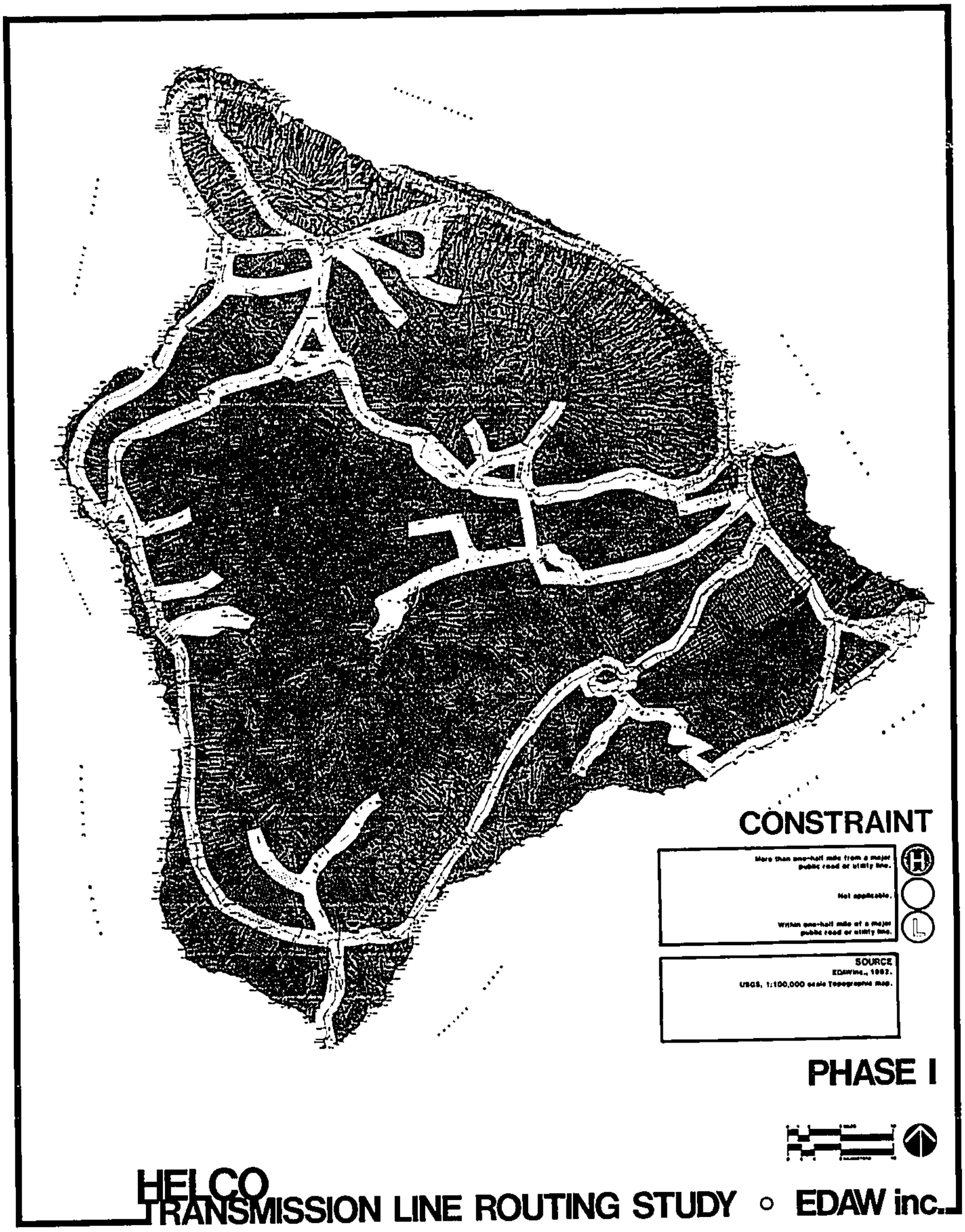

EXHIBIT IV-9:

TRANSPORTATION AND UTILITIES

4. Land Ownership

For safety and access, easements at least 75 feet wide are required for 138 Kv transmission lines. The acquisition of the easement will generally have a much greater impact on the potential use of a small parcel than it would on a large landholding.

The number of landowners within a proposed easement also exacts a public cost. The more property owners which the utility company must deal with in acquiring the easement, the more complicated the procedural requirements. Thus, there is a greater constraint where there is a substantial degree of parcelization.

Much of the island's land area is comprised of extensive private estates and public lands. However, there are scattered areas where a highly parcelized ownership pattern prevails.[15]

While most public lands might present an opportunity for a transmission route, the property under the jurisdiction of the Hawaiian Homes Commission is a unique situation because of Federal and State statutory restrictions which limit the period for the granting of easements across these lands to a maximum of 21 years. Utility companies normally seek a perpetual easement. The Hawaiian Homes Commission intends to initiate legislation to lift this restriction, but, in the meantime, their landholdings should be considered a "medium" constraint for a transmission corridor.

DEGREE OF CONSTRAINT	CRITERIA
High	Areas with a high degree of land parcelization.
Medium	Hawaiian Homes Commission lands.
Low	All remaining areas.

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[15]Department of Geography, University of Hawaii, Atlas of Hawaii, Honolulu, The University Press of Hawaii, 1973, page 41. Areas shown as "small private landowners."

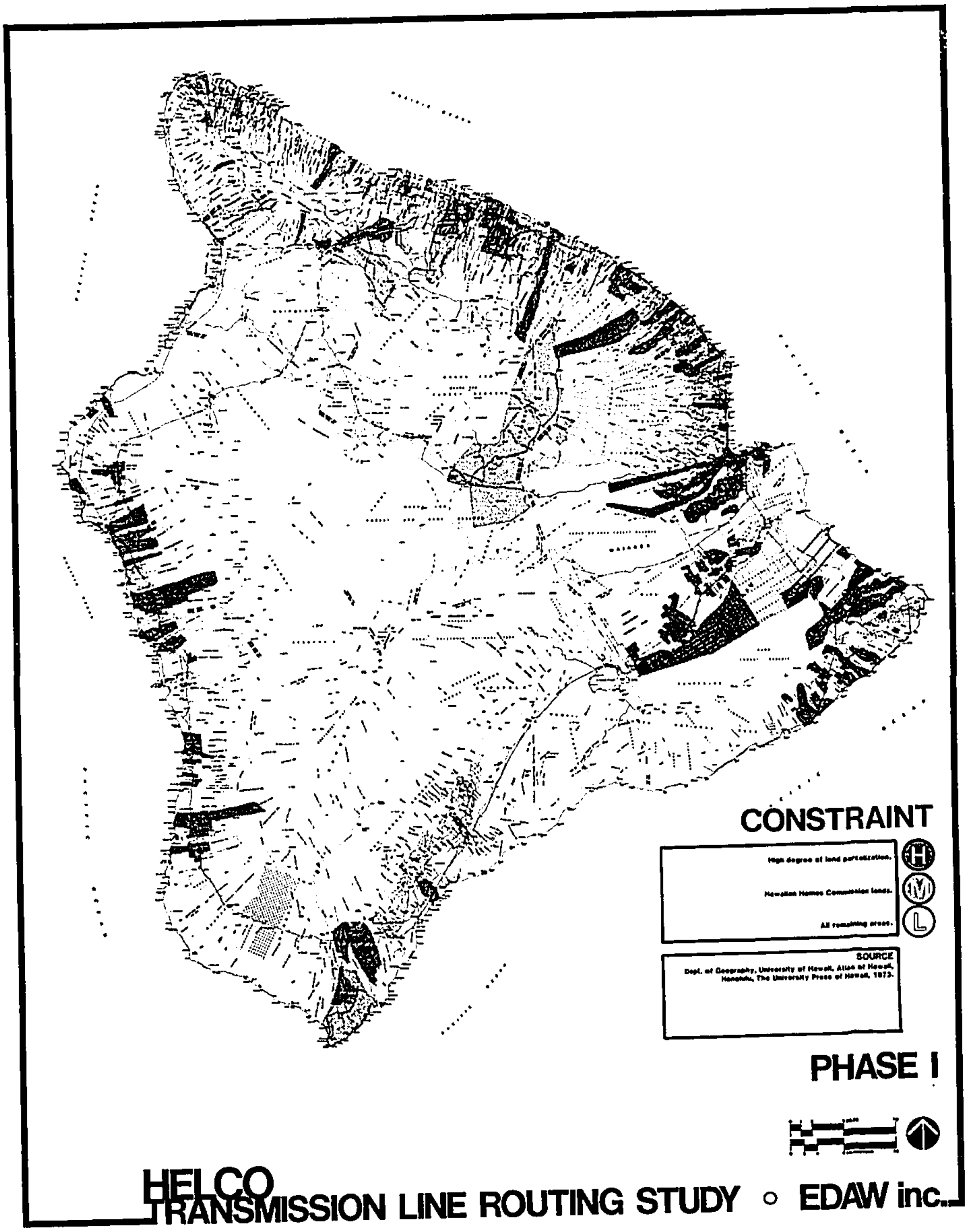

EXHIBIT IV-10:

LAND OWNERSHIP

5. Visual Quality

The General Plan for the County of Hawaii identifies a number of sites which are considered to have significant natural beauty and establishes policies and standards to protect the qualities which make them attractive.[16] Since the General Plan has been adopted by the County, this list of visual resources can be said to represent broad community opinion. Therefore, the areas included on the list are rated as "high" constraint.

The degree of a transmission line's visual impact depends largely upon the visual absorption capability of the landform within the viewshed. For example, a landform that provides a variety of topography and vegetative cover pattern offers the most opportunity for the placement of an overhead transmission line without creating scenic degradation.

Open or homogeneous vegetative cover pattern provides low visual absorption capability. Examples of open landcover on the Island of Hawaii include expansive lava flow areas, grasslands, pastures, sugarcane plantations and low-lying shrub and brush rangeland.[17] Homogeneous landcover would include most of these areas, as well as forests with uniform species types and canopy heights. A transmission line easement tends to be highly visible through such areas because of its distinctiveness.

The visual sensitivity of an open, homogeneous landscape is accentuated by steep topography, particularly when this occurs in a series of ridges and valleys etched by numerous streams, such as along the Hamakua coast. The placement of a transmission line along a steep slope or at the top of a steep ridge increases the probability that it will be silhouetted prominently against

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[16] County of Hawaii Planning Department, The General Plan, County of Hawaii, Hilo, Hawaii, 1971 (Adopted by Ordinance No. 439 on December 15, 1971), pp. 40-43.

[17] Definitions and classifications for landcover are derived from Anderson, J. R., E. E. Hardy, J. T. Roach and R. E. Witmer, A Land Use and Land Cover Classification System for Use with Remote Sensor Data, U. S. Geological Survey Professional Paper 964, 1976.

the sky from several vantage points, especially when the vegetative cover provides an insufficient visual buffer.

A key consideration in the analysis of visual impact is the degree to which an area is exposed to viewers. Obviously, areas in the vicinity of well-travelled roads receive greater exposure. Therefore, areas with low visual absorption capability and high exposure to public views are rated as a "moderate" constraint for the location of a transmission corridor.

DEGREE OF CONSTRAINT	CRITERIA
High	Natural beauty areas, as identified in the General Plan of the County of Hawaii.
Medium	Areas within 1/2-mile of roadways; areas where slopes are 20 percent or more and landcover is open or uniform.
Low	All remaining areas.

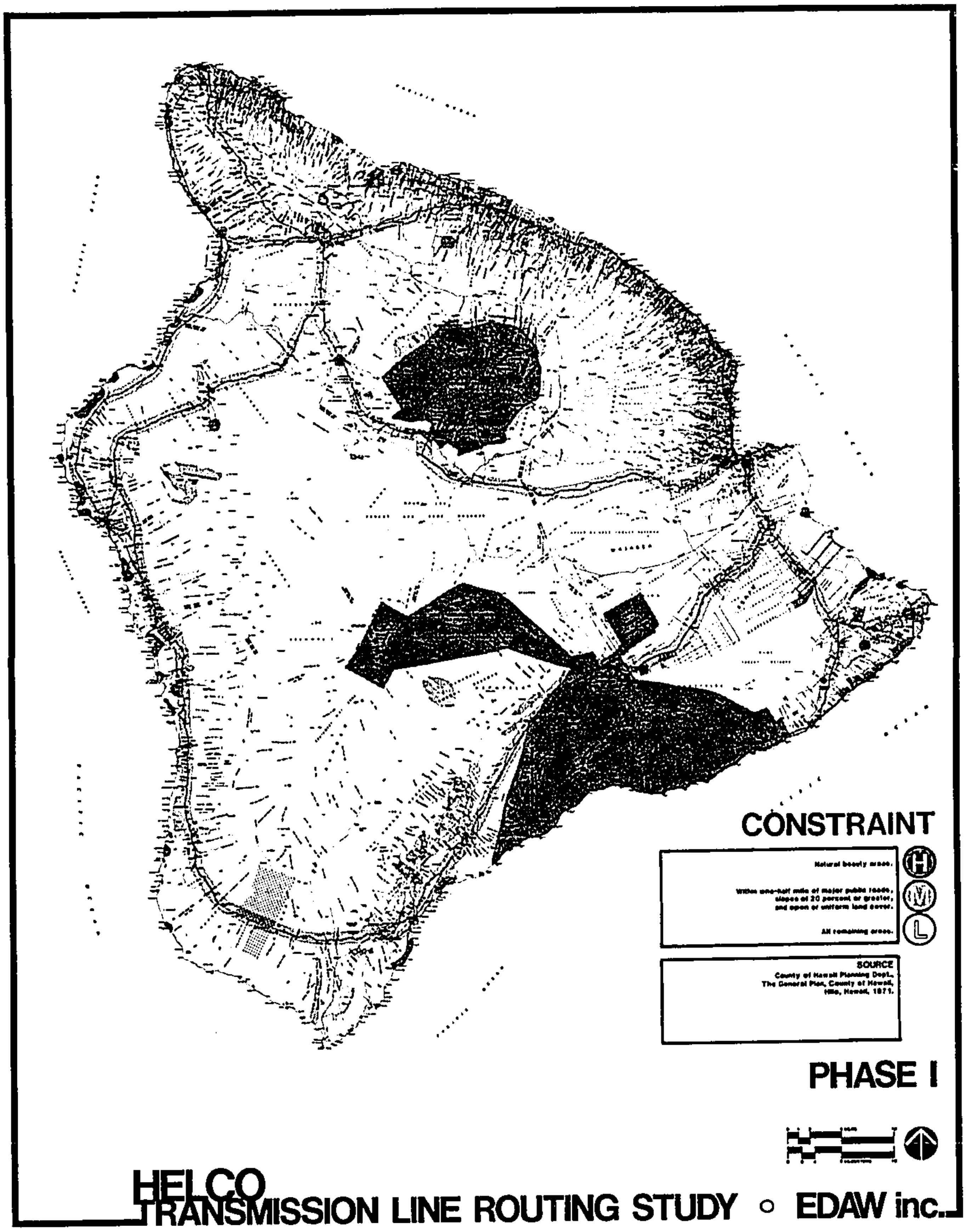

EXHIBIT IV-11:

VISUAL QUALITY

6. History and Archaeology

The construction of a transmission line can detract from the research, cultural and sometimes sacred value of a historic property which lies in or very near its path. In Hawaii, a distinction is generally made between historic properties which pre-date the arrival of Captain James Cook in Hawaii in 1778 and those which are more recent in origin. The former types of properties consist primarily of the archaeological remains of buildings, structures or objects. Unlike more recent historic properties, whose well-defined boundaries circumscribe limited geographic areas, the location and extent of archaeological sites is not fully known.

Some large archaeological complexes have been identified on the Island of Hawaii, such as those at Lapakahi, Honaunau and Honokahau, where major research efforts have been conducted.[18] These are significant enough in size and cultural value to be considered "high" constraint areas. In addition to these major sites, there is a high frequency of smaller known sites and probability of undiscovered sites within certain parts of the island's shoreline region which are thought to have been the areas of concentrated human settlement from the period of 1700 to 1778 A.D.[19] These are considered "moderate" constraint areas. There are a number of other archaeological sites scattered throughout remaining areas of the island and perhaps some of these may appear within the corridor which is selected for further study for the transmission line. However, as individual sites they are too small to consider as a broadscale factor constraint. It will be possible to avoid these sites during the planning of the route alignment. Therefore, most of the island's land area can be categorized as a "low" constraint in this phase of the study.

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[18]Department of Geography, University of Hawaii, Atlas of Hawaii, Honolulu, The University Press of Hawaii, 1973, pp. 85-87.

[19]op. cit.

DEGREE OF CONSTRAINT	CRITERIA
High	Major known archaeological site complexes.
Medium	Areas of possible population concentration, 1700-1778 A.D.
Low	All remaining areas.

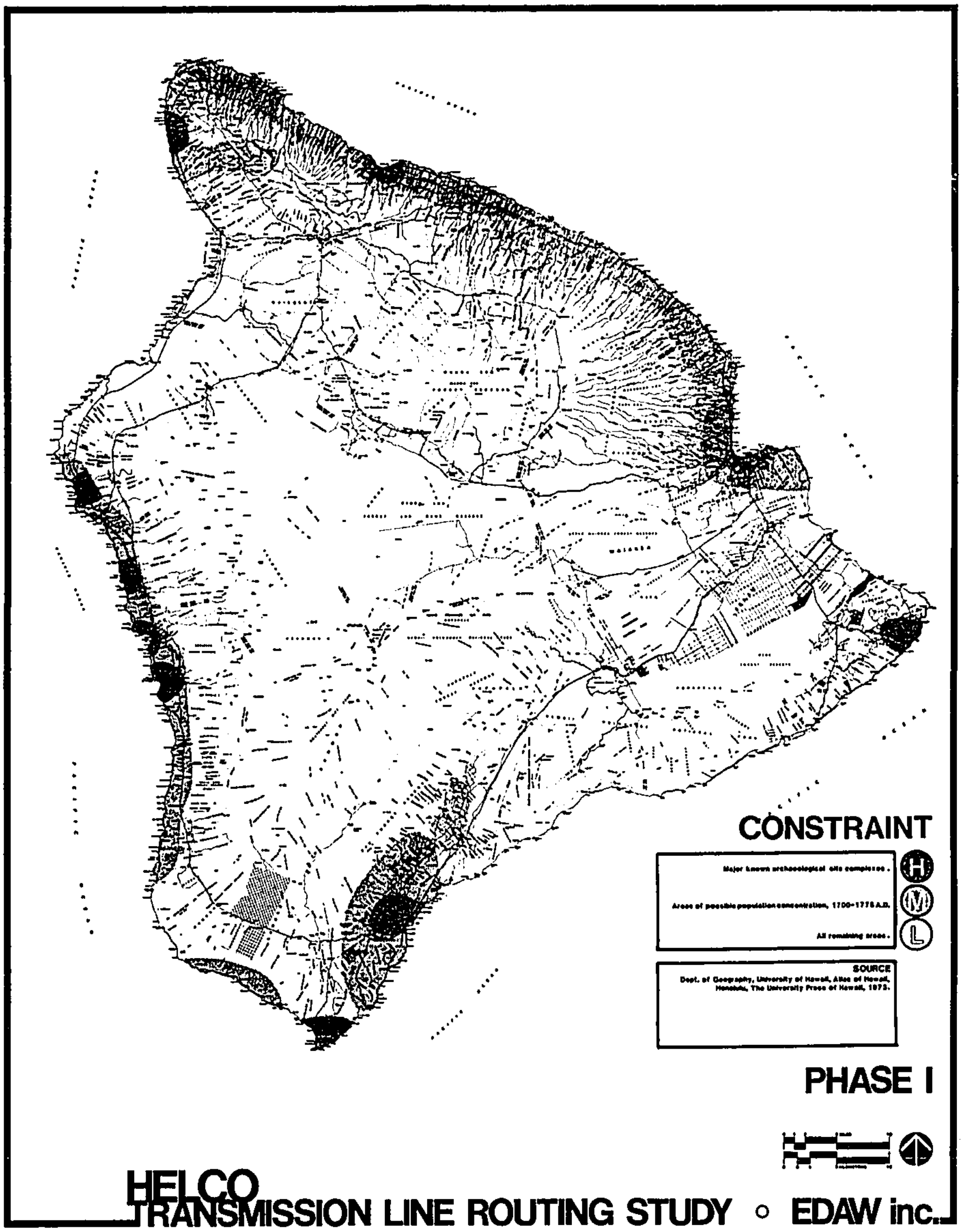

EXHIBIT IV-12:

HISTORY AND ARCHAEOLOGY

7. Land Regulation

There are some areas where the construction of a transmission line would be discouraged by regulatory controls designed to protect special resource values. The controls are not so restrictive that they eliminate these areas from further consideration, such as the Exclusion Areas which were described earlier. Nevertheless, a permit application for a proposed transmission line through these areas would be evaluated in terms of the line's possible conflicts with special resource values.

The State Conservation District contains several subzones and special districts representing a range in degree of restrictiveness. The most restrictive areas are the Natural Area Reserves, which have previously been described as Exclusion Areas. Next in the hierarchy of restrictiveness is the Protective (P) Subzone.[20] This includes "restricted watersheds, fish, plant and wildlife sanctuaries, significant historic, archaeological, geological and volcanological features and sites, and other designated unique areas."

The narrow band of permitted uses within the P Subzone suggests that it is a "high" constraint area for a transmission line route. Somewhat less restrictive are the stated objectives and permitted uses for the Limited (L) Subzone. The L Subzone encompasses areas where "natural conditions suggest constraints on human activities." This is considered a "medium" constraint.

There is a ring of land area encircling the island which has been designated the Special Management Area (SMA) as part of the State's Coastal Zone Management Program.[21] The County reviews permit applications for development within the SMA in terms of a number of policies and guidelines. One of these policies is to "protect the shoreline of the County where needed from encroachment of

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[20]State of Hawaii, Department of Land and Natural Resources, Regulation No. 4 pursuant to Chapter 183-41, Hawaii Revised Statutes, Honolulu, Hawaii, May 1978.
[21]c.f., Chapter 205A, Hawaii Revised Statutes.

man-made improvements and structures.[22] Specifically, uses which are not coastal-dependent are discouraged. The SMA is, therefore, considered a "medium" constraint area.

DEGREE OF CONSTRAINT	CRITERIA
High	Protective Subzone of the State Conservation District.
Medium	Limited Subzone of the State Conservation District; Special Management Area.
Low	All remaining areas.

[22]County of Hawaii Planning Department, "Rules Relating to Administrative Procedures: Planning Commission", Hilo, Hawaii, October 1975.

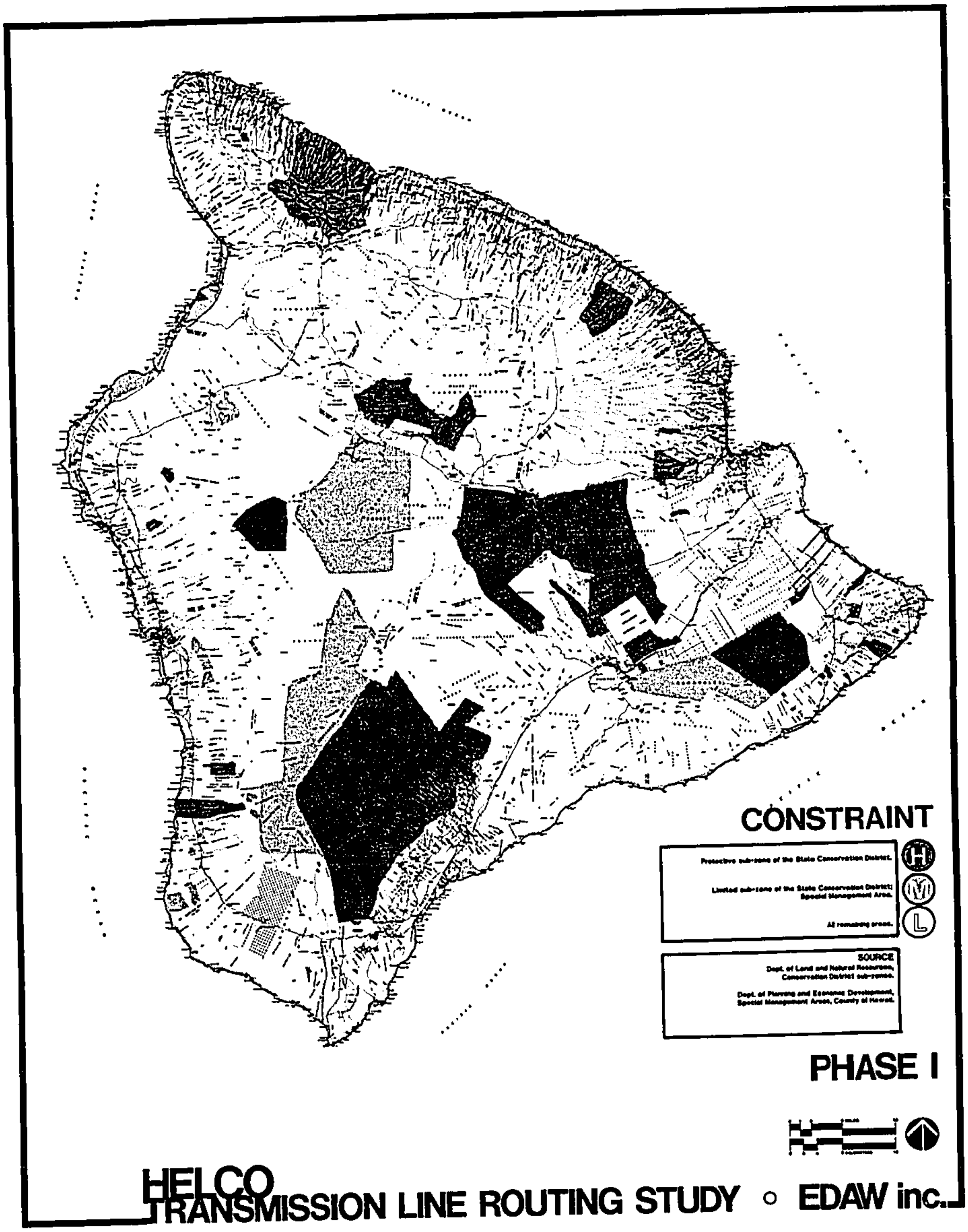

EXHIBIT IV-13:

LAND REGULATION

F. COST FACTORS

1. Land Value

Land value has a direct impact on the cost of acquiring an easement for a transmission line. Utility companies have the power of eminent domain, but usually must pay private property owners a consideration based on an appraised value for transmission line easements.

The present and potential use of a property is the most significant influence on its value. Potential use can be determined by the property's location, physical characteristics and zoning designation. The land use classifications used for real property assessment purposes in Hawaii take potential use into account; e.g., there is a separate classification for "unimproved residential" land.[23] Assessed valuation provides the most comprehensive available indicator of land value according to present and potential use. It is possible, on the basis of public records, to determine the average valuation per acre for different categories of existing and potential use.[24]

Assessed valuations for these categories fall into three distinct groups, corresponding closely to the State Land Use District categories of Urban, Agriculture and Conservation.[25] The Urban District is the high-value category. The Agriculture and Conservation Districts are the medium and low-value categories, respectively.

Market value alone, however, does not determine the cost of a transmission line easement. HELCO has found, for example, that large landowners are willing to provide easements at little or no cost. Often, the transmission line is a benefit to these landowners and can result in an increase in value

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[23] Hawaii uses the code system established by the "Pittsburgh Law" of differential tax rates for real property assessment and taxation. Cf., Chapter 246, Hawaii Revised Statutes.

[24] Appropriate data can be obtained from Department of Planning and Economic Development, State of Hawaii Data Book, 1980, Honolulu, November, 1980; Table 117, p. 143. Department of Research and Development, County of Hawaii Data Book, 1980, Hilo, December, 1980; Table 132, p. 113.

[25] Current State Land Use District boundaries are found on maps provided by the State Land Use Commission.

of certain portions of their properties which they wish to develop. On the other hand, small property owners are less likely to reap these benefits and are more likely to expect compensation from the utility company.

The utility company can usually obtain easements across public land at nominal cost, particularly if the property is located in the State Conservation or Agriculture District. Urban District land is usually more expensive, since an appraisal bases the cost on a percentage of market value. The percentage represents the disutility or diminished utility, a reflection of a property's inability to fulfill its highest and best use.

DEGREE OF CONSTRAINT	CRITERIA
High	Urban District land and areas with a high degree or parcelization.
Medium	Private properties of 5000 acres or more in the Agriculture District.
Low	All remaining areas.

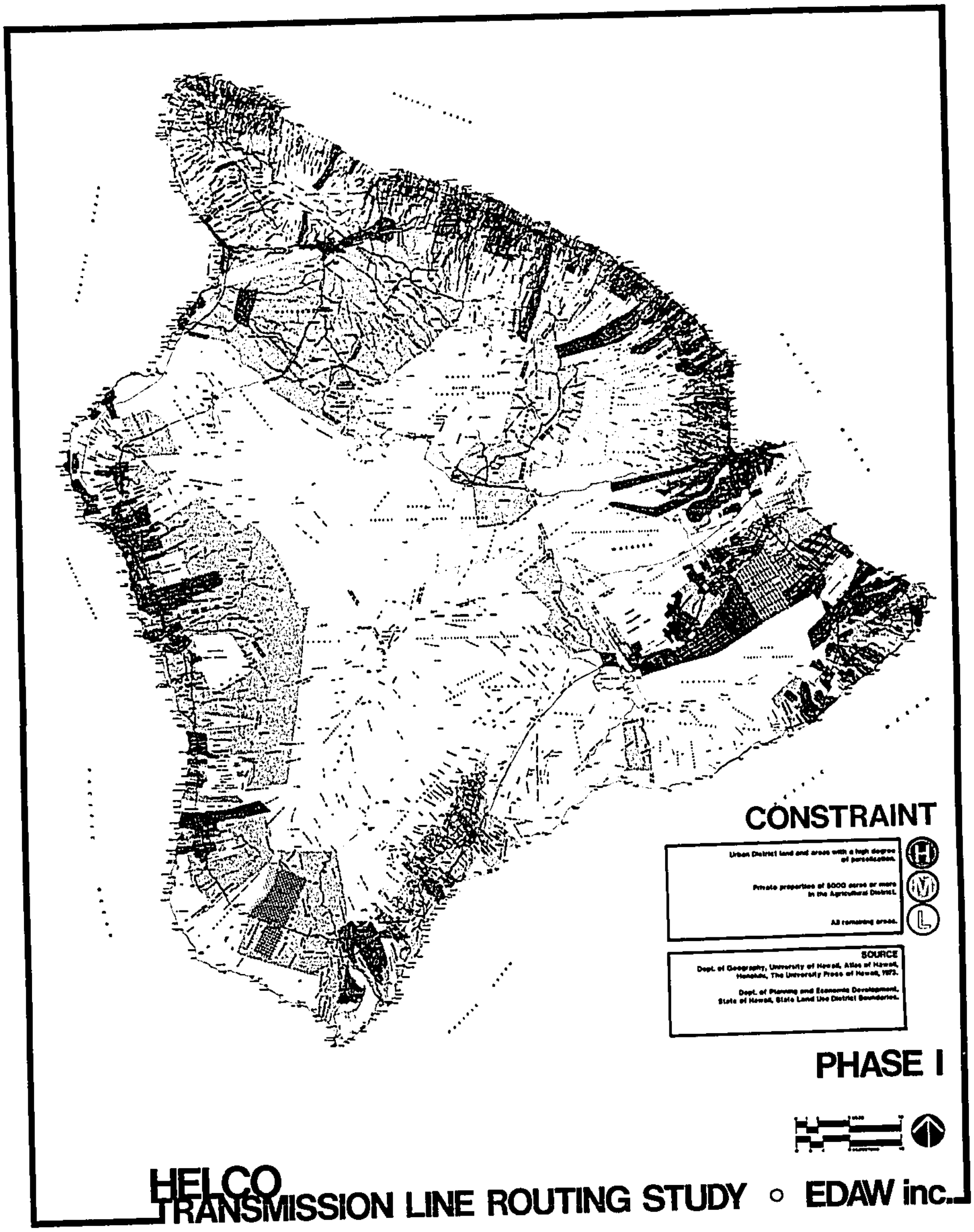

EXHIBIT IV-14:

LAND VALUE

2. Route Length

The length of a transmission line will affect its cost in several ways. Longer routes require more equipment in the form of poles, insulators, conductors and other materials. It will also take more time, energy and manpower to construct and maintain these lines. A longer easement is required, thereby adding to land acquisition costs. Furthermore, the energy loss (or "line loss") will be greater over a longer distance. This is because electric power meets resistance when it travels through the line and is converted to heat. Thus, additional power must be generated to serve the same load.

Theoretically, the shortest, most direct route between the Kaumana and Keamuku terminal points would be a straight line. It is recognized that there are numerous intervening factors, such as elevation changes, topographic features, vegetation zones, and so on which might make the idealized straight-line route impractical. However, the purpose here is to evaluate the distance factor as if all other factors were equal. The constraints for the "intervening" factors are evaluated elsewhere in this broadscale analysis.

To provide some flexibility for the influence of intervening factors on route selection, a "low" constraint area, in terms of route length, is defined as an area circumscribed by a line which deviates less than 10 percent of the straight-line distance between Kaumana and Keamuku. To determine this area, the ends of a string 10 percent longer than the straight-line distance was fixed at either terminal point. The line was then pulled taut at various points along its length, on either side of the straight-line route, to define an oval-shaped area circumscribing the straight-line. The outer boundary of a "medium" constraint area was defined by the same method, using a line which was 20 percent longer than the straight-line distance. There is nothing absolute about these demarcations, but they do represent a reasonable evaluation of the relative constraints of cost due to route length.

DEGREE OF CONSTRAINT	CRITERIA
High	Greater than 20 percent deviation from straight-line distance.
Medium	Ten to 20 percent deviation from straight-line distance.
Low	Less than 10 percent deviation from straight-line distance.

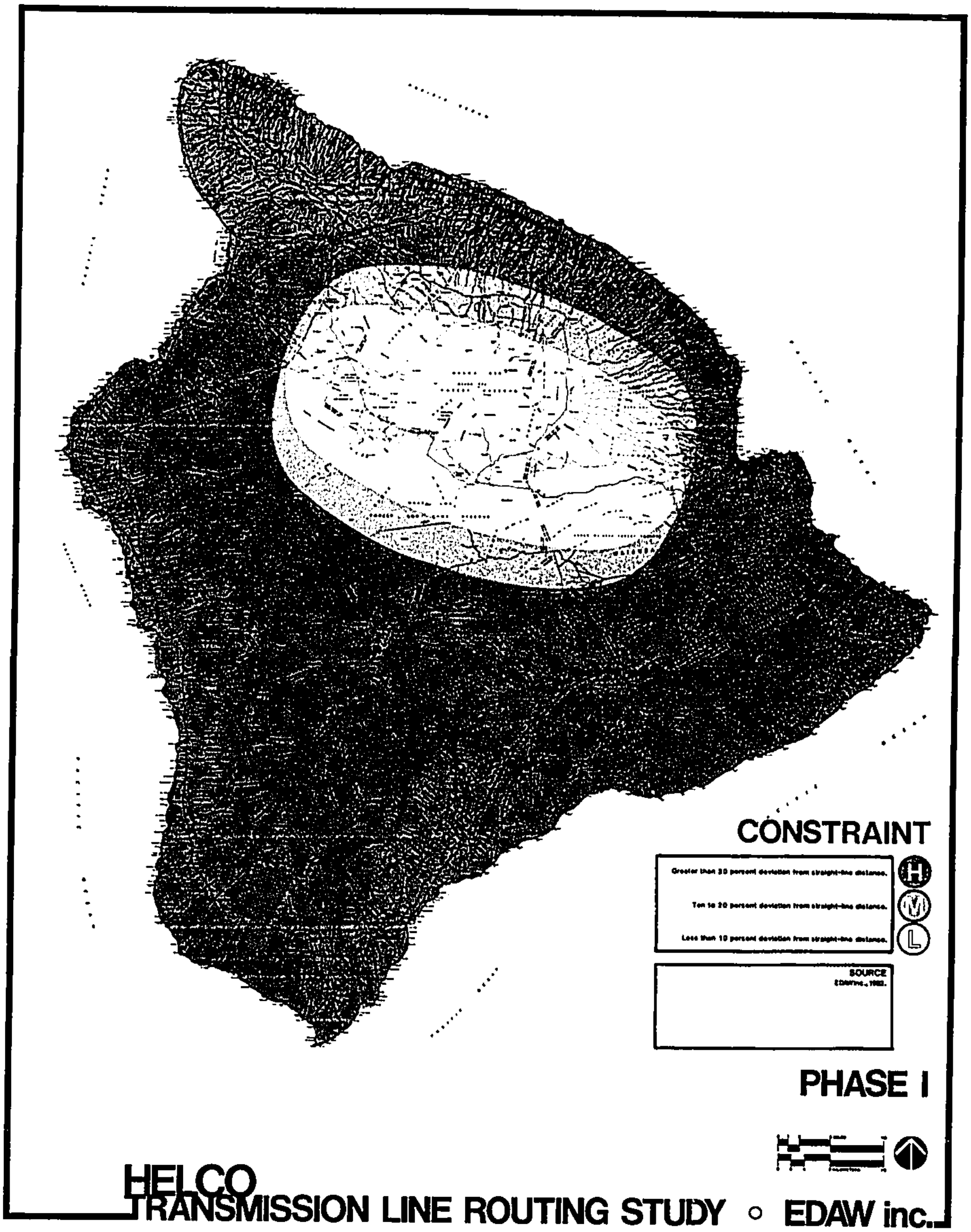

EXHIBIT IV-15:

ROUTE LENGTH

3. Access

The cost of constructing and maintaining a transmission line is affected by the degree of its accessibility. Areas which are distant from existing roads or characterized by rugged terrain or other physical barriers or difficulties, such as the presence of lava tubes, slide areas, perennial water bodies and dense vegetative cover, are the most costly sites for the construction and maintenance of transmission lines. To some extent, proximity to roads and geophysical characteristics are interdependent criteria, since roads tend to be aligned in areas with less difficult physical conditions. Thus, areas whch are more than 5 miles from a paved road or 1 mile of a jeep trail or other unpaved road which is passable throughout the year are considered "high" constraints. Also, areas which are characterized by dense tall tree growth (i.e., more than 75% cover, and canopy heights of about 100 feet or more) and steep slopes (i.e., 20% or greater) are considered "high" constraints. Likewise, areas with unstable subsurface conditions (i.e., presence of lava tubes, rifts, high water table) and surface water bodies (i.e., streams, ponds, lakes and wetlands), fall within this category. Areas which are within 1 to 5 miles of a paved road or within 1 mile of a jeep trail or other unpaved road and do not have these special physical problems can be classified as "medium" constraint zones. The remaining areas near paved roads are classified as "low" constraints.

DEGREE OF CONSTRAINT	CRITERIA
High	Areas more than 15 miles from a paved road or 1 mile from unpaved roads; areas with steep slopes, dense tree growth, perennial surface water or unstable subsurface conditions.
Medium	Areas within 1 to 5 miles from a paved road and 1 mile of an unpaved road which are lacking special physical problems.

Low	Areas within 1 mile of a paved road which are lacking special physical problems.

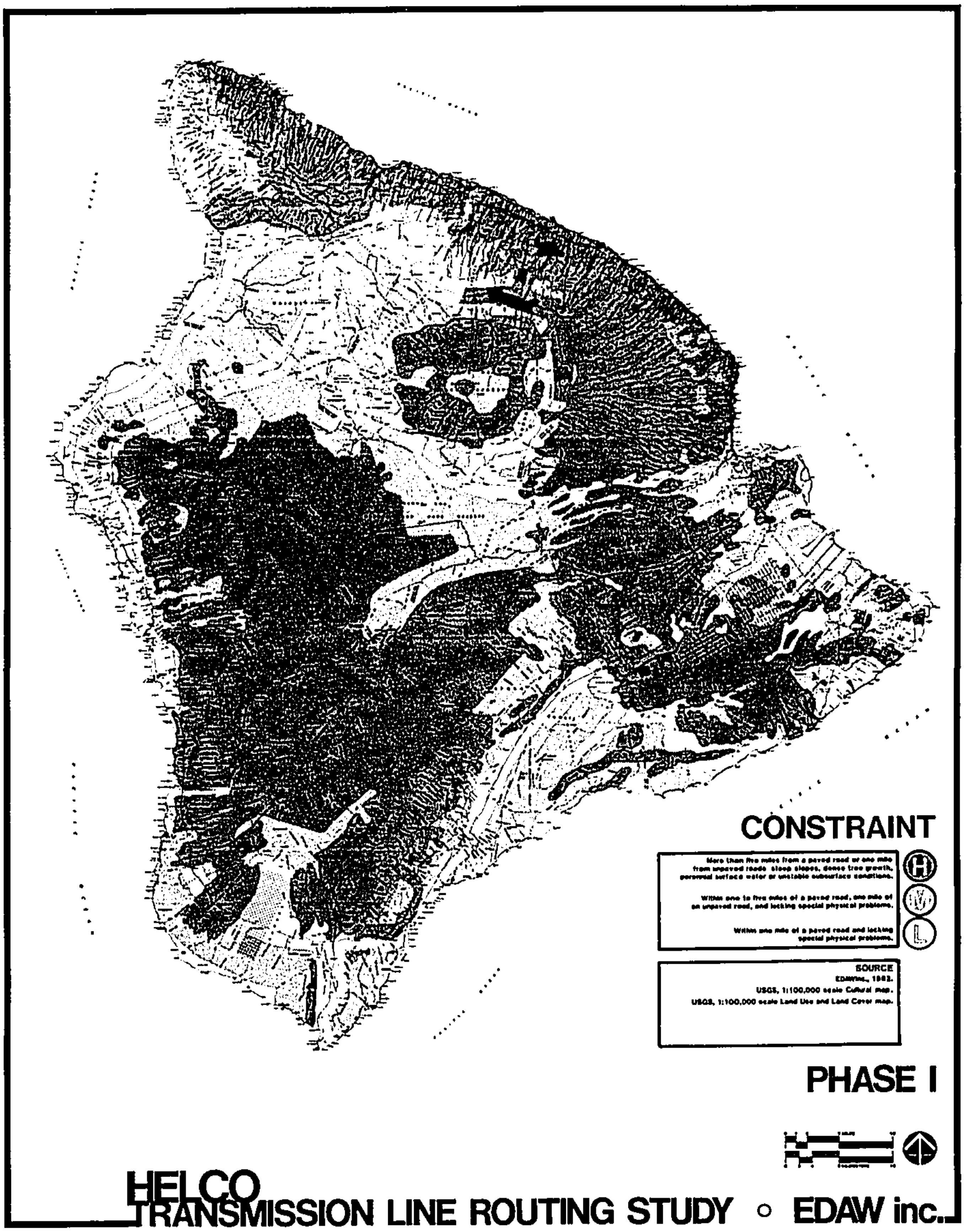

EXHIBIT IV-16:

ACCESS

4. Maintenance

Factors affecting the cost of transmission line maintenance include wind, contamination, vandalism and the amount of rainfall an area receives annually.

Wind carried salt spray near the ocean coats the insulators and creates a situation where flashovers are possible. In coastal areas receiving insufficient annual rainfall to wash the insulators, manual high pressure washing and/or replacement of the insulators is required. Therefore, areas within 4 miles of the shoreline with an average annual rainfall of less than 20 inches are rated as high constraints in terms of maintenance costs. Also rated as high constraint are those areas where high winds (15 mph or more) cause significant movement of the lines. This creates wear on the linkages connecting the line to the pole. More frequent replacement is required in these areas.

Areas rated as medium constraints include those subject to vandalism from hunters, wet areas, areas subject to damage from cattle and residue from cane burning.

The vandalism is associated with the discharge of firearms and the use of the insulators and conductors for target practice. This will generally occur in or near areas where game hunting is common.

Wet areas, where the average annual rainfall is 75 inches or more, tend to promote the rotting of wooden structures. Poles and cross arms need more frequent replacement in these areas.

Cattle sometimes rub against transmission poles and their supports. This will cause permature wear to the guy wires, poles and anchors.

The burning of sugar cane fields generates airborne ash particles. Build-up of ash over the insultors can cause flashovers similar to those along coastal areas.

DEGREE OF CONSTRAINT	CRITERIA
High	Average annual windspeed 15 MPH or greater; coastal areas with 20 inches or less of average annual rainfall.
Medium	Game hunting areas; average annual rainfall of 75 inches or more; pasture lands; sugar cane cultivation.
Low	All remaining areas.

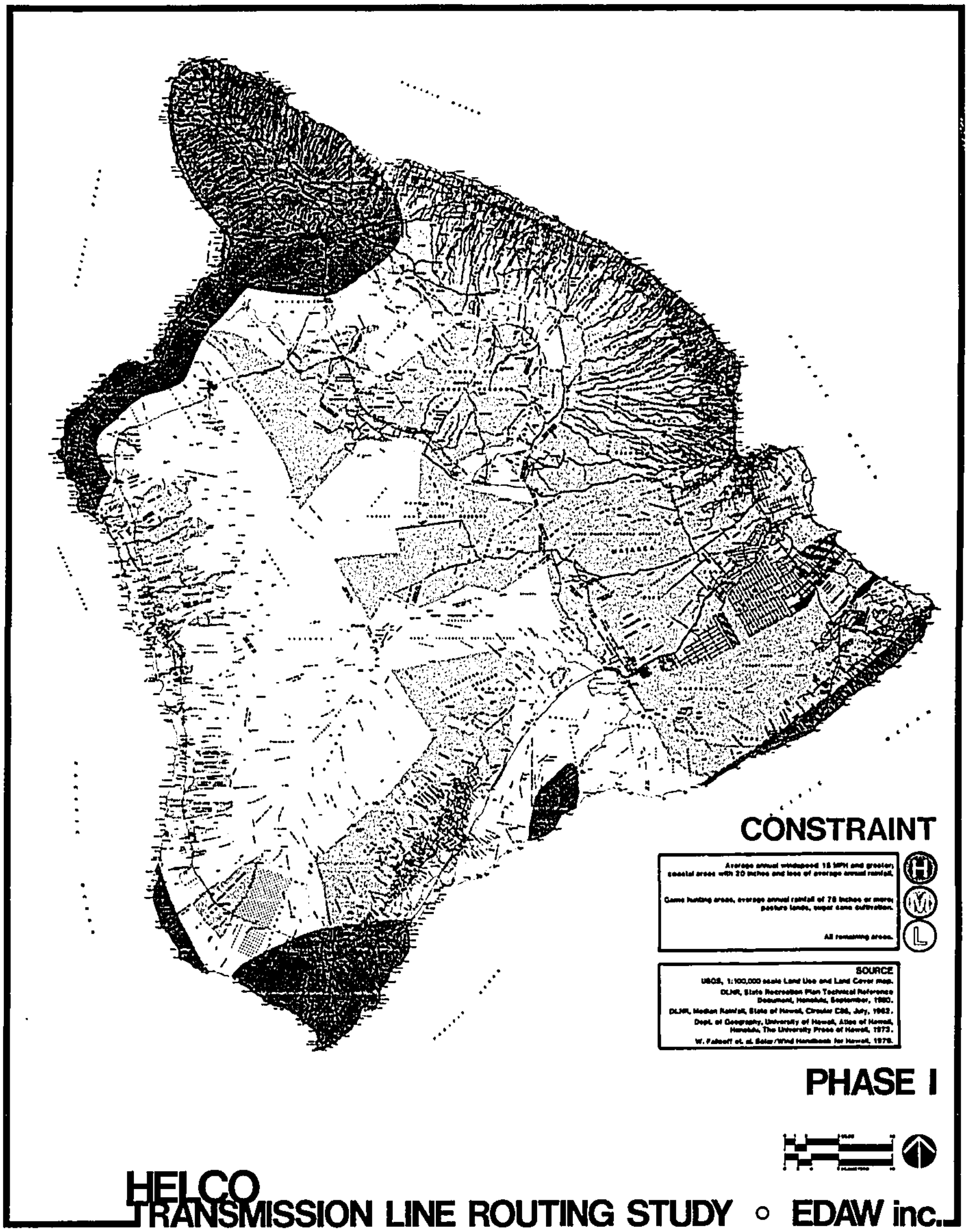

EXHIBIT IV-17:

MAINTENANCE

Chapter V

CHAPTER V: CORRIDOR IDENTIFICATION

A. COMPOSITE MAPS

In order to present an overall view of the constraints and opportunities for the transmission line route, a composite overlay map was prepared for the geophysical, biological, socio-economic, and cost data categories. The composite maps represent the combined constraints of all the data factors in each data category and identify more sharply the areas of least constraint. Least constraint is defined here as those areas shown as having only low constraints or a maximum of one medium constraint for all of the data factors in that category. Areas having two or more medium constraints or one or more high constraint do not qualify as an area of least constraint.

In preparing the data category composite overlays, areas not qualifying as least constraint were mapped with a grey tone. No further distinction as to the value or number of constraints was made. Areas of least constraint were left clear and were viewed as opportunities. Composite maps for the geophysical, biological, socio-economic and most categories are shown in Exhibits V-1, V-2, V-3 and V-4.

By overlaying the four data category composite maps and the Exclusion Areas map prepared during the broadscale analysis, as in Exhibit V-5, one gets a picture of various shades ranging from nearly black (exclusion areas), through dark grey (high constraint) to very light or white (least constraint). Potential corridors can then be identified by linking the lighter-toned areas between Keamuku and Kaumana in various combinations which result in a continuous route between those two points. The corridors varied in width from one to six miles, corresponding to the width of lighter-toned area along the various sections of the corridor. The corridors were further evaluated and refined based on the review of USGS 7.5 minute orthophoto quadrangle sheets and on-the-ground verification. More precise boundaries were determined by taking a closer look at such conditions as highly erosive soils, steep slopes and pu'u (i.e., lava cones or hills), platted agricultural land, lava flows, forests, or restrictive use areas (e.g., Pohakuloa Training Area).

Three corridors were identified for further review and evaluation. They are the overland portion of a marine corridor option, a Saddle Road corridor, and a corridor skirting the north side of Mauna Kea.

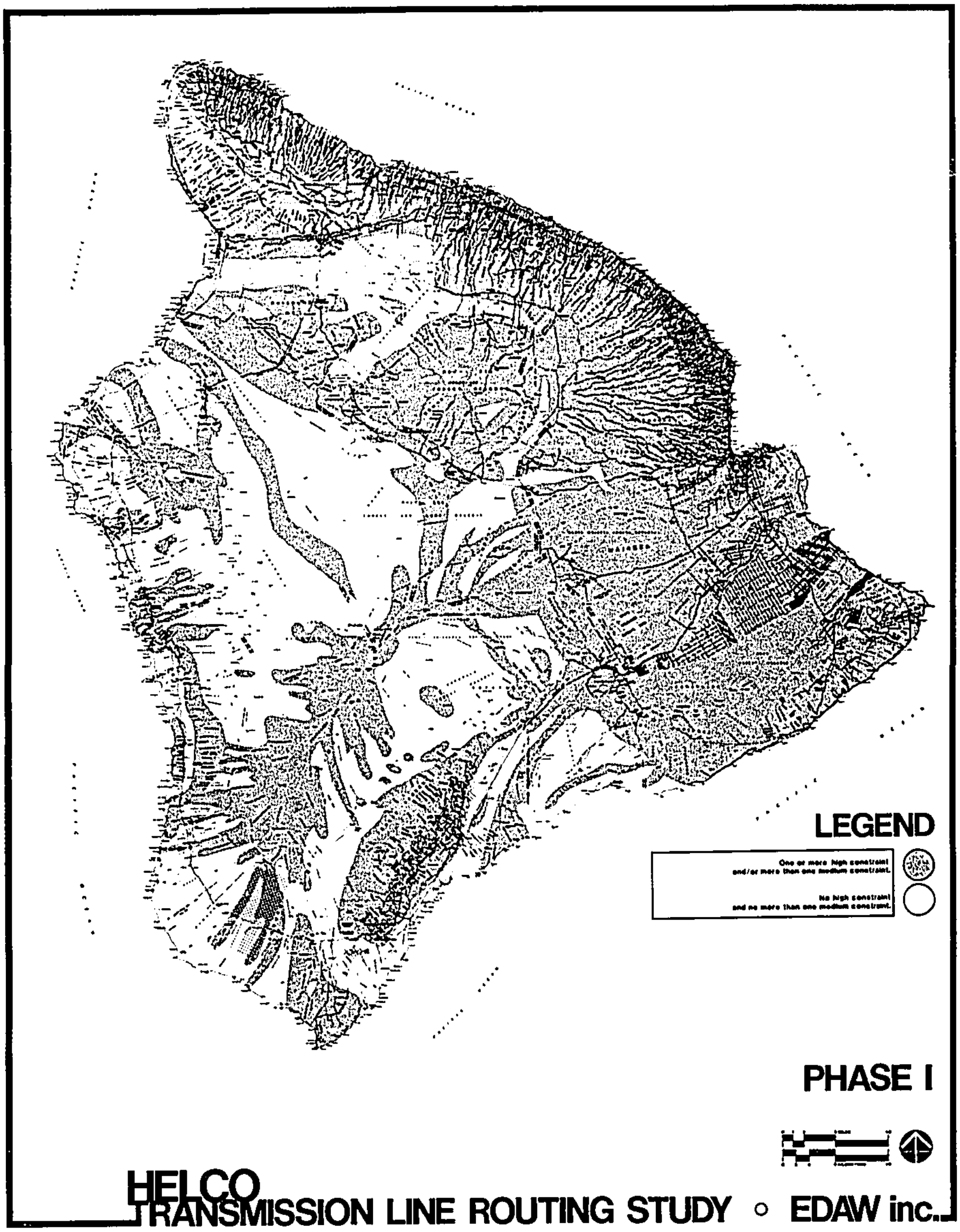

EXHIBIT V-1:

COMPOSITE CONSTRAINTS: GEOPHYSICAL FACTORS

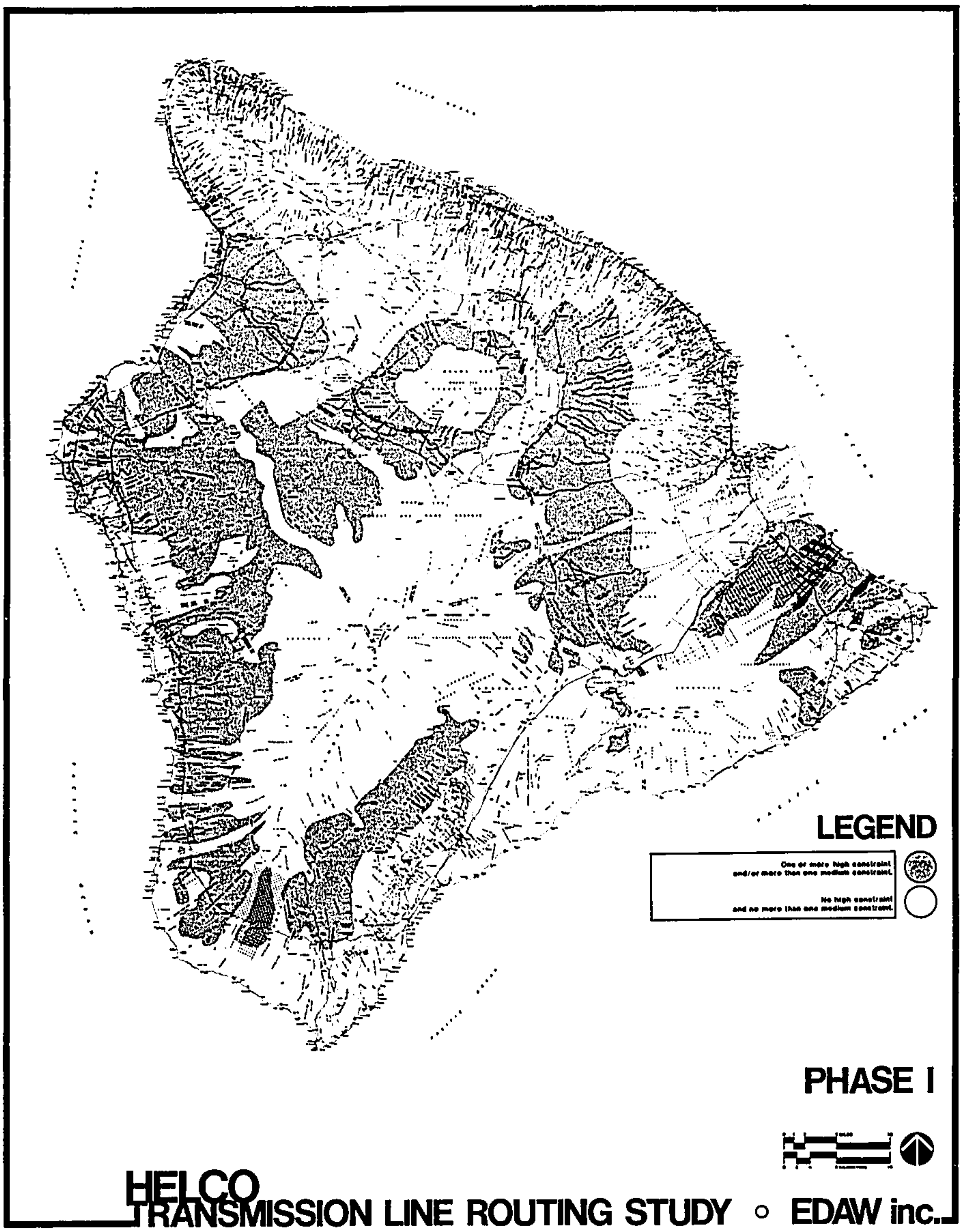

EXHIBIT V-2:

COMPOSITE CONSTRAINTS: BIOLOGICAL FACTORS

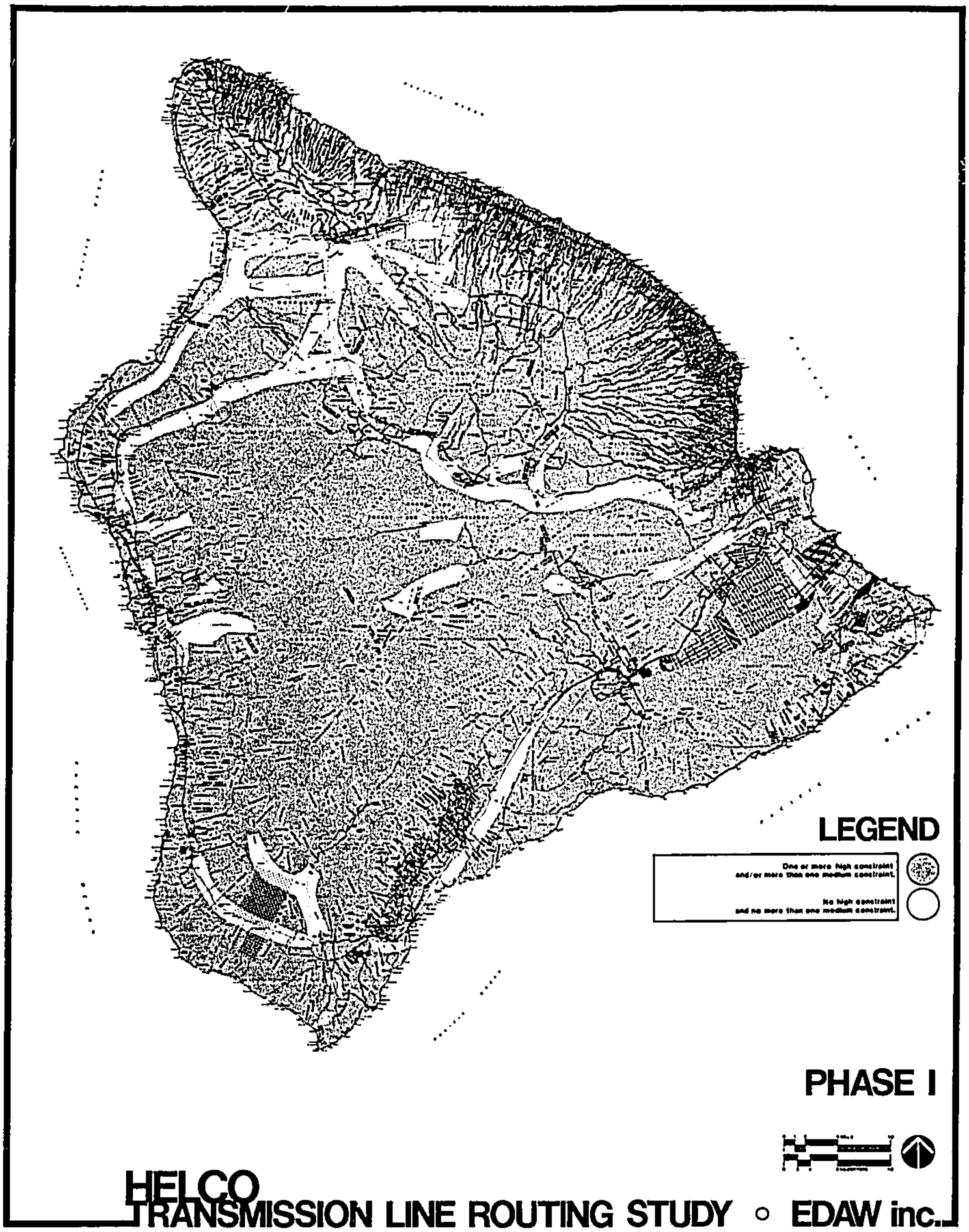

EXHIBIT V-3:

COMPOSITE CONSTRAINTS: SOCIO-ECONOMIC FACTORS

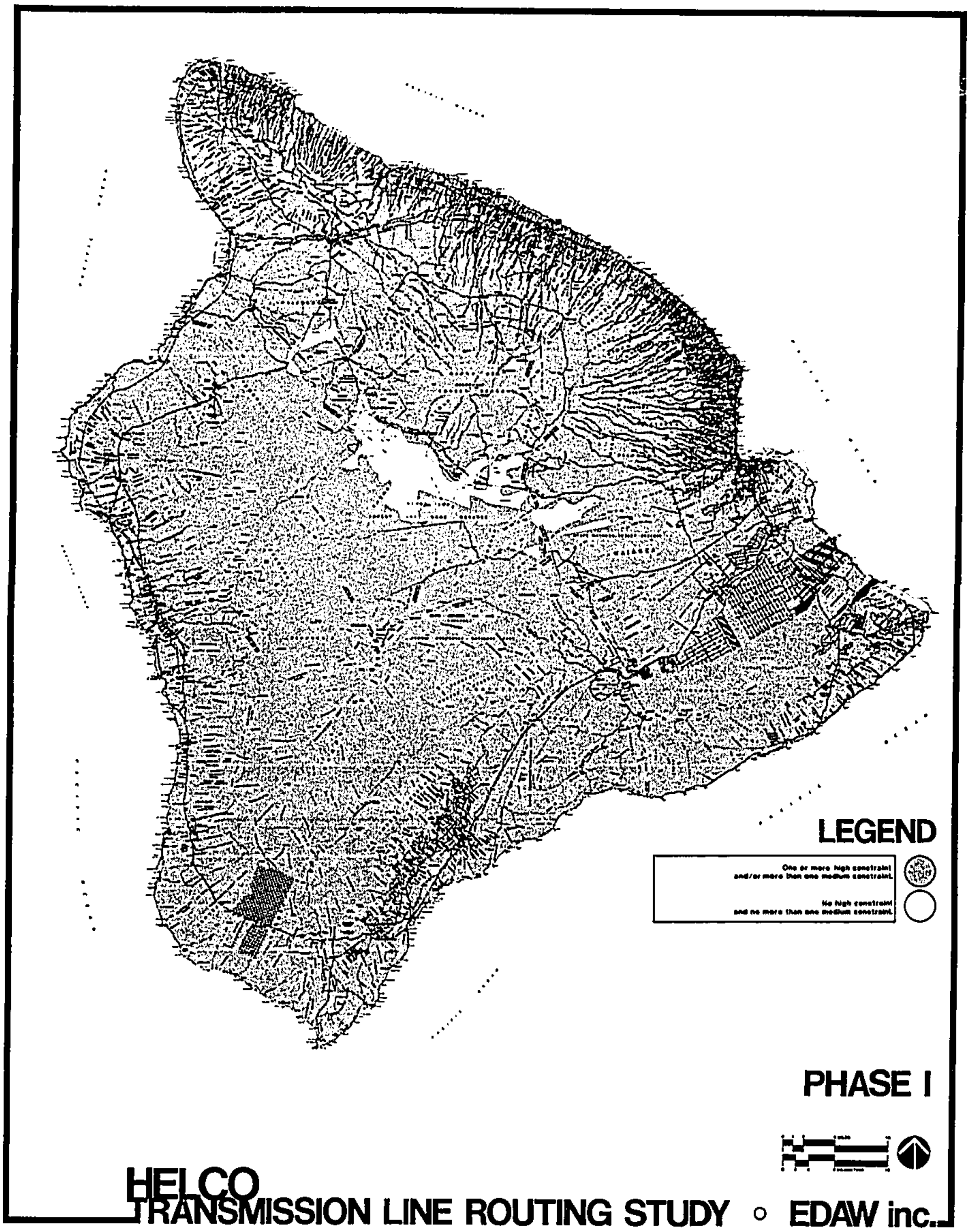

EXHIBIT V-4:

COMPOSITE CONSTRAINTS: COST FACTORS

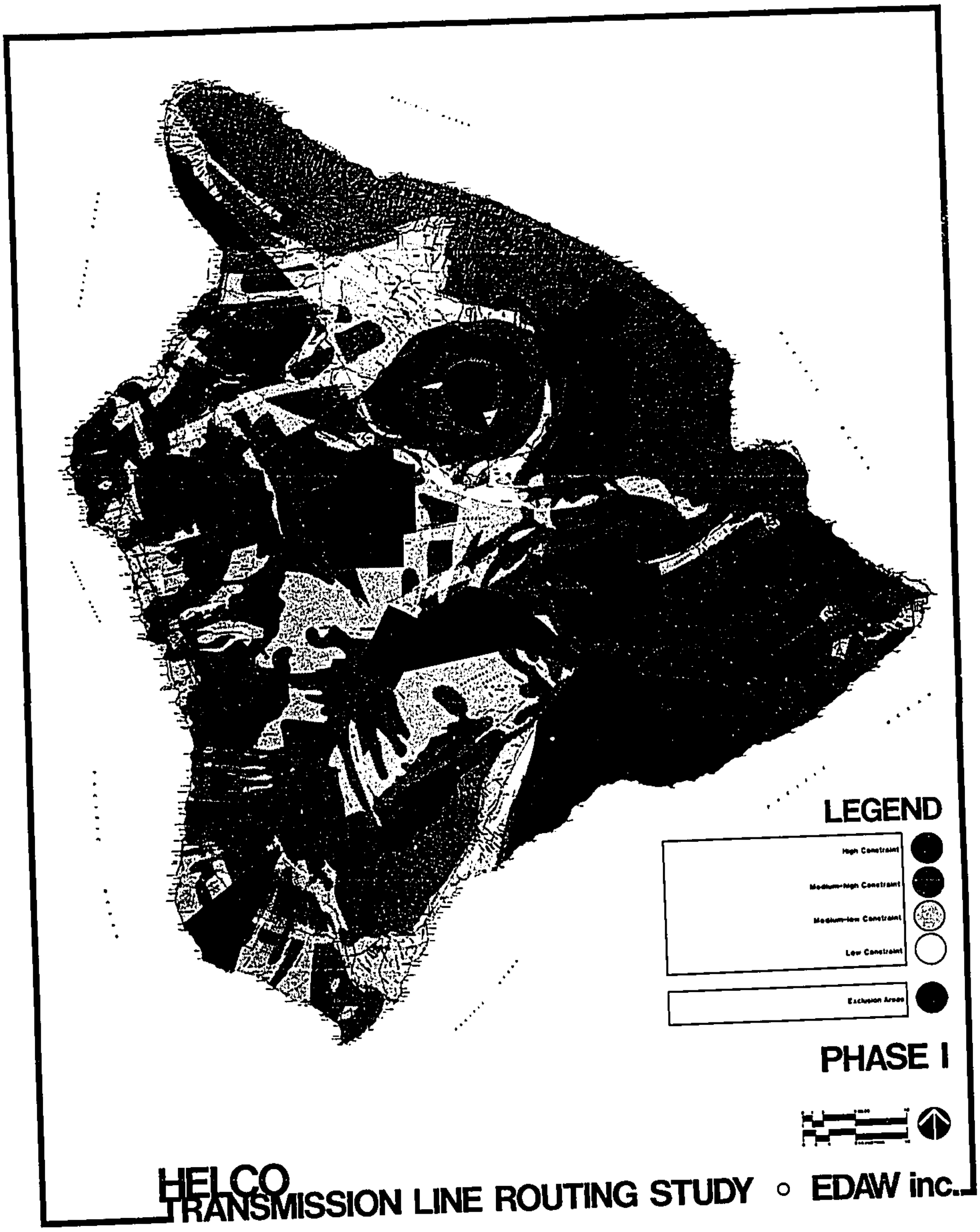

EXHIBIT V-5:

COMPOSITE CONSTRAINTS: ALL DATA CATEGORIES

B. <u>CORRIDOR DESCRIPTIONS</u>

For review purposes, each of the three corridors was divided into segments. The six segments are shown on Exhibit V-6. Segment A and F represent the overland portions of a marine corridor option; segments B, C and E represent the Saddle Road corridor; segments B, D and E represent the corridor along the north side of Mauna Kea.

The following is a brief physical description of the six segments:[1]

Segment A - This segment is one of the two overland portions of a marine corridor option. It originates at the Kaumana substation and terminates at Hilo Bay. The segment generally follows the Saddle Road and passes through the city of Hilo. As the segment leaves the substation toward Hilo, it passes through populated, built-up areas. Development becomes increasingly dense along this segment, which ultimately encompasses Hilo's downtown commercial and shorefront industrial area.

Segment B - This segment is common to both the Saddle Road corridor and the corridor along the north side of Mauna Kea. It originates at the Kaumana substation and proceeds west along the Saddle Road until its intersection with the Mauna Kea Science Reserve access road.

There are houses in the immediate area of the Kaumana substation and along the existing HELCO easement as the line leaves the substation. The eastern three quarters of this segment is generally <u>Ohia-Koa</u> forest. The western quarter is open lava fields on both sides of Saddle Road. The flows south of the road are not as vegetated as those on the north side, indicating their relatively younger age. The western end of the segment passes through the Humu'ula parcel of the State of Hawaii Department of Hawaiian Home Lands. The parcel south of Saddle Road is leased under

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[1]The narrative will describe conditions which are encountered as the observer travels from the Kaumana substation to Keamuku substation. Note that one of the overland portions of the marine corridor, (Segment A) actually proceeds in the opposite direction. However, the destination of the entire marine route is the Keamuku substation.

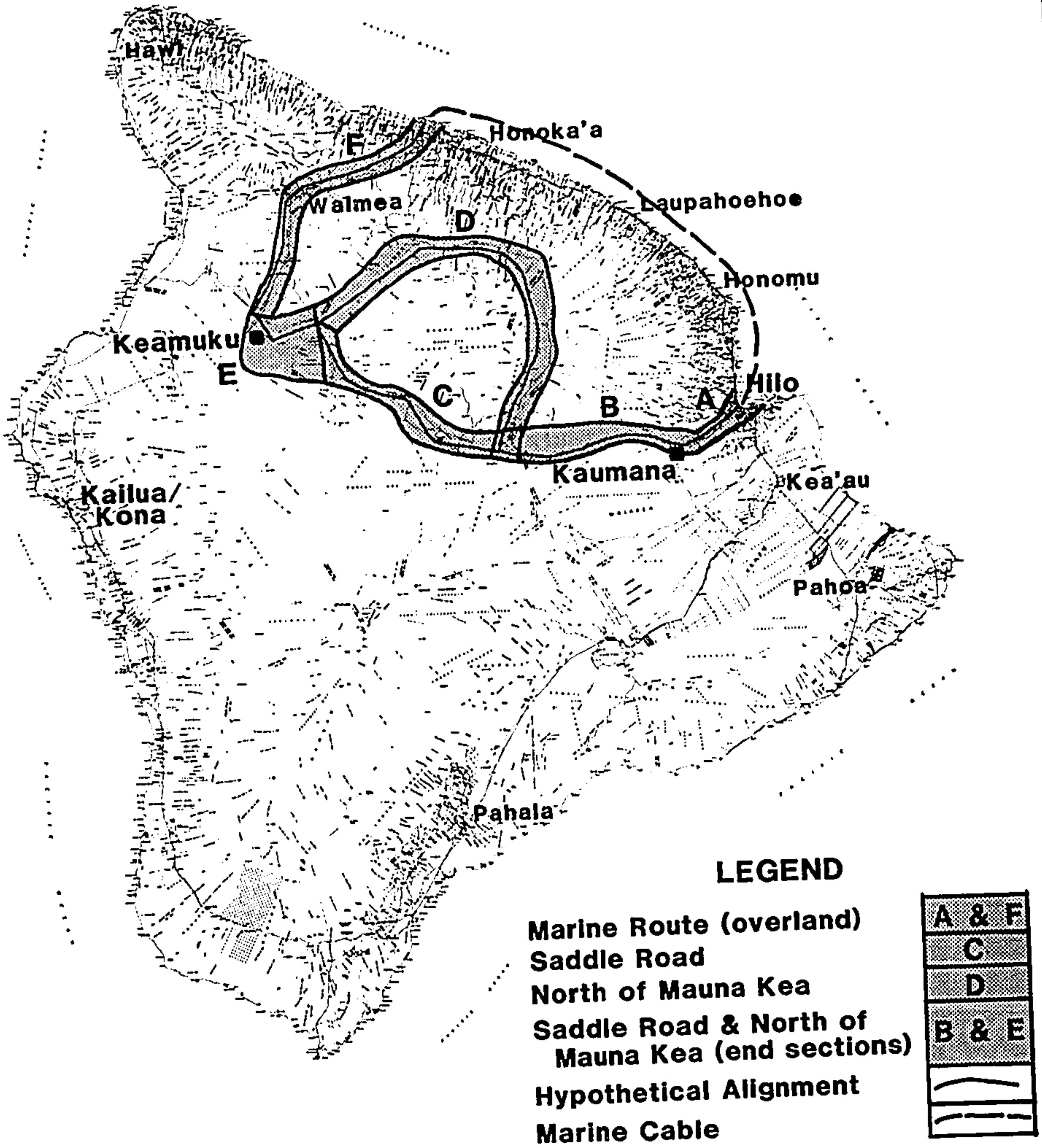

EXHIBIT V-6:
IDENTIFICATION OF ALTERNATIVE CORRIDORS

Executive Order 1653 as public hunting ground and game reserve, Aina Hou. The parcel north of Saddle Road is leased for grazing.

Segment C - This segment continues along the Saddle Road to the town of Waiki'i. To the south the lava fields offer an unobstructed view of Mauna Loa. Varying in age, the lava flows are sparsely vegetated. The gentle climb towards the summit of Mauna Loa is occasionally interrupted by a pu'u in the foreground.

To the north of Saddle Road looms Mauna Kea. The foreground is dominated by grasses covering old lava flows. This area, the Department of Hawaiian Home Lands' Humu'ula parcel, includes the Humu'ula sheep station and is mostly leased for grazing. A small portion on the western side of the Humu'ula parcel is leased to the Pohakuloa Training Area.

The Pohakuloa Training Area is located where the Saddle Road takes a hard turn towards the north. As the road turns back towards Kona, the Pohakuloa base camp and Bradshaw Airfield are located north of the road, nestled between the road and the base of Mauna Kea. Training operations occur both north and south of the road, concentrating south of the road and generally south of Pu'u Moana and Pu'u Kulua.

On the Kona side of the Training Area, the terrain becomes more rolling. Grasses dominate both sides of the road, with an occasional stand of Eucalyptus trees. At the high points in the road, the Kona coast is visible across the long, gently sloping grasslands.

Segment D - This corridor segment traverses the north side of Mauna Kea. It originates at the intersection of Saddle Road and the Mauna Kea Science Reserve access road. Proceeding towards Mauna Kea, the corridor follows the dirt road past the Humu'ula Sheep Station to the right. The first ten miles or so of this segment is within the Department of Hawaiian Home Lands' Humu'ula parcel. It is leased to the Parker Ranch for grazing. The grass-covered slopes are interrupted by pu'u and streams. Mauna Kea is consistently to the left and, in the first quarter of this segment, the city of Hilo is visible to the right. Running through this segment is a discontinuous dirt road, negotiable by four-wheel drive vehicle only, with eighteen gates along its length between the Saddle Road and Waimea.

Approximately sixteen miles into this segment, at Hopuwai, the road begins to pass through a dense ring of Ohia-Koa forest. The terrain is rolling and the road condition deteriorates. On most days, the entire area is shrouded in fog. The Department of Land and Natural Resources manages a hunting area to the right side of the road.

At Honaipoe, about fourteen miles past Hopuwai, this segment diverges mauka from the road and continues around Mauna Kea. Through this roadless area, the segment crosses many streams and joins the Saddle road at Waiki'i.

Segment E - This segment is common to both the Saddle Road corridor and the corridor along the north side of Mauna Kea. It connects the town of Waiki'i and the Keamuku substation located on the Mamalahoa Highway. The terrain is gently rolling grassland, with an occasional stand of trees and shrubs. Land use is predominantly grazing and there are a few jeep trails dissecting the area. The area is not irrigated, although streams are present and flow toward the highway.

Segment F - This is the other overland portion of a marine corridor option. It connects Honoka'a, the point at which a marine cable would come on-shore, and the Keamuku substation.

From the ocean, the corridor rises up the shore to join the highway. Traveling through a populated area, the corridor segment crosses local roads and parallels stream beds. Once at the highway, the segment straddles the road through Waimea to Keamuku. Although the landscape is dominated by grasses, it is occasionally interrupted by stream beds, jeep trails, fences, utility lines or major features such as the airport at Kamuela. The segment passes through the Saddle Road Junction and continues on to the Keamuku substation.

C. CORRIDOR EVALUATION

A hypothetical "best alignment" was drawn through the corridor segment (Exhibit V-6) to provide a point of reference which to evaluate each segment against all the previously mapped data factors. This alignment was based on the composite maps prepared for each data category. It took into consideration, therefore, a generalized constraint identification and did not yet examine each data factor independently.

A hypothetical "best alignment" was then overlayed onto each data factor constraint map. Each time it passed through either a high or medium constraint area, the linear distance through the constraint area was measured in inches. The purpose of this is to generate a rating for each corridor to serve as a basis for comparing the corridor alternatives. The unit of measurement is a relative figure, depending upon the scale of the map or, ultimately, the actual conditions in the field. Therefore, the measurement of constraint becomes the "score" for that data factor in the particular segment where it was encountered. Exhibit V-7 shows the scores for each data factor and each segment of corridor, based on the hypothetical "best alignment". The table also shows a total score for each corridor.

In figuring the total score, each high constraint score was multiplied by two to reflect its relative importance while each medium score was recorded as it was measured. The corridor with the highest total score, or most constraints, is the corridor along the north side of Mauna Kea (B, D and E).

The factors contributing to its high rating include high soil erosion hazard, vegetation, land use, land value and access. Added to each of these factors is the length of this corridor relative to a straight-line distance between the two substations. The likelihood of encountering constraints along this longer route is high.

EXHIBIT V-7

CONSTRAINT SCORES FOR CORRIDOR SEGMENTS, BY DATA FACTOR

Numbers represent the length of constraint area crossed by a hypothetical "best alignment."

DATA FACTOR	CORRIDOR SEGMENT					
	A	B	C	D	E	F
GEOPHYSICAL						
1. Slope and Soils						
High			2.5	.75		1.375
Medium	.375	.5	.375	9.5	1.75	6.175
2. Geologic Hazards						
High		3.875		1.875		
Medium	.625	.5	2.375		.25	
3. Hydrology						
High		1.25				2.5
Medium	.875	3.25			2.0	2.875
BIOLOGICAL						
1. Vegetation						
High			2.5		.125	2.0
Medium	1.125	4.75	1.875	10.75	1.5	5.375
2. Wildlife			1.5			
Medium		3.0				
SOCIO-ECONOMIC						
1. Recreation						
High	.5					.875
Medium		3.75	3.875			.5
2. Land Use						
High	1.0	.625				2.625
Medium	.375		2.0	10.75	1.25	3.625
3. Transportation and Utilities						
High				8.5		
Medium						
4. Land Ownership						
High	1.5	1.125		.25		1.625
Medium			2.25	4.125		1.125

DATA FACTOR	CORRIDOR SEGMENT A	B	C	D	E	F
SOCIO-ECONOMIC (Continued)						
5. Visual Quality						
High	.375					
Medium	1.25	5.0	3.25	.875		7.75
6. History and Archaeology						
High						
Medium	1.0					1.0
7. Land Regulation						
High		1.0	1.125			
Medium	.125					.125
COST						
1. Land Value						
High	1.5	1.125		.25		1.625
Medium			2.625	8.375	1.625	4.75
2. Access						
High		1.625	.375	3.25		1.375
Medium				6.75	1.125	
3. Maintenance						
High						3.75
Medium	1.625	5.0	5.125	5.125	1.75	1.625
HIGH (2X) + MEDIUM	17.125	47.0	39.75	86.0	11.5	70.375

RATINGS FOR THREE POTENTIAL CORRIDORS

Saddle Road (B+C+E) = 98.25

North of Mauna Kea (B+D+E) = 144.5

Marine Route (A+F) = 87.5 + marine portion

The overland portion of a marine corridor option marginally scores the lowest, indicating a relative lack of constraints. This analysis does not, however, address the potential impacts posed by the roughly 45 miles of marine cable. When the limitations of a marine cable, discussed in Chapter III, are added to the analysis, the marine corridor becomes a far less desirable option.

The Saddle Road corridor received the next best (lowest) score. This can perhaps be attributed to the Saddle Road right-of-way, the presence of utility lines, both telephone and electric, and its relatively direct route between two substations. Overall, it is the most favorable corridor, as shown in Exhbit V-8, and is, therefore, selected for detailed analysis of route alignment alternatives.

As mentioned in the introduction to Chapter IV, the overlay mapping method allows the "weighting" of certain data factors if the constraints for those factors are considered significant enough to warrant special consideration. Unlike the objective criteria for establishing constraints <u>within</u> a data factor, which can be documented by reference to scientific studies and official planning documents, the decision as to which data factor should be given more importance is essentially a value judgment.

As the first round of community workshops for this routing study, a questionnaire was distributed to find out how people would rank the data factors in order of importance. The sample size was too small to provide a meaningful conclusion, but it is interesting to note that, even among this small group of respondents, there was a very wide range in priorities. Furthermore, a single data factor would have to be weighted quite heavily before it makes a difference in the corridor evaluation. For example, the score for the "Vegetation" factor would have to be multiplied four times before the north of Mauna Kea corridor appeared more favorable than the Saddle Road corridor. Weighting to such a significant degree would be a rather arbitrary decision.

As a result, there appeared to be no justifiable basis for weighting or giving priority to individual data factors or categories. Thus, the Saddle Road corridor was recommended as the corridor for detailed study of the transmission line alignment. This recommendation found general concurrence at the second round of community and public agency workshops.

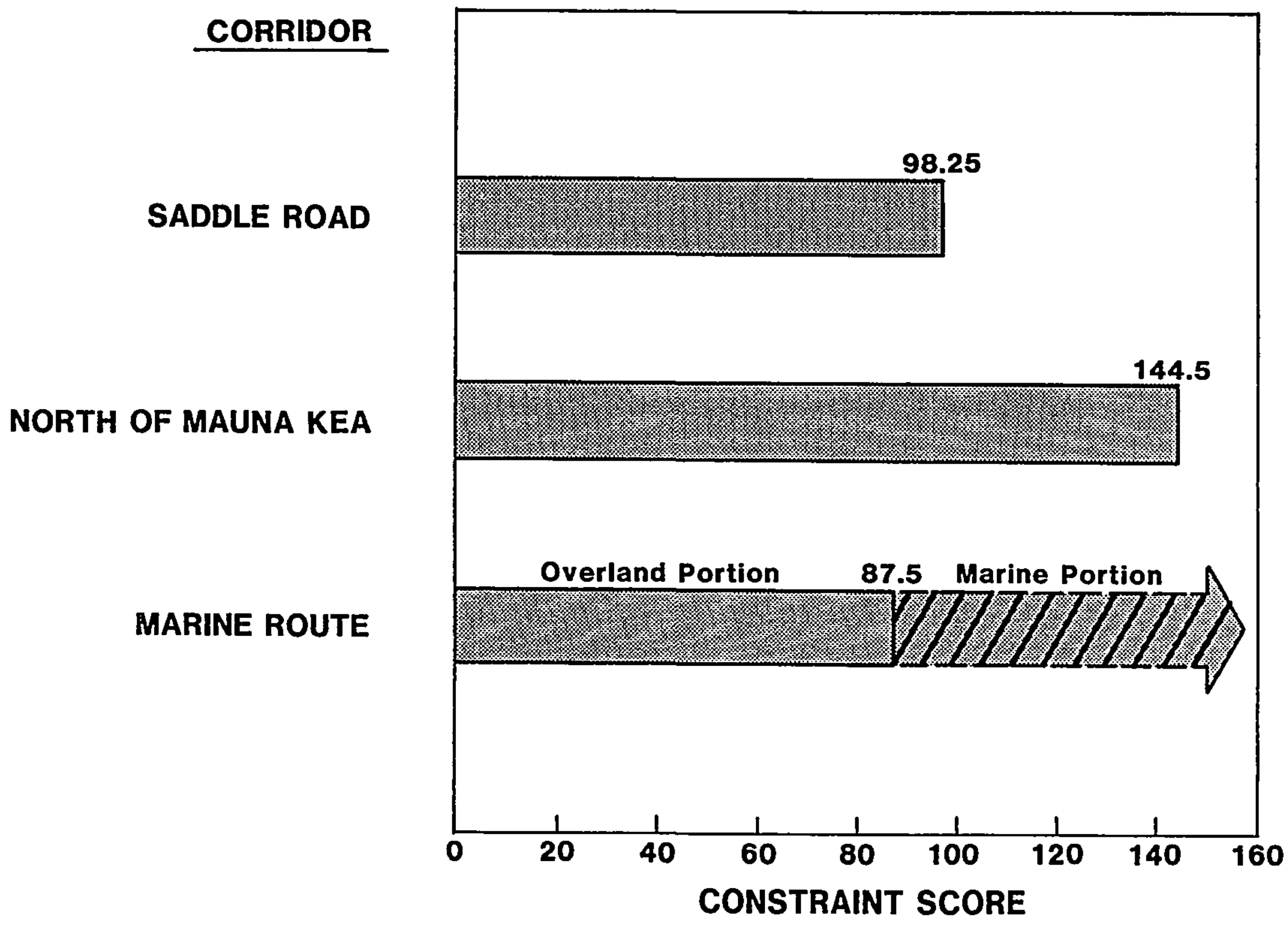

EXHIBIT V-8:
RATINGS FOR ALTERNATIVE CORRIDORS

Chapter VI

CHAPTER VI: DETAILED ALIGNMENT

A. MAP FORMAT AND DATA

A detailed analysis of conditions in the study corridor marks the beginning of Phase 2, in which a large map scale is required. The base maps used for this analysis are USGS 1":24,000" scale topographic sheets. Orthophotos at the same scale and more recent aerial photos at 1":3,600" scale, dated 1980, provided additional information on land use, man-made and natural features, particularly the location and type of vegetation zones. These data were verified by field checks.

The base maps were formatted to display the study corridor in six segments, beginning with the Kaumana Substation in Section 1 and terminating with the Keamuku Substation in Section 6. Section 7 shows the area between the substations at Anaeho'omalu and Waikaloa, which are to be connected by the radial 69 Kv line described in the conclusion to Chapter I. No broadscale analysis preceded the selection of the study corridor for the 69 Kv line because the distance between the points to be connected is so short that feasible routing options are relatively limited. A key to the seven map sections can be found in Exhibit VI-1.

Three types of data maps were prepared for each section: Physical Conditions, Land Control and Visual Resources. Exhibit VI-2 lists these as data categories and a number of subheadings under these categories as data factors. Below is a description of the kinds of the data factors which were mapped.

PHYSICAL CONDITIONS

1. Land Use: Land areas used for some form of human activity were mapped. Urban uses are grouped together because the area within the study corridor covered by such uses is quite small and mostly residential. Any areas occupied by buildings suitable for habitation are described as an urban use. Crop cultivation is defined as an agriculture use and pasture lands as a grazing use. Military use includes all lands leased by the U. S. Army for Pohakuloa Training Area, whether or not the land is actively being used for military training exercises at the present time. Recreation use areas are comprised primarily of hunting areas. Historic sites are those which are or might be listed on the Hawaii State Register of

EXHIBIT VI-1

STUDY CORRIDOR MAP KEY

CORRIDOR SEGMENT	USGS QUANDRANGLE	PROPOSED LINE
Section 1	Portion of Pi'ihonua (Includes Kaumana Substation)	138 Kv line
Section 2	Portion of Upper Pi'ihonua	138 Kv line
Section 3	Portion of Upper Pi'ihonua and Pu'u O'o	138 Kv line
Section 4	Portions of Ahumoa, Pu'u O'o, Mauna Kea and Pu'u Koli	138 Kv line
Section 5	Portions of Keamuku and Ahumoa	138 Kv line
Section 6	Portions of Keamuku and Nohonaohae (Includes Keamuku Substation)	138 Kv line
Section 7	Portion of Pu'u Hinai	69 Kv radial line

EXHIBIT VI-2

PHASE 2 MAP SOURCES

Map Criteria	Sources
PHYSICAL CONDITIONS	
1. Land Use	
Urban Agriculture Grazing	USGS orthophotos (1978) R.M. Towill Corp., aerial photos (1980) and field surveys by EDAW inc.
Military	Property maps prepared by U. S. Army Support Command/Hawaii.
Recreation	Dept. of Land and Natural Resources, State Recreation Plan and Technical Reference Document, Honolulu: State of Hawaii; December 1980.
Historic sites	Dr. William Barrera, Archaeo-logist, Chiniago, Inc.
2. Biological Factors	
Ohia-Koa forest Mamane-Naio forest Introduced forest	USGS orthophotos (1978) and field surveys by EDAW inc.
Palila Critical Habitat	Mr. Lucien Kramer, Biologist, U. S. Fish and Wildlife Service.
Kipuka and cave Habitats	Drs. Wayne C. Gagne, Carl Christensen and Peter O'Connor, Biologists, Bernice P. Bishop Museum.
3. Geophysical Factors	
Slopes 20 percent and greater	USGS topographic sheets (1956)
High Soil erosion hazard	U. S. Soil Conservation Service, Soil Survey of the Island of Hawaii, State of Hawaii, Washington, D. C.: U. S. Government Printing Office, December, 1973.

Map Criteria	Sources
PHYSICAL CONDITIONS	
Geophysical Factors (cont'd)	
Streams Reservoirs	USGS topographic sheets (1956) and field surveys by EDAW inc.
LAND CONTROL	
1. Land Ownership	
Private Hawaiian Home Lands	Dept. of Geography, University of Hawaii, <u>Atlas of Hawaii</u>, Honolulu: The University Press of Hawaii, 1973.
State	Tax maps prepared by Dept. of Taxation, State of Hawaii.
Federal lease	Property maps prepared by U. S. Army Support Command/Hawaii.
2. Land Regulation	
Urban District	State Land Use District maps prepared by State Land Use Commission, State of Hawaii.
Protective Subzone Resource Subzone General Subzone	Conservation District subzone maps prepared by Dept. of Land and Natural Resources, State of Hawaii.
Approach/departure zone	Bradshaw Airfield map prepared by U. S. Army Support Command/ Hawaii.
VISUAL RESOURCES	
1. Visual Screens Solid vegetation Partial vegetation Partial buildings and vegetation Berm along road 2. Views Type A Type B Type C Type D	Field surveys by EDAW inc.

Historic Places. Existing utility lines are also shown. These include a telephone line, most of which is out of service at the present time, with portions having been removed, and HELCO's 69 Kv cross-island transmission line.

2. Biological Factors: Major wildlife habitat areas were mapped. For the most part, these occur in forest areas. A distinction is made between the major types of forest. Forests with predominately introduced species of trees and plans tend to attract introduced wildlife, as well. Native wildlife species are dependent upon native forests, of which there are two major types in study corridor: the Ohia-Koa forest and the Mamane-Naio forest. The latter is a open scrub forest found at higher elevations. Only major forest areas, characterized by a large number of mature trees and a relatively dense pattern of growth, were mapped. This eliminates many of the lava flows where young plant growth is taking root. Certain smaller areas having special value as wildlife habitats were also mapped. These include kipuka, which are oases of older vegetation that have not been covered by lava flows in recent centuries, and collapsed lava tubes within pahoehoe lava flows, which form cave habitats for endemic organisms.

3. Geophysical Factors: Data on slope, soils and surface water bodies appeared in the Phase 1 mapping in a generalized form. Slopes exceeding 20 percent and soils with a "severe" erosion hazard potential rating are shown more precisely on the 1":24,000" scale maps. No distinction is made between wind erosion and water erosion hazards on the map itself, but this difference is noted in the subsequent field studies and analysis of alternative alignments. The study corridor contains no major water bodies or perennial streams, but there are a few intermittent streams which appear after periods of heavy rainfall in Sections 1 and 6. There are also a couple of small reservoirs located in or near grazing areas.

LAND CONTROL

1. Land Ownership: Major landowners are noted on the maps. The State of Hawaii and the Hawaiian Homes Commission hold most of the property in the study corridor. Almost all of the lands shown on the maps as "Federal lease" are State properties being leased to the U. S. Army for the Pohakuloa Training Area. A relatively small diamond-shaped

parcel is leased to the Army by the Hawaiian Homes Commission. Privately-owned lands are grouped together on the maps because the number of private landowners in the study corridor is very large. Tax maps and current tax records are used to supplement this information when decisions on specific portions of the alignment are being made.

2. Land Regulation: Lands within the State Urban District are shown on the maps to indicate where urbanization is likely to occur if it has not already. Within the State Conservation District, the various subzones established by the Board of Land and Natural Resources are shown. Three subzones - Protective, Resource and General - are found in the study corridor. The approach and departure zone for Bradshaw Airfield, part of Pohakuloa Training Area, is the final regulatory feature displayed on the maps.

VISUAL RESOURCES

1. Visual Screens: The maps show features which screen views from passersby on Saddle Road. Four types of screen are noted: (1) Solid vegetation, which consists of a thick growth of trees near the road, (2) partial vegetation, which is a thinner or lower growth of trees allowing occasional or penetrated views, (3) partial buildings and vegetation, which indicate an urban residential environment, and (4) a berm adjacent to the road, which may be either man-made road cuts or natural formations, such as rubble piles from a'a lava flows.

2. Views: Views from Saddle Road were also described as four types. View A represents an expansive open view of the foreground, middleground and distant backdrop or horizon.[1] View B indicates an open view of the foregound only; some type of screen blocks the middleground and distant backdrop or horizon. View C represents an open view of the foreground and middleground, but no view of the distant background. Finally, View

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[1]Viewgrounds can be defined by their range in distance from Saddle Road. The ranges for the foreground and middleground will vary according to the characteristics of the terrain. The Visual Resource maps at the end of this chapter provide notes describing the foreground and/or middleground distances for specific views.

D is an open view of the foreground and background, but no view of the middleground.

The sources used to map these data factors are listed in Exhibit VI-2. As noted in this list, a number of technical specialists assisted in the mapping effort.

B. CONSTRAINT ANALYSIS

From the overlay constraint mapping in Phase 1, it was apparent that there are competing constraints among the various data factors. The conditions which exist in any given area may be considered a constraint for a transmission line under one data factor but an opportunity under another. The same principle applies to constraint mapping at a more detailed scale. The following is an analysis of the relative constraints and opportunities for each of the data factors described in the preceding section.

PHYSICAL CONSTRAINTS

1. Land Use: For the most part, the constraint analysis for the Land Use factor in Chapter IV is relevant to a more detailed map scale, as well. Urbanized areas should be avoided for the reasons stated previously, particularly since these areas consist primarily of residential neighborhoods in the study corridor. Agricultural or crop cultivation areas are not in effect a constraint because they are virtually non-existent in the study corridor. Grazing land can be viewed as an opportunity area in certain respects. The access road through grazing lands can serve a multiple function as a route for ranchers, fire-fighters and transmission line construction and maintenance crews. Roads can also act as a fire-break, which is an asset for some of the drier grassland areas in the western portion of the study corridor. Military and recreation uses are qualified constraint areas. Military areas are a constraint to a transmission line to the extent that the line might conflict with established operations. If they do not interfere, specifically with flight operations at Bradshaw Airfield, military lands can be considered at least nonconstraining areas, if not opportunities. The recreation lands shown on the maps are almost exclusively hunting areas. In order to control hunting and promote proper management, vehicular access through game reserves should be restricted. A new transmission line easement would create additional opportunities for vehicular access and make control of hunting activities more difficult. On the other hand, if

the transmission line were to follow the route of an existing jeep trail through the hunting areas, there would be no conflict with game management objectives. On the contrary, there is greater likelihood that the road would be better maintained if it served more than one purpose. The only park area is Pohakuloa (Mauna Kea) State Park, which the alignment should avoid in order not to create a detrimental visual impact. The park is shown as an "urban"use on the map to indicate that cabins are located there and to emphasize its importance as a constraint. The alignment of the existing 69 Kv line is both a constraint and an opportunity. It is an opportunity because it creates a path which the new transmission line might be able to follow. It is a constraint wherever it might be desirable, for various reasons, for the new line to cross the 69 Kv line. The concern is that, if the conductor for the new line should break, it would fall on top of the 69Kv conductor and short the line. This would put two major transmission lines out of commission and defeat the very purpose of the 138 Kv line, which is to provide system reliability.

2. Biological Factors: The areas with the greatest biological constraint for a transmission line are the *kipuka* and the cave habitats which has been identified on the maps. These small, isolated ecosystems are relatively pristine pockets of native biota and serve as sites for studies in evolutionary biology. Both types of habitat are vulnerable to distrubance or distruction of surface vegetation due to compaction or removal by heavy construction equipment or the use of herbicides.

In general, the alignment for the transmission line should also avoid the creation of new paths through areas of major vegetation. Native forest types, *Mamane-Naio* and *Ohia-Koa*, are biologically more important than introducted forests because many species of indigenous or endemic wildlife are dependent upon these native habitats. The *Palila*, an endemic forest bird which has official status as a rare and endangered species, is a denizen of the *Mamane-Naio* forest. The boundaries of a designated "Critical Habitat" for the *Palila* encompass most of the *Mamane-Naio* growth as shown on the maps of the study corridor. Nevertheless, despite its inclusion as part of the Critical Habitat, *Palila* have never been known to nest at these lower elevations.

Existing paths through major vegetation, created by jeep trails, fire breaks or access roads for utility lines, ease the constraint considerably and may even be viewed as an opportunity at points where biologically sensitive areas span almost the entire width of the corridor or where competing constraints under other data factors urge an alignment through the forested area.

3. GEOPHYSICAL FACTORS

As discussed in Chapter IV, much of the Island of Hawaii is subject to volcanic and seismic hazards, and these extend into the study corridor. While none of the major rift zones are within the corridor, several areas have been covered by lava flows since 1800. The boundaries and dates of these flows cannot reliably be predicted. In general, however, the risk of inundation is greater on the Mauna Loa slope, south of Saddle Road, than on the Mauna Kea slope, lying north of the road.[2]

Of the two types of lava flow, pahoehoe flows are a slightly greater constraint than a'a flows because subsurface cavities or tubes can create a problem for pole placement. Nevertheless, it is a constraint than can usually be remedied by shifting the location of transmission poles a few feet.

Slope, soil erosion hazard and intermittent stream courses can combine to form a significant constraint. The alignment should clearly be located away from relatively steep slopes where the soil erosion hazard potential is severe and streams or gullies are present because lateral support of the transmission poles could be undermined. To a lesser extent, each of these conditions are constraints on their own. It is generally undesirable to site transmission poles on slopes exceeding 20 percent if a feasible alternative is available. Soils with a severe erosion hazard rating should also be avoided, unless they are in an area where there are no steep slopes or water courses to exacerbate the

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2Walter Lum Associates, Inc., "HELCO Transmission Line Routing Study: Geotechnical Factors", Honolulu, December 9, 1982. (unpublished ms.). The full text of this report is contained in the Environmental Impact Statement for this project.

erosion potential, in which case they are only a slight constraint for an overhead transmission alignment. The alignment should avoid paralleling an intermittent stream bed at close range. When crossing gullies or stream beds it is preferable to do so at a right angle in order to minimize the span over the water course.

LAND CONTROL

1. Land Ownership: Landowners' plans and expectations for the use of their property can constrain the location of a transmission line alignment. Most landowners would prefer that a transmission line easement through their property be located adjacent to an existing utility line or road easement or along the boundaries of their property so as to minimize interference with present uses or permit flexibility for future or anticipated uses.

2. Land Regulation: The State Urban District discourages a transmission line route because it designates areas where urbanization is permitted to occur, thereby raising the expectations of property owners and bringing up the issue of incompatibility between transmission lines and urban uses.

   Regulatory constraints in the State Conservation District correspond to the degree of restrictiveness in the permitted uses for the hierarchy of four subzones. As described in Chapter IV, the Protective Subzone is the most restrictive. Transmission lines through this subzone have been strongly discouraged by the Board of Land and Natural Resources. The study corridor contains no Limited Subzone, which is next in the hierarchy of restrictiveness. Much of the study corridor is in the Resource Subzone and a small portion is in the General Subzone, which are the two least restrictive Conservation District subzones.

   The approach and departure zones for Bradshaw Airfield cover a rather small portion of the study corridor, but are a significant constraint in areas close to the runway because of the limitations on the height of structures. The transmission poles will be about 90 feet above grade, so it is doubtful that they would be permitted within 10,000 feet of the end of the runway. Beyond that distance, the transmission line may be permitted to cross the zone, but safety features such as signal lights and other warning devices on the poles or conductors may be required.

VISUAL RESOURCES

1. Visual Screens

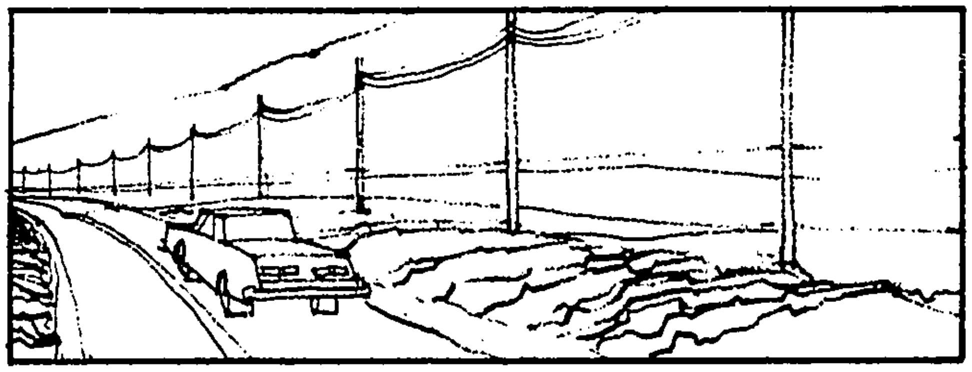
A primary aesthetic consideration in the siting of a transmission line is the extent to which the poles and conductors are screened from view at important vantage points by vegetation, natural landforms and buildings or structures. In the case of the study corridor, the area within visual range of Saddle Road gets the most frequent view exposure since it is the only major roadway and acts as a continuous vantage point for vehicular motorists and passengers who travel it.

Solid vegetation screens offer the best opportunity for masking the view of a transmission line. Solid screens virtually stop one's view at the edge of Saddle Road, creating an enclosure and directing the line of sight away from the screen. A transmission line beyond the screen or well within it would not be visible from Saddle Road.

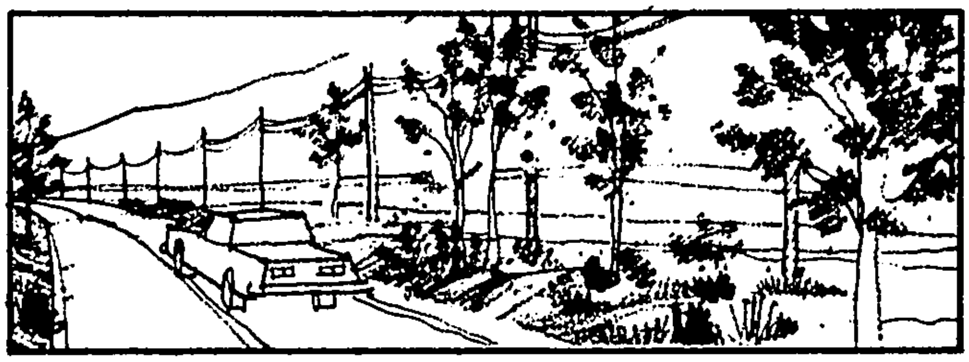
A berm immediately adjacent to the road can serve as a solid screen for the middle ground beyond it. Its effectiveness as a screen, however, depends upon berm height, vegetative cover and slope of the middleground, which vary considerably over short distances. Partial vegetation screens can be quite effective if the line is set back far enough to appear no taller than the screen itself.

Partial building and vegetation screens indicate a residential environment. While this type of screen may block views of the line from Saddle Road, the line may be highly visible from the residential area itself. This is a constraint which should be taken into account when considering specific alignment alternatives.

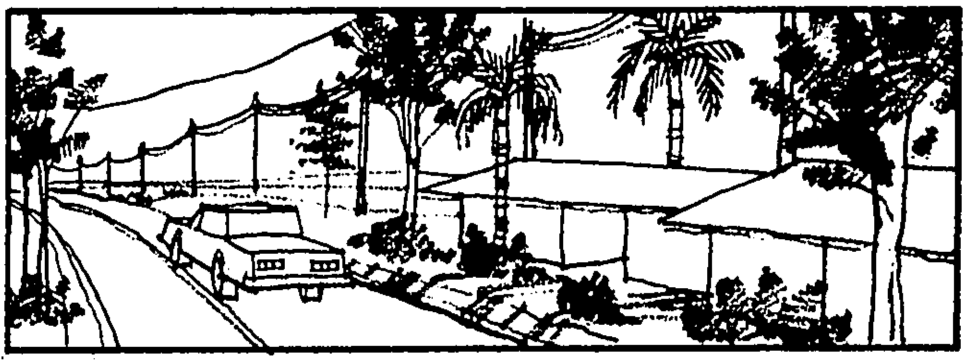
Pu'u, which are primarily dormant volcanic cones or vents of varying shapes, sizes and distances from Saddle Road, create temporary or "moving" visual screens. On the other hand pu'u are visually dominant features of much of the study corridor's landscape. Consequently, they could attract attention to a nearby transmission line rather than screen it, particularly if the poles appear high in relation to the pu'u.



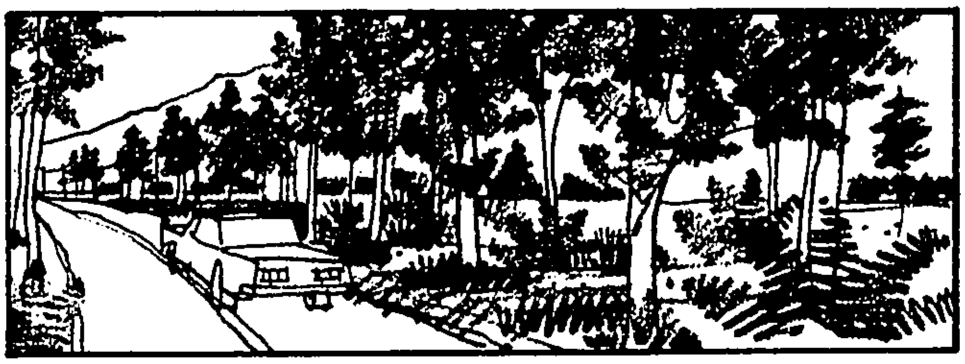
NO SCREEN (OPEN VIEW)



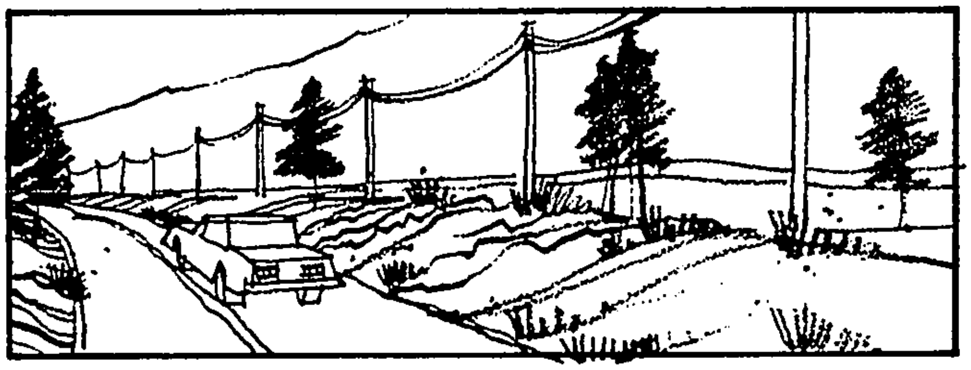
PARTIAL VEGETATION



PARTIAL BUILDING & VEGETATION SCREEN



SOLID VEGETATION SCREEN



BERM ALONG ROAD

EXHIBIT VI-3:
VISUAL SCREENS

2. Views

In the case of view type A, where a vista of foreground, middleground and distant background is present, it is preferable to locate the transmission line directly in front of a total backdrop to avoid having poles and conductors silhouetted against the sky. If this is not advisible due to other constraining factors, the line can be placed adjacent and parallel to the road and an existing utility line in order to minimize dominance of the line in views perpendicular to the road.

In View "B", where only the foreground is visible, the line can be placed immediately in behind the screen which blocks the middleground and background. Alternatively, it can be placed immediately in front of the screen, using it s a backdrop to minimize visual impact.

For Views "C" and "D", where the distant background and middleground, respectively, are not visible, the line is best placed in the unseen areas.

As indicated, the visual impact of the transmission line can be minimized by careful alignment within the viewplane. The line and poles would generally be most dominant and most difficult to conceal whenever it crossed Saddle Road, so the number of crossings should be minimized for aesthetic reasons, as well as safety reasons. If the line must cross Saddle Road, it should do so at a right angle, if possible, in order to shorten the visible length of the line.

C. ALIGNMENT SELECTION

The constraint analysis described above does not lend itself well to overlay mapping. Overlay mapping is an effective technique for synthesizing and evaluating a large amount of data covering an extensive geographic area so that preliminary decisions on route location can be made. There is a rather broad consensus on the criteria for evaluating constraints under the broadscale data factors since they are derived mostly from official planning and scientific studies, and this can form the basis for overlay constraint mapping.

At the Phase 2 scale of analysis, however, the route alignment choices are more limited and greater attention must be paid to detailed criteria. Much of the selection process depends upon consultation with individual landowners whose property would be crossed by the transmission line easement; with government agency staff who will review requests for permits or easements for the transmission line; and with HELCO engineers, construction and maintenance personnel. It also relies upon first-hand field observations by teams of technical specialists in zoology, botany, entomology, malacology, geology, archaeology, soils and civil engineering and landscape architecture to evaluate conditions specifically for this project. Rather than the broadscale widely accepted criteria suitable for overlay mapping, the rationale for selecting the detailed alignment is based on an explicit priority of constraints which emerged from the consultation and field study process. The hierarchy is as follows:

1. Avoid the State Urban District, the Protective Subzone of the State Conservation District and interference with military operations at Pohakuloa Training Area. These criteria get highest priority because they respond to the concerns of governmental bodies which have direct authority for granting permits or easements for the transmission line.

2. Minimize the number of times the new transmission would cross Saddle Road and the existing 69 Kv line. Safety and reliability are the primary reasons why this has high priority. Fewer road crossings also address a major aesthetic concern.

3. Follow the alignment of the existing 69 Kv line as closely as possible. Several reviewers, including government policy personnel and landowners, preferred that the new line be immediately adjacent to the existing line. There is a variety of reasons for this, most of which have been mentioned in the constraint analysis in the preceding section. Briefly, a paralleling alignment would tend to minimize disturbance to natural areas, lessen visual impact and avoid encumbering the future use of property. Nevertheless, it may not be advisable to parallel the 69 Kv line in certain sections where it passes through biologically sensitive or restrictive regulatory areas or is highly visible from Saddle Road. Specifically, the Protective Subzone, *kipuka*, collapsed lava tubes and road crossings should be avoided, even where the 69 Kv route indicates otherwise. Also, close paralleling of two transmission lines makes both lines susceptible to simultaneous outages in the event

of a major storm, lava flow or other threatening condition.

4. Site the line so as to avoid adverse visual impact from Saddle Road, urbanized and urbanizing areas. Visual impact can be mitigated only by siting the line where it is least visible to potential viewers. There is usually a wider range of means to minimize other kinds of potential impact, such as biological factors.

5. Keep within one-half mile of Saddle Road, except where the existing 69 Kv line also departs further than that from the Saddle Road or there is an existing jeep trail which can provide access to the proposed line. While it is not imperative that road access be available at every point along the line, heavy dependence on the use of helicopters for construction and maintenance is costly and may cause delays in repair work.

On the basis of these general guidelines for the constraint analysis, a preferred alignment was delineated. The path of this alignment, in relation to the various data factors for all seven map sections, is shown in Exhibits VI-4 through VI-24. Also shown are alternative alignments, some of which were originally designated the preferred alignment until field studies or view consultations led to a revision. Other alternative alignments were suggested by landowners or technical consultants, viewing the constraints from their specialized perspectives. A narrative accompanying each map section describes the conditions encountered by the preferred alignment travelling westward, and explains the reasons why it was selected over alternative alignments.

CORRECTION

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

SECTION 1 (Exhibits VI-4 through 6)

The preferred alignment leaves the Kaumana Substation in a southeast direction, remaining close to property lines and avoiding urban and urbanizing areas. Approximately 1.5 miles from the existing substation a location for the future 138 Kv substation is identified. While the new substation will not be required until the line is energized at 138 Kv several years from now, this site is proposed because it is removed from urban areas and is ideally situated for a transmission line connection from the south, where geothermal development is expected to occur. From the new substation, the preferred alignment heads southwest, following the edge of the Hilo Forest Reserve, which is marked by a fire break through fairly dense vegetation and defined by the boundary between the Conservation and Agriculture Districts. The alignment is just within the Agriculture District, following the fire break to minimize the removal or disturbance of vegetation. An alternative alignment, paralleling this about .75 miles to the north, was rejected because it was adjacent to Urban District land and the affected landowners objected to this route.

The preferred alignment turns northwest, then southwest again to follow the Hilo Forest Reserve boundary. At approximately Reference Marker 2, as shown on the maps, where the tree cover becomes fairly dense, the route angles northwest toward Saddle Road. There is a short alternative alignment which juts out to the west and angles back to the preferred alignment. Final alignment is dependent on negotiations with the landowners involved.

A major alternative alignment, taking a route south of Saddle Road for a stretch of several miles, also begins at about this point. This alternative was rejected because it crosses through a large portion of the Protective Subzone, which contains a number of kipuka and other biologically important areas. It is also more exposed to the risk of lava inundation.

The preferred alignment crosses Saddle Road and the existing 69 Kv line at a right angle just before Reference Marker 4. This is the first point at which the new transmission line would become visible from Saddle Road. Both crossings were necessary in order to get the alignment north of Saddle Road and behind the existing line. Getting the alignment behind the 69 Kv line permits more flexibility. For example, the alignment can be set back further, when necessary, to avoid intrusion into biologically sensitive areas or view planes from Saddle Road. In any case, the 69 Kv line crosses Saddle Road three more times further down the route, which eventually forces a choice between crossing either the road or the existing line.

In the vicinity of Reference Marker 4, the preferred alignment passes through about 2,500 feet of the Protective Subzone. This would not be a significant intrusion into the subzone, since the alignment is directly alongside the 69 Kv line at the subzone of a major storm, lava flow or other threatening condition.

4. Site the line so as to avoid adverse visual impact from Saddle Road, urbanized and urbanizing areas. Visual impact can be mitigated only by siting the line where it is least visible to potential viewers. There is usually a wider range of means to minimize other kinds of potential impact, such as biological factors.

5. Keep within one-half mile of Saddle Road, except where the existing 69 Kv line also departs further than that from the Saddle Road or there is an existing jeep trail which can provide access to the proposed line. While it is not imperative that road access be available at every point along the line, heavy dependence on the use of helicopters for construction and maintenance is costly and may cause delays in repair work.

On the basis of these general guidelines for the constraint analysis, a preferred alignment was delineated. The path of this alignment, in relation to the various data factors for all seven map sections, is shown in Exhibits VI-4 through VI-24. Also shown are alternative alignments, some of which were originally designated the preferred alignment until field studies or view consultations led to a revision. Other alternative alignments were suggested by landowners or technical consultants, viewing the constraints from their specialized perspectives. A narrative accompanying each map section describes the conditions encountered by the preferred alignment travelling westward, and explains the reasons why it was selected over alternative alignments.

boundary, which is defined by Saddle Road. Biological surveys have not detected any natural resources of unusual value in this area, particularly since it has previously been disturbed.

There are two alternative alignments along this stretch which remain south of Saddle Road to avoid the Protective Subzone. Both of the two affected private landowners in this area objected strenuously to these alternatives because they would create an additional, bisecting easement across their properties. These routes may also have more adverse environmental impact than the preferred alignment because they cross previously undeveloped areas. Moreover, an adverse visual impact would be created by having transmission lines run along both sides of Saddle Road.

Between Reference Marker 5 and the end of Section 1, the preferred alignment remains parallel to the existing 69 Kv line. In general, this minimizes disruption to natural areas and the screening or view characteristics are such that visual impact would not be significant. The alignment appears to pass near or through a small _kipuka_ (K-2300) just past Reference Marker 5. The existing 69 Kv line traverses the edge of this _kipuka_. The preferred alignment may be able to avoid the _kipuka_ entirely by jogging northward a few hundred feet. A radio transmitter station is planned in this area, so the precise alignment will have to be determined during the field survey to avoid the _kipuka_ and the transmitter station.

In this same parallel stretch, two short alternative alignments are shown. Both would bring the line close to Saddle Road in order to avoid forest area. One of the alternatives crosses the 69 Kv to accomplish this, which is undesirable from a safety and reliability standpoint. In addition, both alternatives would make the new line highly visible from Saddle Road. While there are occasional mature trees, there are primarily open-canopied _Ohia_ scrub forests in this area. Their utility as a visual screen diminishes when the alignment approaches Saddle Road. Since the biological constraint of placing the alignment through relatively young forest growth is not significant, the preferred alignment is set back from the 69 Kv line to give the visual constraint priority attention.

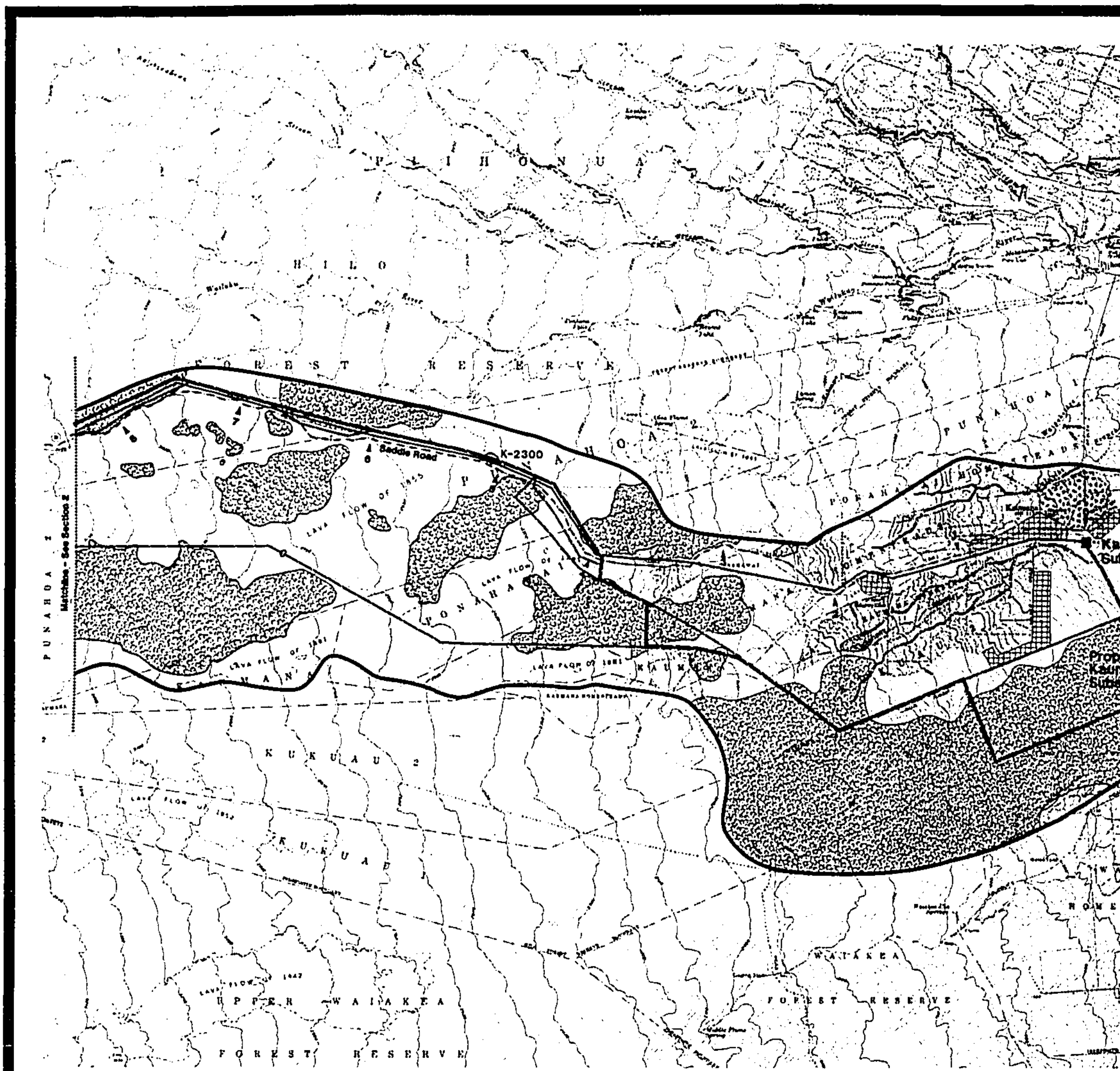
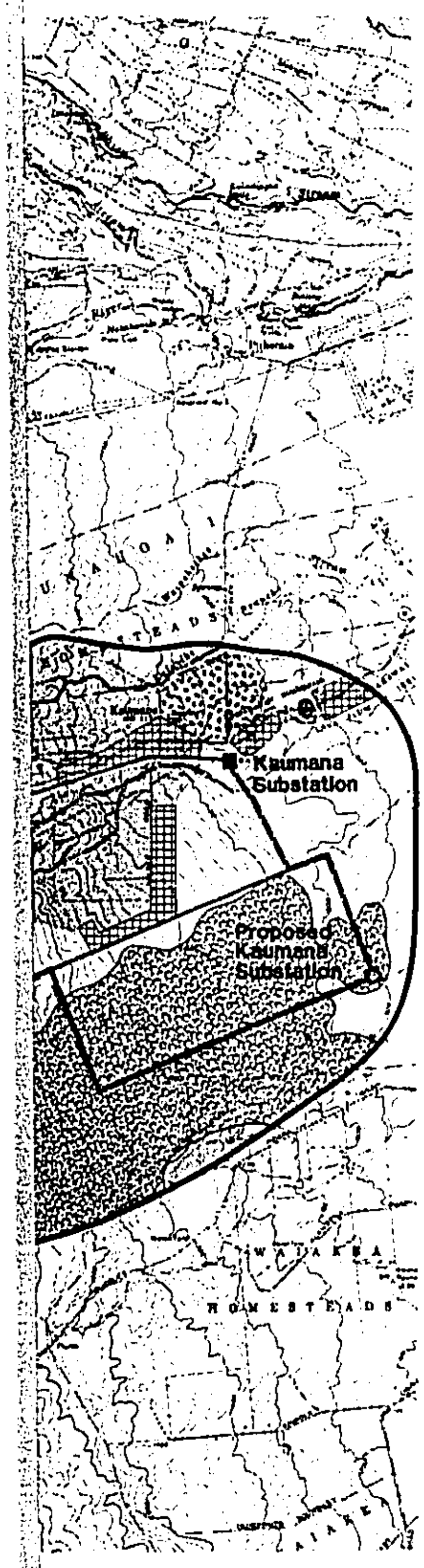


EXHIBIT VI-4

HELCO TRANSMISSION LINE ROUTING STUD



LEGEND

BASE DATA

- Edge of corridor
- Existing road
- Existing telephone line
- Existing 69 KV line
- Substation
- Reference marker
- Matchline
- Preferred 138 KV alignment
- Alternate 138 KV alignment

LAND USE FACTORS

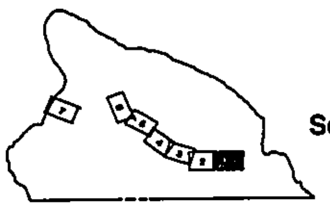
- Urban
- Agriculture
- Grazing
- Military
- Recreation
- Historic site

BIOLOGICAL FACTORS

- Ohia/Koa native forest
- Mamane/Naio native forest
- Introduced forest
- Palila critical habitat
- Kipuka and cave habitats (K-9)

GEOPHYSICAL FACTORS

- Slopes 20% & greater
- High soil erosion hazard
- Stream
- Reservoir



Section 1

PHASE II
Physical Conditions

STUDY ○ EDAW inc.

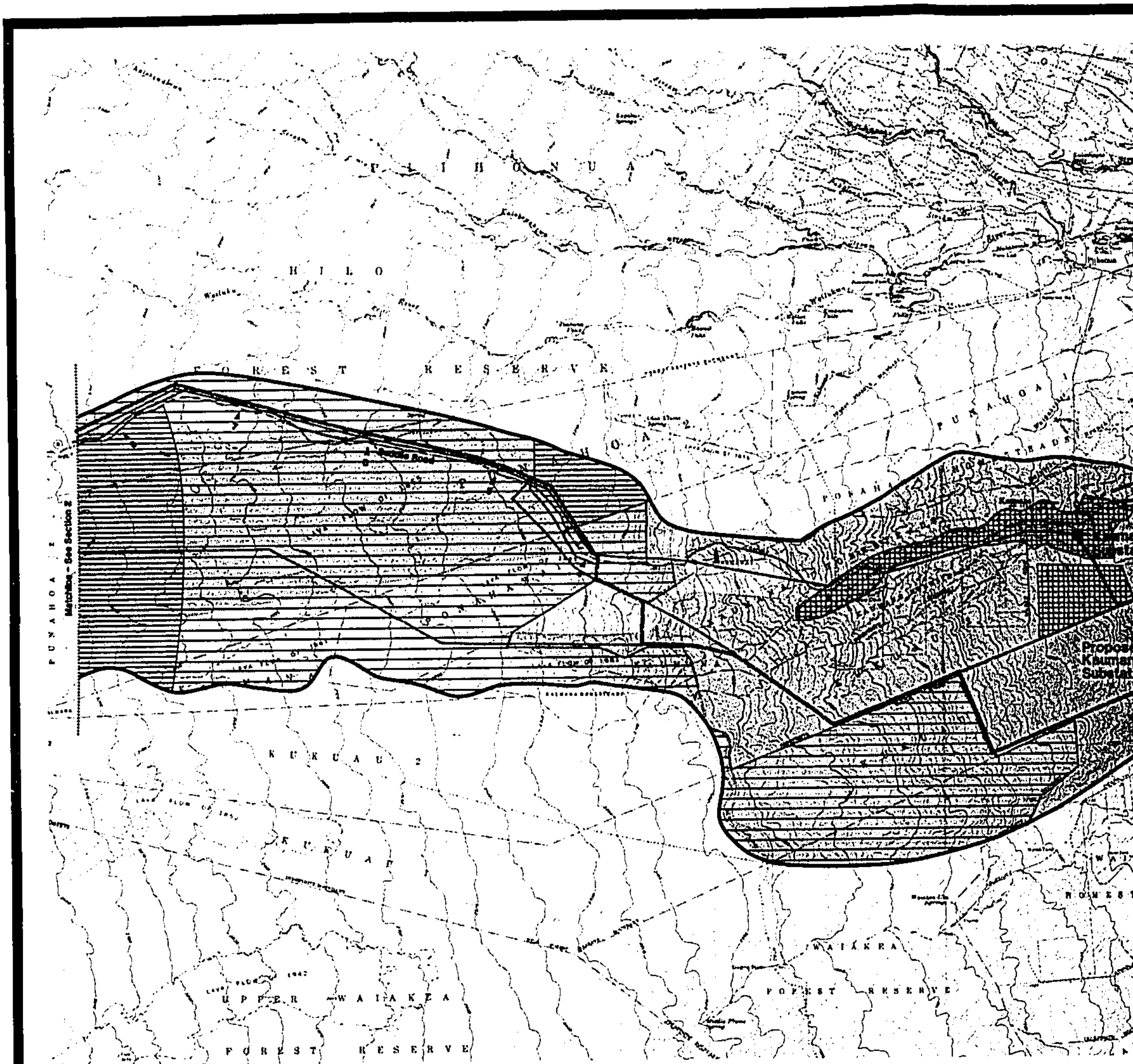
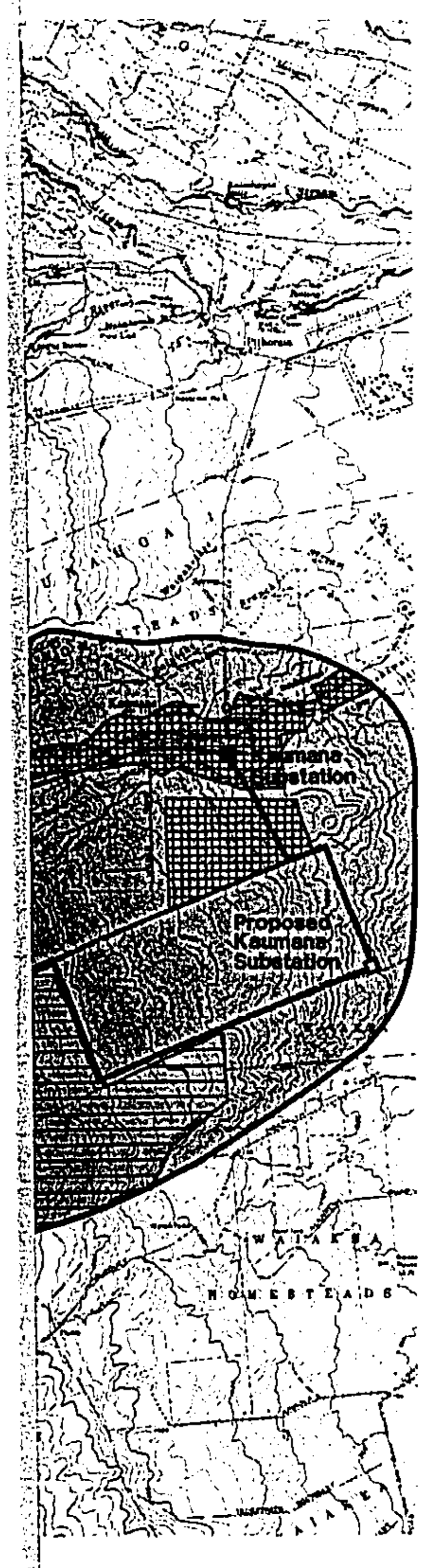


EXHIBIT VI-5

HELCO TRANSMISSION LINE ROUTING STUDY



LEGEND

BASE DATA

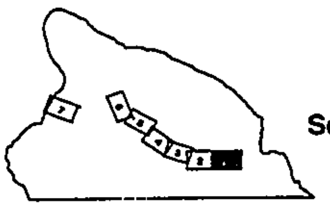
- Edge of corridor
- Existing road
- Existing telephone line
- Existing 69 KV line
- Substation
- Reference marker
- Matchline
- Preferred 138 KV alignment
- Alternate 138 KV alignment

LAND OWNERSHIP

- Private
- Hawaiian Home Lands
- State
- Federal lease

LAND REGULATION

- Urban District
- Protective Subzone
- Resource Subzone
- General Subzone
- Airfield approach/departure zone



Section 1

PHASE II
Land Control

0 1000 2000 5000 FEET 10,000

0 500 1000 1500 METERS 3000

STUDY ○ EDAW inc.

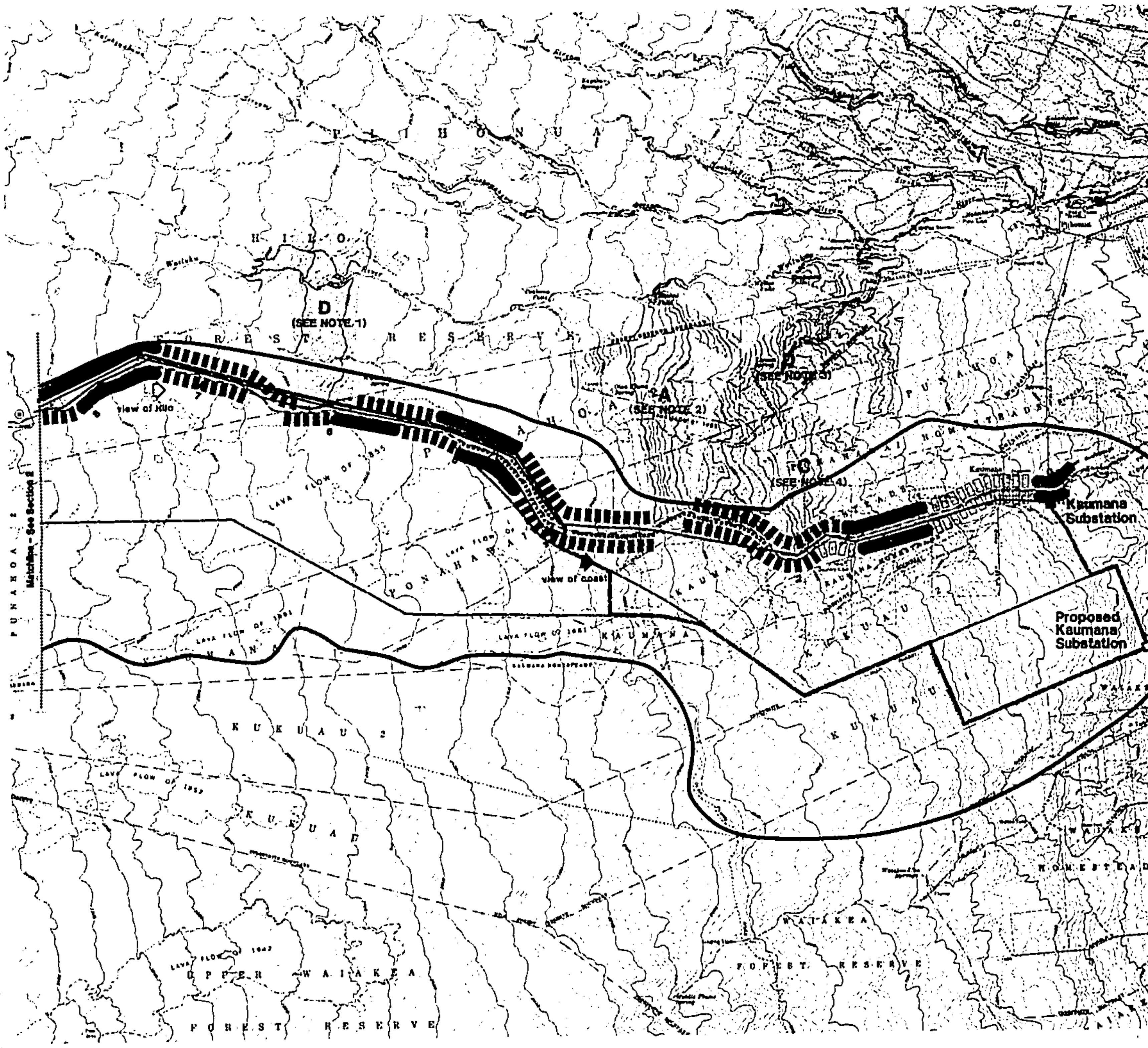
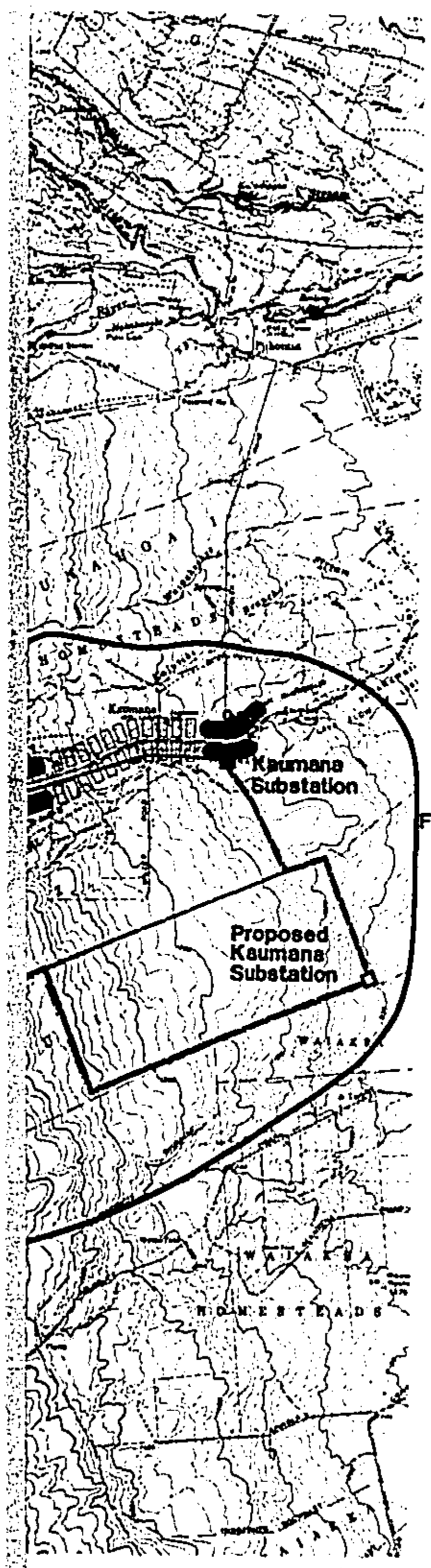


EXHIBIT VI-6

HELCO TRANSMISSION LINE ROUTING STUDY



LEGEND

BASE DATA

- Edge of corridor
- Existing road
- Existing telephone line
- Existing 69 KV line
- Substation
- Reference marker
- Matchline
- Preferred 138 KV alignment
- Alternate 138 KV alignment

VISUAL SCREENS

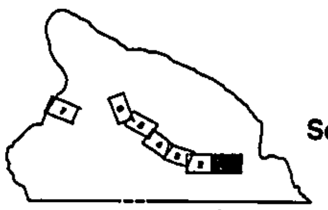
- Solid vegetation screen
- Partial vegetation screen
- Partial buildings & vegetation screen
- Berm along road
- Puu

VIEWS

- Foreground, middleground & distant backdrop or horizon — A
- Foreground — B
- Foreground & middleground — C
- Foreground & distant backdrop or horizon — D

NOTES

1. Long view to distant horizon, middle ground obscured by heterogenous vegetation (approx. 100 feet from road).
2. Long view over tops of trees in middle ground (200-300 yards from road).
3. Long view to coast (approximately 4 miles).
4. Short view, middle ground and distant view obscured by heterogenous vegetation (approx. 300 yards from road).



Section 1

PHASE II Visual Resources

0 1000 2000 5000 FEET 10,000

0 500 1000 1500 METERS 3000

STUDY ○ EDAW inc.

SECTION 2 (Exhibits VI-7 through 9)

The preferred alignment begins to run immediately adjacent to the existing 69 Kv line from Reference Marker 9 until midway between Reference Numbers 11 and 12, where it pulls north to circumvent a collapsed lava tube. Visibility from Saddle Road is minimal due to the forest backdrop. After Reference Marker 14, it abuts the 69 Kv line once again until it approaches the western edge of Section 2. At this point, the alignment diverges to the northwest, running just outside the boundary of the Upper Waiakea Forest Reserve, which is in Protective Subzone.

As in the last portion of Section 1, the route paralleling the 69 Kv line would generally minimize disruption of the Ohia-Koa forest. A combination of tree growth and berms would screen the line from Saddle Road over most of this stretch. There are occasional views, but only one includes the middleground, where the new line would, for the most part, be located.

To the south of Saddle Road is the continuation of an alternative alignment which was rejected because it crosses a long expanse of Protective Subzone.

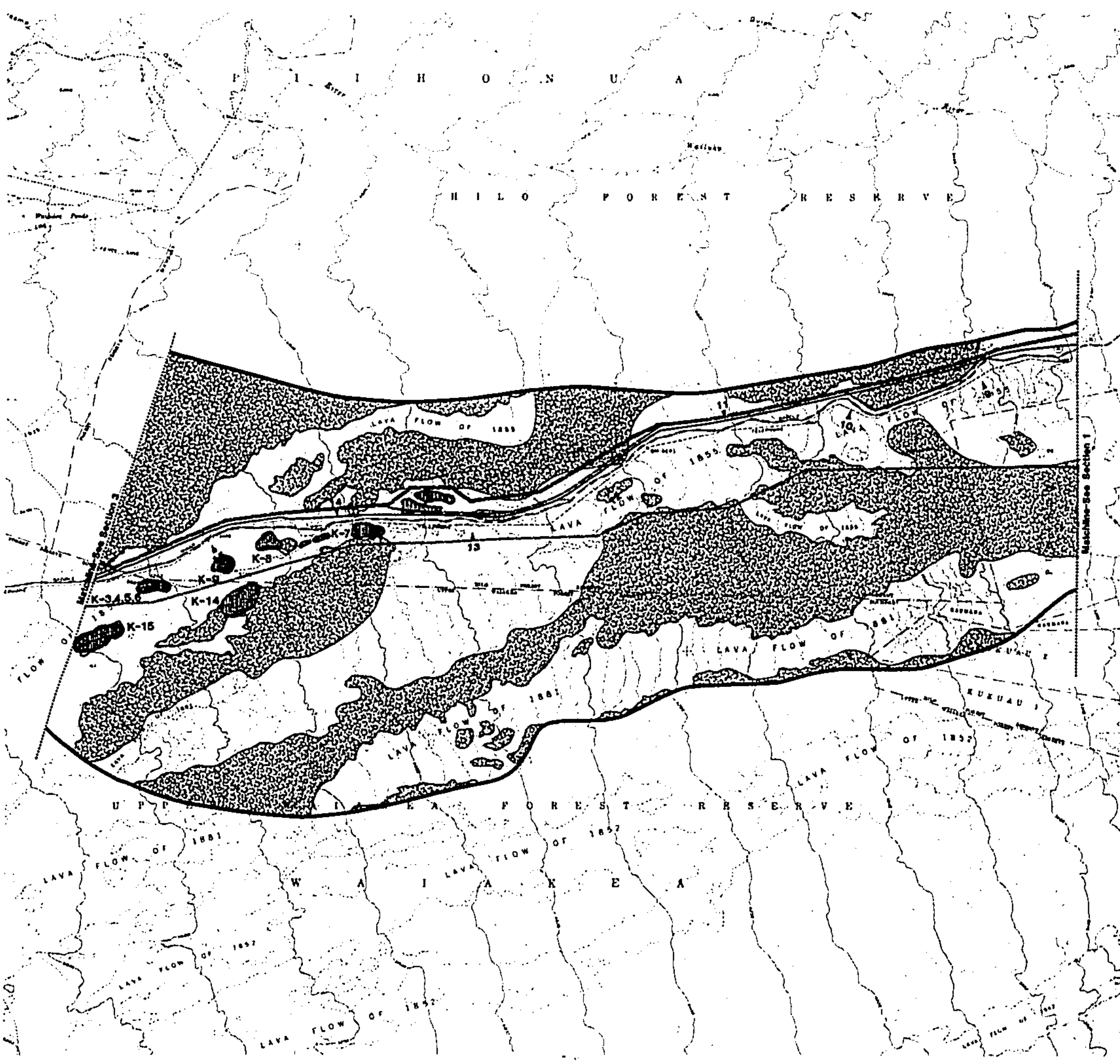
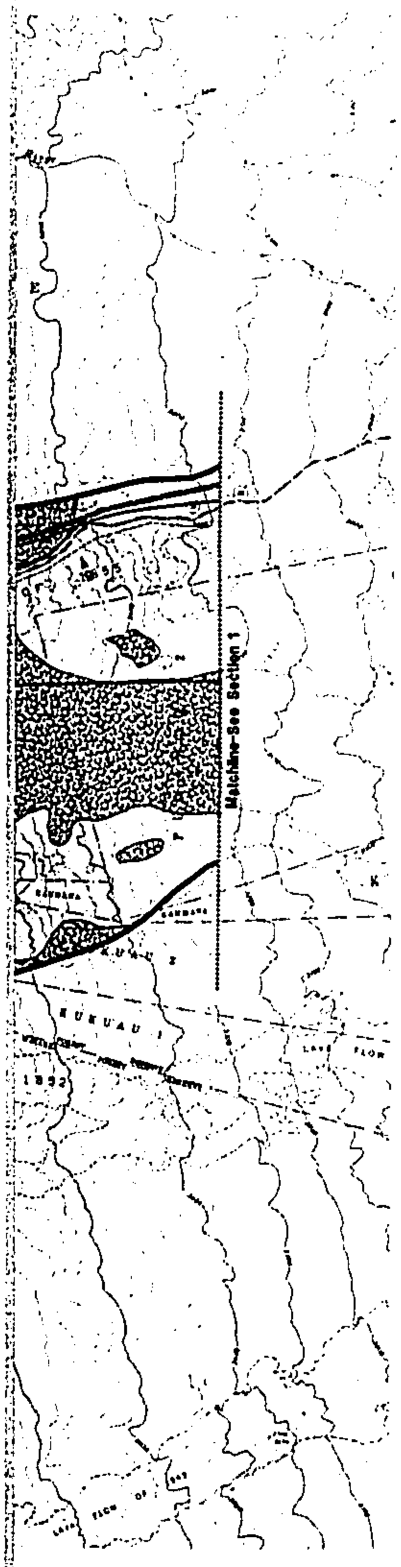


EXHIBIT VI-7

HELCO TRANSMISSION LINE ROUTING STUDY



LEGEND

BASE DATA

- Edge of corridor
- Existing road
- Existing telephone line
- Existing 69 KV line
- Substation
- Reference marker
- Matchline
- Preferred 138 KV alignment
- Alternate 138 KV alignment

LAND USE FACTORS

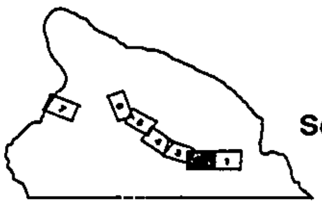
- Urban
- Agriculture
- Grazing
- Military
- Recreation
- Historic site

BIOLOGICAL FACTORS

- Ohia/Koa native forest
- Mamane/Naio native forest
- Introduced forest
- Palila critical habitat
- Kipuka and cave habitats

GEOPHYSICAL FACTORS

- Slopes 20% & greater
- High soil erosion hazard
- Stream
- Reservoir



Section 2

PHASE II

Physical Conditions

0 1000 2000 5000 FEET 10,000

0 500 1000 1500 METERS 3000

STUDY ○ EDAW inc.

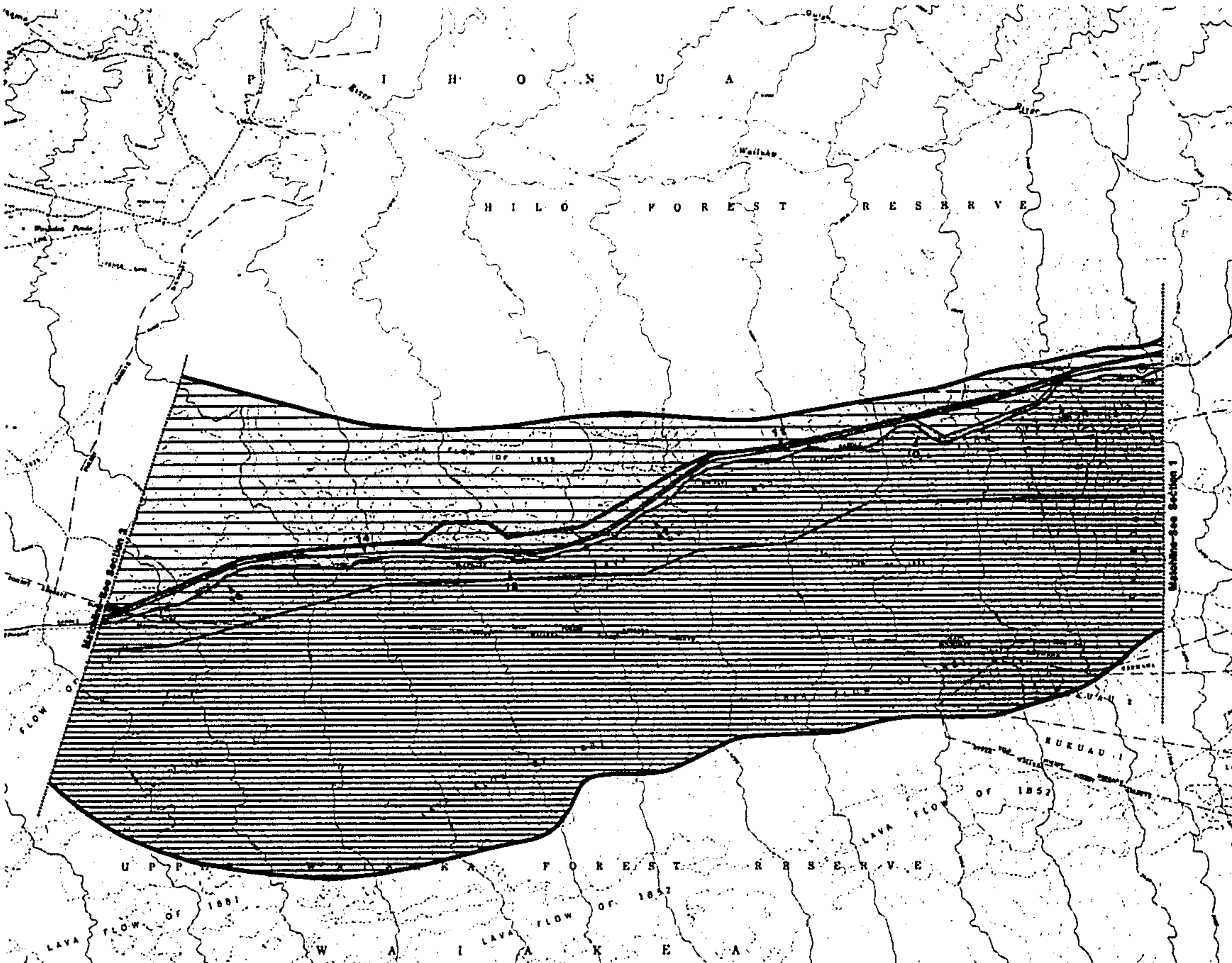
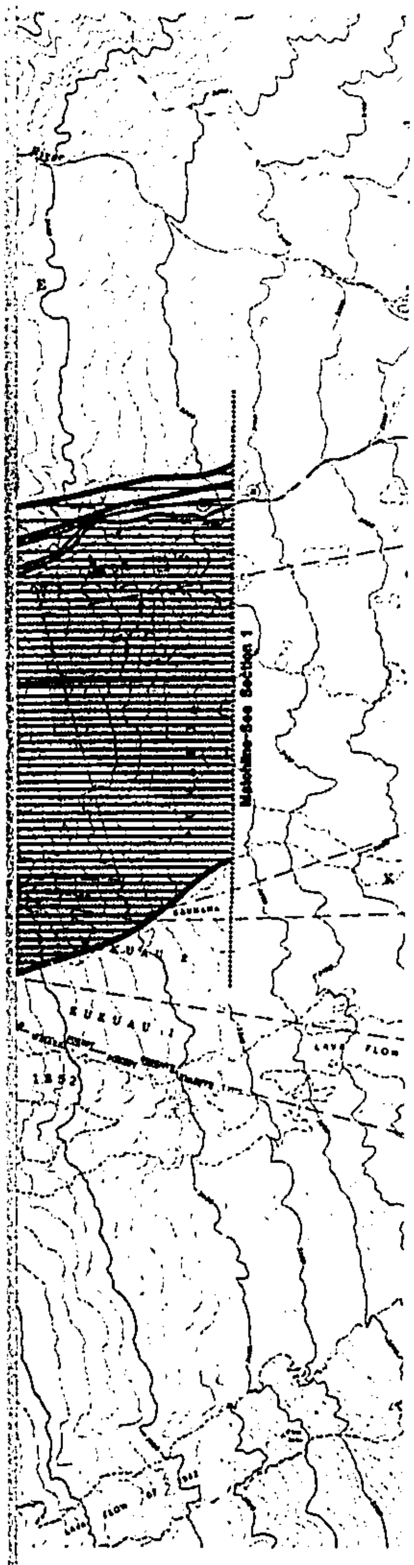


EXHIBIT VI-8

HELCO TRANSMISSION LINE ROUTING STUDY



LEGEND

BASE DATA

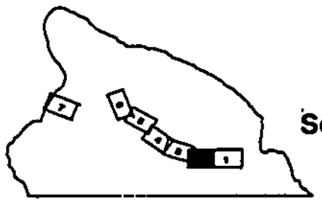
- Edge of corridor
- Existing road
- Existing telephone line
- Existing 69 KV line
- Substation
- Reference marker
- Matchline
- Preferred 138 KV alignment
- Alternate 138 KV alignment

LAND OWNERSHIP

- Private
- Hawaiian Home Lands
- State
- Federal lease

LAND REGULATION

- Urban District
- Protective Subzone
- Resource Subzone
- General Subzone
- Airfield approach/departure zone



PHASE II Land Control

0 1000 2000 5000 FEET 10,000

0 500 1000 1500 METERS 3000

STUDY ○ EDAW inc.

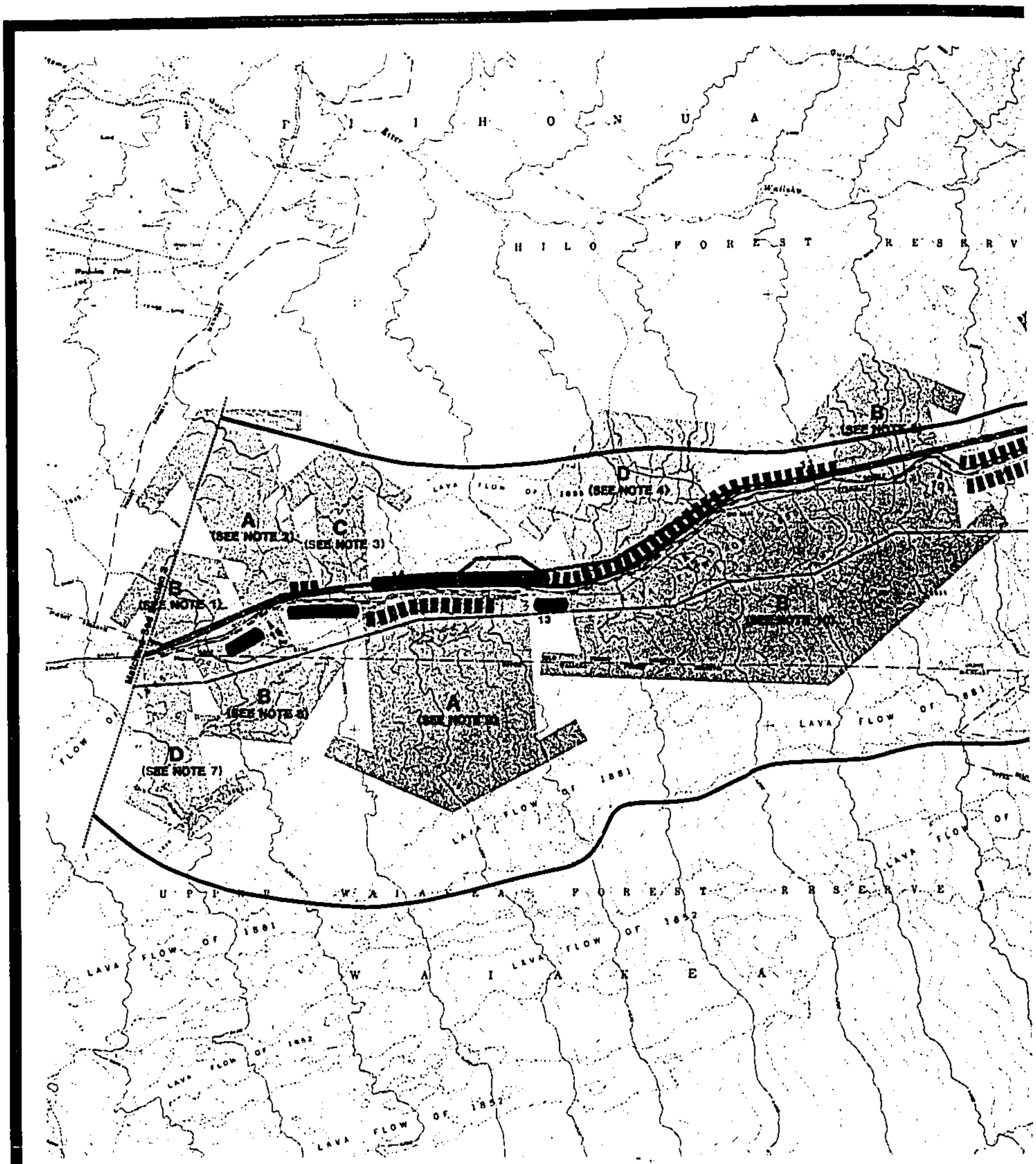


EXHIBIT VI-9

HELCO TRANSMISSION LINE ROUTING

CORRECTION

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

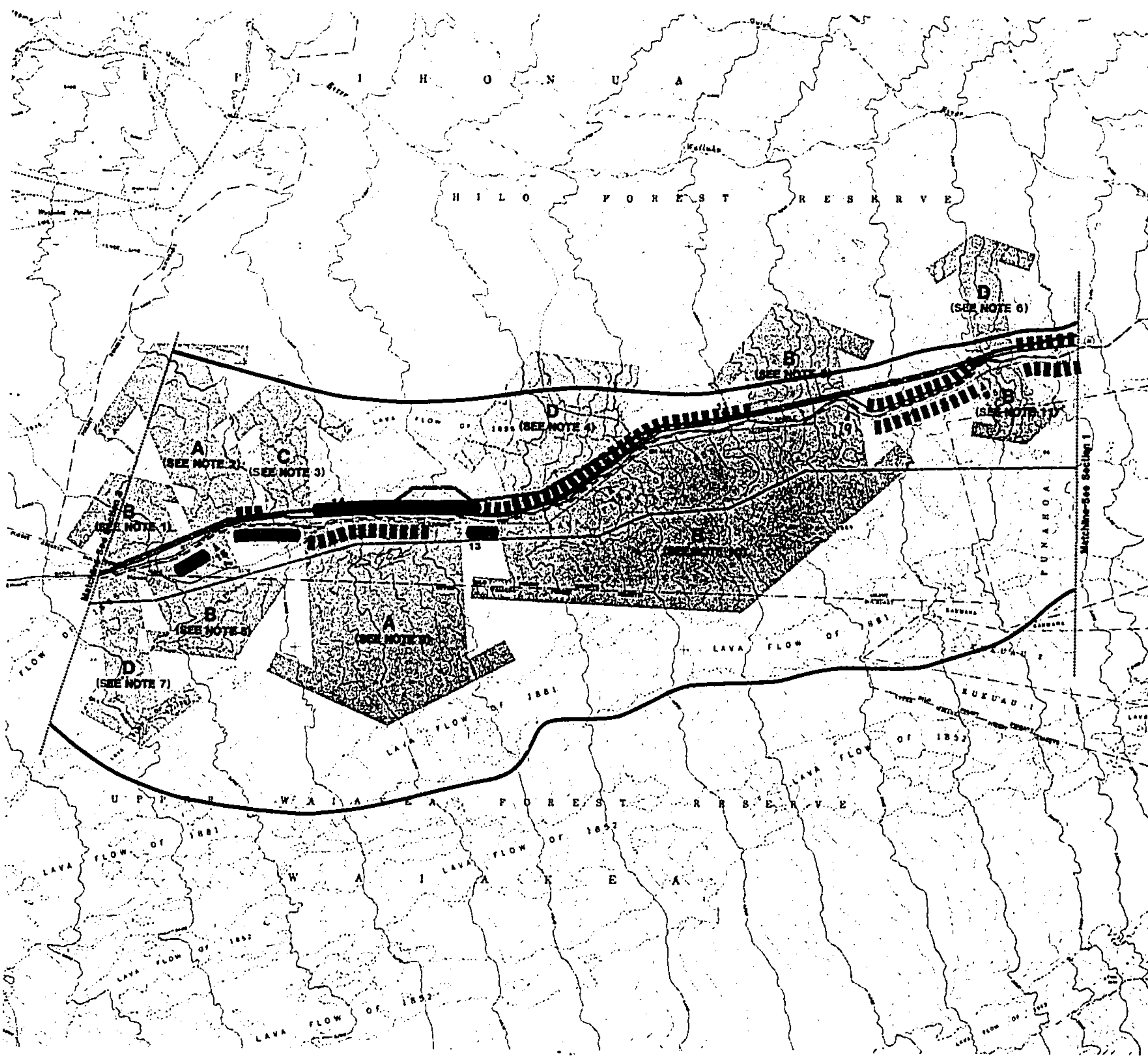
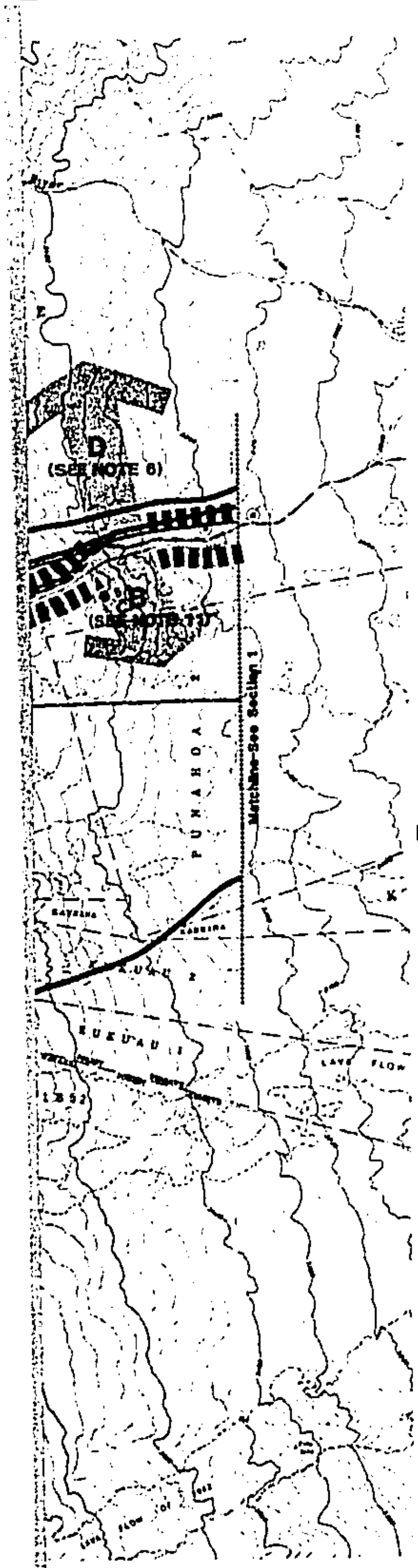


EXHIBIT VI-9

HELCO TRANSMISSION LINE ROUTING STUDY



LEGEND

BASE DATA

- Edge of corridor
- Existing road
- Existing telephone line
- Existing 69 KV line
- Substation
- Reference marker
- Matchline
- Preferred 138 KV alignment
- Alternate 138 KV alignment

VISUAL SCREENS

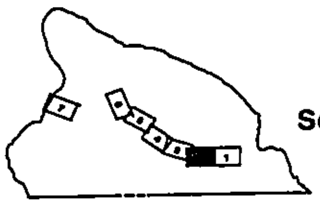
- Solid vegetation screen
- Partial vegetation screen
- Partial buildings & vegetation screen
- Berm along road
- Puu

VIEWS

- Foreground, middleground & distant backdrop or horizon — A
- Foreground — B
- Foreground & middleground — C
- Foreground & distant backdrop or horizon — D

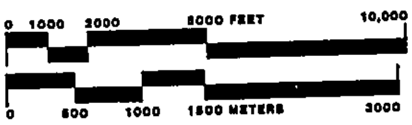
NOTES

1. Short view, middle and distant views obscured by lava formations at road edge.
2. Long view to distant horizon.
3. Distant view screened by tree covered ridge (approx. 2.0 miles from road), tree screen begins approx. 50 yards from road.
4. Long view to distant horizon, middle ground obscured by hetero-genous vegetation (approx. 50 feet from road).
5. Short view, middle and distant views obscured by tree screen (approx. 100 feet from road).
6. Long view to distant horizon, middle ground obscured by heterogenous vegetation and drop in elevation (approx. 100 yards from road).
7. Long view to horizon, middle ground obscured by tree screen (approx. 50 yards from road).
8. Short view, middle and distant views obscured by lava formations and trees.
9. Long view to distant horizon over low tree tops in middle ground.
10. Short view, middle and distant views screened by ridge with solid tree screen (approx. 1/2 mile from road).



Section 2

PHASE II Visual Resources



STUDY ○ EDAW inc.

SECTION 3 (Exhibits VI-10 through 12)

As the preferred alignment follows the outside edge of the Upper Waiakea Forest Reserve and the Protective Subzone, it passes through Ohia-Koa forest in the Agriculture District. Two alternatives to this alignment are shown between Reference Markers 16 and 18. The first nearly parallels the existing line, but remains north of Saddle Road, where the 69 Kv line crosses just to the south at Reference Marker 17. This alternative passes through a lobe of older forest which could very nearly be termed a kipuka. Because of this, its relative visibility from Saddle Road and its location in the Protective Subzone, this alternative route was rejected. Another alternative, suggested by some of the biological field team on this project, would cross Saddle Road to avoid the forest zone, following the alignment of the telephone line which has just been removed at the time field studies were being conducted. This alternative is preferable from a biological standpoint, but is even more visually intrusive than the other alternative and is still within the Protective Subzone.

From Reference Marker 19, the preferred alignment remains 2,000 to 3,000 feet north of Saddle Road, crossing a'a flows interspersed with scattered stands of Ohia trees and occasional pasture lands, until it meets the 69 Kv line at approximately Reference Marker 23. The reason for this setback is to minimize the visual impact of the line from Saddle Road. There is an expansive view from the road toward Mauna Kea along this stretch. A transmission line at this distance against the Mauna Kea backdrop would be barely discernible from the road.

Two major alternative alignments are shown in Section 3. One is the final leg of the route south of Saddle Road which was mentioned in the narratives for Sections 1 and 2. The second is a continuation of one of the two shorter alternatives discussed above. This route remains north of Saddle Road, but at a closer range than the preferred alignment, tending to follow the alignment of the telephone distribution line. This would make the new line more visible from Saddle Road. Since the existing 69 Kv line runs close to the south side of Saddle Road for most of this same segment, there would be a visual impact on both sides of the road. Aesthetic considerations and the Protective Subzone boundary, therefore, constitute the major rationale for the preferred alignment in Section 3.

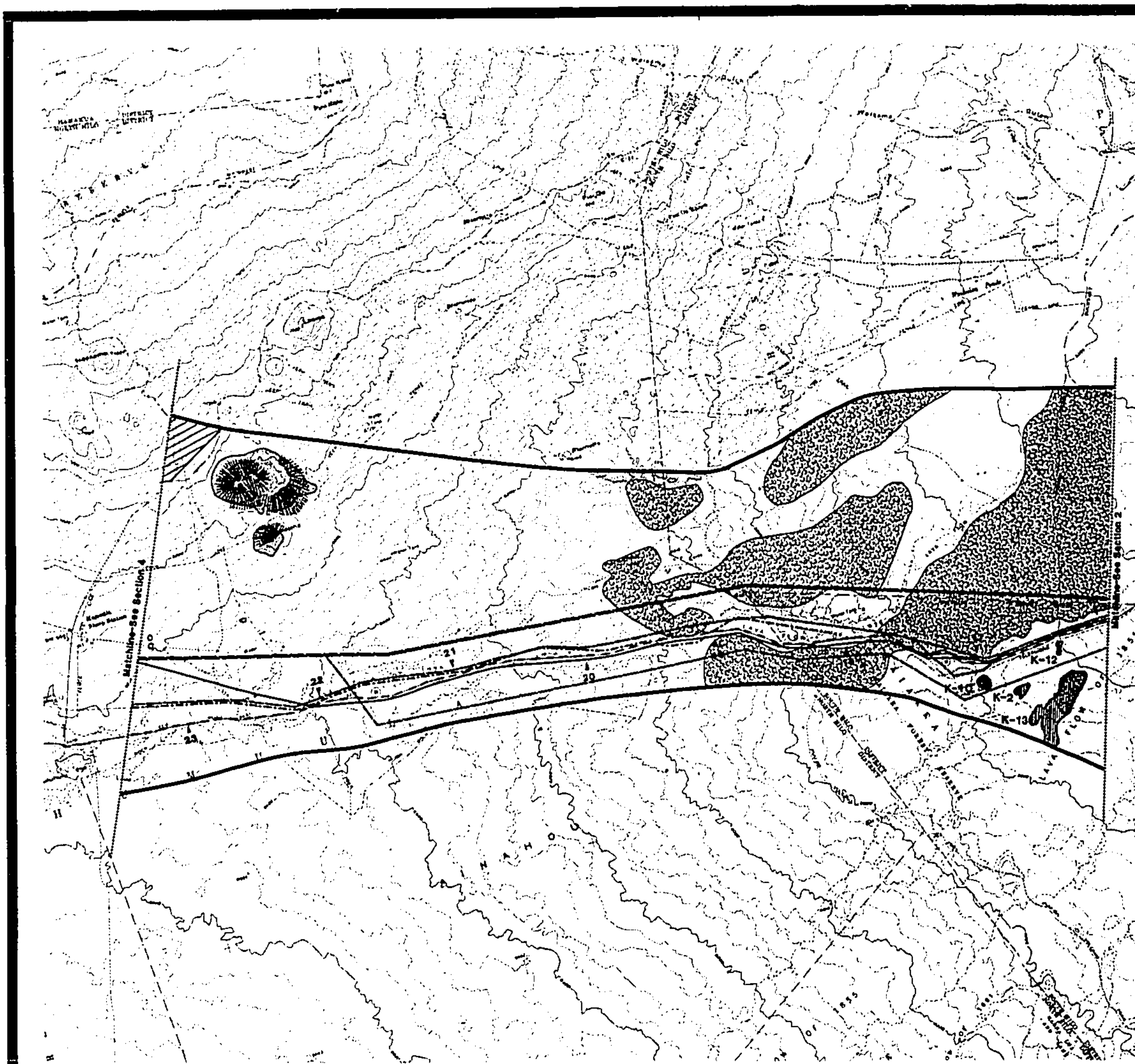


EXHIBIT VI-10

HELCO TRANSMISSION LINE ROUTING STUDY

CORRECTION

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SEE FRAME(S)
IMMEDIATELY FOLLOWING

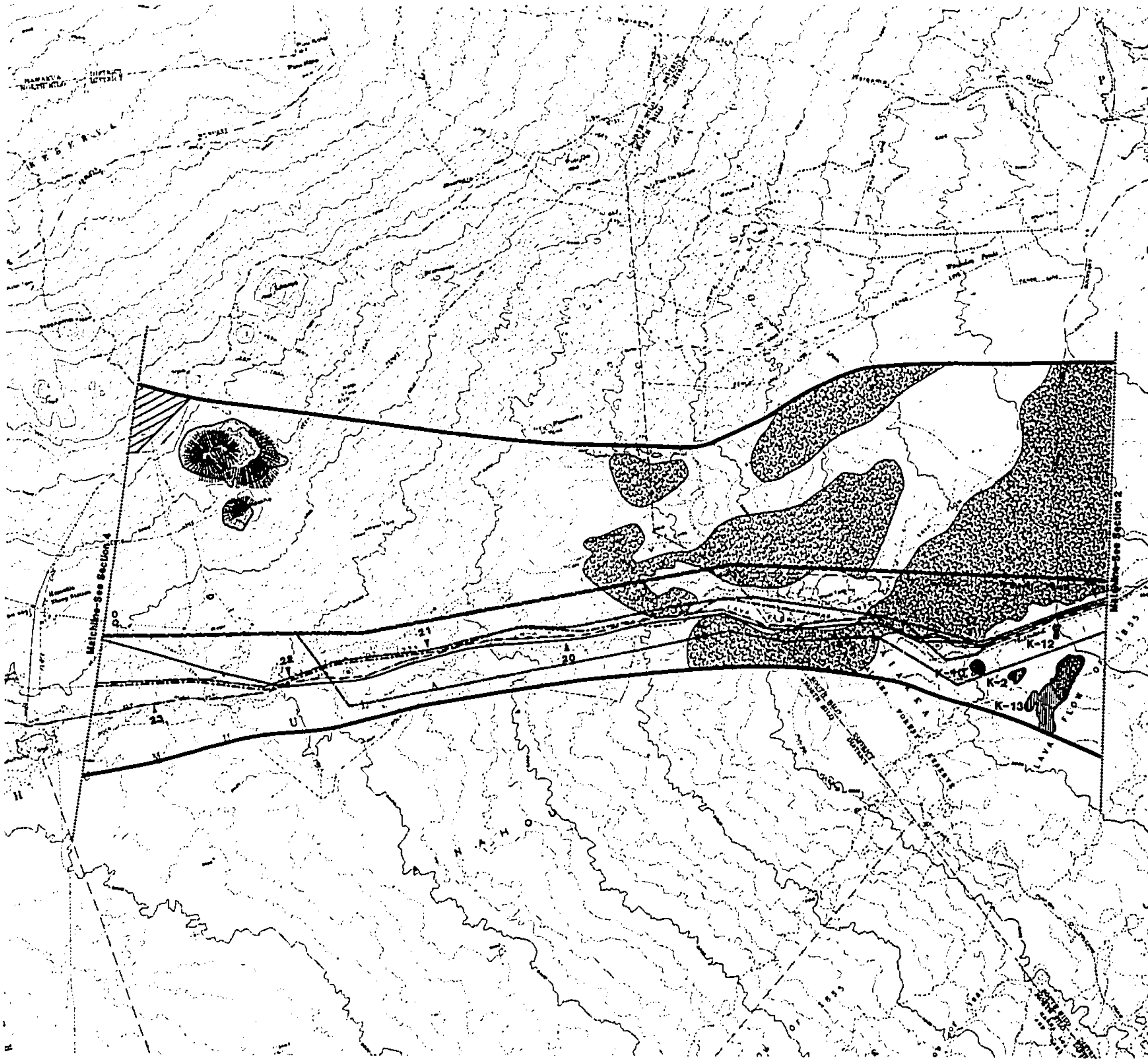
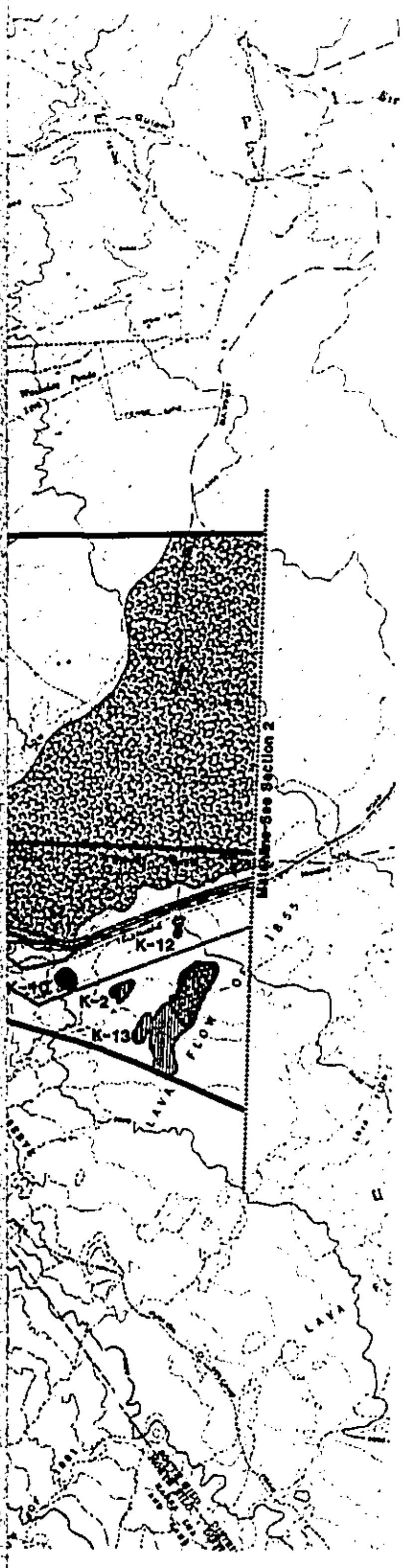


EXHIBIT VI-10

HELCO TRANSMISSION LINE ROUTING STUDY



LEGEND

BASE DATA

- Edge of corridor
- Existing road
- Existing telephone line
- Existing 69 KV line
- Substation
- Reference marker
- Matchline
- Preferred 138 KV alignment
- Alternate 138 KV alignment

LAND USE FACTORS

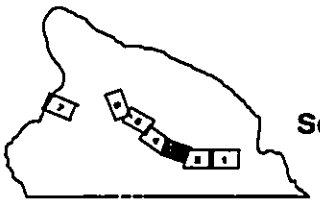
- Urban
- Agriculture
- Grazing
- Military
- Recreation
- Historic site

BIOLOGICAL FACTORS

- Ohia/Koa native forest
- Mamane/Naio native forest
- Introduced forest
- Palila critical habitat
- Kipuka and cave habitats

GEOPHYSICAL FACTORS

- Slopes 20% & greater
- High soil erosion hazard
- Stream
- Reservoir



Section 3

PHASE II

Physical Conditions

STUDY ○ EDAW inc.

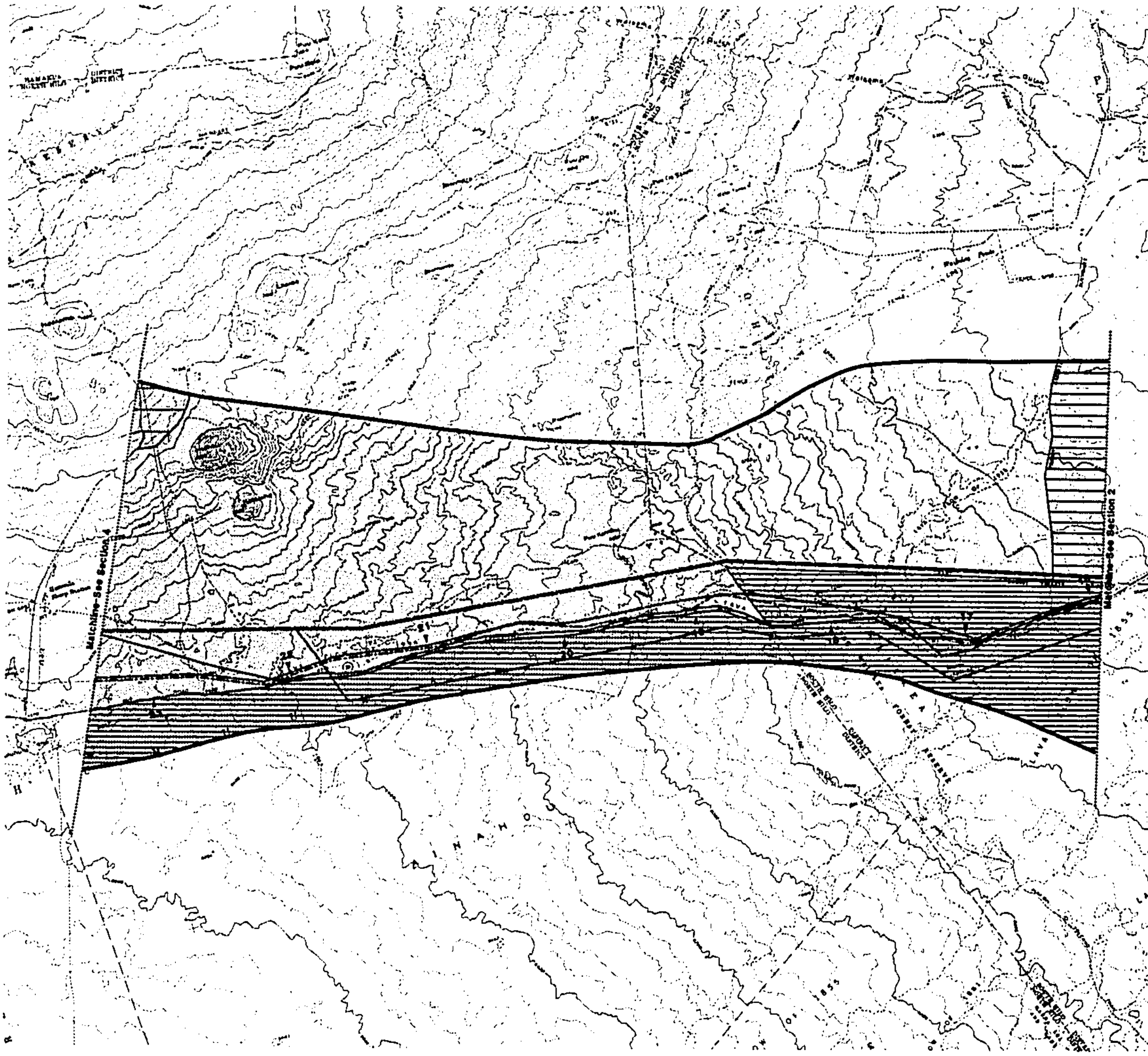
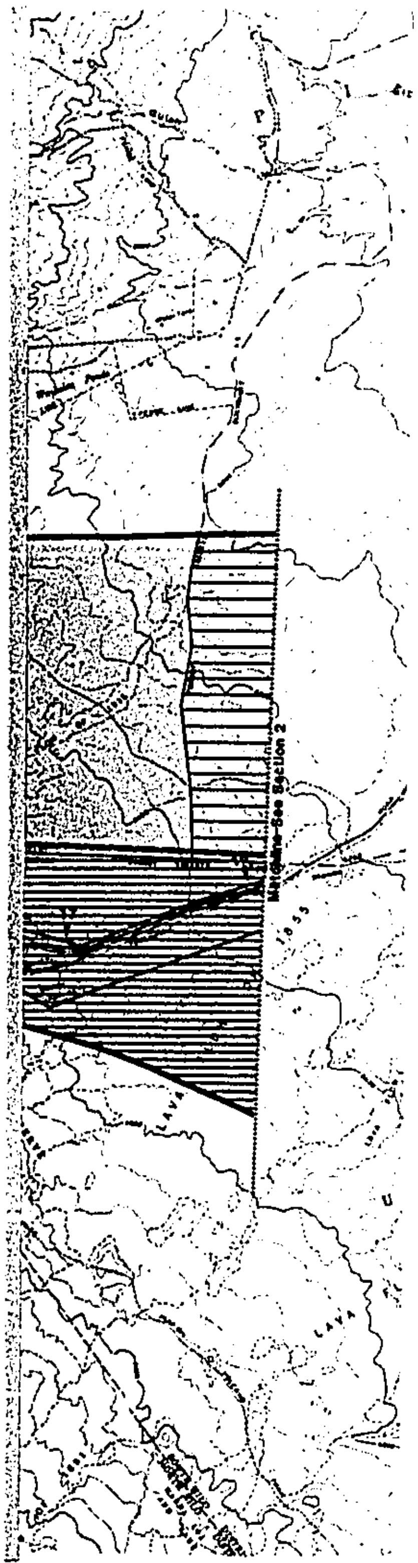


EXHIBIT VI-11

HELCO TRANSMISSION LINE ROUTING STUDY



LEGEND

BASE DATA

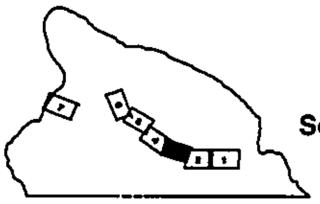
- Edge of corridor
- Existing road
- Existing telephone line
- Existing 69 KV line
- Substation
- Reference marker
- Matchline
- Preferred 138 KV alignment
- Alternate 138 KV alignment

LAND OWNERSHIP

- Private
- Hawaiian Home Lands
- State
- Federal lease

LAND REGULATION

- Urban District
- Protective Subzone
- Resource Subzone
- General Subzone
- Airfield approach/departure zone



Section 3

PHASE II

Land Control

STUDY ○ EDAW inc.

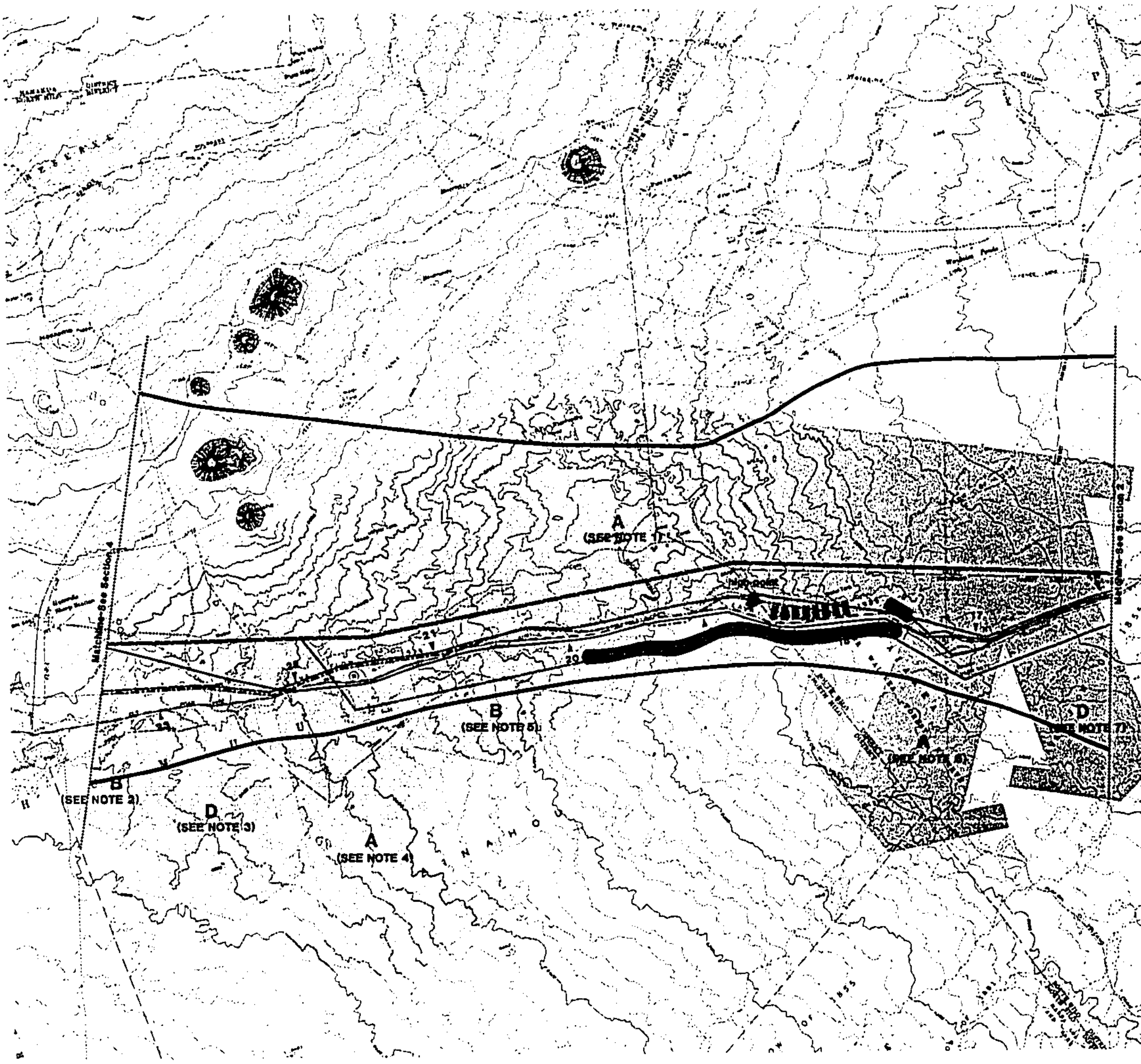
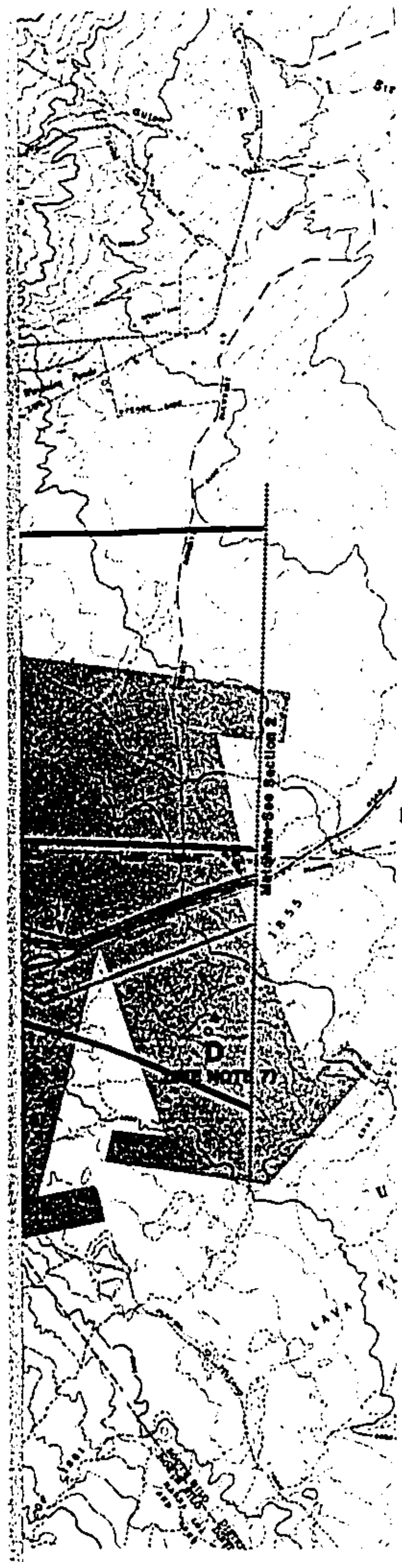


EXHIBIT VI-12

HELCO TRANSMISSION LINE ROUTING STUDY



LEGEND

BASE DATA

- Edge of corridor
- Existing road
- Existing telephone line
- Existing 69 KV line
- Substation
- Reference marker
- Matchline
- Preferred 138 KV alignment
- Alternate 138 KV alignment

VISUAL SCREENS

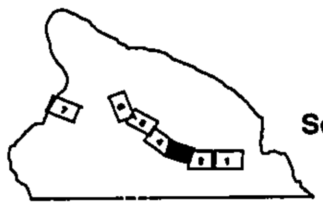
- Solid vegetation screen
- Partial vegetation screen
- Partial buildings & vegetation screen
- Berm along road
- Puu

VIEWS

- Foreground, middleground & distant backdrop or horizon — A
- Foreground — B
- *Foreground & middleground* — C
- Foreground & distant backdrop or horizon — D

NOTES

1. Long view of Mauna Kea (approx. 9 miles to crater) middle ground slightly obscured by lava formations and topography.
2. Short view, middle and distant views obscured by tree screen (approx. 100 yards from road).
3. Long view to Mauna Loa (approx. 17 miles to crater) middle ground screened by solid tree line (approx. 1 mile from road).
4. Long view of Mauna Loa.
5. Short view, middle and distant views obscured by solid tree screen (approx. 200 yards from road).
6. Long view of Mauna Loa.
7. Long view of Mauna Loa, middle ground obscured by tree line (approx. 200 yards from road).



Section 3

PHASE II

Visual Resources

0 1000 2000 5000 FEET 10,000

0 500 1000 1500 METERS 3000

STUDY ○ EDAW inc.

SECTION 4 (Exhibits VI-13 through 15)

When the preferred alignment meets the 69 Kv line at Reference Marker 23 (in section 3), it begins to run adjacent and parallel to that line and continues in this fashion up to the western edge of Section 4. There are many constraints in this area, known as Pohakuloa Flats. All things considered, an alignment following the path of the existing line would have the least impact. The alignment passes just to the south of the Humu'ula Sheep Station and through the sheep pastures, but would not adversely affect ranching operations, according to the Parker Ranch representatives who were consulted. The alignment also crosses the Mauna Kea access road in this vicinity. This crossing is virtually inevitable and not as great as a constraint as crossing Saddle Road due to lighter traffic on the access road. Moreover, the preferred alignment creates less visual impact by crossing the access road at a right angle immediately next to the 69 Kv line. Beyond the pasture lands, beginning at about Reference Marker 27 and continuing through Reference Marker 29, the preferred alignment follows the existing line and adjacent jeep trail, used for access by hunters, through a Mamane-Naio forest. While some portions of this forest have a closed canopy and contain native grasses and vines, as well as trees, the immediate vicinity of the preferred alignment has been disturbed, most likely as the result of the jeep trail, and there are frequent open patches where transmission poles might be placed without requiring the removal of major trees.[3] This Mamane-Naio forest is also part of the designated Critical Habitat for the Palila. As mentioned previously, however, Palila are not typically found in Pohakuloa Flats.[4]

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[3]W. L. Wagner, etal, "Biological Reconnaissance and Environmental Impact Assessment of HECO/HELCO Proposed Cross-Hawaii Island 138 Kv Transmission Line: Botanical, Entomological and Malacological Report", Honolulu: Bernice P. Bishop Museum, December 15, 1982, (unpublished ms.) p. 15. The full text of this report is contained in the Environmental Impact Statement for this project.

[4]Andrew J. Berger "HECO/HELCO Transmission Line Routing and EIS/CDUA Bird and Mammal Report" Honolulu, December 10, 1982, (unpublished ms.) p. 23. The official boundaries of the Critical Habitat included lower elevations at a time when an uncontrolled feral sheep population was destroying the Mamane-Naio forest and the thought was to include as much of this forest area as possible in order to exert legal remedies to bring the Mouflon sheep problem under control. The full text of Dr. Berger's report is contained in the Environmental Impact Statement for this project.

After leaving the denser growth of Mamane-Naio forest, the preferred alignment enters an open area with occasional Mamane and Naio trees, some native grasses and ferns, but a preponderance of exotic herbaceous weeds.[5] The Physical Constraints map indicates a potential soil erosion hazard in this area. The soil within the alignment itself may be subject to wind erosion due to dry conditions and sparse vegetative cover, but this is not a significant constraint, since no new access road would be built. Gullies created by water erosion can clearly be seen 1,000 to 2,000 feet or so to the north, where the steeper slopes of Mauna Kea begin, but are not in evidence along the preferred alignment. Just prior to passing about 2,000 feet behind Pohakuloa State Park, the preferred alignment enters the Protective Subzone for the first and only time, travelling along its very edge, which appears to have been defined by the adjacent 69 Kv line. While intrusion into the Protective Subzone is a high priority constraint, the infringement would be a minor one in an area where environmental sensitivity appears to be no more - and perhaps less - significant than that of neighboring areas in less restrictive subzones. Moreover, by placing the preferred alignment in back, rather than in front, of the existing 69 Kv line, the new transmission line would be barely visible from Pohakuloa State Park and would not have to cross the existing line two additional times.

An alternative alignment is shown between Reference Markers 23 and 32. It runs much closer to Saddle Road, keeping to the north side until approximately Reference Marker 30, where it crosses the road and continues on this side until it crosses the road once again between Pohakuloa State Park and the Army's Pohakuloa Camp to rejoin the preferred alignment. The rationale for this alignment is to avoid the Mamane-Naio forest and the designated Critical Habitat. In doing so, the alternative alignment creates impacts of other kinds. Electric power reliability and public safety are subject to greater risks because the alternative alignment crosses both the 69 Kv line and Saddle Road two more times than the preferred alignment. Visibility from Saddle Road and Pohakuloa State Park would also be far greater, particularly with the two additional road crossings. In general, it would seem that the marginal biological advantages of creating a new path through this entire section are more than off-set by the disadvantages of this alternative alignment.

Midway between Reference Markers 31 and 32, the preferred alignment passes north of Pohakuloa Camp, sharing with the 69 Kv line a small ledge at the toe of Mauna Kea's slopes. It jogs slightly northward of the 69 Kv line to circumvent a

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[5] W. L. Wagner etal, op. cit. p. 14.

group of water tanks, but otherwise remains directly abutting the existing line.

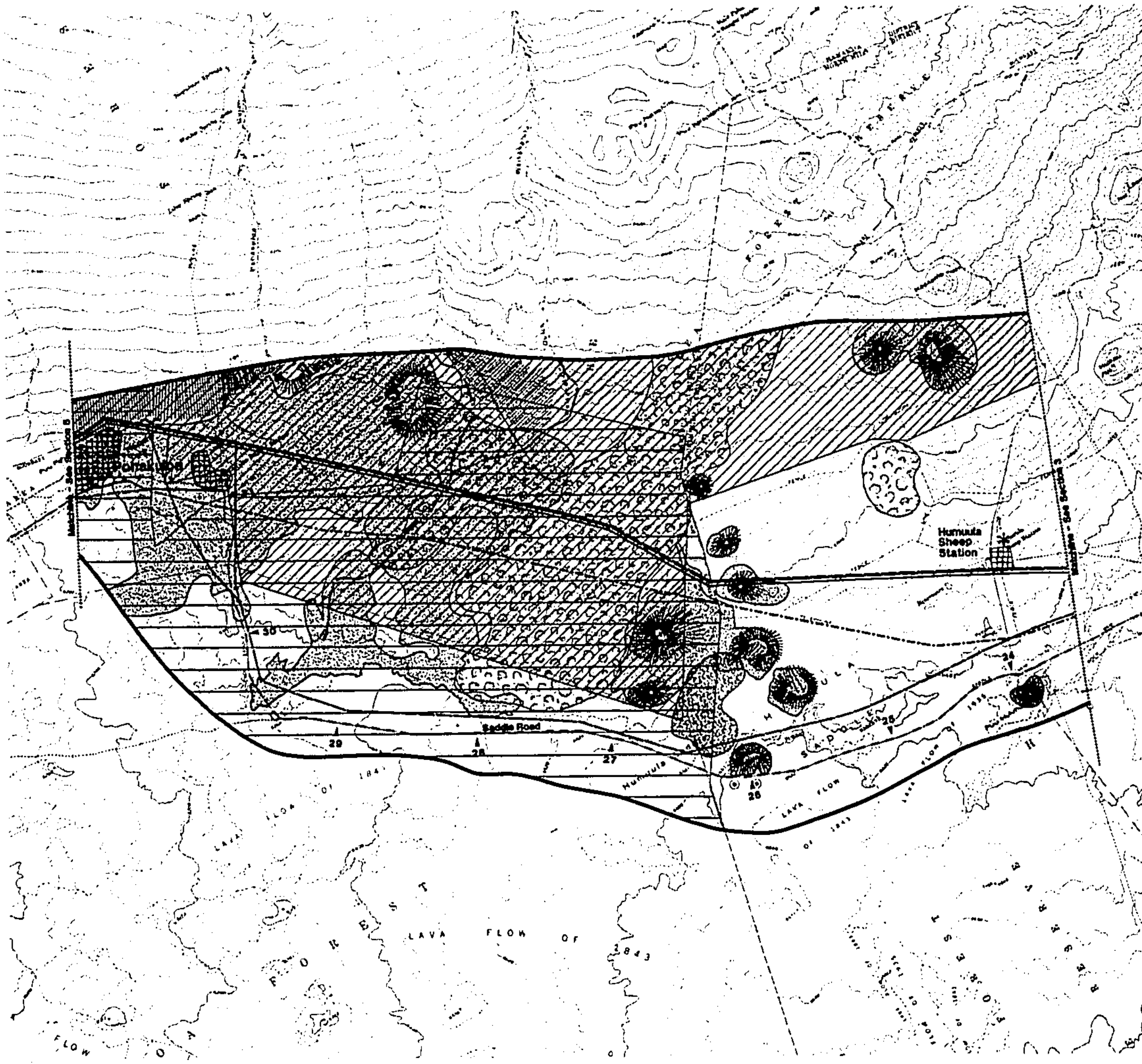
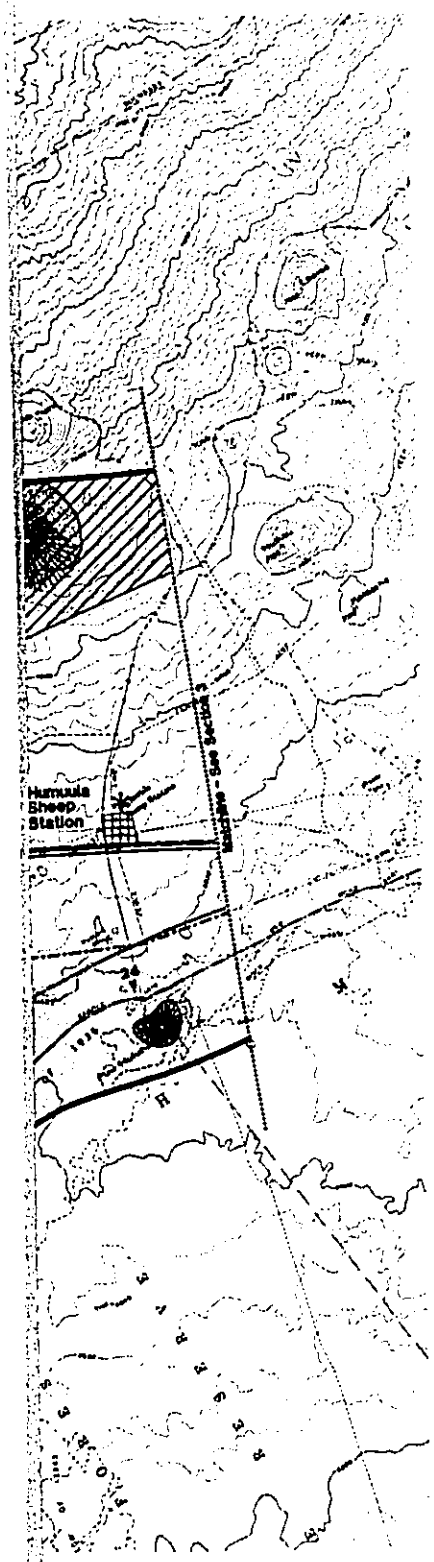


EXHIBIT VI-13

HELCO TRANSMISSION LINE ROUTING STUDY



LEGEND

BASE DATA

- Edge of corridor
- Existing road
- Existing telephone line
- Existing 69 KV line
- Substation
- Reference marker
- Matchline
- Preferred 138 KV alignment
- Alternate 138 KV alignment

LAND USE FACTORS

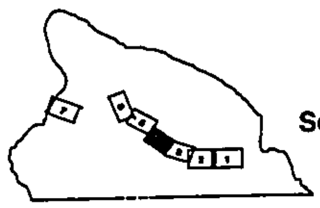
- Urban
- Agriculture
- Grazing
- Military
- Recreation
- Historic site

BIOLOGICAL FACTORS

- Ohia/Koa native forest
- Mamane/Naio native forest
- Introduced forest
- Palila critical habitat
- Kipuka and cave habitats

GEOPHYSICAL FACTORS

- Slopes 20% & greater
- High soil erosion hazard
- Stream
- Reservoir



Section 4

PHASE II
Physical Conditions

0 1000 2000 5000 FEET 10,000
0 500 1000 1500 METERS 3000

STUDY ○ EDAW inc.

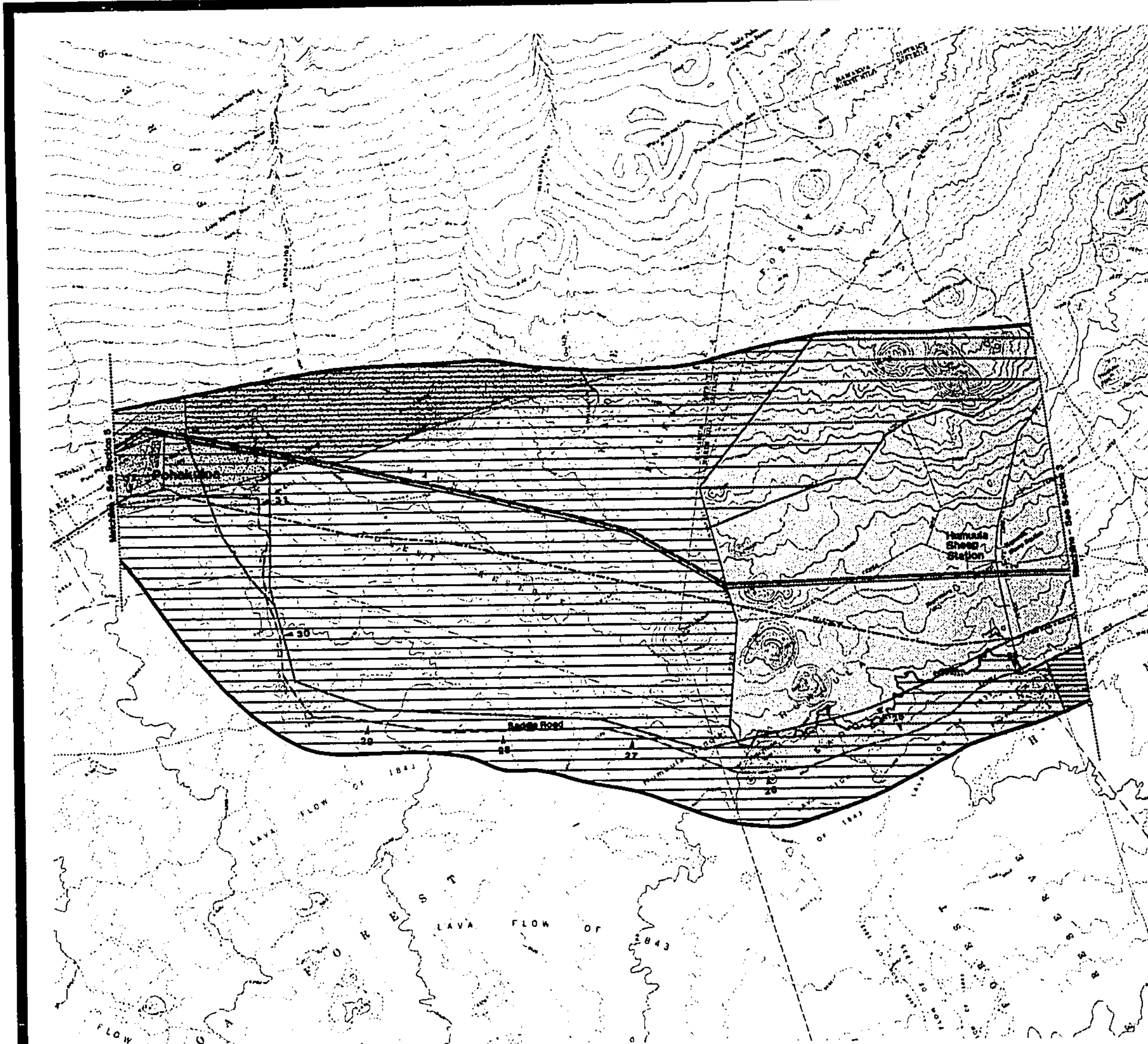
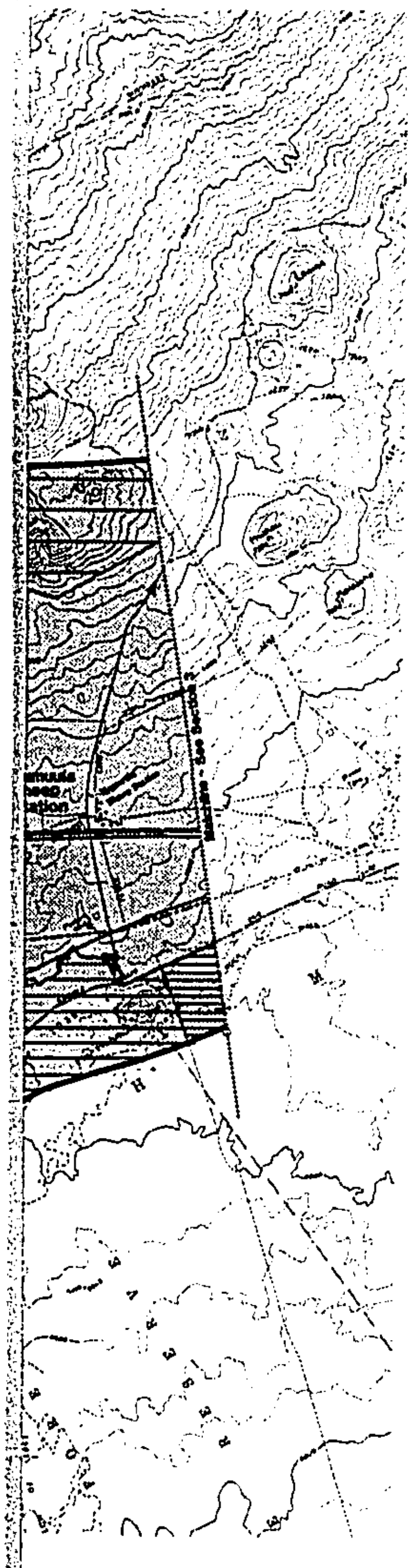


EXHIBIT VI-14

HELCO TRANSMISSION LINE ROUTING STUDY



LEGEND

BASE DATA

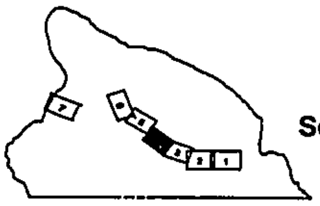
- Edge of corridor
- Existing road
- Existing telephone line
- Existing 69 KV line
- Substation
- Reference marker
- Matchline
- Preferred 138 KV alignment
- Alternate 138 KV alignment

LAND OWNERSHIP

- Private
- Hawaiian Home Lands
- State
- Federal lease

LAND REGULATION

- Urban District
- Protective Subzone
- Resource Subzone
- General Subzone
- Airfield approach/departure zone



Section 4

PHASE II

Land Control

STUDY ○ EDAW inc.

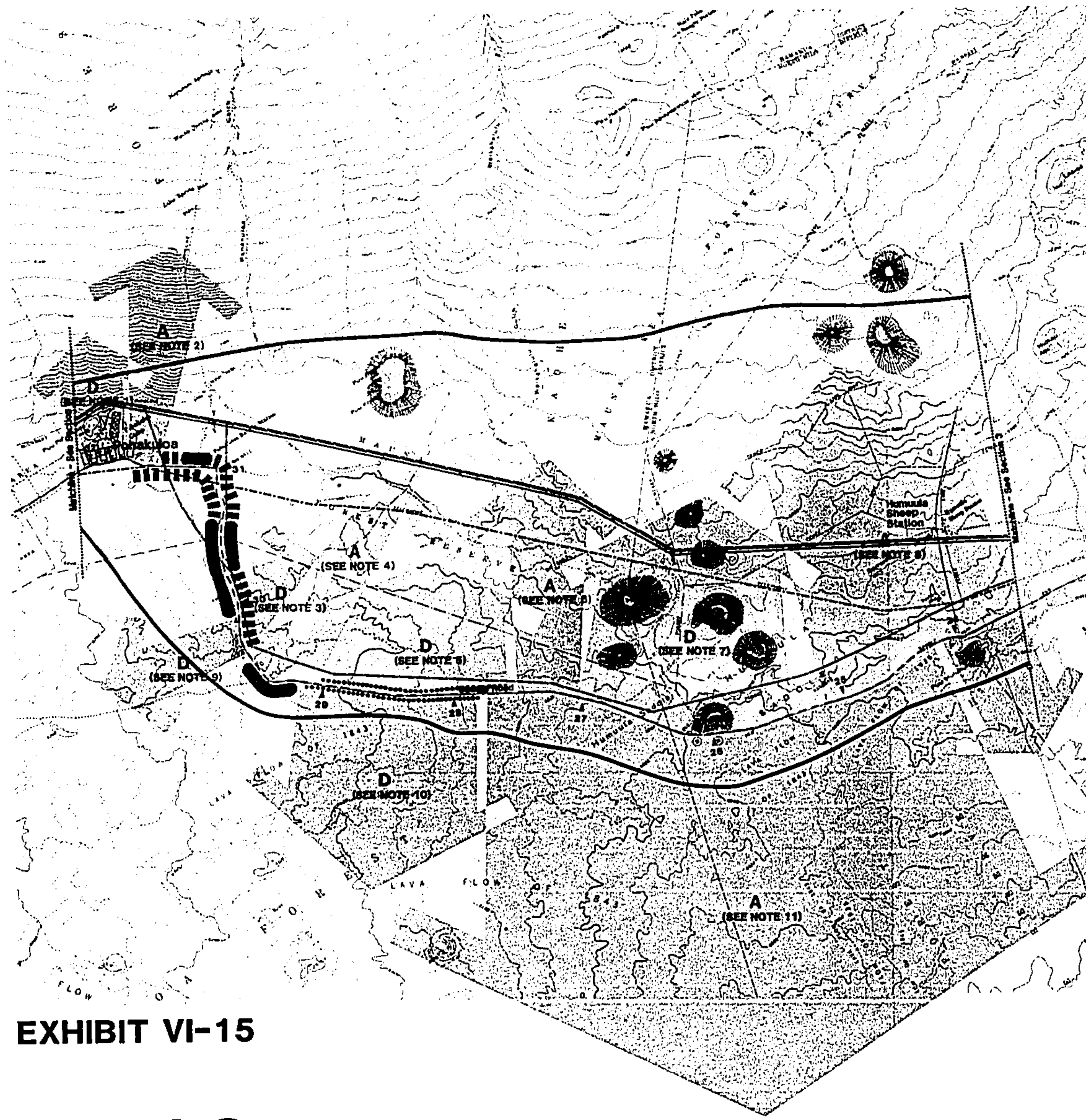
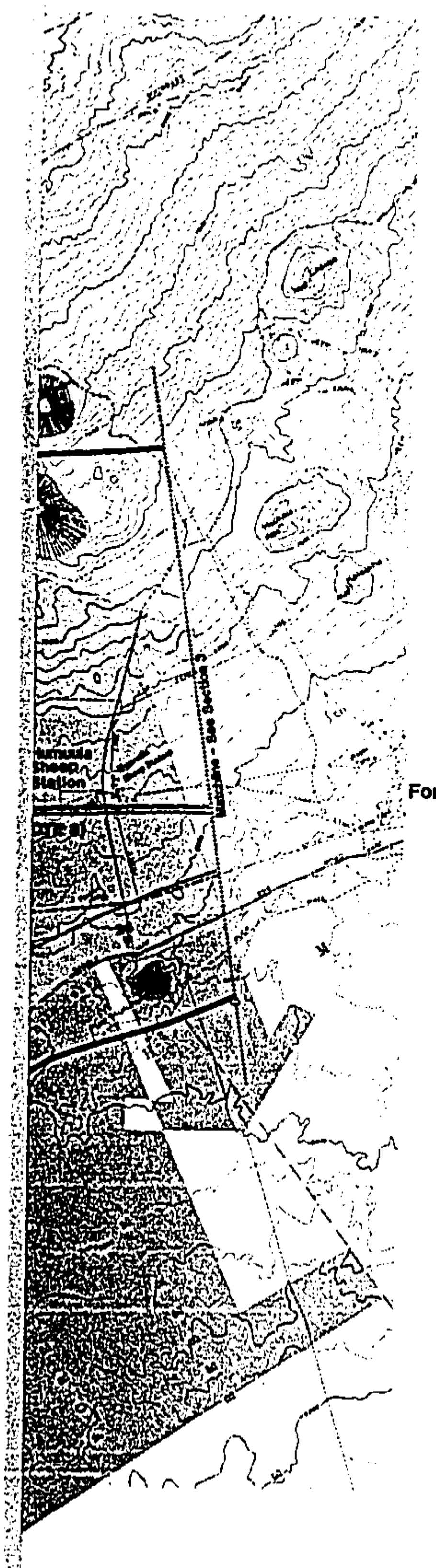


EXHIBIT VI-15

HELCO TRANSMISSION LINE ROUTING STUDY



LEGEND

BASE DATA

- Edge of corridor
- Existing road
- Existing telephone line
- Existing 69 KV line
- Substation
- Reference marker
- Matchline
- Preferred 138 KV alignment
- Alternate 138 KV alignment

VISUAL SCREENS

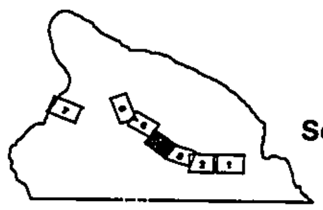
- Solid vegetation screen
- Partial vegetation screen
- Partial buildings & vegetation screen
- Berm along road
- Puu

VIEWS

- Foreground, middleground & distant backdrop or horizon — A
- Foreground — B
- Foreground & middleground — C
- Foreground & distant backdrop or horizon — D

NOTES

1. Long view of Mauna Kea, middle ground obscured by Pohakaloa Training Area.
2. Long view of Mauna Kea.
3. Long view of Mauna Kea, middle ground obscured by tree clumps (approx. 50 yards from road).
4. Long view of Mauna Kea.
5. Long view of Mauna Kea, middle ground obscured by lava ridge (approx. 200 yards from road).
6. Long view of Mauna Kea, middle ground slightly obscured by lava formations.
7. Long view of Mauna Kea, middle ground interrupted by cinder cone focal points.
8. Long view of Mauna Kea.
9. Long view, middle ground obscured by drop in elevation.
10. Long view of Mauna Loa, middle ground obscured by lava ridge (approx. 1/2 mile from road).
11. Long view to Mauna Loa over totally level lava field.



Section 4

PHASE II

Visual Resources

0 1000 2000 5000 FEET 10,000

0 500 1000 1500 METERS 3000

STUDY ○ EDAW inc.

SECTION 5 (Exhibits VI-16 through 18)

The preferred alignment continues to hug the existing 69 Kv line in back of Pohakuloa Camp and Bradshaw Airfield, following its southwesterly direction toward Saddle Road. In doing so, the preferred alignment must cross an area of steeper slope where the 69 Kv line is right at the toe of the slope. Transmission poles in this area will have to be carefully sited to avoid stormwater gulches.

At Reference Marker 35, both the preferred alignment and the 69 Kv line enter flatter terrain and penetrate the approach and departure zone for Bradshaw Airfield. The new transmission poles would be approximately 20 feet higher than the 69 Kv poles, but the height difference is not expected to be a significant constraint for aircraft operations at this distance from the runway. Army aviation officers indicated that it was preferable, from an aircraft safety standpoint, to keep the new transmission line next to an existing utility line because pilots are familiar with the location of existing lines and are accustomed to avoiding them.

Between Reference Markers 36 and 37, the preferred alignment and 69 Kv line run parallel and quite close to Saddle Road. Just beyond Reference Marker 37, the alignment angles south to cross the 69 Kv line and Saddle Road. It is along this approximately one-mile segment that the new transmission line would be most visible from Saddle Road. There are no visual screens along the road and the alignment would cross the lower slopes of two _pu'u_, rendering the new line more visually prominent than the existing line. If alignment line were to angle behind the _pu'u_, as shown in an alternative alignment, the new line would be partially concealed. But the peaks of the _pu'u_ themselves define the boundary of a Protective Subzone lying to the north, so the route adjacent to the existing line seems to be a more feasible alternative.

Once the preferred alignment crosses Saddle Road, it diverges steadily from the 69 Kv line, which continues to follow Saddle Road. The new line would be submerged from view as it enters a middleground with an elevation lower than Saddle Road's. The alignment heads west, traversing a landscape of mixed _pahoehoe_ and _a'a_ flows sparsely covered by both native and exotic grasses and shrubs, and passes north of Pu'u Ke'e Ke'e.

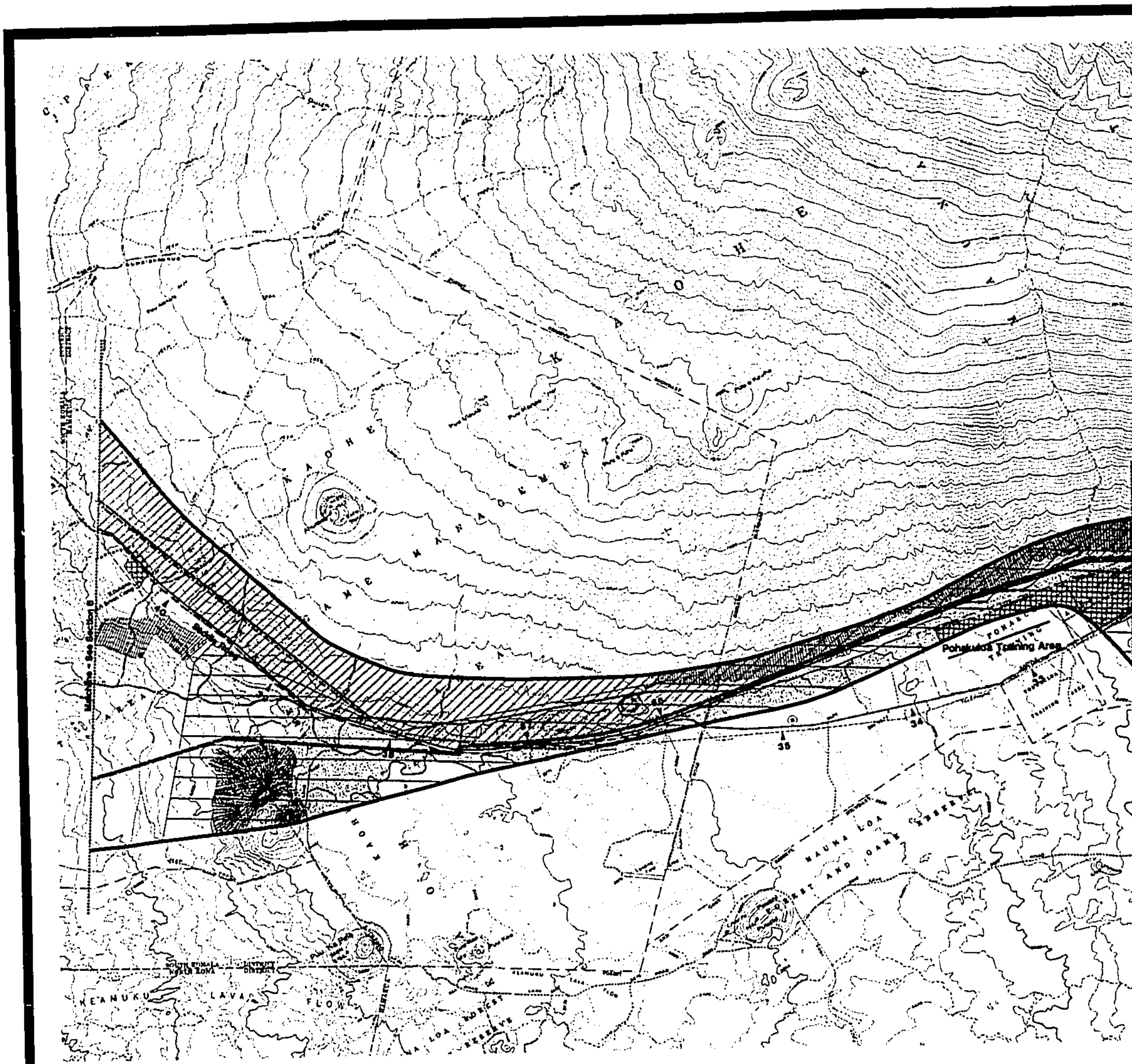
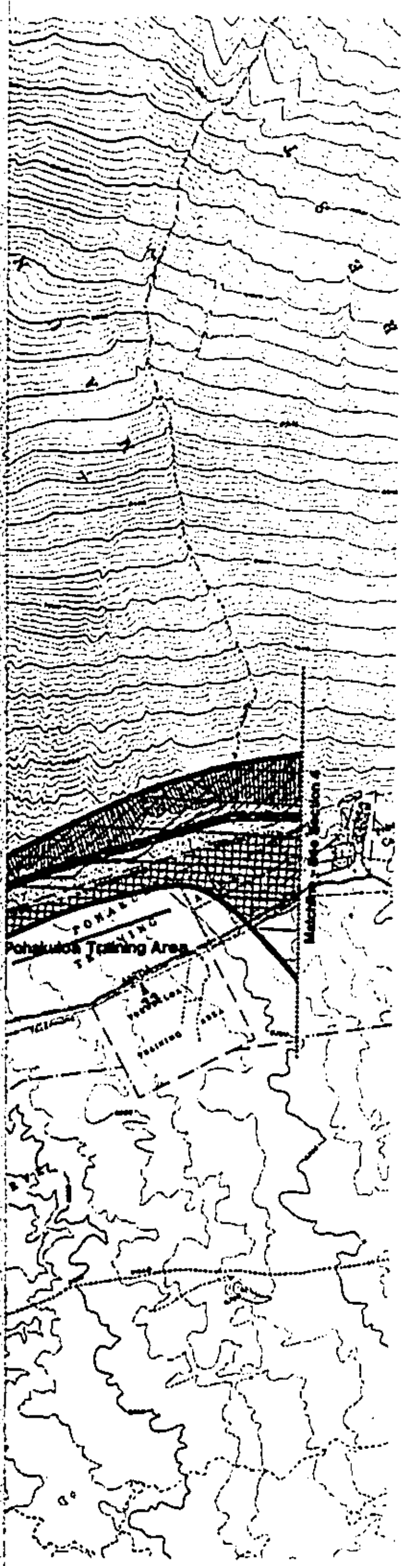


EXHIBIT VI-16

HELCO TRANSMISSION LINE ROUTING STUDY



LEGEND

BASE DATA

- Edge of corridor
- Existing road
- Existing telephone line
- Existing 69 KV line
- Substation
- Reference marker
- Matchline
- Preferred 138 KV alignment
- Alternate 138 KV alignment

LAND USE FACTORS

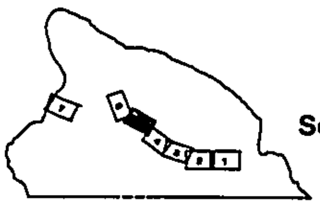
- Urban
- Agriculture
- Grazing
- Military
- Recreation
- Historic site *

BIOLOGICAL FACTORS

- Ohia/Koa native forest
- Mamane/Naio native forest
- Introduced forest
- Palila critical habitat
- *Kipuka and cave habitats* K-9

GEOPHYSICAL FACTORS

- Slopes 20% & greater
- High soil erosion hazard
- Stream
- Reservoir



Section 5

PHASE II

Physical Conditions

0 1000 2000 6000 FEET 10,000

0 600 1000 1800 METERS 3000

STUDY ○ EDAW inc.

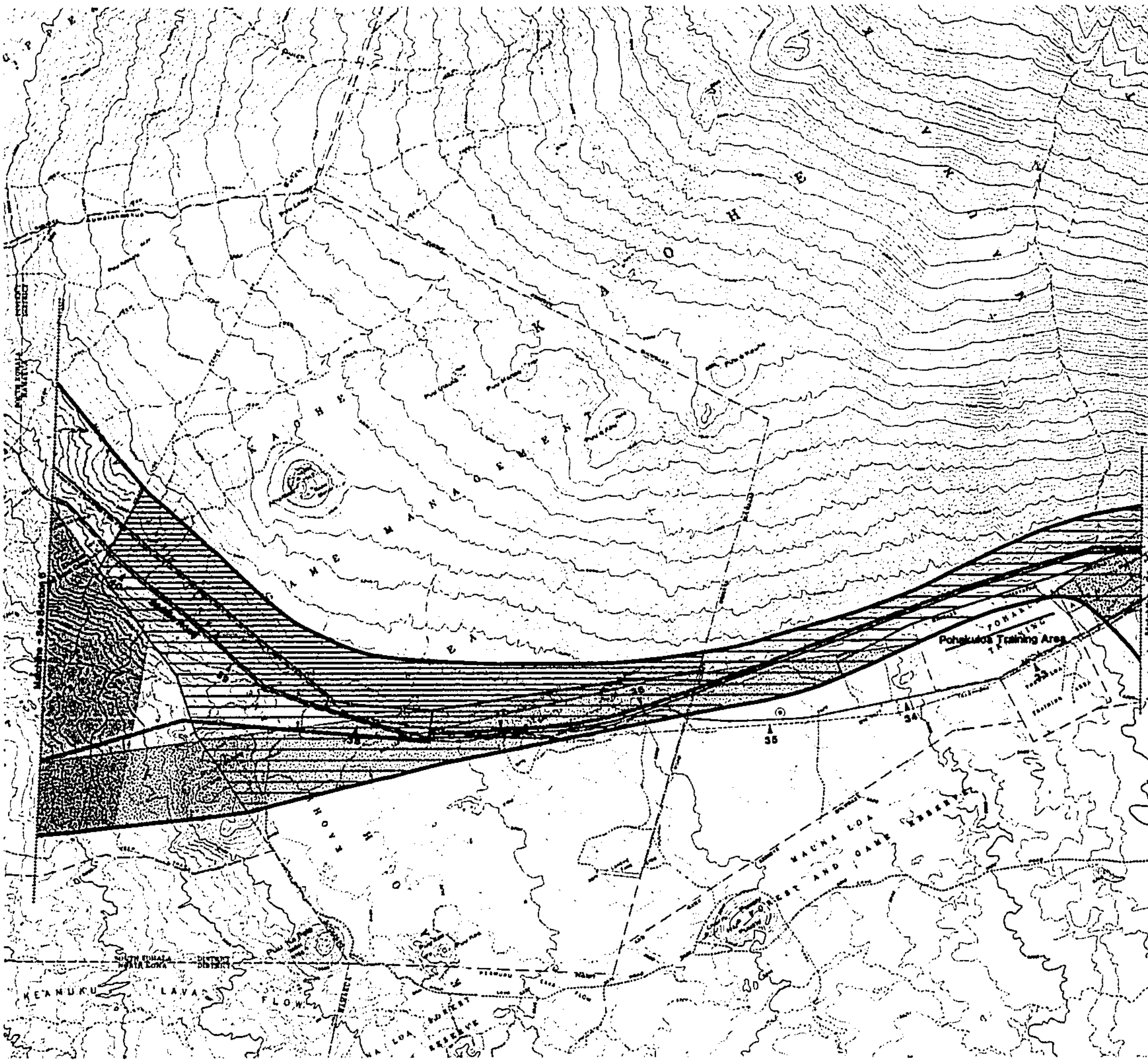
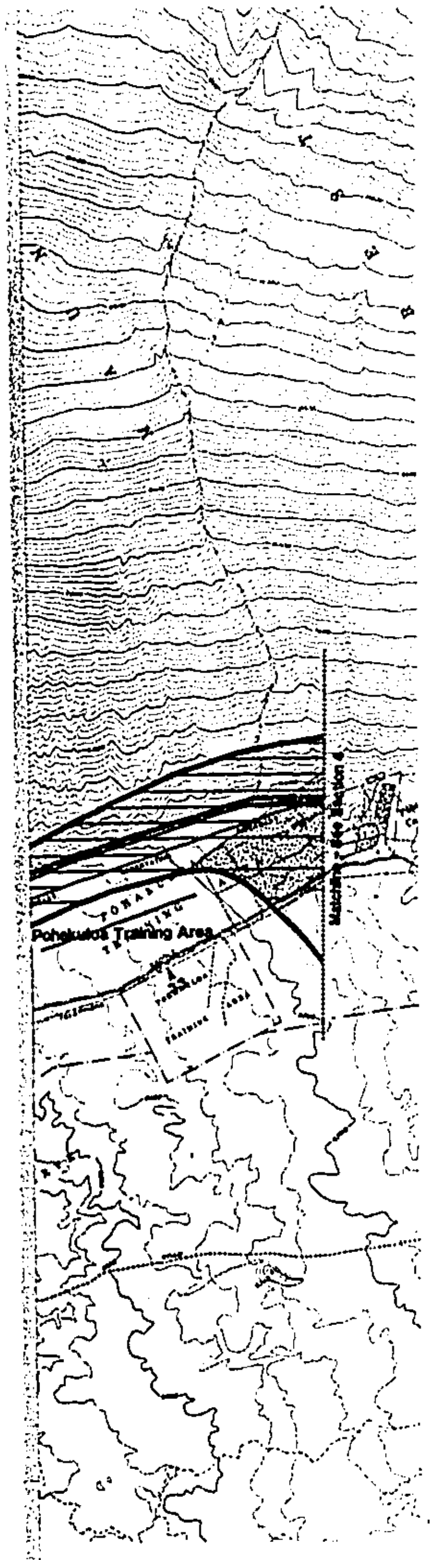


EXHIBIT VI-17

HELCO TRANSMISSION LINE ROUTING STUDY



LEGEND

BASE DATA

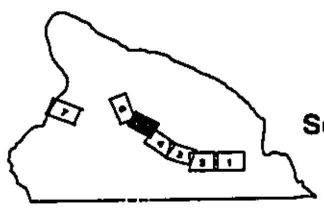
- Edge of corridor
- Existing road
- Existing telephone line
- Existing 69 KV line
- Substation
- Reference marker
- Matchline
- Preferred 138 KV alignment
- Alternate 138 KV alignment

LAND OWNERSHIP

- Private
- Hawaiian Home Lands
- State
- Federal lease

LAND REGULATION

- Urban District
- Protective Subzone
- Resource Subzone
- General Subzone
- Airfield approach/departure zone



Section 5

PHASE II

Land Control

0 1000 2000 5000 FEET 10,000

0 500 1000 1500 METERS 3000

STUDY ○ EDAW inc.

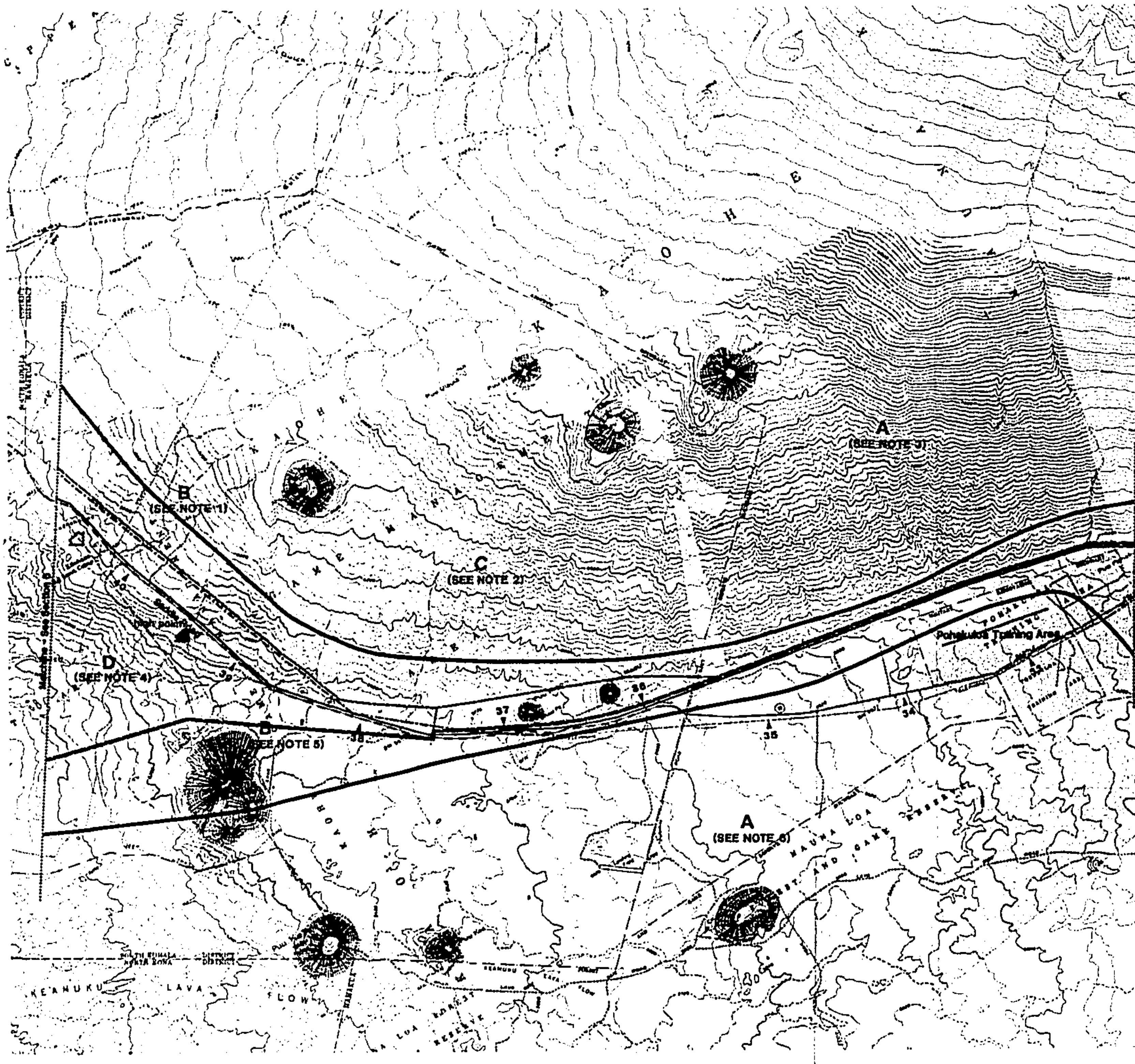
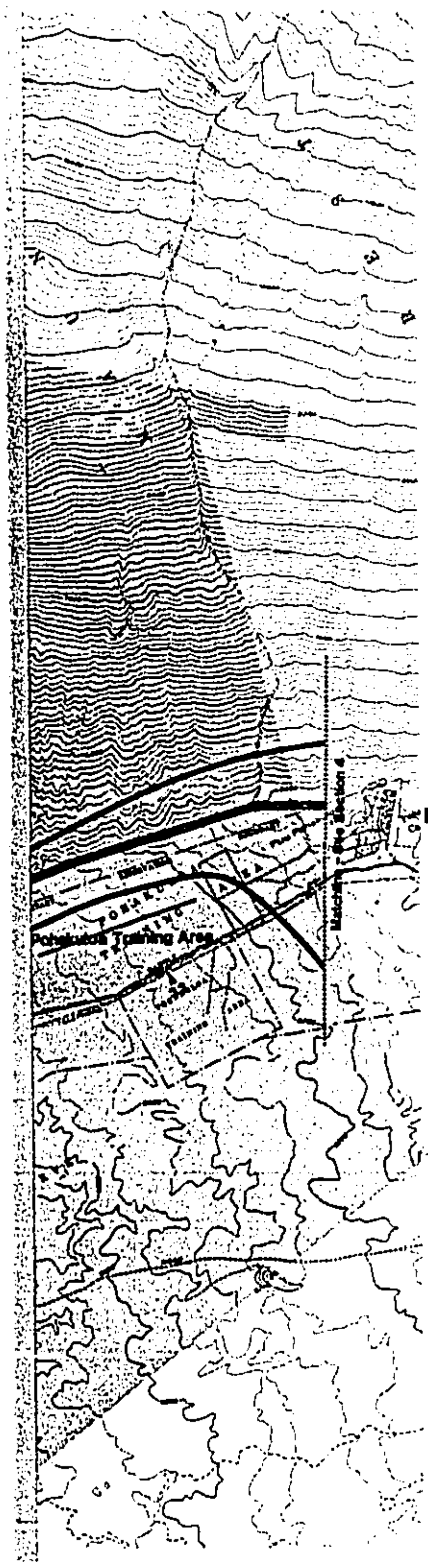


EXHIBIT VI-18

HELCO TRANSMISSION LINE ROUTING STUD



LEGEND

BASE DATA

- Edge of corridor
- Existing road
- Existing telephone line
- Existing 69 KV line
- Substation
- Reference marker
- Matchline
- Preferred 138 KV alignment
- Alternate 138 KV alignment

VISUAL SCREENS

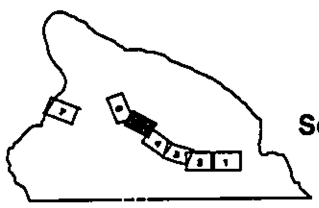
- Solid vegetation screen
- Partial vegetation screen
- Partial buildings & vegetation screen
- Berm along road
- Puu

VIEWS

- Foreground, middleground & distant backdrop or horizon — A
- Foreground — B
- Foreground & middleground — C
- Foreground & distant backdrop or horizon — D

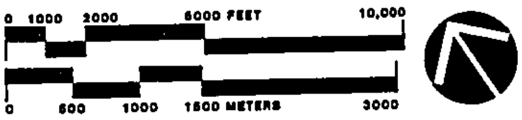
NOTES

1. Short view, middle and distant views screened by ridge (approx. 1/2 mile from road).
2. Long view screened by ridge and cinder cone (approx. 1/2 mile from road).
3. Long view of Mauna Kea.
4. Long view of Mauna Loa, middle ground screened by ridge (approx. 1/2 mile from road).
5. Short view, middle and distant views screened by cinder cone (approx. 1/2 mile from road).
6. Long view of Mauna Loa with cinder cone focal points (approx. 1 mile from road).



Section 5

PHASE II Visual Resources



STUDY ○ EDAW inc.

SECTION 6 (Exhibits VI-19 through 21)

The preferred alignment enters the Pu'u Ke'e Ke'e Game Management Area and turns southwest. The Game Management Area is administered by the State of Hawaii, but the land is owned by Parker Ranch. Introduced game birds and plant species, consisting primarily of grasses and shrubs, are prevalent here. State game management officials did not object to a route through this area. In fact, they viewed a transmission line as an asset if, as a result, an access road were to be built and maintained in the area because it would enhance fire-fighting capabilities. Most of Section 6 is in the rain shadow of Mauna Kea and, therefore, quite dry most of the year. The ground cover is highly fire-prone, particularly the fountain grass which is abundant to the south.

When the preferred alignment leaves the Game Management Area, entering pasture land owned by Parker Ranch, it beigns to parallel, in approximate fashion, the course of Popo'o Gulch at a distance of at least 200 feet. As it approaches its destination it crosses diagonally over Popo'o Gulch and another gully to meet the existing 69 Kv line and pass through the edge of a stand of Eucalyptus trees, which would screen the view of the line from passersby on Old Mamalahoa Highway. The alignment must cross the road to connect with Keamuku Substation. The site for a new 138 Kv substation is immediately north of the existing substation.

An alternative to this route would follow the existing 69 Kv line to the Waiki'i Substation and from there to the Keamuku Substation. This alignment would actually begin in Section 5, just past Reference Marker 37, where the preferred alignment departs from the 69 Kv line. The alternative alignment also separates somewhat from the 69 Kv line. It often follows the alignment of the telephone line, which is set back further from Saddle Road, until it rejoins the 69 Kv line between Reference Markers 42 and 43, and follows it to Waiki'i Substation. The setback from the road would lessen the visual impact of the new line. The existing telephone line was followed wherever possible to minimize disturbance to the natural environment. Nevertheless, there are several disadvantages to this portion of the alternative alignment. First, it crosses a long stretch of Protective Subzone, which extends all the way to Saddle Road for much of this area. It also prolongs the intrusion into the Critical Habitat of the Palila, which also extends to Saddle Road in this area. Finally, a new line along this alignment would be more visible than one along the preferred alignment, despite the setback from Saddle Road, because the elevations north of the road are higher than the road surface and there are several points along the road where there are no screens to conceal the new line.

The alternative alignment confronts other constraints between Waiki'i and Keamuku. Waiki'i itself is a small residential settlement and the new line would be visible from this area, as is the existing 69 Kv line. When the alternative alignment crosses Saddle Road, it passes directly through the middle of a group of properties covering several thousand acres which are currently being developed and marketed as "ranches". While the 69 Kv line now crosses this same area, an easement for a new, higher voltage transmission line is not likely to be granted willingly by the affected landowners. The combination of disadvantages along this alternative alignment, therefore, led to its rejection.

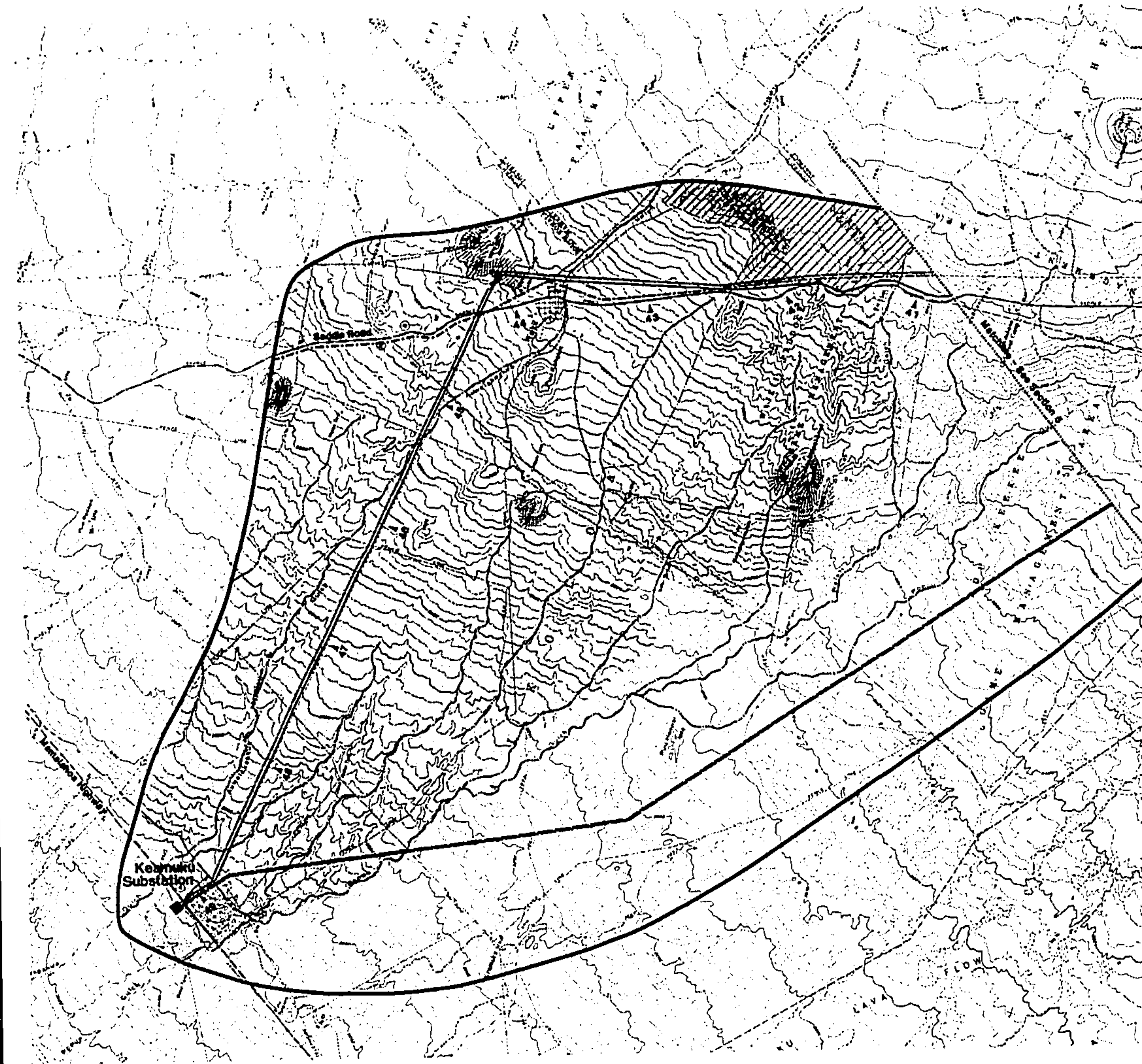
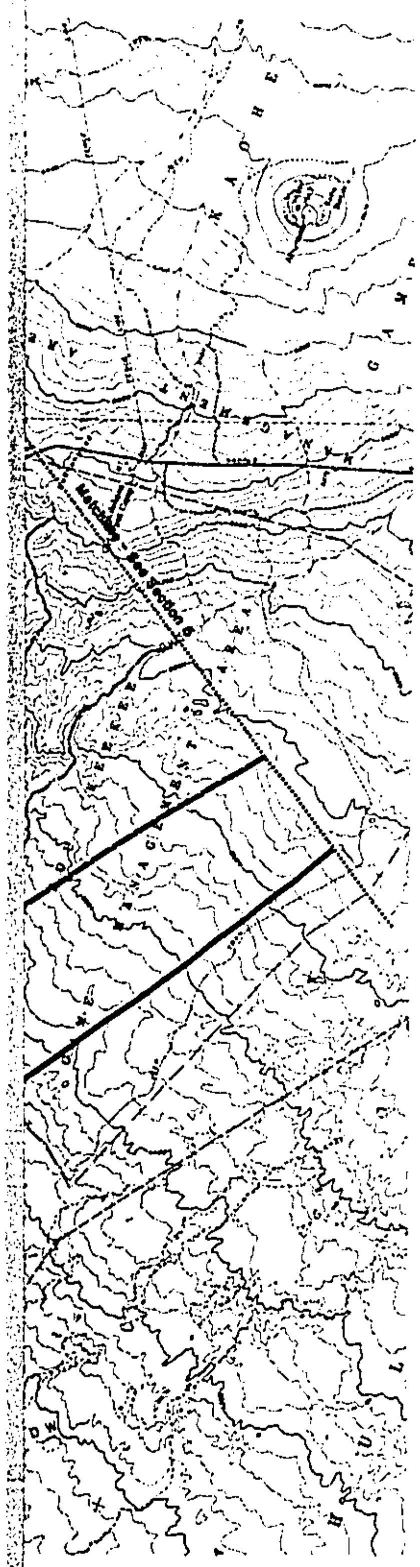


EXHIBIT VI-19

HELCO TRANSMISSION LINE ROUTING STUD



LEGEND

BASE DATA

- Edge of corridor
- Existing road
- Existing telephone line
- Existing 69 KV line
- Substation
- Reference marker
- Matchline
- Preferred 138 KV alignment
- Alternate 138 KV alignment

LAND USE FACTORS

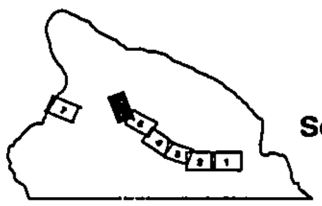
- Urban
- Agriculture
- Grazing
- Military
- Recreation
- Historic site

BIOLOGICAL FACTORS

- Ohia/Koa native forest
- Mamane/Naio native forest
- Introduced forest
- Palila critical habitat
- Kipuka and cave habitats

GEOPHYSICAL FACTORS

- Slopes 20% & greater
- High soil erosion hazard
- Stream
- Reservoir



Section 6

PHASE II

Physical Conditions

0 1000 2000 5000 FEET 10,000

0 500 1000 1500 METERS 3000

STUDY ○ EDAW inc.

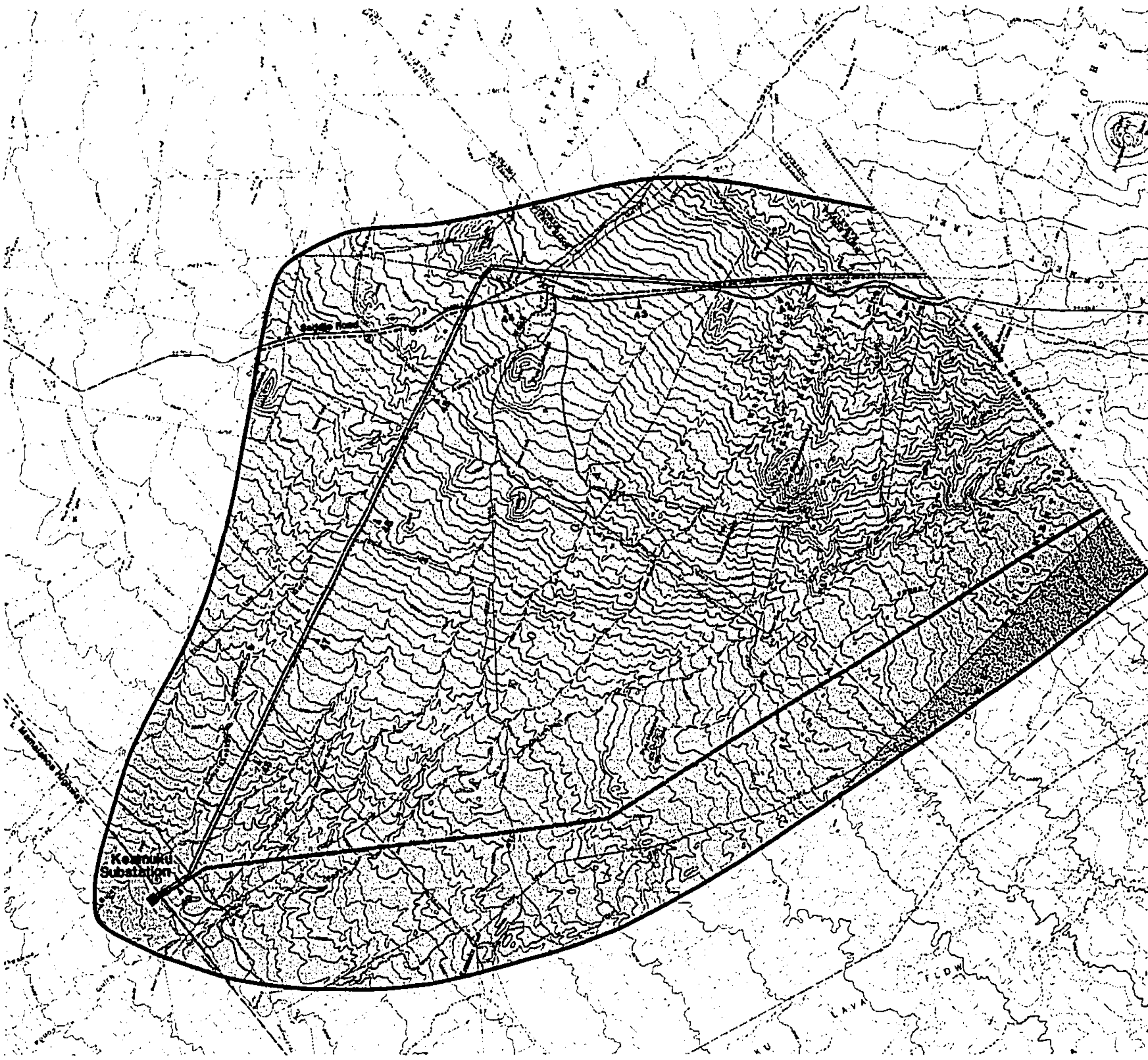
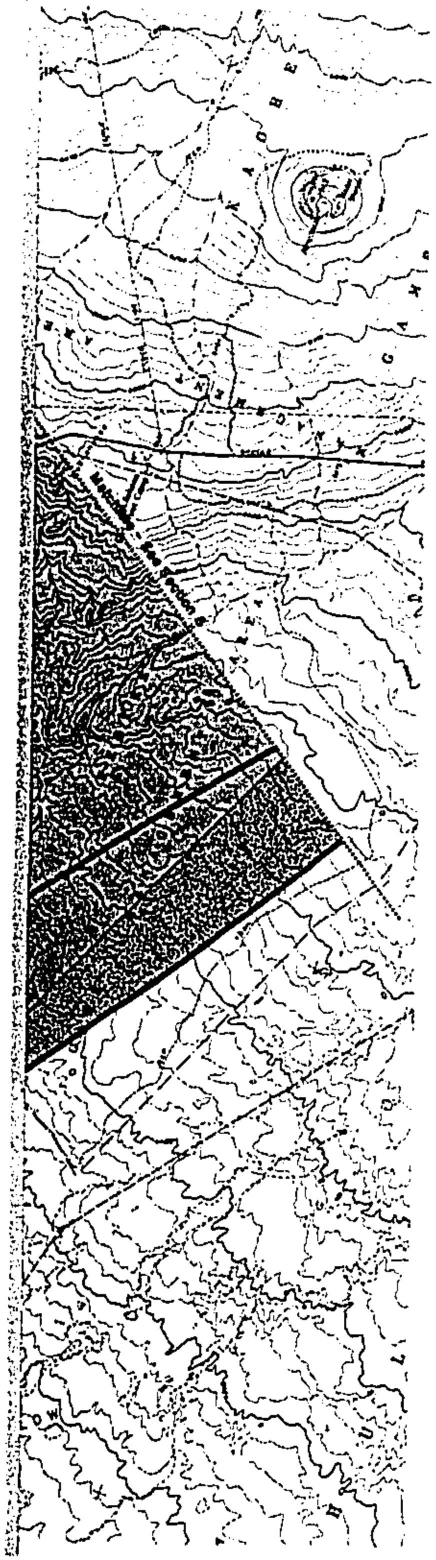


EXHIBIT VI-20

HELCO TRANSMISSION LINE ROUTING STUDY



LEGEND

BASE DATA

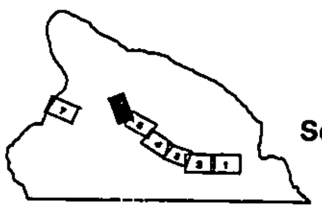
- Edge of corridor
- Existing road
- Existing telephone line
- Existing 69 KV line
- Substation
- Reference marker
- Matchline
- Preferred 138 KV alignment
- Alternate 138 KV alignment

LAND OWNERSHIP

- Private
- Hawaiian Home Lands
- State
- Federal lease

LAND REGULATION

- Urban District
- Protective Subzone
- Resource Subzone
- General Subzone
- Airfield approach/departure zone



Section 6

PHASE II

Land Control

0 1000 2000 5000 FEET 10,000

0 500 1000 1500 METERS 3000

STUDY ○ EDAW inc.

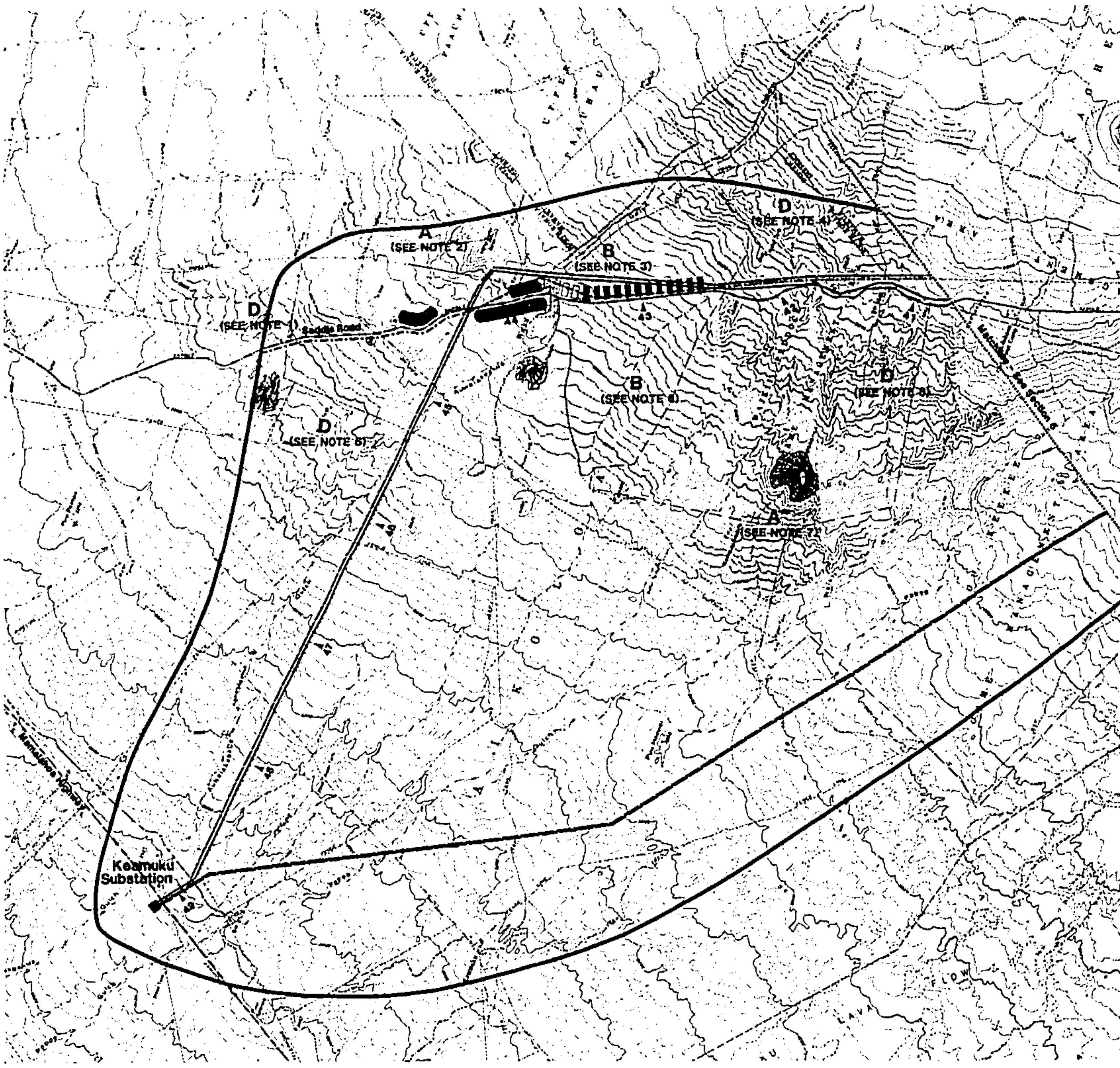
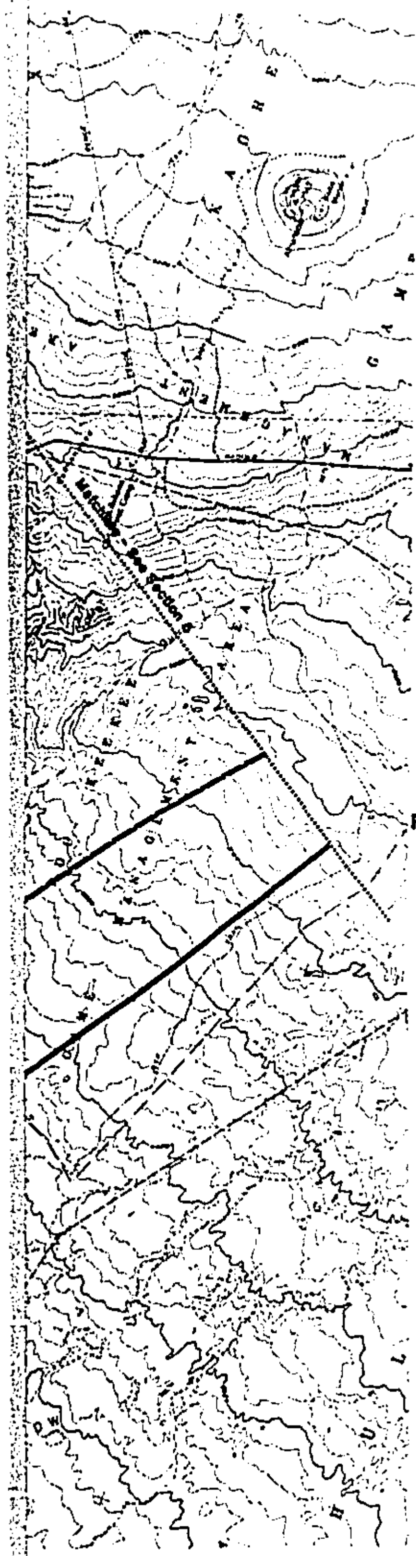


EXHIBIT VI-21

HELCO TRANSMISSION LINE ROUTING STUD



LEGEND

BASE DATA

Edge of corridor
Existing road
Existing telephone line
Existing 69 KV line
Substation
Reference marker
Matchline
Preferred 138 KV alignment
Alternate 138 KV alignment

VISUAL SCREENS

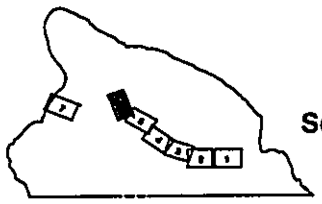
Solid vegetation screen
Partial vegetation screen
Partial buildings & vegetation screen
Berm along road
Puu

VIEWS

Foreground, middleground & distant backdrop or horizon — A
Foreground — B
Foreground & middleground — C
Foreground & distant backdrop or horizon — D

NOTES

1. Long view of Kohala Mountains, middle ground screened by tree line (approx. 250 yards from road).
2. Long view of Kohala Mountains.
3. Short view, middle and distant views obscured by trees (approx. 1/2 mile from road).
4. Long view of Mauna Kea, middle ground screened by hills (approx. 1 mile from road).
5. Long view of Mauna Loa and coast, middle ground obscured by tree line (approx. 1/2 mile from road).
6. Short view, middle and distant views obscured by tree line (approx. 300 yards from road).
7. Long view of Mauna Loa and coast.
8. Long view of Mauna Loa, middle ground screened by hills (approx. 1 mile from road).



Section 6

PHASE II

Visual Resources

0 1000 2000 5000 FEET 10,000

0 500 1000 1500 METERS 3000

STUDY ○ EDAW inc.

SECTION 7 (Exhibits VI-22 through 24)

This area is relatively free of constraints, leaving a rather obvious choice for the preferred alignment for the new radial 69 Kv line connecting Waikaloa and Anaeho'omalu Substations: It runs immediately adjacent to an existing 69 Kv line on the south and east sides. The new line will be virtually unseen from public roadways or urban areas. With the eventual expansion of the Waikaloa development, a northern portion of the new line may someday be visible from residential areas, but, in that case, a new line paralleling an existing line rather than creating a new path would minimize the visual impact. The portion of the alignment which runs from east to west lies just within the boundary of State land which is leased to Pu'uwa'awa'a Ranch. The new line's location along the edge of this property would have negligible effects on ranching oeprations. Most of this area is covered by introduced grasses, so biological constraints are minimal.

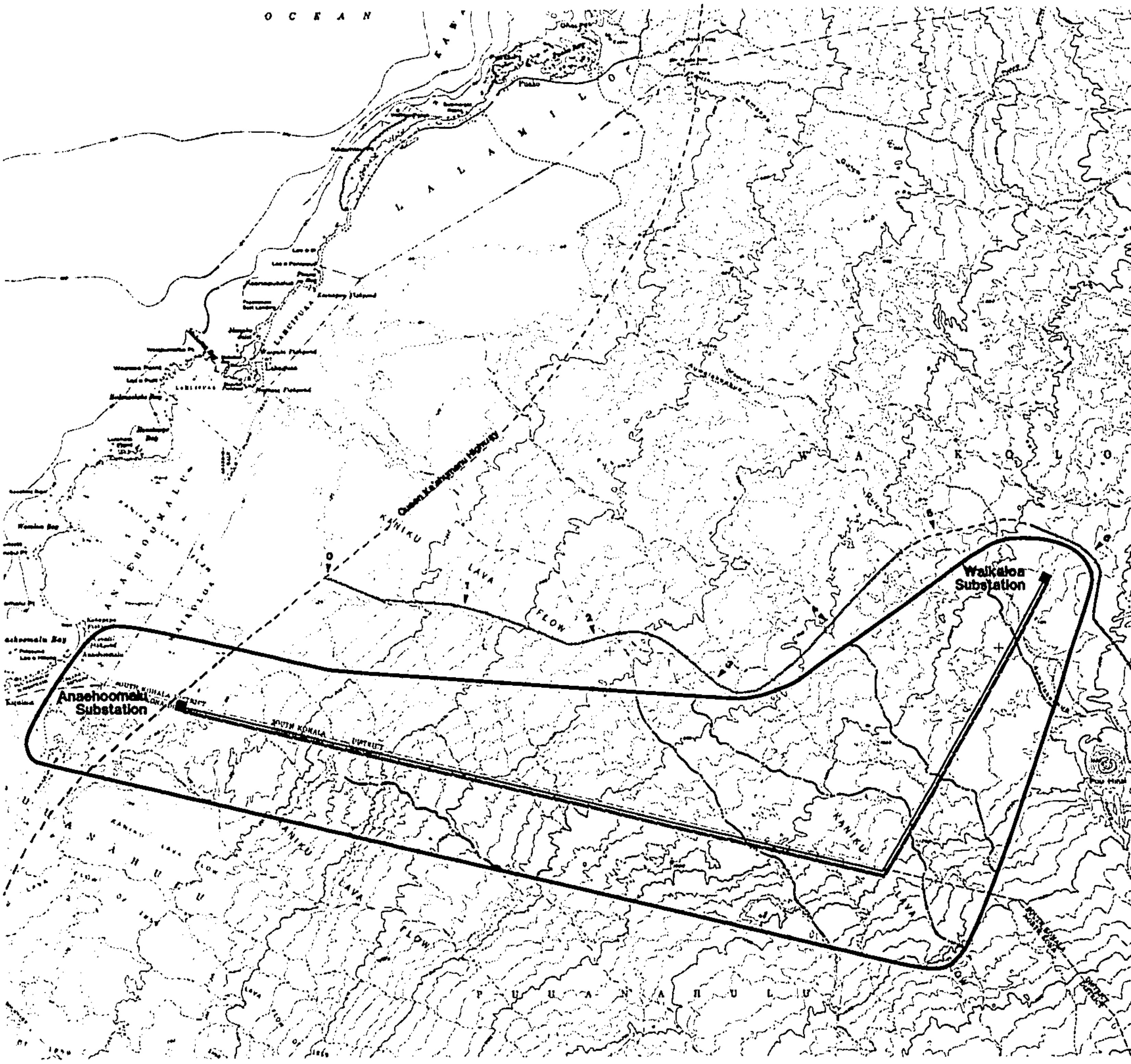
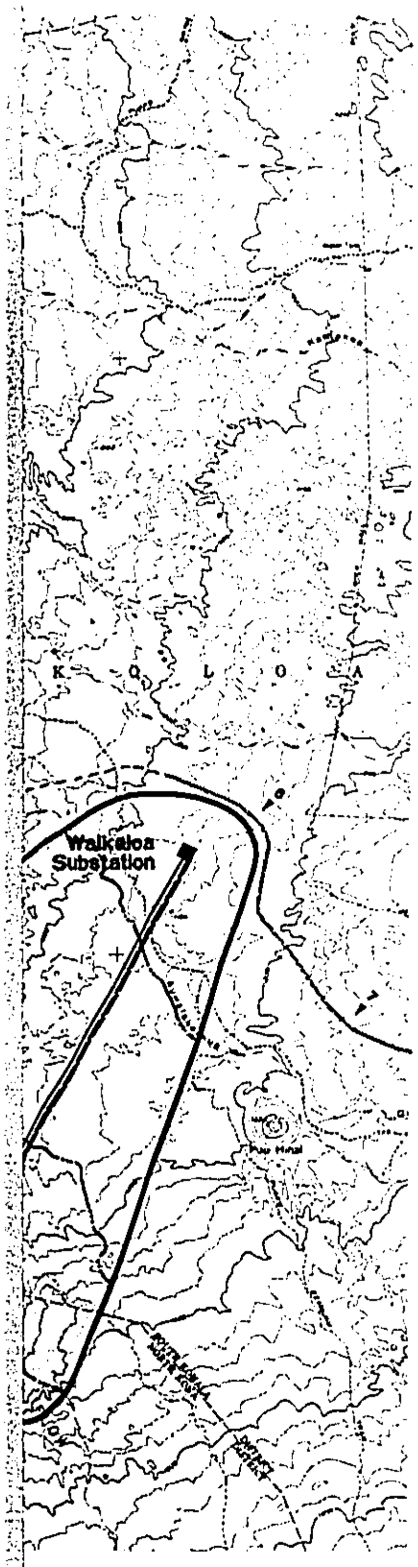


EXHIBIT VI-22

HELCO TRANSMISSION LINE ROUTING STUDY



LEGEND

BASE DATA

- Edge of corridor
- Existing road
- Existing telephone line
- Existing 69 KV line
- Substation
- Reference marker
- Matchline
- Preferred 138 KV alignment
- Alternate 138 KV alignment

LAND USE FACTORS

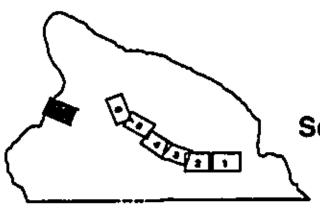
- Urban
- Agriculture
- Grazing
- Military
- Recreation
- Historic site

BIOLOGICAL FACTORS

- Ohia/Koa native forest
- Mamane/Naio native forest
- Introduced forest
- *Palila critical habitat*
- Kipuka and cave habitats K-9

GEOPHYSICAL FACTORS

- Slopes 20% & greater
- High soil erosion hazard
- Stream
- Reservoir



Section 7

PHASE II

Physical Conditions

0 1000 2000 5000 FEET 10,000

0 500 1000 1500 METERS 3000

STUDY ○ EDAW inc.

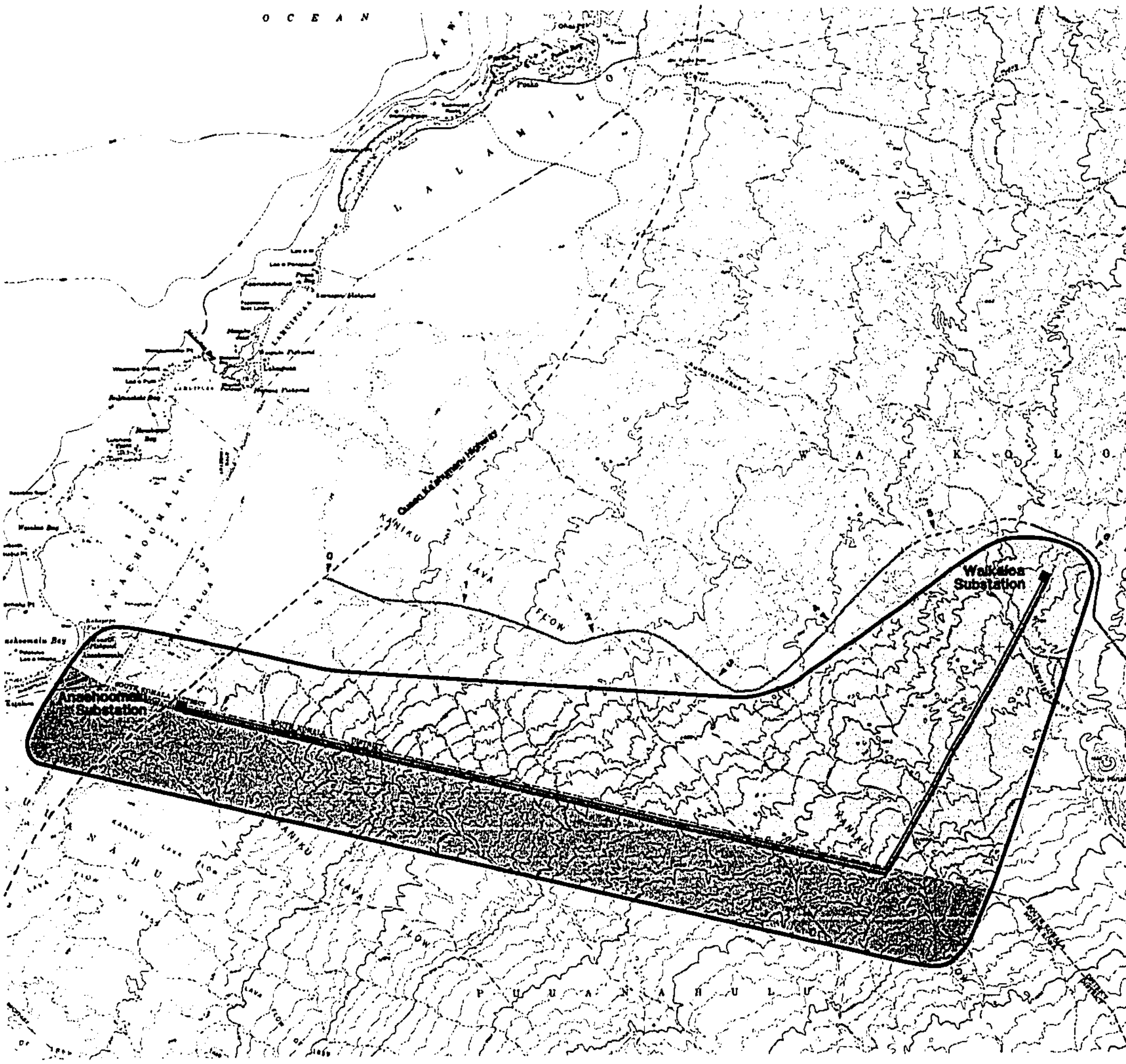
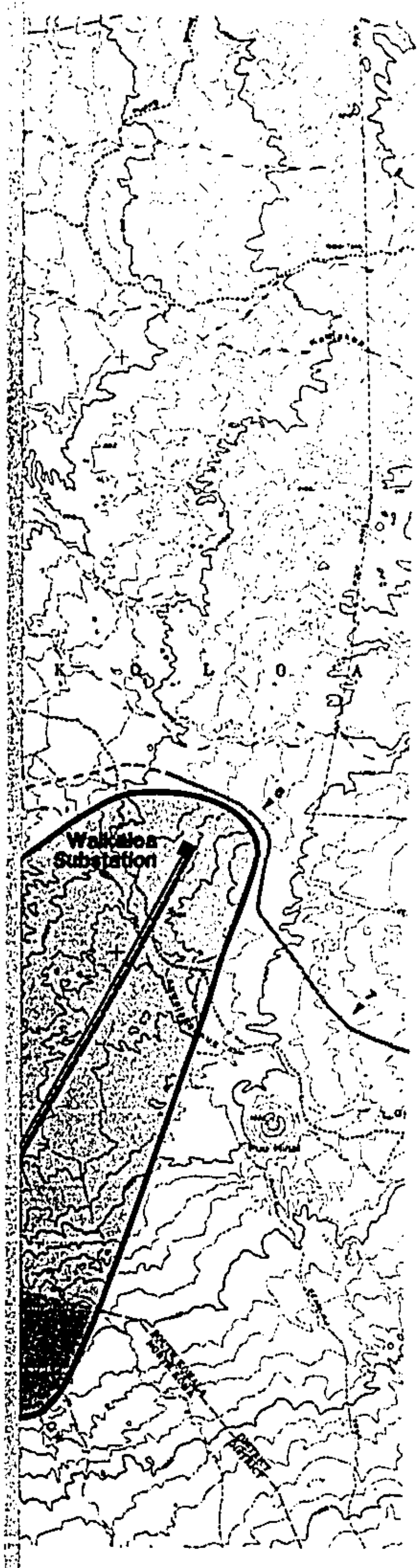


EXHIBIT VI-23

HELCO TRANSMISSION LINE ROUTING STUDY



LEGEND

BASE DATA

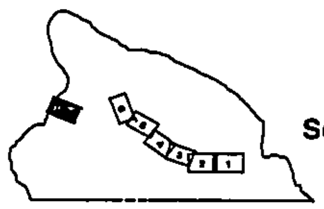
- Edge of corridor
- Existing road
- Existing telephone line
- Existing 69 KV line
- Substation
- Reference marker
- Matchline
- Preferred 138 KV alignment
- Alternate 138 KV alignment

LAND OWNERSHIP

- Private
- Hawaiian Home Lands
- State
- Federal lease

LAND REGULATION

- Urban District
- Protective Subzone
- Resource Subzone
- General Subzone
- Airfield approach/departure zone



Section 7

PHASE II Land Control

0 1000 2000 5000 FEET 10,000

0 500 1000 1500 METERS 3000

STUDY ○ EDAW inc.

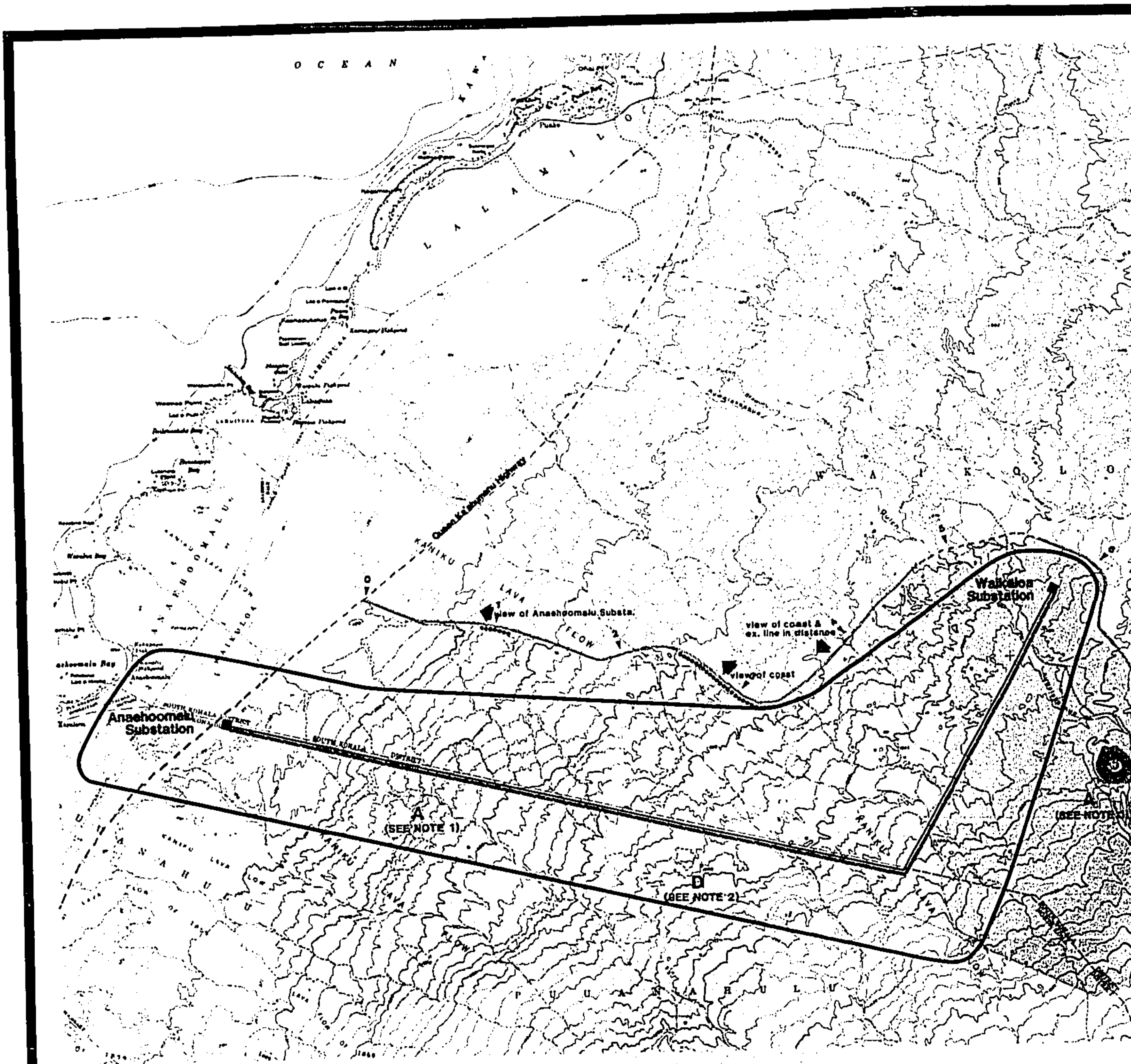
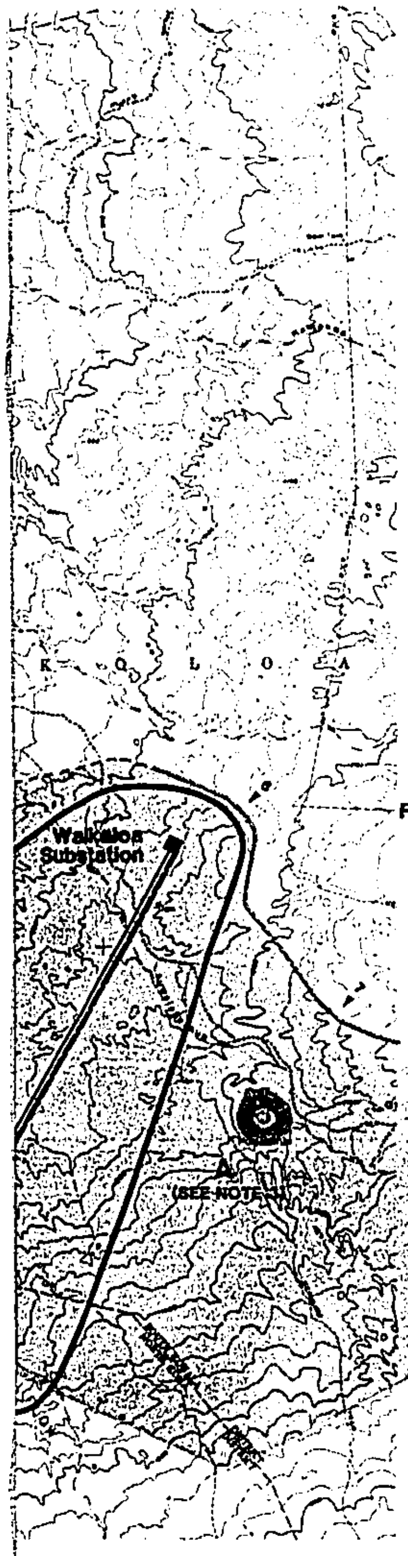


EXHIBIT VI-24

HELCO TRANSMISSION LINE ROUTING STUD



LEGEND

BASE DATA

- Edge of corridor
- Existing road
- Existing telephone line
- Existing 69 KV line
- Substation
- Reference marker
- Matchline
- Preferred 138 KV alignment
- Alternate 138 KV alignment

VISUAL SCREENS

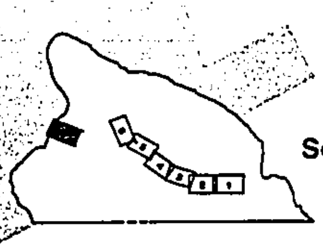
- Solid vegetation screen
- Partial vegetation screen
- Partial buildings & vegetation screen
- Berm along road
- Puu

VIEWS

- Foreground, middleground & distant backdrop or horizon — A
- Foreground — B
- Foreground & middleground — C
- Foreground & distant backdrop or horizon — D

NOTES

1. Long view of Hualalai.
2. Long view of Mauna Loa & Hualalai, middle ground screened by lava ridge line (approx. 1 mile from road).
3. Long view of Mauna Loa & Hualalai across grazing land and lava grass fields.



Section 7

PHASE II

Visual Resources

0 1000 2000 5000 FEET 10,000

0 500 1000 1500 METERS 3000

STUDY ○ EDAW inc.

Appendix A

DEPARTMENT OF REGULATORY AGENCIES

STATE OF HAWAII

TITLE VII - PUBLIC UTILITIES COMMISSION

STANDARDS FOR ELECTRIC UTILITY
SERVICE IN THE STATE OF HAWAII

General Order No. 7

Table of Contents

PART I GENERAL

PART IV CUSTOMER RELATIONS

PART V ENGINEERING

PART VI INSPECTIONS AND TESTS

PART VII STANDARDS OF QUALITY OF SERVICE

PART VIII SAFETY

PART V. ENGINEERING

5.1 REQUIREMENT FOR GOOD ENGINEERING PRACTICE

The electric plant of the utility shall be constructed, installed, removed, maintained and operated in accordance with accepted good engineering practice in the electric industry to assure, as far as reasonably possible, continuity of service, uniformity in the quality of service furnished, and the safety of persons and property.

a. A record shall be kept by each electric utility of defective, unsafe, or hazardous conditions found upon inspection, or otherwise reported or ascertained involving life or property hazard or of interference with service, which record shall describe the location and circumstances of each apparently hazardous condition or possible service interference condition found or reported, and a statement showing the date and general character of its correction.

5.2 ACCEPTABLE STANDARDS

Unless otherwise specified by the Commission, the utility shall use the applicable provisions in the publications listed below as standards of accepted good practice.

a. Hawaii State Public Utilities Commission, General Order No. 6, "Standards for Overhead Electric Line Construction and Maintenance" for overhead electric line construction. (Sept. 1962 revision)

b. "National Electrical Code, NFPA No. 70, ASA C-1" for wiring beyond the service conductors. (1962 edition)

c. "National Electrical Safety Code," as approved by the American Standards Association for transmission and distribution facilities other than those covered in Paragraphs a and b above.

d. "American Standard Code for Electricity Meters, ASA C-12" for meters and associated equipment. (1965 edition)

e. "American Standard Requirements, Terminology and Test Code for Instrument Transformers, ASA C57.13" for instrument transformers. (1954 edition)

5.3 ADEQUACY OF SUPPLY

a. The generation capacity of the utility's plant, supplemented by electric power regularly available from other sources, must be sufficiently large to meet all reasonably expectable demands for service and provide a reasonable reserve for emergencies. A Statement shall be filed annually with the Commission within 30 days after the close the year indicating the adequacy of such capacity and the method used to determine the required reserve capacity which forms the basis for future requirements in generation, transmission, and distribution plant expansion programs required under Rule 2.3h.1.

b. When an electric utility has no generation capacity or limited generation capacity and purchases all or most its electrical energy for resale to its utility customers, the utility must be assured that sufficient firm capacity is dedicated by the supplying company to assure the requirements of Rule 5.3a. A statement as to the adequacy of such commitment and the method used by the utility to determine its reliability shall be filed with the Commission as required in Rule 5.3a.

5.4 INSPECTION OF ELECTRIC PLANT

Each utility shall adopt and file with the Commission a program of inspection of its electric plant in order to determine the necessity for replacement and repair. The frequency of the various inspections shall be based on the utility's experience and accepted good practice. Each utility shall keep sufficient records to give evidence of compliance with its inspection program.

PART VII STANDARDS OF QUALITY OF SERVICE

7.1 STANDARD FREQUENCY

The standard frequency for alternating current distribution systems shall be 60 cycles per second. The frequency shall be maintained within limits which will permit the satisfactory operation of customers' clocks connected to the system.

7.2 VOLTAGE LIMITS

Each utility shall adopt and file with the Commission as part of its tariff its nominal service voltages.

Voltage variations will normally be within the range specified in paragraphs a, b, and c, below. If the voltage is found to be outside these ranges the company must immediately take steps to bring the voltage within these ranges, except as provided in paragraph d, below.

a. Secondary Voltages

For all retail service, except power service, the variations of voltage will normally be no more than 5 percent above or below the nominal voltage. For retail power service the variation of voltage will normally be no more than 7-1/2% above or below the nominal voltage. Where 3-phase service is provided the utility shall exercise reasonable care to assure that the phase voltages are in balance.

b. Primary Voltages

For service rendered principally for industrial or power purposes the voltage variation will normally be no more than 5 percent above or below the nominal voltage.

c. Transmission Voltages

For service rendered at a transmission voltage the variation of voltage will normally be no more than 10% above or 10% below the nominal voltage.

d. Exceptions to Voltage Requirements.

Voltage outside the limits specified above may be furnished when:

1. The customer, by contract, agrees to accept service with unregulated voltage.

2. The variations arise from the action of the elements.

3. The variations are infrequent fluctuations not exceeding 5 minutes' duration.

4. The variations arise from service interruptions.

5. The variations arise from temporary separation of parts of the system from the main system.

6. The variations are from causes beyond the control of the utility.

7. Such fluctuations are caused solely by the load of one particular customer which does not affect the voltage of other customers in the vicinity.

7.3 VOLTAGE SURVEYS AND RECORDS

a. Voltage measurements shall be made at the utility's service terminals. For single phase service the measurement shall be made between the grounded conductor and the ungrounded conductors. For 3 phase service the measurement shall be made between the phase wires.

b. Each utility shall make a sufficient number of voltage measurements, using recording voltmeters, in order to determine if voltages are in compliance with the requirements as stated in Rule 7.2.

c. All voltmeter records obtained under Rule 7.3b shall be retained by the utility for at least 1 year and shall be available for inspection by the Commission. Notations on each chart shall indicate the following:

   1. The location where the voltage was taken.

   2. The time and date of the test.

   3. The results of the comparison with an indicating voltmeter.

7.4 EQUIPMENT FOR VOLTAGE MEASUREMENTS

a. Standards

Each utility shall have at least one indicating voltmeter with a stated accuracy within 0.25% of full scale. This instrument must be maintained within its stated accuracy.

b. Working Instruments

1. Each utility shall have at least 2 indicating voltmeters with a stated accuracy within 1.0% of full scale.

2. Each utility must have at least 2 portable recording voltmeters with a stated accuracy within 2% of full scale.

c. Standards must be checked periodically at the National Bureau of Standards or at a laboratory acceptable to the Commission or at the manufacturer's laboratory or by comparison with a primary standard in the utility's meter laboratory. If the utility maintain primary standards, then these primary standards must be checked periodically at the National Bureau of Standards or at a laboratory acceptable to the Commission or at the manufacturer's laboratory.

d. Working instruments must be check periodically (see Sectin 6.1e2) by comparison with a standard in the utility's meter shop.

e. Extreme care must be exercised in the handling of standards and instruments to assure that their accuracy is not disturbed.

f. Each standard shall be accompanied at all times by a certificate or calibration card, duly signed and dated, on which are recorded the corrections required to compensate for errors found at the last customary test points at the time of the last previous test.

7.5 INTERRUPTIONS OF SERVICE

Each utility shall make reasonable efforts to avoid interruptions of service by when interruptions occur, service shall be re-established within the shortest time practicable, consistent with safety.

a. Each utility shall keep records of interruptions of service of more than one minute and shall make an analysis of the records for the purpose of determining steps to be taken to prevent recurrent of such interruptions. Such records should include the following information concerning the interruptions:

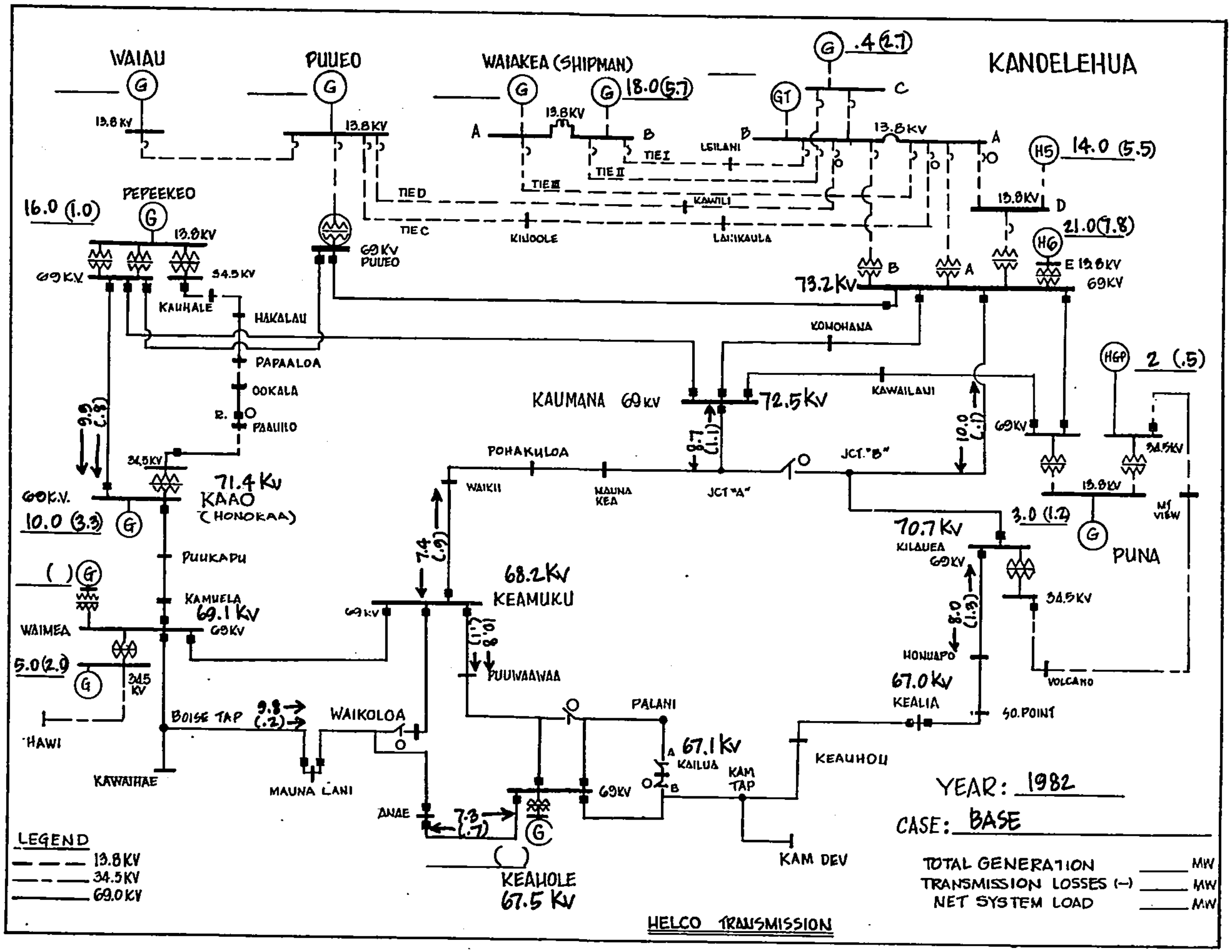
   1. Cause.

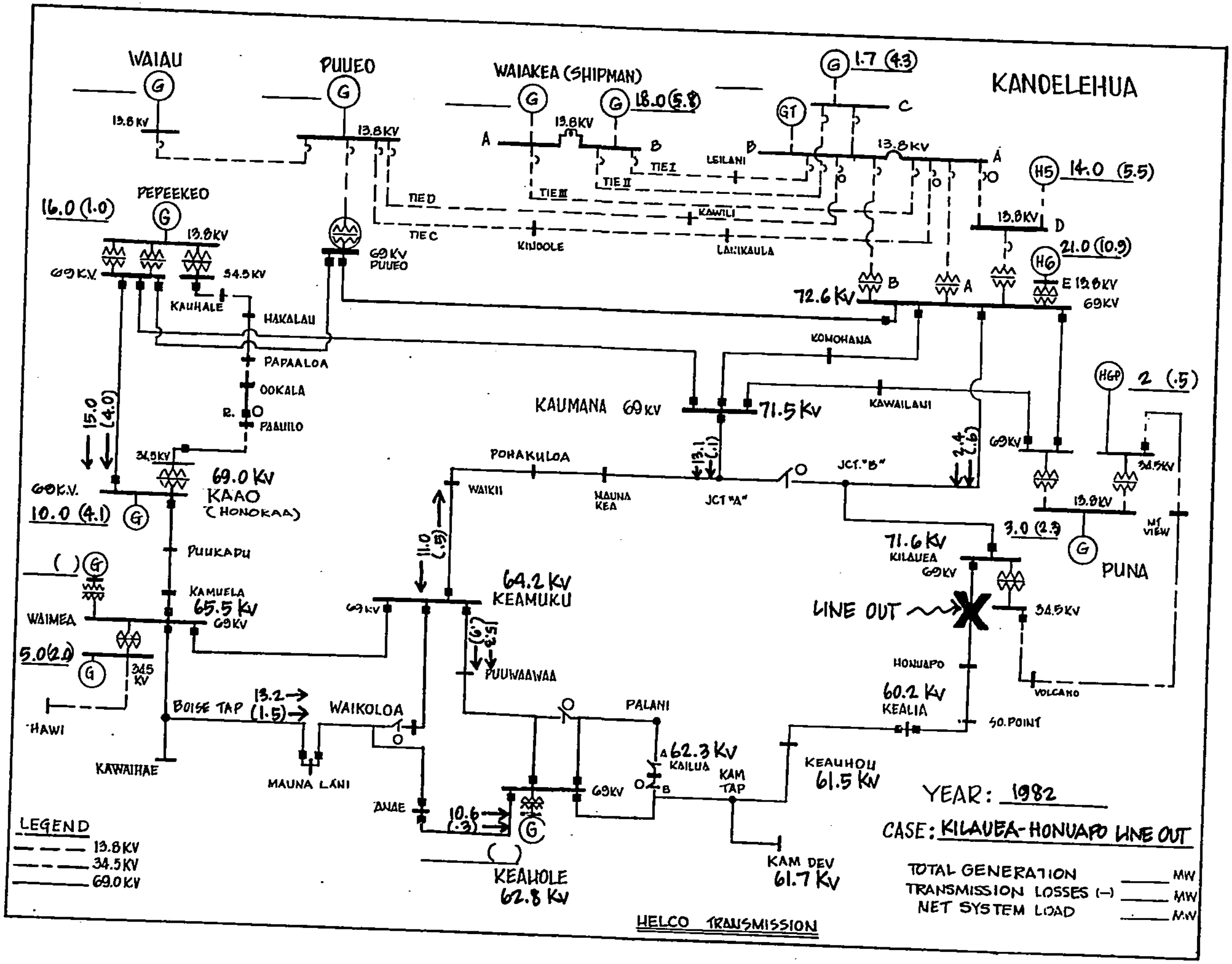
   2. Date and time.

   3. Duration.

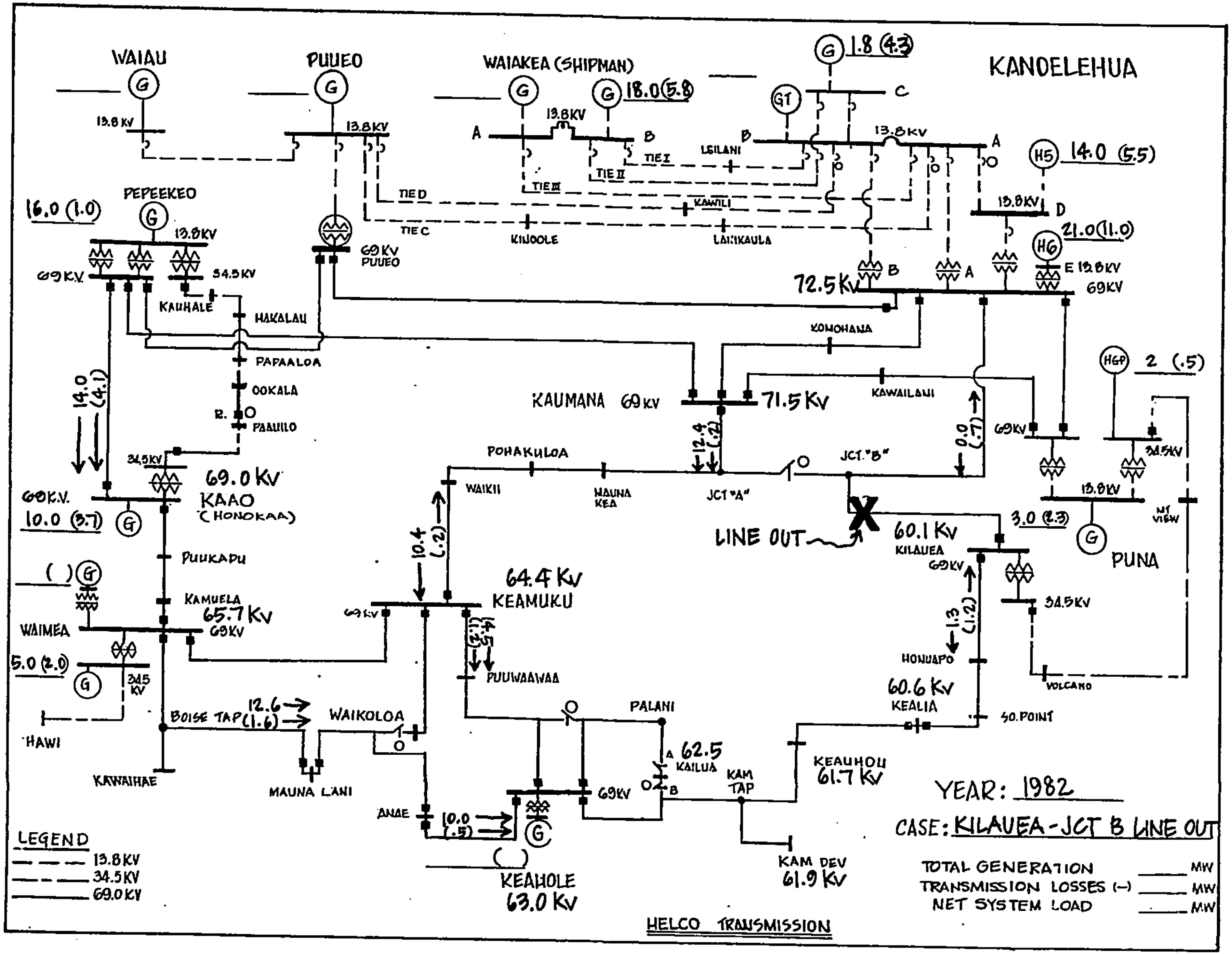
b. Planned interruptions shall be made at a time that will not cause unreasonable inconvenience to customers and shall be preceded, if feasible, by adequate notice to those who will be affected.

Appendix B


KANOELEHUA
WAIAU
PUUEO
WAIAKEA (SHIPMAN)
18.0 (5.7)
.4 (2.7)
14.0 (5.5)
21.0 (7.8)
13.8KV
69KV
34.5KV
TIE D
TIE C
TIE I
TIE II
TIE III
LEILANI
KAWILI
KINOOLE
LANIKAULA
PEPEEKEO
16.0 (1.0)
69KV PUUEO
KAUHALE
HAKALAU
PAPAALOA
OOKALA
PAAUILO
73.2KV
KOMOHANA
KAWAILANI
KAUMANA 69KV
72.5KV
2 (.5)
71.4 KV
KAAO
(HONOKAA)
10.0 (3.3)
POHAKULOA
WAIKII
MAUNA KEA
JCT "A"
JCT "B"
10.0 (.1)
8.7 (1.1)
MT VIEW
3.0 (1.2)
PUNA
70.7 KV
KILAUEA
PUUKAPU
KAMUELA
69.1 KV
WAIMEA
5.0 (2.0)
HAWI
68.2KV
KEAMUKU
7.4 (.9)
8.0 (1.1)
PUUWAAWAA
8.0 (1.3)
HONUAPO
VOLCANO
67.0 KV
KEALIA
50.POINT
BOISE TAP
9.8 (.2)
WAIKOLOA
KAWAIHAE
MAUNA LANI
PALANI
67.1 KV
KAILUA
KEAUHOU
KAM TAP
KAM DEV
ANAE
7.3 (.7)
KEAHOLE
67.5 KV
YEAR: 1982
CASE: BASE
TOTAL GENERATION MW
TRANSMISSION LOSSES (-) MW
NET SYSTEM LOAD MW
LEGEND
13.8KV
34.5KV
69.0KV
HELCO TRANSMISSION



KANOELEHUA
WAIAU
PUUEO
WAIAKEA (SHIPMAN)
18.0 (5.8)
1.7 (4.3)
14.0 (5.5)
21.0 (10.9)
PEPEEKEO
16.0 (1.0)
13.8 KV
34.5 KV
69 KV
72.6 KV
KAUMANA 69 KV
71.5 KV
KOMOHANA
KAWAILANI
LEILANI
KAWILI
KINOOLE
LANIKAULA
TIE I
TIE II
TIE III
TIE C
TIE D
KAUHALE
HAKALAU
PAPAALOA
OOKALA
PAAUILO
69.0 KV
KAAO
(HONOKAA)
10.0 (4.1)
15.0 (4.0)
PUUKAPU
KAMUELA
65.5 KV
WAIMEA
5.0 (2.0)
HAWI
KAWAIHAE
BOISE TAP
13.2 (1.5)
WAIKOLOA
MAUNA LANI
64.2 KV
KEAMUKU
11.0 (.9)
5.3 (.9)
PUUWAAWAA
WAIKII
POHAKULOA
MAUNA KEA
JCT "A"
JCT "B"
13.1 (.1)
2.4 (.6)
HGP 2 (.5)
PUNA
3.0 (2.9)
MT VIEW
71.6 KV
KILAUEA
LINE OUT
HONUAPO
60.2 KV
KEALIA
SO. POINT
VOLCANO
KEAUHOU
61.5 KV
PALANI
62.3 KV
KAILUA
KAM TAP
KAM DEV
61.7 KV
ANAE
10.6 (.3)
KEAHOLE
62.8 KV
YEAR: 1982
CASE: KILAUEA-HONUAPO LINE OUT
TOTAL GENERATION ____ MW
TRANSMISSION LOSSES (-) ____ MW
NET SYSTEM LOAD ____ MW
LEGEND
13.8 KV
34.5 KV
69.0 KV
HELCO TRANSMISSION


KANOELEHUA
WAIAU
PUUEO
WAIAKEA (SHIPMAN)
18.0 (5.8)
1.8 (4.3)
14.0 (5.5)
21.0 (11.0)
PEPEEKEO
16.0 (1.0)
72.5 KV
KAUMANA 69 KV
71.5 KV
KAWAILANI
KOMOHANA
HAKALAU
PAPAALOA
OOKALA
PAAUILO
KAUHALE
69.0 KV
KAAO (HONOKAA)
10.0 (3.7)
PUUKAPU
KAMUELA
65.7 KV
WAIMEA
5.0 (2.0)
HAWI
KAWAIHAE
BOISE TAP
WAIKOLOA
MAUNA LANI
ANAE
64.4 KV
KEAMUKU
PUUWAAWAA
POHAKULOA
MAUNA KEA
WAIKII
JCT "A"
JCT "B"
LINE OUT
60.1 KV
KILAUEA
PUNA
3.0 (2.3)
HGP
2 (.5)
VOLCANO
HONUAPO
60.6 KV
KEALIA
50.POINT
KEAUHOU
61.7 KV
PALANI
62.5
KAILUA
KAM TAP
KAM DEV
61.9 KV
KEAHOLE
63.0 KV
YEAR: 1982
CASE: KILAUEA-JCT B LINE OUT
TOTAL GENERATION ____ MW
TRANSMISSION LOSSES (-) ____ MW
NET SYSTEM LOAD ____ MW
LEGEND
13.8 KV
34.5 KV
69.0 KV
HELCO TRANSMISSION

Appendix C

SUMMARY OF FIRST PUBLIC AGENCY WORKSHOP

Board Room, Department of Land and Natural Resources
Honolulu, Hawaii
Tuesday, September 7, 1982
1:30 p.m.

Nineteen representatives from State and Federal agencies were present at the workshop, as shown on the attached list. The workshop began with a presentation by HELCO on its system planning requirements and the need for the proposed transmission line. This was followed by a presentation by EDAW inc. on transmission line routing methodology and the broadscale data factor maps. Potential study corridors were identified.

After these presentations, workshop attendees were asked to comment on or suggest revisions to the criteria or methodology for the routing study. They were also invited to raise questions regarding any of the material presented. Most of the questions and concerns of agency representatives related to the description and rationale for the project rather than to the criteria or methods to be used for selection of the route.

Specific issues raised during the question and answer period were:

1. Project need and description

   a. Why are wooden poles used rather than steel?
   b. Why not increase the voltage capacity of the existing line?
   c. What is the project cost?
   d. Can a combination of an overhead line and underground line be considered, particularly undergrounding in areas where hazards exist, such as the Pohakuloa Training Area?
   e. Will Federal funding be involved?

2. Routing considerations

   a. What does the term "corridor" mean?
   b. Why not parallel the existing Saddle Road route?
   c. Will route require Federal permits?
   d. What are FAA requirements for pole heights in the vicinity of Pohakuloa Training Area, relative to high velocity jets and helicopters?

Immediate responses were made to most of these questions. Participants were told that additional information on some of these points will be presented at a second workshop to be held in October. The workshop adjourned at 3:30.

WORKSHOP ATTENDEES

PERSON	AGENCY
Fred Nakahara	U. S. Army Support Command (USACH)/ Division of Engineering and Housing (DEH)
Natalie Hiyoto	USACH/DEH
Richard Nakahara	U. S. Geological Survey/Water Research Division
Lucien Kramer	U. S. Fish and Wildlife Service
Dean Nakagawa	State Department of Transportation (DOT)/Airports Division
Fred Shinsato	State DOT/Harbors Division
Manabu Tagomori	State Department of Land and Natural Resources (DLNR)/DOWALD
James Detor	State DLNR/Land Management Division (LMD)
Len Bautista	State DLNR/LMD
Mike Shimabukuro	State DLNR/LMD
John Bedish	U. S. Soil Conservation Service
Shoji Kato	State Department of Health/Office of Environmental Quality Control
Roy Sakamoto	State Department of Health/Office of Environmental Quality Control
Bruce Taylor	State Department of Hawaiian Home Lands/Land Division
Stan Shima	State DLNR/Aquatic Resources Division
Wayne Urada	USACH/DEH (Utilities Division)
Ginger Plasch	University of Hawaii/Institute for Astronomy
Ralston Nagata	State DLNR/State Parks and Historic Sites Division
Bill Gorst	State DLNR/State Parks Division

SUMMARY OF FIRST ROUND OF COMMUNITY WORKSHOPS

Department of Education Annex
Hilo, Hawaii
Wednesday, September 15, 1982
7:00 p.m.

Resolution Room,
Kona-Hilton Hotel
Kailua-Kona, Hawaii
Thursday, September 16, 1982
7:00 p.m.

Hilo Session

Fourteen people attended the workshop in Hilo. As shown on the attached list, representatives of the Sierra Club, American Association of University Women, Aloha Aina, Hawaii National Park and two County agencies were present.

The workshop began with a presentation by HELCO on its system planning requirements and the need for the proposed transmission line. This was followed by a presentation by EDAW inc. on transmission line routing methodology and the broadscale data factor maps. Potential corridors were identified.

After these presentations, workshop attendees were invited to submit their questions and comments. The questions came primarily from three individuals and focused mostly on the need for the project. Many of these questions were very similar to those raised at the public agency workshop and can be categorized in the same way.

1. Project need and description

   a. Why not rebuild or increase the voltage capacity of the existing line?

   b. Why is so large voltage capacity (138 Kv) required? Will it be able, in part, to transmit bulk power from geothermal wells?

   c. Why not build generating plants on the Kona side? How does the cost of building and maintaining a new plant compare to the cost of the transmission line? What is the potential for non-fossil fuel generation on the Kona side?

   d. Will the cross-island line will be needed if geothermal development, even at 25 mw, does not pan out by 1990?

   e. What is the energy demand forecast for specific areas in Kona and Pohakuloa?

2. Routing/environmental considerations?

   a. What are the impacts of a marine cable?

   b. What are the impacts of undergrounding the line?

   c. Why can't you parallel the existing line along Saddle Road?

Most of these questions received an immediate response. Participants were told that additional information will be presented at the second round workshops to be held in mid-November.

Only four of the questionnaires distributed at the workshop were completed and returned to us. Attached is a summary sheet showing composite scores and rankings for 16 routing factors. This is not a very reliable basis for determining public priorities for routing considerations, but it is interesting to note that the costs of building and maintaining the transmission line ranked 2nd and 3rd, respectively, in this small sample.

Kona Session

Three persons attended the workshop in Kailua-Kona. The presentation was identical to that in the Hilo session the previous evening. No comments or questions were raised by participants.

WORKSHOP ATTENDEES

PERSON	AFFILIATION (if any)
Hilo Session	
Melvin Yamaki	
Carole Westby	
Lance Foreman	
Masa Onuma	County of Hawaii Planning Department
Vicki Zaleski	American Association of University Women
George Winsley	Sierra Club
David Ames	Hawaii National Park
Stuart Kearns	County of Hawaii Office of Research and Development
Claude Moore	
Al Kakaji	
Carl Meierdiercks	
Ann Meierdiercks	
Dexter Cate	Aloha Aina
Hugh Ono	
Kona Session	
Mike Mullahey	Kona Chamber of Commerce
Jeffrey A. McNally	
Adam W. Boose	

QUESTIONNAIRE
COMPOSITE SCORES AND RANKS

Instructions:

We would appreciate your taking the time to fill in this questionnaire so that we can find out what you think are the most important things to consider in selecting a transmission line route.

Please look over the following list of factors which can be considered in routing a transmission line. Then rank them by putting a "1" in the blank space to the left of the factor which you consider most important, a "2" next to the second most important factor, and so. You may give two or more factors the same ranking if you feel they are equal in importance and you may omit ranking any factor which you think is not important. If something you are concerned about is missing from this list, please add it at the bottom and show how you would rank that concern.

A TRANSMISSION LINE ROUTE SHOULD AVOID:

RANK	SCORE	
10	23	SOIL EROSION AND USE OF STEEP SLOPES.
1	51	DAMAGE TO THE LINE AND INTERRUPTION OF SERVICE DUE TO VOLCANIC ERUPTIONS AND EARTHQUAKES.
11	20	IMPACTS ON WATER QUALITY AND FISHES.
6	31	IMPACTS ON WILDLIFE AREAS, ESPECIALLY NATIVE BIRD HABITATS.
4	36	IMPACTS ON NATIVE FOREST AREAS.
15	4	RECREATION AREAS, INCLUDING HUNTING AREAS.
14	12	RESORT AREAS.
5	34	RESIDENTIAL AREAS.
8	29	PRIME AGRICULTURAL LAND.
9	27	PRESERVATION LANDS.
12	16	USING LAND OUTSIDE OF EXISTING ROAD OR UTILITY EASEMENTS.
16	1	USING SMALL PRIVATE PROPERTIES.

QUESTIONNAIRE
PAGE 2

RANK	SCORE	
13	15	VISIBILITY OF THE LINES FROM MAJOR SCENIC AREAS OR HEAVILY TRAVELLED ROADS.
7	30	AREAS WHERE ARCHAEOLOGICAL SITES ARE KNOWN TO EXIST.
2	41	HIGHER COSTS FOR CONSTRUCTING THE LINE.
3	37	HIGHER COSTS FOR MAINTAINING THE LINE.

SUMMARY OF SECOND ROUND OF PUBLIC AGENCY WORKSHOPS

HELCO Auditorium
Hilo, Hawaii
Thursday, October 14, 1982
2:00 p.m.

Board Room,
Department of Land and
Natural Resources
Friday, October 15, 1982
10:00 p.m.

(Plus special session with DLNR Planning Office
on October 18, 1982)

Hilo Session

The workshop was attended by eight persons representing State and County agencies, the U. S. Army Pohakuloa, and Hawaiian Telephone Company. (Attendance sheet attached). Representatives from the County Planning Department and Department of Research and Development had seen some of the workshop material at the community workshop held in Hilo in mid-September, but otherwise this was the first opportunity for public and quasi-public agency officials to get an overview of the project.

The workshop began with a presentation by HELCO on system planning considerations and the need for the proposed project. This was followed by EDAW inc.'s presentation on transmission line routing methodology, the broadscale analysis and corridor selection. Attendees were asked for their comments and questions on this material.

All but two of the attendees responded to the questionnaire which was distributed. The comments can be summarized as follows:

- o Undergrounding the line near Pohakuloa should be considered because of possible conflict with air traffic and bombing practice. (This was not raised by the Army representative.)
- o The routing should consider the effects of "uncontrolled, new access to hunting areas."
- o Routing should take into consideration the addition of future cross-island transmission lines, particularly the one(s) which might be built for export of bulk power from geothermal wells.

In addition to these written comments, the County Planning Department official raised a number of questions regarding pole design and system requirements which were similar to those asked during the first agency workshop in Honolulu. He seemed generally satisfied with the responses. However, he mentioned one item that should be given further consideration:

- o An H-frame design for the line supports should be considered so that the second line scheduled for 1995 could be strung without having to acquire a new right-of-way and construct new single-pole supports.

The response to this was that such design is subject to increased risk of line outage in the event of a damaged support; however, the costs and benefits of an H-frame design would be studied and given due consideration.

Honolulu Session

Nine officials from State and Federal agencies attended the workshop in Honolulu. Attendance was substantially smaller than for the first session in mid-September. Less than half of those present attended the first session, but the Federal Aviation Administration was the only agency which had not had a representative at the earlier meeting. A recap of the first workshop was presented for the benefit of those who were getting their first exposure to the project. Following this, there was a presentation on corridor selection.

Only minor comments and questions were raised. For example, the DPED representative wanted some clarification on the locations and capacities of existing and projected generating resources. A DLNR representative wanted to know if the Forestry Division agent on the Big Island was being consulted regarding the routing analysis. The questioners were satisfied with the responses.

Special Session with DLNR Planning Office

Since DLNR's Planning Office was not represented at either the first or second workshop, despite written and oral invitations, a special presentation for Ms. Sherri Samuels of the Planning Office was arranged on October 18th at DLNR's Board Room, per instructions of Mr. Roger Evans. The material presented in both workshops was covered. Ms. Samuels, who is the Planning Office staff person assigned to the review of CDUA's on the Big Island, said that she thought the methodology for route selection addressed all of the Planning Office's concerns. The remainder of the meeting focused on the timetable for CDUA and EIS submittal and review.

WORKSHOP ATTENDEES

PERSON	AGENCY
Honolulu Session	
H. Kido	State Department of Transportation (DOT)/Airports Division
Richard Nakahara	U. S. Geological Survey/Water Research Division
Nobu Honda	State Department of Land and Natural Resources (DLNR)/ Forestry Division
Shoji Kato	State Department of Planning and Economic Development/Planning Division
James Detor	State DLNR/Land Management Division
George Shigano	State DOT/Highway Division
Albert Loo	Federal Aviation Authority
Nobu Kaneshiro	State DLNR/DOWALD
Bill Gorst	State DLNR/State Parks Division
Hilo Session	
Robert L. Michell	U. S. Army/Pohakuloa Training Area
Arthur Isemoto	County of Hawaii Department of Public Works
Hoby Van Gieson II	Hawaiian Telephone Company
Mark Gushiken	State DLNR/Land Management Division
Ronald Bachman	State DLNR/Fish and Game Division
Stuart Kearns	County of Hawaii Office of Research and Development

PERSON	AGENCY
Hilo Session cont'd	
Donald Tong	County of Hawaii Planning Department
Gary Kawasaka	County of Hawaii Department of Water

SUMMARY OF SECOND ROUND OF COMMUNITY WORKSHOPS

HELCO Auditorium
Hilo, Hawaii
Tuesday, November 16, 1982
7:00 p.m.

Kealakehe Elementary School
Cafetorium
Kailua-Kona, Hawaii
Wednesday, November 17, 1982
7:00 p.m.

Hilo Session

The attached attendance sheet indicates that six people were present, including representatives from the Sierra Club, Mauna Kea Observatory, Mauna Kea Sugar Company and the State Public Utilities Commission.

The workshop began with a recap of the first round of workshops and the work accomplished to date. Then, the preferred alignment was described by EDAW inc., using maps illustrating physical conditions, land control and visual resources along the route. No objections were raised to the preferred alignment, but there were a couple of general comments and questions, as follows:

1. Barbara Allen (Sierra Club) asked why the southern alignment was shown in map Section #6 (Keamuku). In response, it was explained that this would avoid visual impact and conflict with a proposed subdivision in the northern area, where the existing 69 Kv line is located. It was also explained that a new line in the southern section would provide a fire break and access road in this dry zone where highly flammable fountain grass has taken root. This would help protect adjacent pasture lands.

2. Megumi Saiki (Mauna Kea Sugar) said he would prefer whatever alignment would be the least costly. He would also prefer, as a landowner, an easement of minimum width. Francis Hirakami (HECO) explained the considerations which go into determining the width of an easement for various types of transmission lines.

There were a couple of other general questions and comments regarding transmission lines:

1. Cathy Lowder (Sierra Club) asked whether a transmission line would interfere with a nearby telephone line. It was explained that there would be no interference. In any case, the telephone line along Saddle Road is dead and a section of it is presently being removed.

2. Cathy Lowder also asked whether an access road was required along the entire length of the line. It was explained that short access roads directly to pole sites may be sufficient when the line is close enough to an existing road. For more remote areas, a parallel access road is desirable if at all possible.

The other questions and comments concerned even more general aspects of HELCO's plans and system requirements, particularly as related to projected regional load growth due to the proposed space launching facility in the Ka'u area, residential subdivisions in the Puna area, a possible manganese module plant. There were also questions regarding HELCO's peak hour load and its plans for geothermal transmission. Alva Nakamura (HELCO) responded to these questions.

Kona Session

The Kona workshop was closed at 7:30 p.m. after no one had appeared.

WORKSHOP ATTENDEES

PERSON	AFFILIATION (if any)
Hilo Session	
Barbara Allen	Sierra Club
J. A. Krieger	Mauna Kea Observatory
Cathy M. Lowder	Sierra Club
Megumi Saiki	Mauna Kea Sugar Company
Skippy Yasutake	State Public Utilities Commission
Pete Leonard	
Kona Session	
N. A.	

Consumer Lines

Vol. I, No. 9 • October 1982

Public helping to select power line route

Big Island residents had the unique experience last month of helping Hawaii Electric Light Company plan the route of its new transmission line across the island.

Workshops were held in Kona and Hilo to give Big Island residents a role in selecting a route for the 138-kilovolt line. Studies have shown that the new transmission line will be needed by the end of this decade to maintain reliable service for customers in growing West Hawaii. Helco President Fred Johnson said the decision to install new transmission lines was reached after studying various alternatives. The September workshops covered several aspects of the proposed project, including costs, environmental considerations, and legal aspects.

Based upon these and other considerations, two potential routes appeared to stand out from the other possibilities — one route along the saddle road paralleling the current transmission line, and another that would skirt the base of Mauna Kea.

The next workshops will be held in Hilo on Nov. 16 in the Helco Auditorium, 1200 Kilauea Avenue and in Kailua-Kona on Nov. 17 in the Kealakehe Elementary School Cafetorium. Both will begin at 7 p.m.

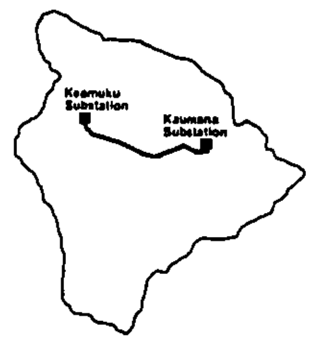
Vol. II, No. 1 • January 1983

Saddle Corridor picked for new line

The Hawaii Electric Light Company is moving further along in the planning for a new 138-kilovolt transmission line across the Big Island. The October edition of *Consumer Lines* reported that public workshops were held in September to give Big Island residents the opportunity to help select the transmission line route. A second round of workshops was held in November to review the proposed alignment, which generally follows the Saddle Road.

The new line is needed to improve reliability of the island's electric system after several years of growth in West Hawaii.

A team of biologists, geologists, soils engineers, archaeologists and landscape architects have surveyed the route to assist in locating an alignment that would have the least environmental impact while keeping costs down. Numerous government officials and landowners have also been consulted about the proposed alignment. Detailed maps of the proposed route showing physical conditions, land ownership, regulatory controls and visual resources along the route are available for public inspection at the Helco office in Hilo.



You may also call Helco's Project Manager Dennis Tanigawa or Helco's Manager of Engineering Alva Nakamura at 935-1171 if you have any questions about the project.

Produced by the Corporate Communications Office of Hawaiian Electric Co. for the customers of Hawaiian Electric, Maui Electric Co., and Hawaii Electric Light Co. • Consumer Lines • PO Box 2750 • Honolulu, Hawaii 96840 • Phone: 548-5670

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HECO/HELCO TRANSMISSION LINE

Routing and EIS/CDUA

Bird and Mammal Report

Andrew J. Berger, Ph.D.

for EDAW inc.

December 10, 1982

HECO/HELCO Transmission Line Routing and EIS/CUDA

Bird and Mammal Report

By Andrew J. Berger

This study was conducted for EDAW, Inc. in accordance with letter contract that was approved on October 7, 1982. Field work was conducted, by myself and one field assistant, between November 14 and 20, 1982. In addition, however, since 1966 I have spent approximately six months (including every month of the year) studying the birds along the Saddle Road and in the mamane-naio forest on Mauna Kea.

I have entitled this a "Bird and Mammal" report because there are no endemic amphibians or land reptiles in the Hawaiian Islands; all have bee introduced by man and none have significance for the proposed project. There are no streams or other bodies of water within the proposed corrido for any fishes, either endemic or introduced.

The three sections of this report are:

1. A brief discussion of all bird and mammal species occurring from the proposed Kaumana Substation to the Anaehoomalu Substation. Special attention will be given to any threatened or endangered Hawaiian bird species.

2. A discussion of the habitat and its avifauna at different elevati along the proposed transmission line and the corridor indicated on the 7 map sections showing the physical conditions of the corridor.

3. A discussion of the possible impacts on the birds and mammals resulting from construction and operation of the power line, and suggestic for mitigation measures if there are thought to be any adverse impacts on the birds and mammals inhabiting the corridor.

Birds Along the Transmission Corridor

Three general groups of birds are found in the Hawaiian Islands: 1) Introduced or exotic birds, those brought to the islands by man; 2) Indigenous birds, those whose total range in the Pacific Basin includes Hawaii: seabirds and migratory shorebirds and ducks that spend only their nonbreeding season in the islands; and 3) endemic species, those that are unique to the Hawaiian Islands and are found nowhere else in the world (Berger, 1981). During this study, I found 24 introduced species of birds, one indigenous species, and seven endemic species. However, I will discuss 26 introduced species and nine endemic species.

I. Introduced birds.

A. Order Galliformes

a. Family Phasianidae, Pheasants, Quails, Francolins, Partridges

1. California Quail, *Lophortyx californicus*.

This quail is native to western North America, from southern Oregon and western Nevada southward into Baja California. Two different geographical races were introduced to Hawaii prior to 1855. On Hawaii this species is found as high as 10,000 feet elevation on the leeward slopes of Mauna Kea and Mauna Loa; they are less common at lower elevations. These quail do not inhabit the ohia-treefern forests, but are common in the mamane-naio forest on Mauna Kea and in the scrub land along the Saddle Road in the Pohakuloa Military Training area. Coveys of as many as 45 to 50 birds were seen in the mamane-naio area in the Pohakuloa flats (section 4 on the maps).

2. Gambel's Quail, Lophortyx gambelii.

This quail also is native to southwestern North America and northwestern Mexico. It is a quail of desert thickets, and occurs in parts of the Mojave and Colorado deserts of California. It sometimes is called the desert quail.

More than 1,000 Gambel's Quail were imported to Hawaii from New Mexico by the State Division of Fish and Game between 1958 and 1961. This species also was released on the Puuwaawaa Ranch during the period between 1959 and 1963, but the species apparently failed to become established in that area (Lewin, 1971). Thus, although it is possible that populations of Gambel's Quail occur on the Kona side of Mauna Kea and Hualalai, I did not happen to find this species during my surveys along the proposed powerline.

3. Chukar, Alectoris chukar.

This partridge is native to the Himalaya Mountains (India and Nepal). Taxonomists recognize 22 different geographical races, and these have a wide distribution extending from Italy, east to Mongolia, northern China, and Manchuria, and south to the Himalayas. As a result of the publication of The Game Birds in Hawaii by Charles and Elizabeth Schwartz in 1949, 17 pairs of Indian Chukars were released in the Pohakuloa Game Management Area on Hawaii that same year. This proved to be an excellent habitat for this species, and personnel of the Division of Fish and Game

estimated that the population had increased to 30,000 birds by 1955. An apparently unidentified subspecies of the Chukar was released by the owners of the Puuwaawaa Ranch in 1961. Birds from the Pohakuloa area have spread into adjacent habitat, and a small, scattered population occurs on the western slope of Kohala Mountain, especially in the Kawaihae region. We saw Chukars in the areas covered by maps 4, 5, and 6 and at lower elevations along the Saddle Road (that is, from the Pohakuloa flats to Waikii and lower elevations).

4. North Indian Gray Francolin, Francolinus pondicerianus interpositus.

This francolin is native to India, from Sind and western Bengal south to Poona and the Godavery River. These birds are inhabitants of dry grasslands, tropical thorn-scrub country, and dry forests up to elevations of 1,500 feet in India. The birds often are found near Indian villages and cultivated land. As is true of most game birds, the birds' wings make a very startling sound when the birds are flushed and swiftly take to wing. The birds begin to run as soon as they land after such a flight. This francolin is kept as a fighting bird in India.

Approximately 1,700 Gray Francolins were imported by the State Division of Fish and Game between 1958 and 1962. The Gray Francolin had become established on all islands where released (that is, all of the main islands except

Oahu). On Hawaii the Gray Francolin now occurs from sea level on the leeward coast to about 7,000 feet on Mauna Kea, but is most common in the lowland mesquite or algaroba thickets. It is a common species at the King Kamehameha Hotel in Kailua Kona, at Kiholo Bay, and at the Mauna Kea Beach Hotel, where I have worked in the past. The almost barren lava flow with fountain grass at the Anaehoomalu Substation apparently does not provide suitable habitat for this francolin and I did not see or hear the species there.

5. Indian Black Francolin, _Francolinus_ _f._ _asiae_.
The Black Francolin is native to northern India and Nepal, where the bird is called the Black Partridge. The State Division of Fish and Game imported about 750 Black Francolin from India during the period from 1959 to 1962; these birds were released on Kauai, Molokai, Maui, and Hawaii. An additional 116 birds from mainland game farms were imported by the owners of the Puuwaawaa Ranch on Hawaii and released there between 1959 and 1962; these birds apparently did not establish a breeding colony (Lewin, 1971). The Black Francolin, however, is now well established on Hawaii, and, in the past I have found it in the dry kiawe or mesquite thickets on the leeward coast, extending from Kukipahu to beyond Puako, and at all elevations above about 40 feet elevation, including the ranch land from Kawaihae to Kamuela. We also saw the

Black Francolin at an elevation of approximately 5,700 feet along the Saddle Road in the Pohakuloa Training Area (Section 5 of the Transmission Line Routing Study).

6. Erckel's Francolin, _Francolinus_ _e._ _erckelii_.
This large francolin is native to the Ethiopian highlands and to the Egyptian Sudan. Nearly 1,400 Erckel's Francolins were imported by the State Division of Fish and Game and the owners of the Puuwaawaa Ranch on Hawaii from 1957 to 1962. On Hawaii Erckel's Francolin has spread out from the three release sites: Pohakuloa, Puako, and Puuwaawaa. I have seen this francolin from near sea level in the Puako-Kawaihae regions to the Pohakuloa Game Management Area on Mauna Kea, but I did not see it during the third week of November 1982.

7. Ring-necked Pheasant, _Phasianus_ _colchicus_.
This pheasant has a wide distribution in temperate Asia. It is a highly variable species and many subspecies or geographical races have been described by taxonomists. Several of these have been introduced to Hawaii. _Phasianus_ _colchicus_ _torquatus_, a native of eastern China, was introduced to the Hawaiian Islands at an unknown date, but perhaps as early as 1865 (Caum, 1933). The Black-necked Pheasant (_P._ _c._ _europaeus_) and a black or melanistic mutant form (_P._ _c._ mut. _tenebrosus_) was obtained from mainland game farms during the period 1959-1962 and released on the Puuwaawaa Ranch. These species interbreed

with each other, as well as with the Japanese Blue Pheasant (Phasianus versicolor) so that many hybrids are seen in certain areas on Hawaii. The Ring-necked Pheasant is not now as common as it was when corn was grown in the Waikii area, but the birds are found in the Pohakuloa flats along the Saddle Road and in the higher mamane-naio forest on Mauna Kea. We saw birds near Puu Hululu and found one dead bird on the Saddle Road in the Pohakuloa Training area.

8. Rio Grande Turkey, Meleagris gallopavo intermedia. Turkeys, native to North America, were first brought to Kailua, Hawaii, from Chile in 1815 (Caum, 1933). Rio Grande Turkeys were imported by the State Division of Fish and Game in 1962 and 1963. A total of 398 birds were released on all of the main islands. The largest populations now appear to occur on Hawaii. I saw a small flock of four adult birds near the Pohakuloa State Park.

B. Order Columbiformes

a. Family Columbidae, Pigeons and Doves

9. Rock Dove or feral pigeon, Columba livia. The pigeon probably was the first exotic bird introduced to the Hawaiian Islands; its importation has been traced back to 1796. Schwartz and Schwartz (1949) wrote that feral pigeons roost and nest the year around in sheltered portions of cliffs along the sea coast, in

rocky gulches, and in collapsed lava tubes up to 10,000 feet on Mauna Kea. They also noted that there had been a drastic decline in the population. "The popular method of shooting birds at their common roosting and nesting sites contributed to the decline and still constitutes a serious threat. In certain places where rookeries are accessible to humans, it was and still is the custom for local residents to periodically take the squabs for food." These authors also found heavy parasitism by tapeworms, and they stated that tapeworm infestation retards proper nutrition and "occludes the intestine, produces undesirable toxins, and hinders breeding." Navvab Gojrati (1970) reported infection by bird malaria, Haemoproteus, and Leucocytozoon in birds at the Honolulu Zoo. Kishimoto and Baker (1969) reported finding the fungus Cryptococcus neoformans in 13 out of 17 samples of pigeon droppings collected on Oahu, where their study was made. The full significance of their findings has not yet been determined, but, in man, this fungus causes a chronic cerebrospinal meningitis; Hull (1963:468) remarked that "in all but the cutaneous form the prognosis [in humans] is very grave." I saw pigeons near the proposed Kaumana Substation site, at Pohakuloa, and at Waikii.

10. Lace-necked, Spotted, or Chinese Dove, _Streptopelia chinensis_.

This Asian dove was introduced to the Hawaiian Islands at an early date; the exact date is unknown, but the birds are said to have been very common on Oahu by 1879. The species is now common to abundant on all main islands and, like the other doves in Hawaii, is classified as a game bird. Although this dove occurs where rainfall exceeds 100 inches per year, the highest densities are found in drier areas where the introduced kiawe is one of the dominant plants. Schwartz and Schwartz (1949), for example, estimated densities as great as 200 birds per square mile in dry areas on Molokai.

The diet, as determined by examining crop contents of 91 birds, was found by the Schwartzes to consist of 77 percent weed seeds and about 23 percent fruits; animal matter was "almost negligible." Tape worm parasitism, however, was found to be heavy, indicating that the small amount of animal matter eaten by the doves was important in contracting the parasites.

The Lace-necked Dove is common in residential areas, in kiawe habitat, and in pasture and agricultural land. It was found at the proposed Kaumana Substation site and on the leeward side of Mauna Kea and Hualalai.

11. Barred Dove, _Geopelia striata_.

This species is called the Zebra Dove in its native range in the Orient and Australia. This dove is said to have been introduced to Hawaii sometime after 1922 (Bryan, 1958). It has been a remarkably successful introduction and it is now abundant on all of the main islands. The Barred Dove also prefers the drier areas where seeds are abundant. Schwartz and Schwartz (1949) estimated densities as great as 400 to 800 birds per square mile in some areas on Oahu (e.g., from Barber's Point to Makaha) and on Molokai. One study of the food habits of this dove in Hawaii revealed that the diet consists of 97 percent seeds and other plant materials; the 3 percent animal matter included several species of beetles, weevils, and wireworm larvae.

Doves avoid dense forests; they are common in residential areas, cutover fields, and at all elevations along the proposed powerline from Pohakuloa to sea level.

b. Family Pteroclidae, Sandgrouse

12. Indian Sandgrouse, _Pterocles exustus erlangeri_.

This sandgrouse is native to peninsular India and West Pakistan, where some birds are nomadic and others are migratory (Ali and Ripley, 1969). Some 780 birds were released by the State Division of Fish and Game, as potential game birds, in 1961 and 1962. It was thought for some years that the introduction was a failure on Kauai, Molokai, and Hawaii, but a population of unknown size still occurs in the Waimea plains area of the Big Island. I did not see this species during my field work, but its occurrence along the transmission line course from Waikii to Anaehoomalu would be irrelevant to the proposed project.

C. Order Strigiformes, Owls

a. Family Tytonidae, Barn Owls

13. Barn Owl, <u>Tyto alba pratincola</u>.

The first Barn Owls were imported from California and released at Kukuihaele, Hawaii, during April 1958. Like the mongooses in the last century, the owls were introduced to Hawaii in the hopes that they would prey upon the rats in the sugarcane fields. One food habits study (Tomich, 1971) indicated that the primary diet of the Barn Owl in Hawaii consists of house mice. By 1962 Barn Owls had spread from Kukuihaele to Laupahoehoe, Waimanu Valley, and to an area near Puuwaawaa "some 30 miles southwest of Kukuihaele, at an elevation of about 1500 feet in dry range country" (Tomich 1962). I have seen this owl near the junction of the Saddle Road and the Hawaii Belt Road (route 190) and it has been reported at Kamuela and at South Point. Barn Owls are predominately nocturnal in habits, and

I did not see any during my field work. However, these owls undoubtedly occur in some areas of the proposed transmission line.

D. Order Passeriformes

a. Family Alaudidae, Larks

14. Skylark, <u>Alauda arvensis</u>.

The first Skylarks were brought to Hawaii from England in 1865; other Skylarks were brought to Hawaii from New Zealand (where they had been introduced from England in 1864) in 1870. Henshaw (1904) wrote that the introduction of the Skylark to Oahu had been "a great success," and that some birds had been released on the windward side of Hawaii, "but their fate is at present unknown." The Skylark is now very rare on Oahu but is an abundant species on Hawaii, being found from near sea level (e.g., at South Point) to above tree line, especially on Mauna Kea. The Skylark is a common species at Pohakuloa and in the pasture land at the Humuhulu Sheep Station as well as along the Saddle Road to the Belt Road.

b. Family Timaliidae, Babblers

15. Melodious Laughing-thrush, <u>Garrulax canorus</u>.

This bird is a member of the babbler family even though it long has been called the Chinese Thrush (Hwa-mei) in Hawaii. The species is native to the Yangtze Valley in China and southward to Laos, and it occurs in

Formosa. The birds were introduced to Hawaii as cage birds. "A number obtained their freedom at the time of the great fire in the Oriental quarter of Honolulu in 1900, and took to the hills behind the city" (Caum, 1933). At a later time, birds were imported and released on Molokai, Maui, and Hawaii. This laughing-thrush is now common on Hawaii, where it prefers fairly dense vegetation. I found this introduced species from the proposed Kaumana Substation area to Pohakuloa, and, in the past, have found it at elevations up to 8,000 feet in the mamane-naio forest on Mauna Kea.

16. Red-billed Leiothrix, *Leiothrix lutea*.

This popular cage bird is known in the trade as the Peking Nightingale and Japanese Hill Robin. It is, however, neither a robin nor a nightingale nor does it occur in Japan nor Peking. The species is native to northern India, the Himalayas, Burma, and southern China. The Leiothrix was first liberated on Kauai in 1918, and during 1928 and 1929 birds were released on Hawaii and other islands. On Hawaii the Leiothrix can be found from sea level to tree line, and one dead bird was found at an elevation of 13,007 feet at Lake Waiau (Berger, 1981). This species occurs in the ohia-treefern forests along the saddle road and in the mamane-naio forest at Pohakuloa, as well as at higher elevations.

c. Family Zosteropidae, White-eyes and Silver-eyes

17. Japanese White-eye, *Zosterops japonicus japonicus*.

This race of the white-eye is native to the main islands of Japan from Honshu to Kyushu and the islands lying between Japan and Korea. The first Japanese White-eyes (Mejiro) were released on Oahu by the Territorial Board of Agriculture and Forestry in 1929 (Caum, 1933). At least 252 White-eyes were released on the island of Hawaii during June 1937 (Berger 1975b). The White-eye presents an example par excellence of the success of introduced birds. It now occurs on all of the main islands, is found from sea level to tree line on Maui and Hawaii, and inhabits very dry areas (e.g., Kawaihae) and those having 300 or more inches of rainfall per year. There is virtually no habitat in Hawaii that is not occupied by white-eyes and I believe it to be the most abundant song bird in the islands. White-eyes eat insects, nectar, soft fruits, the pulp of berries, and buds, so that they can be a serious threat to farmers. The California State Department of Agriculture is greatly concerned about the accidental release of a related species (Gray-backed White-eyes, *Z. palpebrosa*) at San Diego. Two pairs escaped in 1973 or 1974; 150 offspring have been captured since then. "Estimates of the potential loss in soft-fruit crops, should white-eyes ever begin to multiply rapidly and establish large populations, run as high as $2 million a year" (Audubon Magazine, September 1982).

d. Family Sturnidae, Starlings and Mynas

18. Common Indian Myna, *Acridotheres tristis*.

The Myna is native to Sri Lanka, India, West Pakistan, Nepal, and adjacent regions. The Myna was introduced from India "in 1865 by Dr. William Hillebrand to combat the plague of army worms that was ravaging the pasture lands of the islands. It has spread and multiplied to an amazing extent; reported to be abundant in Honolulu in 1879, it is now extremely common throughout the territory" (Caum, 1933). The Myna is common to abundant in lowland areas of the inhabited islands, being most common in residential areas and in the vicinity of houses and barns in outlying districts. I have seen it sitting on the backs of cattle at South Point, Hawaii, and the birds may be encountered at almost any elevation. It is common at Pohakuloa (elevation 6,500 feet) and in the mamane-naio forest at higher elevations, and I found it at sea level at Anaehoomalu Bay.

e. Family Ploceidae, Weaverbirds and their Allies

19. Warbling Silverbill, *Lonchura malabarica cantans*.

This silverbill is native to Africa, being found from Senegal to western and southern Sudan (Traylor, 1968).

The silverbills have been characterized as being "pre-eminently desert birds."

There are no published records of the Warbling Silverbill as having been released in the Hawaiian Islands (Bryan, 1958). It has been assumed that cage birds were released on the Puuwaawaa Ranch, perhaps during the 1960s. I first discovered the Warbling Silverbill near Kawaihae on March 22, 1972 (Berger, 1975a). Later observations have revealed that large populations have become established on the leeward slopes of the Kohala Mountain, Mauna Kea (including Pohakuloa), and Hualalai. In addition, I found a flock of these birds at Anaehoomalu Bay. Silverbills are seed eaters and, with other seed eaters, will make the growing of small grain crops impossible on Hawaii (See Spotted Munia and House Finch).

20. Spotted Munia or Ricebird, *Lonchura punctulata*.

This Asian species was brought to Hawaii by Dr. William Hillebrand about 1865 (Caum, 1933). Caum wrote that the Ricebird "feeds on the seeds of weeds and grasses and does considerable damage to green rice." Rice is no longer grown in Hawaii, but the Ricebird has recently become a serious pest by eating the seeds of sorghum. The Spotted Munia is another abundant species on all of the islands, and it is tolerant of both very dry and very wet habitats. The birds tend to be nomadic during the nonbreeding season, moving over large areas in search of seeds. The birds are prolific, nesting in every month of the year. The birds occur from sea level (e.g., Anaehoomalu and Kiholo bays) to at least 7,500 feet on Mauna Kea. I found this species from the proposed site for the Kaumana Substation to Pohakuloa as well as at lower elevations on the Kona slope of Mauna Kea.

21. House Sparrow, *Passer domesticus*.

Also called the English Sparrow, the House Sparrow was first imported to Oahu in 1871, when nine birds were brought from New Zealand (where the species had previously been introduced from England). Caum (1933) wrote that "whether or not there were further introductions is not known, but the species was reported to be numerous in Honolulu in 1879." The House Sparrow in North America (first introduced in Brooklyn in 1852) became a serious pest, and tens of thousands of dollars were spent in attempting to control the population. The House Sparrow apparently never became a serious pest in Hawaii; it is omnivorous in diet, eating weed seeds as well as insects and their larvae. The House Sparrow typically is found in the vicinity of man and his buildings. I found sparrows common at the Kaumana Substation site, at Pohakuloa, Waikii, and Anaehoomalu Bay.

f. Family Fringillidae, American Sparrows and Buntings.

22. Saffron Finch, *Sicalis flaveola*.

This finch is native to South America, where it occurs throughout except in Chile. This species is now established on the island of Hawaii from Kawaihae to Kailua-Kona. I saw it at Anaehoomalu Bay. It is assumed that the wild population is the result of cage birds released on the Puuwaawaa Ranch during the 1960s.

23. Yellow-billed Cardinal, *Paroaria capitata*.

This South American species is one of the latest successful introductions, being first reported in the Kailua-Kona region of Hawaii. I have seen this species at Kiholo Bay but I did not find it at Anaehoomalu Bay. The Yellow-billed Cardinal inhabits kiawe thickets and may well be found at Anaehoomalu Bay and other areas along the coast north of it. There is no published information on the introduction of this species.

24. Cardinal, *Cardinalis cardinalis*.

The Cardinal also is called the Kentucky Cardinal, Virginia Cardinal, and Red Cardinal. Cardinals were released several times on Kauai, Oahu, and Hawaii between 1929 and 1931. On Hawaii, it occurs from sea level to at least 7,500 feet on Mauna Kea. It occupies very dry areas and those with a high annual rainfall, and it can be found from Hilo to the mamane-naio forest on Mauna Kea.

25. Yellow-fronted Canary, Serinus mozambicus.

This African canary is known as the Green Singing Finch in the petstore trade. Although it probably was first released on the Puuwaawaa Ranch in the 1960s, this canary was not reported on that island until 1978, when a flock was seen on Mauna Kea. Since that time, large numbers have been seen in widely separated areas on Hawaii: Halepohaku, Stainback Highway, Hualalai. I did not happen to see this species during my field work.

26. House Finch, Carpodacus mexicanus frontalis.

This finch is native to western North America. Birds were first brought to Hawaii "prior to 1870" (Caum, 1933). It is now an abundant species in residential and urban areas, in both wet and dry rural areas, and in the high ranch and open forest lands on Maui and Hawaii. Because of their fondness for papaya, the bird is called the Papayabird in Hawaii. Despite their liking for soft fruits, however, House Finches are primarily seed eaters, frequently also eating flower buds. When experimental crops of sorghum were planted in former sugarcane land at Kohala during 1972, Spotted Munias and House Finches destroyed 50 tons of grain from a plot that was expected to produce 60 tons.

II. Indigenous Birds.

E. Order Charadriiformes

a. Family Charadriidae, Plovers.

1. Pacific Golden Plover, Pluvialis dominica fulva.

This winter resident in the Hawaiian Islands spends its breeding season in Alaska or Siberia. Birds generally arrive in Hawaii during August and leave for the nesting grounds by early May. They are found on lawns, in pastures, and in the open mamane-naio forest. I found plovers from the elevation of the proposed Kaumana Substation to the ranch land at the Humuulu Sheep Station and at Anaehoomalu Bay.

III. Endemic Birds

F. Order Falconiformes

a. Family Accipitridae, Hawks

1. Hawaiian Hawk or Io, Buteo solitarius.

The Io occurs on the slopes of Mauna Loa, on both the windward and Kona coasts, and less commonly on Mauna Kea. It is now classified as an endangered species. Very little has been published on the biology of the Io (Berger, 1981), but a mainland graduate student is now making a study of the species. I have never seen the hawk along the Saddle Road (that is, since my studies began in 1966), but I have often seen it along the Belt Road to Kailua-Kona. We saw one hawk in a Eucalyptus grove near the Keamuku Substation.

G. Order Strigiformes

b. Family Strigidae, Typical Owls

2. Hawaiian Short-eared Owl or Pueo, Asio flammeus sandwichensis.

The Pueo is a permanent resident on all main islands in the Hawaiian Chain. The birds are found from sea level to at least 8,000 feet in the mamane-naio forest on Mauna Kea, and the birds are tolerant of wide climatic conditions. It is not classified as an endangered species. We saw the Pueo along the Saddle Road between Waikii and the Belt Road. The Pueo differs from most of the other species of owls in that it is diurnal in habit; hence, they are seen much more often than is the nocturnal Barn Owl.

H. Order Passeriformes

c. Family Turdidae, Thrushes and Bluebirds

3. Hawaiian Thrush or Omao, Phaeornis o. obscurus.

The Hawaii race of the endemic thrush is the most common race; it is not considered to be an endangered species. Along the Saddle Road, the thrush is especially common in the many kipukas, although I did not find it below an elevation of 3,160 feet, nor did I find it at Puu Huluhulu (elevation about 6,700 feet). The thrush does not inhabit the mamane-naio forest on Mauna Kea, nor is it found along any other portion of the proposed transmission line.

d. Family Muscicapidae, Old World Flycatchers

4. Elepaio, Chasiempis s. sandwichensis.

The Elepaio, important in Hawaiian mythology, is a common resident species in the mamane-naio forest at elevations above about 6,500 feet, as well as in the ohia-treefern forests on the island of Hawaii. The birds usually are very quiet during the nonbreeding season and I heard callnotes only in the mixed forest at the Kaumana City housing development (elevation about 2050 feet). The Elepaio is one of the few native forest birds that has been able to adapt to mixed endemic and introduced vegetation and even to almost entirely introduced vegetation in some lowland areas on Oahu. The Elepaio is not an endangered species.

e. Family Drepanididae, Hawaiian Honeycreepers

The members of this endemic family are found only in the Hawaiian Islands. Nearly 40 percent of the species are extinct; another 40 percent are classified as threatened or endangered.

5. Palila, Loxioides bailleui.

This endangered finch-billed honeycreeper is now restricted to the mamane-naio ecosystem on Mauna Kea at elevations between about 6,700 feet and tree line (Van Riper, et al, 1978). It is discussed here only because the proposed transmission line passes through the Pohakuloa flats region and this scrub mamane-naio forest is included in the "critical habitat" as proposed by the Palila Recovery Team. This proposal was made at a time when feral sheep were destroying the mamane-naio forest on Mauna Kea. The thought was to include all of this forest in the critical habitat statement for the Palila even though the Palila had never been known to nest in the Pohakuloa flats forest.

In 1978 the Sierra Club, National and Hawaii Audubon Societies, and Alan Ziegler entered a law suit in behalf of the Palila against the Hawaii State government in order to a force the State to eliminate the feral sheep. Federal Judge Sam King ruled in favor of the Palila and the 9th Circuit Court of Appeals upheld the judge's decision in 1981. Since then the State has made a serious effort to eliminate the feral sheep from Mauna Kea. However, the introduced Mouflon sheep population has increased to the point where this sheep is now continuing the damage to mamane, naio, and the endangered silversword on Mauna Kea (Giffin, 1982). The question now is whether or not the Sierra Club and other plaintiffs will have to sue the State again in order to get the Mouflon sheep eliminated.

During the nonbreeding season, the Palila population moves upslope on the mountain, not downward to the Pohakuloa flats. Van Riper and his coworkers (1978)

found that, during January, no Palila were found below 8,600 feet elevation. Moreover, the Palila population occupies only about 25 percent of the total available habitat on Mauna Kea.

There is absolutely no way that the proposed powerline through the Pohakuloa flats region would impose any adverse effect on the Palila population. The present powerline through this area has been in existence since 1957, and there is no evidence that it has created any significant adverse effects on any of the birds that inhabit this region. A similar statement can be made about the existing buildings of the State Park cabins and the pens and other structures built to raise Nene and other endangered Hawaiian birds by the State Division of Forestry and Wildlife; some of these have been in existence at least since 1949.

6. Amakihi, <u>Hemignathus</u> <u>v</u>. <u>virens</u>.

The Amakihi undoubtedly is the second most common of the surviving honeycreepers. It is common not only in the mamane-naio forest on Mauna Kea but also in the ohia-treefern forests along the Saddle Road and other regions of Hawaii. It shows tolerance toward humans at Volcanoes National Park, as well as at Kokee State Park on Kauai. It is common at the Pohakuloa State Park area, thus showing its tolerance of people as well as of buildings and the existing powerlines.

7. Akiapolaau, Hemignathus munroi (formerly wilsoni).
I mention this endangered honeycreeper only because it is found in the mamane-naio forest above elevations of about 6,800 feet in the Puu Laau area (Berger, 1981). It is possible that very small numbers of birds occur in the larger kipukas of ohia-treefern vegetation along the Saddle Road, although I have never seen it there and I know of no published records of its occurrence there.

8. Iiwi, Vestiaria coccinea.
The Iiwi is the most striking in appearance of the common surviving honeycreepers; it is not an endangered species. It inhabits the ohia-koa-treefern forests on Hawaii. I have not found it below 4,000 feet elevation along the Saddle Road. It is not found in the mamane-naio forest on Mauna Kea.

9. Apapane, Himatione s. sanguinea.
This pretty honeycreeper appears to be the most common bird among the surviving species of honeycreepers. Like the Iiwi, it is found in the ohia-koa-treefern forests on the Big Island. It does not nest in the mamane-naio forest on Mauna Kea. I was, however, very much surprised to find one Apapane in the mamane-naio forest along the present powerline, approximately three miles east of the Pohakuloa State Park cabins (map section 4). The bird was singing a "practice" song (characteristic of immature birds), and undoubtedly was a bird of passage through this region.

Mammals Along the Transmission Corridor

I. Endemic Mammals

The only endemic Hawaiian land mammal is the Hawaiian bat (Lasiurus cinereus semotus), a subspecies of the American hoary bat. The Hawaiian bat is found primarily on the island of Hawaii, where it has been seen from sea level to 13,200 feet (Tomich, 1969; Kramer, 1971). It occurs in Hilo, I have seen it along the Stainback Highway, and it is especially common in Kona, south to South Point. If it occurs along the present transmission corridor, the bat already is accustomed to the buildings and the power lines. Neither would present any difficulty to the bat because of its excellent echolocation system, which enables these primarily nocturnal animals to avoid obstacles during their night flights.

II. Introduced Mammals.

All of these introduced species have proven highly detrimental to man, his buildings, products, and to some of his agricultural products, as well as to the native forests and their birdlife. None, therefore, are of concern as far as detrimental effects resulting from the proposed transmission power line.

Some of these mammal were first brought to the Hawaiian Islands by Captains Cook and Vancouver. Feral cattle, goats (Capra hircus), sheep (Ovis aries), and pigs (Sus scrofa) have been destroying the Hawaiian endemic forests since 1800, and they continue to cause damage to this day. The feral cattle were removed from Mauna Kea in the 1930s, but the other species still ravage the mamane-naio and the ohia-treefern forests.

With the exception of the House mouse (Mus musculus), all of the smaller introduced mammals prey on birds and their nests and eggs.

These small mammals include the roof or black rat (Rattus rattus), Polynesian rat (Rattus exulans), Norway rat (Rattus norvegicus), small Indian mongoose (Herpestes auropunctatus), feral cat (Felis catus), and feral dog (Canis familiaris). All except the Norway rat occur at all levels along the proposed transmission corridor. Unfortunately, the construction and operation of the transmission line will have no adverse effects on these pestiferous mammals.

Bird Habitats Along the Transmission Corridor

The proposed transmission line corridor passes through several very different types of bird habitat. I will discuss these under three general headings as being applicable to the bird species found along the corridor.

I. Ohia-treefern Ecosystem.

The dominant vegetation along the Saddle Road a short distance upslope from the proposed Kaumana Substation to an elevation of approximately 6,500 feet (i.e., to Puu Huluhulu near the Humuulu Sheep Station) consists of ohia (Metrosideros collina) and treeferns (Cibotium spp.). Along much of the proposed corridor, however, the developing forest consists of scattered, low-growing ohia trees because they are found on relatively recent lava flows: e.g., 1855, 1881. Above 5,600 feet elevation, a 1935 flow is virtually devoid of any significant vegetation.

Although the ohia-treefern ecosystem is one of two primary habitats for endemic forest birds, I found only two species at elevations below 3,200 feet: the Elepaio at approximately 2,050 feet at Kaumana City and the Hawaiian Thrush at 3,160 feet. The thrush, not an endangered species, is

found at lower elevations in other forests on the windward coast of Hawaii: e.g., the Laupahoehoe and Puna Forest reserves.

Most of the endemic forest birds along the Saddle Road are most common at elevations between 4,000 and 6,500 feet. During the third week of November 1982, however, I saw only four species, none threatened or endangered: Hawaiian Thrush, Amakihi, Iiwi, and Apapane. The three species of Hawaiian honeycreepers I saw are the three most common of the extant species of this family.

At least 11 species of introduced birds also occur in this habitat between elevations of 1,000 and 6,500 feet. These include the feral pigeon, Lace-necked Dove, Barred Dove, Melodious Laughing-thrush, Red-billed Leiothrix, Japanese White-eye, Common Indian Myna, Spotted Munia, House Sparrow, Cardinal, and House Finch.

II. Mamane-Naio Ecosystem.

This endemic ecosystem is characteristic of the higher slopes (to tree line) and part of the Pohakuloa flats of Mauna Kea. It provides nesting and foraging habitat for five species of endemic forest birds: Pueo, Elepaio, Palila, Amakihi, and Akiapolaau. The Palila and the Akiapolaau are classified as endangered species. Only very rarely is the Palila seen below an elevation of 6,700 feet (usually in the Puu Ahumoa region), and the species has never been found nesting below it (Van Riper et al, 1978; Van Riper, 1980; Berger, 1981). I have never seen the Akiapolaau below 6,800 feet in the mamane-naio forest on Mauna Kea, and I know of no published records of its occurrence below that elevation. This ecosystem also provides habitat for a number of introduced birds. In addition to several species of game birds, these include the Skylark, Melodious Laughing-thrush, Leiothrix, Japanese White-eye, Common Indian Myna, Warbling Silverbill, Spotted Munia, House Sparrow, Cardinal, and House Finch. It should be emphasized that the vast majority of the mamane-naio ecosystem lies above 6,500 feet elevation.

III. Pasture Land and Lava Flows

From the beginning of the Parker Ranch pasture land (western part of map 5 and map 6) there is no native forest at all. The pasture land extends through Waikii to the Belt Road at Kamuela and the Keamuku Substation. Eucalyptus and other introduced trees have been planted in groves and as windbreaks. The pasture land provides habitat for very few species of birds: primarily introduced game birds, the Pueo, and the Skylark.

The habitat is even more depauperate from the Keamuku Substation to the Anaehoomalu Substation, largely because the lower portion, especially, consists of relatively barren lava and scattered clumps of fountain grass and other introduced grasses. There are some scattered wiliwili trees (Erythrina sandwicensis) in the lower reaches of the Waikoaloa area.

Impacts on Birds and Mammals of Construction and Operation of the 138Kv Power Lines

I met with Mr. Warren Wagner at the Bernice P. Bishop Museum on December 6, 1982, in order to get an understanding of the findings of the botanists during their survey of the proposed power-line route. I was told that they did not find any Hawaiian plants listed as rare or endangered on the Federal list at any place along the proposed route. They did find some to many introduced plant species along the proposed corridor, as I had noted during my field work. Some native, but not endangered, plants were found downslope from the present Waikaloa Substation, a dry area which previously had been swept by fire.

It is my considered opinion that construction and operation of the proposed 138Kv power line would have a very minimal impact not only on the birds but also on the habitat that they occupy. The line is designed to skirt important kipukas and the poles can be placed so as to avoid any damage to collapsed lava tubes and other caves.

No population of any endangered Hawaiian endemic bird species is known to nest anywhere within the proposed corridor for the powerline. There is no evidence that the current powerline, the buildings in the Pohakuloa State Park area, or the activities of workers and park users there have any significant impact on the bird species occupying that habitat. The birds obviously have adapted to those conditions, some of which have existed since at least 1949.

Any adverse impact that might affect the introduced mammals would be irrelevant because all are inimical to man and his interests as well as to the vegetation and its animal life. The Hawaiian bat, although primarily a nocturnal mammal, is equipped with a magnificent system for echolocation which enables it to avoid any obstacle in its flight.

Therefore, because of the nature of the habitat, the presence of the current powerline throughout the course of the project, and the fact that any adverse impacts on the birdlife would be minimal, I see no reason for mitigation measures (other than slight shifting of the course of the poles mentioned in the second paragraph above). Anyone who believes that mitigation measures are necessary should read the work by Thorsell (1980) on similar projects on the mainland. I cite three examples from his study: as many as 60 turkeys have been observed roosting on a single powerline tower in West Texas, thus enabling the turkeys to roost out of the reach of certain predators; seven nests of Swainson's Hawk (Buteo swainsoni) were found over a 15-mile distance in New Mexico in a study where the evidence suggested that powerline structures increased the nesting density of this hawk; ducks and other waterfowl almost never (1 in 250,000 birds) collide with power lines during daylight hours, when some ducks migrate. It is highly unlikely, however, that any of the wintering ducks in Hawaii would be migrating through the saddle area or over any other part of the proposed route, and any other bird species found along the corridor also would avoid the power lines when in flight. Moreover, many species of birds perch on power lines.

I cite these examples simply to show that transmission line towers can be an asset to bird populations in certain types of habitats. In the Hawaiian situation, I would not expect the power lines or the towers to improve the habitat for any bird species in the area, but I feel confident—because of the information given in this report—that there would be a

minimal impact on any and all species of birds found throughout the proposed corridor. It is even possible that the Hawaiian hawk would adopt towers for construction of their nests in the Keamuku region.

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BIOLOGICAL RECONNAISSANCE AND ENVIRONMENTAL IMPACT ASSESSMENT OF HECO/HELCO PROPOSED CROSS-HAWAII ISLAND 138 KV TRANSMISSION LINE: BOTANICAL, ENTOMOLOGICAL & MALACOLOGICAL REPORT

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Prepared for EDAW, Inc.

January 3, 1983

LOG OF BORING

PROJECT: HELCO TRANSMISSION LINE ROUTING STUDY

LOCATION: WAIKII (FIELD)

BORING NO. S-5 Page No. 1 of 1
Type of Boring: HAND AUGER
Driller: W. LUM ASSOC.
Date: 11/16/82 Diam. 3"
Elev. ≈ 4940'
Datum:
Field Party: LM, HEW

Rod: –
Sampler: – Split Spoon
– Thin Wall Tube
Hammer: – Weight – Drop
Auger: 3"
Bit: –

Water Level				
Water Level	NOT NOTICED			
Time				
Date	11/16/82			

Sampler	Time	Moisture Content	Sample No.	Sample Depth	Blows/ft/ Sampler	Sample Recovery	DEPTH IN FEET AND CHANGE	Soil Graph	DESCRIPTION - Soil type, firmness, sampler driving records, depth and driving of casing, depth drilling mud used, groundwater variations and times.
HAND	1:00	64	A	0.0 1.0	-	1	0		SOFT TO MEDIUM, DARK BROWN CLAYEY SILT (ASH)
		82	B	1.0 2.0		1			SOFT TO MEDIUM, LIGHT BROWN SANDY SILT. (ASH)
		91	C	2.0 3.0		1			
							5		END @ 3.0' 11/16/82
									1) ~~46.3~~ 43 MILE MARK, NEAR WAIKII.
									2) 300 FT OFF ROADWAY IN FIELD.
									3) PICTURE TAKEN.
									4) Vegetation : Bermuda grass.

Note: Show location of borings by sketch in space provided or on back of first sheet of each day's work.

3-470

Walter Lum Associates, Inc.
Civil Engineers S-5

LOG OF BORING

PROJECT: HELCO TRANSMISSION LINE ROUTING STUDY

LOCATION: KEAMUKU SUBSTATION

BORING NO. S-6 Page No. 1 of 1
Type of Boring: HAND AUGER
Driller: W. LUM ASSOC.
Date: 11/16/82 Diam. 3"
Elev. ±2550'
Datum:
Field Party: LM, HEW

Rod: —
Sampler: — Split Spoon
— Thin Wall Tube
Hammer: — Weight — Drop
Auger: 3"
Bit: —

Water Level: NOT NOTED
Time:
Date: 11/16/82

Sampler	Time	Moisture Content	Sample No.	Sample Depth	Blows/ft/ Sampler	Sample Recovery	DEPTH IN FEET AND CHANGE	Soil Graph	DESCRIPTION - Soil type, firmness, sampler driving records, depth and driving of casing, depth drilling mud used, groundwater variations and times.
HAND	3:05	46	A	0.0 1.0	–	1	0		LOOSE TO MEDIUM, DARK BROWN SILTY FINE SAND. (ASH ORIGIN)
		43	B	1.0 2.0		1			SOFT TO MEDIUM, BROWN CLAYEY SILT. (ASH)
		31	C	2.0 3.0		1			
							5		END @ 3.0 11/16/82.
									1) ACROSS ROADWAY FROM KEAMUKU SUBSTATION.
									2) PICTURE TAKEN.
									3) Vegetation: grass.

Note: Show location of borings by sketch in space provided or on back of first sheet of each day's work.

8-470

Walter Lum Associates, Inc.
Civil Engineers

S-6

LOG OF BORING

PROJECT HELCO TRANSMISSION LINE ROUTING STUDY

LOCATION PUU OO RANCH MILE ~~25~~ 20.7

BORING NO. S-7 Page No. 1 of 1

Type of Boring HAND AUGER

Driller W. LUM ASSOC.

Date 11/17/82 Diam. 3"

Elev. ≈ 6200'

Datum

Field Party LM, HEW

Rod: –

Sampler: – Split Spoon

– Thin Wall Tube

Hammer: – Weight – Drop

Auger: 3"

Bit: –

Water Level	NOT NOTICED			
Time				
Date	11/17/82			

Sampler	Time	Moisture Content	Sample No.	Sample Depth	Blows/ft/ Sampler	Sample Recovery	DEPTH IN FEET AND CHANGE	Soil Graph	DESCRIPTION - Soil type, firmness, sampler driving records, depth and driving of casing, depth drilling mud used, groundwater variations and times.
HAND	12:00	85	A	0.0 0.5	–	1	0		MEDIUM STIFF DARK BROWN CLAYEY SILT W/SOME GRAVEL & ROOTS.
		28	B	0.5+		1			DARK BROWN SANDY GRAVEL.
							5		END @ 0.5+ 11/17/82
									1) NEAR MILE ~~25~~ 20.7 MARK (PUU OO RANCH)
									2) 2000 FT MAUKA OFF ROADWAY.
									3) PICTURE TAKEN.
									4) Vegetation: grass

Note: Show location of borings by sketch in space provided or on back of first sheet of each day's work.

Walter Lum Associates, Inc.
Civil Engineers S-7

8-470

LOG OF BORING

PROJECT: HELCO TRANSMISSION LINE ROUTING STUDY

LOCATION: MILE ~~9~~ 3.5 KAUMANA

BORING NO. G-8 Page No. 1 of 1

Type of Boring: HAND AUGER

Driller: W. LUM ASSOC.

Date: 11/17/82 Diam. 3"

Elev. ≈ 2060'

Datum:

Field Party: LM, HEW

Rod: —

Sampler: — Split Spoon; — Thin Wall Tube

Hammer: — Weight — Drop

Auger: 3"

Bit: —

Water Level	NOT NOTICED			
Time				
Date	11/17/82			

Sampler	Time	Moisture Content	Sample No.	Sample Depth	Blows/ft/ Sampler	Sample Recovery	DEPTH IN FEET AND CHANGE	Soil Graph	DESCRIPTION - Soil type, firmness, sampler driving records, depth and driving of casing, depth drilling mud used, groundwater variations and times.
HAND	1:45	167	A	0.0 1.0	-	1	0		SOFT, LIGHT BROWN CLAYEY SILT w/ TRACE OF SAND (ASH) (LOOSE SOIL CONDITION.)
		247	B	1.0 2.0	-	1			
		201	C	2.0 3.0	-	1			MEDIUM STIFF, TAN BROWN CLAYEY SILT w/ TRACE OF SAND. (ASH)
							5		END @ 3.0' 11/17/82.
									1) ~~9~~ 3.5 MILE MARK, NEAR KAUMANA SUBSTATION.
									2) 50 FT. OFF ROADWAY.
									3) PICTURE TAKEN.
									4) Vegetation: ohia forest.

Note: Show location of borings by sketch in space provided or on back of first sheet of each day's work.

8-470

Walter Lum Associates, Inc.
Civil Engineers G-8

HELCO TRANSMISSION LINE ROUTING STUDY

TABLE II A - SUMMARY OF LABORATORY TEST RESULTS

BORING NO.	S-1	S-2	S-2	S-3
SAMPLE NO.	A	A	C	A
DEPTH BELOW SURFACE	0.0 - 0.5'	0.25 - 0.75'	1.5 - 2.5	0.0 - 0.5
DESCRIPTION	DARK BROWN ORGANIC SILT W/ ROOTS & SOME GRAVEL	DARK BROWN SILTY SAND W/SOME ROOTS	BROWN & BLACK CINDER SAND	DARK BROWN SILTY FINE SAND
GRAIN-SIZE ANALYSIS				
(% Passing)				
Sieve				
1-1/2"		100.0	100.0	100.0
1"		100.0	100.0	100.0
1/2"		100.0	100.0	100.0
#4		99.5	99.1	99.1
#10		95.8	86.3	98.7
#20		84.0	53.0	97.7
#40		60.8	27.2	95.0
#100		31.4	10.7	71.5
#200		23.9	5.9	48.8
ATTERBERG LIMITS				
Air Dried or Natural	NATURAL			
Liquid Limit	215	NON-PLASTIC		NON-PLASTIC
Plastic Limit	99			
Plasticity Index	116			
Natural Water Content, %	116	23	19	16
Dilatancy	RAPID			
Toughness	MEDIUM STIFF			
Dry Strength	LOW TO MED.			LOW
UNIFIED SOIL CLASSIFICATION	OH	SM	SP-SM	SM
APPARENT SPECIFIC GRAVITY				
CBR TEST				
(Surcharge - 51 P.S.F.)				
Molding Moisture, %				
Molding Dry Density, P.C.F.				
Swell upon saturation, %				
CBR at 0.1" Penetration				
MOISTURE-DENSITY RELATIONS OF SOILS				
(ASTM D-1557-70, Method)				
Dry to Wet or Wet to Dry				
Max. Dry Density (P.C.F.)				
Optimum Moisture (%)				

REMARKS:

WALTER LUM ASSOCIATES, INC.
STRUCTURAL & SOIL ENGINEERS

Date 12-1-02 By CH

HELCO TRANSMISSION LINE ROUTING STUDY

TABLE II B - SUMMARY OF LABORATORY TEST RESULTS

BORING NO.	S-4	S-5	S-6	S-6
SAMPLE NO.	A	A	A	B
DEPTH BELOW SURFACE	0.0-1.0	0.0-1.0	0.0-1.0	1.0-2.0
DESCRIPTION	DARK BROWN SILTY FINE SAND	DARK BROWN CLAYEY SILT (ASH)	DARK BROWN SILTY FINE SAND	BROWN CLAYEY SILT (ASH)
GRAIN-SIZE ANALYSIS				
(% Passing)				
Sieve				
1-1/2"	100.0			
1"	100.0			
1/2"	100.0			
#4	100.0			
#10	99.8			
#20	99.1			
#40	96.2			
#100	53.2			
#200	30.4			
ATTERBERG LIMITS				
Air Dried or Natural		NATURAL		NATURAL
Liquid Limit	NON-PLASTIC	103	NON-PLASTIC	72
Plastic Limit		96		63
Plasticity Index		7		9
Natural Water Content, %	21	64	46	43
Dilatancy		RAPID		RAPID
Toughness		WEAK & SOFT		WEAK & SOFT
Dry Strength	LOW	LOW		MEDIUM
UNIFIED SOIL CLASSIFICATION	SM	MH	SM	MH
APPARENT SPECIFIC GRAVITY				
CBR TEST				
(Surcharge - 51 P.S.F.)				
Molding Moisture, %				
Molding Dry Density, P.C.F.				
Swell upon saturation, %				
CBR at 0.1" Penetration				
MOISTURE-DENSITY RELATIONS OF SOILS				
(ASTM D-1557-70, Method)				
Dry to Wet or Wet to Dry				
Max. Dry Density (P.C.F.)				
Optimum Moisture (%)				

REMARKS:

WALTER LUM ASSOCIATES, INC.
STRUCTURAL & SOIL ENGINEERS

Date 12-1-82 By CH

HELCO TRANSMISSION LINE ROUTING STUDY

TABLE II C - SUMMARY OF LABORATORY TEST RESULTS

BORING NO.	S-7	S-7	S-8	
SAMPLE NO.	A	B	B	
DEPTH BELOW SURFACE	0.0-0.5'	0.5'+	1.0-2.0'	
DESCRIPTION	DARK BROWN CLAYEY SILT W/SOME GRAVEL & ROOTS	DARK BROWN SANDY GRAVEL	LIGHT BROWN CLAYEY SILT W/TRACE OF SAND (ASH)	
GRAIN-SIZE ANALYSIS				
(% Passing)				
Sieve				
1-1/2"		100.0		
1"		73.9		
1/2"		58.1		
#4		46.1		
#10		35.3		
#20		25.1		
#40		18.2		
#100		9.4		
#200		5.5		
ATTERBERG LIMITS				
Air Dried or Natural	NATURAL		NATURAL	
Liquid Limit	200		323	
Plastic Limit	121		189	
Plasticity Index	79		134	
Natural Water Content, %	85	28	241	
Dilatancy	RAPID		RAPID	
Toughness	MEDIUM STIFF		MEDIUM STIFF	
Dry Strength	MEDIUM		MEDIUM	
UNIFIED SOIL CLASSIFICATION	MH	GP-GM	MH	
APPARENT SPECIFIC GRAVITY				
CBR TEST				
(Surcharge - 51 P.S.F.)				
Molding Moisture, %				
Molding Dry Density, P.C.F.				
Swell upon saturation, %				
CBR at 0.1" Penetration				
MOISTURE-DENSITY RELATIONS OF SOILS				
(ASTM D-1557-70, Method)				
Dry to Wet or Wet to Dry				
Max. Dry Density (P.C.F.)				
Optimum Moisture (%)				

REMARKS:

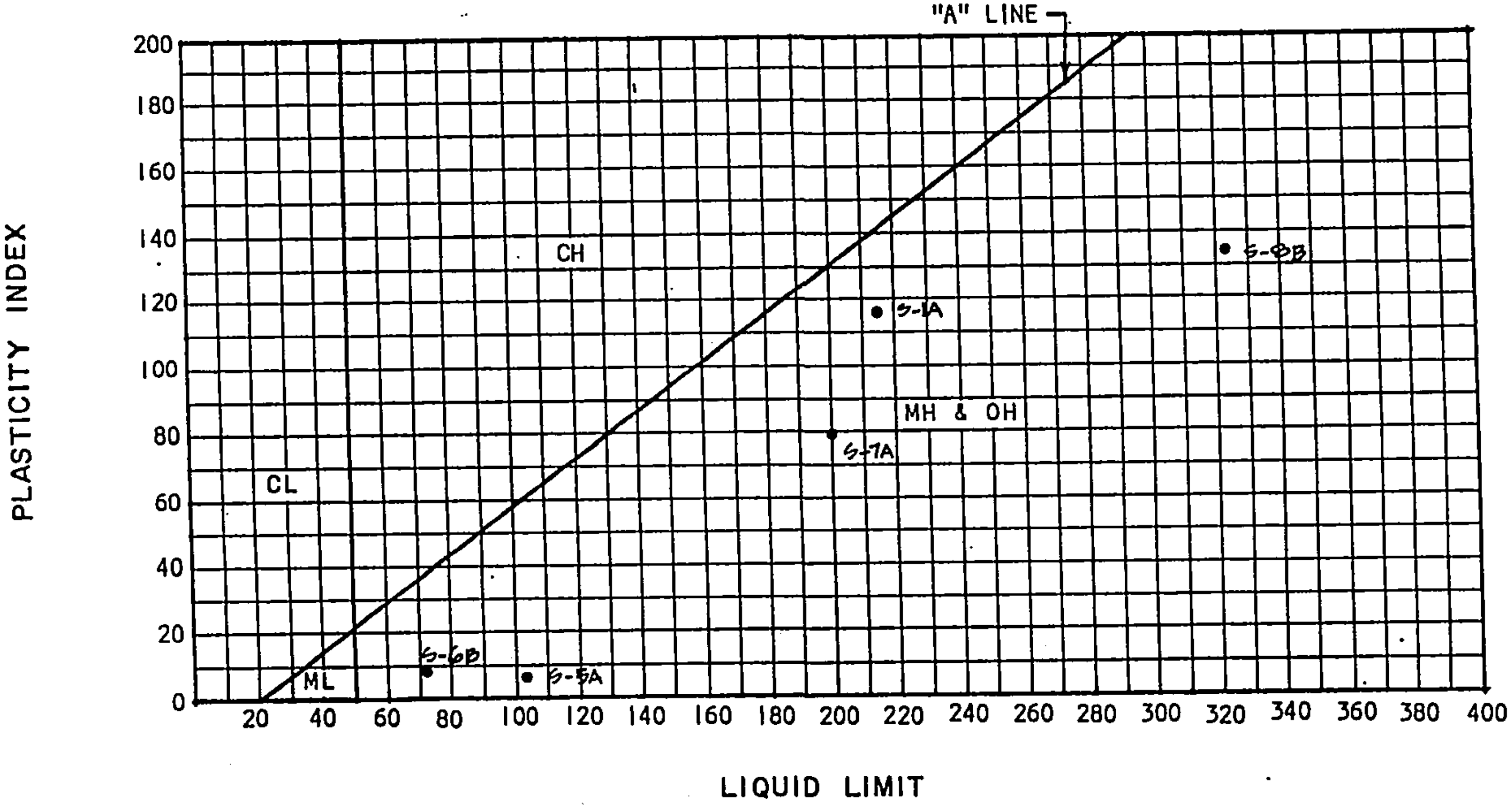
WALTER LUM ASSOCIATES, INC.

STRUCTURAL & SOIL ENGINEERS

Date 12-1-82 By CH

PLASTICITY CHART

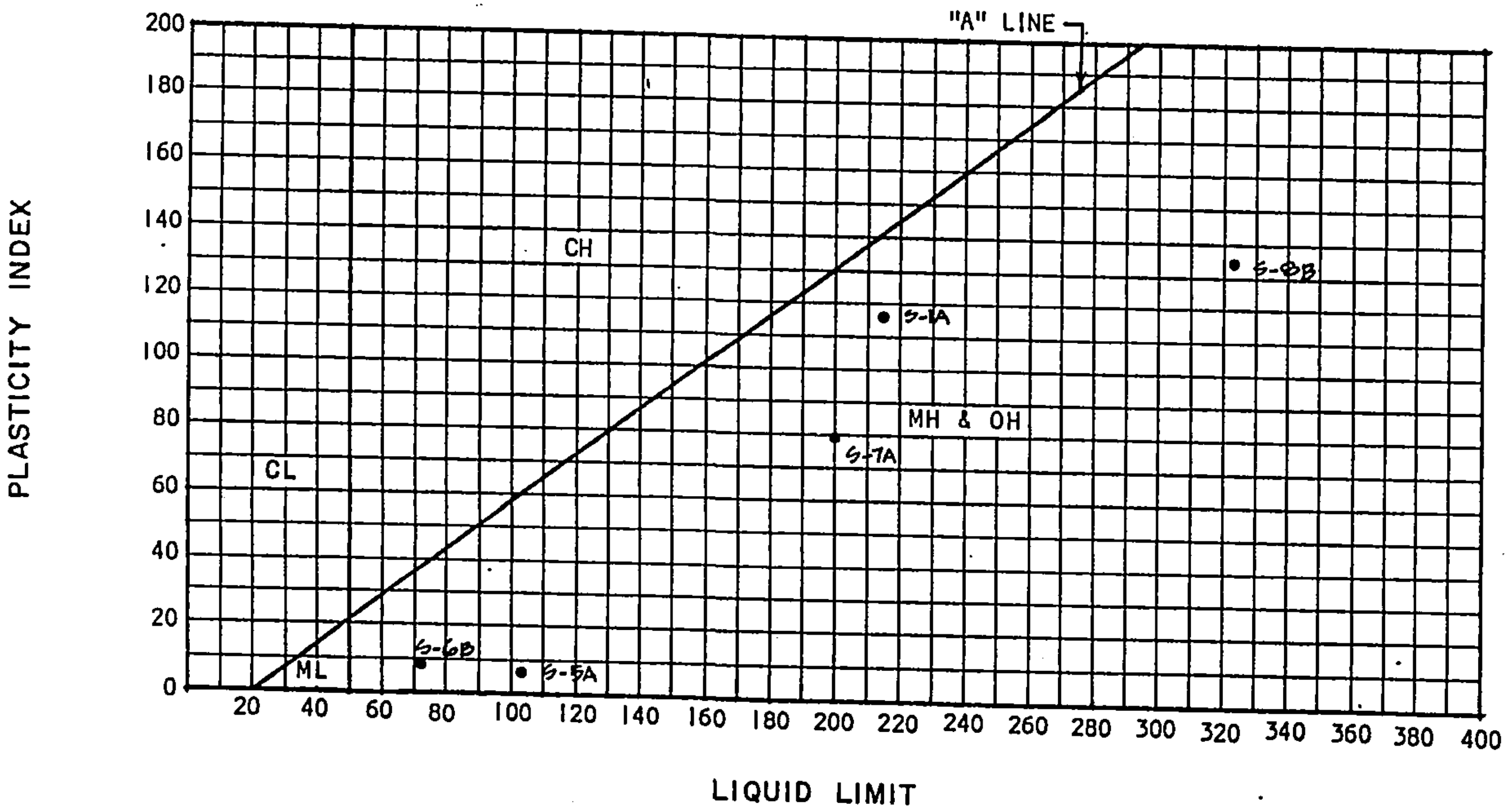
PROJECT: HELCO TRANSMISSION LINE ROUTING STUDY
LOCATION: SADDLE ROAD, HAWAII



DATE 12-1-82 BY CH

PLASTICITY CHART

PROJECT: HELCO TRANSMISSION LINE ROUTING STUDY
LOCATION: SADDLE ROAD, HAWAII

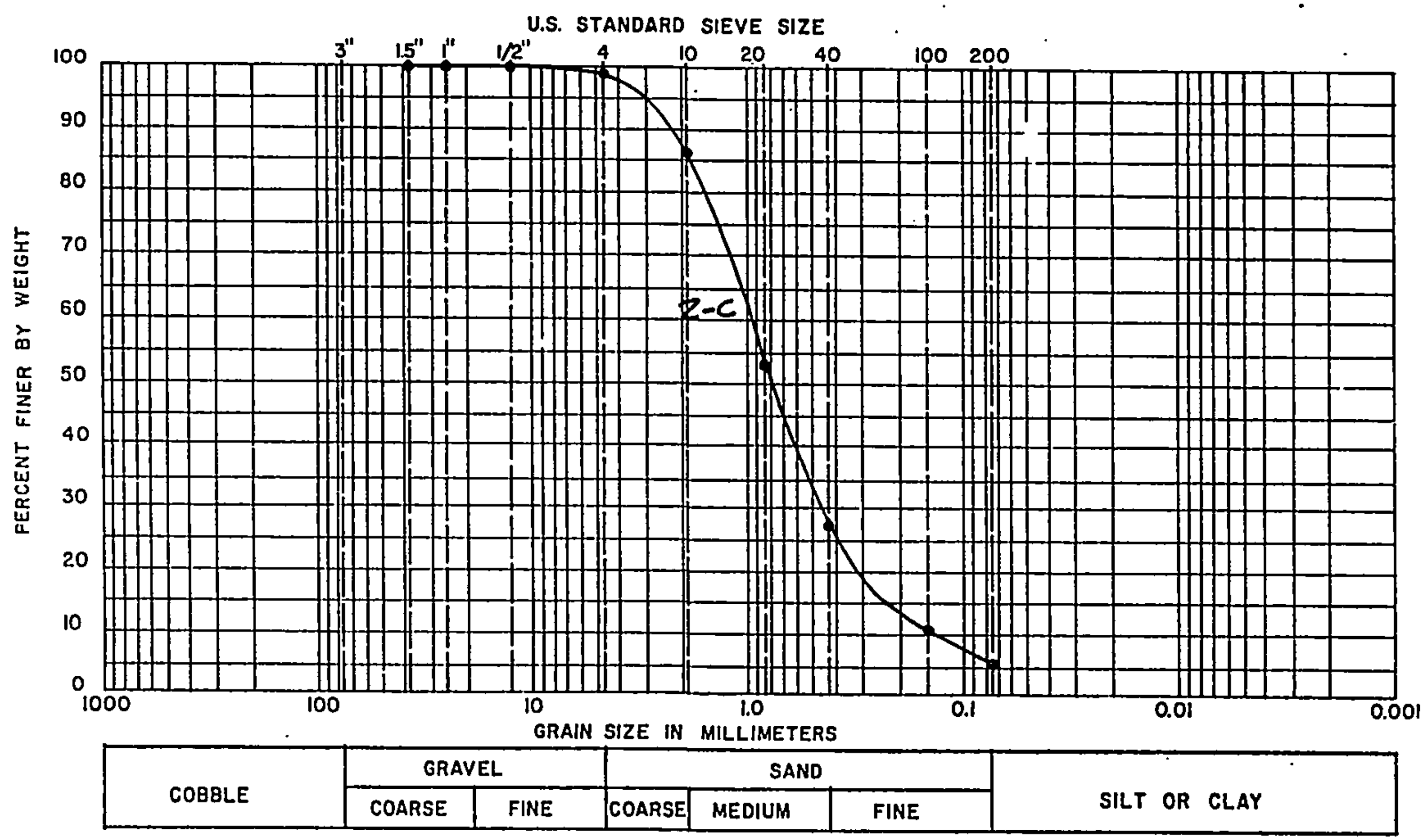


DATE 12-1-82 BY CH

GRAIN-SIZE ANALYSIS CURVE

PROJECT: HELCO TRANSMISSION LINE ROUTING STUDY

LOCATION: SADDLE ROAD, HAWAII

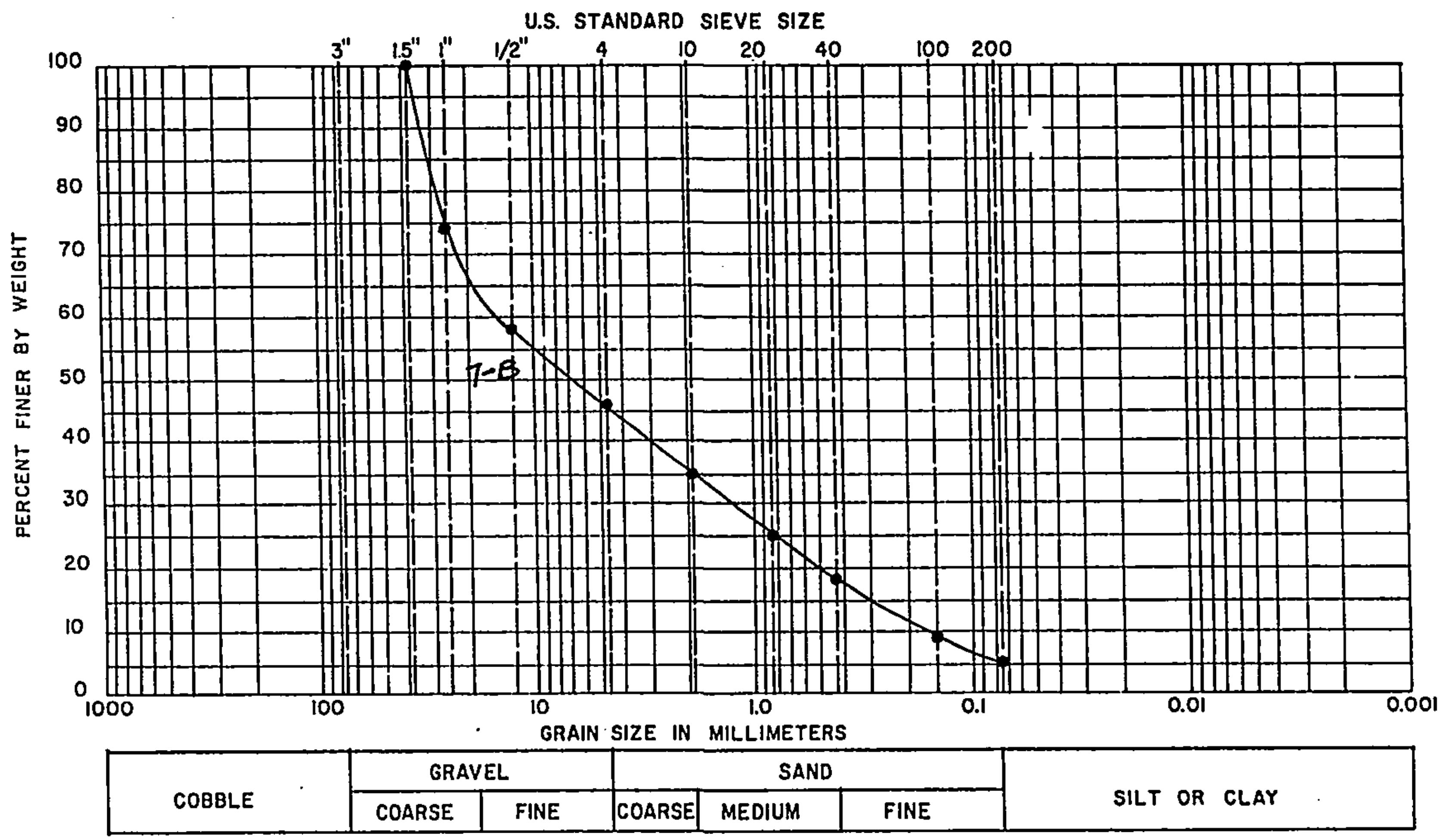


DATE 11-24-82 BY GS

GRAIN-SIZE ANALYSIS CURVE

PROJECT: HELCO TRANSMISSION LINE ROUTING STUDY

LOCATION: SADDLE ROAD, HAWAII



DATE 11-24-82 BY GS

13-570

SADDLE ROAD, HAWAII ISLAND: ARCHAEOLOGICAL RECONNAISSANCE

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FEBRUARY 1983

INTRODUCTION

During January, 1983, Chiniago Inc. conducted a literature search and archaeological reconnaissance survey of the rights-of way of the proposed preferred and alternate alignments of the HECO 138 KV line on the island of Hawaii. One section of the project area extends from Kaumana to Keamuku, and the other extends from near Puu Hinai at Waikoloa to Anaehoomalu.

LITERATURE SEARCH

The study of files at the State Historic Preservation Office revealed the presence of four historic sites in the vicinity of the rights-of-way, none of which are on either the National or State Registers of Historic Places. These are Site 50-10-32-7119 [Humuula Sheep Station] near the Humuula Saddle, 50-10-34-7427 [Miyamoto Store] and 50-10-34-7428 [Kaumana Hangwanji School-Church] at Kaumana, and 50-10-06-7158 [Parker Ranch District]. The Humuula Sheep Station is located north of the existing powerline, which at that point coincides with the preferred 138 KV alignment, and so is well away from any danger that might be posed by construction. The Miyamoto Store and the Kaumana Hangwanji School-Church are also well away from the preferred alignment and are in no danger. Although the Parker Ranch District includes the entire area of the ranch, its historical value is restricted primarily to particular buildings and not to the ground itself. Any concerns that might be raised by the powerline project would be limited to the buildings at Waikii, which are well out of the way of the preferred route.

FIELD RECONNAISSANCE

The lack of precise location data for the rights-of-way and the distances involved [approximately 55 miles for the primary route and 54 miles for the alternates] precluded an intensive inspection of their entire lengths. Rather, the field procedure consisted of detailed on-foot inspection of those areas perceived on the basis of terrain features and already known cultural features to be the most likely locations of archaeological remains. These areas were as follows:

1. A distance of about eight miles in the Puu Oo USGS map section, from approximately 4,000 feet east of the boundary between the districts of North and South Hilo to the hill called Omaokoili near the boundary between the districts of North Hilo and Hamakua. It was felt that there was little possibility of archaeological sites being found in the region to the east of this section both because of the recent age of the lava flows [A.D. 1855 and 1881] and the extremely rough nature of the older terrain.

2. A distance of about six miles from the Pohakuloa Ranger Station to Puu Koko. This section was chosen for detailed study because it lies immediately at the base of Mauna Kea, and thus could have been a logical stopping place for people on their way from the coast to the well-known prehistoric adze quarries at the summit.

3. A distance of one mile to the east of the Keamuku sub-station was chosen so as to sample the open meadowlands of Parker Ranch.

4. The seaward portion of the Puu Hinai to Anaehoomalu section, a distance of about two miles, was chosen because of the presence of known sites in the vicinity.

The only site located during the fieldwork was a cave on the Anaehoomalu to Puu Hinai section which was recorded in 1972 by Bishop Museum and designated as Site 50-Ha-E2-16. This half-mile long lava tube, which had apparently been used as a refuge in prehistoric times, is situated one mile inland of the Anaehoomalu sub-station and approximately 300 feet north of the existing powerline. The site, which is of extremely high significance, is not endangered because new powerline construction is to take place on the opposite [south] side of the existing powerline.

CONCLUSION

The largely negative results of the field survey should not be considered as definitive, but rather only as suggesting a strong probability that significant archaeological or historical sites are absent from the proposed right-of-way of the powerline. In order to accurately ascertain the impact of the powerline construction on such sites it will be necessary for an archaeologist to inspect the exact proposed pole sites as well as any construction areas or other areas to be disturbed as direct or indirect results of powerline installation. Although the presence of significant sites is not anticipated, the remote possibility that minor adjustments might have to be made in the location of individual powerline poles should be kept in mind. Finally, it should be noted that potential disturbance to significant sites would be greatly minimized if the powerline installation were to be done by helicopter.

SITE #	SITE NAME	SIGNIFICANCE	ENDANGERED?
7119	Humuula Sheep Station	Valuable	NO
7427	Miyamoto Store	Marginal	NO
7428	Hangwanji School-Church	Marginal	NO
7158	Parker Ranch District	Valuable	NO
E2-16	Waikoloa Refuge Cave	Valuable	NO

SUMMARY OF SITES IN VICINITY OF PROPOSED 138KV POWERLINE

TABLE 1. Index to sampling site numbers, their vegetation classification, elevation and pole line reference marker (PLRM) (see maps).

SITE #	MAP	EIA DRAFT TEXT PAGE	VEGETATION CLASSIFICATION*	MAP ELEVATION (ME) (in feet)	POLE LINE REFERENCE MARKER (PLRM)
1	7.5**	13	c2Me,nt(M:ns)	5500	1000′ NNW of 56
2	7.5	13	(M:ns-xx)pio	5600	1500′ NNE of midpt. 57 & 58
3	7.5	4	[o3Me,2nt(W:xs:mf)]	1050	0
4	7.5	4	[o2Me,2nt(W:mf,xs,tf)]	1320	4
5	7.5	5	o3Ac-Me,2nt(W:mf-ns-xs,tf)	2000	just E of 10
6	7.5	5	o2Me(M:ns)pio	1980	just E of 10
7	7.5	5	o3Me,Ac-2nt(W:mf-ns,tf)	2160	just N of midpt. 10 & 11
8	7.5	6	o3Me,Ac-2nt(W:mf-ns,tf)	2230	just SW of 12
9	AP+	11	(3Me,2nt(W:tf,ns)	4800	1/3 dist. betw. 47 & 48
10	E++	15	[s1My-So(D:mg-ns,xx)]	6400	1500 NNE midpt. 65 & 66
11	E	15	[s1My-Ep(D:ns-mg)]	5100	ca. 2 mi SSE of 70
12	7.5	7	c3Ac-Me,2nt(W:tf,ns)	2340	just S of 13
13	7.5	7	o2Me(M:ns)pio	2380	just W of 13
14	7.5	8	o3Me,Ac-2nt(W:mf-ns,tf)	2500-2540	just N of 15
15	AP	8	o3Me,Ac-2nt(W:mf-ns,tf)	2920	just SW of 21
16	AP	9	o2Me(M:ns)pio	2880	just E of 21
17	AP	9	o3Me,Ac-2nt(W:mf-ns,tf)	3000	midpt. 21 & 22
18a	AP	9	o3Me,2nt(W:ns)sng	3460	just NW of 25
18b	AP	9	o3Me,2nt(W:ns)sng	3660	1/4 mi NE of 26
19	AP	10	o2Me(M:ns)pio	4180	just NNE of midpt. 32 & 33
20	AP	10	o2Me(M:ns,ng)	4200	1000′ E of 34
21	AP	10	o3Me,2nt(W:mf,ns,tf)sng	4240	1000′ E, 600′ N of 34
22	AP	11	c3Me,2nt(M:ns)	4460	750′ NNE of 37
23	E	14	o2My-So(D:mg,ns)	6360	transect N from 62, 2/3 dist. to 63
24	AP	12	c3Me,2nt(M:ns)	4900	just E of 51
25a	E	18	[s2xt(D:(mg)]	1100	1/3 mi SSE of 72
25b	E	18	[s2xt(D:xg,xs)]	1100	2/3 mi SSE of 72
25c	E	19	[s2xt,1vsnt(D:xg,xs,ns)]	1050	1.6 mi SSE of 72
25d	E	19	[(D:xx,ns-ng)]	400	2 mi makai of 73
25e	E	19	[s2xt(D:mg)]	300	1.5 mi makai of 73
26a	E	16	[(D:ns-mg-xs)]	3600	2.5 mi W of 70
26b	E	17	[(D:xg)]	4600	4 mi NNW of 70
26c	E	18	[(D:xg)]	3640	4.8 mi SE of 71
26d	E	18	[s2xt(D:xg,ns)]	3000	2.3 mi SSE of 71
26e	E	17	[vs1Ep(D:ns-mg)]	3600	4.6 mi S of 71
26f	E	17	[vs1Ep(D:ns-mg)]	3820	5.6 mi WNW of 70
26g	E	17	[o2nt(D:ns-xg-xs)]	3840	5.5 mi NNW of 70

* Bracketed sites [] have not yet been mapped by Jacobi; description provided is based on field survey and generalized to Jacobi's mapping notation (see Appendix A).

** Orthophotoquad map series (7.5′)

\+ Aerial photomap, scale is 1" = 300′

++ EDAW maps of Sections 1-7

TABLE 2. Summary of vegetation classification units from, and in addition to, U.S. Fish and Wildlife maps that occur within proposed 138KV powerline corridor.*

Me**	Ac**	Other**
c2Me,nt(M:ns)++	o3Me,Ac-2nt(W:mf-ns,tf)+++++	c3xt(M:mf-ns-xs)
o2Me(M:ns)pio++++	s3Ac-Me-2nt(W:mf-ns)	s3xt(W:xg)
c3Me,2nt(M:ns)++	o3Ac-Me,2nt(W:mf-ns-xs,tf)+	(W:mg)
o3Me,2nt(W:ns)sng++	c3Ac-Me,2nt(W:tf,ns)+	(M:ns-xx)pio+
c2Me,nt(M:ns)	c3Ac-Me,2nt(M:ns)	c2My,So(D:mg,ns)
c3Me,2nt(W:tf,ns)!9+	o3Ac-Me-2nt(M:xg)	(D:xx)
o3Me,2nt(W:tf,ns)sng	s3Ac-Me-2nt(M:xg)	vs2My-So(D:ng-xx)
s1Me(M:ns-xx)pio	vs3Ac-2nt(D:xg)	o1My-So(D:mg,ns)
s2Me-nt(W:mg-ns)	o3Ac-Me,2nt(M:xg)	o2My-So(D:mg,ns)+
c3Me,2nt(W:ns-tf)	o3Ac-Me,2nt(M:ns-xg)	[s1My-So(D:mg-ns,xx)]+
s2Me(D:mg-ns)	c3Ac-Me,2nt(M:ns-xg)	[s1My-Ep(D:ns-mg)]+
o2Me(D:mg-ns)	vs3Ac-2nt(D:xg)	[(D:ns-mg-xs)]+
vs2Me(D:mg,ns)	vs2Ac-nt(D:xg,ns)	[(D:xg)]++
c2Me,nt(M:ns)	vs2Ac-So(D:xg)	[s2xt(D:xg,xs)]+
o2Me,nt(M:mg-ns)		[s2xt1vsnt(D:xg,xs,ns]+
s3Me-2nt(W:tf,ns)sng		[(D:xx,ns-ng)]+
o2Me(M:ns,ng)!20		[s2xt(D:mg)]+
[o3Me,2nt(W:xs,mf)]		[vs1Ep(D:ns-mg)]++
[o3Me(W:mf-ns,xs,tf)]		
[o3Me,2nt(W:mf,ns,tf)sng]!21+		
[o2Me,2nt(W:mf,xs,tf)]+		

* See Appendix A for key to vegetation types.

** Dominant or codominant species.

+ No. of +'s indicate number of times a vegetational unit was encountered at field study sites.

! Vegetation classification given for our indicated site no. is a more precise description of vegetation than that provided by U.S. Fish and Wildlife Service map by J. Jacobi.

[] Bracketed sites have not yet been mapped by Jacobi; description provided is based on field survey and generalized to Jacobi's mapping notation.

Sites joined by indicated lines are very similar.

Table 3. Reference list of terrestrial mollusk species recorded from pole line corridor.

Pole Line Sequence Number	Site Number	*Tornatellides* sp. A	*Tornatellides* sp. B	*Tornatellides* sp. C	*Tornatellides* sp. D	*Elasmias* sp.	*Auriculella westerlundiana* (Ancey, 1889)	*Nesopupa anceyana* Cooke and Pilsbry, 1920	*Columella* sp.	*Punctum* sp.	*Succinea* sp. A	*Succinea* sp. B	*Succinea* sp. C	*Striatura meniscus* (Ancey, 1904)	Zonitidae (unidentified)	*Oxychilus alliarius* (Miller, 1822)	*Deroceras laeve* (Müller, 1774)	*Limax maximus* Linne, 1758	*Meghimatium bilineatum* (Benson, 1842)	# Native Species	# Species of Uncertain Status	# Exotic Species
		Native Species													Status Uncertain	Exotic Species						
1	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	0	0
2	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	---N/A---		
3	5	-	-	X	-	X	X	-	-	-	X	-	-	-	-	X	-	-	X	4	0	2
4	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	---N/A---		
5	7	-	-	-	-	X	-	-	-	-	X	-	X	-	-	X	-	-	-	3	0	1
6	8	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	1	0	0
7	12	-	-	-	-	X	-	-	-	-	X	-	-	-	-	-	-	-	-	2	0	0
8	13	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	0	0
9	14	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	1	0	0
10	15	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	1	0	0
11	16	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	---N/A---		
12	17	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	---N/A---		
13	18	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	---N/A---		
14	19	-	X	-	-	-	-	-	-	-	-	-	X	-	-	X	X	-	-	0	0	1
15	20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-	2	0	2
16	21	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	0	1
17	22	-	-	-	-	-	-	-	-	-	-	X	-	-	-	X	-	X	-	---N/A---		
18	9	-	-	-	-	-	-	-	-	-	-	-	X	-	-	X	-	-	-	1	0	2
19	24	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	0	1
20	1	X	-	-	-	-	-	X	X	X	-	-	-	X	-	X	-	-	-	0	0	0
21	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5	0	1
22	23	-	-	-	X	-	-	-	-	-	-	X	-	X	X	-	-	-	-	---N/A---		
23	10	-	-	-	-	-	-	-	-	-	-	X	-	-	X	-	-	-	-	3	1	0
24	11	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	1	1	0
25a	25a	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	1	0
25c	25c	-	-	-	-	-	-	-	-	-	-	X	-	-	X	-	-	-	-	0	0	0
																				1	1	0

APPENDIX A

THE VEGETATION OF THE HAWAIIAN ISLANDS
Part I: Preliminary Legend for the Vegetation Maps

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and

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April 27, 1982

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INTRODUCTION

The vegetation mapping program described here was developed jointly through the Hawai'i Forest Bird Survey, (U.S. Fish and Wildlife Service), and the 'Ohi'a Forest Study, (University of Hawai'i, Dept. of Botany). The initial reason for undertaking this program was to provide a series of updated vegetation maps to be used as a basis for detailed ecological studies by these two research programs.

The Hawai'i Forest Bird Survey, under the direction of J. Michael Scott, is seeking to determine the current distribution and status of the native forest birds and their habitats on all of the major Hawaiian Islands, with emphasis on the rare species (Scott 1978, Scott et al. 1981).

The 'Ohi'a Forest Study, working out of the Department of Botany, University of Hawai'i, directed by Dieter Mueller-Dombois, is focusing on the dynamics of the upland rain forests on the windward side of the island of Hawai'i, with particular emphasis on the phenomenon known as 'ohi'a dieback (Mueller-Dombois 1980).

We expect that these maps will also be utilized by other research and resource management programs which deal with the native Hawaiian ecosystems. Therefore we felt it necesary at this time to make available a limited number of pre-publication working maps for interested agencies to review and use.

We would very much appreciate receiving any comments or suggestions on the accuracy or utility of the map sheets. All necessary corrections will be incorporated into the maps before final publication.

AREAS TO BE MAPPED

Eventually, through the efforts of the Hawai'i Forest Bird Survey, map sheets will be prepared for all the areas covered with natural vegetation on most of the Islands. Initial focus in this project has been on the island of Hawai'i, for which vegetation overlays are being produced for at least portions of approximately 50 of the 74 U.S. Geological Survey (USGS) 7.5 minute quad maps (Fig. 1).

The first vegetation map to come out of this program covers the Ka'u Forest Reserve and adjacent lands on the southeastern portion of the island of Hawai'i (Jacobi 1978). This map was published at the scale of 1:48,000 and has information overlaying portions of nine quad map sheets, compiled onto a single sheet.

It is expected that draft copies of all the maps for the island of Hawai'i, at a scale of 1:24,000 will be available in 1982. At that time mapping emphasis will be shifted to the islands of Lana'i, Moloka'i, Maui, and Kaua'i

MAPPING PROCEDURES

The distribution of the different vegetation types recognized is intitally interpreted on aerial photographs using a mirror stereoscope with 3 and 6x magnification. Primary mapping is done on 1:45,000 black and white imagery taken by the USGS in 1977. A set of 1:12,000 color photographs taken in 1972, and a color infra-red series of photographs (1:55,000) taken by NASA in 1975 are also reffered to during the mapping.

The preliminary map units are verified on the ground along transects established by the U.S. Fish and Wildlife Service through each study area, and in detailed vegetation plots sampled by the 'Ohi'a Forest Study. Finally, time is spent on aerial reconnaissance of each area with a fixed-wing aircraft or helicopter.

The corrected map unit boundaries are then compiled onto 1:24,000 quad maps using a Kern PG-2 stereoplotter. Final registry of the mapped units is made to orthophoto quad maps at the same scale, prepared by the USGS and the State of Hawai'i Department of Land and Natural Resources.

DESCRIPTION OF THE VEGETATION TYPE SYMBOLS

Six different types of information can be coded for each vegetation type symbol: 1) tree canopy crown cover, 2) tree canopy height, 3) dominant tree species composition, 4) species association type (5) dominant understory species composition 6) other information pertinent to the map unit (Table 1).

The information for each symbol is presented with a consistent format: information referring to the tree component is always listed first; species association type and understory composition are given next, enclosed in parentheses and separated by a colon; and finally, a symbol element for other information relating to the unit may be coded after the parentheses (Fig. 2). For treeless vegetation types, the symbol elements referring to crown cover, height and species composition are omitted.

Tree canopy crown cover. Crown cover is defined as the vertical projection of a tree's foliage on the ground, expressed as a fraction of a reference area. This defintion assumes a relatively homogeneous distribution of the foliage within the crown without taking into account either crown thickness or foliage layering.

Four canopy classes are recognized on the maps: closed or open canopy, and scattered or very scattered trees. The definition of closed canopy here (>60%) coincides with Mueller-Dombois and Fosberg's (1974) closed forest unit. This cover class can be easily recognized in the field or on aerial photographs as most of the tree crowns in the area are interlocking.

The cover class for an open tree canopy is 25-60% cover. This category generally corresponds to the traditional definition of a woodland (Mueller-Dombois and Ellenberg 1974).

For tree cover less then 25%, two categories are recognized: scattered trees (5-25% cover) and very scattered (<5% cover).

Tree canopy height. Tree height is divided into three classes, low scrub trees, which are 2-5m tall; scrub trees, 5-10m tall; and tall trees, greater than 10m tall.

Tree species composition. Species name abbreviations for all tree species comprising greater than 25% of the total crown cover are listed in the map symbol. If a species does not attain this cover limit, it may be combined with other tree species and listed with a tree species association symbol (xt or nt). Introduced tree species are always indicated by the "xt" symbol, regardless of their canopy cover.

In most of the symbols more than one tree symbol element is coded, separated either by a dash or a comma. A dash indicates a co-dominance of the adjacent species name symbols, while a comma means that the species name or association coded first is dominant over the second coded element.

Also, for symbols with more than one tree element, a tree height symbol may be coded for each element if they are in different tree layers, or only coded for the first element if all the other symbol elements are in the same layer.

Species association type is used to indicate the species composition for any coded native tree or understory plant association symbol. For example, the native shrub association symbol (ns) in a dry area (D:) is dominated by species such as *Vaccinium reticulatum*, *Dodonaea viscosa*, and *Styphelia tameiameiae*. In a mesic area (M:) the same association symbol stands for a species composition dominated by *Rubus hawaiiensis*, *Vaccinium calycinum*, and *Dryopteris paleacea*. For a wet area (W:) dominance shifts to *Broussaisia arguta*, *Vaccinium calycinum*, *Cyrtandra* spp., *Clermontia* spp., etc.

Understory species composition is coded usually with species association symbols. In some cases a species name abbreviation is used if that species is truely a dominant component of the understory and is not obviously identified by the association symbol. If more than one symbol element is coded for the understory, they are separated by either a dash or a comma, again indicating either co-dominance or dominance of one element over the other. The bare ground symbol (xx) is coded if the understory vegetation covers less than 75% of the area.

Other information. Elements in this category may be used to provide additional information on a particular vegetation unit. This information may further define the characteristics of that unit, such as when the element "pio" is used indicating a pioneer or early seral stage, or to provide additional information on the condition of the unit: sng = numerous dead or dying trees present, bur = recently burned, and clr = recently cleared.

FINAL PRODUCTION OF THE VEGETATION MAPS

The final products of this project will be vegetation maps at two different scales: 1:24,000 and 1:100,000. The 1:24,000 maps will be essentially identical to the advance print copies which accompany this text. They will be printed with the vegetation units overlaying either the USGS 1:24,000 quad maps or orthophoto sheets.

The second set of maps will be produced by reducing the scale of the 1:24,000 vegetation overlays and printing them on USGS 1:100,000 metric contour maps. The map units boundaries on this map set will be the same as those on the 1:24,000 maps, however due to the scale reduction, map units less than 5 ha will not be resolvable. Additionally, the detailed vegetation units on this map will be grouped together into more general units and coded by a color overlay. These more general vegetation types will be based on both tree canopy crown cover, and dominant plant species composition. The 1:100,000 maps will be produced in 1982.

ACKNOWLEDGEMENTS

This project would not have been possible without the help and cooperation of many different individuals and agencies.

The development of the mapping strategy was aided by many useful suggestions from J.M. Scott, F.R. Warshauer, C. van Riper III, and T. Casey (U.S. Fish and Wildlife Service); D. Mueller-Dombois, K.W. Bridges, R. Cooray, N. Balakrishnan, L. Stemmermann (Dept. of Botany, Univ. Hawai'i); E. Petteys and M. Buck (State of Hawai'i, Department of Land and Natural Resources).

Field checking of the map units was conducted with the help of F.R. Warshauer, H. McEldowney, R. Schuster, L. Stemmermann, P. Higashino, C. Crivellone, G. Gerrish, R. Cooray, D. Mueller-Dombois, A. Holt, and N. Balakrishnan.

The preliminary map sheets were compiled and drafted by C. Crivellone, H. McEldowney, P. Higashino, and P. Ashman of the U.S. Fish and Wildlife Service. E. Wingert (Dept. of Geography, Univ. Hawai'i) was responsible for photographically compiling the different map overlays onto a single sheet for easier duplication.

I would also like to thank the staff at the Hawai'i Volcano Observatory (USGS) for the use of their compiling equipment (particularly the Kern PG-2) and aerial photographs. Additional equipment and photographs were made available for this project by the State of Hawai'i, Department of Land and Natural Resources.

Finally, I would like to thank the numerous landowners throughout the state for allowing access onto their lands to survey the vegetation and bird populations found there.

Primary financial support for this project was provided by the U.S. Fish and Wildlife Service (Patuxent Wildlife Research Center and Hawai'i Area Office); additional funds for the mapping program were made available to the 'Ohi'a Forest Study (Dept. of Botany, Univ. Hawai'i) through grants from the National Park Service and the National Science Foundation.

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DRAFT

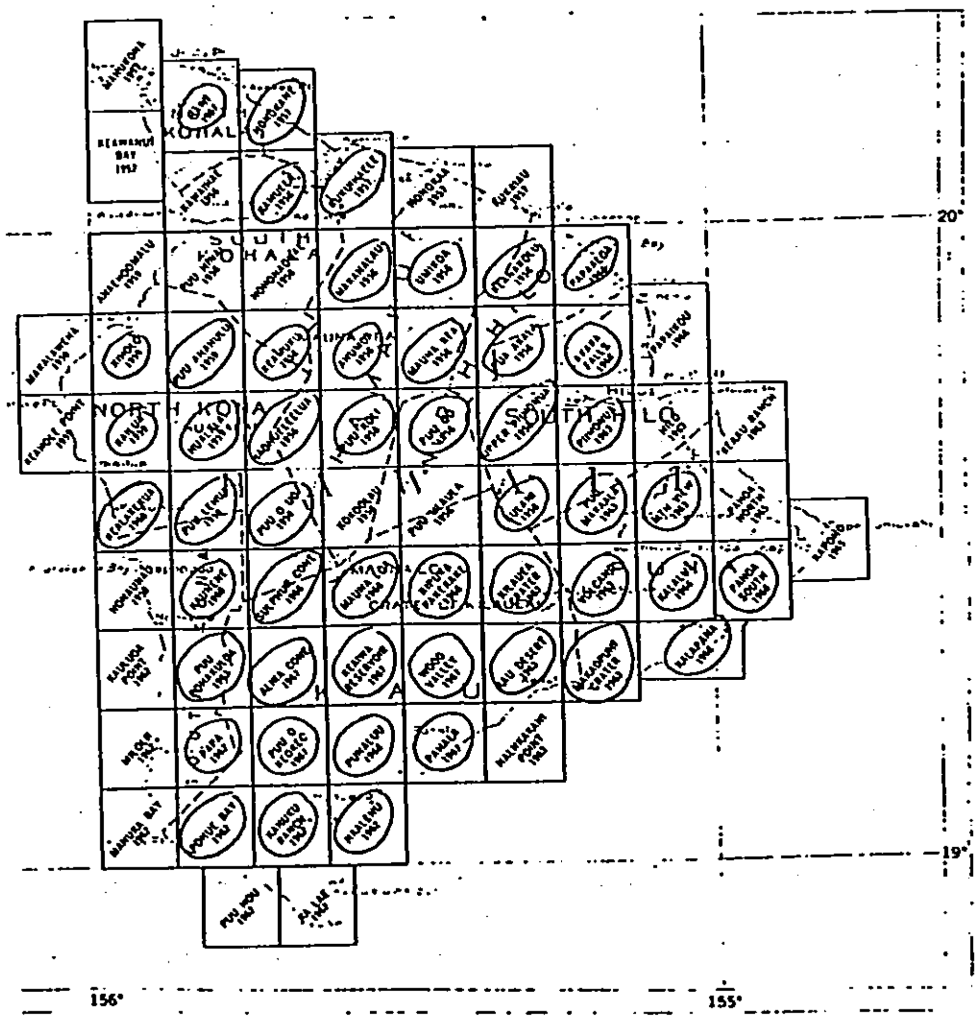

FIG. 1. Location of the USGS 7.5 min. quadrangle maps for the Island of Hawaii. Vegetation type overlays will be prepared for at least portions of the maps which have circles around their names.

KEY TO THE VEGETATION TYPE SYMBOLS USED FOR THE VEGETATION MAPS OF THE HAWAIIAN ISLANDS

```
1 2     3  4    5    6
\ |____/   |  __/_   /
 o3Me,2nt(W:tI,ns)sng
```

Figure 2. Example of a vegetation type symbol showing the format for the six symbol components.

TABLE 1. Elements which can be coded for each vegetation symbol component.

1. TREE CANOPY CROWN COVER

c = closed canopy, most crowns interlocking	>60% cover
o = open canopy, some or no interlocking crowns	25-60% cover
s = scattered trees	5-25% cover
vs = very scattered trees	<5% cover

2. TREE CANOPY HEIGHT

1 = low scrub trees, monopodial	2-5m tall
2 = scrub trees, moderate stature	5-10m tall
3 = tall stature trees	>10m tall

3. TREE SPECIES COMPOSITION

a) Species name or association abbreviations

Ac = Acacia koa (koa)
Ep = Euphorbia sp. ('akoko)
Me = Metrosideros collina ('ohia)
My = Myoporum sandwicensis (naio)
nt = native tree association
Psc = Psidium cattleianum (strawberry guava, waiawi)
Sh = Schinus terebinthifolius (Christmas berry)
So = Sophora chrysophylla (mamane)
xt = introduced tree association

b) Species dominance

Species composition:*	Relative Dominance:
A	only A present
A-B	A and B codominant
A,B	A dominant, B subdominant
A,B-C	A dominant, B and C subdominant
A-B,C	A and B codominant, C subdominant
A-B-C	A,B,C codominant

*Substitute the appropriate species name or association abbreviation for the letters A, B, or C.

4. SPECIES ASSOCIATION TYPE

D = Dry habitat species
M = Mesic habitat species
W = Wet habitat species

5. UNDERSTORY SPECIES COMPOSITION

a) Species name or association abbreviation (Note: Species name abbreviations for trees may also be used if the understory is dominated by individuals of that species, less than 2m tall).

bg = structured bog
Fg = Pennisetum setacium (Fountain grass)
mf= matted ferns, Dicranopteris spp., Hicriopteris sp., Sticherous sp.
mg = mixed native-introduced grasses, sedges, or rushes
ng = native grasses
ns = native shrubs
Pm = Passiflora mollisima (banana poka)
tf = treeferns, Cibotium spp. (hapu'u)
xg = introduced grasses, sedges or rushes
xs = introduced shrubs
xx = bare ground, (at least 25% of the area)

b) Species dominance (use same format as for tree species)

6. OTHER INFORMATION

bur = recently burned
clr = recently cleared or logged
pio = pioneer vegetation, seral stage on recent lava flow
sng = many standing dead or defoliated trees

APPENDIX B. Alphabetical List of Fern Species Observed or Collected at Sampling Sites 1-26. By W. Wagner

Species	Family
Adenophorus pinnatifidus Gaud.	Grammitaceae
A. tamariscinus (Kaulf.) Hook. & Grev.	"
A. tripinnatifidus Gaud.	"
*Adiantum hispidulum Sw.	Adiantaceae
*Angiopteris evecta (Forst.) Hoffm.	Angiopteridaceae
Asplenium adiantum-nigrum L.	Aspleniaceae
A. trichomanes L.	"
Cibotium chamissoi Kaulf.	Dicksoniaceae
C. glaucum (J. Sm.) Hook & Arn.	"
Coniogramme pilosa (Brack.) Hieron.	Hemionitidaceae
Cyclosorus interruptus (Willd.) H. Ito	Thelypteridaceae
Dicranopteris linearis (Burm.) Underw.	Gleicheniaceae
Diplazium sandwichianum (Presl) Diels	Athyriaceae
Doryopteris decipiens (Hook.) J. Sm.	Sinopteridaceae
Elaphoglossum crassifolium (Gaud.) Anderson & Crosby	Elaphoglossaceae
E. hirtum (Sw.) C. Chr.	"
E. wawrae (Luers.) C. Ch.	"
Grammitis hookeri (Brack.) Copeland	Grammitaceae
Lycopodium cernuum L.	Lycopodiaceae
L. phyllanthum Hook. & Arn.	"
L. venustulum Gaud.	"
Nephrolepis cordifolia (L.) Presl	Nephrolepidaceae
N. exaltata (L) Schott	"
Pellaea ternifolia (Cav.) Link	Sinopteridaceae
Pleopeltis thunbergiana Kaulf.	Polypodiaceae
Polypodium pellucidum Kaulf.	"
Psilotum complanatum Sw.	Psilotaceae
Pteridium aquilinum (L.) Kuhn var. decompositum (Gaud.) Tryon	Hypolepidaceae
Sadleria cyatheoides Kaulf.	Blechnaceae
S. pallida Hook. & Arn.	"
Sphaerocionium lanceolatum (Hook. & Arn.) Copeland	Hymenophyllaceae
S. obtusum (Hook. & Arn.) Copeland	"
Sphenomeris chinensis (L.) Maxon	Lindsaeaceae
Sticherus owhyhensis (Hook.) Ching	Gleicheniaceae
Xiphopteris saffordii (Maxon) Copeland	Grammitaceae

APPENDIX C. Alphabetical List of Flowering Plant Species Observed or Collected at Sampling Sites 1-26. by W. Wagner

Species	Family
Acacia koa A. Gray	Fabaceae
*Ageratum conyzoides L.	Asteraceae
Agrostis sandwicensis Hbd.	Poaceae
Alyxia olivaeformis Gaud.	Apocynaceae
*Andropogon glomeratus (Walt.) BSP	Poaceae
*A. virginicus L.	"
Antidesma platyphyllum Mann	Euphorbiaceaea
*Archontophoenix alexandrae (F.Muell.) H. Wendl. & Drude	Arecaceae
*Ardisia crispa (Thunb.) A. DC.	Myrsinaceae
Argemone glauca Pope	Papaveraceae
*Arundina bambusaefolia (Roxb.) Lindl.	Orchidaceae
Astelia menziesiana Sm.	Liliaceae
*Atriplex semibaccata R. Br.	Chenopodiaceae
*Axonopus affinis Chase	Poaceae
*Axonopus compressus (Sw.) Beauv.	"
*Bidens menziesii (A. Gray) Sherff var. filiformis Sherff	Asteraceae
*Bidens pilosa L. var. minor (Bl.) Sherff	"
*Borreria laevis (Lam.) Griseb.	Rubiaceae
*Brachiaria mutica (Forsk.) Stapf	Poaceae
*Brassica nigra (L.) Koch	Brassicaceae
*Bromus catharticus Vahl	Poaceae
Broussaisia arguta Gaud.	Hydrangaceae
Carex wahuensis C.A. Mey	Cyperaceae
*Cassia leschenaultiana DC.	Fabaceae
*Cenchrus ciliaris L.	Poaceae
Centaurea melitensis L.	Asteraceae
*Centaurium erythraea Raf.	Gentianaceae
*Chamaesyce hyssopifolia (L.) Small	Euphorbiaceae
C. olowaluana (Sherff) Croizat & Deg. var. gracilis (Rock) Deg. & Deg.	"
Cheirodendron trigynum (Gaud.) Heller	Araliaceae
*Chenopodium carinatum R. Br.	Chenopodiaceae
Chenopodium oahuense (Meyen) Aellen	"
*Cirsium vulgare (Savi) Tenore	Asteraceae
Clermontia montis-loa Rock	Lobeliaceae
C. parviflora Gaud. ex A. Gray	"
*Conyza bonariensis (L.) Cronq.	Asteraceae
Coprosma ernodeoides A. Gray	Rubiaceae
C. montana Hbd.	"
C. rhynchocarpa A. Gray	"
*Cuphea carthagenensis (Jacq.) Macbride	Lythraceae
Cyanea pilosa A. Gray	Lobeliaceae
*Cymbopogon refractus (R. Br.) A.Camus	Poaceae
*Cyperus brevifolius (Rottb.) Hassk.	Cyperaceae
*C. haspan L.	"
C. hypochlorus Hbd.	"
Cyrtandra paludosa Gaud.	Gesneriaceae
C. platyphylla A. Gray	"
*Dactylis glomerata L.	Poaceae
Deschampsia australis Nees ex Steud.	"
Diospyros ferrea (Willd.) Bakh.	Ebenaceae
Dodonaea sp. - difficult group	Sapindaceae
Dubautia arborea (A. Gray) Keck	Asteraceae
D. linearis Gaud.	"
D. scabra (DC.) Keck	"
*Emilia javanica (Burm.f.) C.B. Robins	Asteraceae
*Epilobium cinereum A. Rich.	Onagraceae
Eragrostis atropioides Hbd.	Poaceae
E. leptophylla Hitchc.	"
*E. tenella (L.) Beauv.	"
Erythrina sandwicensis Deg.	Fabaceae
*Eucalyptus spp. - no attempt was made to determine which of the numerous species of the genus were present; all are exotics.	Myrtaceae
Freycinetia arborea Gaud.	Pandanaceae
*Galinsoga parviflora Cav.	Asteraceae
*Geranium carolinianum L.	Geraniaceae
G. cuneatum Hook.	"
Gnaphalium hawaiiense Deg. & Sherff	Asteraceae
*G. japonicum Thunb.	"
G. sandwicensium Gaud.	"
Gouldia terminalis (Hook. & Ar.) Hbd.	Rubiaceae
*Hedychium gardnerianum Roscoe	Zingiberaceae
Hedyotis centranthoides (Hook. & Arn.) Steud.	Rubiaceae
*Hedyotis corymbosa (L.) Lam.	"
*Helichrysum foetidum (L.) Moench	Asteraceae
Heteropogon contortus (L.) Beauv. ex R. & S.	Poaceae
Heterotheca grandiflora Nutt.	Asteraceae
*Hyparrhenia rufa (Nees) Stapf.	Poaceae
*Hypochoeris radicata L.	Asteraceae
Ilex anomala Hook. & Arn.	Aquifoliaceae
*Indigofera suffruticosa Mill.	Fabaceae
*Juncus planifolius R. Br.	Juncaceae
Korthalsella cylindrica (v. Tiegh.) Engler	Loranthaceae
*Lepidiumm virginicum L.	Brassicaceae
*Leucaena leucocephala (Lam.) de Wit	Fabaceae
*Lindernia crustacea (L.) F. Muell.	Scrophulariaceae
Lipochaeta lavarum (Gaud.) DC.	Asteraceae
*Ludwigia octovalvis (Jacq.) Raven	Onagraceae
Luzula hawaiiensis Buch	Juncaceae
Machaerina angustifolia (Gaud.) Koyama	Cyperaceae
M. gahniaeformis (Gaud.) Kern	"
M. mariscoides (Gaud.) Kern subsp. meyenii (Kunth) Koyama	"
*Mangifera indica L.	Anacardiaceae
*Medicago lupulina L.	Fabaceae
*Melastoma melabathricum L.	Melastomataceae

LOG OF BORING

PROJECT: HELCO TRANSMISSION LINE ROUTING STUDY

LOCATION: 9 MILE MARK SADDLE ROAD

BORING NO. S-1 Page No. 1 of 1

Type of Boring: HAND

Driller:

Date: 11/15/82 Diam. 3"

Elev. ~ 3480'

Datum:

Field Party: LM, HEW

Rod: —

Sampler: — Split Spoon

— Thin Wall Tube

Hammer: — Weight — Drop

Auger: —

Bit: —

Water Level: NOT NOTICED

Time:

Date: 11/15/82

Sampler	Time	Moisture Content	Sample No.	Sample Depth	Blows/ft/ Sampler	Sample Recovery	DEPTH IN FEET AND CHANGE	Soil Graph	DESCRIPTION - Soil type, firmness, sampler driving records, depth and driving of casing, depth drilling mud used, groundwater variations and times.
HAND	—	116	A	0.0 0.5	—	1	0		SOFT, DARK BROWN ORGANIC SILT W/ ROOTS & SOME GRAVEL.
		24	B	0.5		1			PAHOEHOE (GRAVEL).
									END @ 0.5 11/15/82
							5		
									9 MILE MARK OFF SADDLE ROAD.
									1) ~~13.8~~ MI ~~FRONT SADDLE RD. INTER.~~
									2) 20 FT. FROM ROADWAY
									3) PICTURE TAKEN
									4) Vegetation - Ohia forest.

Note: Show location of borings by sketch in space provided or on back of first sheet of each day's work.

8-470

Walter Lum Associates, Inc.
Civil Engineers S-1

LOG OF BORING

PROJECT: HELCO TRANSMISSION LINE ROUTING STUDY

LOCATION: SHEEP STATION HUMUULA SHEEP STATION

BORING NO. S-2 Page No. 1 of 1
Type of Boring: HAND AUGER
Driller: W. LUM ASSOC.
Date: 11/16/82 Diam. 3"
Elev.: ≈ 6760
Datum:
Field Party: LAI, HEW
Water Level: NOT NOTICED
Time:
Date: 11/16/82

Rod: —
Sampler: — Split Spoon
— Thin Wall Tube
Hammer: — Weight — Drop
Auger: —
Bit: —

Sampler	Time	Moisture Content	Sample No.	Sample Depth	Blows/ft/ Sampler	Sample Recovery	DEPTH IN FEET AND CHANGE	Soil Graph	DESCRIPTION - Soil type, firmness, sampler driving records, depth and driving of casing, depth drilling mud used, groundwater variations and times.
HAND	9:15	23	A	0.25 0.75	-	1	0		LOOSE TO MEDIUM, DARK BROWN SILTY SAND W/ SOME ROOTS.
	-	11	B	0.75 1.5		1			MEDIUM DENSE, BROWN & BLACK CINDER SAND.
	-	19	C	1.5 2.5		1			
	-	20	D	2.5 3.0		1			MEDIUM STIFF, BROWN CLAYEY SILT W/ TRACE OF SAND (ASH)
	-	67	E	3.0 3.5		2	5		GRAVEL.
									END @ 3.5 11/16/82
									1) 1000' ABOVE SHEEP STATION ACROSS ROADWAY.
									2) ALONG SMALL ROAD CUT.
									3) PICTURE TAKEN.
									4) Vegetation: Bermuda grass.

Note: Show location of borings by sketch in space provided or on back of first sheet of each day's work.

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Civil Engineers S-2

8-470

LOG OF BORING

PROJECT: HELCO TRANSMISSION LINE ROUTING STUDY

LOCATION: ~~30~~ 34.3 MILE POHAKULOA

BORING NO. S-3 Page No. 1 of 1
Type of Boring: HAND AUGER
Driller: W. LUM ASSOC.
Date: 11/16/82 Diam. 3"
Elev. ≈ 5960'
Datum
Field Party: LM, HEW
Water Level: NOT NOTICED
Time
Date: 11/16/82

Rod: -
Sampler: - Split Spoon
- Thin Wall Tube
Hammer: - Weight - Drop
Auger: -
Bit: -

Sampler	Time	Moisture Content	Sample No.	Sample Depth	Blows/ft/ Sampler	Sample Recovery	DEPTH IN FEET AND CHANGE	Soil Graph	DESCRIPTION - Soil type, firmness, sampler driving records, depth and driving of casing, depth drilling mud used, groundwater variations and times.
HAND	11:15	16	A	0.0 0.5	-	1	0		LOOSE TO MED., DARK BROWN SILTY FINE SAND (ASH ORIGIN)
									MEDIUM, BROWN SANDY SILT W/ SOME GRAVEL.
		9	B	0.5 1.0	-	1			MEDIUM, BROWN SANDY SILT. (ASH)
		15	C	1.0 2.0		2			GRAVEL OR COBBLE, (NO RECOVERY)
							5		END @ 2.0' 11/16/82
									1) ~~30~~ 34.3 MILE MARK - POHAKULOA.
									2) 200' NORTH OFF ROADWAY.
									3) PICTURE TAKEN OF KTBSOIL
									4) Vegetation: sparse growth of grass.

Note: Show location of borings by sketch in space provided or on back of first sheet of each day's work.

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Civil Engineers S-3

3-470

LOG OF BORING

PROJECT: HELCO TRANSMISSION LINE ROUTING STUDY

LOCATION: KILOHANA ~~11~~ 40.5 MILE

BORING NO. S-4 Page No. 1 of 1

Type of Boring: HAND AUGER

Driller: W. LUM ASSOC.

Date: 11/16/82 Diam. 3"

Elev.: ≈ 5640'

Datum:

Field Party: LM, HEW

Water Level: NOT NOTICED

Time:

Date: 11/16/82

Rod: –

Sampler: – Split Spoon; – Thin Wall Tube

Hammer: – Weight – Drop

Auger: 3"

Bit: –

Sampler	Time	Moisture Content	Sample No.	Sample Depth	Blows/ft/ Sampler	Sample Recovery	DEPTH IN FEET AND CHANGE	Soil Graph	DESCRIPTION – Soil type, firmness, sampler driving records, depth and driving of casing, depth drilling mud used, groundwater variations and times.
HAND	12:15	21	A	0.0 1.0	–	1	0		LOOSE TO MED., DARK BROWN SILTY FINE SAND. (ASH ORIGIN)
	–	20	B	1.0 2.0	–	1			
	–	21	C	2.0 3.0	–	1			SOFT TO MEDIUM, LIGHT BROWN SANDY SILT. (ASH)
							5		END @ 3.0' 11/16/82
									1) NEAR KILOHANA GIRL SCOUT CAMP.
									2) 100' FROM ROADWAY.
									3) PICTURE TAKEN.
									4) Vegetation : Grass.

Note: Show location of borings by sketch in space provided or on back of first sheet of each day's work.

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8-470

*Melinus minutiflora Beauv.	Poaceae
*Melochia umbellata (Houtt.) Stapf.	Sterculiaceae
*Merremia aegyptia (L.) Urban	Convolvulaceae
*Metrosideros polymorpha Gaud. subsp. incana (H. Lev.) Skottsb.	Myrtaceae
Metrosideros polymorpha Gaud. subsp. macrophylla	"
*Mollugo pentaphylla L.	Aizoaceae
Momordica charantia L.	Cucurbitaceae
Myoporium sandwicense A.Gray	Myoporacea
Myrsine lanaiensis Hbd.	Myrsinaceae
M. lessertiana A. DC.	"
M. sandwicensis A. DC.	"
*Oenothera stricta Ledeb. ex Link subsp. stricta	Onagraceae
*Olea europaea L.	Oleaceae
*Opuntia megacantha Salm-Dyck	Cactaceae
Oreobolus furcatus Mann	Cyperaceae
Osteomeles anthyllidifolia Lindl.	Rosaceae
*Oxalis corniculata L.	Oxalidaceae
Panicum hillebrandianum Hitchc.	Poaceae
P. tenuifolium Hook. & Arn.	"
*Paspalum conjugatum Berg	"
P. orbiculare Forst. f.	"
*P. urvillei Steud.	"
Pelea clusiaefolia A. Gray	Rutaceae
*Pennisetim clandestinum Hochst. ex. Chiov.	Poaceae
*P. setaceum (Forsk.) Chiov.	"
Peperomia spp. - at least three species were collected, but they are difficult to determine. No attempt was made, during the short time allotted for this project, to make determinations.	Piperaceae
Perrottetia sandwicensis A. Gray var. sandwicensis	Celastraceae
*Picris hieracioides L.	Asteraceae
*Plantago lanceolata L.	Plantaginaceae
*Pluchea odorata (L.) Cass.	Asteraceae
*Polycarpon tetraphyllum (L.) L.	Caryphyllaceae
*Polygala paniculata L.	Polygalaceae
Portulaca cyanosperma Egler.	Portulacaceae
Pritchardia beccariana Rock	Arecaceae
*Prosopis pallida (Humb. & Bonpl. ex Willd.) H.B.K.	Fabaceae
*Psidium cattleianum Sabine	Myrtaceae
*P. guajava L.	"
Psychotria hawaiiensis (A. Gray) Fosb.	Rubiaceae
Rhus sandwicensis A. Gray	Anacardiaceae
Rhychospora spicaeformis Hbd.	Cyperaceae
*Rhynchelytrum repens (Willd.) C.E. Hubb	Poaceae
Rhynchospora lavarum Gaud.	Cyperaceae
*Ricinus communis L.	Euphorbiaceae
Rubus hawaiiensis A. Gray	Rosaceae

*Rubus rosaefolius Sm.	Rosaceae
*Saccharum officinarum L.	Poaceae
*Sacciolepis indica (L.) Chase	"
Santalum sp.	Santalaceae
Scaevola gaudichaudi Hook. & Arn.	Goodeniaceae
Sicyos hillebrandi St. John	Cucurbitaceae
Sida fallax Walp.	Malvaceae
Smilax sandwicensis Kunth	Smilacaceae
Solanum pseudocapsium L.	Solanaceae
*S. nigrum L.	"
Sophora chrysophylla (Salisb.) Seem.	Fabaceae
*Stachytarpheta jamaicensis (L.) Vahl	Verbenaceae
Stenogyne calminthoides A. Gray	Lamiaceae
S. microphylla Benth. - This species is listed as a category 1 taxon currently under review (Federal Register 45(202): 82539.1980)	"
S. rugosa Benth.	"
*Stipa cernua Stebbins & Love	Poaceae
Styphelia tameiameiae (Cham.) F. Muell.	Epacridaceae
*Tagetes minuta L.	Asteraceae
Tetraplasandra meiandra (Hbd.) Harms	Araliaceae
*Tibouchina herbacea Cogn.	Melastomataceae
Trisetum glomeratum (Kunth) Trin	Poaceae
Vaccinium calycinum Sm.	Ericaceae
V. pahalae Skottsb.	"
V. reticulatum Sm.	"
*Verbascum thapsus L.	Scrophulariaceae
*Verbena litoralis H.B.K.	Verbenaceae
*Veronica arvensis L.	Scrophulariaceae
*Wahlenbergia gracilis Schrad.	Campanulaceae
Watheria indica L.	Sterculiaceae
Wikstroemia sp. (taxonomically a very poorly understood group, thus making specific identification virtually impossible).	Thymeliaceae

TABLE I-A. SOIL TYPES AND THE ESTIMATED PHYSICAL PROPERTIES*

Soil Name	Mapping Unit	Depth to Rock (ft)	Permeability In./hr.	Soil Erodibility (k)	Soil Erosion Rating
Soils on East Slope (Mauna Loa Slope)					
Kahaluu extremely rocky muck	rKAD	0 - 1	6.3 - 20	0.05	Slight
Keaukaha extremely rocky muck	rKFD	0 - 1	6.3 - 20	0.05	Slight
Keei extremely rocky muck	rKGD	0 - 1	6.3 - 20	0.05	Slight
Kekake extremely rocky muck	rKHD	0 - 1	6.3 - 20	0.05	Slight
Kiloa extremely stony muck	rKXD	0 - 1	6.3 - 20	0.05	Slight
Lalaau extremely stony muck	rLLD	0 - 1	6.3 - 20	0.05	Slight
Mawae extremely stony muck	rMWD	0 - 1	6.3 - 20	0.05	Slight
Lava Flow (Both East and West Slopes)					
Pahoehoe	rLW	0		0	None
Aa	rLV	0		0	None

* Information extracted from Reference Nos. 4 and 6.

TABLE I-B. SOIL TYPES AND THE ESTIMATED PHYSICAL PROPERTIES*

Soils on West Slope (Mauna Kea Slope)

Soil Name	Mapping Unit	Depth to Rock (ft)	Permeability in./hr.	Soil Erodibility (k)	Soil Erosion Rating
Kaimu extremely stony peat	rKED	0 - 1	6.3 - 20	0.05	Slight
Kawaihae extremely stony very fine sandy loam	KNC	1-1/2 - 3-1/2	0.63 - 2.0	0.28	Moderate
Keekee loamy sand	KTB	3-1/2 - 8	6.3 - 20	0.10	Moderate to severe**
Kilohana loamy fine sand	KZD	4 - 8	6.3 - 20	0.10	Slight
Laumaia extremely stony silt loam	LUC	3 - 6	2.0 - 6.3	0.17	Slight
Puu Pa extremely stony very fine sandy loam	PVD	1-1/2 - 5	2.0 - 6.3	0.17	Moderate
Rock land	rRO	-	-	0.10	Slight
Very stony land	rVS	-	-	0.05	Slight
Waikoloa very fine sandy loam	WLC	1-1/2 - 6	0.63 - 6.3	0.17	Moderate
Waimea very fine sandy loam	WMC	2-1/2 - 5	2.0 - 6.3	0.17	Moderate

* Information extracted from Reference Nos. 4 and 6.

** Keekee loamy sand (KTB) located around Pohakuloa is subject to moderate to severe wind erosion.

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INTRODUCTION

The Bishop Museum was contracted by EDAW, Inc. to do a portion of the biological survey for the proposed trans-island 138 KV transmission line from the Kaumana Substation to the Keamuku Substation and from the Waikoloa Substation to the Anaeho'omalu Substation on the Island of Hawai'i. The proposed corridor totals approximately 60 transmission line miles. The survey team spent the period 15-21 November in the field. A total of 44 person-days were expended of which 23 person-days were devoted to entomological survey, 25 person-days for botanical survey and 6 person-days to malacological survey. The team consisted of 4 entomologists (W.C. Gagne, F.G. Howarth, G. A. Samuelson and G.M. Nishida), 2 botanists (F.R. Warshauer and W.L. Wagner), and 1 malacologist (C.C. Christensen).

The botanical, entomological, and malacological surveys were conducted simultaneously for the most part, for two reasons. First, since the members have a basic familiarity with all three disciplines, a team approach directly benefited the survey by including additional pairs of eyes for each discipline. Also, all members benefited from each other's background knowledge and acumen to share the task of surveying such a vast area in so brief a time.

Secondly, we believe that it is essential to have an integrated assessment of the biota in order to recommend the least destructive possible powerline alignment through use of an overall habitat approach, or that alignment which produces the minimum destruction or potential destruction to the native habitats along the proposed route. These native habitats include sites of residency for native species including those that are endangered, rare, or restricted to certain habitats.

Three of the team members (entomologists Gagne and Howarth, and botanist Warshauer) made a one-hour helicopter reconnaissance of much of that portion of the proposed corridor from the Kaumana Substation to a point approximately halfway between Pu'u Ke'eke'e and the Keamuku Substation. This flight helped the team to pinpoint areas within that sector for more detailed ground survey. Approximately 37 sites were field checked on the ground and that portion between Pu'u Ke'eke'e and the Keamuku Substation, as well as the area along the preferred Waikoloa to Anaeho'omalu corridor, were driven and spot-checked from four-wheel drive vehicle. These sampling sites are described in detail below.

The time constraints make it necessary to express caveats with regard to the thoroughness of our survey. For example, not all plant or animal species are present (or at least observable) throughout the year. Many are seasonal, and portions of the proposed corridor on the Kona side of the island experience prolonged droughts. Our survey was conducted near the end of the dry season when many sought-for species were inactive and not observable. Also, we were led to believe that the preferred routing of the transmission line from Pu'u Huluhulu to Mauna Kea State Park was adjacent to the Saddle Road. Thus, a portion of the Critical Habitat of the Palila (*Psittirostra bailleui*) (Section 4 of Critical Habitat) did not benefit from a ground survey. We strongly recommend a ground survey of this section prior to a final decision on poleline placement through this area (see also note under Sampling Site 23).

Our recommendations on transmission line routing are based on our best estimates of the native biological resources pertaining during that one week long November period. The survey focussed upon three areas that are considered to have the highest biotic sensitivity because of the existence of high quality or unperturbed native ecosystems in comparatively pristine conditions or the presence, or possible presence, of endangered plant and animal species. These are: (1) kipukas along the Saddle Road between the Kaumana Substation and Pu'u Huluhulu which contain relatively pristine native ecosystems, (2) areas in and adjacent to the Critical Habitat of the Palila on the northern boundary of the Pohakuloa Training Area and (3) the area between Pu'u Ke'e Ke'e and the Keamuku Substation where officially listed endangered plants such as *Haplostachys haplostachya* (A. Gray) St. John might occur. These sensitive areas have been delineated in detail below in order to show how to best avoid perturbing them.

SAMPLING METHODS AND TECHNIQUES

Flowering plant species and ferns were sampled and identified by field reconnaissance except for difficult or unknown species. In those situations specimens were collected and pressed for later identification and permanent storage in the Bishop Museum Herbarium. Bryophytes, fungi, and some other plant groups were not sampled for lack of available expertise among the field team on these. Nomenclature for the plant species follows H. St. John's *List of flowering plants in Hawaii* (1973). For plant species not listed in St. John, as well as a few exceptional situations, the names were supplied by D. Herbst (U.S. Fish and Wildlife Service, Honolulu). Dr. Charles Lamoureux of the University of Hawaii provided determination of fern collections as well as nomenclature for all the species of ferns.

Specialized traps or baits were not widely utilized to collect insects. However, a Malaise trap (a specially designed tent-like device to intercept flying and balooning arthropods) and a mercury vapour light (to attract night-flying insects) were positioned in and adjacent to a couple of kipukas along the Saddle Road. These were used to check the richness and endemicity of certain of the arthropod community in that area. The entomologists relied heavily on sweep sampling of vegetation with insect nets, and to a lesser extent observations of insects. Common and scientific names of certain insects are found in

Hawaiian Entomological Society (1979), otherwise the Insects of Hawaii series (Zimmerman 1948-present) is the authority.

Terrestrial mollusks were sampled by means of hand-picking of individuals observed during field survey and by laboratory analysis of dried leaf litter (necessary to record micro-mollusks not likely to be observed by the field party).

For terrestrial mollusks, identification is to generic level only in most cases, due to the unsettled state of nomenclature of Hawaiian land snails. Identifications were made with the aid of published sources and the collection of the Division of Malacology, Bishop Museum.

Some lava tubes which intercepted the preferred transmission alignment were visually inspected using headlamps in the twilight and dark zones of these. The entomological team then also watched for materials, or indications, of possible archaeological significance. Lava tubes can and do harbor native ecosystems of great scientific interest (Howarth 1972) and, if not avoided, are a potential hazard to heavy equipment and their operators. Since such lava tubes are easily degraded by "pot hunters" and "glory holers" when they become known to the general public, (Howarth & Stone, 1982) their precise locations are kept in confidence.

SURVEY RESULTS

Data Arrangement

At each of the 37 sites which were field checked, we provide a description of the vegetation following the methodology developed by J. Jacobi (U.S. Fish and Wildlife Service) and his co-workers, followed by lists of plant species encountered at each site. Notes then follow on the entomology and malacology for sites where unusual diversity or other special circumstances were observed.

The arrangement and discussion of the field sites correspond to arbitrary reference markers placed on the maps; they are referred to as poleline reference markers (PLRM). Often a study site was located at some distance from the biologically preferred poleline route and thus the PLRM's. In these situations the distance and cardinal direction from the nearest PLRM is given.

The enumeration of the biological survey field sites was roughly chronological. All Bishop Museum survey biologists used the same field survey site numbers to more easily integrate their data. Such numbering follows no otherwise orderly arrangement as the sites were surveyed as personnel, vehicles, schedules, equipment and weather permitted. An alphabetical index to plant species is provided at the end of the report followed by a table listing terrestrial mollusks recorded at each site.

Sampling Site Descriptions

The arrangement of description of sample sites is as follows: (1) Pole Line Reference Marker (PLRM), followed by the Sampling Site number, followed by the location with Map elevation (Me) in feet and meters, followed by the vegetation classification from Jacobi's map, or as mapped by us; (2) Vegetation and Flora (note: an asterisk (*) before a plant name indicates that it is an exotic species); (3) Entomology (where pertinent); (4) Malacology (where pertinent), and (5) other biologically pertinent notes and remarks.

PLRM: 0, SAMPLING SITE 3. LOCATION: Vicinity of the Kaumana substation, south of housing subdivision; map elevation 1050 ft. (320 m). Vegetation not mapped by Jacobi, but mapped by us (using the Jacobi system, see Appendix A) as: o3Me,2nt(W:xs,mf).

VEGETATION & FLORA: The substrate is the 1881 pahoehoe lava flow with adjacent pockets of deep ash soil with remnants of sugarcane cultivation. It is a disturbed ohia (Metrosideros polymorpha subsp. incana) forest. The forest was relatively open with some pockets of closed canopy. Tree height was up to 12 m. The understory consisted of *Melastoma malabathricum, two species of guava (*Psidium cattleianum and *P. guajava), *Melochia umbellata, *Mangifera indica, *Archontophoenix alexandrae, Rhus sandwicensis, *Andropogon glomeratus, *A. virginicus, *Brachiaria mutica, *Paspalum conjugatum, *Melinus minutiflorus, *Saccharum officinarum, Machaerina angustifolia, Dicranopteris linearis, Lycopodium cernuum, *Nephrolepis exaltata, *Borreria laevis, *Polygala paniculata, *Cuphea carthagenensis, *Cyperus brevifolius, *Lindernia crustacea, *Hedyotis corymbosa.

This site had a high proportion of exotic weedy species, especially notable is the very aggressive guava. The site, however, does have a number of native taxa present.

PLRM: 4, SAMPLING SITE 4. LOCATION: West of the end of Wilder Rd. in Kaumana; map elevation 1320 ft (402 m). Vegetation not mapped by Jacobi, but mapped by us as: o2Me,2nt(W:mf,xs,tf).

VEGETATION & FLORA: Disturbed open ohia forest 6-12 m in height with a dense understory of uluhe (Dicranopteris linearis) forming a virtually continuous mat 1 to 2 m high. Few exotic species such as *Melastoma malabathricum, *Stachytarpheta jamaicensis, *Psidium cattleianum and *P. guajava were present. A number of native species were present in the largely undisturbed site including Ilex anomala, Tetraplasandra meiandra, Freycinetia arborea, Cibotium chamissoi and Elaphoglossum crassifolium. A bulldozed road through a portion of the area contained exotic species similar to those at sampling site 3.

PLRM: Just E. of 10, SAMPLING SITE 5. LOCATION: Kipuka west of first fork in Flume Rd.; map elevation 2000 ft. (610 m).

Mapped by Jacobi as o3Ac-Me,2nt (W:mf-ns-xs,tf).

VEGETATION & FLORA: This older pahoehoe kipuka is dominated by a closed canopy of koa (Acacia koa) and ohia (Metrosideros) trees both up to 16 m tall or more and 70 cm dbh. An open to closed understory of native trees and shrubs such as Psychotria hawaiiensis, Coprosma sp., C. rhynchocarpa, Antidesma platyphyllum, Broussaisia arguta, Clermontia parviflora, Perrottetia sandwicensis and the exotic species *Psidium cattleianum, *Ardisia crispa, and *Rubus rosaefolius. Other native species include Freycinetia arborea, Nephrolepis exaltata, Smilax sandiwicensis, Cibotium chamissoi, C. glaucum, Adenophorus tripinnatifidus, A. pinnatifidus, A. tamaricinus, Lycopodium phyllanthus, and Dicranopteris linearis.

This kipuka appears to have been disturbed in the past, but no recent disturbances were observed. Exotic species were less common toward the interior of the kipuka.

ENTOMOLOGY: Good arthropod habitats and many native spp. were seen. Native crickets Paratrigonidium were singing.

MALACOLOGY: This site supported the second-richest native snail fauna encountered during this survey: four species were found crawling on vegetation, including Auriculella westerlundiana (found only at this site), an unidentified species of Succinea, and one species each of Elasmias and Tornatellides. Two exotic species, the "garlic snail" (Oxychilus alliarius) and the slug Meghimatium bilineatum, were also present.

PLRM: Just E. of 10, SAMPLING SITE 6. LOCATION: Lava flow at first fork in Flume Rd. makai of site 5; map elevation 2000 ft (610 m). Vegetation mapped by Jacobi as o2Me(M:ns)pio.

VEGETATION & FLORA: The vegetation is an open-canopied pioneer community dominated by ohia scrub 1 to 6 m high. Other species include Machaerina angustifolia, Dicranopteris linearis, Lycopodium cernuum, Vaccinium reticulatum, Wikstroemia sp. and the exotics *Arundina bambusaefolia and *Hyparrhenia rufa. This site is relatively undisturbed except near the road.

PLRM: just N. of midpoint between 10-11, SAMPLING SITE 7. LOCATION: Kipuka north of Saddle Rd. above last Kaumana water tank; Map elevation 2160 ft (660 m). Vegetation mapped by Jacobi as o3Me,Ac-2nt(W:mf-ns,tf).

VEGETATION & FLORA: This pahoehoe substrate kipuka has a perimeter of closed canopy ohia-koa forest with the core of the kipuka dominated by an open canopied and highly disturbed ohia-koa forest.

The closed outer portion is closed canopy ohia-koa forest to 15 m plus with an open canopied secondary tree layer. Tree ferns, Cibotium spp. ground ferns, exotic shrubs, native shrubs, exotic grasses, native herbs and native vines are also present.

No recent disturbance was observed and leaf litter (rather than exposed soil or mud) is present on the forest floor. The relatively sparse ground layer however, approximately 70% exposed, indicates prior disturbance.

The open central part of the kipuka is vegetated by large diameter ohia and koa trees to 16 m plus tall. The native understory is scattered, with the ground being covered primarily with exotic weedy species including *Andropogon virginicus and *Tibouchina herbacea. As with the outer portion of the kipuka, no recent pig disturbance was seen but the low species diversity and presence of weedy exotic species indicates such past disturbances.

Outer portion flora. Native species: Metrosideros polymorpha subsp. macrophylla, Acacia koa, Pelea clusiaefolia, Coprosma rhynchocarpa, Ilex anomala, Psychotria hawaiiensis, Myrsine sandwicensis, Antidesma platyphyllum, Cheirodendron trigynum, Gouldia terminalis, Broussaisia arguta, Vaccinium calycinum, Wikstroemia sp., Clermontia parvifolia, Hedyotis centranthoides, Cibotium chamissoi, C. glaucum, Adenophorus tamariscinus, A. pinnatifidus, A. tripinnatifidus, Sadleria pallida, Sphaerocionium lanceolatum, S. obtusum, Grammitis hookeri, G. sp., Dicranopteris linearis, Elaphoglossum hirtum, E. crassifolium, Psilotum complanatum, Lycopodium cernuum, L. phyllanthum, Astelia menziesiana, Peperomia (2 species), Cyrtandra paludosa, Alyxia olivaeformis, Stenogyne calminthoides, Freycinetia arborea, Smilax sandwicensis, Machaerina mariscoides, and M. angustifolia. Exotic species: *Hedychium gardenerianum, *Rubus rosaefolius, *Tibouchina herbacea, *Psidium cattleianium, *Ardisia crispa, *Axonopus compressus and *Angiopteris erecta.

Disturbed inner portion flora includes: native species: Metrosideros polymorpha subsp. macrophylla, Acacia koa, and Freycinetia arborea. Exotic species: *Archontophoenix alexandrae, *Tibouchina herbacea, *Andropogon virginicus, *Sacciolepis indica, *Cyperus haspan, *Axonopus compressus, *Paspalum conjugatum, and *P. orbiculare.

MALACOLOGY: Three native land snail species (Elasmias sp. and two species of Succinea) were found on leaves of trees and shrubs.

PLRM: Just SW of 12, SAMPLING SITE 8, LOCATION: Kipuka 4.7 mi east along Saddle Rd. from junction with rd. to Piihonua in Kaumana; map elevation 2230 ft (680 m). Vegetation mapped by Jacobi as o3Me,Ac-2nt(W:mf-ns,tf).

VEGETATION & FLORA: This kipuka is similar to Sampling Site 7, though not as disturbed in the interior. The open canopied koa-ohia forest is about 16 m tall with the koa up to 45 cm dbh and the ohia to 30 cm dbh. Of interest in this kipuka are several individuals of Pritchardia sp., a native palm. The subcanopy is comprised largely of native trees, shrubs and uluhe (Dicranopteris). While exotic grasses occur in patches in this kipuka, they do not dominate as they do in the central portion of the kipuka designated as sampling Sampling Site 7.

Although no recent pig activity was observed, it presumably was an influence in the past.

PLRM: Just S. of 13, SAMPLING SITE 12, LOCATION: Small kipuka ("K-2300") with deep soil north of Saddle Rd., 5.1 mi above jct. with rd. to Piihonua in Kaumana; map elevation 2340 ft (714 m). Vegetation mapped by Jacobi as c3Ac-Me,2nt(W:tf,ns).

VEGETATION & FLORA: The tall canopy is composed of Acacia koa (koa) and Metrosideros polymorpha (ohia). The medium height subcanopy and understory consists primarily of Ilex anomala, Coprosma rhynchocarpa, Antidesma platyphyllum, Psychotria hawaiiensis var. hawaiiensis, P. h. var. hillebrandii, Clermontia parviflora, Pipturus sp., Cibotium glaucum, C. chamissoi, Freycinetia arborea and some *Psidium cattleianum, especially toward the kipuka margin. The ground cover includes Broussaisia arguta, Peperomia spp., Diplazium sandwichianum, Elaphoglossum crassifolium, *Rubus rosaefolius, Nephrolepis cordifolia, *Paspalum conjugatum, and *Tibouchina herbacea. This site was somewhat disturbed. This same community type at other locations generally contains fewer exotics and more native species.

ENTOMOLOGY: Native plants in this kipuka had the usual complement of plant feeding insects (eg. Nesophrosyne leaf hoppers on Psychotria, Clermontia and Ilex, Orthotylus sp. on Clermontia, Nesiomiris hawaiiensis Kirkaldy on Ilex) indicating a healthy assemblage of native plant-associated insects. These host plants were also reproducing. There was, however, indications of (?) illegal tree fern harvesting in these and certain other kipukas which were closely adjacent to the Saddle Road. Many species of of native arthropods are dependent on tree ferns for food and/or shelter, and are in turn food sources for other species of arthropods, birds, etc. This is kipuka "K-2300" of the Drosophila Project and therefore important scientifically also.

PLRM: Just west of 13, SAMPLING SITE 13, LOCATION: Adjacent to site 12, 100-200 mi West along dirt road. Vegetation mapped by Jacobi as o2Me(M:ns)pio.

VEGETATION & FLORA: This site has a fairly early successional ohia scrub on pahoehoe at the 1855 lava flow. Low and a few medium stature Metrosideros were found in small stands emergent above a low scrub of Machaerina angustifolia, Hedyotis centranthoides, small Metrosideros, Sadleria cyatheoides, Vaccinium reticulatum, Rhynchospora lavarum, Lycopodium cernuum, Dicranopteris linearis, and an occasional Clermontia parviflora. Near the roads and pole lines exotics were occasional to common including *Sacciolepis indica, *Axonopus affinis, *Cyperus haspan, *Melastoma malabathricum, *Tibouchina herbacea and abundant *Andropogon virginicus and *Arundina bambusaefolia. Feral pig damage is minimal near the Saddle Road and adjoining

roads.

PLRM: Just north of 15, SAMPLING SITE 14, LOCATION: Kipuka west of "Kipuka 2300" just north of Saddle Road; map elevation 2500-2540 ft (763-774 m). Vegetation mapped by Jacobi as o3Me,Ac-2nt(W:mf-ns,tf).

VEGETATION & FLORA: The tall canopy is open and of Acacia koa and Metrosideros polymorpha. An understory contains some of the canopy trees and mostly medium to low statured trees and tall shrubs, including Cheirodendron trigynum, Pelea clusiaefolia, Coprosma sp., Myrsine lessertiana, Antidesma platyphyllum, Psychotria hawaiiensis var. hawaiiensis, Pelea sp., Cibotium glaucum, Cibotium chamissoi, Gouldia terminalis var. terminalis and Freycinetia arborea. Smaller shrubs include Clermontia parviflora, Hedyotis centranthoides, Broussaisia arguta, Vaccinium calycinum, Alyxia olivaeformis, Smilax sandwicensis, Scaevola gaudichaudiana, Myrsine sandwicensis, and a few *Tibouchina herbacea. The ground cover is dominated by matted ferns, mostly Dicranopteris linearis and a bit of Sticherus owhyhensis. Also included are *Paspalum conjugatum, Cyclosorus interruptus, Machaerina mariscoides subsp. meyenii, Elaphoglossum crassifolium, Lycopodium cernuum, *Sacciolepsis indica, *Ludwigia octovalvis, *Cyperus sp., Machaerina angustifolia, *Andropogon virginicus, Astelia menziesiana (mostly as an epiphyte), Stenogyne calaminthoides, *Paspalum urvillei. There has been some (?) illegal tree fern harvesting here.

This basic community is found in numerous kipuka of the "Saddle" region, although it differs spatially in regard to canopy closure and relative dominance of Acacia vs. Metrosideros; relative prominence of matted ferns (mostly Dicranopteris linearis) vs native shrubs, etc.; occurrence and prominence of past Metrosideros defoliation and mortality (as most readily evidenced by the presence of standing snags); relative presence of exotic species (increased by disturbance along road and pole-line paths and by feral pigs); and exact species composition which is influenced by all of the above, and kipuka size, elevation and chance establishment.

Some kipukas contain Pritchardia beccariana, Cyrtandra spp., and a few Cyanea platyphylla and C. pilosa.

PLRM: Just east of 21, SAMPLING SITE 15, LOCATION: Area of scrub on 1885 lava flow east of site 14 and north of Saddle Road; map elevation 2880 ft (880 m). Vegetation mapped by Jacobi as o2Me(M:ns)pio.

VEGETATION & FLORA: This site has basically the same structure and species composition as Sampling Site 13 with the exception that away from roads there are practically no exotic species, i.e. only natives. The existing 69 KV poleline crosses site 15, and where no access roads were built little impact on the native pioneer community is evident. This is in sharp contrast to neighboring kipuka (Sampling Site 14) where the character of the forest has been drastically altered along the existing poleline alignment.

PLRM: Just southwest of 21, SAMPLING SITE 16, LOCATION: Kipuka north of Saddle Rd., just east of mile marker "12"; map elevation 2920 ft (890 m). Vegetation mapped by Jacobi as o3Me,Ac:2nt(W:mf-ns,tf).

VEGETATION & FLORA: This community is very similar to that of Sampling Site 14, although more variable within than Sampling Site 14. The portion ≤ 100 m north of the existing 69 KV powerline is fairly diverse [i.e., more matted fern (uluhe), Dicranopteris linearis, is present]; and the area along the existing powerline contains more exotic species.

PLRM: midpoint between 21 & 22, SAMPLING SITE 17, LOCATION: 100-200 m west of mile marker "12" and north of Saddle Rd.; map elevation 3000 ft (915 m). Vegetation mapped by Jacobi as o3Me,Ac-2nt(W:mf-ns,tf).

VEGETATION & FLORA: This community is about the same as those of Sampling Sites 14 and 15 except that this site contains more exotic species along the spur road to the pole line and that there has been more recent and more extensive Metrosideros mortality ("ohia dieback") at this site.

PLRM: Just northwest of 25 and 1/4 mi northeast of 26, SAMPLING SITES 18a & b, LOCATION: Transect through large area of forest along road and adjacent areas of north of Saddle Rd.; map elevation 3460-3660 ft (1055-1116 m). Vegetation mapped by Jacobi as o3Me,2nt(W:ns)sng.

VEGETATION & FLORA: The canopy is of medium and (mostly) tall Metrosideros. The understory contains lots of Metrosideros and Cheirodendron, as well as Myrsine lessertiana, Ilex anomala, Coprosma sp., Pelea clusiaefolia, Wikstroemia sp., and a few Tetraplasandra meiandra, Cibotium glaucum, C. chamissoi, a few Psychotria hawaiiensis. There is also much shrub cover including Broussaisia arguta, Clermontia montis-loa, Wikstroemia sp. saplings, Coprosma sp., Cheirodendron trigynum, Clermontia parviflora, Vaccinium calycinum, Sadleria pallida, Styphelia tameiameiae, Cyrtandra platyphylla, Hedyotis centranthoides, Dicranopteris linearis, Rubus hawaiiensis and Gouldia terminalis. Ground cover is variable from place to place depending on the degree of disturbance and degree of canopy defoliation, particularly with regard to the relative presence of exotics. Ground cover includes Stenogyne calaminthoides, Machaerina angustifolia, Lycopodium cernuum, Dubautia scabra, Nephrolepis sp., *Andropogon virginicus, *Juncus planifolia, *Sacciolepis indica, *Cuphea carthagenensis, Cyclosorus interruptus, Coniogramme pilosa, and *Axonopus affinis. Feral pig damage is common at this site and often quite severe, with resulting decrease in diversity of native ground cover plants and an increase in presence of exotic species. Pigs also disturb soil enough to impede drainage in some areas.

PLRM: Just NNE of midpoint between 32 & 33, SAMPLING SITE 19, LOCATION: open area of pioneer scrub opposite Tree Planting Rd. on 1855 lava flow; map elevation 4180 ft (1275 m). Vegetation mapped by Jacobi as o2Me(M:ns)pio.

VEGETATION & FLORA: This site was a pioneer community of low shrubby ohia over an area that has a number of old jeep roads over the lava. Other species are typical of this type of community and include Hedyotis centranthoides, Sadleria sp., Coprosma ernodeoides, and Vaccinium reticulatum. The exotic grass *Andropogon virginicus was also present.

PLRM: 1000' east of 34, SAMPLING SITE 20, LOCATION: ohia forest on a'a flow opposite 4200 ft (1280 m). Vegetation mapped by Jacobi as c2Me,nt(M:ns).

VEGETATION & FLORA: The vegetation of the area that we observed was slightly different than that listed above by Jacobi. The primary differences are that we observed a relatively open canopied ohia forest rather than a closed one and the presence of the native sedge Machaerina angustifolia also was not included in his description. The vegetation observed can be better summarized as follows: o2Me(M:ns,ng). Understory shrubs at the site included small Metrosideros polymorpha, Styphelia tameiameiae, Hedyotis centranthoides, Vaccinium calycinum, V. reticulatum, Coprosma sp., Sadleria cyatheoides, Dicranopteris linearis and Nephrolepis cordifolia. The species that comprise the ground cover include: Machaerina angustifolia, Lycopodium cernuum, L. venustulum, Dubautia scabra, Coprosma ernodeoides and considerable numbers of bryophyte species. In disturbed areas such as under the existing 69 KV line, along the trail and along the access road the flora included mostly the exotic grasses *Andropogon virginicus, *Paspalum urvillei, and *Sacciolepis indica as well as the exotic orchid *Arundina bambusaefolia. The exotic species are prominent in these disturbed areas and transitional adjacent areas, but their frequency declines sharply as one passes into undisturbed areas.

NOTE: Dr. Win Ko of the University of Hawaii, Hilo has a ohia decline study plot at the junction of the Tree Planting Rd. and the Saddle Rd. as indicated by the circled "X" on Aerial Photo Map no. 10. This is on the opposite side of the Saddle Rd. from Sampling Sites 20 and 21. This research plot should not be disturbed during pole line construction or maintenance.

PLRM: 1000' east, then 600 ft north of 34, SAMPLING SITE 21, LOCATION: This site is located just to the north of site 20 and further into the denser ohia forest that is a "dieback-regeneration" stage-map elevation 4240 ft (1293 m). Vegetation mapped by Jacobi as s3Me-2nt(W:tf,ns)sng.

VEGETATION & FLORA: Our observation of the vegetation of this site was slightly different than that in the Jacobi map, primarily the canopy was more dense and *Dicranopteris*, uluhe (mf) was present. Our summary of this vegetation then is o3Me,2nt(W:mf,ns,tf)sng. The major components of the vegetation can be summarized as follows:

Canopy: Scattered to open tall *Metrosideros*, some old standing snags, trees and tall shrubs.

Understory: *Metrosideros*, *Ilex anomala*, *Myrsine lessertiana*, *Gouldia terminalis*, *Coprosma* sp., *Dicranopteris linearis*, *Cyrtandra platyphylla*.

Groundcover: *Dicranopteris linearis*, *Machaerina angustifolia*, *Nephrolepis exaltata*, *Stenogyne calaminthoides*.

There was little or no presence of exotic species (undisturbed areas). Similar "dieback" ohia forest areas along roads and pole-line access are usually liberally interspersed with numerous exotics.

PLRM: 750' NNE of 37, SAMPLING SITE 22, LOCATION: kipuka north of Saddle Rd. with lava tube entrance between kipuka and Saddle Rd. (entrance adjacent to existing 69 KV power pole no. 341); map elevation 4460 ft (1360 m). Vegetation mapped by Jacobi as c3Me,2nt(M:ns).

VEGETATION & FLORA: Kipuka vegetation similar to that at site 1 (i.e. closed canopy of ohia with other native trees such as *Myrsine lessertiana*, *Ilex anomala* and the native shrubs *Psychotria hawaiiensis*, *Styphelia tameiameiae*, *Coprosma* sp., *Sadleria pallida*, *Cibotium glaucum*, *Dicranopteris linearis*, *Gouldia terminalis*, *Stenogyne calminthoides*, *Hedyotis centranthoides*, *Broussaisia arguta*, *Coprosma* sp., *Alyxia olivaeformis*, and *Peperomia* sp.). The species composition of this kipuka approaches 100% native species; **Rubus rosaefolius* was the only conspicuous exotic species.

ENTOMOLOGY: *Leptogryllus elongatus* Perkins (a native tree cricket) was discovered in dead tree fern fronds. This endemic species may be taken as one indication of a relatively undisturbed habitat.

PLRM: 1/2 distance between 47 & 48, SAMPLING SITE 9, LOCATION: Kipuka south of Saddle Rd. ca. 10.5 mi below hunter station; map elevation 4800 ft (1460 m). Vegetation mapped by Jacobi as o3Me,2nt(W:tf,ns)sng.

VEGETATION & FLORA: The portion of this kipuka that we studied was somewhat different in structure and composition that that mapped by Jacobi. Primarily the difference is that it was a closed canopy ohia forest with little or no "dieback". In the Jacobi map code system this is written as c3Me,2nt(W:tf,ns). The species composition can be summarized as follows: Canopy: medium to tall *Metrosideros polymorpha*. Understory: *Cheirodendron trigynum*, *Myrsine lessertiana*, *M. sandwicensis*,

Coprosma ochracea, *Ilex anomala*, *Broussaisia arguta*, *Styphelia tameiameiae*, *Gouldia terminalis*, *Hedyotis centranthoides*, *Pelea* sp., *Vaccinium calycinum*, *V. reticulatum*, *Sadleria cyatheoides*, *Cibotium glaucum*, *Rubus hawaiiensis*, *Cyrtandra platyphylla*, *Alyxia olivaeformis*, *Psychotria hawaiiensis*. Ground cover: *Lycopodium cernuum*, *Xiphopteris saffordii*, *Grammitis hookeri*, *Machaerina angustifolia*, *Elaphoglossum hirtum*, *E. wawrae*, *Astelia menziesii*, *Dicranopteris linearis*, and the parasite on ohia, *Korthalsella cylindrica*.

There was very little or no disturbance at this site by pigs, people, etc., i.e., there were very few exotic species present.

ENTOMOLOGY: Near Sampling Site 9 -- A Malaise trap was erected in the unnumbered kipuka at 4800 ft (1460 m) S of Saddle Road. This site is indicated by the letters "MT" inside a circle on the Aerial Photo Map. The trap was placed just inside the kipuka within its western boundary. Predominant trees noted were *Metrosideros* and *Cheirodendron*. *Cibotium* was more or less common in the understory. Certain light-tolerant species like *Dicranopteris* and *Styphelia* were present near the trap and the boundary of the kipuka. This trap intercepted and collected Lepidoptera (moths), many species of Diptera (flies) including a mixture of native and exotic species, and fewer numbers than the preceding orders of Heteroptera (true bugs), Hymenoptera (bees and wasps) as well as a species of Neuroptera (lacewings). Most of these specimens likely emanated from the kipuka in which this trap was placed as only a few species, for example exotic calliphorid (blue bottle) flies, were not apparently associated with the flora of the kipuka or its dependent arthropods. The many specimens of the fly genus *Lispocephala* captured probably indicate an abundance of native pomace flies in the vicinity since *Lispocephala* immatures are predators of immature pomace flies (Hardy 1981).

This Malaise trap captured 125 moths, representing 38 species, of which 33 (87%) were endemic. Endemic species of *Scoparia*, *Carposina*, *Shrankia*, and Gelechiidae dominated the catch along with the exotic *Opogona omoscopa*.

The mecury vapor light was operated for 4 hours the evening of 19 Nov. at 4750' on the N. side of the Saddle Rd. The light was suspended in front of a large white sheet. This site is indicated by the letters "MV" inside a circle on the Aerial Photo Map. The insects alighting on the sheet were collected. An effort was made to capture at least one representative of each species of moth so attracted. About 200 specimens of moths were collected, representing 50 species. Of these 33 (66%) were endemic. The more common species were all endemic and included *Agrostis charmocrita*, *Hyles wilsoni*, *Oeobia pyranthes*, 2 species of *Scotorythra*, and several spp. of *Scoparia*.

PLRM: Just E of 51, SAMPLING SITE 24, LOCATION: Kipuka north side of Saddle Rd.; map elevation 4900 ft (1490 m). Vegetation mapped by Jacobi as c3Me,2nt(M:ns).

VEGETATION & FLORA: Vegetation similar to that of Site 22 as well as other kipukas in area (K-7, K-8, K-9 and Unnamed Kipuka). Note: The telephone line is indicated on maps as crossing Saddle Rd. here, but it does not.

PLRM: 1000' NNW of 56, SAMPLING SITE 1, LOCATION: Low to medium stature ohia forest on primarily pahoehoe but some portions on 'a'a near the mile marker 21 on north side of Saddle Rd.; map elevation 5500 ft (1680 m). Vegetation mapped by Jacobi as c2Me,nt(M:ns).

VEGETATION & FLORA: This area is dominated by an open to closed canopy Metrosideros of low to medium stature, intermixed with scattered, smaller Santalum sp., Coprosma sp. and Myrsine lessertiana trees and a few Ilex anomala and Cheirodendron trigynum. The understory is of native shrubs of various sizes, mostly small Metrosideros, Vaccinium reticulatum, Styphelia tameiameiae, Coprosma sp., and Coprosma ernodeoides. Less common shrubs include saplings of the trees, small Cibotium glaucum, Dubautia scabra, Sadleria pallida, Vaccinium pahalae, V. calycinum, Geranium cuneatum, and Rubus hawaiiensis.

The ground cover is made up of Machaerina angustifolia, M. gahniaformis, Oreobolus furcatus, Carex wahuensis, Luzula hawaiiensis, Astelia menziesiana, Deschampsia australis, Agrostis sandwicensis, Panicum hillebrandii, Rhychospora spicaeformis, *Axonopus affinis, Stenogyne rugosa, *Hypochoeris radicata, and the ferns Dicranopteris linearis, Pleopeltis thunbergina, Polypodium pellucidum, Elaphoglossum wawrae, Elaphoglossum hirtum, Sphenomeris chinensis, and Pteridium aquilinum var. decompositum.

Feral pig damage to vegetation is nearly absent near the Saddle Road.

MALACOLOGY: This kipuka just southwest of this site with vegetation similar to that of Sampling Site 9 supported the richest native snail assemblage observed during this survey; five species, including Tornatellides sp., Nesopupa anceyana, Columella sp., Punctum sp., and Striatura meniscus, were collected. The presence of Columella is of particular interest, as representatives of this genus are rarely collected in Hawaii. The nearly ubiquitous "garlic snail" (Oxychilus alliarius) was the only exotic species found.

PLRM: 1500' NNE of midpoint between 57 & 58, SAMPLING SITE 2, LOCATION: Area of pioneer scrub on 'a'a adjacent to Site 1; map elevation 5600 ft (1710 m). Vegetation mapped by Jacobi as (M: ns-xx)pio.

VEGETATION & FLORA: The total vascular plant cover is ca.

5-15%. There is also considerable cover by the moss Rhacomitrium lanuginosum and the lichen Stereocaulon vulcani. Except for very scattered Metrosideros polymorpha 1-2 m tall, most of the vascular plants were <1 m in height. The species included were: Dubautia scabra, Vaccinium reticulatum, Sadleria cyatheoides, Hedyotis centranthoides, Asplenium adiantum-nigrum, Asplenium trichomanes, a few small Cibotium glaucum, Coprosma ernodeoides and Polypodium pellucidum. There was no evidence of feral pig damage.

PLRM: Transect N from 62 to 2/3 distance to 63, SAMPLING SITE 23, LOCATION: Triangular transect from 0.4 mi southeast of Mauna Kea State Park north toward Pohakuloa Training area water tanks; map elevation 6360 ft (1940 m). Vegetation not mapped by Jacobi but classified by us as o2My-So(D:mg,ns).

VEGETATION & FLORA: This area is dominated by an open canopied Naio (Myoporum sandwicense) - Mamane (Sophora chrysophylla) forest. The understory species included the natives Chenopodium oahuense and Dodonaea sp. and the grasses Eragrostis atropioides and Deschampsia australis, and the fern Pellaea ternifolia. Numerous exotic herbaceous weeds occur in open areas at this site (as they do throughout this general region) and included: *Stipa cernua, *Conyza bonariensis, *Rhynchelytrum repens, *Pennisetum setaceum, *Oenothera stricta, *Picris hieracioides, *Bromus catharticus, *Galinsoga parviflora, *Tagetes minuta, *Helichrysum foetidum, *Wahlenbergia gracilis, *Polycarpon tetraphyllum, *Bidens pilosa, *Heterotheca grandiflora, *Centaurium erythraea, *Brassica nigra, *Lactuca scariola, *Verbena litoralis, *Cirsium vulgare, and *Lepidium virginicum.

ENTOMOLOGY: We found that native plants had their usual complement of host-specific sap-sucking bugs although one or more species of the native seed bugs (Nysius spp.) appeared to be feeding on introduced Conyza bonariensis since both adults and immatures were present in abundance on this host. Another as yet undetermined seed bug was shaken from clumps of native and exotic bunch grasses; this might prove to be an undescribed species or possibly a new introduction into Hawaii. There are large complexes of these seed bugs here and their precise determination is a painstaking and time-consuming task. We also took a long series of an exotic dung beetle (Scarabaeidae) found dead adjacent to decomposed cow or horse dung. This species is new to the island.

MALACOLOGY: A surprisingly rich fauna of three species of native land snails (Tornatellides sp., Succinea sp., and Striatura meniscus) was recorded at this site, as well as an unidentified species of Zonitidae that may be either native or exotic. All snails were found under rocks and stones.

NOTE: In reference to the area of Critical Habitat of the Palila below the Pohakuloa Training Area that was not surveyed, the following comments seem pertinent to the Sophora-Myoporum forest north of Saddle Rd. and east of Mauna Kea State Park.

This area contains some of the best extant Mamane-Naio forest on Mauna Kea. The canopy is open to closed and has open patches interspersed. The latter contain several species of native grasses (Trisetum glomeratum, Eragrostis atropioides, Agrostis sandwicensis, Panicum tenuifolium, Deschampsia austalis and perhaps Eragrostis leptophylla). The native vine Sicyos hillebrandii occurs there. Also Stenogyne microphylla, Argemone glauca, Chenopodium oahuensis, Coprosma montana, Gnaphalium sandwicensis, Sida fallax, and Dodonaea sp. On rockier outcrops in the vicinity are a few Chamaesyce olowaluana var. gracilis, and a very few Dubautia arborea. Also seen nearby are Bidens menziesii var. filiformis, and Osteomeles anthyllidifolia. In the disturbed portions, and somewhat overall, are a number of exotics including *Pennisetum setaceum, *Tagetes minuta, *Lepidium virginicum, *Heterotheca grandiflora, *Verbascum thaspus, *Conyza bonariensis, *Helichrysum foetidum and *Dactylis glomeratum. This narrative is based upon notes made by F. Warshauer on a previous visit through this area.

PLRM: 1500' NNE of midpoint between 65 & 66, SAMPLING SITE 10, LOCATION: next main drainage from Mauna Kea northwest of Pohakuloa Gulch; the area surveyed was alluvium of fine ash mixed with more coarse material and exposed rocks near the gulch; map elevation 6400 ft (1950 m). Vegetation not mapped by Jacobi, but classified by us as sl My:S(D:mg-ns,xx).

VEGETATION & FLORA: the vegetation is composed of low stature trees and tall shrubs 2-4 m tall. Myoporum sandwicense and Sophora chrysophylla are found in small clumps or as individuals, scattered over the shrub/grassland and concentrated along the stream course. The open shrubland is dominated by Dodonaea sp. and Chenopodium oahuense, with Sida fallax, small individuals of Myoporum sandwicense, a few Argemone glauca and several tall weeds. The open grassland is made up of Eragrostis atropioides, some *Pennisetum setaceum, some Deschampsia australis, and included the native Gnaphalium hawaiiense and Pellaea ternifolia. Where fires and other disturbance have occurred the proportion of woody plants is diminished and the occurrence of exotic species often is increased. Eragrostis leptophylla may be a component of the vegetation here as it is in the same unit to the east 1-2 km. There is a large proportion of exotic weed species at the site. Species composition of weeds similar to that of Sampling Site 23. No recent ungulate damage was observed.

ENTOMOLOGY: (See comments under Sampling Site 23 for comments on plant-associated bugs, which largely applies here also.)

PLRM: ca. 2 mi SSE of 70, SAMPLING SITE 11, LOCATION: ca. 0.5 mi northwest of Pu'u Ke'eke'e, just southeast of Parker Ranch fenceline and 0.5 mi northeast of Keamuku lava flow. The area has ridges and patches of 'a'a and large blocks of brecciated

pahoehoe between areas of deeper ash accumulation or loess soil; map elevation 5100 ft (1555 m). Vegetation not mapped by Jacobi, but classified by us as slMy-Ep(D:ns-mg).

VEGETATION & FLORA: Trees are scattered or occur in small stands primarily, Myoporum sandwicense (naio) and on rocky outcrops stands of Chamaesyce (=Euphorbia) olowaluana . There are also a few Myrsine lanaiensis. The native shrub common in the area is Dodonaea sp. Thus the vegetation is a native shrubland with scattered trees intermixed with exotic and native grasses. The exotic grasses dominate where fires and grazing have recurred. The grazed portions of the area have a concomitant reduction in the woody species. The native grass is Eragrostis atropioides which occurs mixed with the exotic *Pennisetum setaceum. Other species include Sida fallax, Dubautia linearis (on rocky outcrops only), Chenopodium oahuense, Bidens menziesii var. filiformis, Gnaphalium sp., Asplenium trichomanes, Asplenium adiantum-nigrum, Pleopeltis thunbergiana, Pellaea ternifolia, *Tagetes minuata, Argemone glauca, *Atriplex semibaccata, *Lactuca scariola, *Plantago lanceolata, *Verbena litoralis and *Brassica nigra. There were signs of girdling and browsing by feral goats and sheep south of the fence and well as extensive cattle grazing to the north. The number of individuals of Chamaesyce olowaluana was prominently reduced to three individuals on the Parker Ranch side of the fence, in comparison with the much larger number on the opposite side.

ENTOMOLOGY: The presence of the big-headed ant (Pheidole megacephala) on the patch of blooming 'akoko trees (Chamaesyce olowaluana var. gracilis) was most disquieting because this disturbance-adapted ant is considered by many entomologists to be a voracious predator on non-adapted native arthropods. This site is also the highest elevation (5100 ft) that any of the entomological team members could recall having encountered it; thus this species unfortunately appears to be expanding its range. Dead branches were noted on some of the 'akoko trees; these mostly contained old galleries of a rare native long-horned beetle (Plagithmysus montgomeryi Gress. & Davis). No active beetle galleries were noted, and this may possibly be one example of the impact of the ant upon a native insect. Some of the native insects which were fast-moving in both their adult and immature stages such as plant bugs of the genus Psallus and leafhoppers of the genus Kirkaldiella appeared still able to avoid or tolerate the presence of these ants.

PLRM: 2.5 mi W of 70, SAMPLING SITE 26a, LOCATION: ca. 16 mi west of Kilohana Scout Camp; an area of ash soil with rock outcrops of blocky pahoehoe; map elevation 4850 ft (1480 m). Vegetation not mapped by Jacobi, but mapped by us as (D:ns-mg-xs).

VEGETATION & FLORA: This site is a shrubland-grassland mixture. The proportion of grassland being directly related to the grazing pressure or other disturbance. Dodonaea sp. is the dominant shrub and *Pennisetum setaceum, *P. clandestinum, Eragrostis atropioides, *Bromus catharticus and *Dactylis glomerata are the dominant grasses. Other species include *Lepidium virginicum, *Verbena litoralis, *Brassica nigra, *Heterotheca grandiflora, *Conyza bonariensis, *Tagetes minuta, *Cirsium vulgare, *Plantago lanceolata, *Centaurium erythraea, *Gnaphalium japonicum, *Helichrysum foetidum, *Centaurea melitensis, Bidens menziesii and Gnaphalium sandwicensis.

PLRM: 4 mi NNW of 70, SAMPLING SITE 26b, LOCATION: Near Puu Kanalopahanui, an area of deep ash soil; map elevation 4600 ft (1400m). Vegetation not mapped by Jacobi, but mapped by us as (D:xg).

VEGETATION & FLORA: The vegetation is a close-cropped pasture of primarily *Pennisetum clandestinum with a few remnant trees and shrubs in the gulches such as Sophora chrysophylla. Sida fallax, Chenopodium oahuense and a very few individuals of Cibotium glaucum.

PLRM: 5.6 mi WNW of 70, SAMPLING SITE 26f, LOCATION: near fenceline ca. 1 mi SSW of Puu He'ewai; map elevation 3820 ft (1165 m). Vegetation not mapped by Jacobi, but mapped by us as vslEp(D:ns-mg).

VEGETATION & FLORA: Similar to site 26e. It is a more grazed area and thus there is a higher proportion of exotic grasses and fewer shrubs and herbaceous cover.

PLRM: 5.5 mi NNW of 70, SAMPLING SITE 26g, LOCATION: ca. 1/2 mi south of Puu He'ewai where jeep road crosses gulch, ca. 1/3 mi south of Puu He'ewai; map elevation 3840 ft (1170 m). Vegetation not mapped by Jacobi but mapped by us as o2nt(D:ns-xg-xs).

VEGETATION & FLORA: The flats are mostly pasture dominated by exotic grasses. The gulch also has exotic grasses such as *Pennisetum clandestinum as well as small populations of Sophora chrysophylla, Myrsine lanaiensis, Chenopodium oahuense, Dodonaea sp. and Osteomeles anthyllidifolia. On the cut banks of the gulch were *Solanum pseudocapsicum, and the ferns Pleopeltis thunbergiana, *Adiantum hispidulum, Pellaea ternifolia, and Asplenium trichomanes.

PLRM: 4.6 mi S of 71, SAMPLING SITE 26e, LOCATION: SSE of Keamuku camp ca. 1/2 mi W of Puu He'ewai, an area of 'a'a outcrops surrounded by deep soil; map elevation 3600 ft (1100 m). Vegetation not mapped by Jacobi but mapped by us as vslEp(D:ns-mg).

VEGETATION & FLORA: On the rocky outcrops are a few Chamaesyce olowaluana. Open shrub lands in the area are dominated by Dodonaea sp., Osteomeles anthyllidifolia, Wikstroemia sp., Sida fallax and a few Dubautia linearis. The grasses are *Pennisetum setaceum, *P. clandestinum, and

*Rhynchelytrum repens. Other species of herbaceous plants included *Conyza bonariensis, *Gnaphalium japonicum, G. sandwicensium and *Tagetes minuta.

PLRM: 2.3 mi SSE of 71, SAMPLING SITE 26d, LOCATION: W of Keamuku Camp, southeast of Mamalahoa Highway; map elevation 3000 ft (915 m). Vegetation not mapped by Jacobi but mapped by us as s2xt(D:xg,ns).

VEGETATION & FLORA: This area is dominated by olive trees (*Olea europaea) with some *Eucalyptus sp. trees also in the general area. The olive trees are scattered amid a grazed pasture of *Pennisetum clandestinum, *P. setaceum and *Rhynchelytrum repens with other species such as Sida fallax, Wikstroemia sp., and *Plantago lanceolata.

PLRM: 4.8 mi SE of 71, SAMPLING SITE 26c, LOCATION: ca. 1.2 mi west of Waiki'i under existing 69 KV powerline; map elevation 3640 ft (1110 m). Vegetation not mapped by Jacobi but mapped by us as (D:xg).

VEGETATION & FLORA: It is an area of close-cropped pasture primarily consisting of *Pennisetum clandestinum. There are also stands of cultivated *Eucalyptus sp.

NOTE: Late November is an unfavorable season to survey much of this area (i.e. Sampling Sites 26 a-g) because some of the rare plants that should occur here die back for the season and are thus exceedingly difficult to observe at this time. One species, Haplostachys haplostachya, of the mint family (Lamiaceae) should occur in this area. H. haplostachya is listed as an endangered species (Federal Register 45(202): 82483. 1980).

PLRM: 1/3 mi SSE of 72 to 1.5 mi makai of 73, SAMPLING SITES 25a-e, LOCATION: Transect along existing 69 KV powerline from Waikoloa substation to Anaeho'omalu Substation; map elevations 1100 ft to 300 ft (335 to 90 m). Vegetation not mapped by Jacobi, but mapped by us as indicated below under respective sampling sites.

VEGETATION & FLORA: These sites are all basically grasslands with scattered or clumped stands of shrubs or trees. Individually each can be characterized as follows:

PLRM: 1/3 mi SSE of 72, Sampling Site 25a, map elevation 1100 ft: In the Jacobi system the area would be classified as s2xt(D:mg). Grassland on deep ash soil on 'a'a with interspersed scattered *Prosopis pallida, and some *Indigofera suffruticosa. Swaths of Eragrostis atropioides are interspersed in a matrix of *Pennisetum setaceum. Other species include Waltheria indica, Sida fallax, a few Lipochaeta lavarum, large amounts of *Leucaena leucocephala, Heteropogon contortus, *Cassia leschenaultiana.

PLRM: 2/3 mi SSE of 72, Sampling Site 25b, map elevation

1100 ft: In the Jacobi system the vegetation would be classed as s2xt(D:xg,xs). This area has been burned in the past and is now dominated by open to closed stands of *Prosopis pallida of medium stature. Scattered shrubs include *Indigofera suffruticosa, *Opuntia megacantha, *Leucaena leucocephala and Sida fallax. The ground cover is dominated by *Cenchrus ciliaris with some *Pennisetum setaceum, *Cassia leschenaultiana, Waltheria indica, *Emilia javanica, a few Sicyos hillebrandii, and *Solanum nigrum.

PLRM: 1.6 mi SSE of 72, Sampling Site 25c; map elevation 1100 ft: In the Jacobi system the vegetation would be classed as s2xt,vslnt(D:xg,xs,hs). The area has scattered *Prosopis pallida and very scattered Erythrina sandwicensis on hilltops as well as Diospyros ferrea. Other species include *Momordica charantia, *Ricinus communis, *Pluchea odorata, Sida fallax, *Pennisetum setaceum (the dominant grass), Portulaca cyanosperma, *Cassia leschenautiana, Waltheria indica, *Emilia javanica, *Ageratum conyzoides, Doryopteris decipiens and *Conyza bonariensis.

PLRM: 2 mi makai of 73, Sampling Site 25d, map elevation 400 ft: Area of barren 'a'a lava of the Kaniku flow.
In the Jacobi system the vegetation would be classed as (D:xx,ns-ng). Vegetational cover is very sparse and consists primarily of native species except along roads. The species composition consists of Lipochaeta lavarum, Sida fallax, Heteropogon contortus, Gnaphalium hawaiiense, *Ageratum conyzoides and Doryapteris decipiens.

PLRM: 1.5 mi makai of 73, Sampling Site 25e, map elevation 300 ft: In the Jacobi system the vegetation would be classed as s2xt(D:mg). Older pahoehoe flows with some soil cover dominated by *Pennisetum setaceum with scattered *Prosopis pallida, Heteropogon contortus and a few scattered exotic weeds.

ENTOMOLOGY: Sampling Sites 25 a-e. Since fountain grass, *Pennisetum setaceum, is dominant through a considerable portion of Section 7 of the proposed corridor (except as noted under the vegetation observations), it was sweep sampled repeatedly for insects. An introduced plant bug (Stenotus sp.) was the most prevalent insect on it followed by the introduced red-shouldered stink bug (Thyanta accerra McAtee), which might be previously unrecorded from the Big Island. Several species of parasitic and predatory wasps (including the ensign wasp, a cockroach parasite), some of which may be native species, and a couple of specimens of a native grass-associated plant bug (Trigonotylus ?hawaiiensis) were also collected. An endemic species of the moth genus Tamsica was also common. The presence of adults and immatures of the bugs is taken to indicate that they are likely feeding on the fountain grass. However, this fire-adapted plant is considered a threat to native ecosystems in drought-prone areas of the Big Island. The National Park Service has earmarked it for biological control as it is considered to be beyond mechanical or chemical means of control (Gardner & Davis 1982).

Cave Resources

Anaeho'omalu Caves: Three large collapsed cave entrances occur in a line crossing the proposed alignment. These entrances give access to a large lava tube which extends mauka approximately 200 m from the upper entrance and an undetermined distance downslope from the lower or makai entrance. Time constraints prevented any more than a brief reconnaissance but enough of it was seen to recommend avoidance during powerline construction. This can be accomplished by spanning the line of sinks with the maximum distance between poles and using short spurs from the existing access road for access to the pole sites. The cave entrances are highly disturbed by feral sheep and goats, but some evidence of prehistoric human usage is also present (see site no. 50-Ha-E2-151; McEldowney, 1977). The cave does contain a true cave deep zone environment (Howarth, 1981) and is worthy of further biological study. Insect cocoons attached to tree roots penetrating the roof in total darkness belonged to an undescribed species of cave moth and were the only native cave invertebrate noted during this brief survey. Several spiders were also collected representing two spp. (Loxosceles sp. and probably Cyclosa sp.); both are presumed exotic.

Other caves: Significant caves are known within both the 1881 and 1855 lava flows just outside the powerline route, and the geological evidence indicates that additional large caves occur within the pahoehoe sections of both of these flows within the corridor. Although we found a number of sinkholes and collapsed pits within the 1855 flow, we found only one short cave. This entrance is near the existing corridor at ca. 4400 ft, and a large cave is clearly present there, but access is completely blocked by collapse only 10 m from the entrance.

RATIONALE FOR SELECTION OF PREFERRED POWERLINE ROUTING

Introduction

In selecting the recommended "Preferred Powerline Alignment" we have been guided by two main constraints: (a) avoidance of adverse impact on Federally- or State-protected Threatened or Endangered Species; and (b) avoidance of adverse impact on habitats having a high diversity of native plants and animals. The first of these constraints is observed in recognition of legal protection accorded to designated plant and animal taxa under the Endangered Species Act of 1973 and other laws and regulations. The second constraint is no less important, because in Hawaii many plant and animal taxa are in danger of extinction but have not yet been accorded legal protection under the Endangered Species Act or other laws. These taxa are nevertheless "endangered" in the biological sense, and should be protected from adverse impacts. Because information on the occurrences of these endangered plants and animals is generally incomplete, we believe that adverse impacts upon them can best be minimized by avoiding and thus protecting those sites supporting high-diversity communities of native plants and animals.

Endangered Species.

Designated Endangered Species inhabiting (or probably inhabiting) the powerline corridor are the plant *Haplostachys haplostachya* and one bird species, the Palila (*Psittirostra bailleyi*) (although ornithological constraints are beyond the scope of this report, as designated Critical Habitat of the Palila is known to be present in the corridor, we have taken this fact into account when analyzing alternative routes).

High-diversity Communities

During the field survey, particular attention was paid to locating areas supporting high diversity native plant and animal communities. These "sensitive areas" were found to include kipukas (areas of native vegetation surrounded by recent lava flows having vegetation of younger successional stages) and lava tubes (caves supporting isolated "islands" of habitat favorable to endemic cave-adapted animals (principally arthropods).

Consideration of Indirect Impacts

Aside from the obvious destruction of native plants and animals resulting from construction activities, we have endeavored to consider indirect or long term effects of such construction. These include:

a). Disturbed areas as focal points for introduction and spread of exotic plants.

b). Feral pig damage due to greater accessibility resulting from road construction (pigs are reluctant to cross 'a'a lava flows, so kipukas surrounded by such flows are partially protected from pig damage; roads through these kipukas allow easier access by pigs, and thus greater damage to native vegetation).

c). Effects of tree fern harvesting. (Additional roads through areas of native forest allow greater access by persons (illegally ?) harvesting tree ferns (hapu'u), and thus negatively impacting the native community.

Other Factors

Additional factors considered in our recommendations are zoning regulations (mandating avoidance of Preservation Subzone of Conservation District), and preference for use of already-degraded areas (such as recently bulldozed track along old telephone line, apparently to remove old telephone poles) for pole siting over relatively undisturbed sites.

Thus, the minimum damage to native ecosystems along the corridor would occur from construction and maintenance of the 138

KV line by helicopter. This method would produce "islands" of site-specific disturbance as compared with more extensive disruption from additional construction of access and maintenance roads, with ther subsequent negative indirect impacts (see above). In the discussion of the biologically preferred pole-line routings, we have focussed on possible routings through presently disturbed areas, whether pole-line construction is by helicopter or on the ground.

BIOLOGICALLY PREFERRED POLE LINE ROUTING (See Maps Also)

Pole Line Reference Markers (PLRM) 0-3. Follow preferred alignment.

PLRM 3-4. Place line directly parallel to existing road because of easier access for construction and line maintenance; This also minimizes disturbance of native vegetation.

PLRM 4-9. Use preferred alignment.

PLRM 9-10. At fork in Flume Rd. (Sampling Site 5) place poles on either side of Kipuka vegetation and access poles only on existing access roads outside of the Kipuka.

PLRM 10-12. Use modified preferred alignment.

12-15. Skirt N. of Kipuka 2300' (Sampling Site 12) and avoid disturbance to Kipuka. Then parallel existing jeep track from 13-15, crossing preferred alingnment at 15.

(Use orthophotoquad, 7.5' series, for PLRMs 0-15, and aerial photomap, 1" - 300', for PLRMs 15-52 for biologically preferred pole line siting.)

PLRM 15-17. Between PLRMs 15-16, cross 69 KV line and Saddle Rd. Between PLRMs 16-17 cross Saddle Rd. and parallel it.

PLRM 17-18. Between PLRM 17 &18, place poles in either side of Kipuka, then parallel Saddle Rd.

PLRM 18-22. From PLRM 18, cross Saddle Rd. to PLRM 19, parallel Saddle Rd. on S. side to PLRM 20, then cross to N. side of Saddle Road to PLRM 21. From PLRMs 21-22, parallel S. side of 69KV, using existing pole line access road.

PLRM 22-23. Place line between 69 KV and Saddle Rd., if sufficient space. Otherwise cross to S. side of Saddle Rd.

PLRM 23-25. Hwy N. side of Saddle Rd. between 69KV line &Rd, using Saddle Rd. for construction access.

PLRM 25-28. Parallel existing jeep road on N. side of Saddle Rd. At PLRM 26,cross 69 KV line and stay 75' N. of 69 KV line from PLRMs 27 to 28.

PLRM 28-30. Situate poles to skirt kipukas (PLRMs 28, 29 & 30 are approximate pole sitings to skirt kipukas.)

PLRM 30-31. Parallel on 69 KV line, 75' on its N. side.

PLRM 31-32. These PLRMs indicate approximate pole sitings.

PLRM 33-34. Use existing jeep track on N. side of Saddle Rd. for access to 138 KV construction.

PLRM 34-35. Parallel 69 KV on its N. side.

PLRM 35-36. Between PLRMs 35 & 36, cross 69 KV line and Saddle Rd. within area so indicated by the encircled area on Aerial Photo Map No. 13.

PLRM 36-50. Hug S. side of Saddle Rd. with short spurs to access 138 KV line construction, between road and Preservation (P) subzone. Numbered sites are approximate 138 KV pole sites. Entering margin of "P" subzone was considered less biologically damaging to avoid kipuka vegetation on N. side of Saddle Rd. However, avoid disturbance to kipukas on S. side of Saddle Rd., namely kipukas K-7, K-8, and K-9 and unnumbered kipuka.

PLRM 50-52. Cross Saddle Rd. from 50-51 from S. side to N. side, PLRM 51 is approximate 139 KV pole site. From PLRMs 51 to 52 cross 69 KV line, from S to N, using existing jeep road for access.

(Now refer back to 7.5 map series for PLRMs 53-60.)

PLRM 53-56. Stay on N. side of 69 KV line using existing jeep roads for 138 KV construction. At PLRMs 54 & 55, stay in S. side of sensitive vegetation to avoid same.

PLRM 56-57. From PLRM 56-57 cross 69 KV line, then Saddle Rd. to their S. sides to existing jeep track & use it for 138 KV line construction access.

PLRM 58-59. Cross ohia forest with minimal disturbance using short spur access roads for 138 KV line from Saddle Rd. and cross to N. side of Saddle Rd. at PLRM 59.

PLRM 59-60. Parallel N. side of Saddle Rd. and S. side of 69 KV line. Use short spurs roads from Saddle Rd. At PLRM 60, reconnect north preferred alternate 138 KV Route.

(Now refer to EDAW transmission line routing study, Section 4 for PLRM's 61-73.)

PLRM 61-62. Follow preferred Alternate 138 KV Route along Saddle Rd.

PLRM 62-63. Cross Saddle Rd. east to west, and rejoin

preferred 138 KV alignment. Avoid Palila Critical Habitat, visual impact on Mauna Kea State Park and State Endangered Bird Rearing Facility.

PLRM 63-69. Following preferred 139 KV, at 75' maximum distance from 69 KV transmission line.

PLRM 69-70. Parallel 69 KV line, 75' distant. This would minimize hazard to aircraft approach and departure from Bradshaw Airfield. This will also avoid Palila Critical Habitat.

PLRM 70-71. Follow biologically preferred alignment over pasture lands avoiding native shrublands to Keamuku Substation. (This area needs field checking following wet season to avoid potentially existing endangered plant species.)

PLRM 72-73. Follow preferred 138 KV alignment, 75' maximum distance from 69 KV line, using existing jeep road for construction access and maintenance. Avoid native grasslands near Waikoloa Substation, native shrubs and trees throughout, and avoid Cave Site No. 0 - HA-E2-151 by spanning cave course, with maximum spacing of 138 KV poles, then proceed on to Anaeho'omalu Substation.

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HELCO TRANSMISSION LINE ROUTING STUDY

GEOTECHNICAL FACTORS

To:
EDAW, INC.

WALTER LUM ASSOCIATES, INC.
CIVIL, STRUCTURAL, SOILS ENGINEERS

DECEMBER 9, 1982

CONTENTS

HELCO TRANSMISSION LINE ROUTING STUDY

GEOTECHNICAL FACTORS

PROJECT DESCRIPTION

The Hawaii Electric Light Company (HELCO) is proposing to expand its existing electric transmission system on the Island of Hawaii.

The proposed project will consist of:

A Cross-Island Transmission Line

This line will connect the existing Kaumana Substation at the outskirts of Hilo to the Keamuku Substation above Waikoloa Village. Much of the line will be constructed along Saddle Road for transmission of 138 KV power.

Extending an Existing 69 KV Line

The existing 69 KV line from the Keamuku Substation to Waikoloa Substation will be extended to service the Anaehoomalu area.

SCOPE OF STUDY

The study involved a team of several scientists and engineers from different disciplines. Walter Lum Associates, Inc. was assigned to study the geotechnical factors.

The scope of this study includes the following:

A. Office study of available literature on soil and geologic conditions along the proposed corridor.

B. Field reconnaissance of the existing soil, geologic and terrain conditions.

C. Identification of areas that may be sensitive to soil erosion resulting from construction and operation of the project.

D. Suggestion or recommendation of measures to mitigate the probable adverse effects on soil erosion.

METHODOLOGY

The general methods of study included:

A. Review of available information, literature and soil survey and geologic maps of the Island of Hawaii.

B. Field reconnaissance including aerial fly-by and ground observation, and soil sampling at selected locations.

C. Laboratory testing of soil properties including soil moisture content, grain-size analysis and Atterberg limit test for identification and classification.

D. Qualitative evaluation of the effects of construction and operations on soil erosion.

PROJECT LOCATION

The proposed electric transmission line will begin at the existing Kaumana Substation and generally follows Saddle Road to the existing Keamuku Substation, a total distance of about 50 miles.

The corridor for this line is generally located north of Saddle Road except for the east end near Kaumana and the west end beyond the 39-mile mark where the alignment will be located south of Saddle Road.

On the east end, the route bypasses the urban zone of Hilo and away from Saddle Road to the south and west along the forest and then crosses Saddle Road to the north near the 4-mile mark.

On the west end, the route crosses Saddle Road near the 39-mile mark to the southwest towards the existing Keamuku Substation away from Saddle Road.

TOPOGRAPHY

A. Topography

The ground elevation along the corridor rises from Elev. 1,050 ft at Kaumana Substation to the highest point on Saddle Road, Elev. 6,632 ft at the 26-mile mark. (The 26-mile mark will be referred to as the divide in the rest of the report.) North of Saddle Road, at the divide, the corridor reaches to Elev. 6,800 ft somewhere near the Humuula Sheep Station. From the divide, the elevation drops to 5,500 ft near the 39-mile mark to Elev. 2,500 ft at Keamuku Substation and to Elev. 1,080 ft at Waikoloa Substation and finally to Elev. 70 ft at Anaehoomalu Substation.

B. Slope

1. East slope

From the divide eastward, the ground slopes down towards Hilo at an average gradient of about 5% (varies from 3% to 10%).

2. West slope

From the divide westward, the ground slopes down towards Anaehoomalu at an average gradient of about 4% (varies from 3% to 12%).

HYDROLOGY

A. Rainfall

The "Basic Water Resources Data: Island of Hawaii," 1970 (Reference No. 1) indicates that the mean annual rainfall varies from as high as 250 in. near Kaumana to as low as 10 in. near Anaehoomalu (Figure 1).

Annual rainfall decreases steadily from 250 in. at Kaumana to 50 in. near Humuula Sheep Station and to 20 in. at Pohakuloa. Between Pohakuloa and the Kilohana Girl Scout Camp, the annual rainfall is less than 20 inches. From the Kilohana Girl Scout Camp to Keamuku, the rainfall is about 20 inches. Below Keamuku, the rainfall drops further from 20 in. to 10 in. at Anaehoomalu.

B. Drainage

There is no major perennial stream located within the corridor studied. Wailuku River (a major perennial stream in Hawaii) is located north of the corridor at the eastern end of the project. Auwaiakeakua Gulch (an intermittent stream) is located near the western end of the project between Waikii and Keamuku. The corridor roughly drains in two directions from the divide, easterly to the Hamakua Coast and westerly to the Kona Coast.

VEGETATION

Vegetation discussed in this section will only be general patterns that relate to soil formations. Detailed discussions of vegetation and biological factors for this project are covered by others.

The vegetation distribution within the corridor generally relates to the geology of the area, the rainfall pattern and land use.

A. East Slope (Mauna Loa Slope)

The natural vegetation consists of Ohia, various types of ferns, vines and guava.

Vegetation is thicker and taller on the lower slopes and on older lava flows where rainfall is higher and the soil thicker (Photo 1). Vegetation on the more recent flows occurring after 1,800 A.D. is sparse (Photo 2).

B. West Slope (Mauna Kea Slope)

The natural vegetation or the western slope is generally grass (Bermuda grass, Orchard grass and mountain dandelion), brush and cactus. The land is mainly used for cattle ranch (Photo 3).

GEOLOGY

The Island of Hawaii has been built by five volcanoes: Kohala, Mauna Kea, Hualalai, Mauna Loa and Kilauea. The geology along the corridor in this study as shown in Figure 2 is mainly associated with Mauna Kea and Mauna Loa.

Based on Stearns and MacDonald (References 2 and 3), geology along the corridors are classified as follows:

A. East Slope (Mauna Loa Slope)

Kahuku Volcanic Series:

Pkl: Basaltic lava flows capped by Pahala ash, small area near Kaumana.

Kau Volcanic Series:

Prehistoric member.

Qkl: Basaltic lava flows, older flows covered with vegetation.

Historic member (1832 - 1942).

Hml: Basaltic lava flows, recent flows with little vegetation.

B. West Slope (Mauna Kea Slope)

Hamakua Volcanic Series:

Pml: Lava flows capped by Pahala ash.

Laupahoehoe Volcanic Series:

Lower member:

Pll: Andesitic and basaltic lava flows, area near Keamuku.

Plc: Cinder cones at source of flows, isolated areas.

Pla: Thick deposits of vitric ash overlying lava flows, areas between the Humuula Sheep Station and Kilohana Girl Scout Camp.

Alluvium and Talus:

Qa: Unconsolidated and consolidated alluvium and talus, areas near Pohakuloa.

In general, type and thickness of soil formations are closely related to the geology of the area. In areas covered with volcanic ash, thicker soil layers are formed. In areas of lava flows, only thin layers of soil are formed. In more recent lava flows, no soil has developed.

Some of the recent flows of the Kau Volcanic Series (1832 - 1942) cover portions of the corridor along the east slope (Mauna Loa slope). A future volcanic eruption of Mauna Loa could result in a lava flow cascading down the east slope.

The location of the corridor on the west slope will generally be on the Mauna Kea slope and will be well away from any recent lava flows, except at the west end near Anaehoomalu which will be near the 1859 lava flow.

SOIL

The soil formation along the corridor is generally related to the geologic age and occurrence. The Mauna Loa slope is younger and more rocky with more recent lava flows and thinner soil cover. The Mauna Kea slope is older with more soil developed from volcanic ash deposits.

A. East Slope (Mauna Loa Slope)

The soil and rock on the east slope (Mauna Loa slope) along the corridor are generally either lava flows or thin, mucky soils over lava flows.

The lava flows, both "pahoehoe" and "aa," mapped on the Soil Survey Map (Reference No. 4), generally included flows after 1832. Soil has not yet formed. Soil erosion is not a problem (Photo 2).

In areas where the lava flows occur prior to 1832, a thin layer of soil, 0 to 12 in. thick, has developed and/or accumulated. The soils are generally organic or mucky with high water contents (Photo 1).

According to the "Soil Survey of Island of Hawaii" by the Soil Conservation Service (Reference No. 4), these soils are high in permeability, water runoff is slow to medium, and erosion hazards are rated as "slight."

B. West Slope (Mauna Kea Slope)

The soil and rock on the west slope (Mauna Kea Slope) from the Humuula Sheep Station to Keamuku are generally silty and sandy soil developed from volcanic ash of the Hamakua Volcanic Series (Pahala Ash) and Laupahoehoe Volcanic Series. The thickness of the soil ranges from 1-1/2 ft to 8 ft overlying lava rock.

The ash soils are generally of low plasticity and cohesion, and medium to high permeability. Soil erosion hazards are rated as moderate to slight.

These soils, when protected by vegetation and at gentle slopes, do not present erosion problems. Potential for erosion increases for steeper slopes. Slopes of 20% or steeper may be subjected to higher erosion hazards (Photo 4).

The soils at the far western end of the corridor between Waikoloa and Anaehoomalu are lava flows or Kawaihae extremely stony very fine sandy loam.

The Kawaihae extremely stony very fine sandy loam (SCS Mapping Unit KNC) near the Waikoloa Substation is rated as more erodible than other soils. However, the lower slope gradient and very low rainfall in this area limit the extent of erosion of this soil (Photo 5).

A summary of the soil types and the pertinent physical properties is listed in Tables 1-A and 1-B.

LABORATORY SOIL TEST RESULTS

Soil samples at eight locations were collected for laboratory tests and identification. The locations of the samples are shown on the Physical Conditions Map.

Laboratory tests included: moisture content, grain-size analysis and Atterberg limits.

Boring logs and summary of test results are attached. The general ranges of the test values are summarized as follows:

Soils on the East Slope

Moisture content: 85 to 281

Liquid limit: 200 to 323

Plasticity index: 79 to 134

Soils on the West Slope

Moisture content: 9 to 91

Liquid limit: 72 to 103

Plasticity index: 7 to 9

The soils are generally classified as "MH" or "SM" by the Unified Soil Classification System.

EFFECT OF CONSTRUCTION ACTIVITIES ON SOIL EROSION

A. Natural Erosion

The definition of natural erosion by EPA Publication 430/9-73-007 (Reference No. 5) excerpt follows:

> "In a classical sense erosion is defined as the process by which the land surface is worn away by the action of water, wind, ice, or gravity. One of the natural processes by which the topographic features of the land are formed is referred to as natural or geologic erosion. Except for some cases of shore and stream channel erosion, natural erosion is a very slow process. In that it has occurred at a slow and relatively uniform rate over thousands of years, natural erosion does not, to any large extent create an environmental problem. In fact, the sediment derived from such erosion is an essential ingredient in the balance of the environment."

B. Accelerated Erosion

Water-generated erosion can become a serious problem when natural vegetation is removed by man's activities. These activities include exposing the soil surface, altering drainage patterns, and covering permeable soil surfaces with impermeable structures. All of these factors can accelerate the overall rate of erosion. When this occurs, the erosion is commonly referred to as "accelerated" erosion. Accelerated erosion must be controlled in order to minimize damage to water resources as well as land resources.

EVALUATION OF SOIL EROSION - UNIVERSAL SOIL LOSS EQUATION

The amount of soil eroded from an area by rainfall runoff can be estimated by the Universal Soil Loss Equation to the quantity and intensity of rainfall, soil erodibility, slope, crop management and erosion control practice:

$$E = R\ K\ (LS)\ C\ P$$

Where E = soil loss per unit area (ton/acre/year)

R = rainfall factor

K = soil erodibility factor

L = slope length factor

S = slope gradient factor

C = crop management factor (soil cover)

P = erosion control practice factor

Values of the various factors for Hawaii are tabulated by the Soil Conservation Service (Reference No. 6).

The factors governing soil erosion can be grouped into four major headings: climate, vegetation cover, soil and length and gradient of slope.

A. Climate: Amount, intensity and frequency of rainfall.

Runoff water causes erosion. Runoff occurs when the intensity of rainfall exceeds the infiltration rate of the soil.

East slope

Along the corridor, the high rainfall areas are located on the east slope where the annual rainfall ranges from 50 in. to 250 inches. The average annual rainfall factor (K) varies from 200 to 450.

The infiltration of the soil ranges from 6 to 20 in. per hour which is very high. The high infiltration rate reduces the volume of runoff thus minimizing the effect of erosion.

West slope

The west slope is on the Leeward side of the island. Rainfall ranges from 10 in. to 50 in., and the rainfall factor, K, ranges from 125 to 200.

The soil infiltration rate varies from 2 to 20 in. per hour except that of the Kawaihae soil which varies from 0.63 to 2 in. per hour.

The lower rainfall coupled with a high infiltration rate results in low runoff in this area.

B. Vegetation

Vegetation is one of the more important factors influencing or reducing soil erosion. It shields the soil from the impact of the raindrops, retards surface flow of water thereby permitting greater infiltration, maintains a pervious soil surface capable of absorbing water, and removes subsurface water between storm events by transpiration.

East slope

Vegetation on the recent lava flows is sparse. The lava rocks from recent flows are resistent to erosion.

The older lava flows are covered by an Ohia forest which protects soil from erosion. Removal of the vegetation will expose the area to accelerated erosion. However, the warm and wet environment favors revegetation in this area. Construction should be planned to limit time of soil exposure. Exposed areas should be replanted as soon as practicable.

West slope

Vegetation in this area is described as grass land which provides protection from erosion.

Vegetation cover in the Pohakuloa area appeared to be sparse (Photo 6). Wind erosion may be a problem. Revegetation in the area may require more effort due to the dry climate.

C. Soil

The types of soils at a site are another major factor affecting soil loss. A fine-textured soil having large amounts of silt and fine sand is most susceptible to erosion from rainsplash and runoff.

East slope

Soils on the east slope are either rock from recent lava flow or older rock with a thin layer of mucky soil.

Soils on the east slope are generally low in erodibility.

West slope

Soils on the west slopes are generally sandy and silty which have moderate to high erodibility. These soils are fairly stable on gentle slopes with grass cover. Erosion could present a problem on steeper slopes (more than 20%) and/or if the grass cover is removed.

D. Length and Steepness of Slope

All other factors being equal, a long slope will collect more runoff than a short slope, thus the greater the likelihood of erosion. To minimize the problem, long slopes can be altered so that they function as a series of short slopes by utilizing diversion structures such as benches, terraces, ditches, dikes or cross drains. Steepness of slope, surface roughness, and the amount and intensity of rainfall govern the velocity of the runoff flowing down the slope.

The overall ground slopes are long and gentle at 4 to 5% with local variations of up to about 20%.

Gully erosion appeared to be located on slopes steeper than 15 to 20% on the west slope. These areas should be avoided in the alignment, if practicable.

ASSESSMENT

Study of the soil geology and general terrain conditions with respect to soil erosion along the proposed corridor may be summarized as follows:

A. The annual rainfall varies from a high of 250 in. on the east side to 10 in. on the west end.

B. The high infiltration rate of the soil and rock points to a small runoff. This is indicated from the lack of perennial stream on the corridor.

C. Erosion on the east slope appeared to be slight.

D. Erosion on the west slope appeared to occur mainly on steeper slopes (20% or steeper).

E. Wind erosion appeared to occur on the flat and dry areas around Pohakuloa.

F. The west end of the project near Waikoloa and Anaehoomalu is very dry. Replanting of any construction area will need watering until root systems are established.

MITIGATION MEASURES

When an area is exposed during construction, the severity of erosion can be greatly reduced if proper control measures are used. Erosion control measures perform one or more of the following functions: minimize soil exposure, control runoff and shield the soil.

Minimizing soil exposure involves confining areas of construction activity and revegetation so that a minimum of soil surface is exposed at any one time.

Runoff is controlled by the interception, diversion, and safe disposal of runoff. It may also be controlled by decreasing the amount of runoff through special grading practices, the staging of construction activities, and the preservation of natural vegetation.

To shield the soil surface from the impact of raindrops and from the scouring effects of both overland and channelized runoff flow, surface covers of mulch or gravel may be used. This can be very effective in high moisture soils. Well-graded gravel can be used to cover the soil and to provide support for foot or wheeled traffic. Vegetative growth through the gravel is possible as traffic diminishes.

An effective tool in controlling erosion is good site planning. This involves a judicious selection of control practices, site selection and layout.

On the east slope, location of the alignment through lava flows will result in less problems related to soil erosion.

On the west slope, the alignment along gentler slopes will mean fewer erosion problems. In case it is necessary to traverse steep slopes, poles should be located at the toe of slope and on the ridge. The mid-slopes where erosion can be severe should be avoided insofar as pole locations are concerned.

West of 39-mile mark, moving the alignment further south as suggested by EDAW, Inc. may represent an improvement with respect to soil erosion. The soils further south are more stony and shallower than the proposed alignment. The stony terrain breaks down the long slope into many shorter slopes which slow down the runoff.

OTHER RECOMMENDATIONS ON CONSTRUCTION

A. Pahoehoe lava is associated with voids and cavities. Poles should be located away from cavities or tubes.

B. Poles in lava flow areas should be backfilled with lava rock broken to small pieces and rammed tight to properly support the poles (Photo 7).

C. Poles should be located away from the top of cut or fill slopes to develop lateral support.

D. Island of Hawaii is located in an area that is seismically more active than other areas in the State of Hawaii. The Building Code and earthquake zoning are being upgraded. The seismic effect should be considered in the design of this project.

E. Hurricane "Iwa" has caused substantial damages to the islands of Kauai and Oahu. Wind effect on the pole structures should be considered in the design of the transmission structures.

F. Access or service roads in the high moisture area should be covered with well-graded crushed rock to support service traffic and to allow grass to grow through.

G. Dry ash soils on the Leeward slope may be difficult to compact. Compaction properties of these soils should be investigated prior to or during construction to obtain optimum results.

H. The high moisture soils in the Ohia forest are generally thin. These soils should not be used for backfill of poles.

I. Poles located in the Ohia forest may be subject to high humidity and resulting accelerated deterioration.

REFERENCES

1. State of Hawaii, Department of Land and Natural Resources, "An Inventory of Basic Water Resources Data: Island of Hawaii," Honolulu, Hawaii, 1970.

2. Harold T. Stearns and Gordon A. Macdonald, U.S.G.S., "Geologic and Topographic Map of the Island of Hawaii," Territory of Hawaii, Division of Hydrography, 1945.

3. Harold T. Stearns and Gordon A. Macdonald, U.S.G.S., "Geology and Ground-water Resources of the Island of Hawaii, Territory of Hawaii," 1946.

4. U. S. Department of Agriculture, Soil Conservation Service, "Soil Survey of Island of Hawaii, State of Hawaii," 1973.

5. U. S. Environmental Protection Agency, "Processes, Procedures, and Methods to Control Pollution Resulting from All Construction Activity," EPA 430/9-73-007, Wash., D.C., 1973.

6. U. S. Department of Agriculture, Soil Conservation Service, "Erosion and Sediment Control Guide for Hawaii," Honolulu, Hawaii, 1981.

Photo 1 - Ohia forest, lower east slope.
High rainfall, 4-ft soil cover.

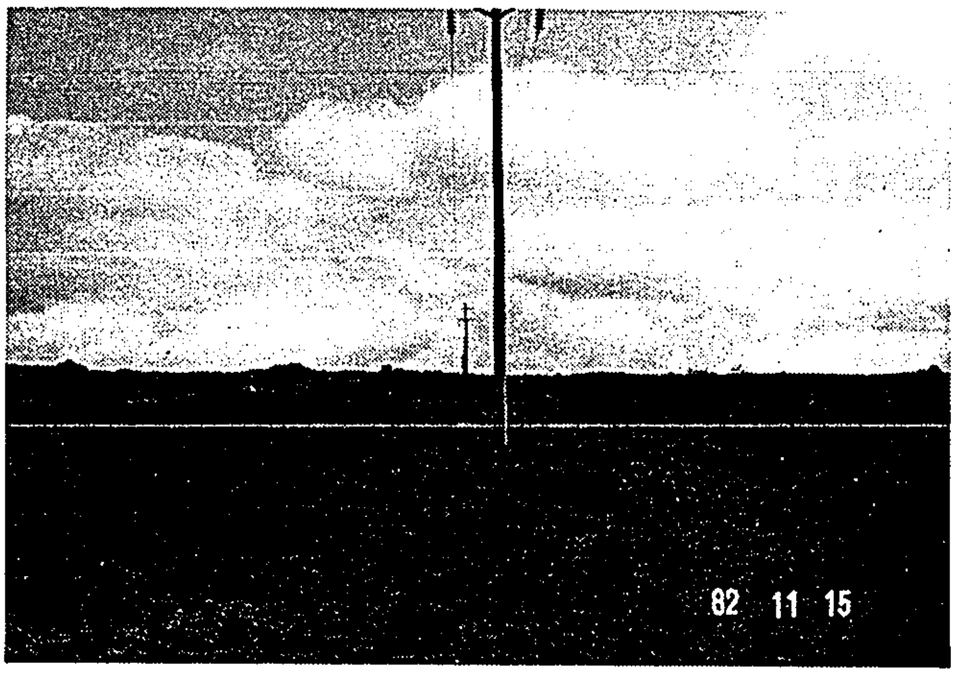


Photo 2 - Sparse vegetation, upper east slope.
Recent lava flow.

Photo 3 - Grassland, west slope near Waikii.
Gentle topography, service road to
power pole does not affect the vegetation.

Photo 4 - Grassland near Kilohana Girl Scout Camp.
No erosion on gentle slope (foreground).
Gully erosion on steep slope (background).

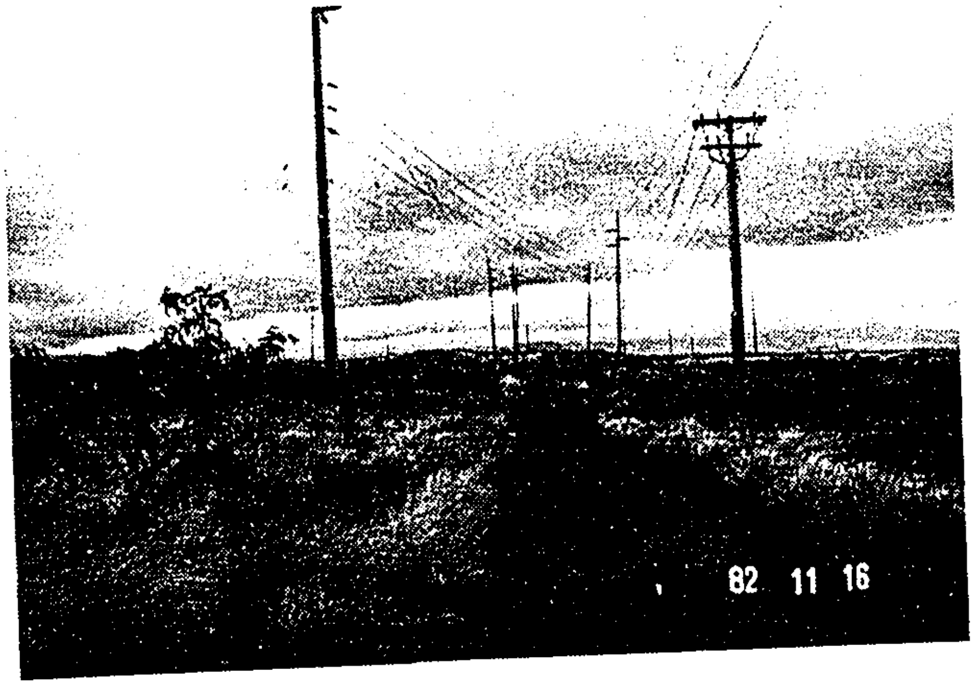


Photo 5 - Light brush near Waikoloa Substation.
Extremely stony soils, soil erosion light.

Photo 6 - Sparse vegetation, Pohakuloa training area.
Dry and windy, subject to wind erosion.

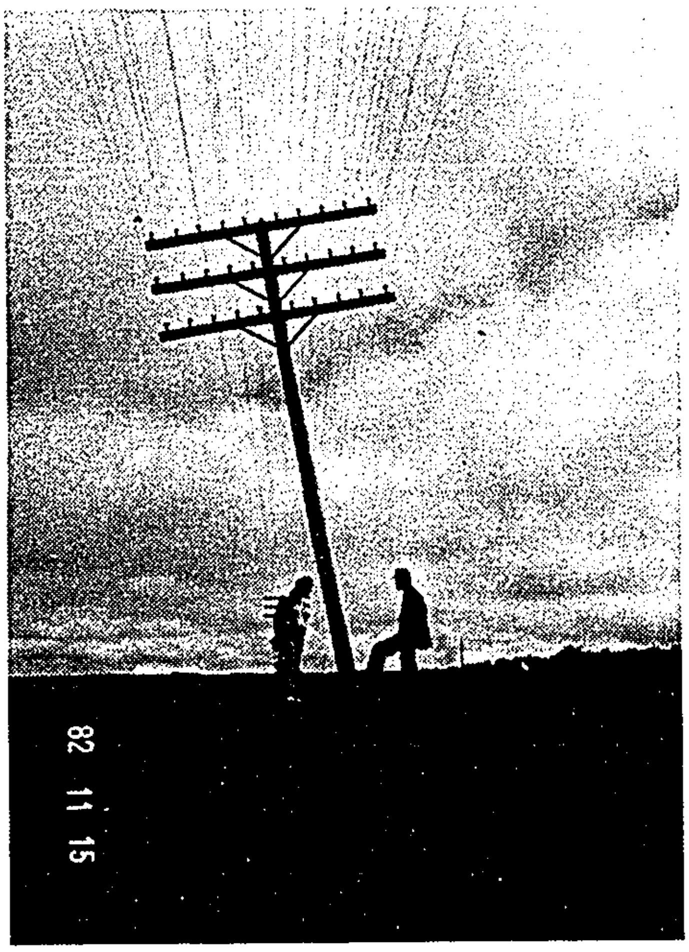


Photo 7 – Pole foundations on recent Pahoehoe lava flows. Voids in lava formations sometimes provide poor lateral support.

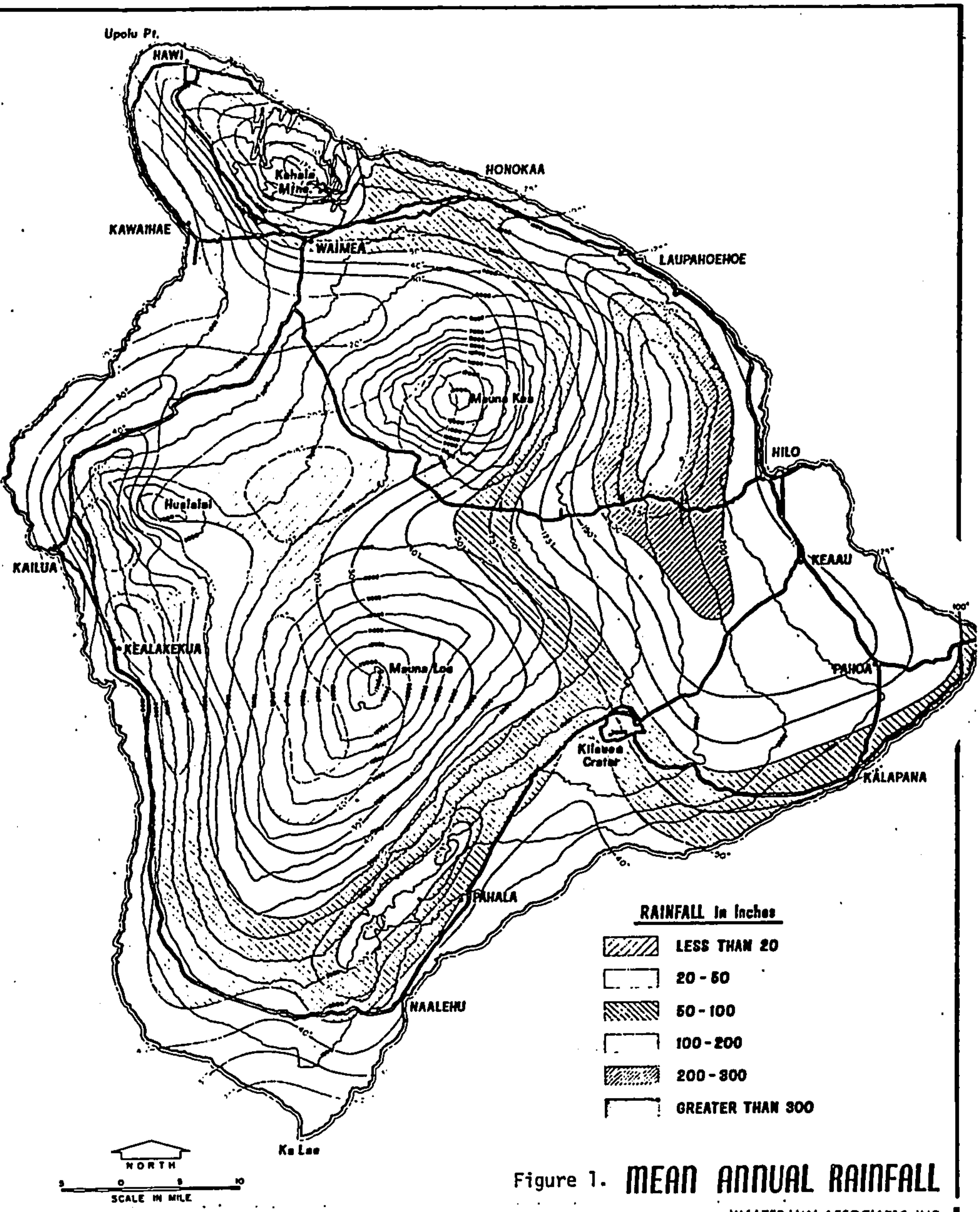
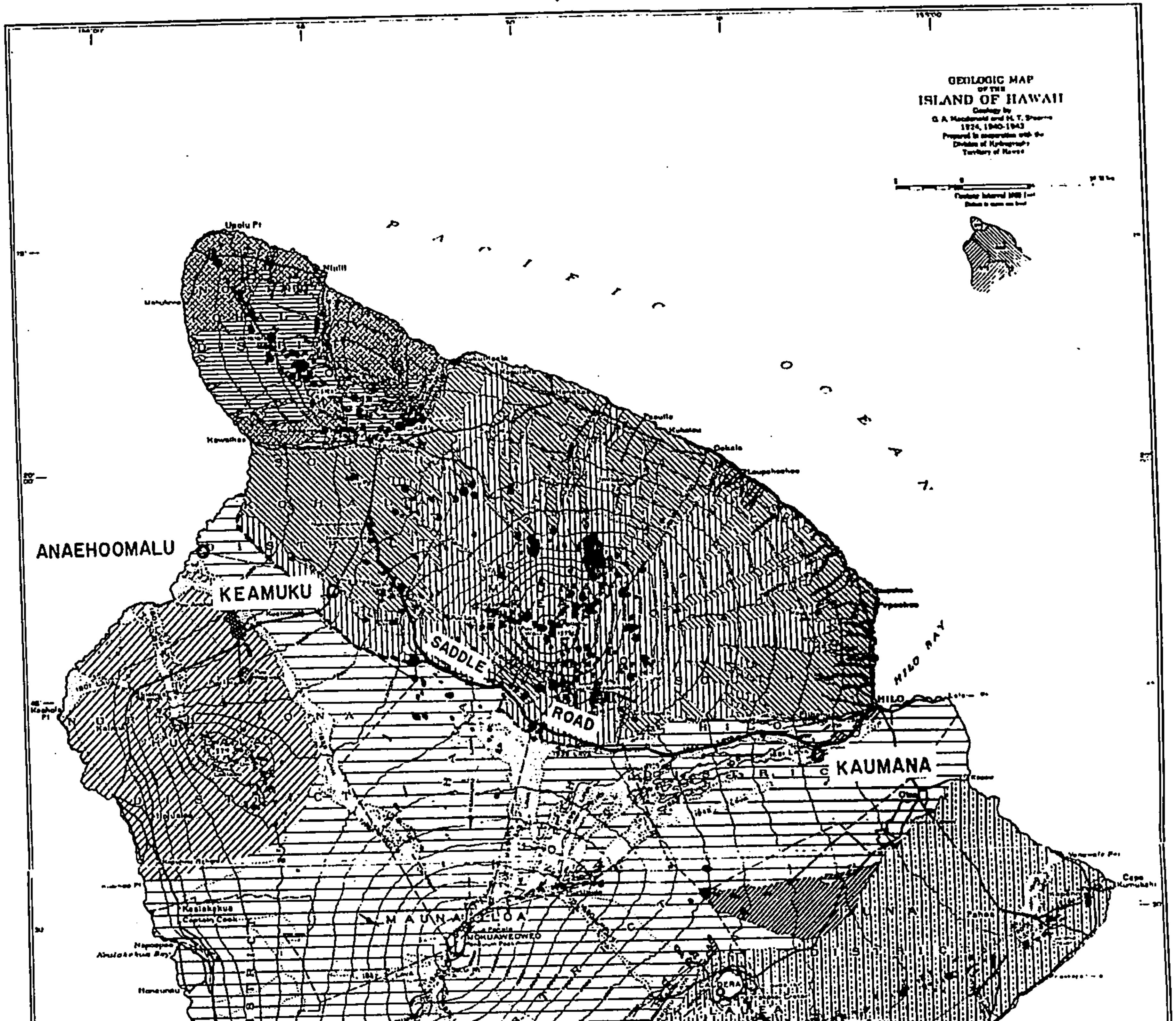


Figure 1. MEAN ANNUAL RAINFALL

WALTER LUM ASSOCIATES, INC.
CIVIL, STRUCTURAL, SOILS ENGINEERS


GEOLOGIC MAP
ISLAND OF HAWAII
P A C I F I C O C E A N
Upolu Pt
HILO BAY
HILO
ANAEHOOMALU
KEAMUKU
SADDLE
ROAD
KAUMANA
MAUNA LOA
MOKUAWEOWEO
Kealakekua
Captain Cook
Napoopoo
Kealakekua Bay
Honaunau
Cape Kumukahi
Kawaihae
Laupahoehoe

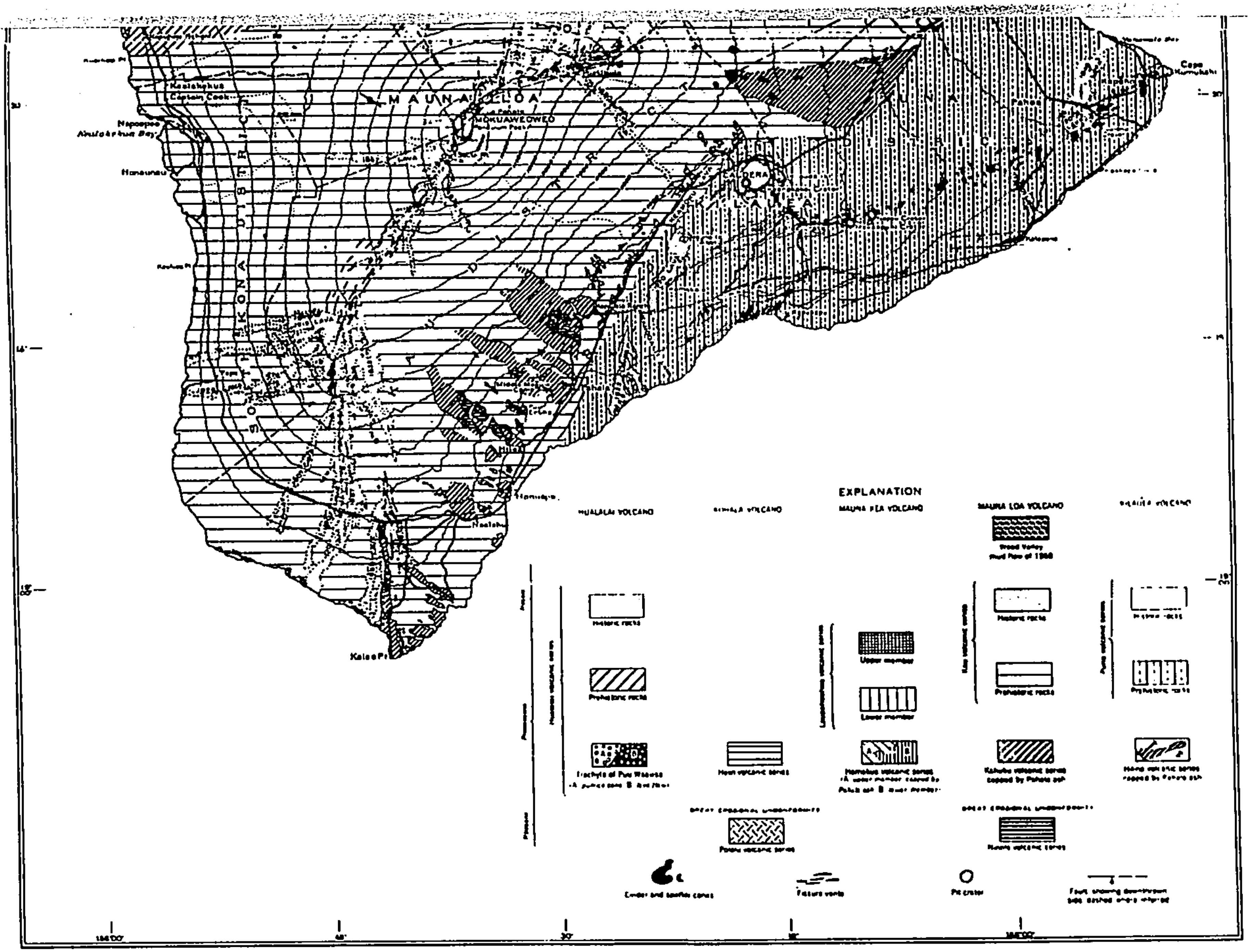


Figure 2. Geologic map of the island of Hawaii. (From Macdonald, 1949*b*.)

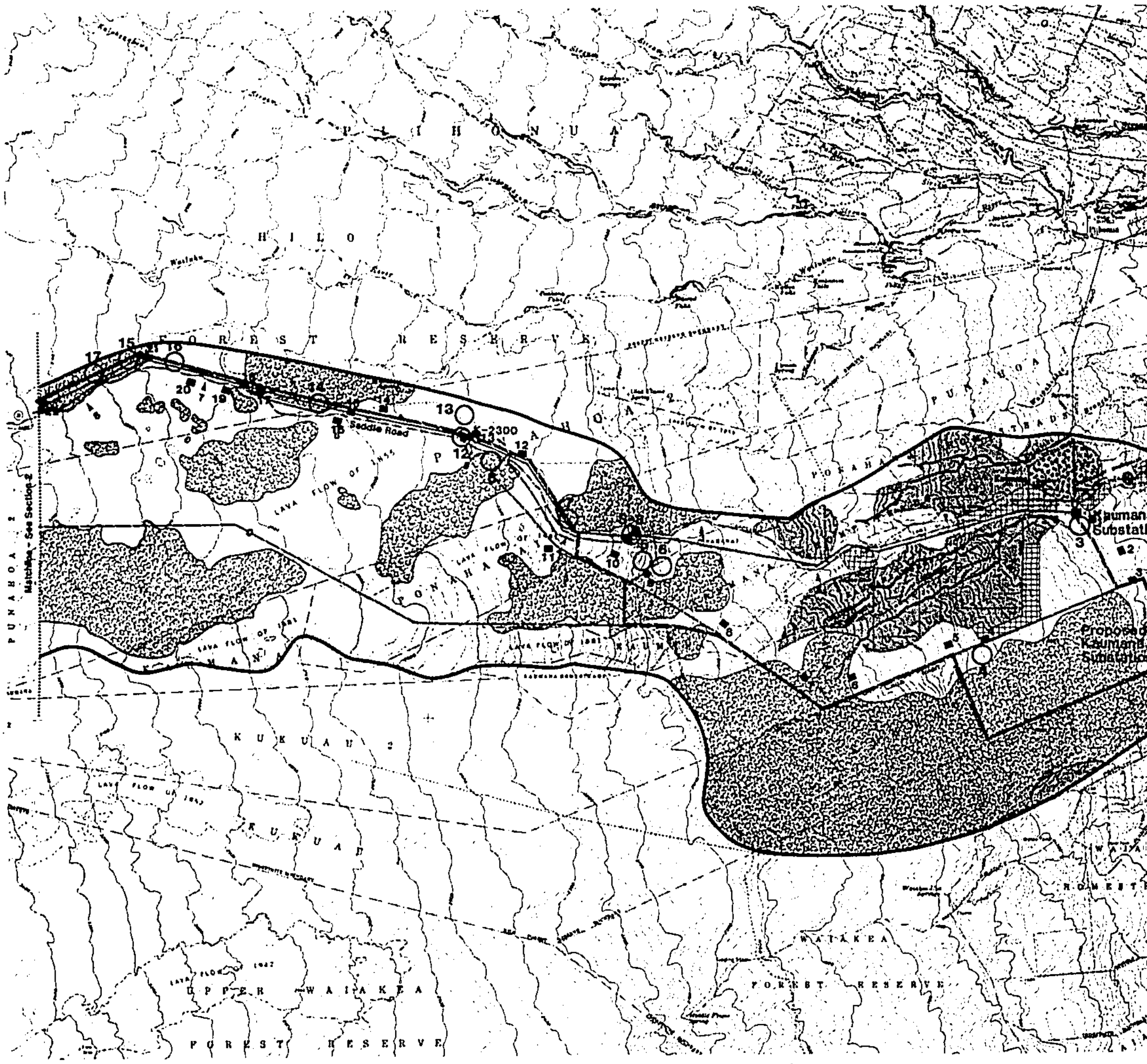


EXHIBIT A - SECTION 1

Legend

- ⦿ Archaeological Survey - Chiniago Inc.
- S-1 Geological Survey - Walter Lum & Associates
- 18A ○ Biological Survey - Bishop Museum
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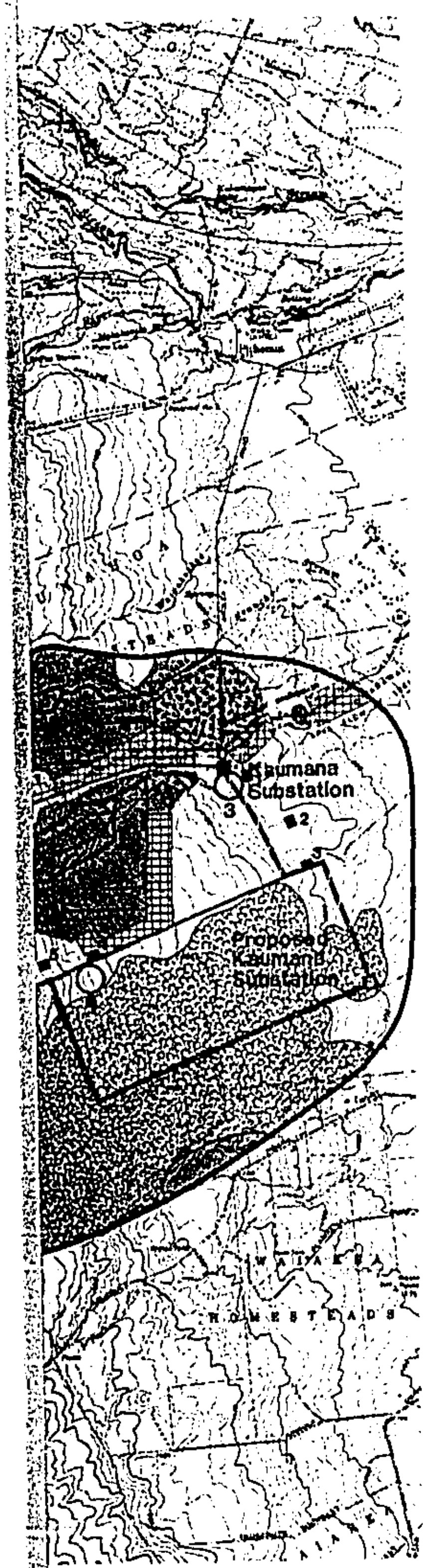
HELCO
TRANSMISSION LINE ROUTING STUDY



LEGEND

BASE DATA

- Edge of corridor
- Existing road
- Existing telephone line
- Existing 69 KV line
- Substation
- Reference marker
- Matchline
- Preferred 138 KV alignment
- Alternate 138 KV alignment

LAND USE FACTORS

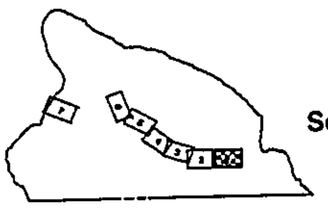
- Urban
- Agriculture
- Grazing
- Military
- Recreation
- Historic site

BIOLOGICAL FACTORS

- Ohia/Koa native forest
- Mamane/Naio native forest
- Introduced forest
- Palila critical habitat
- Kipuka and cave habitats

GEOPHYSICAL FACTORS

- Slopes 20% & greater
- High soil erosion hazard
- Stream
- Reservoir



Section 1

PHASE II

Physical Conditions

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Marker (PLRM) - Bishop Museum

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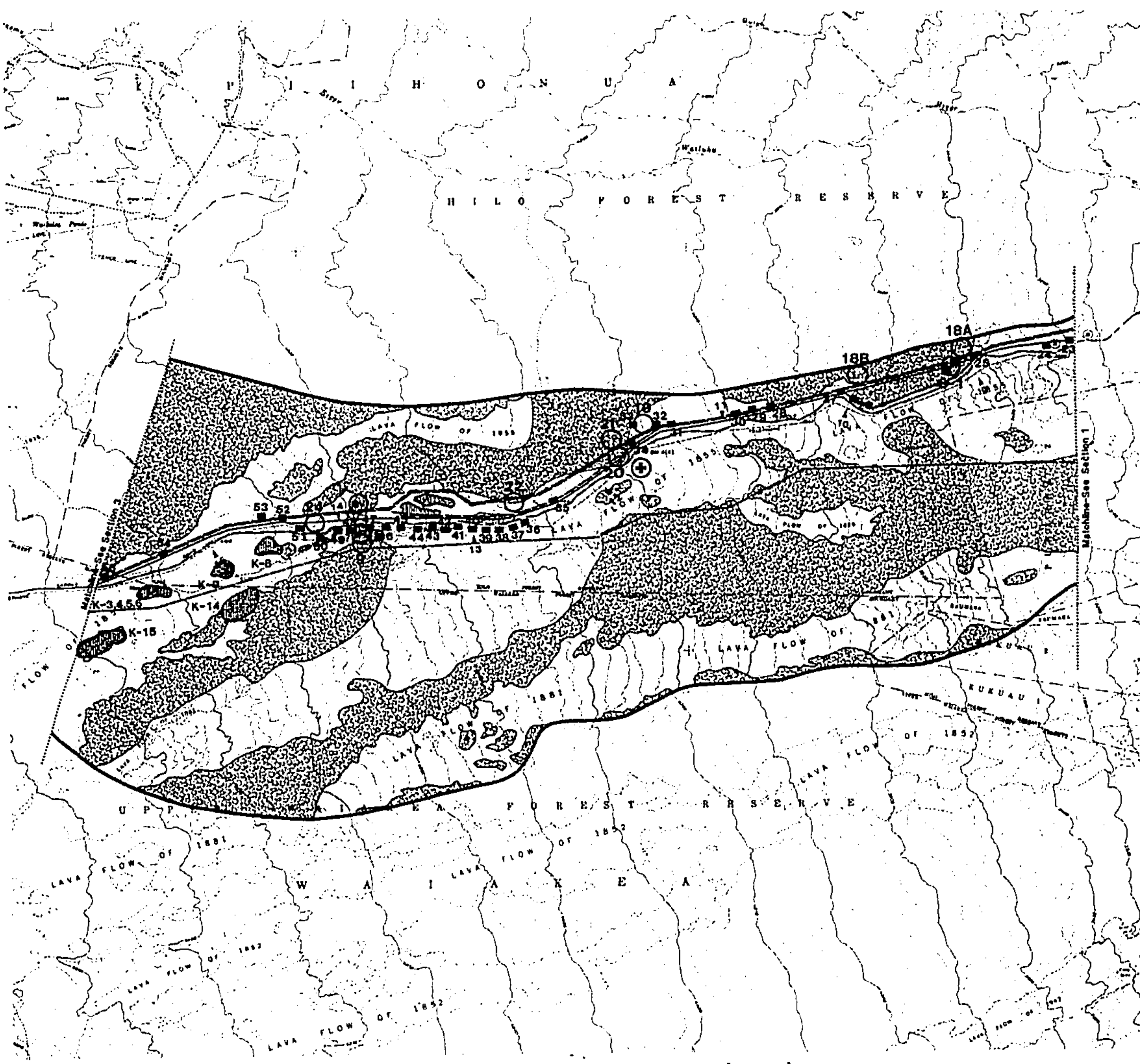

EXHIBIT A - SECTION 2

Legend

- Archaeological Survey - Chiniago Inc.
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- 18A Biological Survey - Bishop Museum
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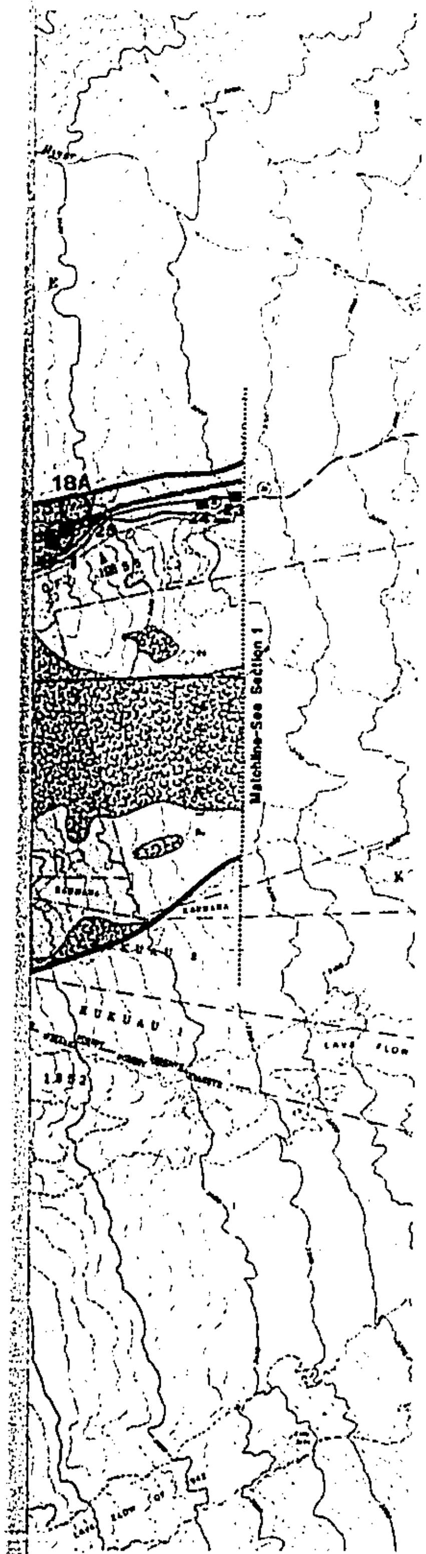

LEGEND

BASE DATA

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Existing road
Existing telephone line
Existing 69 KV line
Substation
Reference marker
Matchline
Preferred 138 KV alignment
Alternate 138 KV alignment

LAND USE FACTORS

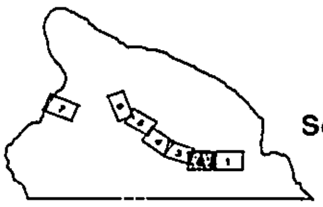
Urban
Agriculture
Grazing
Military
Recreation
Historic site

BIOLOGICAL FACTORS

Ohia/Koa native forest
Mamane/Naio native forest
Introduced forest
Palila critical habitat
Kipuka and cave habitats

GEOPHYSICAL FACTORS

Slopes 20% & greater
High soil erosion hazard
Stream
Reservoir



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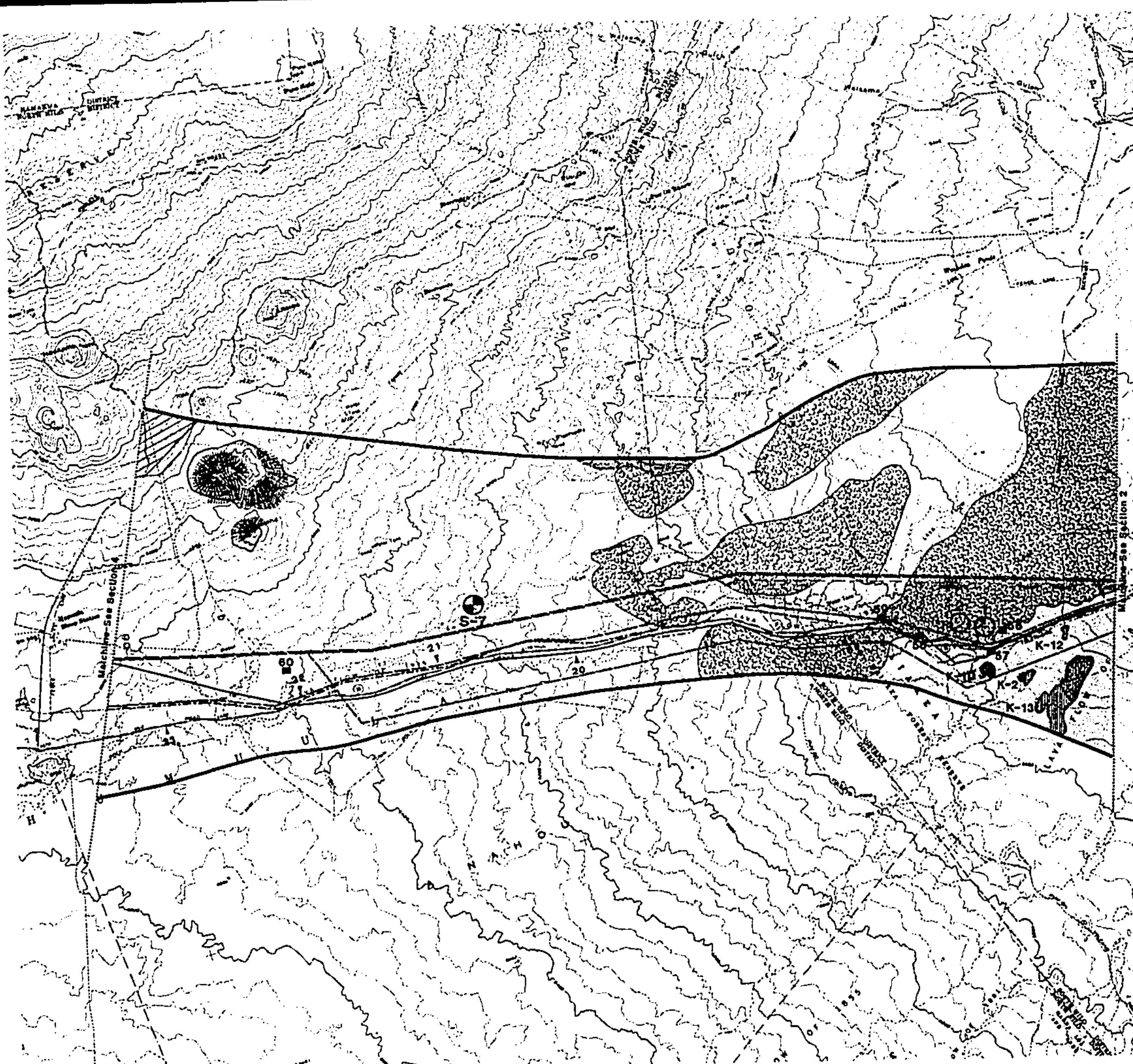


Legend

- ⊙ Archaeological Survey – Chiniago Inc.
- S-1 Geological Survey – Walter Lum & Associates
- 18A ◯ Biological Survey – Bishop Museum
- 26 ■ Pole Line Reference Marker (PLRM) – Bishop M

EXHIBIT A – SECTION 3

HELCO TRANSMISSION LINE ROUTING STUD

LEGEND

BASE DATA

- Edge of corridor
- Existing road
- Existing telephone line
- Existing 69 KV line
- Substation
- Reference marker
- Matchline
- Preferred 138 KV alignment
- Alternate 138 KV alignment

LAND USE FACTORS

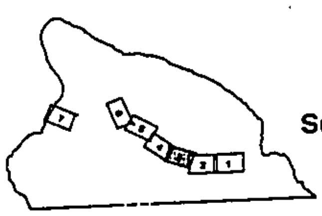
- Urban
- Agriculture
- Grazing
- Military
- Recreation
- Historic site

BIOLOGICAL FACTORS

- Ohia/Koa native forest
- Mamane/Naio native forest
- Introduced forest
- Palila critical habitat
- Kipuka and cave habitats

GEOPHYSICAL FACTORS

- Slopes 20% & greater
- High soil erosion hazard
- Stream
- Reservoir



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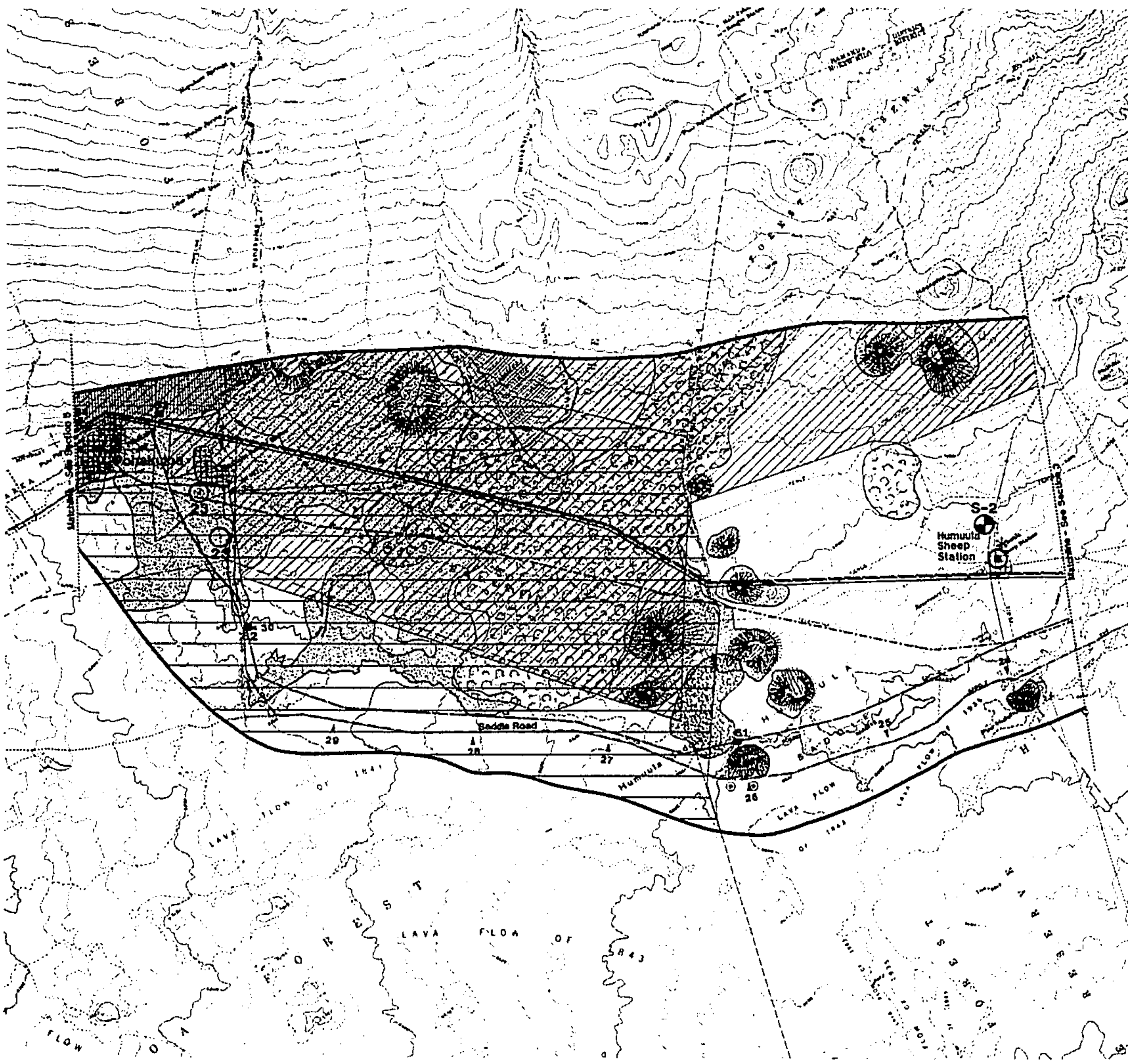

EXHIBIT A - SECTION 4

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- 18A ◯ Biological Survey - Bishop Museum
- 26 ■ Pole Line Reference Marker (PLRM) - Bishop Mus

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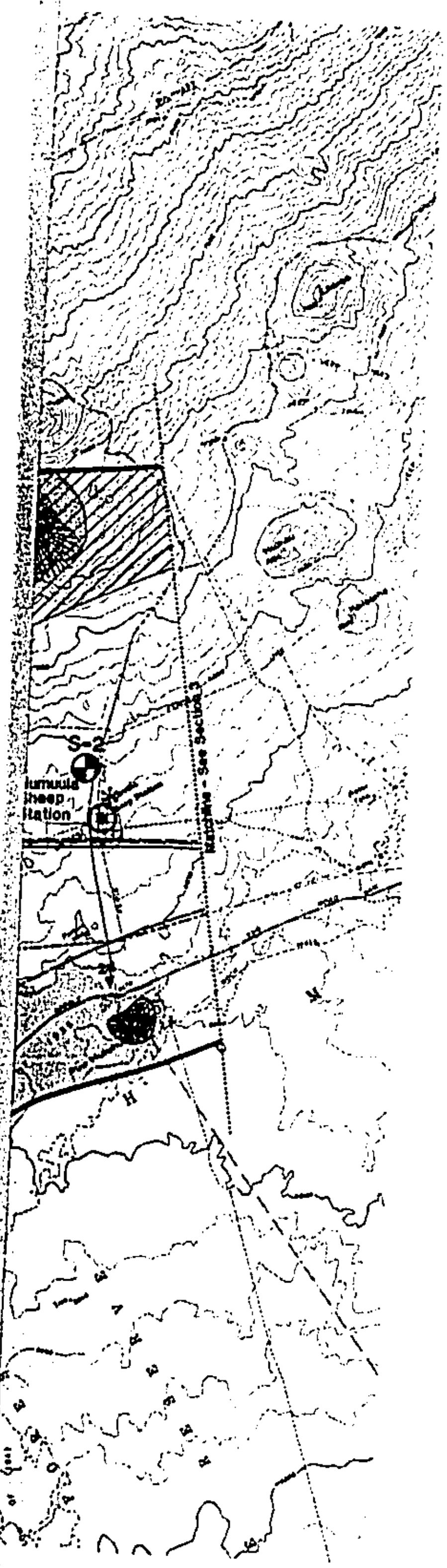

LEGEND

BASE DATA

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- Existing road
- Existing telephone line
- Existing 69 KV line
- Substation
- Reference marker
- Matchline
- Preferred 138 KV alignment
- Alternate 138 KV alignment

LAND USE FACTORS

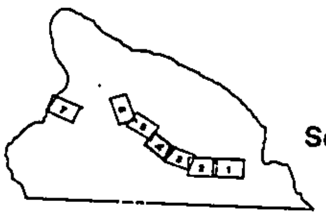
- Urban
- Agriculture
- Grazing
- Military
- Recreation
- Historic site

BIOLOGICAL FACTORS

- Ohia/Koa native forest
- Mamane/Naio native forest
- Introduced forest
- Palila critical habitat
- Kipuka and cave habitats K-9

GEOPHYSICAL FACTORS

- Slopes 20% & greater
- High soil erosion hazard
- Stream
- Reservoir



Section 4

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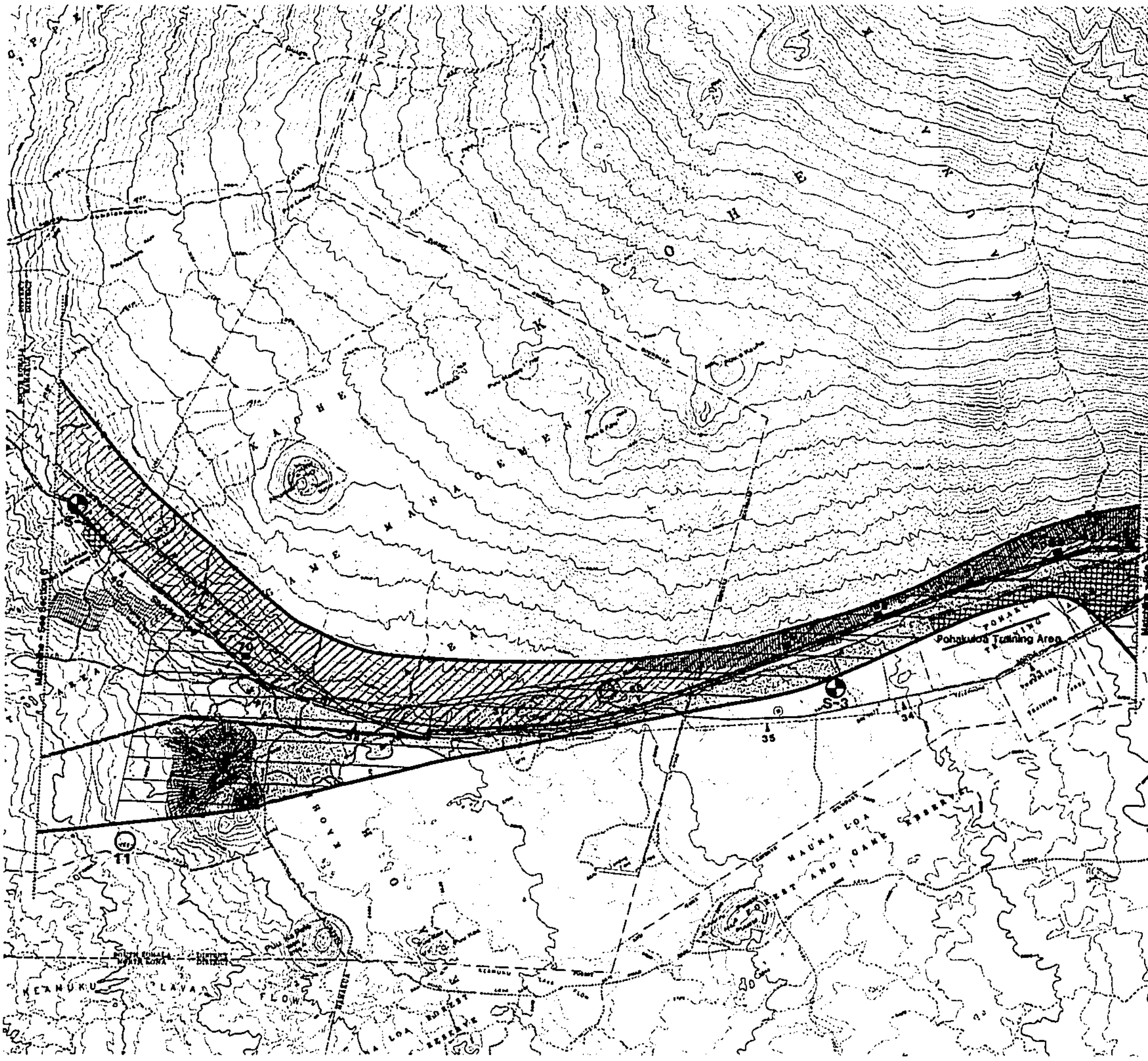

EXHIBIT A - SECTION 5

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- S-1 Geological Survey - Walter Lum & Associates
- 18A ○ Biological Survey - Bishop Museum
- 26 ■ Pole Line Reference Marker (PLRM) - Bishop Museum

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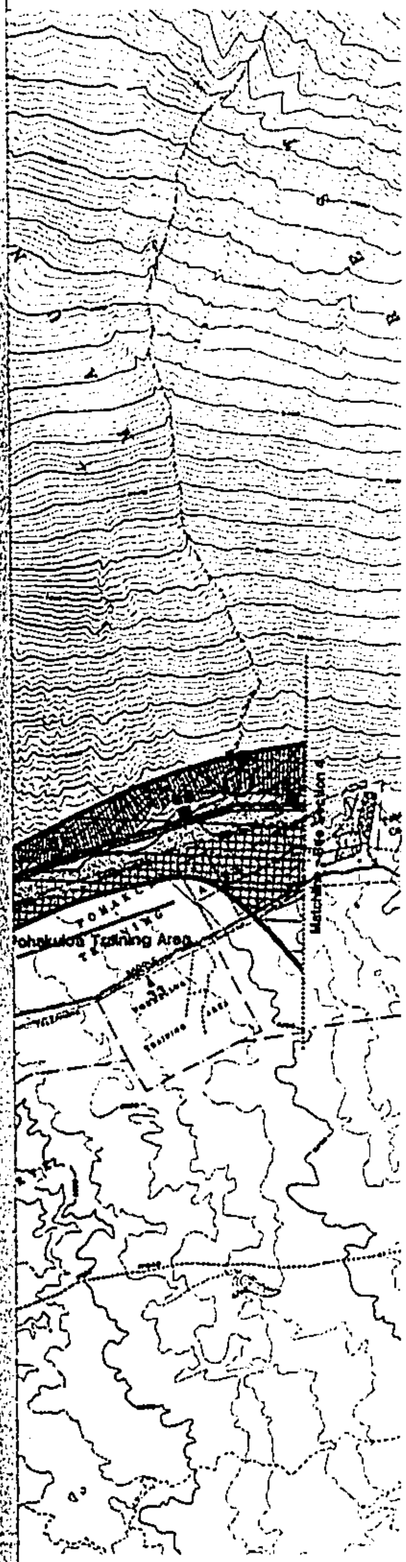

LEGEND

BASE DATA

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- Substation
- Reference marker
- Matchline
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LAND USE FACTORS

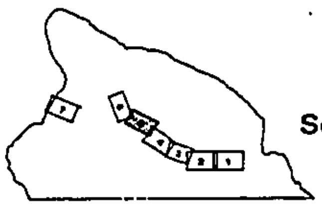
- Urban
- Agriculture
- Grazing
- Military
- Recreation
- Historic site *

BIOLOGICAL FACTORS

- Ohia/Koa native forest
- Mamane/Naio native forest
- Introduced forest
- Palila critical habitat
- Kipuka and cave habitats K-9

GEOPHYSICAL FACTORS

- Slopes 20% & greater
- High soil erosion hazard
- Stream
- Reservoir



Section 5

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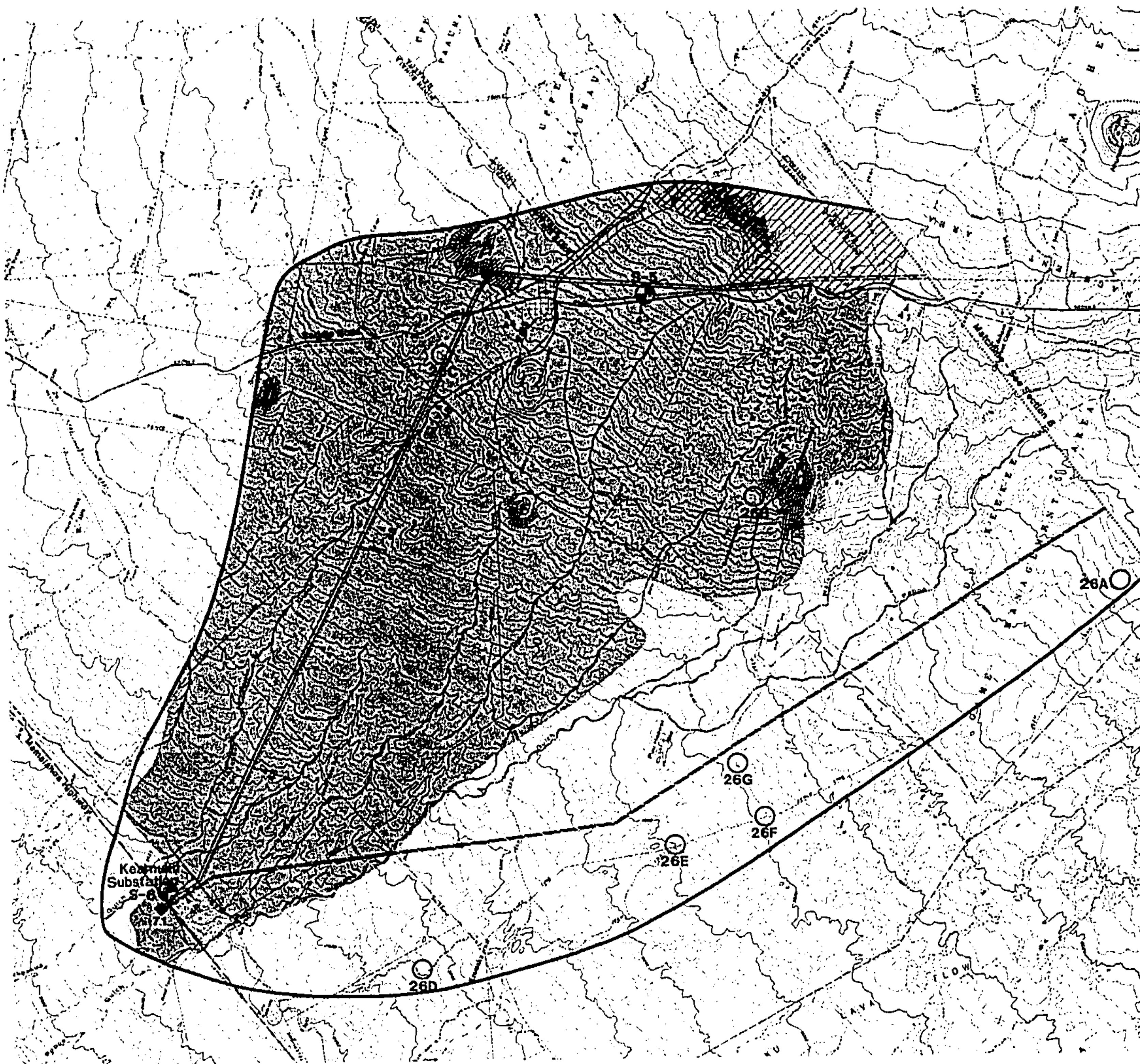

EXHIBIT A - SECTION 6

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- ⊙ Archaeological Survey - Chiniago Inc.
- S-1 Geological Survey - Walter Lum & Associates
- 18A ○ Biological Survey - Bishop Museum
- 26 ■ Pole Line Reference Marker (PLRM) - Bishop Mus

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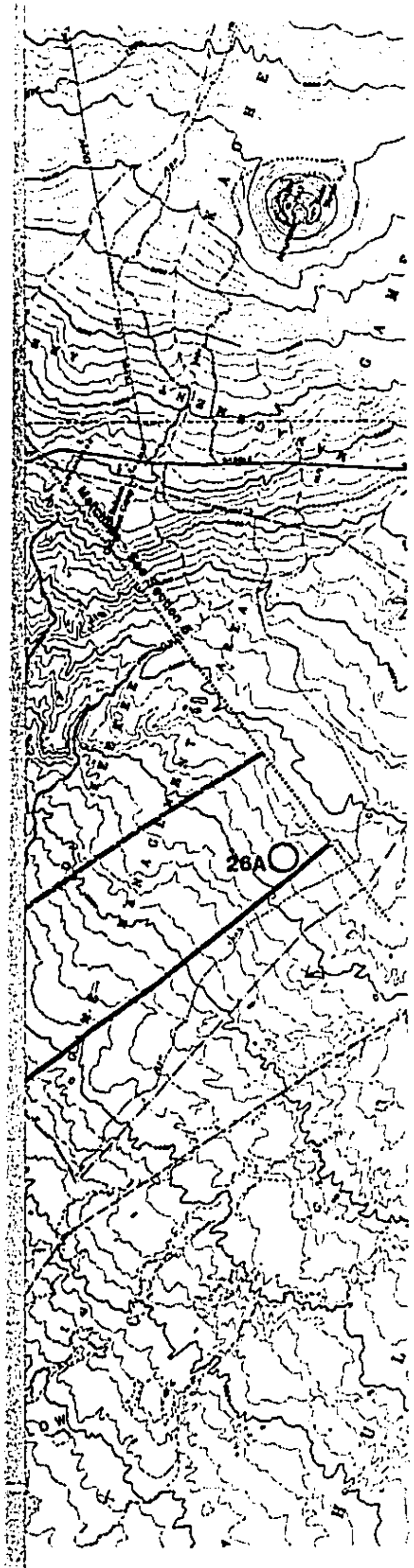

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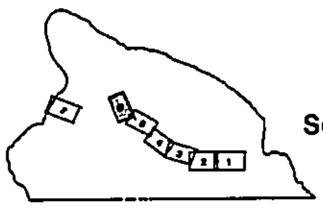

Section 6

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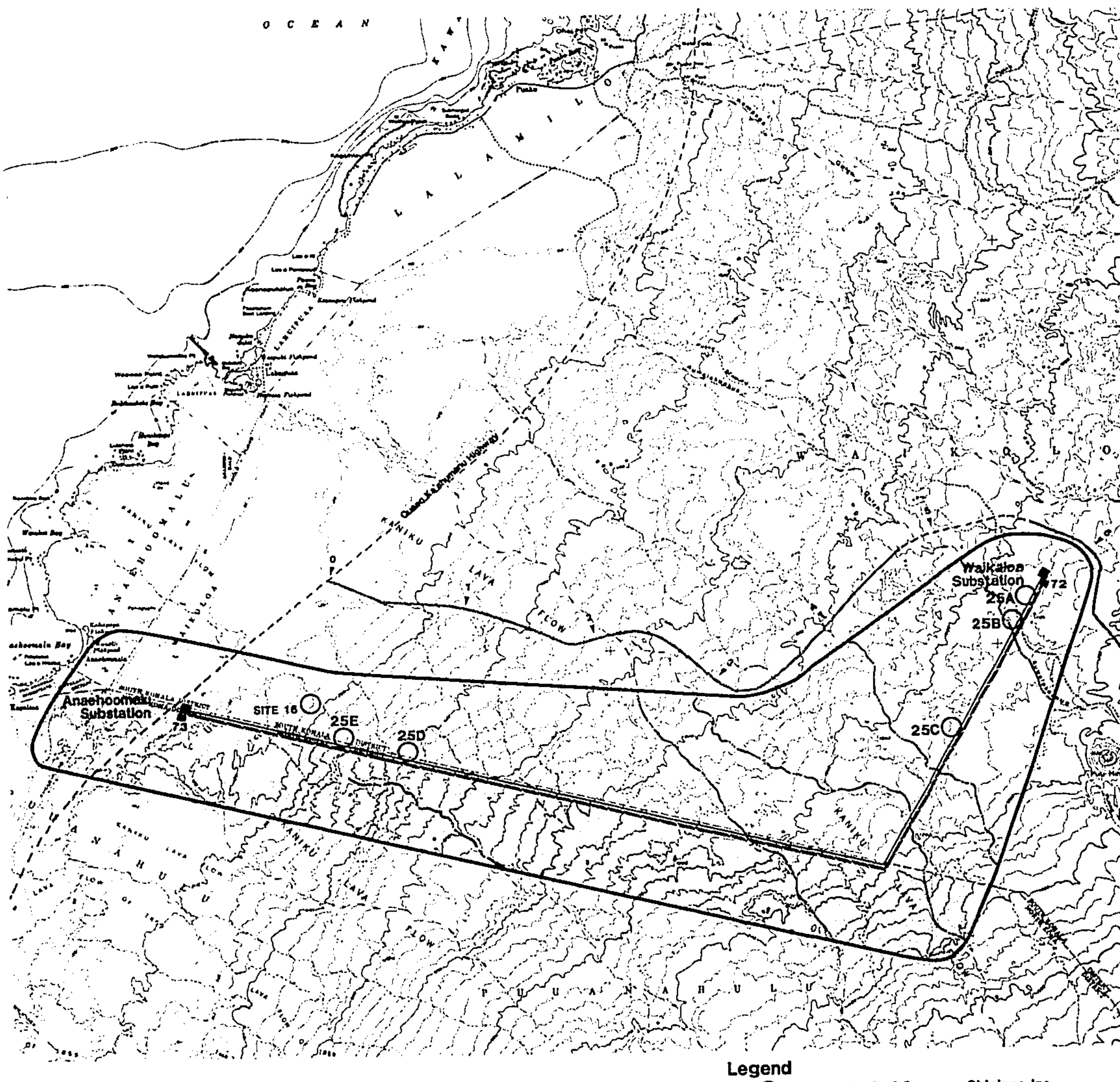

EXHIBIT A - SECTION 7

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- ⊙ Archaeological Survey - Chiniago Inc.
- S-1 Geological Survey - Walter Lum & Associates
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- 26 ■ Pole Line Reference Marker (PLRM) - Bishop M

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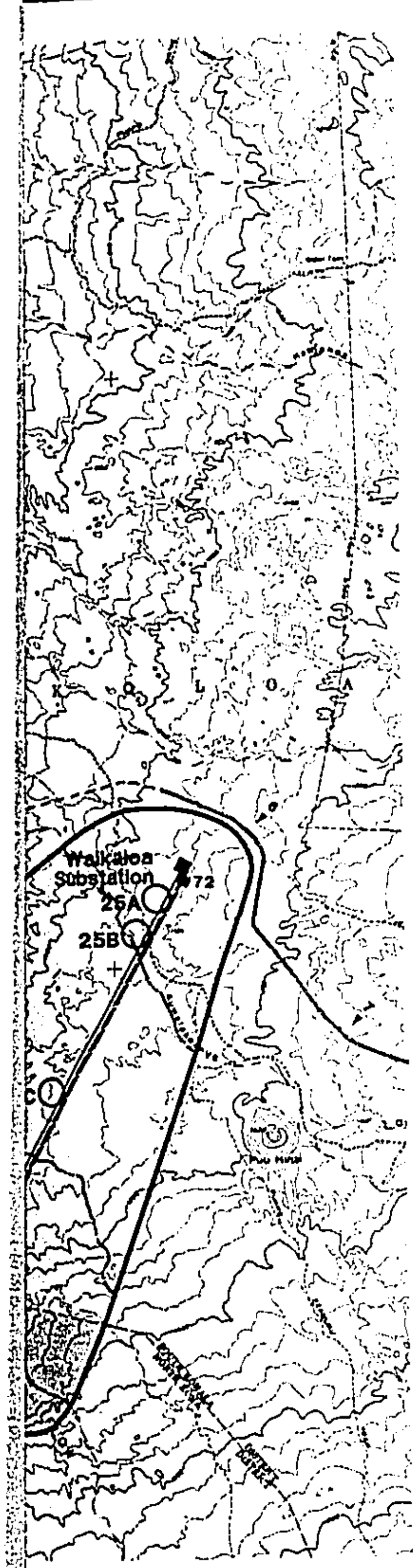
TRANSMISSION LINE ROUTING STUD



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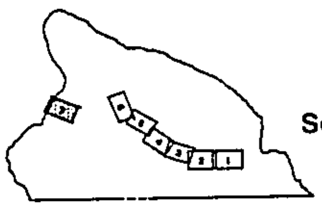

Section 7

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