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AQUACULTURE DEVELOPMENT PROGRAM
AQUATIC RESOURCES
BOATING AND OCEAN RECREATION
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CONSERVATION AND RESOURCES ENFORCEMENT
CONVEYANCES
FORESTRY AND WILDLIFE
HISTORIC PRESERVATION
LAND MANAGEMENT
STATE PARKS
WATER AND LAND DEVELOPMENT

File No.: HA-2672

MAR 21 1994

Hawaii Electric Light Company, Inc.
P.O. Box 1027
Hilo, Hawaii 96721-1027
Attn: Dennis Tanigawa

Dear Mr. Tanigawa,

Suject: Final Environmental Impact Statement for the Keahole-Kailua 69 KV Transmission Line Project

We have completed our review of your Final Environmental Impact Statement. The judgement in question is whether the Final EIS is an acceptable or non-acceptable document under Chapter 343, Hawaii Revised Statutes, as amended. Acceptance means that the document fulfills the definition of an Environmental Impact Statement (EIS), adequately describes identifiable environmental impacts, and satisfoctorily responds to comments received during the review of the statement as prescribed by Title 11, Chapter 200, Hawaii Administrative Rules. Adequate disclosure means factual description the environmental effects of the proposed action, effects of the proposed action on the economic and social welfare of the community and State, measures proposed to minimize adverse effects and alternatives to the action and their environmental effects.

Considering our focus on the requirements for information and disclosure as having been adequately met, we find the document acceptable under Chapter 343, Hawaii Revised Statutes, as amended.

In our view, the document, in and of itself, should not be used as a vehicle to promote or detract from any required subsequent judgement on the proposed project itself. We have consistently maintained this position in the past.

We should also point out that the acceptability of the document is based upon the criteria set forth and does not resolve any of the outstanding issues on the separate but related Keahole Generating Station Expansion project.

If you have any questions, please feel free to contact Don Horiuchi of the Office of Conservation and Environmental Affairs at 587-0381.

Very truly yours,

Keith W. Ahue

cc: Bennett Mark, CH2M Hill

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KEAHOLE - KAILUA TRANSMISSION LINE

FILE COPY

Final Environmental Impact Statement

KEAHOLE - KAILUA
69 kV TRANSMISSION LINE PROJECT

APPLICANT

Hawaii Electric Light Company, Inc.
An HEI Company

JANUARY 1994

CH2M HILL

Final Environmental Impact Statement

KEAHOLE - KAILUA
69 kV TRANSMISSION LINE PROJECT

APPLICANT

Hawaii Electric Light Company, Inc.

An HEI Company

Submitted pursuant to CHAPTER 343, HAWAII REVISED STATUTES
Accepting authority: STATE OF HAWAII, DEPARTMENT OF LAND AND NATURAL RESOURCES
Approving agency: STATE OF HAWAII, BOARD OF LAND AND NATURAL RESOURCES

JANUARY 1994

CH2M HILL

PRINTED ON RECYCLED AND RECYCLABLE PAPER

EXECUTIVE SUMMARY

Executive Summary

Proposed Action:

Hawaii Electric Light Company, Inc. (HELCO) proposes to install an approximately 6.8-mile-long double-circuit 69 kV overhead transmission line from its Keahole Switching Station to its Kailua Substation.

Purpose of this EIS:

This environmental impact statement (EIS) was prepared pursuant to Chapter 343, Hawaii Revised Statutes (HRS). Any project proposing the use of lands within the State's Conservation District or lands owned by the State must comply with Chapter 343, HRS. Portions of this project are located within Conservation District lands and/or are on land owned by the State of Hawaii.

Subsequent Discretionary Approvals Required:

A Conservation District Use Approval (CDUA) and Use of State Lands approval is required from the State of Hawaii Board of Land and Natural Resources (BLNR). Following this, approval by the Public Utilities Commission (PUC) is required.

Compatibility with Land Use Plans and Policies:

The proposed use is an expansion of an existing non-conforming use in the General Subzone of State Conservation District land and is an allowable use of State of Hawaii land.

Benefits of This Project:

The proposed transmission line would accommodate load growth and maintain system reliability. Planning studies have concluded that the proposed line must be in place by December 1994 in order for service quality and reliability to be maintained. This project would lessen the potential for interruption of power.

Alternatives Considered:

Overhead, underground, and submarine technology alternatives and eight different corridor route alternatives were analyzed for environmental impacts by CH2M HILL, HELCO's environmental consultant. In CH2M HILL's environmental sensitivity analysis, the overhead and underground alternative corridors along the mauka edge of the Queen Kaahumanu Highway and along Kaiwi Street emerged as the top two preferred alternatives.

Incompatibility with the State Department of Transportation's plans to widen Queen Kaahumanu Highway renders the underground alternative impractical.

Adverse Impacts of This Project and Proposed Mitigation Measures:

Views from automobiles on Queen Kaahumanu Highway and from areas in close proximity to the highway already include the existing wood poles. These views would be minimally affected since the existing wood poles will be replaced with slightly taller wood or steel poles. Landscaping mitigation was considered but is not being proposed because plans by the State Department of Transportation for eventual widening of Queen Kaahumanu Highway involve grading that would remove any plantings from this project.

There is an insignificant potential for impact to a plant species *(Capparis sandwichiana)* which is relatively abundant in the study area and is a candidate for federal listing. Biological mitigation would involve a biologist at pre-construction meetings with site engineers, and the surveying of proposed individual pole locations and construction areas, in order to help identify and avoid *Capparis sandwichiana* shrubs. In areas where *Capparis sandwichiana* have been identified, helicopter-assisted stringing of conductors and low-impact direct charges for excavating holes may be utilized to avoid the shrubs. Even if individual *Capparis sandwichiana* shrubs are removed during the construction of pole foundations, biologists have indicated that the potential impact to this plant species is likely to be insignificant.

Overall, the potential impact to cultural resources is low because the existing transmission line alignment will be followed. Individual pole locations, and areas where construction activities may occur, will be reviewed by an archeaologist before work begins to ensure that identified cultural sites and features are avoided.

Traffic on Queen Kaahumanu Highway would be affected temporarily during construction. Traffic mitigation would involve adherence to the State of Hawaii Department of Transportation regulations on how construction projects must be carried out in order to reduce traffic impacts to acceptable levels

Unresolved Issue: The issue of public health effects from electric and magnetic fields (EMF) remains unresolved. The double-sided double-circuit overhead configuration proposed by HELCO has the lowest EMF field values of all the alternatives examined, both overhead and underground.

Community Involvement: On December 3, 1992, HELCO met with a group of interested citizens in Keahou to describe the process used for identifying and ranking the alternative corridors. This meeting was followed by two community workshops, one held in Kailua-Kona on December 15, 1992, and another on February 9, 1993. The purpose of these meetings was to gather public input on the alternative technology and alternative corridor selection process.

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Note: This final environmental impact statement (EIS) incorporates by reference Appendixes A through H, which are presented in a separate volume, *Environmental Impact Statement: Appendixes: Keahole-Kailua 69 kV Transmission Line Project* (April 1993). In response to comments on the draft EIS, this environmental impact statement also incorporates by reference the following revisions to Appendix A, page A-3, as requested by the State of Hawaii Land Use Commission: (1) The Board of Land and Natural Resources designates the State Land Use Conservation District, Protective Subzone, and (2) The Land Use Commission, pursuant to Chapter 205, Hawaii Revised Statues, has established the State Land Use Districts throughout the state.

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ACRONYMS & ABBREVIATIONS

Acronyms and Abbreviations

$\mu g/m^3$	micrograms per cubic meter
AAAC	all-aluminum alloy conductor
AC	alternating current
ALISH	Agricultural Lands of Importance to the State of Hawaii
Btu/hr	British thermal units per hour
CAB	Clean Air Branch
CDUA	Conservation District Use Application
CFR	Code of Federal Regulations
CO	carbon monoxide
CT	combustion turbine
dB	decibel
dBA	A-weighted decibel
DLNR	Department of Land and Natural Resources
DLNR-SHPD	State Historic Preservation Division of the Department of Land and Natural Resources
DOH	Department of Health
EA	environmental assessment
EIS	environmental impact statement
EISPN	Environmental Impact Statement Preparation Notice
ELF	extremely low frequency
EMF	electric and magnetic fields
EPA	U.S. Environmental Protection Agency
EPRI	Electric Power Research Institute
FAA	Federal Aviation Administration
FEMA	Federal Emergency Management Agency
FIRMs	flood insurance rate maps
GO-6	Hawaii PUC's General Order No. 6
H_2S	hydrogen sulfide
HAR	Hawaii Administrative Rules
HCZMP	Hawaii Coastal Zone Management Program
HECO	Hawaiian Electric Company, Inc.
HELCO	Hawaii Electric Light Company, Inc.
HFDC	Housing Finance and Development Corporation
HOST	Hawaii Ocean Science and Technology
HPFF	high-pressure fluid-filled
HRS	Hawaii Revised Statutes
Hz	hertz
IITRI	Illinois Institute of Technology Research Institute
kcmil	one thousand circular mils
kV	kilovolt
kV/m	kilovolts per meter
L_{dn}	day-night sound level

L_{eq}	equivalent sound level
LPFF	low-pressure fluid-filled
LUDs	Land Use Districts
L_{xx}	percentile exceeded sound level
mg/m^3	milligrams per cubic meter
mG	milliGauss
MW	megawatts
NAAQS	National Ambient Air Quality Standards
NELH	Natural Energy Laboratory of Hawaii
NESC	National Electric Safety Code
NO_2	nitrogen dioxide
O_3	ozone
OEQC	Office of Environmental Quality Center
Pb	lead
PHRI	Paul H. Rosendahl, Ph.D., Inc.
PM_{10}	particulate matter less than 10 microns in diameter
ppb	parts per billion
psi	pounds per square inch
PUC	Public Utilities Commission
PVC	polyvinyl chloride
RF	radio frequency
ROW	right-of-way
SAB	Science Advisory Board
SF_6	sulfur hexafluoride
SMA	Special Management Area
SMP	Special Management Area Use Permit
SO_2	sulfur dioxide
TSP	total suspended particulate matter
V/m	volts per meter

CHAPTER 1

Chapter 1
Summary

Background

The Keahole-Kailua transmission line project is proposed as a 69 kilovolt (kV) alternating current transmission line between the Keahole Switching Station (which is next to Keahole Generating Station, near Keahole Airport) and Kailua Substation (located on Kaiwi Street in Kailua-Kona) (Figure 1-1). The line would extend approximately 6.8 miles and would generally follow the mauka edge of Queen Kaahumanu Highway. This environmental impact statement (EIS) evaluates two alternatives in the proposed alignment: an overhead alternative and an underground alternative. The overhead alternative is the preferred alternative of Hawaii Electric Light Company, Inc. (HELCO).

Purpose and Need

The proposed transmission line is needed to accommodate load growth and maintain system reliability. From 1992 to 1997, electrical loads are predicted to grow from 45 megawatts (MW) to 63 MW in the North Kona and South Kona districts. HELCO must expand and improve the West Hawaii transmission system to accommodate growing electrical demand.

Schedule

Given the growing demands for electricity, the proposed Keahole-Kailua transmission line must be in place and energized by December 1994 for HELCO to maintain an acceptable level of reliability on the system.

Alternatives Examined in the EIS

CH2M HILL, HELCO's environmental consultant, has gone through a lengthy process to identify potential alternatives for the Keahole-Kailua transmission line project, as documented in this EIS. This evaluation has included technical analyses and consultation with agencies and the general public.

Technology Alternatives

CH2M HILL initially evaluated overhead, submarine, and underground technologies (including typical trenched underground cable and shallow trench, near-surface, and surface methods of installation), as documented in Chapter 4 of this EIS. Considering system reliability, environmental factors, and costs, CH2M HILL concluded that only overhead and underground trenched cable technologies would be analyzed further.

Corridor Identification

The environmental resources of the study area were mapped in order to identify constraints and opportunities for the siting of transmission line corridors. Environmental factors mapped for the study area included land ownership and regulation; existing and proposed land uses; visual, biological, geological, and cultural resources; and utility and transportation systems. An evaluation of the constraints and opportunities related to these environmental factors led to the identification of three main transmission line corridors, each one-quarter to one-half mile wide.

Corridor S-1 (Queen Kaahumanu Highway)

This corridor has two variations—one that follows the mauka edge of the highway right-of-way and one that follows the makai edge of the highway right-of-way.

Corridor S-1 Mauka (Queen Kaahumanu Highway—mauka of center line). This corridor contains an existing 69 kV transmission line and follows the mauka edge of the Queen Kaahumanu Highway right-of-way. Queen Kaahumanu Highway provides a linear corridor that could accommodate the new transmission line.

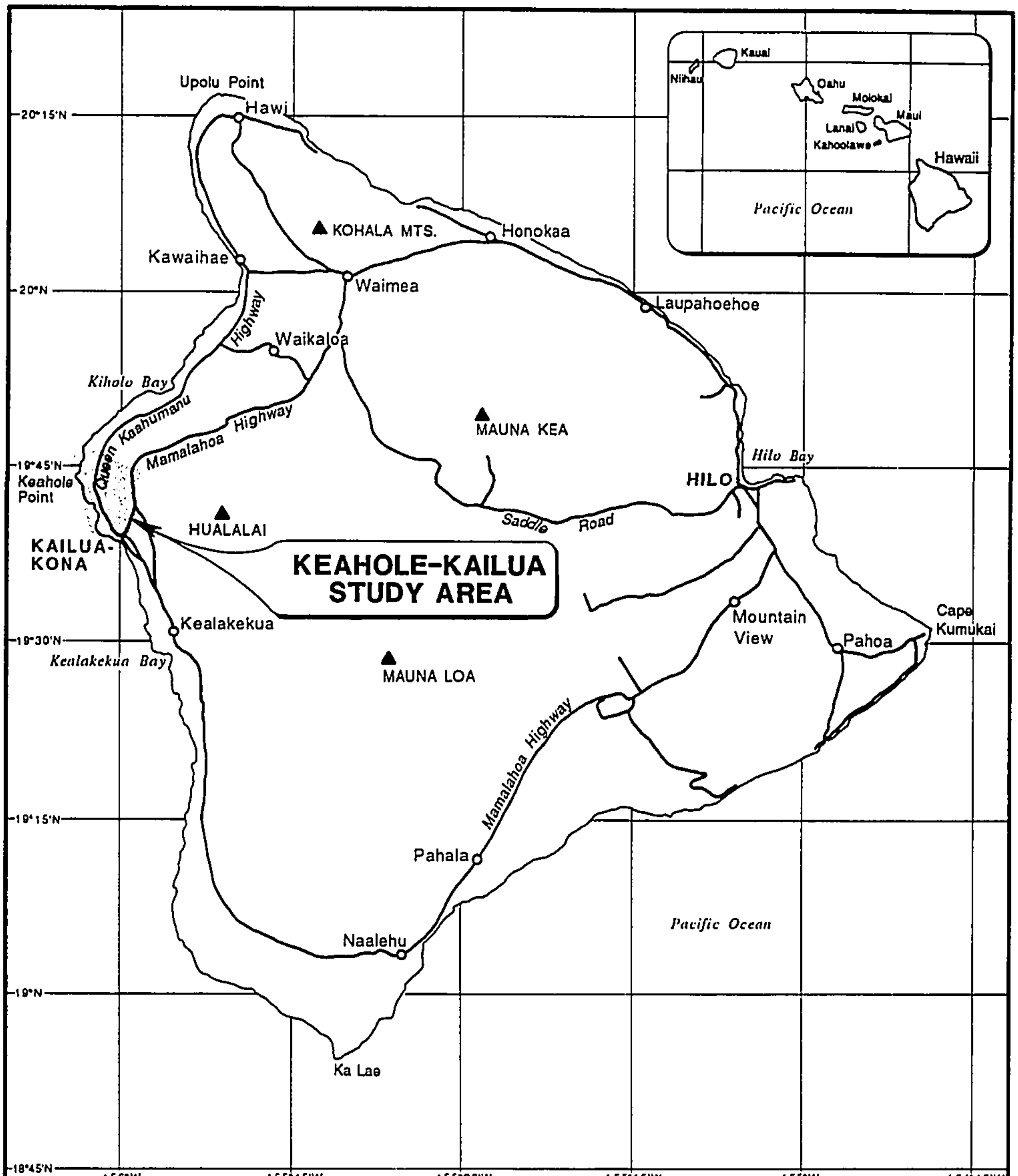
Corridor S-1 Makai (Queen Kaahumanu Highway—makai of center line). This corridor follows the makai edge of the Queen Kaahumanu Highway right-of-way. There are no existing transmission or utility lines in this corridor.

Corridor S-2 (Midlevel, about one-half mile mauka of Queen Kaahumanu Highway)

This corridor is situated midway between Queen Kaahumanu Highway and Mamalahoa Highway. Corridor S-2 contains several significant natural resources, including endangered plants and animals, natural biological communities, a remnant forest dominated by native Hawaiian vegetation, and lava tube openings and potential lava tube corridors that may support candidate endangered invertebrates.

Corridor S-3 (Mamalahoa Highway/Palani Road)

This corridor runs parallel to and includes existing 69 kV lines from Keahole Switching Station mauka to Mamalahoa Highway; it then travels south along Mamalahoa Highway and Palani Road. This corridor provides opportunities to follow existing 69 kV transmission lines and existing road rights-of-way to the Kailua Substation. Because of the terrain, if an additional transmission line were installed, it would need to cross Palani Road several times. This corridor passes through many residential areas and would require easements from more private landowners than the other main corridors would. A residential area and the West Hawaii campus of the University of Hawaii are proposed uses in this corridor. Rare biological elements are found in this corridor.



LEGEND

- o City or Town
- ——— Highway or Major Road
- ▲ Mountain

KEAHOLE-KAILUA TRANSMISSION LINE PROJECT

FIGURE 1-1

PROJECT LOCATION MAP

NORTH

0 5 10 20 MILES

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Variations of this corridor connect portions of Corridor S-2 and Corridor S-3 with one of four makai-to-mauka connectors.

Corridor Evaluation

Using a quantitative sensitivity analysis, each of the corridors was evaluated in terms of the following criteria:

- Avoiding existing residential areas, schools, recreation areas, and other high-public-use areas
- Minimizing conflicts with proposed residential and commercial projects
- Maximizing the use, wherever possible, of existing 69 kV transmission line corridors
- Maximizing the use of existing transportation corridors
- Minimizing the number of separate land jurisdictions that the corridor traverses
- Avoiding areas that contain significant biological and cultural resources
- Avoiding areas that are politically infeasible and/or controversial to the public
- Minimizing corridor length

This evaluation led CH2M HILL to eliminate from further consideration Corridor S-3 and its variations, since these corridors contain large areas rated as high constraint because of environmental factors. Most prominently, these corridors all contain several existing and proposed residential areas and schools. Portions of these corridors also contain sensitive biological resources (such as remnant forests dominated by native Hawaiian vegetation) and sensitive cultural resources (e.g., trails and archaeological sites or features).

CH2M HILL also decided to eliminate Corridor S-2 from further consideration, for reasons similar to those that led to the elimination of Corridor S-3. Although Corridor S-2 has fewer existing and proposed residential areas and schools than Corridor S-3, it does have endangered and possible candidate endangered plant species and significant trails and archaeological sites or features that could be adversely affected by the proposed project.

Corridor S-1 Makai was also eliminated from further consideration because of the potential for land use conflicts and visual and cultural resource impacts. The corridor is within a coastal zone Special Management Area and would run through sections of both the Kaloko-Honokohau National Historic Park and the Mamalahoa Trail. The siting of transmission lines in any of these areas is strongly discouraged. Makai views from Queen Kaahumanu

Highway, mauka views from the Kaloko-Honokohau National Historic Park, and parts of the Mamalahoa Trail could be adversely affected by this alternative.

After eliminating from further consideration Corridor S-1 makai, Corridor S-2, and Corridor S-3 and its variations, only Corridor S-1 mauka was analyzed further to identify alternative alignments.

Identification of Alternative Alignments

CH2M HILL identified two alternative alignments within the S-1 mauka corridor:

- **S-1 Mauka Overhead Alternative.** This alternative would be an overhead transmission line consisting of three conductors on wood or steel poles. Upon leaving the Keahole Switching Station, the new transmission line would be placed within the mauka edge of the Queen Kaahumanu Highway right-of-way at the approximate location of the existing 69 kV line. At Kaiwi Street, the new line would cross the highway and follow the existing 69 kV alignment to Kailua Substation. New wood or steel poles would replace the existing wood poles. New 69 kV conductors for the new transmission line and replacement 69 kV conductors for the existing transmission line would both be placed on the new poles.

- **S-1 Mauka Underground Alternative.** This alternative would follow the same alignment as the overhead alternative, but the line would consist of three solid dielectric cables encased in a concrete shell buried 3 to 4 feet below the ground surface.

Evaluation of Alternative Alignments

Table 1-1 and Figure 1-2 summarize the characteristics and potential environmental effects of the underground and overhead alignment alternatives along the mauka edge of the Queen Kaahumanu Highway right-of-way. As the table shows, overhead transmission lines generally have greater visual impacts than underground lines but fewer surface and subsurface impacts. Figure 1-2 shows that, although the overhead alternative would be more visible, it would have less potential for adverse impacts to biological and cultural resources than the underground alternative would. In addition, the overhead alternative would be easier to maintain and would be far less costly to ratepayers. For these reasons, which are documented in more detail in this EIS, HELCO proposes to construct the overhead alternative.

Table 1-1
S-1 Mauka Overhead and Underground Alternatives
Summary of Engineering Characteristics and Potential Impacts

Engineering Characteristics				Construction, Operation, and Maintenance Effects			
Transmission Technology	Basic System Components	Approximate Line Length	Construction Cost ($M/Mile)	Geophysical, Biological, and Cultural Resources	EMF and Visual Resources	Traffic Considerations	Maintenance Considerations
Overhead	Wood or tubular steel poles. Double-circuit lines on one side of pole (Configuration No. 1, see Figure 3-1). Pole height: 70 to 85 feet. Double-circuit lines, with one circuit on each side of pole (Configuration No. 2, see Figure 3-1). Pole height: 60 to 75 feet. Low-reactance (unlike) phasing. Direct embedment and augered concrete pier foundations. Three aluminum conductors per circuit and one shield wire.	6.8	Wood poles: 0.24 Tubular steel poles: 1.1	Clearing of surface vegetation at pole sites. Excavation for pole foundations. Trees near the alignment trimmed within 10 feet of conductor position in high wind. Subsurface archaeological features may be disturbed in excavations. Requires field archaeologist to survey pole sites.	EMF[a] Double-circuit lines on one side of pole (Configuration No. 1, see Figure 3-1). Maximum electric field near center of alignment approx. 0.175 kV/m. Maximum magnetic field near center of alignment approx. 1.30 mG. Double-circuit lines, with one circuit on each side of pole (Configuration No. 2, see Figure 3-1). Maximum electric field near center of alignment approximately 0.091 kV/m. Maximum magnetic field near center of alignment approximately 1.01 mG. Visual Poles and conductors visible throughout.	Construction For roadway near alignment, one lane of traffic obstructed for 4-6 weeks each mile during peak traffic periods (two lanes off-peak). Maintenance Potential traffic disruption or delays depending on type of repair and maintenance practices.	Location and access to line repair relatively easy. Repair time: hours.

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Table 1-1
S-1 Mauka Overhead and Underground Alternatives
Summary of Engineering Characteristics and Potential Impacts

Engineering Characteristics				Construction, Operation, and Maintenance Effects			
Transmission Technology	Basic System Components	Approximate Line Length	Construction Cost ($M/Mile)	Geophysical, Biological, and Cultural Resources	EMF and Visual Resources	Traffic Considerations	Maintenance Considerations
Underground (Solid Dielectric Cable)	Solid dielectric cables (three per circuit) encased in concrete shell. Splice vaults (manholes) every 1,000 feet.	6.8	1.0-3.8	Construction Trench excavation 4 feet wide and 8 feet deep. Temporary loss of surface vegetation and revegetation of low-growing vegetation only. Potential soil layer mixing and topographic alteration as a result of cut and fill required for access. Potential to disrupt surface cultural resources within alignment. May require extensive survey and salvage plan. Operation In case an underground cable fails, spare ducts may be used for a replacement cable, without the need for excavation.	EMF[a] No electric field from underground cable. Magnetic field of approximately 10.44 mG at soil surface directly above cables. Visual No impact from underground cable.	Construction Longer period of traffic disruption for trenching and cable installation than with conventional overhead. Maintenance Potential traffic disruption during maintenance.	Potential for heavy traffic disruption during maintenance or repairs. Difficult to locate faults: hours to days. Repair period: days.

[a]The electric and magnetic field values presented in this table are the maximum values for the two proposed overhead line configurations with low-reactance (unlike) phasing of conductors and for the possible underground cable installed near the existing overhead line, configured with normal (like) phasing. These maximum values are summarized in a series of graphs (Figures G-3, G-5, G-8, G-10, and G-11) in Appendix G, "Electric and Magnetic Fields: Plots of Calculated Values," produced by Enertech Consultants. For the possible underground cable, electric fields would result only from the existing overhead transmission line, because shielding around the underground cable would contain the cable's electric fields. The maximum values cited here are consistent with those presented in Table 1-2; however, the maximum electric and magnetic field values are not always found exactly at the center of the existing poles because of the offset spacing of the conductors and the assumed location of the underground cable in relation to the existing poles.

IMPACT AREA	S-1 Mauka Overhead	S-1 Mauka Underground	No-Action
Land Use	No adverse impact	No adverse impact	No adverse impact
Demographics and Employment	No adverse impact	No adverse impact	No adverse impact
Visual Resources	Minor adverse impact	No adverse impact	No adverse impact
Geological Resources	No adverse impact	No adverse impact	No adverse impact
Biological Resources	No adverse impact	Minor adverse impact	No adverse impact
Cultural Resources	No adverse impact	Minor adverse impact	No adverse impact
Transportation and Traffic	No adverse impact	No adverse impact	No adverse impact
Air Quality	No adverse impact	No adverse impact	No adverse impact
Noise	No adverse impact	No adverse impact	No adverse impact
Utilities and Pipelines	No adverse impact	No adverse impact	No adverse impact
Public Services	No adverse impact	No adverse impact	No adverse impact
Maintenance	No adverse impact	Minor adverse impact	No adverse impact
Construction Cost	Minor adverse impact	Adverse impact	No adverse impact
Electric Service Reliability	No adverse impact	No adverse impact	Adverse impact

No adverse impact

Minor adverse impact

Adverse impact

KEAHOLE-KAILUA
TRANSMISSION LINE PROJECT

FIGURE 1-2

SUMMARY OF IMPACTS

CH2M HILL

HELCO's Preferred Alternative

HELCO's preferred alternative is an overhead transmission line located within the mauka edge of the Queen Kaahumanu Highway right-of-way. The proposed line would replace the existing single-circuit 69 kV transmission line with a double-circuit 69 kV transmission line on a single set of wood or steel poles. There are two possible configurations for the double-circuit 69 kV transmission line:

- A double-circuit, single-sided arrangement on poles that are 70 to 85 feet high. In this arrangement, all of the conductors for both 69 kV circuits would be on one side of the pole.
- A double-circuit, double-sided arrangement on poles that are 60 to 75 feet high. In this arrangement, the conductors for one 69 kV circuit would be placed on one side of the pole while the conductors for the other circuit would be placed on the other side of the pole.

Potential Impacts and Proposed Mitigation Measures

The proposed transmission line should cause no significant adverse impacts to existing or proposed land uses. In order to eliminate any conflict between the location of new transmission line poles and the State of Hawaii Department of Transportation's proposed widening of Queen Kaahumanu Highway, HELCO will coordinate its plans with the Department of Transportation.

The new transmission poles will be higher than the existing 55- to 65-foot-high poles, and the new poles will be more visible. In the double-circuit configuration where the conductors of both circuits are on one side of the pole, the poles will be 70 to 85 feet high; in the double-circuit configuration where the conductors are on opposite sides of the pole, the poles will be 60 to 75 feet high. Landscape mitigation is not being proposed for this project because the State of Hawaii Department of Transportation's plans call for widening the highway from its current two lanes to a four-lane divided highway with frontage roads. The planting of any landscaping materials would be temporary at best because the ultimate highway design will involve grading, and this would require the removal or destruction of any planting materials. It is more appropriate that landscaping along this alignment be accomplished in conjunction with the planned widening of Queen Kaahumanu Highway than with this project.

No adverse impacts are expected on geological or groundwater resources, although construction in some areas of pahoehoe lava may require excavating and backfilling any large cavities discovered at pole footing locations.

No endangered or threatened animal or plant species are likely to be affected. Specimens of the native pua pilo shrub (also known as maiapilo), a species of some concern, may be located along the proposed alignment. A biologist familiar with the biological resources of the project area will survey the proposed locations of individual poles to ensure that pua pilo shrubs are avoided wherever possible. To the maximum extent possible, construction sites will be accessed from the highway, and any construction staging or pole assembly areas will be located in previously approved disturbed areas.

The likelihood of adverse impacts on cultural resources is low, both because the existing transmission line alignment would be followed and because the line can be constructed and maintained from Queen Kaahumanu Highway. An archaeologist will review each pole site to ensure that identified cultural sites and features are avoided.

Air quality impacts will be minimal and will consist primarily of short-term automotive emissions and dust during construction. Dust will be controlled during construction, and emission control devices in construction vehicles will be maintained to ensure that combustion emissions are minimized. Construction near residences will be scheduled to minimize noise annoyance.

Construction activities will conform to State of Hawaii Department of Transportation rules regarding construction on highways, in order to minimize potential disruption of traffic along Queen Kaahumanu Highway.

No significant impacts are anticipated to employment, demographics, public services, or utilities.

Electric and Magnetic Field Levels

Electric fields are related to voltage level. Higher voltages result in stronger electric fields. Electric fields can be blocked through the use of shielding and grounding techniques, especially with underground lines. Magnetic fields, on the other hand, are related to the flow of current through a conductor. The higher the current flow, the stronger the magnetic field. Magnetic fields cannot be blocked with shielding, as electric fields can. However, magnetic fields can be lowered by using specific engineering design measures and operating procedures.

HELCO is committed to designing and operating an overhead 69 kV transmission line in a way that minimizes public exposure to both electric and magnetic fields measurable at ground level. HELCO will use the following engineering design measures and operating procedures for its proposed overhead line:

- **Equal current distribution.** HELCO will equalize the currents in each of three conductors in the proposed overhead 69 kV transmission line circuit. This arrangement results in minimization of magnetic fields.

- **Low-reactance phasing.** HELCO will use reverse phasing of the proposed overhead 69 kV transmission line circuit with the existing 69 kV transmission line circuit and with the existing underbuilt 12 kV distribution line circuits, wherever these 12 kV distribution line circuits occur. This reverse phasing allows electric and magnetic fields from one circuit to cancel the fields in the others. This arrangement of circuits is called the low-reactance (or unlike) phasing configuration. Installing the proposed overhead 69 kV transmission line with the new line adjacent to the existing overhead 69 kV transmission line will reduce the proposed line's electric and magnetic field levels.

- **Maximize distance to existing residential area.** HELCO will install the 69 kV transmission line circuit as high above ground as possible, and as far away from existing neighboring residential areas as is possible, subject to airport flight hazard regulations, state highway requirements for use of the highway right-of-way, and visual considerations. This will minimize public exposure to electric and magnetic fields because the field intensity decreases with increasing distance from the line. Like the existing overhead 69 kV transmission line, the proposed 69 kV transmission line will be approximately 300 feet from six dwelling units adjacent to Queen Kaahumanu Highway and within Keahole Agricultural Park. Table 1-2 shows the electric and magnetic field levels 1 meter above ground level at the center of the transmission line alignment and 300 feet away from the center of the alignment.

Placing a 69 kV transmission line circuit underground does not necessarily reduce the magnetic fields at ground level because magnetic fields readily penetrate rock and soil. The magnetic field values produced by an underground transmission line are reduced at a given distance from the line because the conductors are much closer together than for an overhead line; however, it is possible to get much closer to the lines. The net result is that the magnetic field values at the center of the line and 3 to 4 feet aboveground are similar for overhead lines and for solid (or extruded) dielectric underground 69 kV transmission cables.

For underground transmission lines, two factors affect the magnetic fields measured near ground level. These factors tend to counter each other and do not necessarily result in higher or lower magnetic field levels. First, magnetic field levels of underground lines are reduced more than the magnetic field levels of overhead transmission lines, as a result of the higher phase cancellation of the magnetic fields. Phase cancellation is higher because the three conductors of an underground circuit are closer together than the three conductors of an overhead circuit. Second, magnetic field levels from underground transmission lines measured near ground level directly above the underground lines are higher than magnetic field levels measured near ground level directly beneath overhead transmission lines. The magnetic field at ground level is higher because the distance from the underground transmission line to ground level (i.e., 3 to 4 feet) is less than the distance from an overhead transmission line to ground level (i.e., 30 to 40 feet). Distance from the transmission line conductors is the main factor in reducing magnetic field levels in most cases.

Table 1-2
Electric and Magnetic Field Levels

	Electric Field (kV/m)					Magnetic Field (mG)				
	Distance from center line of pole near ground level (feet)					Distance from center line of pole near ground level (feet)				
Typical Configurations	**-20**	**0**	**100**	**200**	**300**	**-20**	**0**	**100**	**200**	**300**
Existing Overhead Line[a] Single-circuit 69 kV Single-circuit 12 kV underbuild (Summer peak load)	0.052	0.103	0.022	0.008	0.004	2.27	3.40	0.45	0.13	0.07
Proposed Overhead Line Configuration No. 1[b] Double-circuit, single-sided 69 kV Single-circuit 12 kV underbuild Low-reactance (unlike) phasing (Summer peak load)	0.149	0.115	0.004	0.003	0.002	1.03	1.29	0.19	0.08	0.05
Proposed Overhead Line Configuration No. 2[b] Double-circuit, double-sided 69 kV Single-circuit 12 kV underbuild Low-reactance (unlike) phasing (Summer peak load)	0.079	0.082	0.011	0.003	0.001	0.69	1.01	0.07	0.03	0.02
Proposed Underground Three Single-Conductor 69 kV Cables in PVC Ducts[c] With existing overhead line configuration (Summer peak load)	0.052	0.103	0.022	0.008	0.004	10.44	2.81	0.42	0.08	0.05

Notes: All values calculated for 1 meter aboveground. Assumes equalization of currents in each of the three conductors in a circuit. Underground three single-conductor 69 kV cables buried at -20 feet from existing pole, shielded to eliminate any measurable electric field outside of cable, with single-point grounded cables, and with the assumption of no induced sheath currents.

[a]Assumes 73 amperes for the overhead 69 kV circuit and 5 amperes for overhead 12 kV underbuild.

[b]Assumes 73 amperes for each overhead 69 kV circuit and 5 amperes for the overhead 12 kV circuit underbuild.

[c]Assumes 73 amperes for the underground 69 kV circuit, 73 amperes for the overhead 69 kV circuit, and 5 amperes for the overhead 12 kV circuit underbuild.

Source: Enertech Consultants and Power Delivery Consultants.

Table 1-2 compares the electric and magnetic field values for the overhead transmission line and underground transmission line alternatives that HELCO believes are the most practical to construct. Table 1-3 expands on the alternatives compared in Table 1-2 by adding the two underground options suggested by Power Delivery Consultants. Table 1-3 compares the magnetic field values for all overhead and underground configurations with the following:

- The assumed existing amperage (73 amperes)
- The normal maximum amperage (900 amperes for the overhead configurations and 890 amperes for the underground configurations)
- The emergency maximum amperages (1,035 amperes for the overhead configurations and 1,020 amperes for the underground configurations)

Electric field values are not included in Table 1-3 because the metallic sheath or steel pipe that surrounds the cables would shield the electric fields so that the electric field potential outside the pipe would be zero or very low; thus, the electric field coming from the underground transmission lines would not be measurable above ground level. The electric field values are identical to those of the "existing overhead line" and the "proposed underground three single-conductor 69 kV cables in PVC ducts" shown in Table 1-2.

Table 1-3 shows that, for underground transmission line configurations, the greatest degree of magnetic field attenuation occurs with underground transmission line Option 1, which consists of two three-phase circuits (two cables per phase) in a concrete-encased PVC duct with reverse (unlike) phasing between the two circuits, installed in a concrete-encased bank. For the overhead transmission line configurations, the greatest degree of magnetic field attenuation occurs with overhead Configuration 2, the double-circuit, double-sided overhead transmission line.

In comparing the overhead configurations with the underground configurations, the highest degree of magnetic field attenuation occurs with overhead Configuration 2, the double-circuit, double-sided overhead transmission line.

Table 1-3
Magnetic Field Levels with Optional Underground Configurations

Typical Configurations	Description	Magnetic Field (mG) Distance from Centerline of Pole Near Ground Level (feet)				
		-20	0	100	200	300
Existing Overhead Line						
Single-circuit 69 kV	Assumed existing amperage (73 A)	2.27	3.40	0.45	0.13	0.07
Single-circuit 12 kV underbuild	Normal maximum amperage (900 A)	28.56	40.87	5.42	1.61	0.84
	Emergency maximum amperage (1,035 A)	32.85	46.99	6.23	1.86	0.97
Proposed Overhead Line Configuration No. 1						
Double-circuit, single-sided 69kV	Assumed existing amperage (73 A/73 A)	1.03	1.29	0.19	0.08	0.05
Single-circuit 12 kV underbuild	Normal maximum amperage (900 A/900 A)	12.23	14.52	2.15	0.90	0.56
Low-reactance phasing	Emergency maximum amperage (1,035 A/1,035 A)	14.06	16.69	2.47	1.03	0.65
Proposed Overhead Line Configuration No. 2						
Double-circuit, double-sided 69 kV	Assumed existing amperage (73 A/73 A)	0.69	1.01	0.07	0.03	0.02
Single-circuit 12 kV underbuild	Normal maximum amperage (900 A/900 A)	10.93	16.43	0.95	0.36	0.23
Low-reactance phasing	Emergency maximum amperage (1,035 A/1,035 A)	12.61	18.95	1.09	0.42	0.27
Proposed Underground Three Single Conductor 69 kV Underground Cables in PVC Ducts						
With existing overhead line configuration	Assumed existing amperage (UG 73 A/OH 73 A)	10.44	2.81	0.42	0.08	0.05
	Normal maximum amperage (UG 890 A/OH 890 A)	127.28	34.26	5.12	0.98	0.61
	Emergency maximum amperage (UG 1,020 A/OH 1,020 A)	145.88	39.26	5.87	1.12	0.70

Table 1-3
Magnetic Field Levels with Optional Underground Configurations

Typical Configurations	Description	Magnetic Field (mG) Distance from Centerline of Pole Near Ground Level (feet) -20	0	100	200	300
Underground Option 1						
Six UG single-conductor cables, two cables per phase	Assumed existing amperage (UG 73 A/OH 73 A)	0.82	3.19	0.40	0.10	0.05
Low-reactance phasing	Normal maximum amperage (UG 890 A/OH 890 A)	10.00	38.89	4.88	1.22	0.61
One cable in each of 6 PVC ducts	Emergency maximum amperage (UG 1,020 A/OH 1,020 A)	11.46	44.57	5.59	1.40	0.70
With existing overhead line configuration						
Underground Option 2						
Six UG single-conductor cables, two cables per phase	Assumed existing amperage (UG 73 A/OH 73 A)	2.02	3.22	0.40	0.10	0.05
Three cables in each of two steel pipes	Normal maximum amperage (UG 890 A/OH 890 A)	24.63	39.26	4.88	1.22	0.61
With existing overhead line configuration	Emergency maximum amperage (UG 1,020 A/OH 1,020 A)	28.23	44.99	5.59	1.40	0.70

Notes: All values calculated for 1 meter aboveground. Assumes equalization of currents in each of the three conductors in a circuit. Underground 69 kV cables buried at -20 feet from existing pole, shielded to eliminate any measurable electric field outside of cable, with single-point grounded cables, and with the assumption of no induced sheath currents.

Key: UG = underground circuit's total amperage
OH = overhead circuit's amperage

Source: Enertech Consultants and Power Delivery Consultants.

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Unresolved Issues

Electric and Magnetic Fields

Electric fields are not generally suspected of posing a health hazard; however, the issue of public health effects from magnetic fields from electric utility transmission lines remains unresolved, as does the larger issue of health effects from magnetic fields from existing distribution lines, wall wiring, appliances, and light fixtures. In 1991, the State of Hawaii Department of Health issued a policy relating to electromagnetic fields from electric power lines. The policy states:

> A prudent approach is needed at this time to regulate electric and magnetic fields around low-frequency electric power facilities, including high-voltage transmission lines. The existing research data are inconclusive and not sufficient for adequate, accurate risk assessment. However, the data suggest that a "prudent avoidance" approach to siting new facilities is appropriate.
>
> Where technically feasible and practical, public exposures should be minimized. Too little is presently known to be able to determine where or what rules would provide useful public-health protection. (State of Hawaii, Department of Health)

The proposed alignment uses the "prudent avoidance" approach and minimizes exposure to electric and magnetic fields by avoiding most existing and planned residential areas and by using technically feasible and practical engineering design measures and operating procedures.

Placing the Proposed 69 kV Transmission Line Underground

Two considerations are most often expressed by the public as the reasons why a transmission line, such as the 69 kV transmission line proposed in this EIS, should be placed underground:

- Aesthetics
- Potential for health risks from human exposure to electric and magnetic fields

From the preceding section (and from the electric and magnetic field section of Chapter 5), it is clear that the most effective underground transmission line option in reducing magnetic field values would not be as effective as the overhead transmission line with a double-circuit, double-sided configuration with low-reactance (unlike) phasing. Thus, in this case, the argument for placing this 69 kV transmission line underground to reduce public exposure to electric and magnetic fields is not valid.

The issue of whether it is justifiable for the ratepayer to bear additional cost for placing a transmission line underground for aesthetic reasons will have to be determined by the Public Utilities Commission. Similarly, the Hawaii State Legislature or the County of Hawaii Council would need to weigh the additional public costs that will be incurred if legislation is enacted to require placing transmission lines underground.

Whether to place a transmission line underground for aesthetic reasons and the issue of its higher costs to the ratepayer or to the public will remain unresolved.

Compatibility with Land Use Plans and Policies

If located within the mauka edge of the Queen Kaahumanu Highway right-of-way, the overhead and underground alternatives for the Keahole-Kailua transmission line project would be compatible with all applicable land use plans and policies, including the State Land Use Law, the *Hawaii State Plan*, the State Functional Plan for Energy, the *West Hawaii Regional Plan*, the *Hawaii County General Plan*, and Hawaii County's *Keahole to Kailua Development Plan*.

Compatibility with Plans for Widening Queen Kaahumanu Highway

The State of Hawaii Department of Transportation's plans to widen Queen Kaahumanu Highway will require that HELCO reset or relocate its poles or underground cables when the highway is built to its ultimate design. Initial stages of a phased planning effort would involve only the widening of the highway from its current two lanes to a four-lane divided highway. This first phase of highway widening would allow HELCO to temporarily place transmission line poles or an underground cable system in the area proposed for the frontage road on the mauka side of the four-lane divided highway. During construction of the frontage road, existing poles or underground cables on the mauka edge of the highway will need to be reset or relocated to accommodate final elevations and grade construction of the frontage road.

Permits and Approvals

The State of Hawaii and County of Hawaii permits that would be required for either the underground or overhead alternative are shown in Table 1-4.

Table 1-4
Potential Permits or Approvals Required for Transmission Line Alternatives

Authorizing Agency	Permit/Approval	S-1 Mauka Overhead	S-1 Mauka Underground
Federal			
Department of Transportation, Federal Aviation Administration	Notice of Proposed Construction or Alteration	Y	N
State			
Department of Land and Natural Resources	Environmental Impact Statement Approval	Y	Y
	Use of State Lands	Y	Y
	Conservation District Use Application	Y	Y
	Historic Site Review	P	P
Department of Transportation, Highways Division	Permit to Perform Work	Y	Y
Department of Transportation, Airport Division	Permit to Construct Within Airport Hazard Area Zone	Y	N
Public Utilities Commission	Approval of Capital Expenditure Exceeding $500,000	Y	Y

Y = Yes, permit required or probably required.
P = Permit potentially required, depending on location of alignment.
N = No, permit not required.
Note: A County of Hawaii Special Management Area Use Permit (SMP) is not required because no part of the proposed alignment is within the Special Management Area (SMA).

CHAPTER 2

Chapter 2

Purpose and Need for the Action

Project Purpose and Need

The Keahole-Kailua transmission line project is proposed as a 69 kilovolt (kV) alternating current (AC) transmission line between the Keahole Switching Station (which is next to the Keahole Generating Station, near Keahole Airport) and Kailua Substation (located just makai of Queen Kaahumanu Highway on Kaiwi Street in Kailua-Kona). The line will extend approximately 6.8 miles and will generally follow the mauka edge of Queen Kaahumanu Highway. The project area is shown in Figure 2-1.

The two major reasons for the Keahole-Kailua transmission line project are system reliability and load growth. These are discussed in more detail in the following sections.

Existing Power Generation and Transmission System

Hawaii Electric Light Company, Inc. (HELCO) supplies the electrical needs for a population of 120,000 on the island of Hawaii. It maintains service to approximately 25,000 metered accounts through its generation, transmission, and distribution systems. HELCO currently has a generating capacity of 182 megawatts (MW). The island's peak evening load in 1993 was approximately 155 MW.

About 75 percent of HELCO's generating capacity is located on the eastern side of the island. The remainder is located in West Hawaii at the Keahole and Waimea power generating stations.

The existing transmission system consists of four major 69 kV transmission lines that transport the power generated on the east side of the island to the west side. Two lines run through the saddle, one line runs along the northern coastline of the island, and one line runs along the southern coastline.

The second transmission line through the saddle connects the Kaumana Switching Station near Hilo with the Keamuku Switching Station located near the intersection of Waikoloa Road and Mamalahoa Highway. The Keamuku Switching Station is currently connected to the generation station at Keahole with 69 kV circuits. Figures 2-2 and 2-3 illustrate the existing West Hawaii transmission and substation system.

The Kailua Substation is currently served with two parallel 69 kV transmission lines between Keahole and Kahaluu. These lines consist of a mauka line (Keahole-Mamalahoa Highway-Palani Road-Kailua) and a makai line (Keahole-Queen Kaahumanu Highway-Kailua). Both of these lines provide a vital link to loads as far south as Kealia.

System Reliability

Transmission system reliability is a measure of the quality of service provided to HELCO's customers. Electric system reliability is enhanced by a network of transmission lines that can serve the peak loads under both normal and abnormal conditions. For example, if a section of a transmission line is damaged by storm or de-energized for maintenance, the transmission system must have the capability to continue service by routing the power around the affected line segment. Each segment of the transmission system must be capable of elevated loadings while power is temporarily rerouted and must be able to maintain acceptable voltage levels per HELCO's transmission planning criteria. For this reason, HELCO transmission planning engineers routinely evaluate contingency scenarios and load ratings for each line segment. As normal loads increase, the capacity of the system to handle these contingency loads is compromised. Planning studies have concluded that, to meet the growing demand for electricity, the proposed Keahole-Kailua transmission line must be in place and energized by December 1994 to maintain service quality and reliability.

Electrical Load Projections

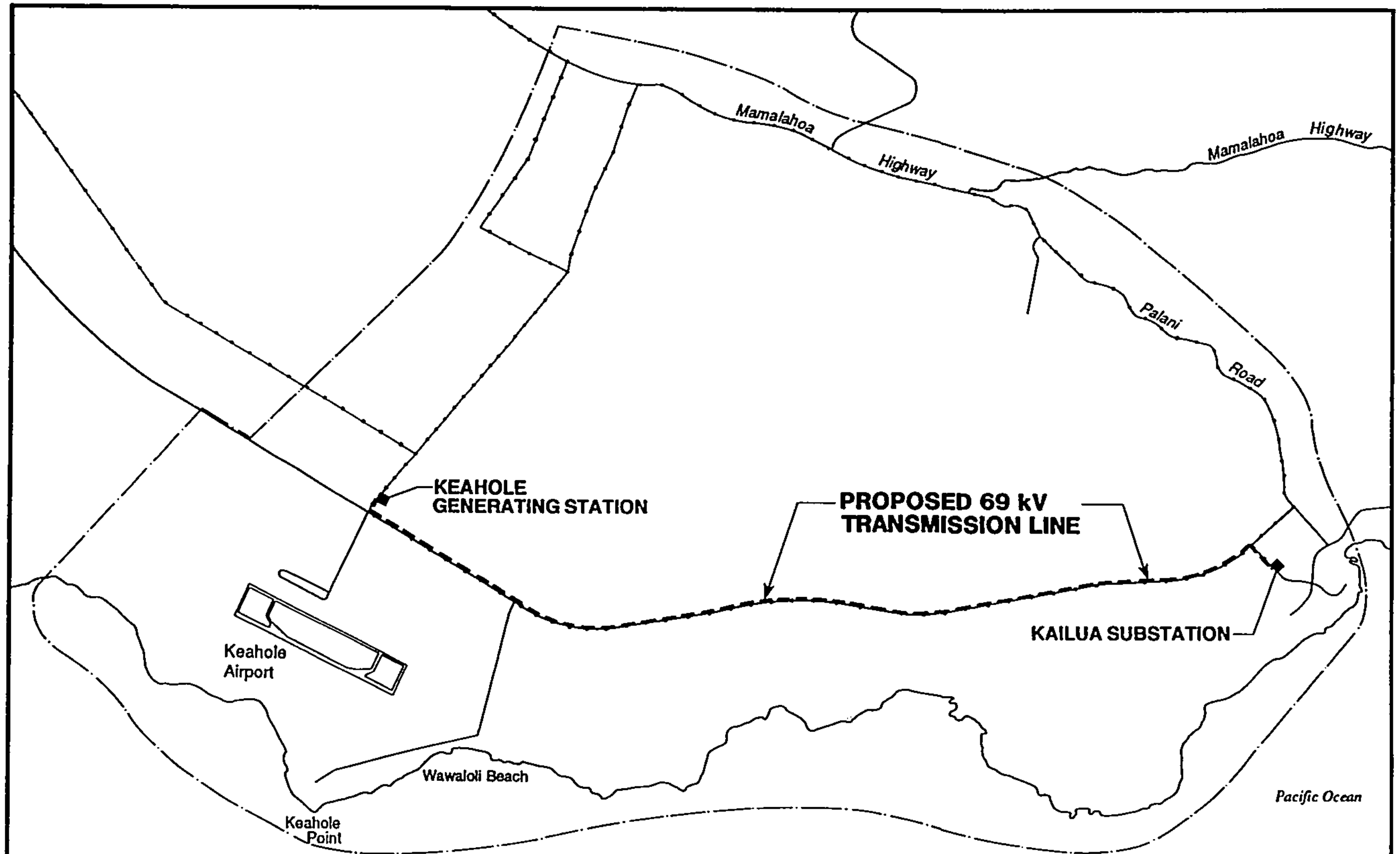
Major components of electric transmission lines usually have an expected life of 35 to 50 years, depending on their quality, the climate, where they are used, and how quickly they become obsolete. Ideally, such components are selected to handle the load growth projected through the years considered in the system's long-range plan.

Islandwide Electrical Load Growth

A forecast of future loads is updated annually by HELCO's Forecast Planning Committee. Factors considered in the load forecasts include historical data on loads and population growth, projected future development, increases in population, and new industries. Figure 2-4 illustrates the actual peak islandwide electrical loads for the period 1985 through 1991 and the projected loads for the next 18 years, 1992 to 2010. Between 1985 and 1991, peak system loads grew rapidly from 102 to 145 MW as the result of an average annual load growth of 5.9 percent. HELCO reported an evening peak demand of 151 MW in November 1992 and 155 MW in November 1993. Load growth is expected to be vigorous in the near future and then taper down to a more moderate rate of about 3.8 percent per year through 2010.

West Hawaii Electrical Load Growth

Table 2-1 provides historical and projected loads for West Hawaii and eastern Hawaii from 1985 to 1997. In this 5-year forecasting period, loads in the North Kona and South Kona districts in West Hawaii are expected to increase from 45 MW in 1992 to 63 MW in 1997. It is evident that the load growth has been more rapid in West Hawaii than for the island as a whole. Since 1987, more than half of HELCO's system load shifted from eastern Hawaii to the West Hawaii area. With roughly half of the system load located on the west side of the island and only about one-fourth of the system's generation facilities currently located



LEGEND

Study Area Boundary

Existing 69 kV Transmission Line

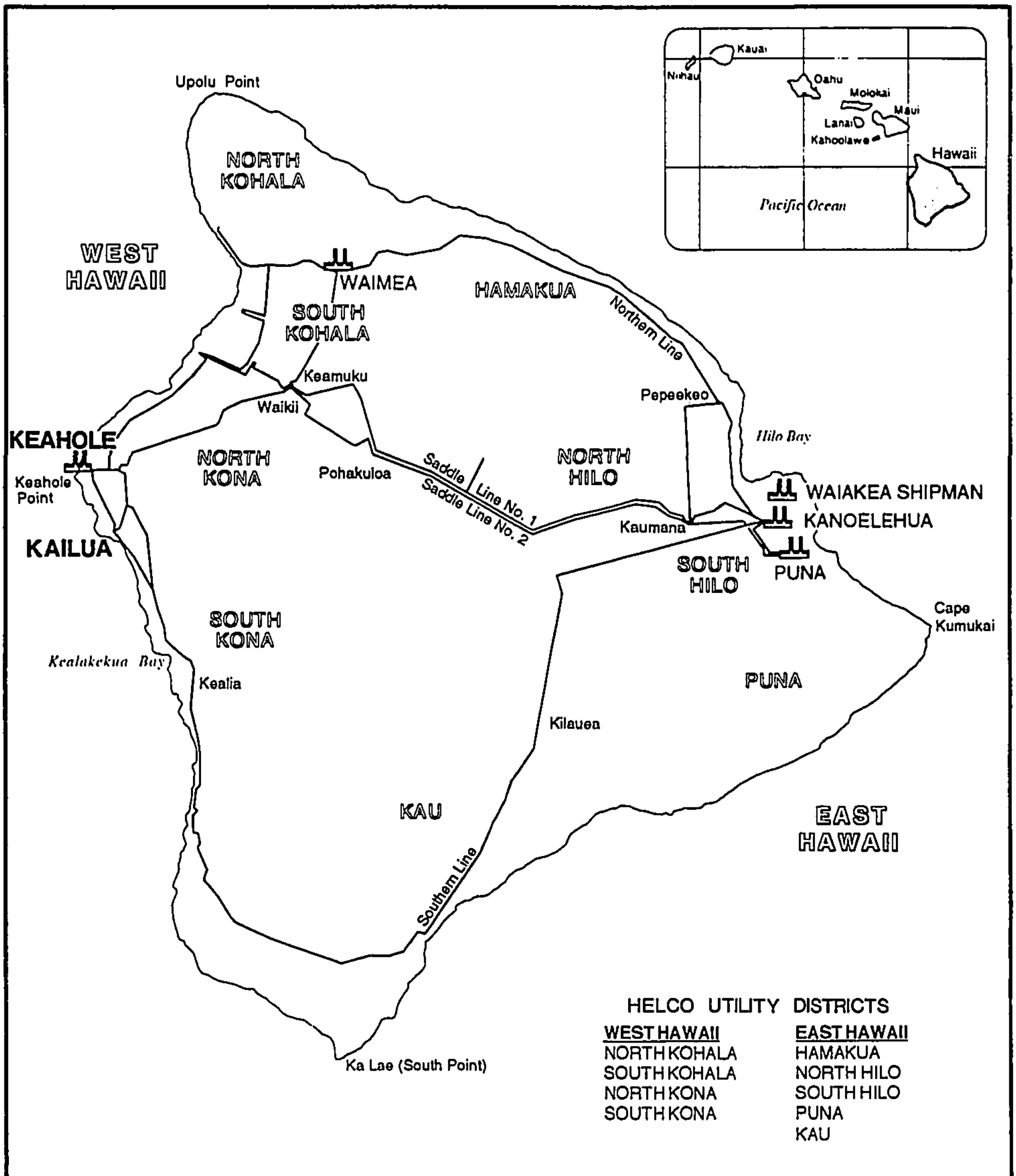
KEAHOLE-KAILUA
TRANSMISSION LINE PROJECT

FIGURE 2-1

PROPOSED PROJECT

NORTH 0 1 2 MILES

CH2M HILL



LEGEND

Generating Station (HELCO)

Existing Transmission Line

KEAHOLE-KAILUA TRANSMISSION LINE PROJECT

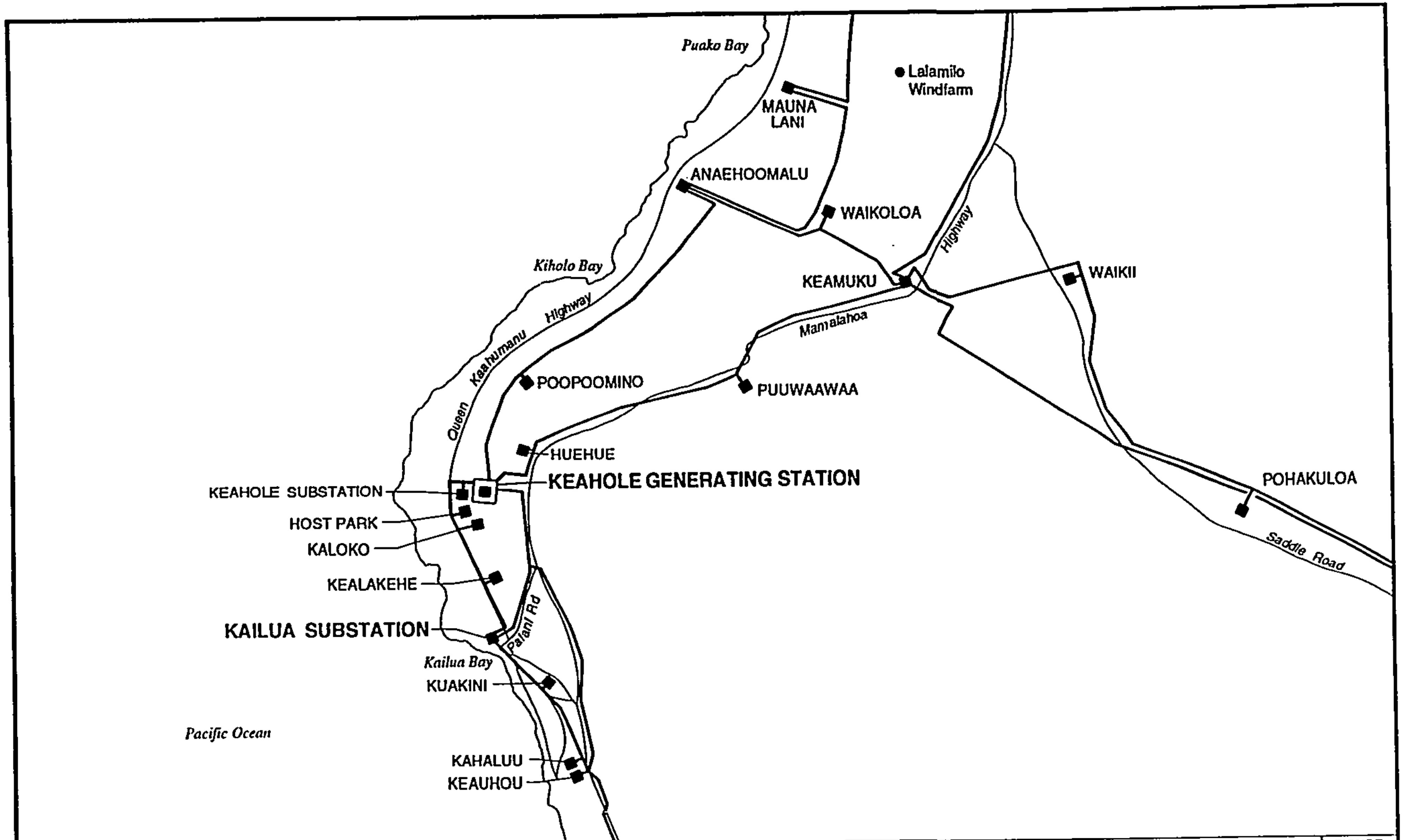
FIGURE 2-2

HELCO FACILITIES

NORTH

0 10 20 MILES

CH2M HILL



LEGEND

- Substation/Switching Station
- Generating Station
- Existing Transmission Line

KEAHOLE-KAILUA TRANSMISSION LINE PROJECT

FIGURE 2-3

EXISTING WEST HAWAII TRANSMISSION AND SUBSTATION SYSTEM

NORTH

0 5 10 MILES

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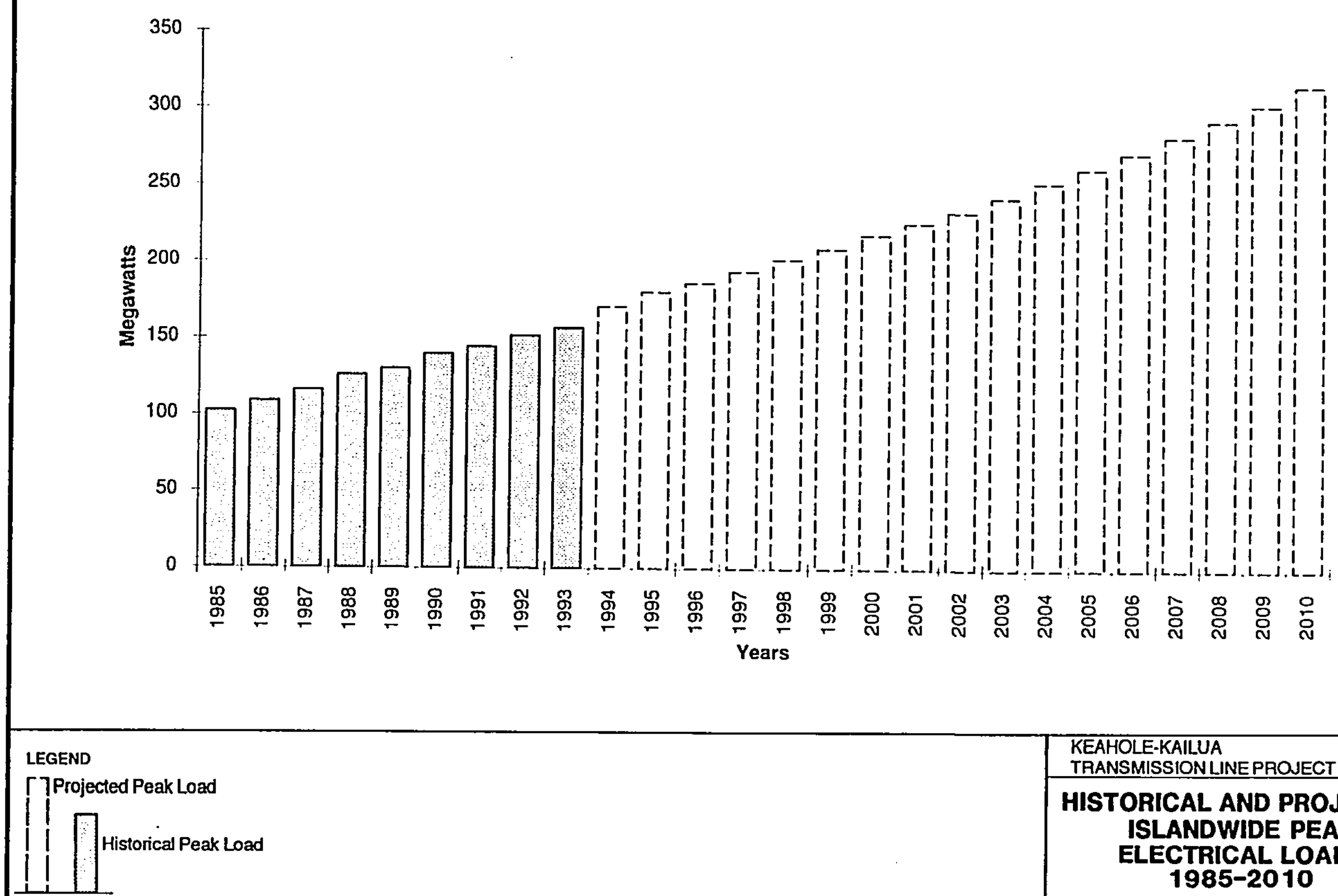


KEAHOLE-KAILUA TRANSMISSION LINE PROJECT

FIGURE 2-4

HISTORICAL AND PROJECTED ISLANDWIDE PEAK ELECTRICAL LOADS 1985-2010

CH2M HILL

Table 2-1
Islandwide Historical and Projected Electrical Loads[a]
1985-1997
(kilowatts)

	Historical								Projected				
Area	1985	1986	1987	1988	1989	1990	1991	1992	1993[b]	1994	1995	1996	1997
East Hawaii													
Hamakua	4,448	5,088	4,945	5,438	3,183	5,409	5,156	5,608	5,500	6,100	6,300	6,600	6,800
North Hilo	907	996	1,163	1,000	912	956	1,959	1,771	1,600	1,700	1,800	1,900	2,000
South Hilo	32,784	32,551	35,333	35,623	44,119	33,681	32,743	34,670	40,200	43,700	44,300	46,400	48,400
Puna	9,598	11,321	9,986	11,829	8,726	19,091	20,930	21,363	17,700	19,200	19,400	20,300	21,200
Kau	3,293	2,776	3,177	2,174	2,030	2,412	2,437	2,709	4,700	5,200	5,300	5,600	5,800
Subtotal	51,030	52,732	54,604	56,064	58,969	61,550	63,224	66,121	69,700	75,900	77,100	80,800	84,200
	52.5%	51.1%	49.5%	46.7%	47.6%	46.2%	45.8%	46.3%	46.5%	46.0%	45.5%	45.5%	45.5%
West Hawaii													
North Kohala	2,105	2,301	2,760	3,373	3,210	3,630	4,103	4,182	4,100	4,500	4,700	4,900	5,100
South Kohala	11,361	11,662	13,060	21,061	18,574	25,175	25,472	26,831	26,300	29,200	30,300	31,800	33,100
North Kona	27,143	30,617	33,613	34,283	37,810	37,104	39,804	39,827	43,100	47,800	49,500	51,900	54,200
South Kona	5,641	5,857	6,163	5,205	5,237	5,825	5,527	5,729	6,700	7,500	7,800	8,100	8,500
Subtotal	46,250	50,438	55,596	63,921	64,831	71,735	74,906	76,569	80,200	89,000	92,300	96,700	100,900
	47.5%	48.9%	50.5%	53.3%	52.4%	53.8%	54.2%	53.7%	53.5%	54.0%	54.5%	54.5 %	54.5 %
Total	97,280	103,170	110,200	119,985	123,800	133,285	138,130	142,690	149,900	164,900	169,400	177,500	185,100

[a]The total peak load shown for each year does not reflect the recorded or projected peak because system losses are not included.
[b]The 1993 electrical load data by district were not available when this table was prepared.

there, the West Hawaii loads are highly dependent on the four existing cross-island transmission lines. HELCO must expand and improve the West Hawaii transmission system to accommodate growing electrical demand.

North Kona and South Kona loads currently make up roughly 45 MW, or 32 percent, of the system load, of which Kailua accounts for 14 MW. The loads in North Kona and South Kona are projected to be 55 MW by 1994. As a consequence, the transmission system needs to be reinforced to provide the required reliability.

Future System Requirements

As the North Kona and South Kona area loads increase, the lines into Kailua become inadequate to support this area when a line into Kailua is taken out of service for maintenance or as a result of a fault condition, because the remaining lines must carry all of the load. Low voltages would occur because of the loss of one of the parallel circuits between Keahole and Kahaluu. The addition of the third Keahole-Kailua 69 kV line will reduce the line loadings and thereby raise the voltage levels in the Kona area. System reliability will also improve because the third Keahole-Kailua 69 kV line will provide a backup route for the existing Keahole-Kailua lines.

Future transmission system requirements for West Hawaii include:

- Construction of the proposed Keahole-Kailua transmission line project and completion of the associated switching station or substation work

- Construction of the proposed Keahole-Keamuku transmission line project and completion of the associated switching station or substation work

Recommended System Improvements

In order to meet the 1994 projected system load projections and provide adequate transmission system reliability, transmission planners have recommended that a new 69 kV line be constructed between Keahole Switching Station and Kailua Substation. Along with other associated system improvements, which would be constructed in later years, the new line from Keahole to Kailua would be built with aluminum conductors sized to adequately serve the projected loads of the long-range planning period.

The new transmission line would also require modifications and additions to both Keahole Switching Station and Kailua Substation. New terminal equipment to be installed would include circuit breakers, switches, protective relays to control the circuit breakers, and load monitoring instruments and devices, as well as supervisory control provisions.

CHAPTER 3

Chapter 3
Project Description

Location

The Keahole-Kailua transmission line project is proposed as a 69 kV alternating current (AC) transmission line. It would be constructed principally along the mauka edge and within the right-of-way (ROW) of Queen Kaahumanu Highway from the Keahole Switching Station (which is next to the Keahole Generating Station, located mauka of Keahole Airport), to Kaiwi Street. It would then cross the highway and be connected to the Kailua Substation, located makai of Queen Kaahumanu Highway on Kaiwi Street in Kailua-Kona.

Engineering Description

General Configuration

Transmission line planners at HELCO and HECO have determined that the proposed 69 kV transmission line would be constructed overhead with wood or steel poles. The construction would be designed in accordance with HECO's overhead construction standards and the requirements of the Hawaii Public Utilities Commission's (PUC) General Order No. 6 (Rules for Overhead Electric Line Construction) and the National Electric Safety Code (NESC).

The proposed project requires a single 69 kV circuit consisting of three conductors (i.e., wires) attached to the poles. It is planned that the poles would be designed with all three of the new conductors on one side of the pole, with the three conductors of the existing 69 kV circuit arranged on that same side or on the opposite side of the pole, as shown in Figure 3-1. Table 3-1 summarizes the design characteristics of the project.

Poles

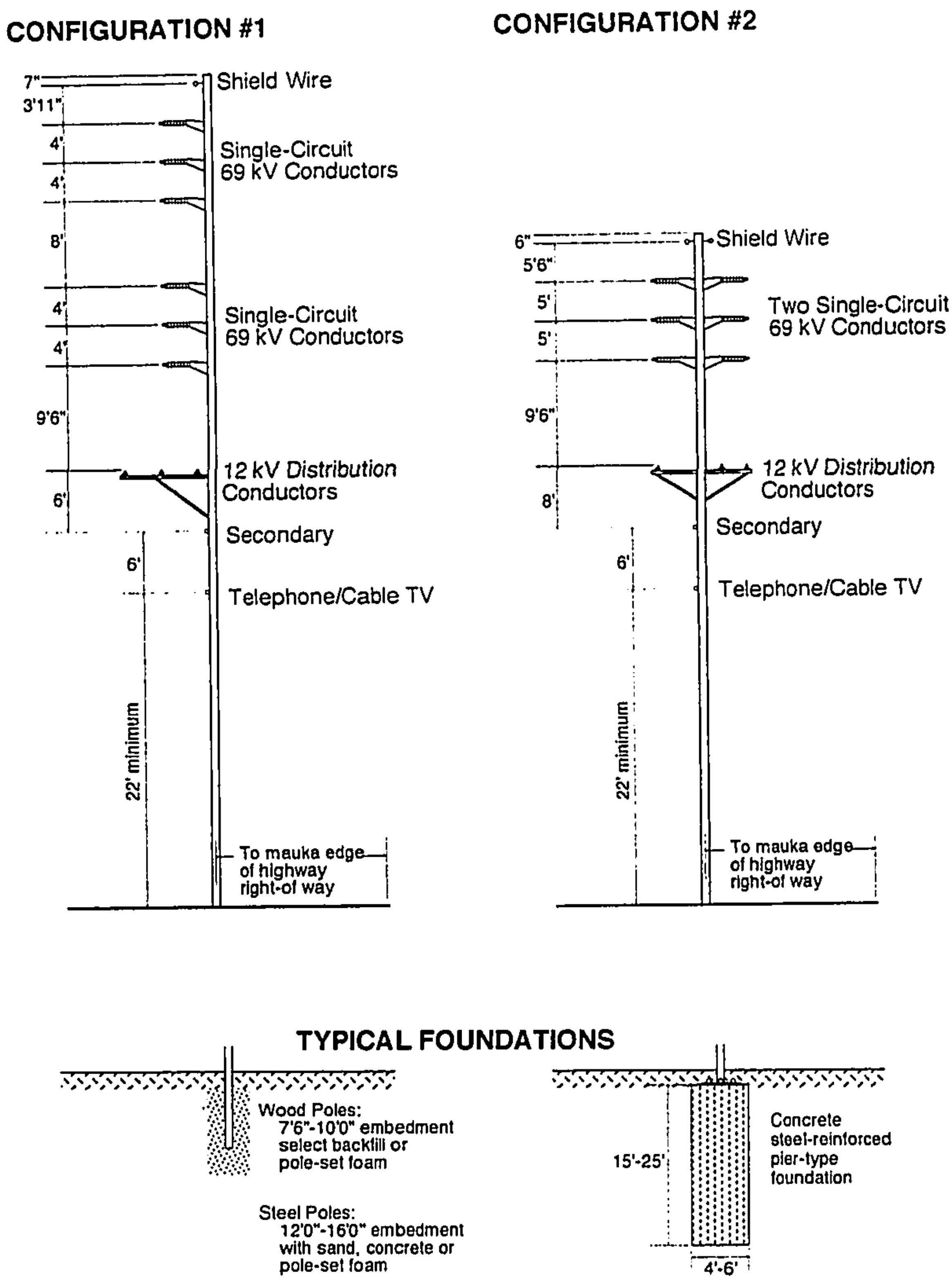
Tapered wood poles are strong and chemically treated to resist damage and deterioration and weigh from 3,900 to 6,000 pounds each. Poles would be protectively coated below the ground line and directly embedded to a depth of approximately 7 feet 6 inches to 10 feet. The poles would be directly embedded with select backfill or pole-set foam.

Tubular steel poles are custom designed and manufactured by several mainland vendors. Steel poles come in two or three sections and weigh approximately twice as much as wood poles. They can be directly embedded with sand, concrete, or pole-set foam, or they can be fitted on steel-reinforced concrete foundations. Steel-reinforced concrete pier-type foundations are constructed with an augered shaft 4 to 6 feet in diameter and 15 to 25 feet deep. The foundations are designed to resist overturning forces.

Table 3-1
Keahole-Kailua 69 kV Transmission Line Design Characteristics

Characteristics	Units
Line length	6.8 miles (along Queen Kaahumanu Highway and Kaiwi St.)
Type of structure	Wood or steel, single-pole
Structure height	Double-circuit lines on one side of pole (see Figure 3-1, Configuration No. 1), 70 to 85 feet on flat terrain; double-circuit lines with one circuit on each side of pole (see Figure 3-1, Configuration No. 2), 60 to 75 feet on flat terrain; taller as required
Structure weights (typical)	Wood, 3,900 to 6,000 pounds Steel, 7,800 to 12,000 pounds
Typical structure foundation type	Wood, directly embedded 7.5 to 8.5 feet deep Steel, directly embedded 12 to 16 feet deep
Optional structure foundation	Augered/reinforced concrete piers 15 to 25 feet deep; 4 to 6 feet in diameter
Average span length	300 to 500 feet
Number of structures per mile	Wood, 10 to 14 poles Steel, 9 to 12 poles
69 kV conductor configuration	
• Description	One conductor per phase (three phases per circuit):
• Conductor size and type	795 kcmil;* AAC
• Insulator assembly options	Horizontal fiberglass/polymer post insulators Horizontal "V" fiberglass/polymer assemblies Steel davit arms and porcelain suspension insulators
• Shield wire	195.7 kcmil (3/0) AAAC "AMHERST" or 3/8-inch extra high strength wire
• 69 kV conductor ground clearance	30 ft. minimum at 212°F, final sag
Normal operating voltage	69,000 volts AC (69 kV) ± 5%
69 kV conductor ampacity (thermal capacity)	85.5 MVA normal (715 amps) 98.0 MVA emergency (822 amps)
Land temporarily disturbed	
• Foundation	12 ft. by 40 ft., or 480 ft.^{2} (approximately)
• Conductor pulling site	50 ft. by 100 ft., or 5,000 ft.^{2} (approximately)
Wind loading factor	
• Horizontal wind pressure	25 pounds per square foot
• Wind speed	100 miles per hour maximum (gust)

*Cross-sectional measure of the conductor area in thousands of circular mils.
AAC = all-aluminum conductor
AAAC = all-aluminum alloy conductor



KEAHOLE-KAILUA
TRANSMISSION LINE PROJECT

FIGURE
3-1

PROPOSED 69 kV
OVERHEAD STRUCTURES

NOT TO SCALE

CH2M HILL

Pole heights, locations, and span lengths are carefully designed and are determined by the following factors:

- Maximum sag of the conductor
- Ground clearance requirements
- Natural terrain and topography
- Structural strength
- Costs
- Visual considerations
- Existing and proposed land uses
- Crossings of constructed features, such as roads and telephone lines
- Other criteria that may be unique to the project

The poles could vary in height. Poles with double-circuit lines on one side of the pole (Configuration No. 1) would be 70 to 85 feet high. Poles with double-circuit lines with one circuit on each side of the pole (Configuration No. 2) would be 60 to 75 feet high. The poles would be spaced approximately 300 to 500 feet apart. There may be some longer or shorter spans, depending on final transmission line design. The distances between poles would vary according to the terrain (e.g., the need to span a gulch or roads), the number of curves and angles in the route, and the locations of physical features or obstructions. There would be an average of 10 to 14 wood poles per mile or 9 to 12 steel poles per mile.

Along parts of Queen Kaahumanu Highway, 12 kV distribution lines are now attached to the same pole line as the existing 69 kV lines. Generally, these existing wooden poles are 55 to 65 feet high and are spaced 150 to 300 feet apart. When the new 69 kV circuit is constructed in these areas, the existing 69 kV and 12 kV circuits must be transferred to the taller proposed 69 kV wood or steel poles.

Conductors and Insulators

Proposed 69 kV Conductors

The project design would provide for three separate all-aluminum conductors arranged in a vertical configuration. Each conductor constitutes one phase of the 69 kV three-phase circuit.

Shield Wires

At the top of each pole and attached at the end of a short crossarm is a shield wire. The shield wire is a conductor positioned to shield the 69 kV or other attached circuits from direct lightning strikes. Lightning that does strike the shield wire is conducted to the ground through a ground wire attached to a grounding electrode at the base of each pole.

Existing 69 kV Conductors

Where an existing 69 kV circuit would be attached to the new, taller pole for the proposed 69 kV conductors, line designers may choose to transfer existing conductors or install new conductors more appropriate to the long-range plan. Construction requirements may also dictate replacement of an existing conductor.

69 kV Insulators

Horizontal post or suspension insulator assemblies would be used to suspend the 69 kV conductors. The 69 kV horizontal post insulators are approximately 4 feet long and contain a fiberglass rod encased by polymer weathersheds. A pole mounting bracket is fitted to one end and a conductor clamp to the other end. The strength of horizontal post insulators is limited by the diameter and length of the fiberglass rod.

The second option for attaching conductors to the poles involves attaching three upswept horizontal steel arms (davit arms) arranged one over the other at 4-foot spacing intervals on one side of the pole. Hanging vertically from the end of each arm is a polymer suspension insulator or a string of six to eight porcelain suspension insulators. The conductor is attached with a suspension clamp at the bottom of each string. The davit arm and suspension insulator option provides some engineering advantages on straight runs. However, suspension insulators are free to swing perpendicular to the line. This insulator swing complicates design for wind and line angle deflections.

Foundations

The types of foundations to be used in each pole location would be determined after general geotechnical investigations (including borings and field and laboratory testing at selected sites), to be conducted prior to final design of the project. In general, straight-line poles would be directly embedded, and angle or dead-end poles would be supported by concrete-reinforced foundations. Once soil strengths are determined by the geotechnical investigations, the depth and the effective diameter of the direct embedment or foundation would be determined so that the embedment would be able to support the conductor tension and wind loads. Foundation types are described in more detail in the construction practices section of this chapter.

Easement Acquisition

A transmission easement is the strip of land occupied by the transmission facilities. Easements are the land rights acquired for the construction, operation, and maintenance of the transmission line within private property. The easement for a transmission line is established only when all private easement rights and public land permits have been acquired, recorded, and documented.

The proposed transmission line project would not require an easement in the state highway right-of-way to comply with HELCO standards and the Hawaii PUC's General Order No. 6 (G0-6) clearance requirements. Where new easements or widening of existing easements are required, HELCO would negotiate with the landowners. In places where the proposed pole is adjacent to a roadway, every attempt would be made to site the line within the roadway right-of-way and thus limit easements required from private landowners.

HELCO uses a small number of easements along Queen Kaahumanu Highway from Keahole to Kailua for its existing 69 kV transmission line. These easements over private property are used mostly for pole anchors and, in one case, to cross private property where, because of a road alignment curvature, this could not be avoided. In the Kealakehe area, from the vicinity of Kealakehe Parkway southward for nearly a mile to the vicinity of Kealakehe Substation, HELCO maintains a 25-foot-wide easement on State of Hawaii property for its existing 69 kV transmission line. All except the most southern portion of this 25-foot-wide easement is located more than 30 feet mauka and outside of the highway right-of-way.

In areas where new easements are required, a right of access to the proposed easement would be required for initial surveys and for construction and maintenance of the transmission lines. These access roads would be established at a location mutually convenient for both landowners and HELCO. If the easement is adjacent to a public road, HELCO's franchise rights typically provide access from the roadway to the line for construction and maintenance.

Several steps are involved in obtaining an easement. Initially, a land agent contacts each owner (and other parties of interest) to negotiate a perpetual easement to accommodate the proposed transmission line. If purchasing land rights becomes necessary, the land to be crossed is surveyed and mapped and an appraisal is prepared to provide a basis for determining the market value of the land rights to be acquired. The appraisal is prepared by an independent real estate appraiser, and the report is the basis for determining a value payable for the easement. The owner of each affected parcel is then contacted by HELCO's land agent, and a price for the easement is negotiated. Adjustments to the appraisal value may be necessary. When a price has been agreed upon with the owners, the required documents are prepared and executed, the landowner is paid, and the sale is recorded.

A "right-of-entry" (i.e., a temporary right of access) may also be negotiated if entry is necessary for surveys or construction before the perpetual easement has been recorded and takes effect. The landowner grants HELCO an easement for its facilities but retains title to the land and full use of the easement area, subject to operational and safety limitations and other conditions mutually agreed upon by all parties.

Where easement negotiations are unsuccessful and adjustments to construction or routing requirements are impractical, HELCO may invoke a legal option. The state constitution grants certain public bodies and utilities the right of eminent domain. This right gives utilities the power to acquire, through the courts, property rights for facilities to be built in the public interest. Eminent domain (sometimes called condemnation) is used as a last resort if an agreement cannot be reached between a landowner and HELCO and an owner refuses to grant an acceptable easement. The court provides for fair compensation to be paid for the easements acquired in condemnations.

HELCO attempts to minimize the impact of construction activity on the right-of-way. Claims for damages to land and crops are generally resolved through repair or compensation after construction is completed.

Construction Practices

During the construction of typical HELCO transmission lines, most or all of the following phases of work must be accomplished: surveying, determining access requirements, establishing construction facilities or base yards, digging pole holes, installing foundations, erecting poles, installing conductors, and cleaning up and removing construction equipment. Table 3-2 lists typical equipment used during the construction phase or transmission line projects.

Surveying Phase

Surveying for construction of transmission lines includes property, right-of-way, ground profile, access road, and construction surveys. A typical survey crew consists of three people.

A geotechnical reconnaissance is often conducted along with the survey plan and profile to identify any obvious soil features that could affect design on the selected route. After preliminary structure locations are determined, a drilling rig is used to conduct more comprehensive geotechnical investigations at selected locations, and soils are sampled to a depth of 30 to 35 feet. These geotechnical investigations at selected locations will determine the types of foundations required at key pole sites.

Clearing Requirements

Right-of-way clearing is done when required to prepare for efficient installation of poles and conductors and to provide for required electrical clearances. Because trees are the primary cause of transmission and distribution outages, HELCO attempts to maintain rights-of-way free of tall-growing trees.

Access Requirements and Traffic Management Practices

Surface access to each pole location is required during construction. Existing roads are used wherever possible.

When poles are installed adjacent to roads, part of the road must sometimes be occupied by equipment used in installing foundations, poles, and conductors. Work on public roads must follow traffic control procedures prescribed by the U. S. Federal Highway Administration, the Highways Division of the State Department of Transportation, and the County of Hawaii Public Works Department. Work adjacent to a state road or highway requires a Permit to

Table 3-2
Typical Equipment Used During Construction

Page 1 of 2

Construction Category	Purpose
1. Access, Clearing, and Cleanup	
1/2-ton pickup truck	Transport personnel and hand tools
Crew-cab truck	Transport personnel and hand tools
2-ton truck	Haul materials, debris
Chipper	Dispose of cleared trees and limbs
2. Wood or Steel Pole Construction	
A. Foundations	
1/2-ton pickup trucks	Transport personnel
Crew-cab trucks	Transport personnel
Mechanic's service trucks	Make field repairs
Truck-mounted auger	Excavate foundations
Compressors	Drive pneumatic tools
5-ton trucks	Haul materials
10-ton trucks	Haul materials
20-ton trucks	Haul materials
Tilted trailer	Haul equipment
Concrete mixer trucks	Haul concrete
Tool van	Tool storage
Mobile office trailer	Supervision and clerical office
Front-end loader	Load excavated material
Concrete pump truck	Pump concrete
B. Pole erection	
1/2-ton pickup trucks	Transport personnel
Crew-cab trucks	Transport personnel
5-ton trucks	Haul materials
10-ton trucks	Haul materials
20-ton trailer	Haul materials

Table 3-2
Typical Equipment Used During Construction

Page 2 of 2

Construction Category	Purpose
30-ton cranes (mobile)	Erect structures
15-ton cranes (mobile)	Erect structures
80-ton or larger crane, depending on need (mobile)	Erect structures
3. Conductor Installation	
1/2-ton pickup trucks	Transport personnel
Crew-cab trucks	Transport personnel
Tensioners (truck-mounted)	Install conductor
Pullers (truck-mounted)	Install conductor
Helicopter	Install conductor
Reel trailer with reel stands (semi-trailer type)	Haul conductor
Tractors (semi-type)	Haul conductor
Low-bed trailer	Haul materials
5-ton trucks	Haul materials
10-ton trucks	Haul materials
Take-up trailers (sock line)	Install conductor
Reel winders	Install conductor
Crawl tractors	Install conductor
Auger (truck-mounted)	Excavate pole holes for clearance structures
Line truck	Install clearance structures
Tool vans	Tool storage
Mobile office trailer	Supervision and clerical office

Perform Work on State Highways, which must incorporate a Traffic Control Plan approved by the Highways Division. The County of Hawaii requires observation of state and federal traffic control regulations for any work on county roads.

According to state procedures, only one lane at a time may be closed on a multilane highway and, on a two-lane highway, lanes of adequate width in both directions must be provided wherever possible. All lanes must be open to traffic during morning peak hours (6:00 to

8:30 a.m.) and afternoon peak hours (3:30 to 6:00 p.m.). HELCO and its construction contractors follow state guidelines for the types of signs, lights, markers, position of traffic cones, areas coned off, and the use of flaggers and/or police officers (State of Hawaii Department of Transportation; U.S. Federal Highway Administration, 1978).

Coning off a lane of traffic is usually required during the foundation, pole, and conductor installation phases of line construction. At any point along the new 69 kV transmission line route, traffic might have to be interrupted for several relatively brief periods over the course of a few months.

Construction of Support Facilities

A construction yard headquarters would be identified in a location near the new line's route. This headquarters is the base station where employees report at the start and end of each day's activities. These facilities are also used for other activities, including the field office; pole and insulator assembly laydown areas; helicopter landing and take-off areas; storage of materials, equipment, and vehicles; and security.

Foundation Installation

Installation of a directly embedded pole requires that a hole be augered to the specified depth and some 12 to 16 inches larger in diameter than the butt of the pole. The hole depth is usually overexcavated by 12 inches to allow a layer of compacted crushed rock or soil under the pole base. After the pole is set in the hole, excavated or select material is continuously compacted as backfill for wood poles; sand, concrete, or commercial pole-set foam is used as backfill for steel poles.

Foundations made with steel-reinforced concrete require the boring of a large-diameter hole in the ground and placement of a reinforcing steel and anchor bolt cage in the hole. Each hole is filled with concrete to a depth of 2 feet below finished grade. While the concrete is curing, any necessary backfill is placed and compacted around the foundations. Where holes fill with groundwater during augering or where hole walls are unstable, a corrugated steel culvert pipe is lowered or driven as a casing. The casing is then pumped dry or concrete is tremied into the hole, displacing the water. Concrete is allowed to cure for 2 to 4 weeks before the poles are placed into the foundations and secured. After the poles are erected and plumbed, grout is packed under and around the pole's base.

Pole Assembly and Installation

After the pole holes are dug or the foundation concrete is cured, the poles are transported to the pole locations, assembled, and erected. If new poles are installed in the same alignment as existing poles, a safe distance must be maintained between the existing conductors of the existing poles and the crews installing the new poles and lines. This safe separation distance can be created by slightly tilting the original existing poles. With a safe separation distance established, the new poles can be installed in the same alignment while the conductors on the original existing poles remain energized. A mobile crane is used to lift each assembled pole or section into place. Insulator hardware is assembled and installed on each pole after it is erected.

Four to seven workers can erect approximately two to four poles per day.

Conductor Installation

Conventional helicopters are planned to be used for stringing the conductors. Before conductor installation begins, temporary clearance structures may be installed at road crossings and at locations where the conductors might inadvertently contact existing electrical or communication facilities or vehicular traffic during installation.

"Tension-stringing" is used to install the conductors. This method prevents the conductors from touching the ground or other objects by maintaining a certain tension and sag during the stringing operation. The conductors, the tensioner, the puller, and other related equipment and materials are assembled at sites along the route at 1- to 2-mile intervals. A pulling line (or sock line), which is usually a Dacron or nylon rope, is pulled from pole to pole through pulleys (i.e., sheaves) attached to the insulators. The conductor is then pulled through the sheaves behind the sock line, brought to a specified sag and tension, and clipped in to the conductor clamps.

In pole locations adjacent to roadways, one lane may be closed to traffic during pulling and sagging operations. Approximately 2 weeks is required to complete each mile of conductor installation.

Quality Control, Cleanup, and Removal of Construction Materials

As sections of the transmission lines are completed, HELCO inspects the work thoroughly to verify that the lines are built according to specifications and standards. Anything that does not comply is corrected.

Cleanup work generally includes:

- Removing all temporary crossing and clearance structures and backfilling any remaining holes used for temporary poles.
- Where new poles are installed in the same alignment as the original poles, cleanup work includes removing the conductors from the original poles, transferring telephone and television cables to the new poles, removing the original poles, and backfilling the pole holes. The transfer of the telephone and television cables would be done by the utility companies responsible for those lines.
- Disposing of packing crates, reels, shipping material, and debris.

- Dressing roads, work sites, and pole sites to remove ruts and leveling and preparing areas for seeding, if required.
- Repairing gates and fences to their original condition or better.
- Adding ground rods and ground wire connections to private fences and trellises, as needed.
- Repairing any damage that occurred during construction.

Switching Station and Substation Improvements

Improvements to the Keahole Switching Station and the Kailua Substation would involve installing equipment required to connect each end of the new 69 kV circuit to the existing switching station and substation buswork. All work would take place within existing HELCO property.

Keahole Switching Station will be converted from its existing straight bus system to a two-bay, breaker-and-a-half configuration, in order to increase the switching station's reliability (see Figure 3-2). Site preparation will include excavation, and grading, and foundation installation. Plans for the Keahole Switching Station call for the eventual relocation of three transformers and two circuit breakers, and the installation of two new circuit breakers, disconnect switches, bus work, and associated equipment. A temporary overhead transmission line will be installed to connect the two buses. Eventually, three 485-foot-long underground transmission line circuits will be constructed and the temporary overhead transmission line will be removed.

Kailua Substation will be converted from a substation to a switching station to increase reliability (see Figure 3-3). Site preparation will involve minimal grading, and will require foundation installation. Plans for the Kailua Substation call for its eventual conversion to a switching station with a ring bus configuration. Initially, the Kailua Substation will be converted to a switching station with a straight bus configuration; this will involve the installation of circuit breakers, disconnect switches, two transformers, and associated equipment. Subsequently, additional circuit breakers will be installed, and the straight bus configuration will be converted to a ring bus configuration.

Project Schedule, Cost, and Work Force

Construction of the transmission line and the conversion of the Keahole Switching Station and the Kailua Substation are expected to begin in May 1994. The transmission line, and those portions of the conversion to the Keahole Switching Station and the Kailua Substation necessary for energizing the transmission line, are scheduled for completion and energization in December 1994. The capital cost for the transmission line project is estimated at $2.5 million using wood poles and $7.3 million using steel poles, not including the costs of land acquisition and switching station and substation construction. HELCO has allocated $400,000 of the cost of Keahole Switching Station's conversion and $946,000 of the cost of Kailua Substation's conversion to the Keahole-Kailua transmission line project.

The construction work force for the project would consist of 30 to 40 workers. There would be two separate work forces: one for switching station and substation improvements and another for transmission line construction.

Pole hole digging, foundation construction, pole erection, and stringing would probably be performed by contractors. Contracted construction crews may also be used to make necessary substation improvements.

Operation and Maintenance

Operational Characteristics and Procedures

The proposed transmission line would be energized and operated at a nominal voltage of 69 kV, plus or minus 5 percent. With HELCO's supervisory control system, dispatchers in a power control center direct the day-to-day power scheduling and operate switchgear and other devices, as required, to maintain safe work practices. Circuit breakers operate automatically in an emergency to help ensure the security and stability of the system.

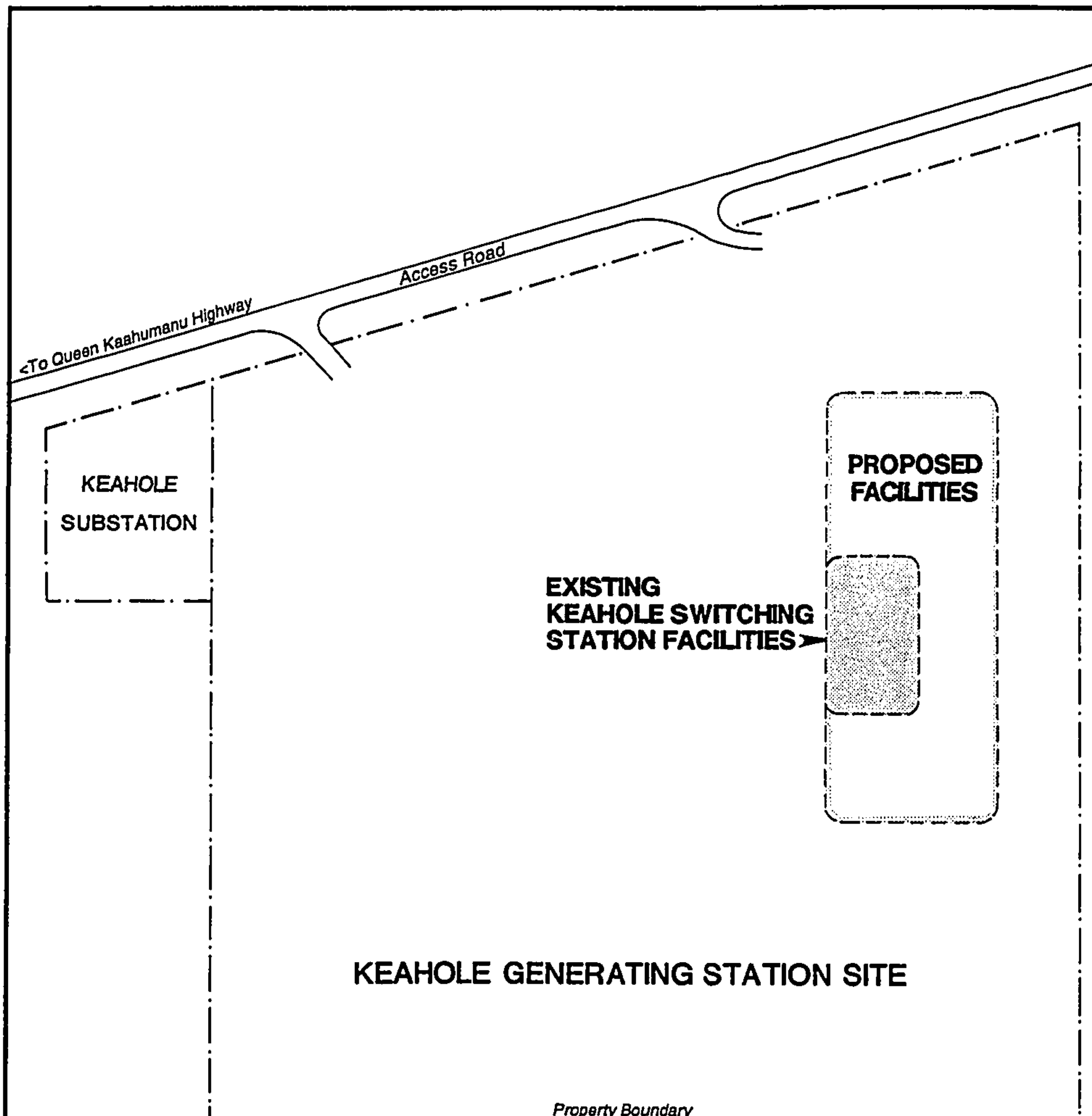
Easement Use

Land use activities within and adjacent to the transmission line easement would be permitted within the terms of the easement. Incompatible activities within the right-of-way include constructing buildings, drilling wells, growing trees that may interfere with line operation, or other activities that may compromise safety. If necessary, appropriate techniques would be used within the right-of-way to control vegetation that might interfere with reliable service. Low-growing vegetation may be left in the right-of-way.

Maintenance Practices

The proposed transmission line's structures and rights-of-way would be inspected regularly and a "detailed inspection/structure upgrade" of the lines would be conducted according to HELCO's maintenance schedules.

Emergency repair would be made if the transmission line were damaged and required immediate attention. Maintenance crews use tools, trucks, assist trucks, aerial lift trucks, cranes, and other equipment for the repair and maintenance of insulators, conductors, and structures.



KEAHOLE-KAILUA TRANSMISSION LINE PROJECT

FIGURE 3-2

CONCEPTUAL DESIGN OF KEAHOLE SWITCHING STATION IMPROVEMENTS

NORTH

NOT TO SCALE

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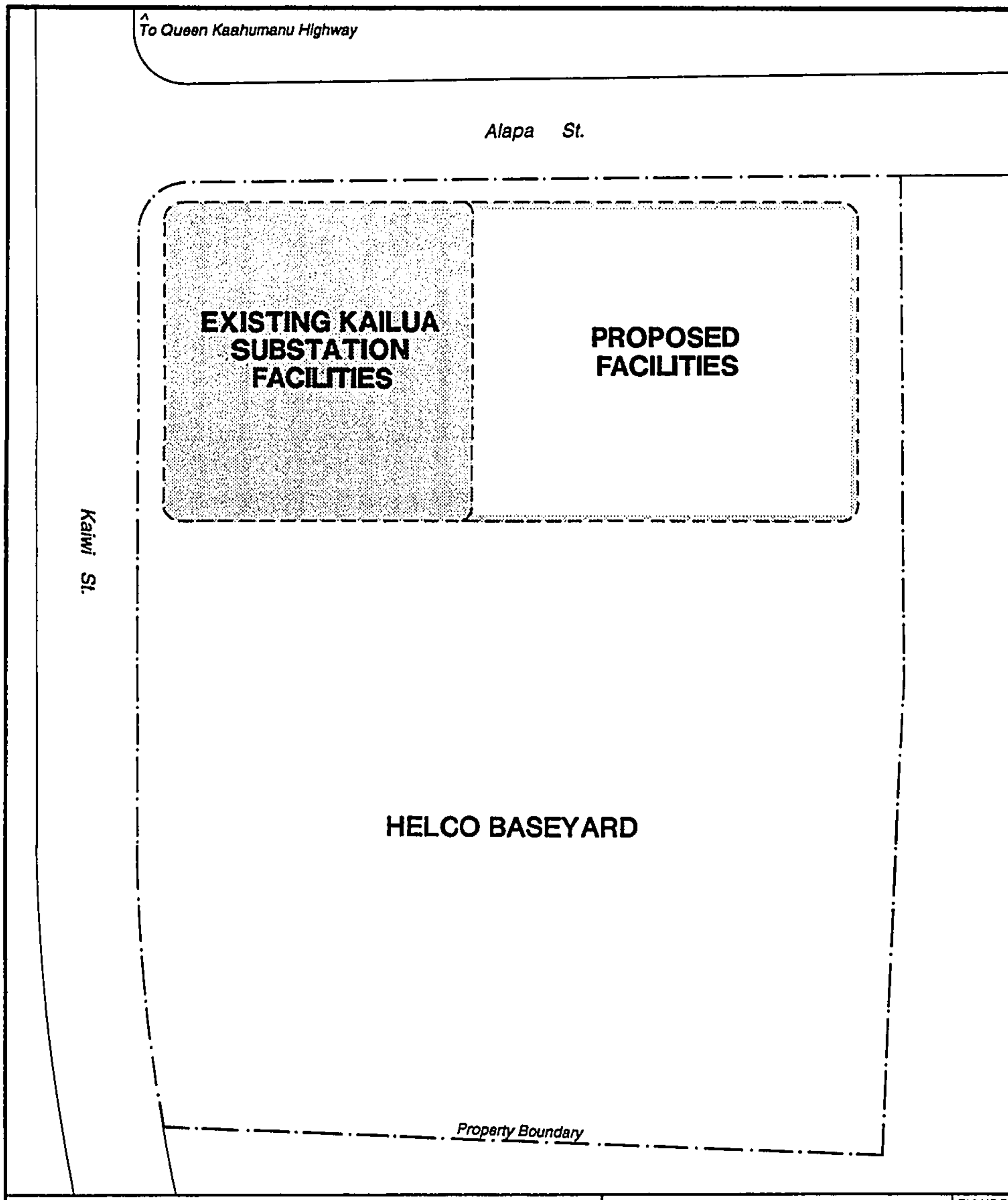

KEAHOLE-KAILUA TRANSMISSION LINE PROJECT

FIGURE 3-3

CONCEPTUAL DESIGN OF KAILUA SUBSTATION IMPROVEMENTS

NORTH

NOT TO SCALE

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CHAPTER 4

Chapter 4

Alternatives Considered, Including the Applicant's Proposed Action

Electric Power Transmission Line Technologies

There are three alternative technologies that may be used to construct the 69 kV transmission line between Keahole and Kailua: conventional overhead construction, underground construction, and submarine cable. The following analysis presents the basic elements of the three possible transmission technologies and compares the environmental and economic considerations of construction and maintenance for each technology.

Overhead Transmission Line

In general, conventional contemporary overhead 69 kV construction consists of stranded aluminum conductors supported by monopole structures (usually wood or steel), multipole structures (wood or steel), or lattice structures (steel). The conductors are electrically insulated from the structure with porcelain or polymer/fiberglass insulators (Figure 4-1). HELCO transmission lines are designed to exceed the standards of the Hawaii PUC's General Order No. 6 (GO-6), "Revised Rules for Overhead Electric Line Construction" (State of Hawaii Department of Regulatory Agencies, 1969). GO-6 specifies standards for ground clearance, conductor clearances, and other aspects of construction to ensure safe and reliable service.

The type of support structure selected depends principally on the topography and land uses in and around the proposed right-of-way. Lattice steel, tubular steel, and multipole wood structures are used in remote or mountainous terrain where span lengths are long (i.e., 600 to 1,200 feet). The cost per mile is relatively low; however, the steel towers can be visually intrusive. Tubular steel poles and wood poles are generally used where the span lengths are moderate (i.e., 300 to 600 feet) (Figure 4-1). Wood and steel poles typically require guy wires and anchors for support at angles and dead ends; however, steel poles can be designed to be self-supporting with reinforced concrete pier-type foundations if anchor easements cannot be obtained. Both lattice steel structures and tubular steel poles can be painted to blend in with or complement the surrounding environment.

Underground Transmission Cable

Typical Underground Transmission Cable

Historically, typical underground power transmission lines in the United States have been buried at depths of about 4 feet, primarily to ensure that they are protected from other utility excavations and roadwork, and to maintain public safety.

In the United States, most typical underground transmission systems at voltages of 115 kV and higher are high-pressure fluid-filled pipe systems. For lower voltages, such as the 69 kV of the proposed Keahole-Kailua line, solid (or extruded) dielectric cables are used more often because of their lower cost and simpler construction requirements.

A typical solid (or extruded) dielectric cable system for a 69 kV transmission line (Figure 4-2) would consist of three cables (one for each phase) for each circuit. Each cable would consist of a 1,500-kcmil (one thousand circular mils) aluminum conductor, encased in several layers of insulation and copper shielding, and surrounded by a polyethylene jacket. The 3-inch-diameter cable would be placed inside a 5-inch polyvinyl chloride (PVC) conduit. The three conduits that make up the circuit would be placed inside a rectangular concrete shell large enough to allow at least 3 inches between conduits that would be covered with a backfill material with specified thermal properties. The entire system would be buried at least 4 feet below the ground surface. If HELCO were to install an underground system for this line, it would probably install spare conduits to replace a faulty cable or for an extra future circuit in case the need for an additional circuit ever arose. Splice vaults (manholes) would be installed approximately every 1,000 feet. A typical concrete splice vault would be 6 feet wide, 14 feet long, and 6.5 feet deep.

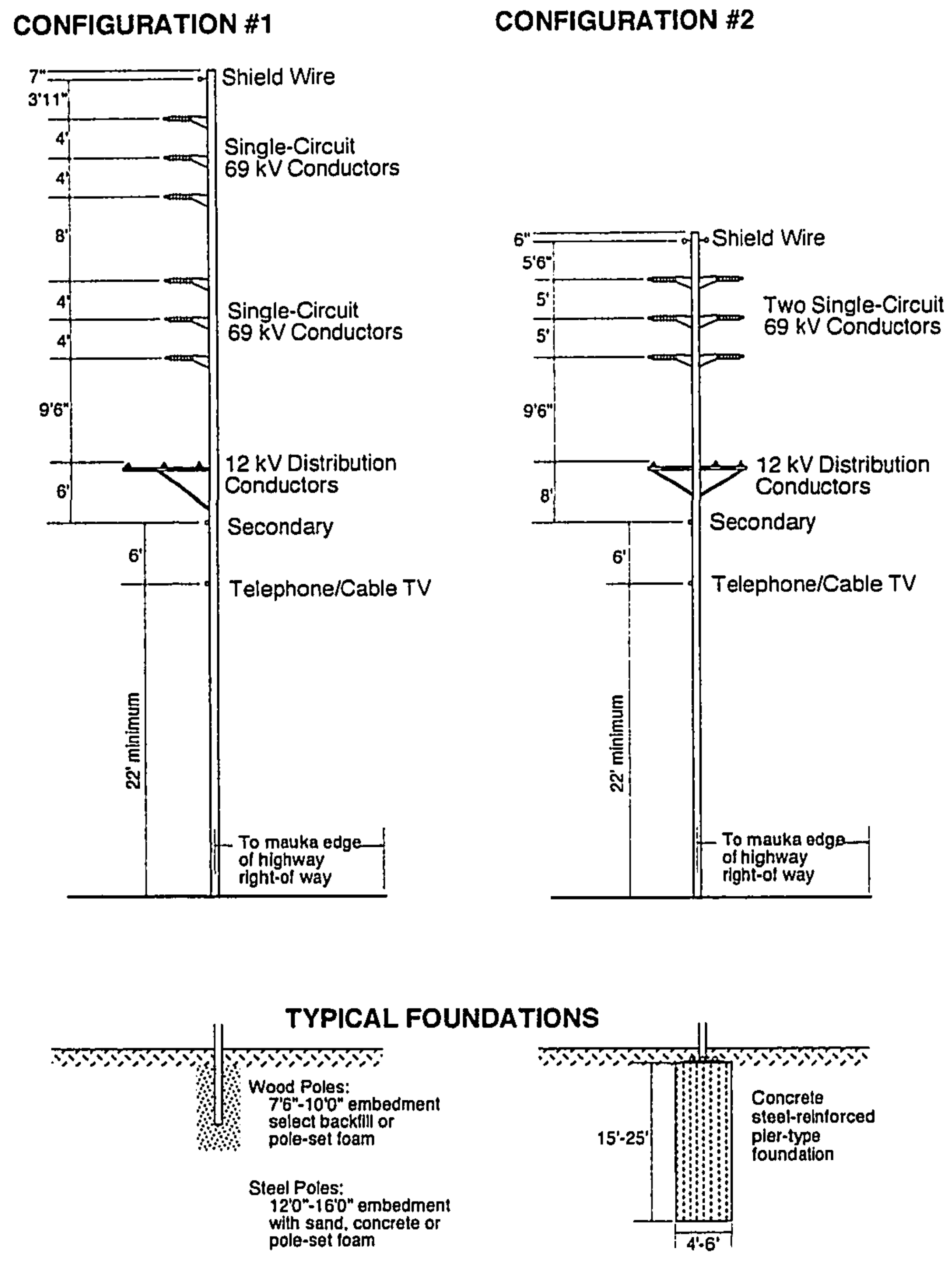
Shallow Trench, Near-Surface, and Surface Installation of Transmission Cable

The installation of shallow trench, near-surface, and surface transmission lines is similar to the typical undergrounding of a transmission line cable, except that the transmission line cable would be installed at existing grade, or in a shallow trench. Unlike typical undergrounding, where the transmission line cable and protective cover would be 4 feet below grade, the transmission line would be protected by a berm of protective materials placed over it and above the existing grade. The berm might include thermal sand, concrete, soil, or other materials.

A report prepared by Electric Power Research Institute (Electric Power Research Institute, October 1987) evaluated the installation of underground transmission lines. The report discussed shallow trench, near-surface, and surface installation techniques that are currently in use in rural areas of Europe.

In rural installations, the potential for physical damage is greatly reduced. However, the existing and proposed uses in the project area are or are proposed to be intensively urban. This substantially increases the possibility of damage to shallow trench, near-surface, and surface installation of transmission line cables as future developments will require more streets and driveways to be constructed.

There is a presumption that shallow trench, near-surface, and surface installation should cost less than typical undergrounding because of reduced trenching costs. However, these methods would involve costs similar to those involved in typical undergrounding because of the need to prepare a continuous linear foundation onto which the cable would be placed and the need



KEAHOLE-KAILUA
TRANSMISSION LINE PROJECT

FIGURE
4-1

POSSIBLE CONFIGURATIONS FOR 69 kV OVERHEAD STRUCTURES

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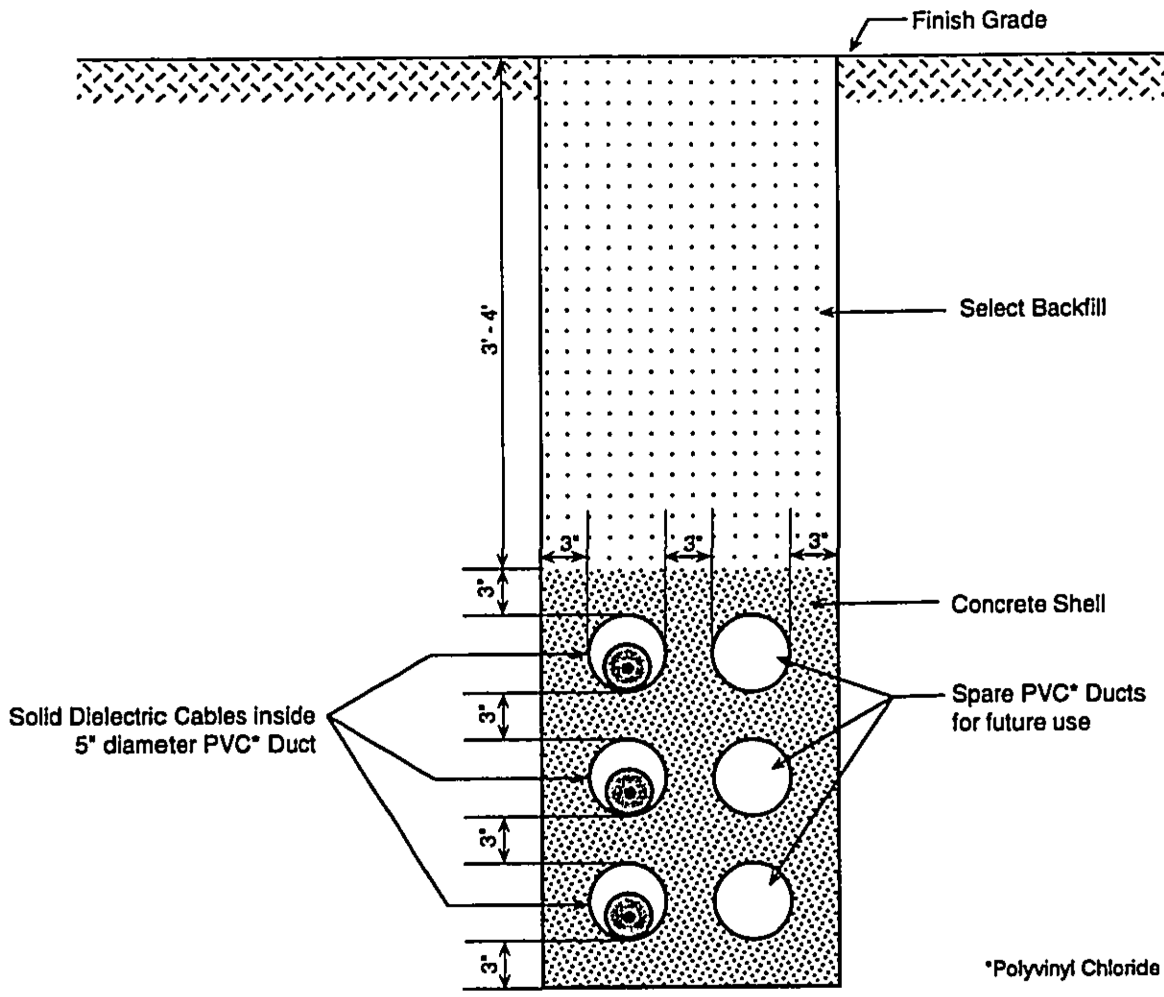
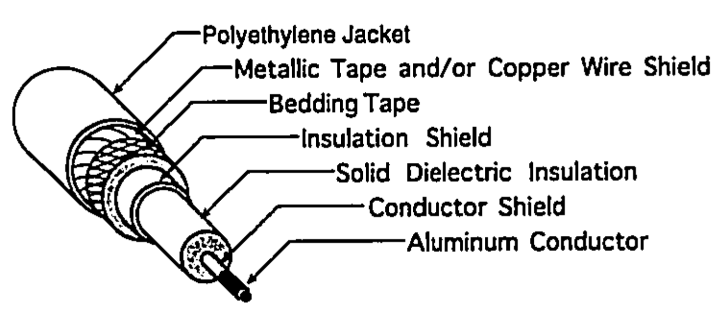
DUCT ENCASEMENT DETAIL



*Polyvinyl Chloride

69 kV SOLID DIELECTRIC CABLE



KEAHOLE-KAILUA
TRANSMISSION LINE PROJECT

FIGURE
4-2

TYPICAL 69 kV UNDERGROUND CABLE SYSTEM

NOT TO SCALE

CH2M HILL

to place the transmission line 4 to 6 feet underground at vehicular and pedestrian access points.

A berm would require large amounts of soil to be imported to maintain the necessary cover over the transmission cables and could affect visual and biological resources, public health and safety, and traffic. A continuous berm could block significant views in an area, permanently destroy the substrate on which sensitive plants grow, and increase the risk of vandalism and accidental damage to the lines from the public and automobile drivers. In some locations, a continuous berm may have a greater visual impact than overhead transmission lines installed on poles.

Further, although the Hawaii Public Utilities Commission has specific rules regarding overhead and underground transmission lines, there are no specific rules regarding the shallow trench, near-surface, and surface installation of transmission lines. It is uncertain how the PUC would respond to a HELCO request for shallow trench, near-surface, or surface installation of a transmission line.

Comparison of Underground Transmission Cable Technologies

Of the two underground transmission cable alternatives (i.e., shallow trench, near-surface, or surface installation versus conventional underground), only the conventional underground transmission cable with a solid dielectric system or high-pressure fluid-filled pipe has been used in the United States. There is no body of knowledge or practical technology available to use for the installation of shallow trench, near-surface, or surface transmission cables. The best practical technology available to HELCO at this time is the conventional underground transmission cable system. For this reason and those described above, HELCO believes that the most reliable, most practical, and safest choice is the conventional underground transmission cable system. As indicated above, if a conventional underground transmission cable system were used, HELCO would probably use solid dielectric cable.

Of the two underground technologies, the shallow trench, near-surface, and surface installation technology will be dropped from further consideration. The conventional underground transmission cable technology will be retained for further analysis.

Submarine Transmission Cable

Compared with overhead transmission circuit miles, relatively few miles of submarine cable are in use in the world today. Of the four types of submarine cables (self-contained low-pressure fluid-filled; high-pressure fluid-filled; solid-type paper-insulated; or solid dielectric, polyethylene-insulated), solid dielectric, polyethylene-insulated cables would be HELCO's preference if a submarine transmission cable were chosen as the technology for the Keahole-Kailua transmission line. The submarine link would require one circuit with a spare cable. Figure 4-3 illustrates a typical submarine cable system.

Offshore, in areas where the ocean depth is 100 feet or less, the submarine cables would be buried in a trench below the ocean floor to protect them from wave action and small boat anchors. In areas where the ocean depth is greater than 100 feet, the cable would be laid on the ocean floor. The terminals of the line would be located within the Keahole Switching Station and Kailua Substation (Figure 4-4). The distance from the shoreline to the terminal substations would be traversed with underground cable buried in a trench and backfilled with a thermal sand. The underground distance from the shoreline area closest to the Keahole Switching Station (located near the Keahole Generating Station) is approximately 12,000 feet. The underground distance from the shoreline area closest to the Kailua Substation is approximately 5,000 feet.

Comparison of Electric Power Transmission Line Technologies and Environmental Considerations

Each of the overhead, underground, and submarine transmission technologies described earlier in this chapter differs significantly in cost, maintenance requirements, and environmental impacts. The following environmental and socioeconomic resource sections compare relevant engineering characteristics and the potential impacts of installing each transmission technology for the 69 kV line between the Keahole Switching Station and the Kailua Substation (Table 4-1).

Geophysical Considerations

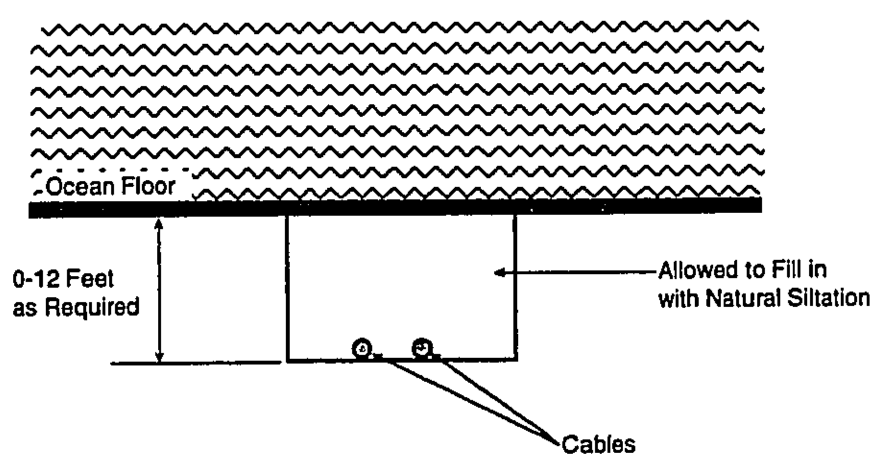
The installation, operation, and maintenance of each of the transmission technologies could affect topography and soils differently.

Overhead Transmission Line. The construction of an overhead line generally has minimal impact on topography and soils because only the soils in and around the pole locations would be disturbed. At each pole, soils are temporarily disturbed for augured excavations and backfilling. In some cases, low-impact directed charges may be used for excavating holes. The soil not required for backfill for direct-embedded poles would be mounded around the pole and the excess spread at the site. For concrete pier-type foundations, excess soil would be spread at the site or trucked to a fill site. The land between the poles would remain undisturbed except where equipment used for conductor pulling and splicing might require access. In general, surface soils may be compacted from movement of equipment, and there is the possibility of soil loss through erosion until vegetation is reestablished.

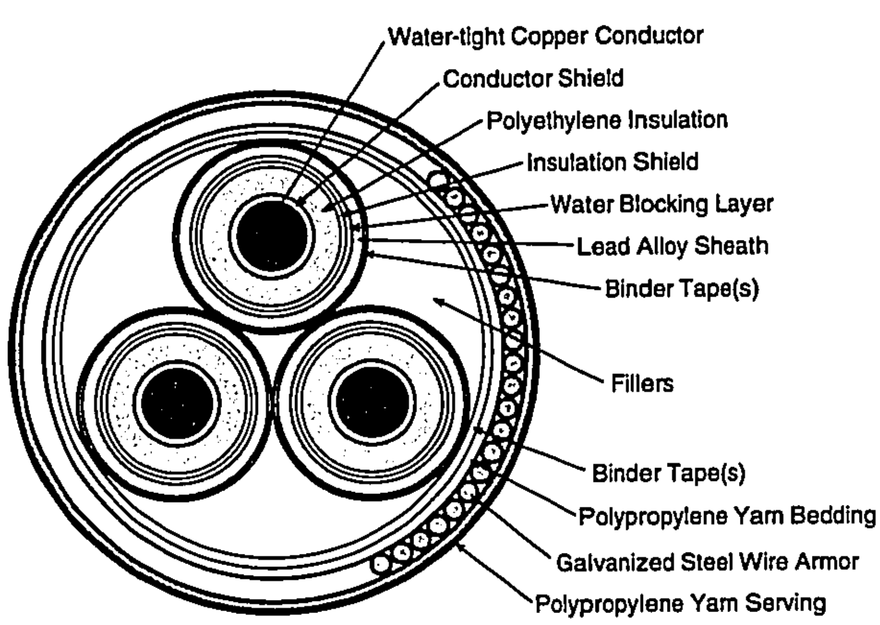
Underground Transmission Cable. The amount of excavation required for installation of a 69 kV solid dielectric system depends on the number and sizes of conduit pipes to be installed, which in turn depend on the capacity of the line and the need for spare or emergency circuits. The degree of the excavation determines the degree of disturbance of surface and subsurface soils or rock.

The Keahole-Kailua line would require six 5-inch-diameter ducts and an excavated trench approximately 8 feet deep by 4 feet wide.

TYPICAL SUBMARINE CABLE TRENCH SYSTEM



TYPICAL CABLE CONSTRUCTION



KEAHOLE-KAILUA
TRANSMISSION LINE PROJECT

FIGURE
4-3

TYPICAL 69 kV
SUBMARINE CABLE SYSTEM

NOT TO SCALE

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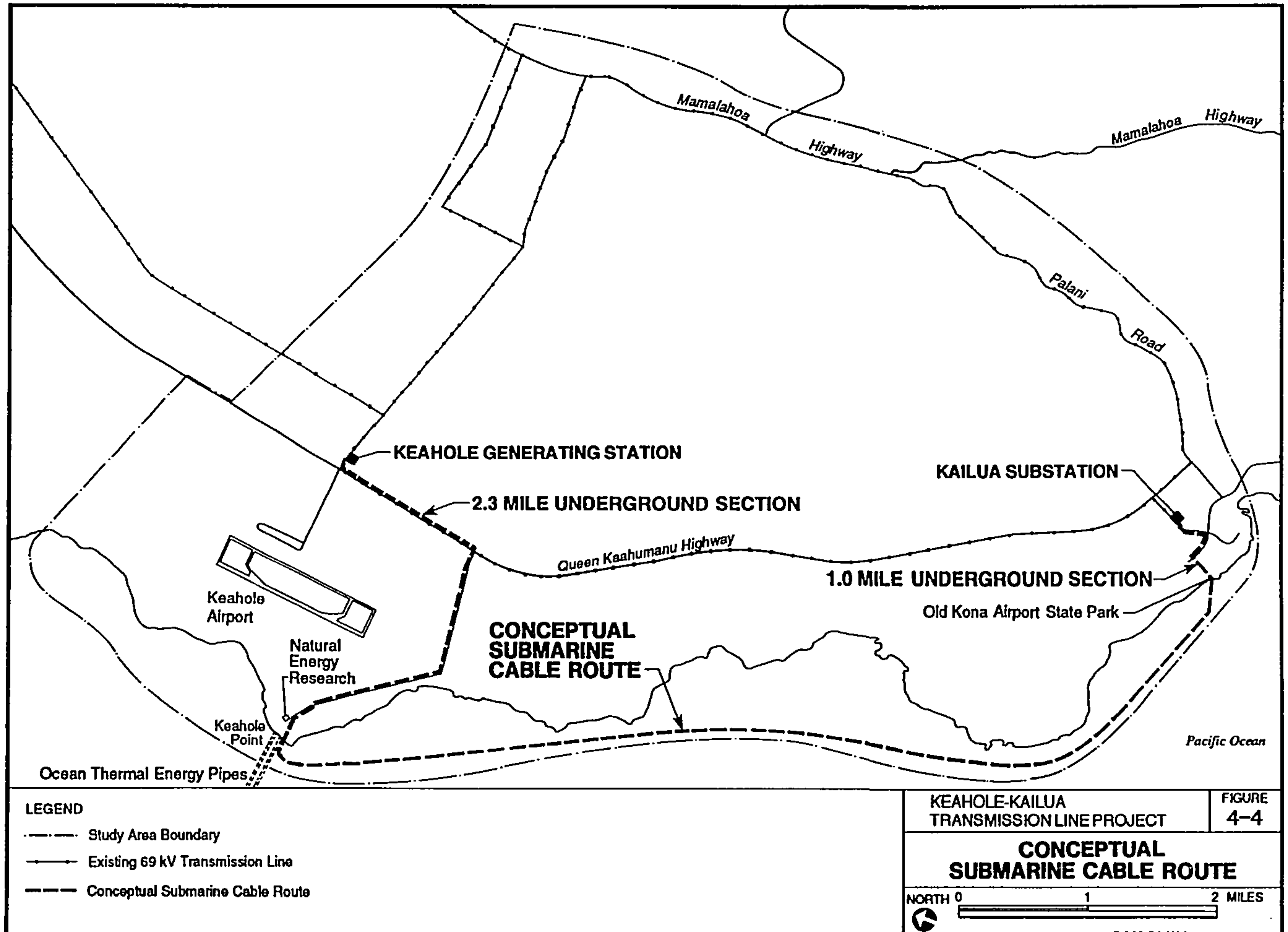

KEAHOLE-KAILUA TRANSMISSION LINE PROJECT

FIGURE 4-4

CONCEPTUAL SUBMARINE CABLE ROUTE

CH2M HILL

Table 4-1
Transmission Technologies
Summary of Engineering Characteristics and Potential Impacts

Engineering Characteristics				Construction, Operation, and Maintenance Effects			
Transmission Technology	Basic System Components	Approximate Line Length	Construction Cost ($M/Mile)	Geophysical, Biological, and Cultural Resources	EMF and Visual Resources	Traffic Considerations	Maintenance Considerations
Conventional Overhead	Wood or tubular steel poles. Double-circuit lines on one side of pole (Configuration No. 1, see Figure 4-1). Pole height: 70 to 85 feet. Double-circuit lines with one circuit on each side of pole (Configuration No. 2, see Figure 4-1). Pole height: 60 to 75 feet. Direct embedment and augered concrete pier foundations. Three aluminum conductors per circuit and one shield wire.	6.8-10.5 miles, depending on route.	Wood poles: 0.24 Tubular steel poles: 1.1	Clearing of surface vegetation at pole sites. Excavation for pole foundations. Trees near the alignment trimmed within 10 feet of conductor position in high wind. Subsurface archaeological features may be disturbed in excavations. Requires field archaeologist to survey pole sites.	EMF[a] Double-circuit lines on one side of pole (Configuration No. 1, see Figure 4-1). Maximum electric field near center of alignment approx. 0.175 kV/m or less. Maximum magnetic field near center of alignment approx. 3.76 mG. Double-circuit lines, with one circuit on each side of pole (Configuration No. 2, see Figure 4-1). Maximum electric field near center of alignment approx. 0.229 kV/m or less. Maximum magnetic field near center of alignment approx. 6.04 mG. Visual Poles and conductors visible throughout	Construction For roadway near the alignment, one lane of traffic obstructed for 4-6 weeks each mile during peak traffic periods (two lanes off-peak). Maintenance Potential traffic disruption or delays depending on type of repair and maintenance practices.	Location and access to line repair relatively easy. Repair time: hours.

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Table 4-1
Transmission Technologies
Summary of Engineering Characteristics and Potential Impacts

Engineering Characteristics				Construction, Operation, and Maintenance Effects			
Transmission Technology	Basic System Components	Approximate Line Length	Construction Cost ($M/Mile)	Geophysical, Biological, and Cultural Resources	EMF and Visual Resources	Traffic Considerations	Maintenance Considerations
Underground (Solid [or Extruded] Dielectric Cable)	Solid (or extruded) dielectric cables (three per circuit) encased in PVC ducts in concrete shell. Splice vaults (manholes) every 1,000 feet.	6.8-10.5 miles, depending on route.	1.0-3.8	Construction Trench excavation 4 feet wide and 8 feet deep. Temporary loss of surface vegetation and revegetation of low-growing vegetation only. Potential soil layer mixing and topographic alteration as a result of cut and fill required for access. Potential to disrupt surface cultural resources within the alignment. May require extensive survey and salvage plan. Operation In case an underground cable fails, spare ducts may be used for a replacement cable, without the need for excavation.	EMF* No electric field from underground cable. Magnetic field of approximately 10.44 mG at soil surface directly above cables. Visual No impact from underground cable.	Construction Longer period of traffic disruption for trenching and cable installation than with conventional overhead. Maintenance Potential traffic disruption during maintenance.	Potential for heavy traffic disruption during maintenance or repairs. Difficult to locate faults: hours to days. Repair period: days.

Table 4-1
Transmission Technologies
Summary of Engineering Characteristics and Potential Impacts

	Engineering Characteristics			Construction, Operation, and Maintenance Effects			
Transmission Technology	**Basic System Components**	**Approximate Line Length**	**Construction Cost ($M/Mile)**	**Geophysical, Biological, and Cultural Resources**	**EMF and Visual Resources**	**Traffic Considerations**	**Maintenance Considerations**
Submarine Cable	Land Portions Same as for submarine cable, below.	Land Portions 3.3 miles underground	Land Portions 1.0-3.8	Land Portions Same as conventional underground technology.	Land Portions EMF[a] Field strengths comparable to those with conventional underground technology. Visual Same as conventional underground technology.	Land Portions Same as conventional underground technology.	Land Portions Same as conventional underground technology.
	Submarine Portion Two cables (including one spare cable) laid in a trench, or on the ocean floor. Each cable contains the three conductors required for a single circuit.	Submarine Portion 7 miles submarine.	Submarine Portion 7.4-9.5	Submarine Portion Temporary disruption of benthic habitat.	Submarine Portion EMF[a] Field strengths low to negligible at surface, depending on depth of cable. Visual No impact underwater.	Submarine Portion Construction Potential boat traffic disruption during construction. Maintenance Dive inspections may affect boat traffic.	Submarine Portion Periodic dive inspections. Susceptible to damage by ship anchors. Difficult to locate faults: days or weeks. Lengthy repair period: weeks. Potential for heat buildup in cable, possible cable wear as a result of chafing action or damage to shoreline facilities from storms.

[a]The electric and magnetic field values presented in this table are the maximum values for the two proposed overhead line configurations with either normal (like) or low-reactance (unlike) phasing of conductors and for the possible underground cable installed near the existing overhead line, configured with normal (like) phasing. These maximum values are summarized in a series of graphs (Figures G-1 to G-12) in Appendix G, "Electric and Magnetic Fields: Plots of Calculated Values," produced by Enertech Consultants. The lower values cited elsewhere in this EIS (in Chapter 5 and in Chapter 1) are those associated with minimized values using low-reactance (unlike) phasing of conductors for the proposed overhead lines. For the possible underground cable, shielding around the cable would contain the cable's electric fields. Low-reactance phasing is discussed in Chapter 5, in the section on electric and magnetic fields.

Soil compaction and mixing of soil layers may result from cable trenching and backfill. This, in turn, may affect soil particle sizes and chemical characteristics. The surface of the trench is vulnerable to soil erosion until vegetation is reestablished. The surface landform might be altered by cut and fill grading within the easement where this is required for construction equipment access.

Splice vaults could be as large as 6 feet by 14 feet by 6.5 feet deep and would require excavations of 12 feet by 20 feet by 8 feet deep. These vaults could be required at about 1,000-foot intervals, depending on the topography and number of turns in the route. Thirty-six or more such excavations could be required for the estimated 6.8-mile line length from the Keahole Switching Station to Kailua.

Submarine Transmission Cable. Construction activities would require dredging and trenching of the sea floor from a point just off the beach at Keahole Point south to Kailua. Other geophysical concerns include potential heat buildup in the cable. Ocean bottom silts may have poor thermal conductivity. The design of submarine trenching and cable laying must mitigate potential chafing action and cable wear if the new line is placed in an exposed area where storms cause surge action. The landfalls at Keahole and Kailua must also be designed to limit potential damage to the shoreline during storms.

Biological Considerations

The undeveloped portions of the areas are dominated by nonnative plant species. The study area includes both dry and barren lands and agricultural and forested lands. Two native natural communities have been recorded in the study area and are significant because they provide habitats for endangered and candidate endangered or threatened plants. In addition, one federally endangered native animal taxon, the Hawaiian hoary bat (*Lasiurus cinereus semotus*) is known to occur within or near the study area. Lava tube entrances have been identified in the study area and may contain significant native subterranean ecosystems. These sensitive and endangered plant and animal resources can almost always easily be avoided by siting the transmission line out of the area of impact. Those lands crossed by transmission lines would be impacted only during construction and maintenance activities because the operation of a new transmission line is relatively benign. The marine habitat offshore and at landfalls would be affected during construction and maintenance of the submarine cable.

Overhead Transmission Line. Impacts to vegetation in agricultural land, grasslands, and low shrubland would be limited to areas required for line construction and maintenance access. Construction activities usually require selective clearing and/or removal of vegetation from construction pads and pole sites. Natural revegetation normally returns to these sites within one to three growing seasons except in areas occupied by poles.

If a line is constructed through dense shrubland, selective clearing or trimming of trees and woody plants may be necessary to provide room for construction equipment and proper conductor clearances. The amount of trimming required is usually determined by calculating the extreme position of conductors in high winds. Trees that are not located within the right-of-way but that are tall enough to contact the line if they fall are either removed or trimmed. Low-growing trees and shrubs are usually permitted to remain in a 69 kV right-of-way. In developed areas where overhead construction of 69 kV lines is adjacent to roads and streets, trees are usually trimmed to provide safe conductor clearance.

Underground Transmission Cable. Trench excavation may adversely affect existing vegetation (both natural communities and landscaping) and wildlife habitat. Where the transmission line route runs parallel to a roadway, surface vegetation along the route may have to be removed during construction; however, revegetation would take place naturally or could be expedited by planting a ground cover. Because of potential re-excavation for maintenance or repairs, and to minimize damage to the cable from tree roots, trees and large shrubs should not be planted over the underground cable route.

If any sizable area of vegetation were removed for trenching or facilities, it is possible that food and cover for wildlife would be lost.

Submarine Transmission Cable. Dredging or trenching the ocean floor would temporarily disrupt benthic ecosystems during the laying of the submarine cable. Because the submarine cable would be located in areas subject to wave action and storm surges, proper design would require that the cable be embedded in the ocean floor. As with underground systems, this practice would be costly. In addition, backfill and natural siltation may exacerbate heat buildup in the cables.

Energy loss through the cable would be dissipated as heat and conducted to the water surrounding the cable. This discharged heat could have an impact on the benthic organisms in the immediate area of the cable. The elevation in temperature would be locally confined primarily to the surface substrate because of the flow and dissipative effect of the surrounding water.

Electric and Magnetic Fields

An electric field is produced in the area surrounding a conductor (such as a transmission line or cable) when voltage is applied to the conductor. Magnetic fields occur when electric current flows through a conductor. Any electrical device, including transmission lines and household appliances, will create electric and magnetic fields (EMF).

For many years, scientist have investigated whether electric and magnetic fields produce harmful effects. No conclusive, convincing, and consistent relationship between exposure to electric and magnetic fields and adverse health effects has been demonstrated. This is reflected in a policy statement by the Hawaii Department of Health noting that "the existing research data are inconclusive and not sufficient for adequate, accurate risk assessment." Recent studies have suggested a need for additional research. These studies are described more fully in Chapter 5 of this EIS, in the section on electric and magnetic fields. The following sections compare the calculated electric and magnetic field strengths near each of the three transmission technologies. The electric and magnetic field values presented in these sections are the values for the two proposed overhead line configurations with either normal (like) or low-reactance (unlike) phasing of conductors and for the possible underground cable installed near the existing overhead line, configured with normal (like) phasing. These maximum values are summarized in a series of graphs (Figures G-1 to G-12) in Appendix G, "Electric and Magnetic Fields: Plots of Calculated Values," produced by Enertech Consultants. The lower values cited elsewhere in this EIS (in Chapter 5 and in Chapter 1) are those associated with minimized values using low-reactance (unlike) phasing of conductors for the proposed overhead lines. For the possible underground cable, shielding around the cable would contain the cable's electric fields.

Overhead Transmission Line. Overhead transmission line conductors are insulated from each other and the ground by insulators and the surrounding air. Electric and magnetic fields exist around each conductor. The strength of these fields diminishes in proportion to the square of the distance from the conductor. At the ground level, field strengths are highest almost directly under the conductors at the point where the conductors sag closest to the ground (usually at the midpoint between transmission poles). At that point, the maximum electric field underneath a typical 69 kV transmission line is about 0.10 to 0.23 kilovolts per meter (kV/m) or less. The corresponding maximum magnetic field would be on the order of 1.0 to 6.0 milliGauss (mG) under summer peak line loadings.

Underbuilt or adjacent 69 kV or underbuilt 12 kV distribution lines may cancel out some of the electric and magnetic fields, and in these fields, field strengths directly under the 69 kV conductors could be somewhat lower—about 0.10 to 0.15 kV/m (electric field) and about 1.0 to 1.5 mG (magnetic field). Actual electric and magnetic field strengths will vary somewhat for specific projects with different designs and loadings. These field strengths are lower than field strengths associated with some of the higher-voltage transmission lines (such as 500 kV and 765 kV) that are typical of utility systems in other parts of the United States.

Underground Transmission Cable. The metallic tape or copper wire shield that encases the conductor in typical solid dielectric underground cable systems effectively eliminates any measurable electric field outside the cable. Magnetic fields could measure from 10 to more than 12 mG at the surface of the soil directly above the ducts. The magnetic field of underground cables would decrease over a much shorter distance from the line than would be the case with an overhead line because underground cables can be placed closely together.

Submarine Transmission Cable. The electric and magnetic fields at the surface of the water above a submarine transmission cable would vary according to the depth of the cable, but generally they would be negligible.

Socioeconomic Factors

Some socioeconomic factors (e.g., land jurisdiction and use and transportation and utility easements) depend on the route selected rather than on the type of transmission technology selected. The major socioeconomic considerations related to the selection of a transmission technology are the potential visual impacts, television and radio interference, traffic disruption during construction and maintenance, and potential impacts on cultural resources.

Visual Quality

Overhead Transmission Line. An overhead transmission line is visible to the public. Assessing the visual effect requires considering the displacement and/or addition of visual elements in the landscape, the degree of change to existing visual resources, the configuration of the overhead line and its supporting structures, and the number and subjective preferences of people affected by these changes.

Underground Transmission Cable. After an underground cable is installed, there is no visual impact from the cable itself. Underground systems require underground-to-overhead transition facilities at either end of the underground portion. These facilities would be installed in the existing Keahole Switching Station and Kailua Substation.

Submarine Transmission Cable. The underwater portions of a submarine cable system would not be visible above the water surface. A submarine cable would require transition equipment at each end of the cable. Submarine cable terminal equipment would be installed in the existing Keahole Switching Station and Kailua Substation.

Television and Radio Interference

Overhead Transmission Line. Overhead transmission lines do not usually interfere with normal radio or television reception. There are two potential sources of interference: gap discharges and corona. Corona can affect AM radios, while gap discharge can affect both television and radio reception.

Corona is the physical manifestation of energy loss, and it can transform energy into very small amounts of light, sound, radio noise, chemical reaction, and heat. Corona activity is usually minimized through proper design of the line and is, therefore, almost never a source of interference. The Keahole-Kailua 69 kV transmission line will be designed not to cause television interference, and corona will not be a source of television interference.

Gap discharges are a source of radio noise and television interference. They are caused by electrical discharges between damaged or poorly fitting hardware such as insulators, clamps, or brackets. Hardware is designed and installed to be problem free, but gunshot damage, wind motion, corrosion damage, wear, or other factors sometimes can create gap discharges. The discharges act as small transmitters at frequencies that can be received on some radio and television receivers. Gap discharge sources can be located by HELCO engineers and repaired.

HELCO engineers design all transmission lines to be as free as possible from corona and other sources of interference. Radio and television interference complaints are recorded, evaluated, and investigated when necessary and corrective measures are taken as required.

Underground Transmission Cable. Radio and television interference would be virtually nonexistent from an underground cable system.

Submarine Transmission Cable. Radio and television interference would be virtually nonexistent from a submarine cable system.

Traffic Disruption During Construction and Maintenance

Overhead Transmission Line. For an overhead line, the major traffic disruption would occur during construction. All construction and restoration or roadways would be performed in accordance with applicable standards set forth by federal, state, and county authorities.

Preparing foundations, setting poles, and stringing conductor could require a lane of traffic to be closed temporarily. HELCO's construction crews might need to close a lane of traffic on multilane roads during off-peak traffic periods (8:30 a.m. to 3:00 p.m.). Construction would occur in stages, separated by the time required to coordinate work tasks.

The initial construction activity would be right-of-way access preparation, pole hole digging, and foundation installation. Pole installation would occur next. About two to three poles would be installed per day. For routes along highways, construction may require a 1,000- to 1,500-foot section of road to be coned off. This coned-off section would move forward as pole installation is completed along the route.

Pulling conductor, tensioning, and dead-ending are usually done in segments of about 1 to 5 miles long. Traffic would be coned off at the beginning of a segment to accommodate the reel that holds conductor and at the end of the segment to accommodate pulling equipment. A few bucket trucks located between the beginning and the end of the segment may also require traffic coning.

After construction, traffic disruption for routine maintenance would be less frequent and of shorter duration. Because overhead lines are easily visible, HELCO's inspection is essentially a "drive-by" inspection.

Underground Transmission Cable. Because an underground cable would require trenching along its entire route, traffic disruption during construction would be more extensive and for longer periods than for overhead lines.

If a fault were to occur on underground lines, it could take several days or weeks to locate and repair the problem. Traffic disruption during repair could be more prolonged than for overhead lines because excavation and backfilling would be required.

Submarine Transmission Cable. The undersea portion of the Keahole-Kailua line submarine transmission system could interfere with the use of the beaches and shoreline while each cable is being laid or while maintenance is performed. The underground portions would have the impacts described above for underground cables.

Cultural Resources

The construction activities associated with each of the three transmission technologies could disrupt surface and subsurface cultural resources.

Overhead Transmission Line. During the route selection process for an overhead line, a professional archaeologist prepares a survey of the proposed alignment. The survey identifies the locations of cultural resources in or near the proposed route, as well as areas where there is a significant probability of finding artifacts below the soil surface. The process of selecting a route includes conducting a cultural resource survey to avoid areas with the potential for cultural resources. During design, careful pole siting can help avoid disruption of cultural resources.

Underground Transmission Cable. The potential for disrupting cultural resources (especially subsurface resources) is higher with an underground cable than with an overhead line because of the greater extent of excavation. A cultural resource survey could be used to screen surface features before the cable alignment is selected, but there would still be some potential for disrupting cultural resources during trenching.

Submarine Cable. It is unlikely that the submarine cable from Keahole to Kailua would disturb any cultural resources offshore. The land portion of the submarine route could have impacts described above for underground transmission cable.

Maintenance and Repair Considerations

Maintenance techniques vary for each type of transmission system. The time needed for repair depends on maintenance techniques, the degree of repair required, and the location of the outage or area requiring repair.

Overhead Transmission Line. Operation and maintenance for overhead lines are routine and relatively inexpensive compared with underground or marine options. Although overhead lines are more vulnerable to vandalism and damage from hurricanes, earthquakes, or tsunamis, repairs of outages can usually be accomplished within hours.

On a pole that has two circuits installed on it, maintenance or repair of a circuit may require that both circuits be de-energized. This is especially true for the double-circuit, single-sided arrangement (Configuration No. 1) because the lower circuit must be shut off before maintenance personnel can access the top circuit. Because both circuits on the same pole may be shut down whenever maintenance or repairs to one circuit is required, the remaining energized circuits in the transmission line system must be relied on to carry additional loads and to support the regional transmission line system, in case any of the remaining energized circuits develops a fault and has to be removed from service. If maintenance or repairs are required on a circuit on a pole that has two circuits, the remaining transmission line system becomes more vulnerable to overloads and outages during these maintenance or repair operations.

Underground Transmission Cable. Underground cables are quite reliable; however, the repair of this system requires skilled workers trained and experienced in cable splicing.

Splicing is a critical procedure that requires absolute cleanliness in cable preparation and the heat-shrinking of insulation to the solid dielectric polyethylene insulated cable. The insulation shield tape must also be replaced and the conduit repaired. HELCO would need to organize special crews, develop procedures, and acquire equipment for maintaining and repairing an underground transmission cable.

Because of the difficulty of locating faults in an underground cable and obtaining access for repair crews and equipment, repair of outages would take far longer than for an overhead line (i.e., days or weeks rather than hours).

Submarine Transmission Cable. Marine cable considerations include potential heat buildup in the cable if it is buried in ocean bottom silts that act as insulation, and potential damage to shoreline facilities or cables caused by storms or ships' anchors.

Most reported damage to existing submarine cables is attributed to mechanical damage caused by fishing and trawling gear or by anchors. Damage from fishing is not expected to be a factor along this route because there is no significant commercial fishing industry in West Hawaii. However, vessels could drop anchor, which could damage the cable from the direct impact of an anchor or by snagging the cable as the anchor is dragged. Therefore, near-shore embedment of the cable is likely to be required to mitigate this risk. Consequently, locating and repairing cable damage would be more difficult.

The cost of operating and maintaining a submarine cable system is minimal because there are no manholes to open or splices to inspect. Emergency repairs to the cable represent a significant cost. By installing a spare cable, a single-faulted cable can be switched out and the spare cable switched in. However, if more than one cable is damaged, the outage duration would be longer than for an underground or overhead system because the repair vessel would not be permanently moored in Hawaii. Adverse weather and sea conditions could seriously impede access to the cable.

Repairing a damaged or failed marine cable requires locating the fault, uncovering the faulted section of cable, raising it to a barge, and splicing in a length of new cable. The repair excavation would be extensive to accommodate a longer repaired cable. The cable repair technique is even more demanding than repairs on underground cables because the cable must be retrieved from the ocean bottom before repairs can be made. In addition, the lead sheath and steel armor must be replaced. The time required to complete repairs is long and will affect service to customers.

Cost

The estimated relative construction costs for the three transmission technologies vary significantly, as shown in Table 4-2. A range of costs is shown for the overhead technology (using wood or steel poles) and the underground technology to reflect the impact of following different routes from Keahole to Kailua. The costs do not include the cost for land acquisition or switching station or substation construction.

Table 4-2
Comparative Construction Costs for Alternative Transmission Technologies

	Overhead	Underground	Submarine
Entire line	$1,600,000 to $11,600,000	$ 6,800,000 to $39,900,000	$64,000,000 to $70,000,000

Permit Requirements

A preliminary analysis of permit requirements suggests that the overhead and underground technologies would have similar permit requirements, determined by the locations of the rights-of-way. These permits may include:

- Conservation District Use Application for Use of State Conservation District Land (Hawaii Department of Land and Natural Resources)
- Historic Site Review (Hawaii Department of Land and Natural Resources)
- State Special Use Permit for Use of State Agricultural District Land (Hawaii State Land Use Commission, Hawaii County Planning Department, and Hawaii County Planning Commission)
- Permit to Perform Work Upon a State Highway (Hawaii Department of Transportation)
- Special Management Area Use Permit (Hawaii County Planning Department and Hawaii County Planning Commission)

Agencies' consideration and review might differ somewhat between these two options. Permitting agencies could be expected to give more attention to the visual effects of overhead lines and, perhaps, more attention to possible impacts on biological and cultural resources and existing underground structures (such as pipelines and water mains) for underground lines.

Two additional permits or reviews would be required for the overhead alternative:

- Proposed Construction or Alteration of Objects that May Affect Navigable Airspace (U.S. Department of Transportation, Federal Aviation Administration)

- Proposed Change of the Land Use or Construction or Alteration of a Structure Located Within the Airport Hazard Zones of Any Public, Quasi-Public, or Military Airports Within the State (Hawaii Department of Transportation, Airports Division)

The submarine cable technology would require an additional set of permits and reviews. Permits in addition to those required for overhead and underground transmission lines may include the following:

- Shoreline Setback Variance (Hawaii County Planning Department)

- U.S. Department of Army Permits for Activities in Waterways (U.S. Army Corps of Engineers)

Electric Power Transmission Line Technologies Considered for Further Analysis

After reviewing the alternatives to an overhead transmission line, HELCO chose to further analyze the conventional overhead line and underground technologies on the basis that they would be the most viable alternative technologies for the Keahole-Kailua 69 kV transmission line project.

Several considerations make the submarine cable technology unreasonable. The marine technology is fairly rare in the United States and has never been used by HELCO or HECO; therefore, the potential for costly delays and higher construction costs is greater than for the other technologies. In addition, the location and repair of faults in the underwater cable would be costly and time-consuming. The construction costs of a submarine cable are considerably higher than those of overhead lines. For all of the above reasons, the submarine cable technology alternative is being eliminated from further consideration.

The underground cable technology has both advantages and disadvantages. The principal advantage is the low level of visual impact and greater protection from natural hazards such as hurricanes and fires than is the case with overhead lines. The disadvantages include significantly higher construction and maintenance costs. In addition, the extensive excavation required for construction of an underground cable would pose a greater risk to biological and cultural resources in sensitive areas. Locating and repairing faults would be costly and time-consuming. The costs of an underground cable would be four to eight times higher than those of an overhead line, with the potential to increase the cost of electricity to customers. Nonetheless, HELCO retained the underground alternative for further analysis because the underground technology is a practical technology in common use in the United States, and HECO is using it on a limited basis for a few transmission lines on Oahu.

In conclusion, the submarine cable was eliminated from further consideration and the overhead and underground alternative technologies were retained for further analysis in the identification and selection of a preferred alignment.

Transmission Line Routing Methodology

Overview of the Routing Study Process

The methodology for selecting a new transmission line route is a sequence of the following analytical tasks:

- Project definition
- Regional study and corridor identification
- Corridor evaluation
- Alternative alignment identification
- Preferred alignment selection

The route selection process considers many factors simultaneously, including:

- Public concerns
- Government agency concerns
- Landowner concerns
- HELCO's existing transmission system and system reliability
- Potential environmental and land use impacts
- Project economics, including construction, operation, and maintenance costs

The objective of the siting process was to systematically reduce a relatively large geographic study area to alternative corridors through the evaluation of opportunities and constraints. The width of the alternative corridors may vary from one-quarter to one-half mile, depending on the number of constraining factors in any particular area. However, corridors must be wide enough to permit the location of several alternative alignments.

More detailed study of the corridors results in the selection of a preferred corridor, which is then followed by the identification of alternative alignments. Alignments are strips of land within the corridor, approximately 150 to 200 feet wide, on which the transmission line can be sited and constructed. The alternative alignments are subject to further detailed evaluation, which results in the selection of a preferred alignment.

Throughout the process, as the study area narrowed to a defined route, environmental data were collected and analyzed, the public and agencies were consulted, and fieldwork was conducted. The information and results gathered from these efforts were continually refined and reevaluated.

Regional Study and Corridor Identification Methodology

Study Area Definition

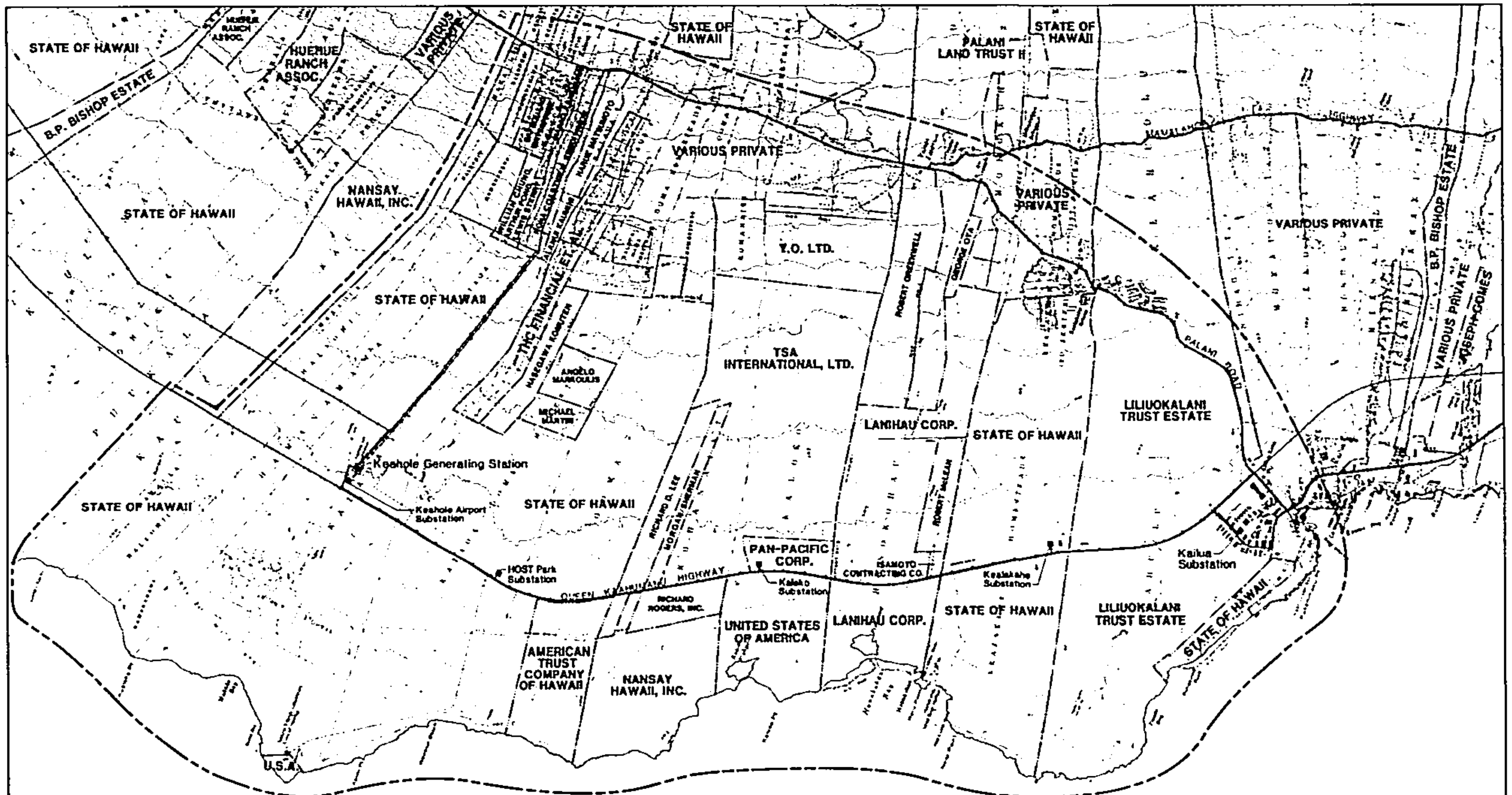
The Keahole-Kailua study area is located on the west side of the island of Hawaii in the vicinity of the Keahole Airport and occupies an area approximately 8 miles long by 5 miles wide. The study area essentially occupies all of the plain makai of Mamalahoa Highway between the Keahole Switching Station (which is adjacent to the Keahole Generating Station) and the Kailua Substation; it includes the offshore waters and ocean floor out to a distance of no more than 1 mile.

The following general guidelines were used to define the study area for the entire Keahole-Kailua transmission line project:

- Minimize the length of the route connecting the Kailua Substation and Keahole Switching Station
- Maximize the use of existing transportation and utility corridors
- Include sufficient area to allow for flexibility in locating a new transmission right-of-way
- Include all shoreline areas, but minimize open-water areas

Environmental Resource Category Maps and Environmental Data Factors

To structure the regional analysis and provide a means for narrowing the study area to alternative corridors, a comprehensive range of environmental resource categories was identified and, within these environmental resource categories, sets of environmental data factors were established. These environmental data factors included those environmental and land use data that would influence the location of a corridor one-half mile wide and, when considered in total, formed a comprehensive data base that characterized environmental conditions and uses within the study area. Data were collected from available information, and supplemented with field verification. During the process of identifying alternative corridors, the data factors within each environmental resource category map were evaluated independently of other data factors from other environmental resource category maps. The objective was to analyze the opportunities and constraints relative to each environmental resource category map as if all other environmental category maps were equal. No single environmental resource category map determined corridor location. Environmental resource category maps (Figures 4-5 through 4-12) show the location of the data factors for each resource category and support the discussion of the Regional Resource Inventory and Constraints Evaluation (see Appendix A). Those proposed land uses that had progressed substantially in the land use regulatory process were considered as existing land uses in this analysis; they are shown in Figure 4-7.



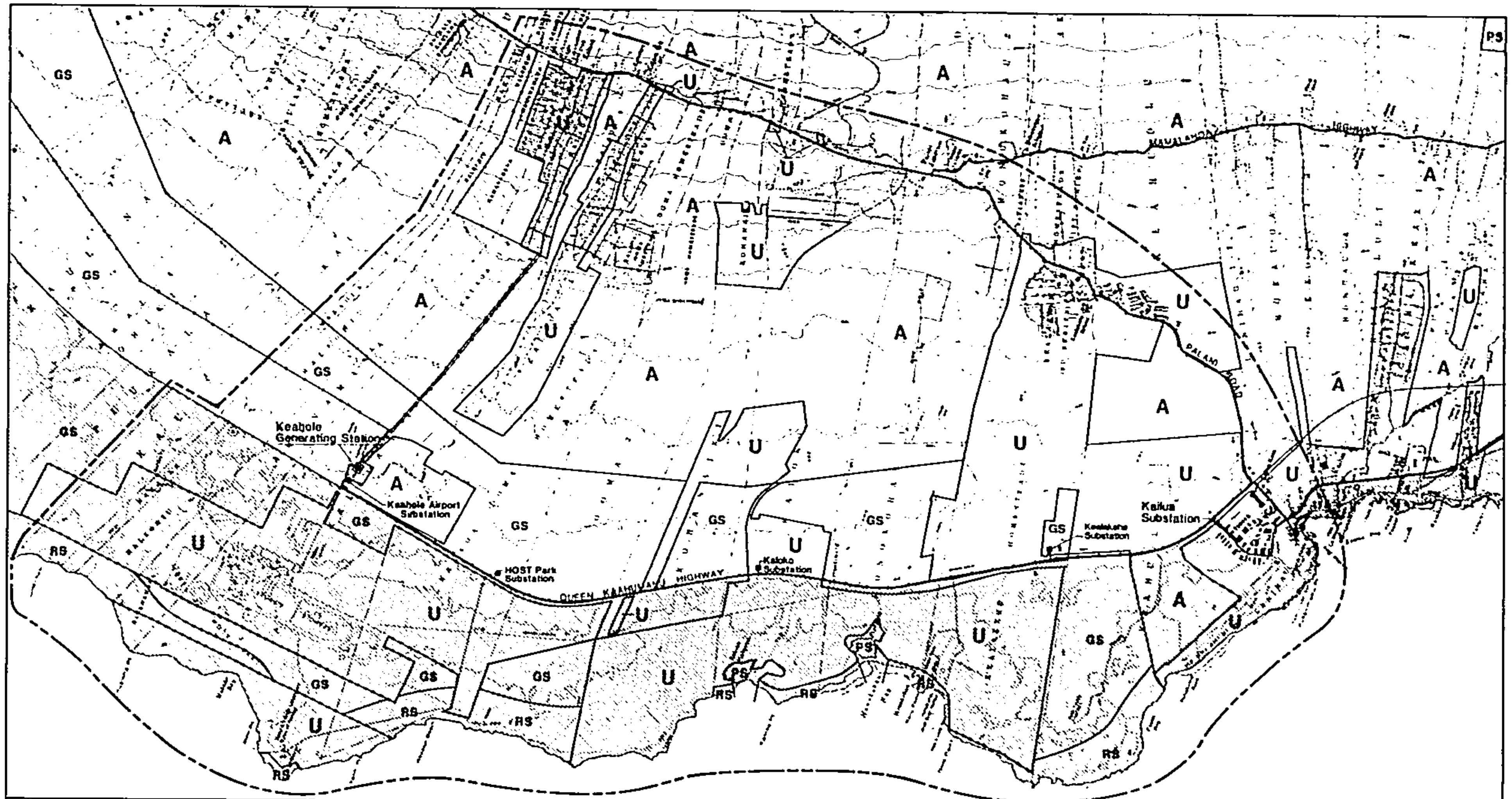
- Study Area Boundary
- Corridor Boundary
- Power Facility
- Switching or Substation
- 69 kV Line
- Property Boundary

KEAHOLE-KAILUA TRANSMISSION LINE PROJECT
Hawaii Electric Light Company, Inc.

LAND OWNERSHIP

NORTH 0 2000 4000 6000 FEET 0 0.5 1 MILE

FIGURE 4-5



- - - Study Area Boundary
— · — Corridor Boundary
Power Facility
Switching or Substation
69 kV Line

STATE LAND USE CLASSIFICATION

A Agricultural District

U Urban District

Conservation District

PS Protected Subzone

GS General Subzone

RS Resource Subzone

County Special Management Area

KEAHOLE-KAILUA TRANSMISSION LINE PROJECT

Hawaii Electric Light Company, Inc.

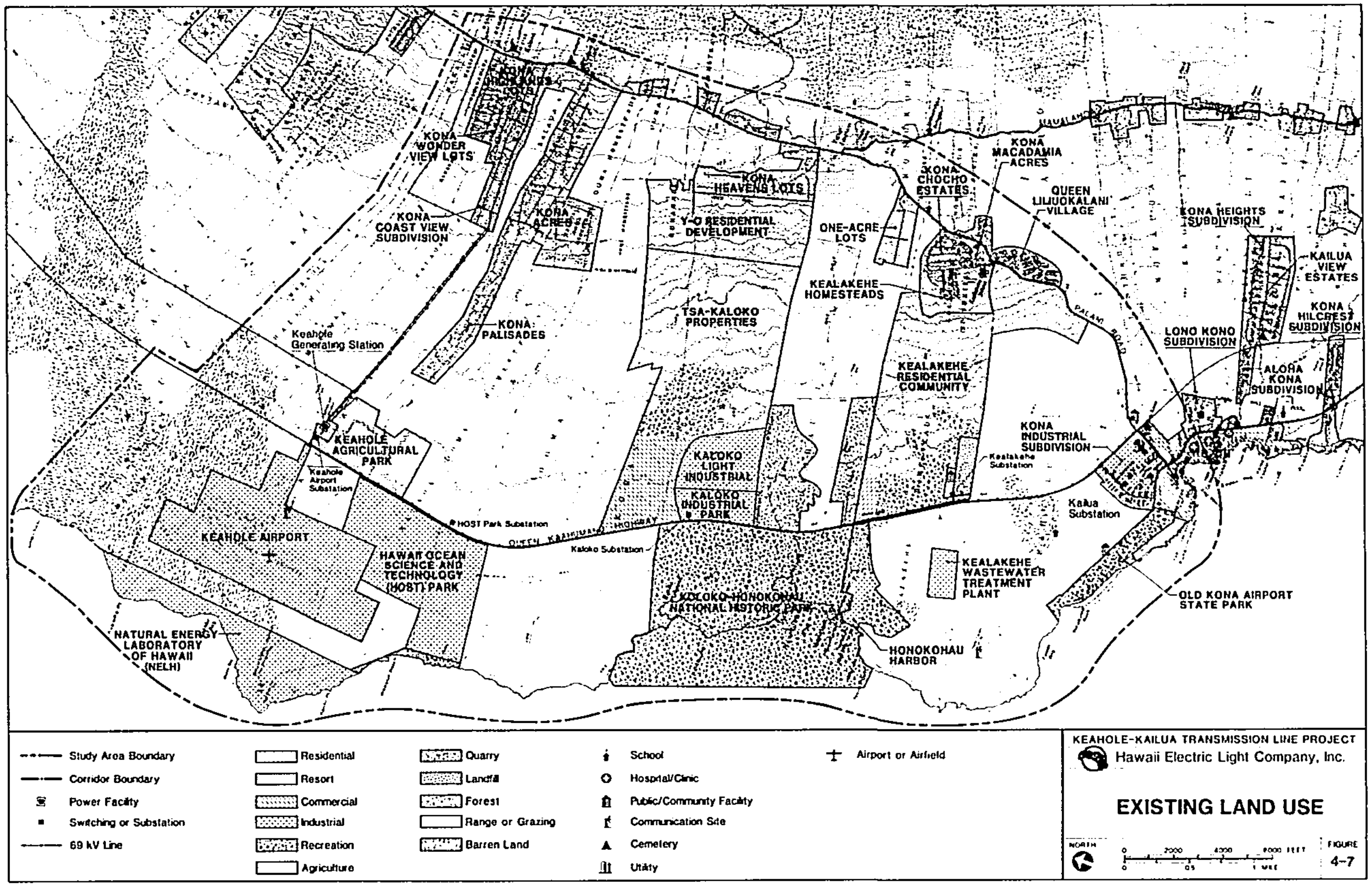
LAND REGULATION

NORTH

0 2000 4000 6000 FEET

0 0.5 1 MILE

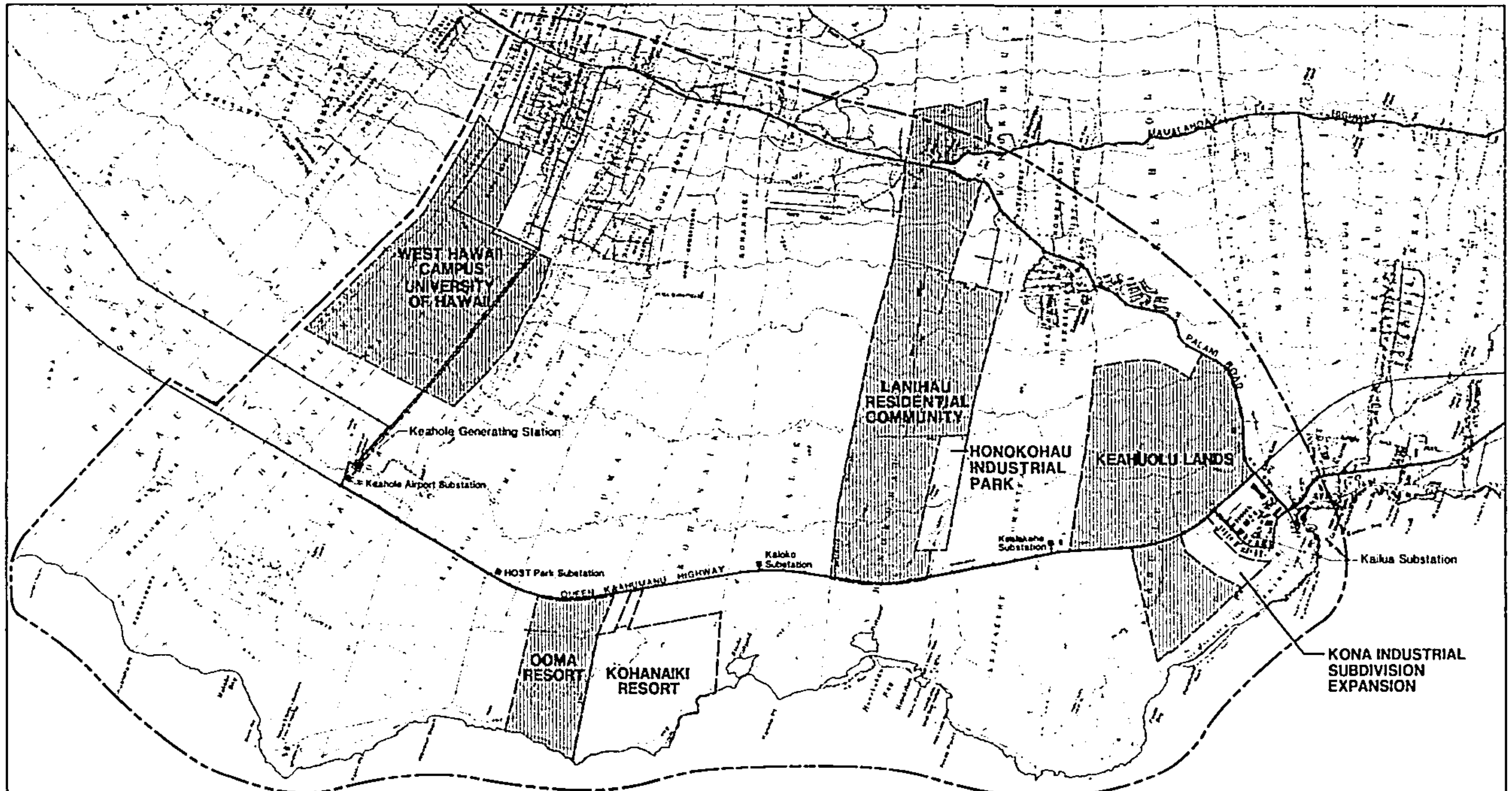
FIGURE 4-6



KEAHOLE-KAILUA TRANSMISSION LINE PROJECT
Hawaii Electric Light Company, Inc.

EXISTING LAND USE

FIGURE 4-7



Study Area Boundary
Corridor Boundary
Power Facility
Switching or Substation
69 kV Line

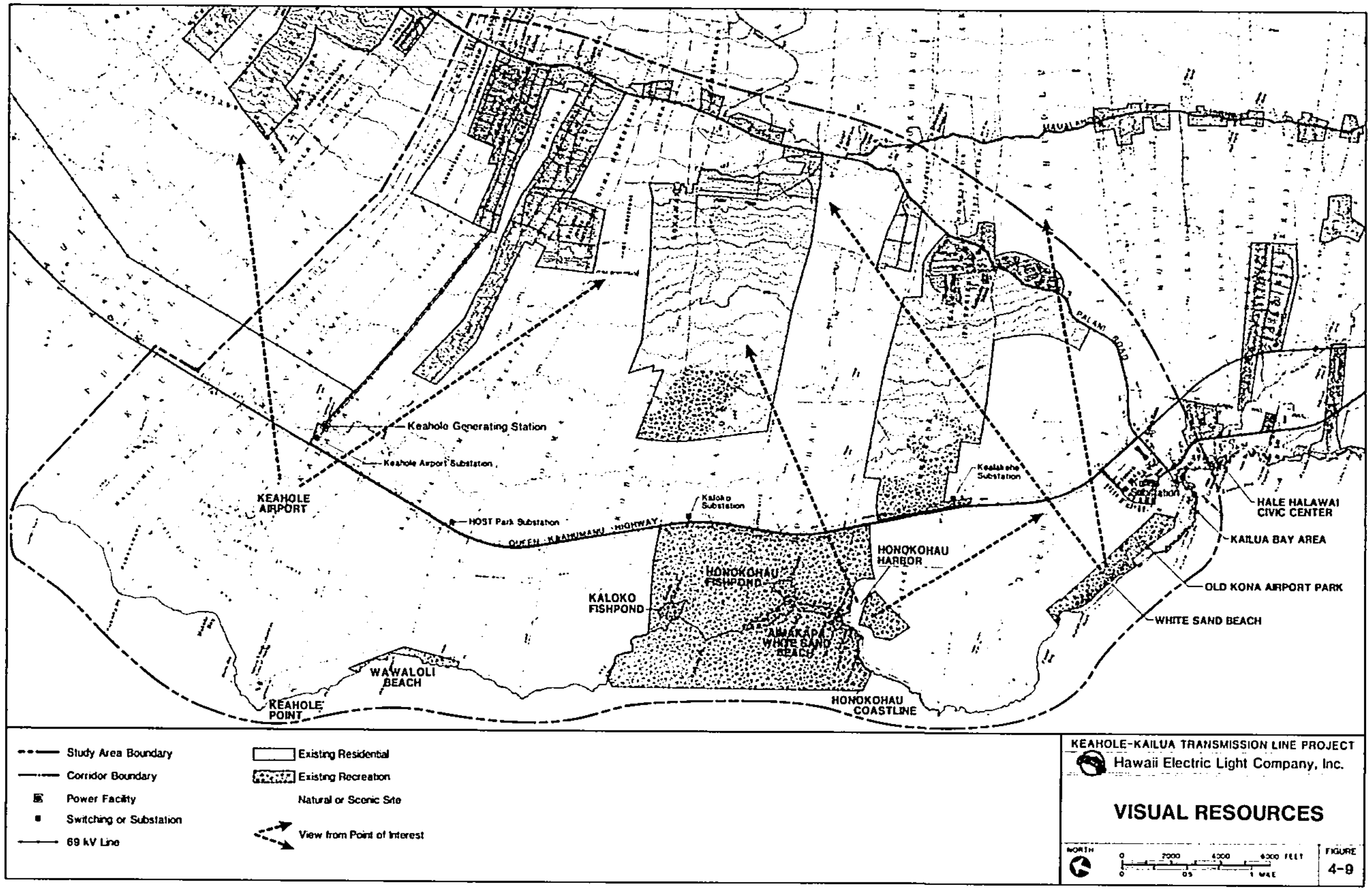
PROPOSED LAND USES
Planned/Proposed (No permits or approvals granted)
Approved (Some or all permits or approvals granted)

KEAHOLE-KAILUA TRANSMISSION LINE PROJECT
Hawaii Electric Light Company, Inc.

PROPOSED LAND USE

NORTH
0 2000 4000 6000 FEET
0 0.5 1 MILE

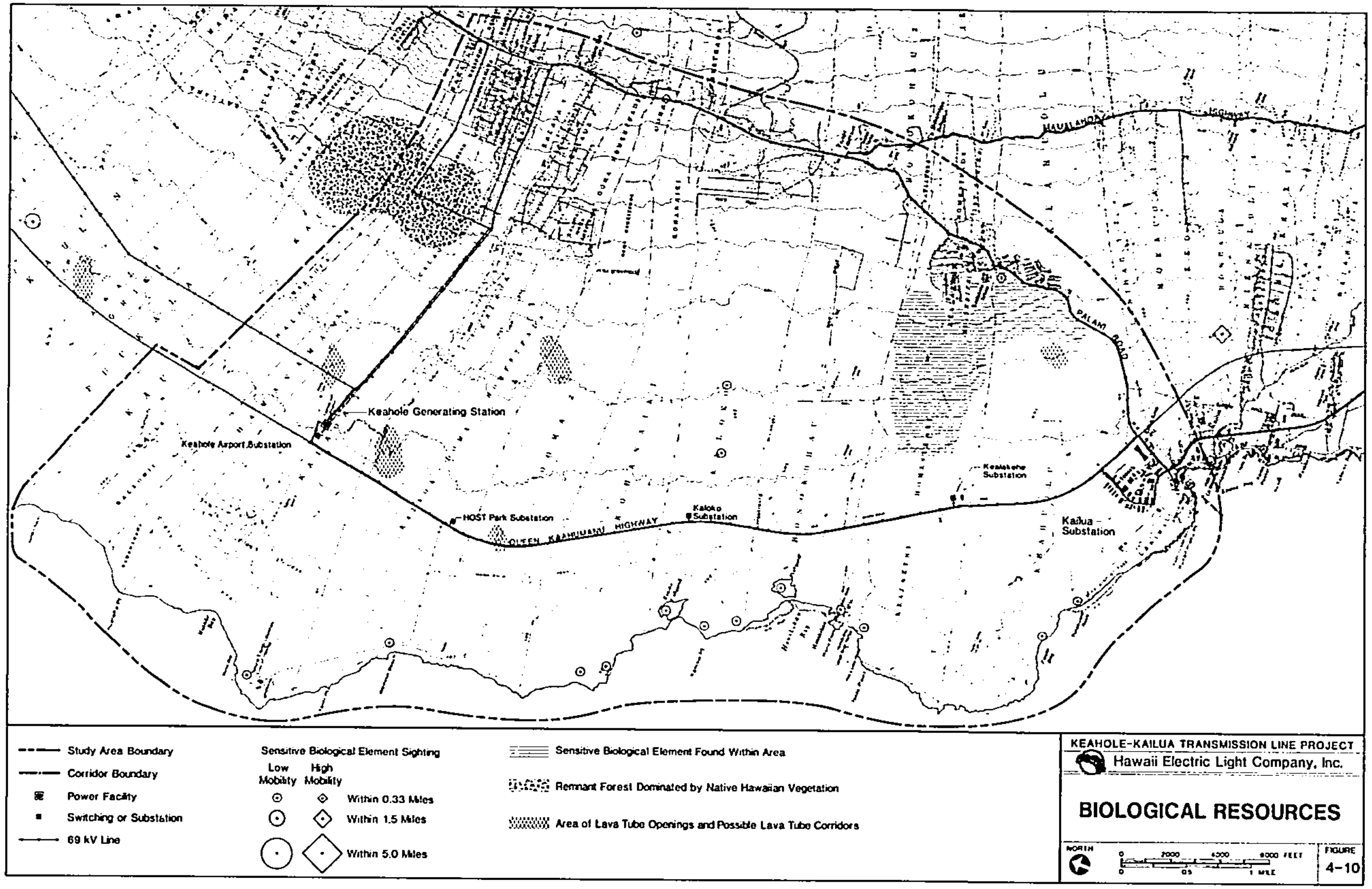
FIGURE 4-8

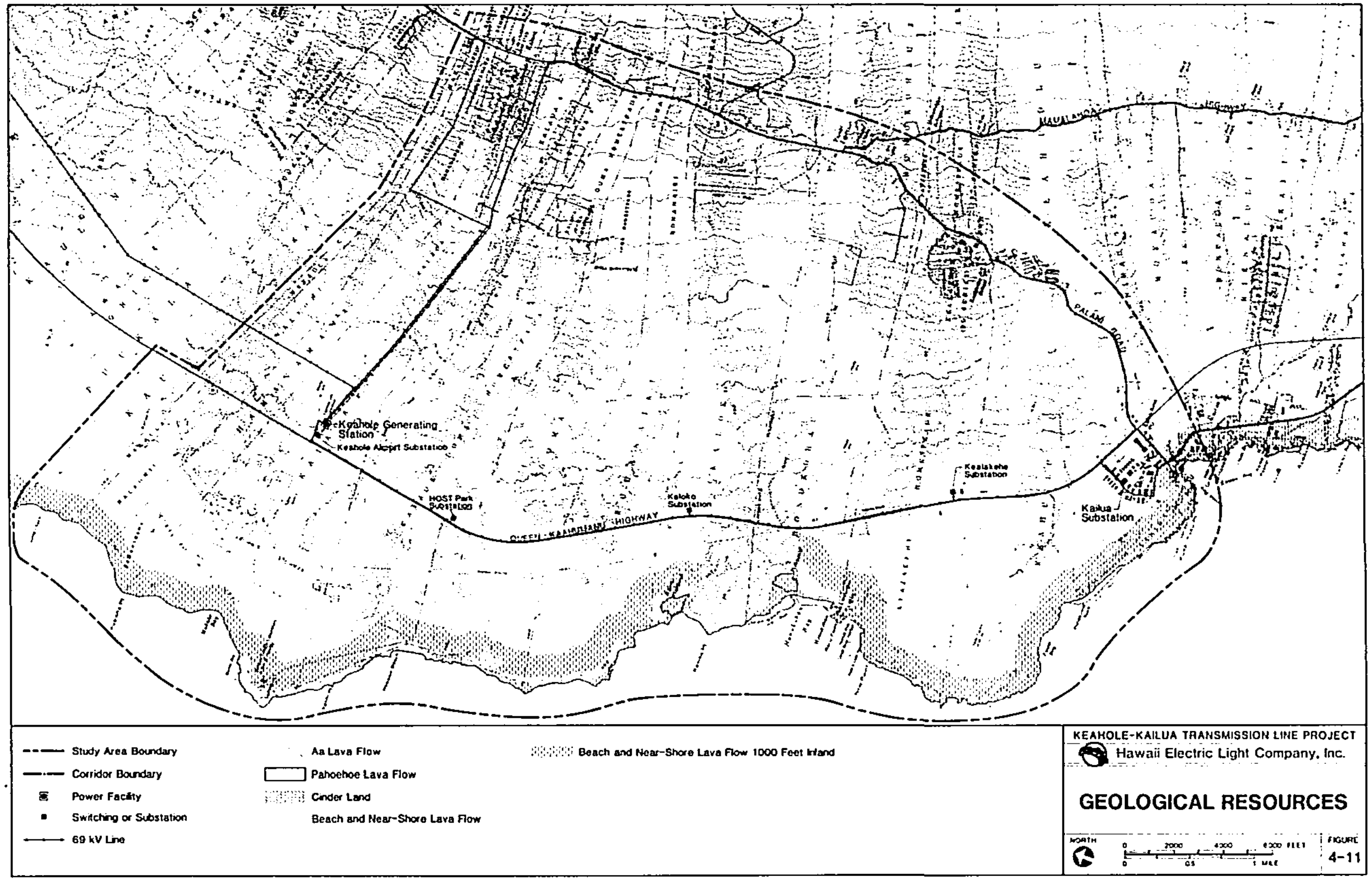


KEAHOLE-KAILUA TRANSMISSION LINE PROJECT
Hawaii Electric Light Company, Inc.

VISUAL RESOURCES

FIGURE 4-9


Keahole Generating Station
Keahole Airport Substation
HOST Park Substation
Kaloko Substation
Kealakehe Substation
Kailua Substation
QUEEN KAAHUMANU HIGHWAY
PALANI ROAD
MAMALAHOA
Study Area Boundary
Corridor Boundary
Power Facility
Switching or Substation
69 kV Line
Sensitive Biological Element Sighting
Low Mobility
High Mobility
Within 0.33 Miles
Within 1.5 Miles
Within 5.0 Miles
Sensitive Biological Element Found Within Area
Remnant Forest Dominated by Native Hawaiian Vegetation
Area of Lava Tube Openings and Possible Lava Tube Corridors
KEAHOLE-KAILUA TRANSMISSION LINE PROJECT
Hawaii Electric Light Company, Inc.
BIOLOGICAL RESOURCES
NORTH
0 2000 4000 6000 FEET
0 0.5 1 MILE
FIGURE
4-10

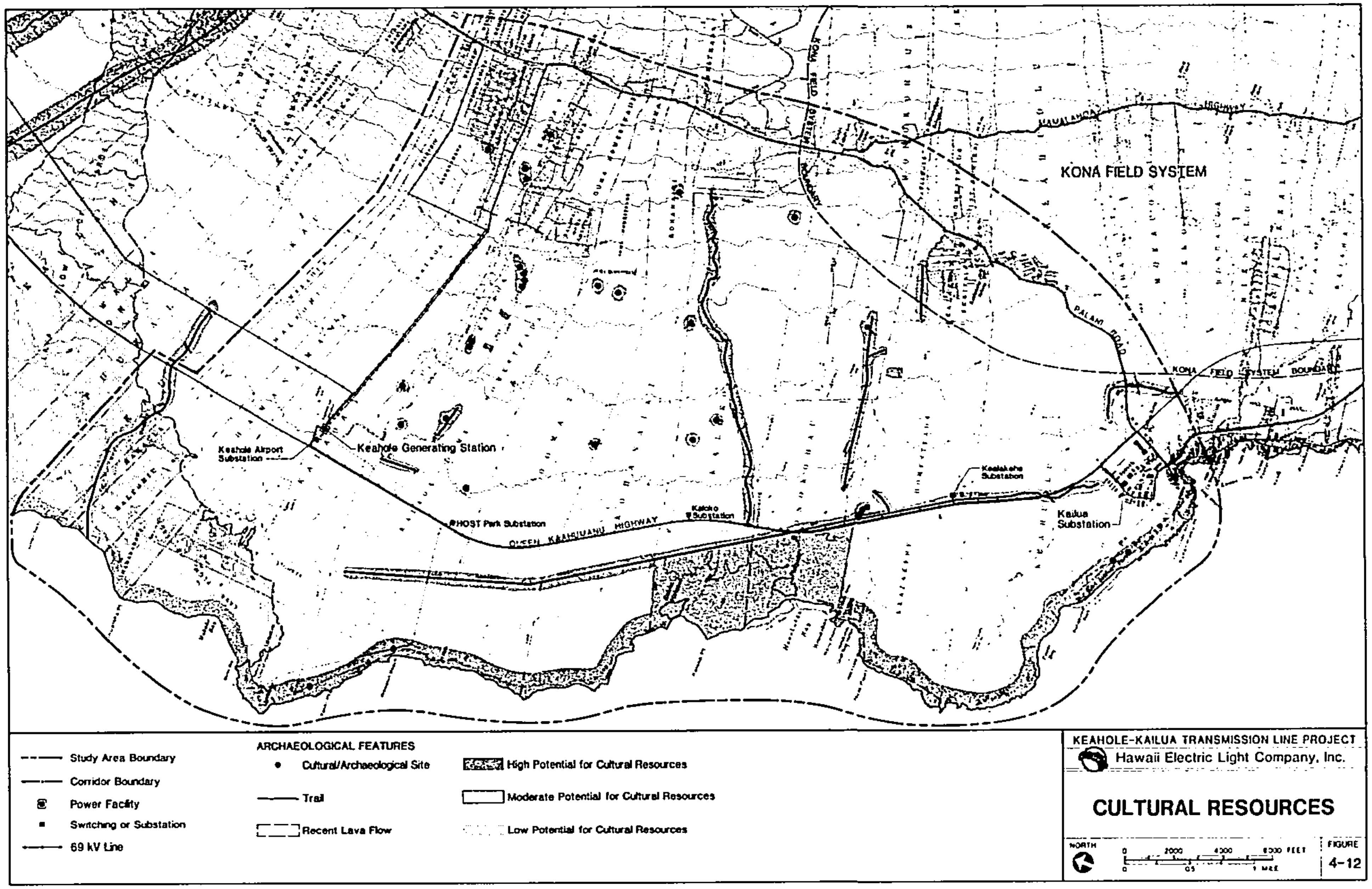


KEAHOLE-KAILUA TRANSMISSION LINE PROJECT

Hawaii Electric Light Company, Inc.

GEOLOGICAL RESOURCES

FIGURE 4-11



KONA FIELD SYSTEM
PALANI ROAD
KONA FIELD SYSTEM BOUNDARY
Keahole Airport Substation
Keahole Generating Station
HOST Park Substation
QUEEN KAAHUMANU HIGHWAY
Kaloko Substation
Kealakehe Substation
Kailua Substation
Study Area Boundary
Corridor Boundary
Power Facility
Switching or Substation
69 kV Line
ARCHAEOLOGICAL FEATURES
Cultural/Archaeological Site
Trail
Recent Lava Flow
High Potential for Cultural Resources
Moderate Potential for Cultural Resources
Low Potential for Cultural Resources
KEAHOLE-KAILUA TRANSMISSION LINE PROJECT
Hawaii Electric Light Company, Inc.
CULTURAL RESOURCES
NORTH
0 2000 4000 8000 FEET
0 0.5 1 MILE
FIGURE
4-12

Constraint Ratings

To interpret the data factors within each environmental resource category map as opportunities or constraints, constraint rating criteria were developed for relating each data factor's degree of sensitivity to the development of transmission lines. The criteria would define high-, medium-, and low-constraint areas. Table 4-3 lists the data factors mapped on each environmental resource category map and the constraint rating assigned to each data factor.

Each data factor was evaluated in terms of the degree of constraint that it would have upon the siting of a transmission corridor one-half mile wide. The constraints ranged from "high" to "low" for each data factor, reflecting the degree of difficulty that the data factor could impose upon a proposed siting of a transmission line corridor. High- and medium-constraint ratings were applied if the data factor would conflict with or constrain transmission corridors. For example, existing and proposed residential areas were rated high-constraint and medium-constraint areas, respectively. Conflicts between transmission line siting and existing residential areas would most likely be high, whereas potential conflicts between transmission line siting and proposed residential development can be minimized through early consultation with the project proponent. The low-constraint rating was assigned to factors judged to be compatible with transmission lines or that could provide opportunities for siting. Generally, low-constraint areas are considered areas of opportunity for the siting of a transmission corridor; they include areas near or parallel to existing transmission lines, utility corridors, or major roadways.

Alternative Corridors and Selection Methodology

The environmental data factors mapped on all of the environmental resource category maps (Figures 4-5 through 4-12) and Table 4-3 provide the basis for the creation of a composite constraints map and the selection of possible alternative corridors. Figure 4-13 is a composite constraints map showing the highest constraint ratings derived from the data factors on each of the eight environmental resource category maps. If a hypothetical area called Area A showed only low constraints on all environmental resource category maps, the highest constraint—in this case low constraint—was shown on the composite constraint map. If the highest of any of the constraints was medium constraint, then medium constraint was shown on the composite map. If high constraint appeared on any environmental data map for Area A, it was shown with a high constraint on the composite constraint map.

This method of preparing the composite constraints map results in areas with multiple high constraints being depicted in the same way as areas with a single high constraint. For example, the area mauka of Queen Kaahumanu Highway generally passes through areas with a single high constraint (visual) and appears in Figure 4-13 identically to areas with multiple high constraints (such as the area makai of Palani Road south of Kealakehe Homesteads, which has existing residential, visual, and biological high-constraint areas).

Alternative corridors were selected on the basis of their ability to meet the primary objective of connecting the Keahole Switching Station to the Kailua Substation while at the same time

Table 4-3
Environmental Resource Categories,
Environmental Data Factors, and Constraint Ratings

Environmental Resource Category	Environmental Data Factors Mapped	Constraint Rating
Land ownership	• Federal lands • State/county lands • Private lands	• Federal lands are rated **high constraint.** • State/county and private lands are rated low constraint.
Land regulation	State land use districts • Urban • Agricultural • Conservation - GS (General Subzone) - LS (Limited Subzone) (none in the study area) - PS (Protective Subzone) - RS (Resource Subzone) County-administered regulations • Special Management Area (SMA) • Shoreline Setback Area (40-foot)	• State Conservation District lands (Protective Subzone) and the Shoreline Setback Area are rated **high constraint.** • State Conservation District lands (Limited and Resource Subzones) and the Special Management Area (SMA) are rated medium constraint. • State Urban, Agricultural, and Conservation District lands (General Subzone) are rated low constraint.
Existing land use	• Residential • Industrial • Commercial • Agricultural • Forest • Range or grazing • Barren land • Public and community facilities • Schools • Resort and recreation areas, and cemeteries • Hospitals and clinics • Utilities • Landfills • Quarries • Communication sites • Airports, airfields, and harbors	• Residential areas, schools, resort and recreation areas, cemeteries, hospitals and clinics, communication sites, airports, airfields, and harbors are rated **high constraint.** • Public and community facilities and commercial areas, and landfills and quarries are rated medium constraint. • All other areas (industrial, agricultural, forest, range or grazing, barren land, and utilities) are rated low constraint.
Proposed land use	• Proposed residential • Proposed schools • Proposed resort • Proposed recreation • Proposed industrial	• Proposed residential, schools, resort, and recreation are rated medium constraint. • Proposed industrial is rated low constraint.

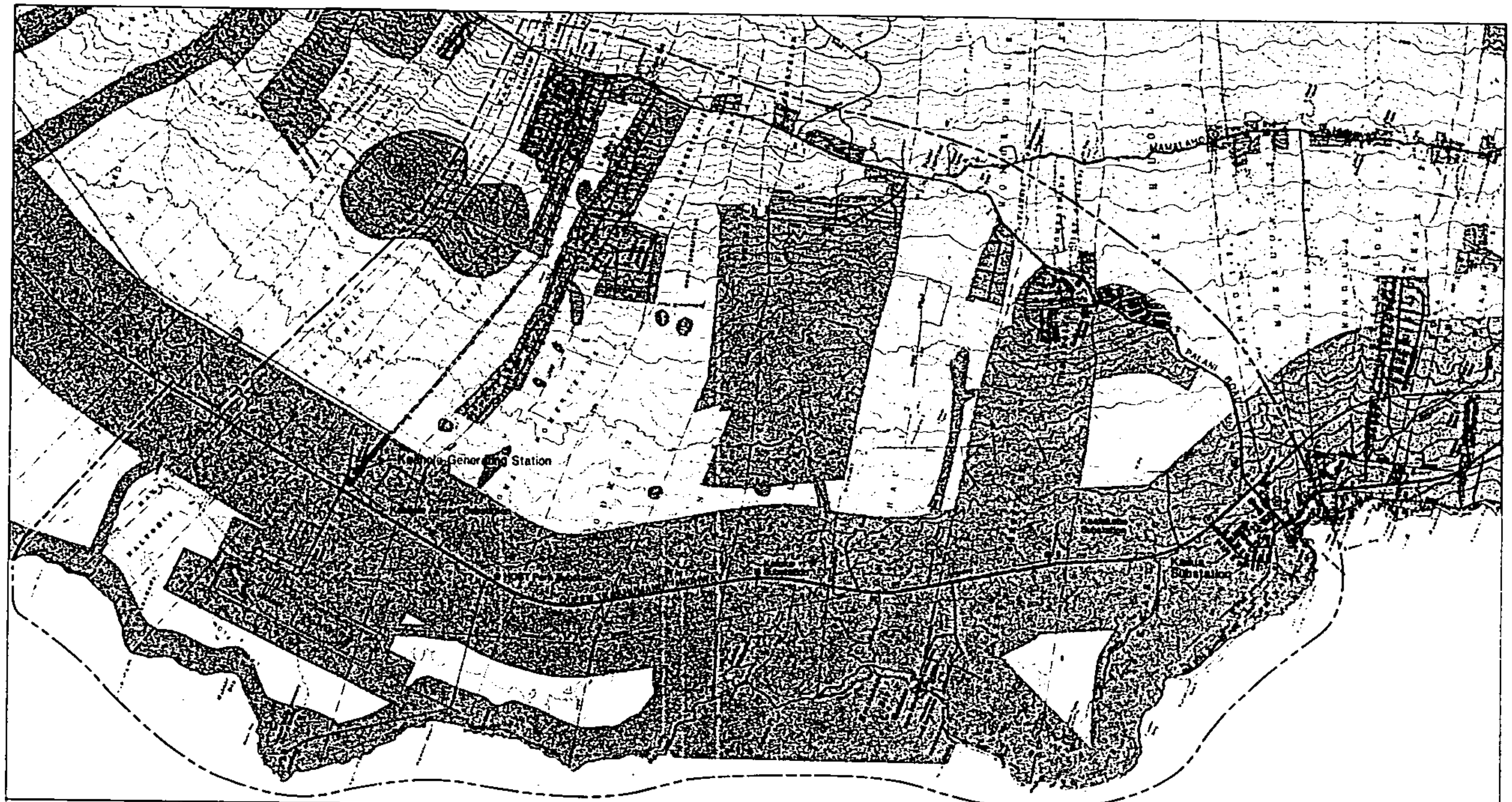
Table 4-3
Environmental Resource Categories,
Environmental Data Factors, and Constraint Ratings

Environmental Resource Category	Environmental Data Factors Mapped	Constraint Rating
Visual resources	• Existing residential • Existing recreation areas • Natural and scenic sites per County General Plan • Views from points of interest per County Development Plan	• Natural and scenic sites per County General Plan and views from points of interest per County Development Plan are rated **high constraint.** • Existing residential and recreation areas are rated **medium constraint.**
Biological resources	• Remnant forest dominated by native Hawaiian vegetation • Lava tube openings/corridors • Sensitive biological elements within an area • Individual sightings of sensitive biological elements	• Remnant forest dominated by native Hawaiian vegetation and sensitive biological elements within an area are rated **high constraint.** • Lava tube openings/corridors and individual sightings of sensitive biological elements are rated **medium constraint.**
Geological resources	• Pahoehoe lava flows • Aa lava flows • Beaches and near-shore lava flows 1,000 feet inland	• Beaches and near-shore lava flows 1,000 feet inland are rated **high constraint.** • Pahoehoe and aa lava flows are rated **low constraint.**
Cultural resources	• Areas with high potential for cultural resources • Areas with moderate potential for cultural resources • Areas with low potential for cultural resources	• Areas with high potential for cultural resources are rated **high constraint.** • Areas with moderate potential for cultural resources are rated **medium constraint.** • Areas with low potential for cultural resources are rated **low constraint.**

Table 4-3
Environmental Resource Categories,
Environmental Data Factors, and Constraint Ratings

Page 3 of 3

Environmental Resource Category	Environmental Data Factors Mapped	Constraint Rating
Utility and transportation system	• Areas with no existing utility or transportation system • Areas adjacent to an existing utility or transportation system • Areas within an existing utility or transportation system easement Note: A separate environmental data map for a utility and transportation system was not created because this data factor appears on all maps.	• Areas with no existing utility or transportation system are rated **high constraint.** • Areas adjacent to an existing utility or transportation system are rated **medium constraint.** • Areas within an existing utility or transportation system easement are rated **low constraint.**



- - - Study Area Boundary
—·— Corridor Boundary
■ Power Facility
▪ Switching or Substation
- · - · 69 kV Line

High Constraint
Medium Constraint
Low Constraint

KEAHOLE-KAILUA TRANSMISSION LINE PROJECT
Hawaii Electric Light Company, Inc.

COMPOSITE CONSTRAINTS

4-13

avoiding as much as possible all those areas of high constraint and taking advantage of areas of opportunity created by a utility or transportation system. Low-constraint areas, if available, would be the first choice for a corridor. Medium-constraint areas were the second choice, and high-constraint areas were the last choice, unless there was an opportunity created by a utility or transportation system.

Only one low-constraint area appears on the northeast corner of the Keahole-Kailua map, but is not within the study area. The study area consists only of high-constraint and medium-constraint areas. The alternative corridors selected were for the most part selected through areas of medium constraint. High-constraint areas were avoided as much as possible. Alternative corridors were selected in areas of high constraint only if there was a clear opportunity created by a utility or transportation system.

The following is a brief physical description of the alternative corridors that were selected for further evaluation in the Keahole-Kailua study area (Figure 4-14). Three main corridors measuring one-quarter to one-half mile wide were identified:

- The S-1 corridor includes Queen Kaahumanu Highway where transmission lines already exist.
- The S-2 corridor is located approximately one-half mile mauka of, and parallel to, Queen Kaahumanu Highway in an area not crossed by transmission lines.
- The S-3 corridor includes several variations of a route that travels mauka from the Keahole Generating Station to the Mamalahoa Highway, then south to Palani Road. Each of the corridor variations combines portions of the S-2 corridor, one of four makai to mauka segments—S-A, S-B, S-C, and S-D—and portions of the Mamalahoa Highway and Palani Road S-3 corridor.

Alternative Corridors Evaluation

Alternative Corridors Identification

Figure 4-14 shows the alternative corridors that were selected following review of the environmental resource category inventory and data factors constraints evaluation. Tables 4-4 and 4-5 provide an inventory the environmental resource categories and data factors for all of the alternative corridors.

Basically, three main alternative corridors were identified that could connect Keahole Switching Station (near the Keahole Generating Station) to the Kailua Substation.

The alternative corridors were divided into two groups: main corridors and variations of one of the main corridors. Below is a general description of each alternative corridor that was identified for further evaluation.

The three main corridors are:

- **Main Corridor S-1 (Queen Kaahumanu Highway)**

  There are two variations to this corridor: S-1 Mauka and S-1 Makai. These variations are:

  - **Main Corridor S-1 Mauka (Queen Kaahumanu Highway—mauka of center line)**

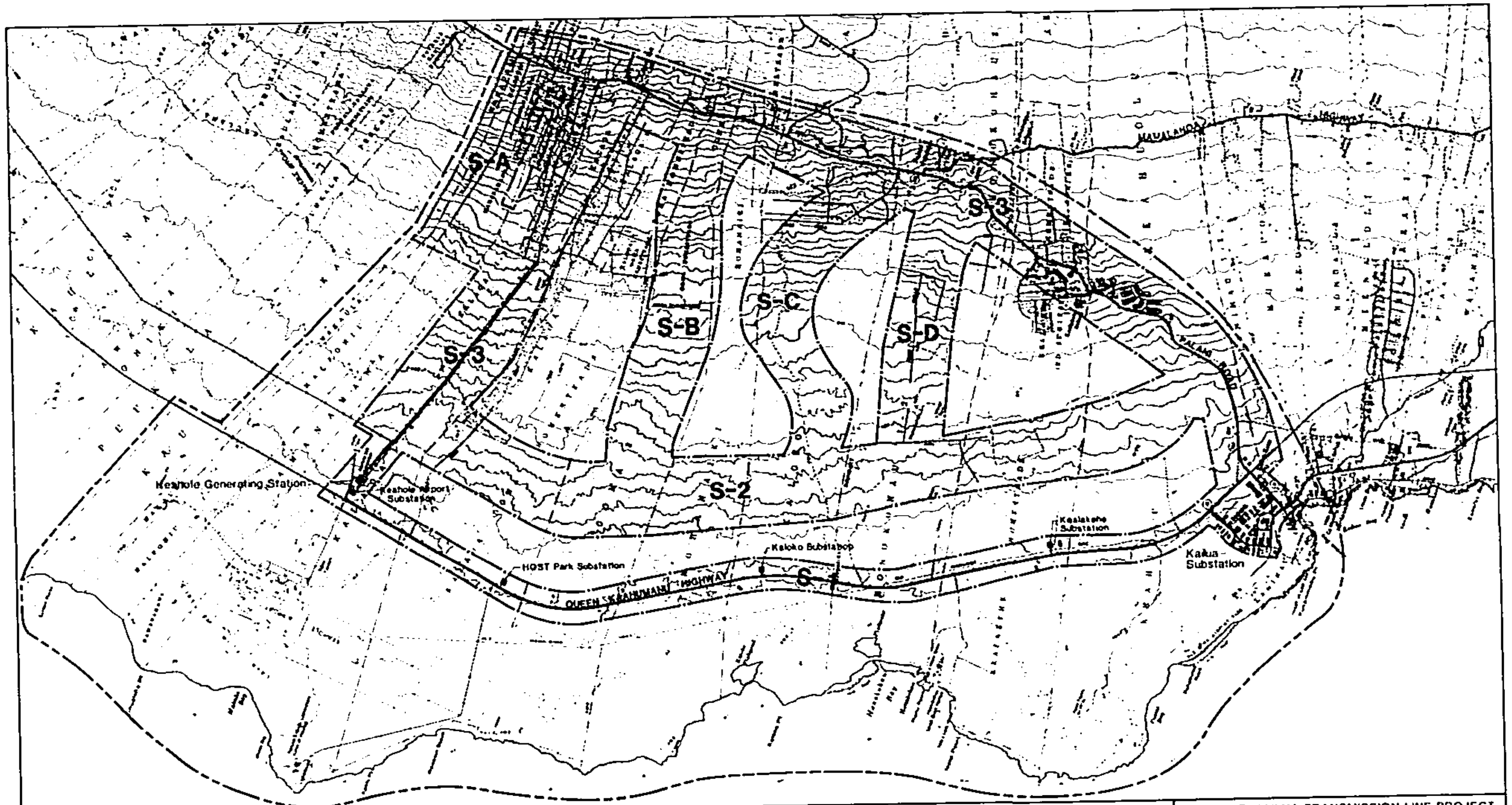
    This corridor follows the mauka edge of Queen Kaahumanu Highway. Queen Kaahumanu provides a linear corridor that could accommodate the new transmission line. A minimum horizontal or vertical separation requirement would need to be met between the existing 69 kV lines and the new 69 kV lines. For the most part, existing rights-of-way owned by the State of Hawaii could be used for the siting of a transmission line in this corridor. Some easements may be required from private landowners to establish a horizontal separation from the existing 69 kV line if a new alignment is placed mauka of the existing 69 kV line.

  - **Main Corridor S-1 Makai (Queen Kaahumanu Highway—makai of center line)**

    This corridor follows the makai edge of Queen Kaahumanu Highway. There are no existing transmission or utility lines in this corridor, and siting would impair makai views of the ocean from this designated scenic highway. This corridor is located in a Special Management Area (SMA), and the project would require an SMA permit from the County of Hawaii Planning Department. A transmission line would pass adjacent to a national historical park, which could be a deterrent to siting. Two proposed resorts would be adjacent to the corridor in the Ooma and the Kahanaiki land sections.

- **Main Corridor S-2 (Midlevel, about one-half mile mauka of Queen Kaahumanu Highway)**

  This corridor contains several significant natural resources, including sensitive plants, natural communities, a remnant forest dominated by native Hawaiian vegetation, and lava tube openings and potential lava tube corridors that may support candidate endangered invertebrates. State and federal natural resource agencies would be concerned about potential impacts to plant and animal resources that are listed or are candidates for listing on the federal or state endangered list.



- - - Study Area Boundary
— · — Corridor Boundary
Power Facility
Switching or Substation
69 kV Line

Alternative Corridor
S-A Corridor Segment

KEAHOLE-KAILUA TRANSMISSION LINE PROJECT

Hawaii Electric Light Company, Inc.

ALTERNATIVE CORRIDORS

NORTH

0 2000 4000 6000 FEET

0 .5 1 MILE

FIGURE 4-14

Table 4-4
Inventory of Main Alternative Corridors

Environmental Resource Category	Alternative Corridor		
	S-1	S-2	S-3
Land Ownership	Mauka of highway: State of Hawaii, Richard D. Lee, Kaumaina, TSA International Ltd., various private, K.M. Young & Assoc., Lanihau Corp., Liliuokalani Trust Estate. Makai of highway: Liliuokalani Trust Estate, State of Hawaii, Lanihau Corp., U.S.A., Richard Rogers Inc., State Mutual Life Assurance Co. of America, American Trust Co. of Hawaii.	State of Hawaii, THC Financial et al., Hasegawa Komuten, Richard D. Lee, Kaumaina, TSA International Ltd, Lanihau Corp., Robert McLean, Liliuokalani Trust Estate, various private.	State of Hawaii, William Chang, Arthur Fong, Lewis Sterry, Safeguard Enterprise, Masao Kanemura, Kona Coastview Subdivision, Alanui Kaumini, Harue Matsumoto, THC Financial et al., various private, Robert Greenwell, Palani Land Trust II, George Ota, Liliuokalani Trust Estate.
Land Regulation	State Land Use: Conservation General Subzone, Agriculture, and Urban. SMA makai of highway center line.	State Land Use: Conservation General Subzone, Urban, and Agriculture.	State Land Use: Agriculture and Urban.
Existing Land Use (Note: Proposed land uses that had progressed substantially in the regulatory process were considered existing land uses in this inventory.)	Mauka of Queen Kaahumanu Highway: Existing 69 kV transmission line along edge of highway right-of-way, HOST Park Substation, Kaloko Substation, Kealakehe Substation, Keahole Agricultural Park, commercial portion of TSA-Kaloko Properties, Kaloko Industrial Park, quarries, commercial and recreational portions of Kealakehe Residential Community, police station, landfill, range and grazing lands, and barren land. Makai of Queen Kaahumanu Highway: HOST Park, Kaloko-Honokohau National Historic Park, Honokohau Harbor, barren land, range or grazing lands.	Portion of Kona Palisades Residential; range and grazing lands; commercial, recreational, and residential portions of TSA-Kaloko Properties; Kaloko Light Industrial; quarries; residential/recreational portion of Kealakehe Residential Community; Palani Road; agriculture.	Existing 69 kV transmission line goes mauka from Keahole Switching Station into Kona Coast View and Kona Highlands residential area; it then turns south and follows Mamalahoa Highway and Palani Road into Kailua. Because of terrain, the line crosses the road several times. Mauka of Mamalahoa Highway/Palani Road: Queen Liliuokalani Village Residential, several pockets of residences, two schools, two cemeteries, agriculture, forests, range or grazing land. Makai of Mamalahoa Highway/Palani Road: Portions of Kona Palisades Residential, Kona Acres Residential, Kona Wonder View residential lots, Kona Highlands residential lots, Kona Heavens residential lots, 1-acre residential lots, Kona Chocho Estates residential, Kona Macadamia Acres Residential, Kealakehe Residential Community, one school, agriculture, range or grazing lands.
Proposed Land Use	Mauka of Queen Kaahumanu Highway: Lanihau Residential Community, Honokohau Industrial Park, and Keahuolu Lands. Makai of Queen Kaahumanu Highway: Ooma Resort, Kohanaiki Resort, Keahuolu Lands, Kona Industrial Subdivision Expansion.	University of Hawaii's West Hawaii campus, Lanihau Residential Community, Honokohau Industrial Park, Keahuolu Lands.	University of Hawaii's West Hawaii campus, Lanihau Residential Community, Keahuolu Lands.

Table 4-4
Inventory of Main Alternative Corridors

Environmental Resource Category	Alternative Corridor		
	S-1	S-2	S-3
Visual Resources	Within 1 mile of Keahole Airport, Honokohau Harbor, Old Kona Airport Park. Within one-half mile of Queen Kaahumanu Highway: Kaloko-Honokohau National Historic Park, Kaloko Fish Pond, Honokohau Fish Pond, Aimakapa White Sand Beach, recreation area at Kealakehe Residential Community.	Within one-half mile of Queen Kaahumanu Highway: Kona Palisades, residential and recreational areas in TSA-Kaloko Properties, residential and recreational areas in Kealakehe Residential Community, residential areas in Kailua.	Within one-half mile of Queen Kaahumanu Highway near Kailua: Kona Highlands lots, Kona Wonder View lots, Kona Coast View Subdivision, Kona Acres, Kona Palisades, Kona Heavens lots, Y-O Residential Development, 1-acre residential lots, Kona Chocho Estates, Kona Macadamia Acres, Queen Liliuokalani Village, Kealakehe Homesteads, Kealakehe Residential Community, several pockets of residential areas mauka of Mamalahoa Highway, residential areas in Kailua.
Biological Resources	Areas of lava tube openings and possible lava tube corridors located mauka of Queen Kaahumanu Highway at Kaloko Agricultural Park, and on both mauka and makai sides of Queen Kaahumanu Highway south of HOST Park substation.	Sensitive biological elements in the vicinity of Kealakehe Residential Community.	Remnant forest dominated by native Hawaiian vegetation in the vicinity of Kona Coast View Subdivision. Sensitive biological elements found south of Kealakehe Homesteads, makai of Palani Road.
Geological Resources	Pahoehoe and aa lava flows. Small portion of beach and near-shore lava flow 1,000 feet inland located near Honokohau Bay.	Pahoehoe and aa lava flows.	Pahoehoe and aa lava flows.
Cultural Resources	Archaeological features include three trails and four sites that have a high potential for cultural resources. These are located south of Kaloko Substation along the mauka side of Queen Kaahumanu Highway toward Kealakehe Substation, and along the makai side of Queen Kaahumanu Highway near Kailua Substation.	Archaeological features include four trails and six sites that have a high potential for cultural resources located. These features occur all along this segment.	Archaeological features include four sites that have a high potential for cultural resources. These sites are located in the vicinity of the Kona Acres and Kona Wonder View Lots and a trail cutting across Palani Road mauka of Queen Kaahumanu Highway in Kailua.
Utility and Transportation Systems	Mauka of Queen Kaahumanu Highway: HOST Park Substation, Kealakehe Substation. A 69 kV transmission line follows the mauka edge of Queen Kaahumanu Highway.	The north edge of this segment abuts a 69 kV transmission line that leads from Keahole Switching Station and goes mauka toward Mamalahoa Highway. The center section of this segment, in the vicinity of TSA-Kaloko Properties and the Kaloko Light Industrial area, intercepts a mauka-makai road that connects Queen Kaahumanu Highway and Mamalahoa Road.	Mamalahoa Highway, Palani Road: A 69 kV transmission line extends eastward from Keahole Switching Station going mauka toward Kona Coast View Subdivision. At Kona Coast View Subdivision, the 69 kV transmission line splits into two lines, with one line turning north eventually to run along the edge of Mamalahoa Highway, and the other line continuing mauka through Kona Coast View Subdivision and Kona Highlands lots to Mamalahoa Highway. At Kona Highlands lots the 69 kV transmission line turns south and runs along Mamalahoa Highway to the Palani Road junction, where it splits again into two lines—one following Mamalahoa Highway southward and the other line continuing along Palani Road into Kailua. Because of the terrain, the 69 kV line crosses the road several times.

Table 4-5
Inventory of Mauka to Makai Alternative Corridors
Keahole-Kailua Transmission Line

Environmental Resource Category	S-3 Portion	S-A	S-B	S-C	S-D
Land Ownership	State of Hawaii, William Chang, Arthur Fong, Lewis Sterry, Safeguard Enterprise, Masao Kanemura, Kona Coast View Subdivision, Alanui Kaumini, Harue Matsumoto, THC Financial et al.	State of Hawaii, Safeguard Enterprise.	State of Hawaii, various private.	Y-O Ltd, TSA International Ltd., various private.	Lanihau Corp., Robert Greenwell, Palani Land Trust II, George Ota, various private.
Land Regulation	State Land Use: mostly Agricultural, some Urban.	State Land Use: mostly Agricultural, some Urban.	State Land Use: mostly Agricultural, some Urban.	State Land Use: Agricultural, Urban.	State Land Use: Agricultural.
Existing Land Use (Note: Proposed land uses that had progressed substantially in the regulatory process were considered existing land uses in this inventory.)	Range or grazing land, Kona Highlands, Kona Wonder View lots, Kona Acres, Kona Palisades.	Mostly range or grazing land, portion of Kona Wonder View lots and Kona Highlands lots.	Mostly range or grazing land, portions of Kona Acres, Y-O Residential Development, and residential portion of TSA-Kaloko Properties.	Kona Heavens lots, Y-O Residential Development, Residential and Recreational portions of TSA-Kaloko Properties.	Range or grazing land.
Proposed Land Use	University of Hawaii's West Hawaii campus	University of Hawaii's West Hawaii campus.	None	None	Lanihau Residential Community.
Visual Resources	Within one-half mile of Kona Highlands Lots, Kona Wonder View lots, Kona Coast View Subdivision, Kona Acres, Kona Palisades.	Within one-half mile of Kona Highlands Lots, Kona Wonder View lots, Kona Coast View Subdivision.	Within one-half mile of Kona Acres, Kona Heavens lots, Y-O Residential Development, residential or recreational portions of TSA-Kaloko Properties.	Within one-half mile of Kona Heavens Lots, Y-O Residential Development, residential or recreational portions of TSA-Kaloko Properties.	Within one-half mile of Kona Heavens Lots, Y-O Residential Development, residential or recreational portions of TSA-Kaloko Properties, 1-acre lots, Kona Chocho Estates, Kealakehe Residential Community.
Biological Resources	Remnant forest dominated by native Hawaiian vegetation in the vicinity of Kona Coast View Subdivision.	Remnant forest dominated by native Hawaiian vegetation in vicinity of Kona Coast View Subdivision.	Area of lava tube openings and possible lava tube corridors in vicinity of Kona Palisades.	One rare biological element sighting, low mobility, within 0.33 mile, in vicinity of Kaloko Light Industrial.	None
Geological Resources	Aa and pahoehoe lava flow.	Mostly aa lava flow. Some pahoehoe lava flow.	Mostly pahoehoe lava flow. Some aa lava flow.	Mostly aa lava flow. Some pahoehoe lava flow.	Mostly pahoehoe lava flow. Some aa lava flow.
Cultural Resources	Archaeological features include four sites that have a high potential for cultural resources. These sites are located in the vicinity of Kona Acres and Kona Wonder View lots.	None	Archaeological features include two sites that have a high potential for cultural resources and are located in the vicinity of Kona Acres.	Archaeological features include a trail and a site that have a high potential for cultural resources. The mauka-makai trail traverses most of this segment, and the site is located midway along the segment, north of the trail.	Archaeological features include a trail and site that have a high potential for cultural resources located to the south, near the makai edge of this segment.
Utility and Transportation Systems	Eastern section adjacent to Mamalahoa Highway. A 69 kV transmission line traverses this section from Keahole Switching Station to Mamalahoa Highway.	Eastern section adjacent to Mamalahoa Highway. A 69 kV transmission line traverses this section from Kona Coast View Subdivision to Mamalahoa Highway.	Eastern section adjacent to Mamalahoa Highway. A 69 kV transmission line is located along the edge of Mamalahoa Highway.	Eastern section adjacent to Mamalahoa Highway. Longitudinal center line of this segment is the mauka-makai road that connects Queen Kaahumanu Highway and Mamalahoa Highway. A 69 kV transmission line is located along Mamalahoa Highway.	Eastern section adjacent to Mamalahoa Highway and Palani Road at the Mamalahoa Highway/ Palani Road junction. 69 kV transmission lines located along Mamalahoa Highway and Palani Road.

100120C7.USR

- **Main Corridor S-3 (Mamalahoa Highway/Palani Road [through Kalaoa])**

  This corridor runs parallel to and includes existing 69 kV lines from the Keahole Switching Station mauka to Mamalahoa Highway; it then travels south along Mamalahoa Highway and Palani Road. This corridor provides opportunities to follow existing 69 kV transmission lines and existing road rights-of-way to the Kailua Substation. Because of the terrain, several crossovers of Palani Road would be required to install an additional transmission line. This corridor passes through many residential areas and would require easements from more private landowners than the other main corridors would. A residential area and the West Hawaii campus of the University of Hawaii are proposed uses in this corridor. Sensitive biological elements are found in this corridor.

The makai-to-mauka corridors are variations of Main Corridor S-3, using Mamalahoa Highway/Palani Road. These variations are:

- **Corridor S-3A (S-3, Mamalahoa Highway/Palani Road, using makai-mauka Corridor S-A through Hamanamana)**

  This corridor is the same as the S-3 corridor except for one area. The area includes a segment of the existing 69 kV line that splits off to the north at a point approximately midway between the Keahole Switching Station and Mamalahoa Highway. This corridor segment lies just north and adjacent to the upper half of the mauka-to-makai section of the S-3 corridor. Development of this corridor would affect the proposed University of Hawaii West Hawaii campus and a remnant forest dominated by native Hawaiian vegetation.

- **Corridor S-3B (S-3, Mamalahoa Highway/Palani Road, using a portion of S-2 and makai-mauka Corridor S-B through Ooma)**

  This corridor uses a portion of the S-2 corridor from the Keahole Switching Station to the Ooma area, where it turns mauka and follows a relatively straight line, joining the S-3 corridor at Mamalahoa Highway. The mauka segment of this corridor passes through mostly undeveloped land owned by the State of Hawaii and other private landowners. There is also an area of lava tube openings and possible lava tube corridors in the mauka section of this corridor.

- **Corridor S-3C (S-3, Mamalahoa Highway/Palani Road, using a portion of S-2 and makai-mauka Corridor S-C through Kaloko)**

  This corridor uses a portion of the S-2 corridor from the Keahole Switching Station to the Kaloko area, where it turns mauka and follows an existing road (and potential transmission corridor) before joining the S-3 corridor at the mauka segment of this corridor. Commercial and industrial uses are located toward the makai boundary of this corridor. Recreational and residential uses proposed for the central part of the S-C corridor are not yet in place but have received approvals and were considered existing uses for the purposes of this analysis. Sensitive plants have been sighted near the S-C makai boundary. Cultural resources, including trails and archaeological sites and features, have been identified in the S-C portion of the corridor.

- **Corridor S-3D (S-3, Mamalahoa Highway/Palani Road, using a portion of S-2 and mauka-makai Corridor S-D through Honokohau)**

  This corridor uses a portion of the S-2 corridor from the Keahole Switching Station to the Honokohau area, where it turns mauka and follows a straight path before joining the S-3 corridor at the Mamalahoa Highway. The S-D segment of the corridor is privately owned. The segment is mostly undeveloped, and quarry activities take place in the makai portion. Residential development is planned for almost the entire S-D segment. There are cultural resources, including trails and archaeological sites and features, in the S-D segment of the corridor.

Criteria for Alternative Corridor Evaluation

Based on the data factors identified in Table 4-3 in the previous section and general knowledge of the study region, a list of environmental/land use and engineering criteria was developed to aid in evaluating the alternative corridors. Both quantitative and qualitative criteria guided the comparative evaluation of these alternative corridors. These criteria are described below.

Environmental/Land Use Criteria

- **Avoid existing residential areas, schools, recreation areas, and other high-public-use areas.** There is an emerging awareness of the potential adverse health effects associated with electric and magnetic fields (EMF) surrounding transmission lines. As a result, it was recommended that the preferred transmission line corridors avoid existing or planned high-public-use areas that include existing and planned residential developments and resorts, as well as schools or parks.

  Most of the study region is currently undeveloped, with portions north of Kailua-Kona being either developed or proposed for development. There is existing residential development adjacent to the existing 69 kV alignment between Keahole Switching Station and Kailua Substation along Mamalahoa Highway. Kalaoa School is located adjacent to Mamalahoa Highway. Kealakehe Intermediate School is also located adjacent to and west of Palani Road. For purposes of this study, proposed uses that were well along in the land use approval process were included in the residential inventory. These existing uses and plans for proposed uses were considered in the alternative corridor selection process.

- **Minimize conflicts with proposed residential and commercial projects.** Numerous residential and commercial projects are planned in the area north of Kailua-Kona and in other parts of the study region. Because many of these projects are in the early planning stages and are not anticipated to be developed for another 5 to 10 years, potential conflicts between transmission line siting and any new development may be mitigated through early consultation with landowners and developers.

- **Maximize the use, wherever possible, of existing 69 kV transmission line corridors.** Siting the new lines within an existing 69 kV transmission line corridor would allow the possible use of an existing alignment. Combining new lines on a single set of poles could eliminate the need to acquire a new right-of-way for the proposed lines, reduce incremental visual impacts, and reduce EMF effects.

- **Maximize the use of existing transportation corridors.** Because much of the study region could be developed in the next 5 to 10 years, existing road and highway rights-of-way provide good opportunities for siting a transmission line corridor. The existing 69 kV corridors between Keahole Switching Station and Kailua Substation are adjacent to the Queen Kaahumanu and Mamalahoa Highways. HELCO's franchise grants it the authority to use state and county road rights-of-way for transmission and distribution lines. A new roadway from the Kaloko industrial area to Mamalahoa Highway provides another opportunity for siting a new 69 kV transmission line. Siting a new transmission line within an existing transportation corridor could reduce the number of rights-of-way that would have to be secured.

- **Minimize the number of separate land jurisdictions that the corridor traverses.** Securing rights-of-way and/or easements outside HELCO's jurisdiction for siting a new transmission line would involve negotiations with individual private property owners to obtain approval to use their land. The difficulty of this task is significantly reduced by eliminating or minimizing the number of private properties the transmission line corridors traverse.

- **Avoid areas that contain significant biological and cultural resources.** The presence of significant biological and cultural resources affects the selection of a transmission line corridor. Areas where there are known endangered or threatened or candidate endangered or threatened plant or animal species, or where there are known or potentially significant cultural sites or features, were considered in the selection of the preferred corridor.

- **Avoid areas that are politically infeasible and/or controversial to the community.** Public involvement during the early phase of the project ensured that local landowners, public decision makers, and the general public's concerns and preferences were taken into consideration as the preferred corridors were selected. Through a series of informal and formal consultations, briefing meetings, and public meetings, areas that were infeasible from a political perspective and/or publicly controversial were identified.

Engineering Criteria

- **Minimize corridor length.** As a general rule, if all other criteria are equal, the cost of constructing a new transmission line is a factor of distance: the shorter the distance traveled, the lower the construction and maintenance costs.

Environmental Resources Constraints Sensitivity Analysis

A sensitivity analysis was conducted to quantitatively measure each corridor alternative's relative sensitivity to the environmental resource and engineering criteria. The sensitivity analysis is based on the environmental resources constraint criteria used to identify corridor alternatives. The sensitivity analysis is the sum of all of the constraints mapped on each of the environmental resource category maps. The analysis was conducted by measuring the distance that each corridor alternative passed through a high-, medium-, or low-constraint area on each environmental resource category map. Each time a corridor passed through a high-constraint area, the measurement for that area was tripled, while each time a corridor passed through a medium-constraint area, the measurement was doubled. The measurement through a low-constraint area was used without modification.

Two sets of distance data were measured. The first set was measured through the probable path of the transmission line, and the second set was measured through the areas adjacent to the probable path but not including the probable path. These areas are shown as "through" and "adjacent" in Table 4-6. The combination of the two data sets is shown as "combination" and is of the most interest in this analysis.

Utility and Transportation Opportunities Sensitivity Analysis

Siting a new 69 kV transmission line through areas that do not have any existing utility or transportation systems poses more of a difficulty than siting a new transmission line adjacent to or within an easement containing an existing utility or transportation system. Long transmission line corridors are also more costly than shorter transmission line corridors.

The utility and transportation opportunity sensitivity analysis was conducted by measuring the distance that each corridor passed through areas that did not have any utility or transportation system, areas that were adjacent to an existing utility or transportation system, or areas that were within an existing utility or transportation easement. The areas that did

Table 4-6
Sensitivity Analysis Table

Corridor	Total Environmental Constraints				Utilities and Transportation Opportunity				Total Constraints and Opportunities			
	High + Medium + Low				High + Medium + Low				High + Medium + Low			
	Through	Adjacent	Combination	Combination Rank	Through	Adjacent	Combination	Combination Rank	Through	Adjacent	Combination	Combination Rank
S-1 mauka	74.29	8.32	82.62	1	6.81	0.00	6.81	1,2 Tie	81.11	8.32	89.43	1
S-1 makai	67.92	22.42	90.34	2	6.81	0.00	6.81	1,2 Tie	74.73	22.42	97.16	2
S-2	85.04	5.63	90.67	3	19.62	0.00	19.62	6	104.66	5.63	110.30	3
S-3	98.67	13.52	112.19	4	9.61	0.00	9.61	3	108.28	13.52	121.80	4
S-3A	110.99	15.16	126.15	8	10.72	0.00	10.72	4	121.70	15.16	136.87	7
S-3B	105.74	11.29	117.03	6	19.18	0.00	19.18	5	124.92	11.29	136.21	6
S-3C	111.55	10.67	122.23	7	21.62	0.00	21.62	8	133.17	10.67	143.85	8
S-3D	102.89	10.77	113.66	5	21.62	0.00	21.12	7	124.01	10.77	134.78	5

not have any utility or transportation systems were designated as high-constraint areas, with the distance measurement through these areas tripled. The areas that were adjacent to an existing utility or transportation system were designated as medium-constraint areas, with the distance through these areas doubled. The areas that were within an existing utility or transportation system easement were designated low-constraint areas, with the distance through these areas used without modification.

The utility and transportation analysis favors shorter lines over longer lines. This analysis also penalizes a corridor where there are no utility or transportation systems, compared to a corridor that is adjacent to or within the same easement as an existing utility or transportation system. The corridor alternative with the least constraints has the best utility and transportation opportunity.

Preliminary Preferred Corridors Selection

Environmental Resources Constraints Ranking

The results of the analysis described above show that, considering environmental constraint factors alone, the three corridors with the least environmental constraints are:

Rank	Corridor
1	S-1 mauka, Queen Kaahumanu Highway
2	S-1 makai, Queen Kaahumanu Highway
3	S-2 midlevel, about one-half mile mauka of Queen Kaahumanu Highway

Corridor S-3 and its variations (S-3A, S-3B, S-3C, and S-3D) rank below the top three corridors because the S-3 corridors contain larger areas with two or more high constraint ratings as a result of environmental factors. More prominently, these corridors all contain existing land uses (e.g., residential areas and schools) and sensitive visual receptors (existing residential areas and schools or those currently under construction) that are rated high constraint. Portions of these corridors are rated high constraint as a result of sensitive biological resources (remnant forests dominated by native Hawaiian vegetation) and sensitive cultural resources (trails and archaeological sites or features).

Corridor S-2 ranks higher than Corridor S-3 and its variations. Corridor S-2 also has areas with two or more high environmental constraint ratings as a result of land use and visual receptors; however, Corridor S-2 has substantially smaller areas with two or more high constraint ratings as a result of environmental factors. Most obvious is that there are fewer areas that are rated high constraint as a result of existing land uses (residential areas and schools) and sensitive visual receptors (existing residential areas and schools or those currently under construction). Portions of Corridor S-2 had additional high-constraint areas because of sensitive biological resources (rare biological elements found within the area) and sensitive cultural resources (trails and archaeological sites or features).

Corridor S-1 makai ranks higher than Corridor S-2 because Corridor S-1 makai has fewer areas rated high constraint as a result of environmental factors. The impacts on Corridor S-1 makai are due primarily to the sensitivity of the visual resources (the views along Queen Kaahumanu Highway and the soon-to-be-developed recreation area in the Kaloko-Honokohau National Historic Park), the cultural resources (Mamalahoa Trail), and the one area with a high environmental constraint rating as a result of land ownership (federal ownership of the Kaloko-Honokohau National Historic Park).

The sensitivity of the visual resources (the views along Queen Kaahumanu Highway) and the cultural resources (Mamalahoa Trail) result in Corridor S-1 mauka and Corridor S-1 makai having nearly the same amount of high environmental constraints; however, Corridor S-1 mauka is ranked higher than Corridor S-1 makai because of the one additional area of high constraint (Kaloko-Honokohau National Historic Park) and the continuous areas rated medium constraint that occur only on the makai side of Queen Kaahumanu Highway. The medium environmental constraints ratings on the makai side of Queen Kaahumanu Highway are a result of the land regulations (County Special Management Area).

Utilities and Transportation Opportunities Ranking

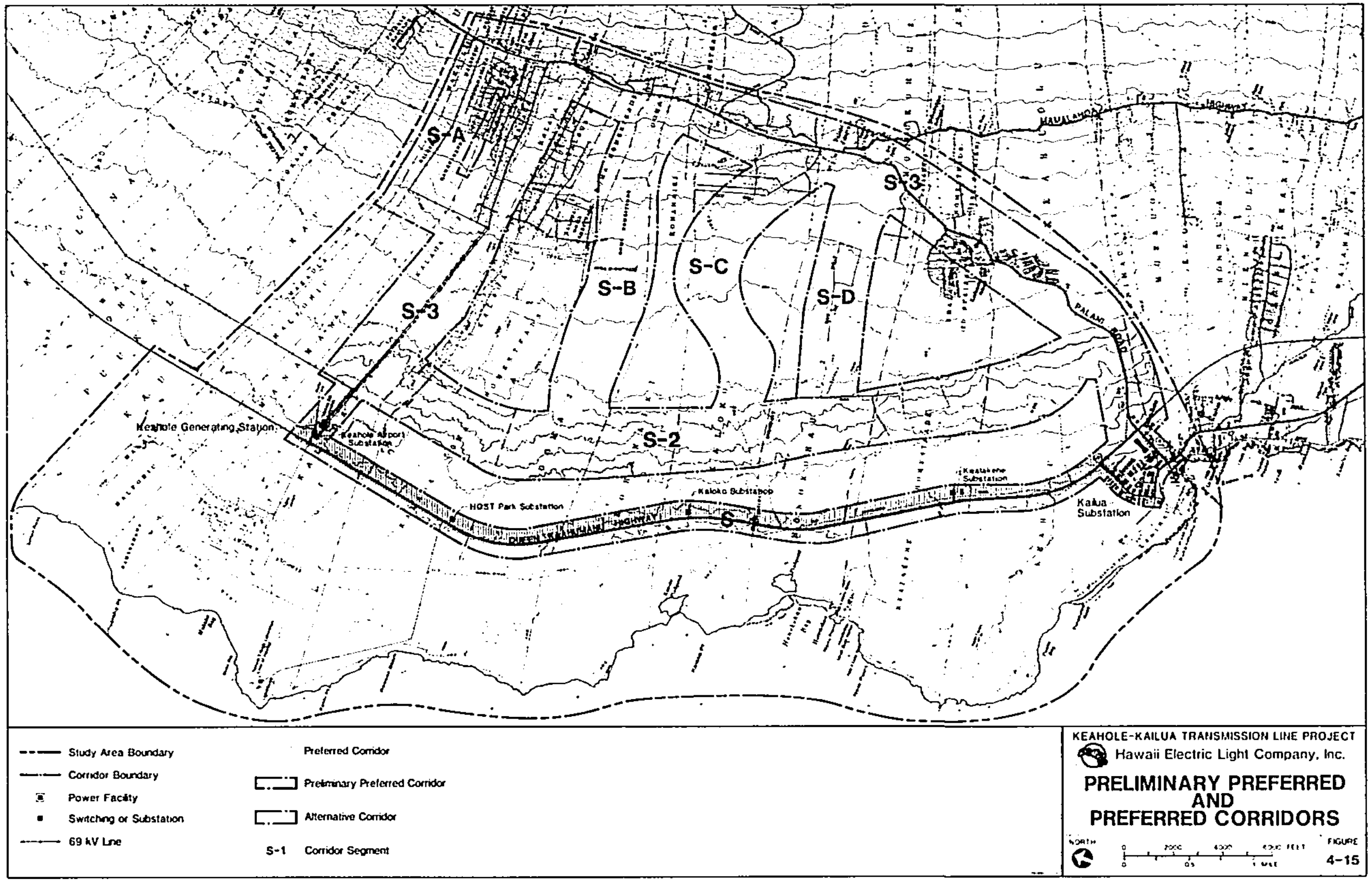
Considering utility and transportation opportunities, the three corridors that provide the best opportunities for siting a transmission line are:

Rank	Corridor
1, 2 Tie	S-1 mauka, Queen Kaahumanu Highway
1, 2 Tie	S-1 makai, Queen Kaahumanu Highway
3	S-3 Mamalahoa Highway/Palani Road, through Kalaoa

The shortest corridors that are within or adjacent to existing transportation or utility systems rank the highest. At 6.8 miles each, Corridor S-1 mauka and Corridor S-1 makai are the shortest corridors; they are adjacent to an existing 69 kV transmission line and to Queen Kaahumanu Highway. Corridor S-1 mauka and Corridor S-1 makai are tied for the highest rank. Ranked third is Corridor S-3, at 9.6 miles. Corridor S-3 is the next longest corridor that is continuously adjacent to an existing 69 kV transmission line and portions of Mamalahoa Highway and Palani Road.

Combined Ranking

The combination of the environmental constraints and the utility and transportation opportunities yields a total constraints and opportunities score. Using this composite analysis, the ranking of the three most preferable corridors is as follows (also shown in Figure 4-15):



KEAHOLE-KAILUA TRANSMISSION LINE PROJECT
Hawaii Electric Light Company, Inc.

PRELIMINARY PREFERRED AND PREFERRED CORRIDORS

FIGURE 4-15

Rank	Corridor
1	S-1 mauka, Queen Kaahumanu Highway
2	S-1 makai, Queen Kaahumanu Highway
3	S-2 midlevel, about one-half mile mauka of Queen Kaahumanu Highway

In this combination ranking, the utility and transportation opportunities score and the scores for each of the eight environmental resource categories were considered equally. All of the factors, weighted equally and considered together, quantitatively yielded the overall rank of each of the corridors. By this method of quantitative analysis, the top three corridors were selected.

These top three corridors were subsequently subjected to detailed and intensive analysis that consisted of field observations of the top three corridors' geological, biological, and cultural resources. The findings are described briefly in the following section of this chapter and more fully in Chapter 5. The geological, biological, and cultural field reports are presented in Appendixes C, D, E, and F.

Preferred Corridor Selection

Field observations by biological, archaeological, and geological specialists were done in the Keahole to Kailua area in Corridor S-1 mauka, Corridor S-1 makai, and midlevel Corridor S-2.

In Corridor S-2, the Hawaiian uhiuhi plant (*Caesalpinia kavaiensis*), which is listed as endangered (U.S. Fish and Wildlife Service, 1991), was identified in the Kaloko and Kealakehe areas. Another plant, the Hawaiian aupaka wahine noho kula (*Isodendrion pyrifolium*), scheduled to be proposed as a federally endangered species, was identified in Corridor S-2 in the Kealakehe area. Finally, the Hawaiian kookoolau plant (*Bidens micrantha*), which is a Category 2 candidate for listing, was identified in the S-2 corridor in the Kaloko area. More information is needed before a Category 2 candidate can be proposed for the endangered list.

In Corridor S-2, archaeological and cultural resources of high cultural value were identified north of Palani Road in the Keahuolu area. Some of these sites contain skeletal remains and, therefore, are recommended for preservation. Corridor S-2 also has archaeological and cultural sites in the Kealakehe and Honokohau areas, but this is not considered a constraint because these sites have recently undergone mitigation programs.

There are few geological differences between Corridor S-2 and Corridors S-1 mauka and S-1 makai except that the number of lava tubes in Corridor S-2 would make construction more difficult.

Based on the field observations and analysis, it is clear that the midlevel Corridor S-2 contains significant biological and cultural resources. Because of the possible adverse impact that development in the vicinity of such significant biological and cultural resources may have, Corridor S-2 was eliminated from further consideration.

Using Corridor S-1 makai would require an SMA permit from the Hawaii County Planning Commission; in addition, significant visual impacts on the makai views from Queen Kaahumanu Highway would be expected, and the probability of permitting delays beyond the required service date would be high because makai views from Queen Kaahumanu Highway would be a major consideration for the SMA permit. The preliminary environmental and land use analysis, the detailed analysis based on field observations of biological, geological and cultural resources, and the input from the two community meetings guided and validated the analytical process and HELCO's choice to eliminate the makai side of the Queen Kaahumanu Highway as a preferred corridor. Based on the analysis described throughout this chapter and the input of the community, HELCO identified its preferred corridor as Corridor S-1 mauka, Queen Kaahumanu Highway.

Preferred Corridor

The following preferred corridor (shown in Figure 4-16) remains for consideration:

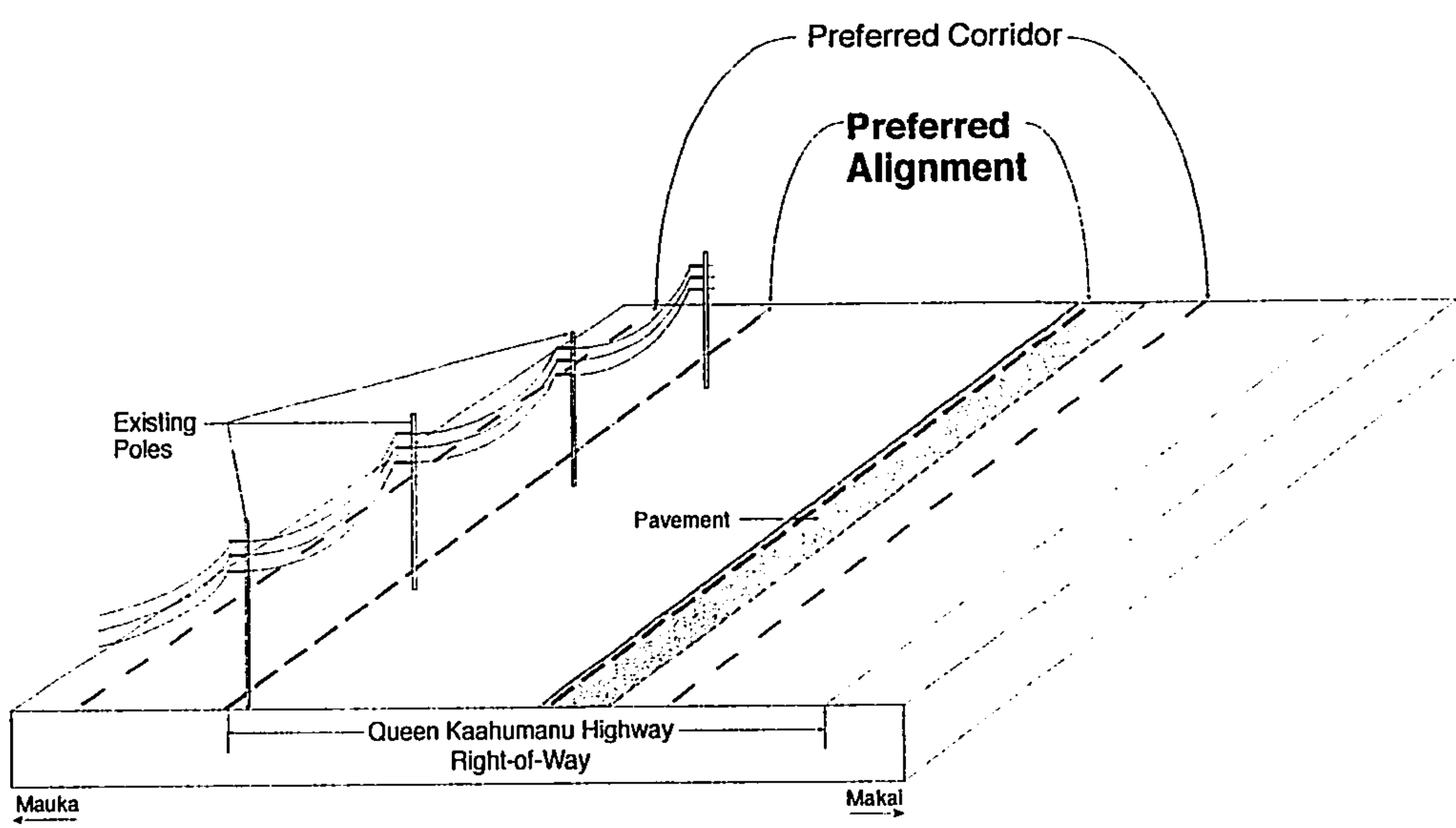
Rank	Corridor
1	S-1 mauka, Queen Kaahumanu Highway

No-Action Alternative

Under the No-Action alternative, no transmission line would be constructed between the Keahole Switching Station and the Kailua Substation. The existing 69 kV transmission line would remain, but there would be no construction associated with a new line. The purpose and need for the project would not be met: growing loads in West Hawaii could not be served reliably and the risk of major electrical system outages would increase.

Community Involvement Program

A key component of the overall route selection process was the implementation of a community involvement program. Community involvement activities took place from the beginning of the corridor selection process through the identification of the preferred alternative. On December 3, 1992, HELCO met with a group of interested citizens in Keauhou to discuss the process used for identifying and ranking corridors. Two community workshops were held in Kailua-Kona, one on December 15, 1992, and one on February 9, 1993. The public's input regarding the corridor selection and alternative alignment selection process was received at the workshops. A detailed description of the community involvement program can be found in Chapter 12 of this document.



KEAHOLE-KAILUA TRANSMISSION LINE PROJECT

FIGURE 4-16

DIAGRAM OF PREFERRED CORRIDOR AND ALIGNMENT

NOT TO SCALE

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CHAPTER 5

Chapter 5

Environmental Setting, Probable Impacts, and Mitigation

Land Use, Demographics, and Employment

The area analyzed for the proposed 69 kV transmission line extends a distance of 6.8 miles between the Keahole and Kailua substations on both sides of Queen Kaahumanu Highway. This area includes the S-1 mauka preferred corridor shown in Figure 4-16. Two alternative alignments, overhead and underground, have been identified within the project area. Resources located mauka of the project area have also been identified in figures throughout the chapter, and these resources are discussed where applicable.

Environmental Setting

Land ownership and land regulation are shown in Figure 5-1. Existing and proposed land uses are shown in Figure 5-2.

Existing Land Uses

Existing land uses adjacent to and mauka of Queen Kaahumanu Highway include agriculture, industry, and commercial uses. Specific existing developments include Keahole Agricultural Park, Kaloko Industrial Park, Allied Aggregate Corporation, West Hawaii Concrete, the County of Hawaii's Kealakehe Landfill, and the county's North Kona District Police Station. Areas not currently developed consist of vacant land. Kealakehe Residential Community is a mixed-use project currently under construction. A second mixed-use project under development is TSA-Kaloko Properties.

Makai of Queen Kaahumanu Highway, existing land uses are industrial and recreational. Specific developments include Keahole Airport, the Hawaii Ocean Science and Technology (HOST) Park, Kaloko-Honokohau National Historic Park, and Kona Industrial Subdivision. There are also areas of vacant, undeveloped land.

Keahole Agricultural Park. The 179-acre Keahole Agricultural Park is owned by the State of Hawaii and leased for agricultural purposes. This park is subdivided into 34 lots of approximately 5 acres each. Thirty-one lots are leased for 55-year terms for agricultural purposes. One residential dwelling unit is permitted on each lot. There are a total of 21 residences in the park. The closest residence is located approximately 300 feet from the existing 69 kV transmission line.

Hawaii Ocean Science and Technology (HOST) Park. HOST Park is on land owned by the State of Hawaii. It is located approximately 3,000 feet south of Keahole Airport Road. HOST Park, along with Natural Energy Laboratory of Hawaii (NELH), make up the Natural Energy Laboratory of Hawaii Authority. The portion of HOST Park located immediately adjacent to the project area is currently vacant and undeveloped.

TSA-Kaloko Properties. This privately owned 1,168-acre mixed-use development includes residential, business/commercial, light industrial, and recreational uses. The makai portion of this site, located adjacent to and mauka of Queen Kaahumanu Highway, is proposed for business/commercial uses. A mauka-makai roadway (Hina Lani Drive) that bisects this project site is completed but not yet open for use. Subdivision approval for this project is pending.

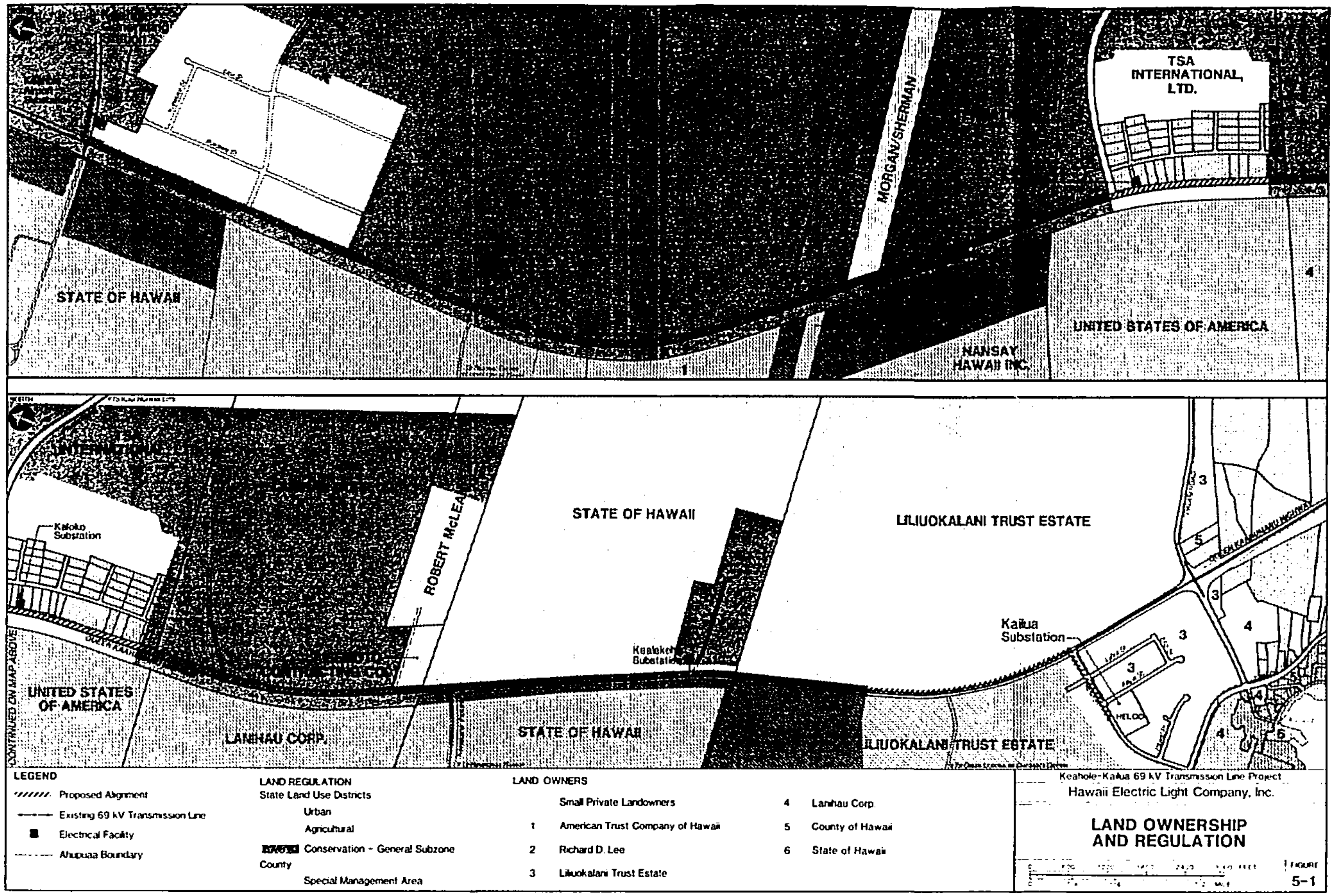
Kaloko Industrial Park. Kaloko Industrial Park is a 240-acre development subdivided into 194 1-acre lots for light industrial use. Phase I of this four-phase project is completed and includes 49 lots located immediately adjacent to and mauka of Queen Kaahumanu Highway. Existing tenants in this portion of the industrial park include Kona Trade Company, American Fence Company, and Big Island Marine. Subdivision and development of the remainder of the park are pending.

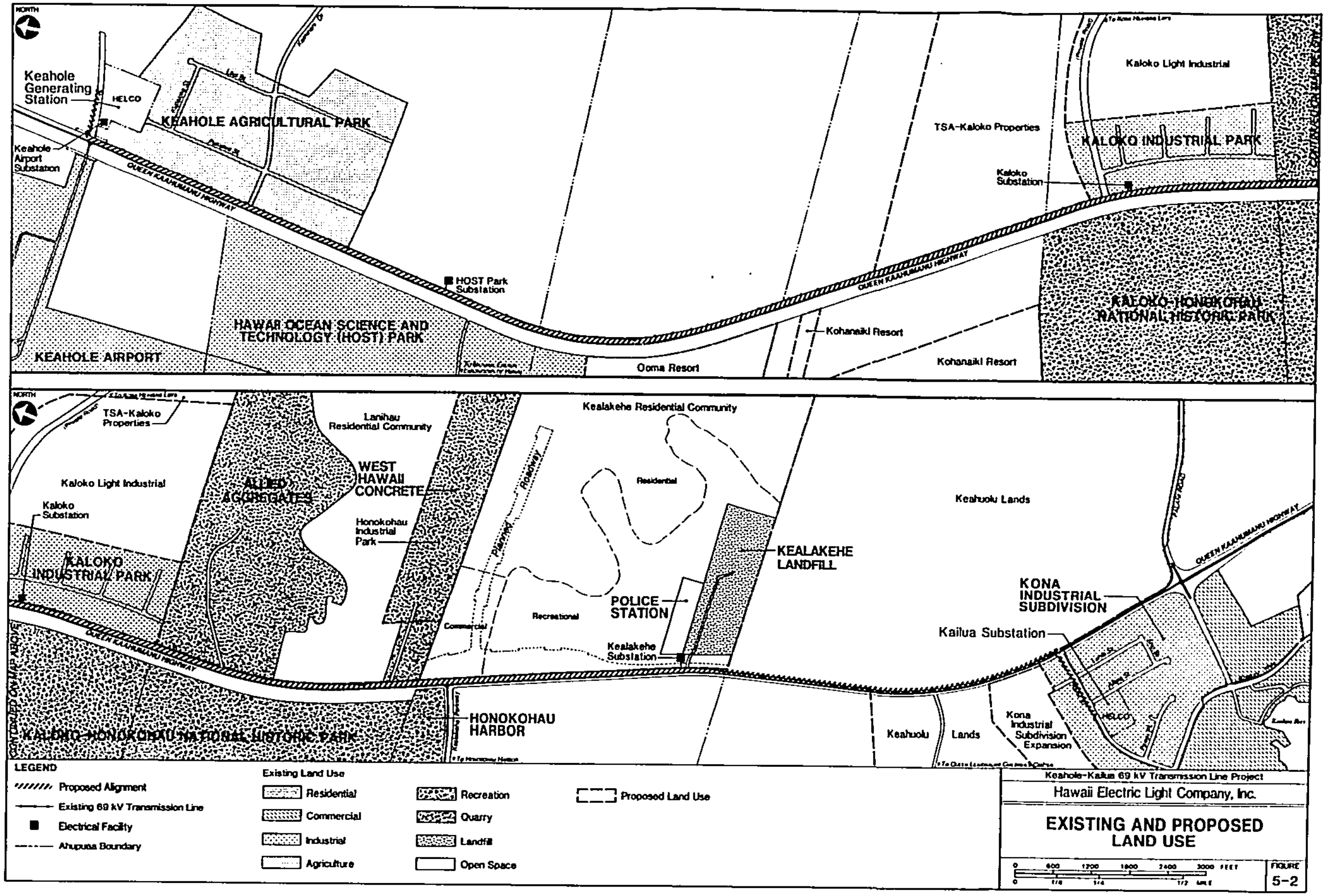
Kaloko-Honokohau National Historic Park. The U.S. National Park Service (U.S. Department of the Interior) is responsible for Kaloko-Honokohau National Historic Park. This park is on approximately 600 acres midway between Kailua Village and Keahole Airport. The purpose of this park is to develop a center for the preservation, interpretation, and perpetuation of traditional native Hawaiian activities and culture. One road into the site and a portable visitor center have been constructed. Tentative planned uses adjacent to and makai of Queen Kaahumanu Highway include a visitor orientation center with parking, an amphitheater, and administration buildings.

Allied Aggregates Corporation and West Hawaii Concrete. Two quarries operated by Allied Aggregates and West Hawaii Concrete are located about one-half mile mauka of Queen Kaahumanu Highway and south of Kaloko Industrial Park. Allied Aggregates is nearest Kaloko Industrial Park, while West Hawaii Concrete is located farther south. The area immediately adjacent to and mauka of Queen Kaahumanu Highway between these two quarries is currently vacant and undeveloped. A boat storage area is located near the West Hawaii Concrete facilities.

Kealakehe Residential Community. Kealakehe Residential Community is a mixed-use project being developed by the Housing Finance and Development Corporation (HFDC) of the State of Hawaii. It is located about 2 miles north of Kailua between Queen Kaahumanu Highway and Palani Road. Kealakehe Residential Community is the largest new development project in the North Kona district. It includes approximately 4,200 residential dwelling units on approximately 968 acres. Neighborhood commercial services, a golf course, and other recreation facilities are also planned for development.

Kealakehe Landfill. Kealakehe Landfill is a 15-acre county-operated facility located about 1 mile north of Kailua Substation and approximately 1,500 feet mauka of Queen Kaahumanu Highway. Closure of Kealakehe Landfill will commence when the new county landfill near Puu Anahulu begins operating. The landfill closure process may take 15 to 30 years. Other uses on this property include the Kealakehe Transfer Station and Recycling Center.


TSA
INTERNATIONAL,
LTD.
MORGAN/SHERMAN
STATE OF HAWAII
UNITED STATES OF AMERICA
HANSAY HAWAII INC.
1
4
CONTINUED ON MAP ABOVE
Kaloko Substation
ROBERT McLEAN
STATE OF HAWAII
LILIUOKALANI TRUST ESTATE
Kealakehe Substation
Kailua Substation
UNITED STATES OF AMERICA
LANIHAU CORP.
STATE OF HAWAII
LILIUOKALANI TRUST ESTATE
HELCO
3
4
5
6
LEGEND
Proposed Alignment
Existing 69 kV Transmission Line
Electrical Facility
Ahupuaa Boundary
LAND REGULATION
State Land Use Districts
Urban
Agricultural
Conservation - General Subzone
County
Special Management Area
LAND OWNERS
Small Private Landowners
1 American Trust Company of Hawaii
2 Richard D. Lee
3 Liliuokalani Trust Estate
4 Lanihau Corp
5 County of Hawaii
6 State of Hawaii
Keahole-Kailua 69 kV Transmission Line Project
Hawaii Electric Light Company, Inc.
LAND OWNERSHIP
AND REGULATION
FIGURE
5-1



Keahole-Kailua 69 kV Transmission Line Project

Hawaii Electric Light Company, Inc.

EXISTING AND PROPOSED LAND USE

FIGURE 5-2

North Kona District Police Station. North Kona District Police Station is located about 800 feet mauka of Queen Kaahumanu Highway approximately 5 miles south of Keahole Substation near Kealakehe Landfill. This police station has a staff of 60 officers serving West Hawaii.

Kona Industrial Subdivision. Kailua Substation is located approximately 1,400 feet makai of Queen Kaahumanu Highway in Kona Industrial Subdivision. Kona Industrial Subdivision encompasses approximately 175 acres.

Proposed Land Use

The University of Hawaii is planning to develop an approximately 500-acre site mauka of the Keahole Generating Station for the university's West Hawaii campus. Two mixed-use residential projects—Lanihau Residential Community and Keahuolu Lands—are proposed for development adjacent to and mauka of Queen Kaahumanu Highway. Additionally, the Hawaii Department of Transportation has plans to enlarge Queen Kaahumanu Highway from two to four lanes, and to develop two grade-separated interchanges along Queen Kaahumanu Highway—one at Keahole Airport Road and the second at Kealakehe Parkway near the access road to Honokohau Harbor.

Proposed developments adjacent to and makai of Queen Kaahumanu Highway include two resort projects, Ooma and Kohanaiki, and the expansion of Kona Industrial Subdivision.

University of Hawaii's West Hawaii Campus. The University of Hawaii has selected a site for its planned West Hawaii campus on approximately 500 acres mauka of the Keahole Generating Station. The project will include a core-university site and university-related residential areas. The University of Hawaii intends to apply for a 65-year lease with the Hawaii Department of Land and Natural Resources (DLNR) and to submit a budget request at the 1993 session of the Hawaii State Legislature.

Ooma Resort. Ooma Resort is located about 2 miles south of Keahole Substation. This 314-acre project will include a 600-unit resort hotel, 300 multifamily residential units, an 18-hole golf course and clubhouse, a 20-acre office park, a 50-acre high-tech area, open space, and a sewage treatment plant. The projected completion date is 1996.

Kohanaiki Resort. Kohanaiki Resort is a residential/resort project planned for development on 470 acres adjacent to and south of the proposed Ooma Resort. Project plans include 1,050 hotel units, 710 residential units, and an 18-hole golf course. Land immediately adjacent to and makai of Queen Kaahumanu Highway is designated as conservation and open space. The application for this project's Special Management Area use permit is currently being contested.

Lanihau Residential Community. Lanihau Residential Community is a proposed mixed-use residential project on 3,000 acres between Queen Kaahumanu and Mamalahoa highways and mauka of Mamalahoa Highway. This project includes 3,000 multifamily low-density units, with public parks, recreation areas, and open space. Commercial and light industrial areas will be developed mauka of Queen Kaahumanu Highway in the project area, adjacent to and south of Kaloko Industrial Park. Other land in the project area is designated as high-density urban. The project is anticipated to be completed after the year 2000.

Honokohau Industrial Park. This area already contains Kealakehe Landfill and the Kealakehe Transfer Station and Recycling Center. There are conceptual plans to further develop this 84-acre area mauka of Queen Kaahumanu Highway for light industrial use. Increment I of the project is proposed to occur on a total of 40 acres on the makai segment and would include a nursery; retail and manufacturing of lumber projects; an office complex; automotive sales, service, and repair; and short-term quarry use. The remaining 44 acres on the mauka segment may be subdivided at a later date as part of Increment II development. An application for rezoning of the makai segment is in process. The project will be developed in stages and is expected to be completed during the next 10 to 15 years.

Keahuolu Lands. Conceptual plans have been prepared to develop a mixed-use residential project on 1,135 acres owned by Liliuokalani Trust Estate mauka and makai of Queen Kaahumanu Highway near Kailua Village. Project plans include a mix of 1,365 single-family and 1,550 multifamily units, as well as commercial, agricultural, and service or industrial uses, parks or open space, and a wastewater treatment plant. The concept plan for this project shows a combination of business and commercial or financial uses planned along areas immediately mauka and makai of Queen Kaahumanu Highway within the project area.

Kona Industrial Subdivision Expansion. This project involves expansion of Kona Industrial Subdivision onto 100 acres adjacent to and north of the existing development. The proposed project calls for subdivision of 76 lots ranging in size from 1 to 2 acres.

Land Ownership

The two types of land ownership identified mauka of Queen Kaahumanu Highway in the project area are state and private lands. The State of Hawaii owns land adjacent to and mauka of Queen Kaahumanu Highway from Keahole Generating Station south for a distance of approximately 2 miles. The state also owns the Queen Kaahumanu Highway right-of-way and the area being developed as the Kealakehe Residential Community. Major private landowners mauka of Queen Kaahumanu Highway include TSA International, Ltd., Lanihau Corporation, and the Queen Liliuokalani Trust.

The project area makai of Queen Kaahumanu Highway has three categories of land ownership: federal, state, and private. The Kaloko-Honokohau National Historic Park is federally owned. State-owned land includes Keahole Airport, HOST Park, the Queen Kaahumanu Highway right-of-way, and undeveloped property adjacent to and north of the proposed Keahuolu Lands project. Major private landowners makai of the highway include Nansay Hawaii, Inc., Lanihau Corp., and the Queen Liliuokalani Trust Estate.

Land Regulation

The state classifies all lands in one of four Land Use District designations. Three designations are applicable to the study area lands mauka of Queen Kaahumanu Highway: Agricultural, Conservation, and Urban. Overhead transmission lines are a permitted use within Urban and Agricultural Districts. Siting new lines in a Conservation District requires a Conservation District Use Application.

The Conservation District is further classified into four subzones: General, Limited, Resource, or Protective. Each subzone varies in terms of its level of restrictiveness over allowable land uses. The least restrictive subzone is the General Subzone. Transmission lines are permitted in the General Subzone.

Land designated Urban mauka of Queen Kaahumanu Highway includes Kaloko Industrial Park and Kealakehe Residential Community. A portion of Queen Kaahumanu Highway in front of Kaloko Industrial Park is within the Urban District. Agricultural District lands include part of the proposed Keahuolu Lands project, Keahole Agricultural Park, and the portion of Queen Kaahumanu Highway in front of the proposed Keahuolu Lands project. The Conservation District, General Subzone designation covers the remainder of the project area mauka of and including Queen Kaahumanu Highway; the Conservation District area mauka of the highway is currently undeveloped.

The area makai of Queen Kaahumanu Highway includes land in the Urban, Agricultural, and Conservation, General Subzone Districts. The Agricultural District is limited to the makai portion of the proposed Keahuolu Lands project and the area of the proposed expansion of Kona Industrial Subdivision Expansion immediately adjacent to and makai of Queen Kaahumanu Highway. The Urban land district covers Kaloko-Honokohau National Historic Park, HOST Park, and the proposed Kohanaiki Resort. A strip of the Conservation, General Subzone District extends along most of the makai side of Queen Kaahumanu Highway and ranges in width from approximately 150 to 300 feet.

The only applicable county land use control that would regulate transmission lines in this portion of the project area is the Special Management Area (SMA). The general purposes of SMAs are to protect valuable resources, to control development along the shoreline, and to ensure adequate access to publicly owned or used beaches, recreation areas, and natural reserves. On the island of Hawaii, the County of Hawaii Planning Department designates and administers the SMAs. Development within a designated SMA requires an SMA Use Permit. The SMA designation applies to all land makai of the center line of Queen Kaahumanu Highway to the shoreline.

Demographics and Employment

The population of the island of Hawaii has been increasing steadily since 1960 and is projected to continue to grow into the next century. According to the 1990 U.S. census, the population of the County of Hawaii was 120,317. Population projections in the 1989

Hawaii County General Plan indicate that by the year 2005, the population of Hawaii County is projected to be between 173,000 and 258,000.

Population growth in West Hawaii has contributed significantly to recent increases in the county's population. Between 1980 and 1990, the population of West Hawaii increased by approximately 58 percent, reaching a population of 43,373 in 1990.

The North Kona district has also undergone rapid population growth. Population within the district grew from 13,748 in 1980 to 20,697 in 1987, an increase of over 50 percent. Population projections for the island of Hawaii show that 25 percent of the island's population in the year 2005 is expected to be located in the North Kona district.

According to population projections reported in the 1991 *Keahole to Kailua Development Plan* prepared for the county, between 1987 and 2020 the resident population in the area defined by the shoreline to the west, Kau ahupuaa to the north, Mamalahoa Highway to the east, and Palani Road to the south, is expected to grow by 10,162, an increase of approximately 225 percent. The number of residential units in this area is projected to increase during this same period, from 1,511 in 1987 to a total of 5,774 in 2010, a 282 percent increase. Total employment in this area for the year 2010 is projected to reach about 6,600.

Recent and projected population growth in the North Kona district is primarily attributed to employment opportunities and economic activities associated with the visitor industry. Resort developments are concentrated in the South Kohala-North Kona region. In 1989, there were 4,748 visitor units in the North Kona district. The majority of visitor units in the study region are located in Kailua Village and at the Keauhou Resort south of Kailua Village. It is anticipated that the visitor industry in this region will continue to expand.

Agriculture is a major sector of the economy on the island of Hawaii and accounts for about 10 percent of the island's employment. Major local agricultural enterprises in the North Kona district include coffee, cattle ranching, and cultivation of fruits and vegetables. Quarrying also provides jobs.

Probable Impacts

Both the S-1 mauka overhead and underground alternatives would generate new construction jobs; however, this increase would be temporary (i.e., would last only until construction is completed) and would not be significant to the West Hawaii economy. Existing and future employment and demographics would not be affected.

S-1 Mauka Overhead Alternative

The S-1 mauka overhead alternative uses the mauka edge of the Queen Kaahumanu Highway right-of-way. The alignment would be adjacent to Keahole Agricultural Park, Kaloko Industrial Park, Allied Aggregate Corporation, West Hawaii Concrete, and Kealakehe

Landfill. There are 21 residences located within Keahole Agricultural Park. Of these, the six residences closest to the proposed alignment are located about 300 feet mauka of Queen Kaahumanu Highway. They are mauka of the existing 69 kV transmission line alignment and the proposed S-1 mauka overhead alignment. No adverse impacts to these or other existing land uses mauka of Queen Kaahumanu Highway are anticipated.

Two mixed-use projects are soon to be under construction adjacent to and mauka of Queen Kaahumanu Highway. Both TSA-Kaloko Properties and Kealakehe Residential Community are mixed-use projects, incorporating residential, commercial, and recreational uses. In both developments, intervening commercial and recreational uses will separate residential areas from the proposed transmission line alignment. The existing transmission line is barely visible from the areas where these residential developments will be constructed. Although the new line would be visible from the proposed commercial areas immediately adjacent to the proposed alignment, it would continue to be barely visible from the soon-to-be-constructed residential areas because of distance and, in some cases, because the makai views will be obstructed by commercial structures.

As currently planned, the Keahuolu Lands development proposes to locate commercial uses immediately adjacent to the mauka side of Queen Kaahumanu Highway. These intervening commercial uses would provide some separation between residential areas and the proposed transmission line alignment, thereby minimizing the visual impact of the line on these proposed residential areas.

Lanihau Residential Community is in the early stages of planning, and its final layout is not yet known. The project is proposed as a mixed-use community with residential, commercial, and agricultural uses. If, as in the new and proposed projects described above, the commercial and agricultural uses are placed along Queen Kaahumanu Highway and residential uses are placed farther mauka, the impact of the proposed transmission line on proposed residential areas would be minimal.

HOST Park, Kaloko-Honokohau National Historic Park, and Kona Industrial Subdivision are located makai of Queen Kaahumanu Highway (i.e., on the opposite side of the highway from the proposed transmission line alignment). Within these sites, the areas immediately adjacent to the highway are undeveloped open space; construction of the transmission line on the mauka side of the highway would have no adverse impacts on existing uses on these sites.

Proposed projects on the makai side of Queen Kaahumanu Highway include the Ooma and Kohanaiki Resorts and a portion of the Keahuolu Lands development. These proposed projects should be minimally affected by the proposed transmission line (on the mauka side of the highway) because the line would be separated from them by the intervening highway and because the view of interest would be toward the ocean and away from the highway.

The location of this alignment would need to be coordinated with the Hawaii Department of Transportation's plans to expand Queen Kaahumanu Highway from two to four lanes and to add grade-separated interchanges at Keahole Airport and at Kealakehe Parkway (see the section in this chapter on transportation and traffic).

S-1 Mauka Underground Alternative

Existing land uses and proposed projects located near this alternative are the same as those described above for the S-1 mauka overhead alternative. The S-1 mauka underground alternative would have no significant land use impacts on existing agricultural, commercial, recreational, and industrial areas along the alignment; however, it would need to be coordinated with the Hawaii Department of Transportation's plans to expand and improve Queen Kaahumanu Highway (see the section in this chapter on transportation and traffic).

Mitigation

HELCO will coordinate plans for the proposed transmission lines with the Hawaii Department of Transportation's Highways Division on the expansion of Queen Kaahumanu Highway and the proposed interchanges along Queen Kaahumanu at Keahole Airport Road and Kealakehe Parkway.

Visual Resources

Environmental Setting

Visual Resource Goals and Policies

Goals to protect Hawaii's natural beauty and scenic qualities are addressed in the *Hawaii County General Plan* (Hawaii County, Department of Planning, November 1989). These goals include:

- Protecting, preserving, and enhancing the quality of areas endowed with natural beauty, including the quality of coastal scenic resource

- Protecting scenic vistas and view planes from becoming obstructed

- Maximizing opportunities for present and future generations to appreciate and enjoy natural and scenic beauty

Specific general plan policies seek to improve public access to scenic places and to preserve views of scenic or prominent landscapes viewed from specific locations. The general plan lists views of the mountains and the ocean along Queen Kaahumanu Highway as examples of natural beauty. Other examples of natural beauty in the study area cited in the general plan include Kaloko Pond, Honokohau Fish Pond, Honokohau Harbor, the Honokohau coastline, Aimakapa White Sand Beach, the White Sand Beach at the Old Kona Airport State Park, Keahole Point, and Kailua Bay.

Views from points of interest cited in the Hawaii County *Keahole to Kailua Development Plan* (Hawaii County, Department of Planning, April 1991) include those mauka views from Keahole Airport, Honokohau Harbor, and the Old Kona Airport State Park, as well as the mauka and makai views from Queen Kaahumanu Highway.

Field Evaluation of Visual Resources in the Study Area

A field evaluation of visual resources within the study area was conducted during the corridor evaluation stage. The following description of existing conditions was used as the basis for evaluating the visual impacts of the transmission line alternatives.

The predominant backdrops in the study area are the ocean and the slopes of the Hualalai volcano. Overall, vistas are sweeping with occasional interruptions by artificial structures. The vegetation is sparse to nonexistent and consists of low-growing grasses and scattered shrubs and trees that are typically less than 10 feet high. The dominant landscape color is a dark brown (from barren lava flows), which is interspersed with the light-brown and green colors of vegetation. Existing wood transmission and telephone poles and lines follow the mauka edge of the Queen Kaahumanu Highway. The visual quality of the barren expanses, accentuated by the lack of trees and prominent land features, makes this area generally sensitive to visual impacts.

Key Views. Generally, the views of concern in the study area fall into two categories: views available from cars driving north or south on Queen Kaahumanu Highway along the proposed alignment, and stationary views of the proposed project from the closest existing and proposed residential and recreational areas.

Views from Automobiles from Queen Kaahumanu Highway

Southbound. Traveling south on Queen Kaahumanu Highway from the Keahole Generating Station affords drivers and passengers expansive makai views for the first 3 miles. At that point, the road turns slightly mauka and draws the eye to expansive views of Hualalai and extremely distant views of Mauna Loa, as shown in Figure 5-3. The existing wood utility poles and lines and other artificial structures are dominant features in the foreground. Keahole Agricultural Park, Kaloko Industrial Park, and occasional commercial and municipal structures occur on the mauka side of the highway along the 6.8-mile-long project area.

Northbound. Traveling north on Queen Kaahumanu Highway from the intersection of Kaiwi Road and Queen Kaahumanu Highway, raised embankments keep the driver's focus on the foreground and the highway ahead. Progressing north, the embankments are intermittent and eventually become level with the road; the eye is drawn to the expansive makai views. The wood utility poles and lines dominate the foreground on the mauka side of the highway. Figure 5-4 shows a typical view driving north in the project area on Queen Kaahumanu Highway.

Views from Existing and Proposed Residential/Recreational Areas

Keahole Agricultural Park. A total of 21 residents live within Keahole Agricultural Park. The residents of this agricultural park would be nearest to the proposed project. Makai views from the agricultural park are of Queen Kaahumanu Highway in the foreground (with its existing utility poles) and of the coastal plains, Keahole Airport, and the ocean in the background.

Kona Palisades. Kona Palisades, the nearest existing residential area, is located approximately 1 mile mauka of Queen Kaahumanu Highway. The view from Kona Palisades toward the proposed project is dominated by the gently downsloping terrain and the Pacific Ocean. The Keahole Airport is a distant secondary view. From Kona Palisades, the existing wood utility poles and lines are barely visible along the mauka side of Queen Kaahumanu Highway.

Kaloko-Honokohau National Historic Park. The nearest recreational area, the Kaloko-Honokohau National Historic Park, is not yet operational, but a management plan calls for increased visitor use. The park is located midway between Kailua and Keahole Airport across Kaloko Industrial Park on the makai side of Queen Kaahumanu Highway. As for the mauka view of the project, the rising terrain and the industrial uses in the area (Kaloko Industrial Park and nearby quarrying operations) lessen the contrast of the transmission line poles against the background.

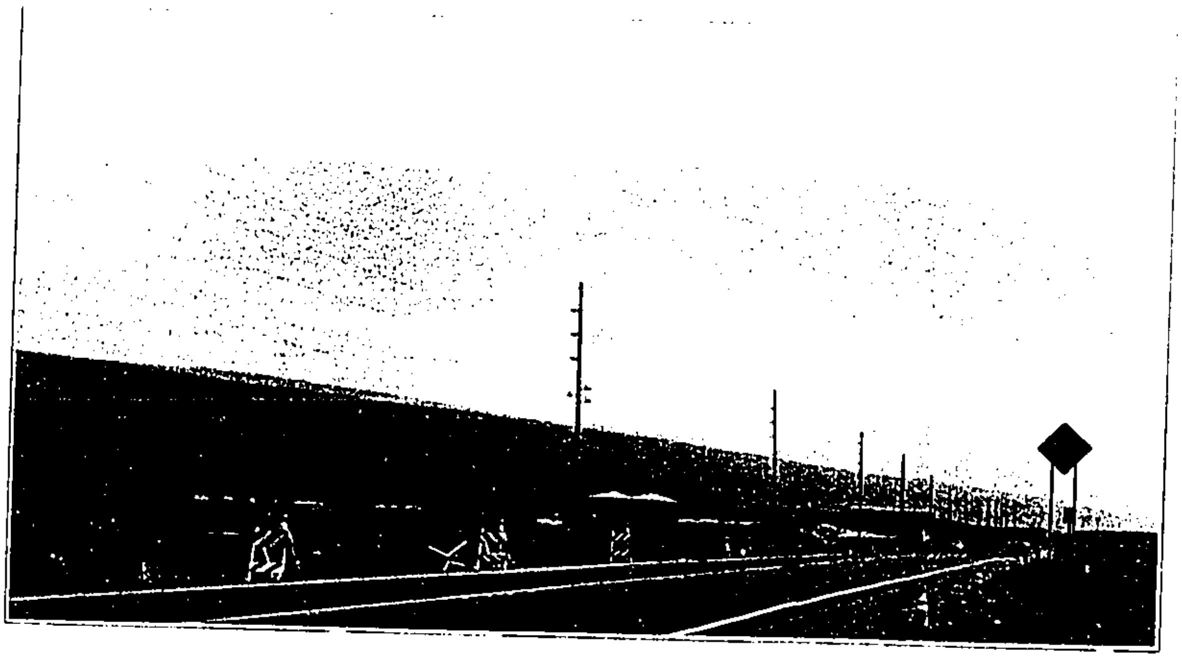
Kealakehe Residential Community. Future plans call for residential and recreational uses in the Kealakehe Residential Community, an area that would be located adjacent to and mauka of Queen Kaahumanu Highway in the vicinity of the existing police station. A golf course is planned for the area closest to the highway. The view from the proposed golf course toward the project would be dominated by the Pacific Ocean.

Probable Impacts

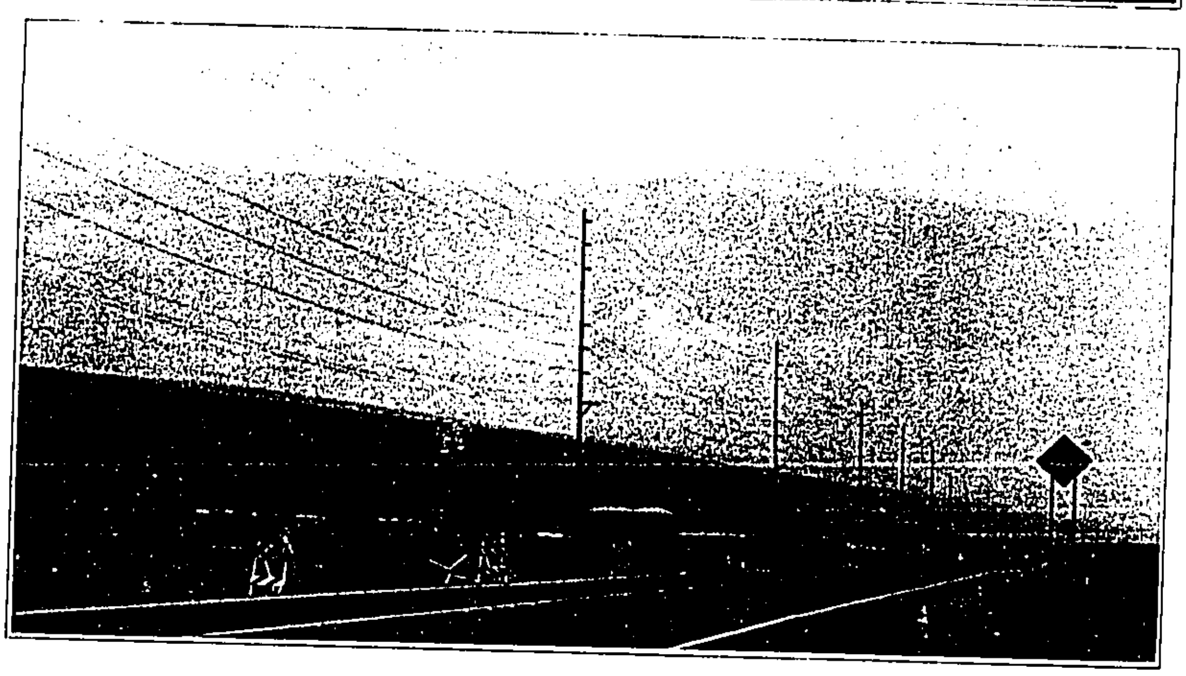
In keeping with the goals and policies of the *Hawaii County General Plan*, views from scenic vistas and view planes were analyzed for possible visual impact, as discussed below.

S-1 Mauka Overhead Alternative

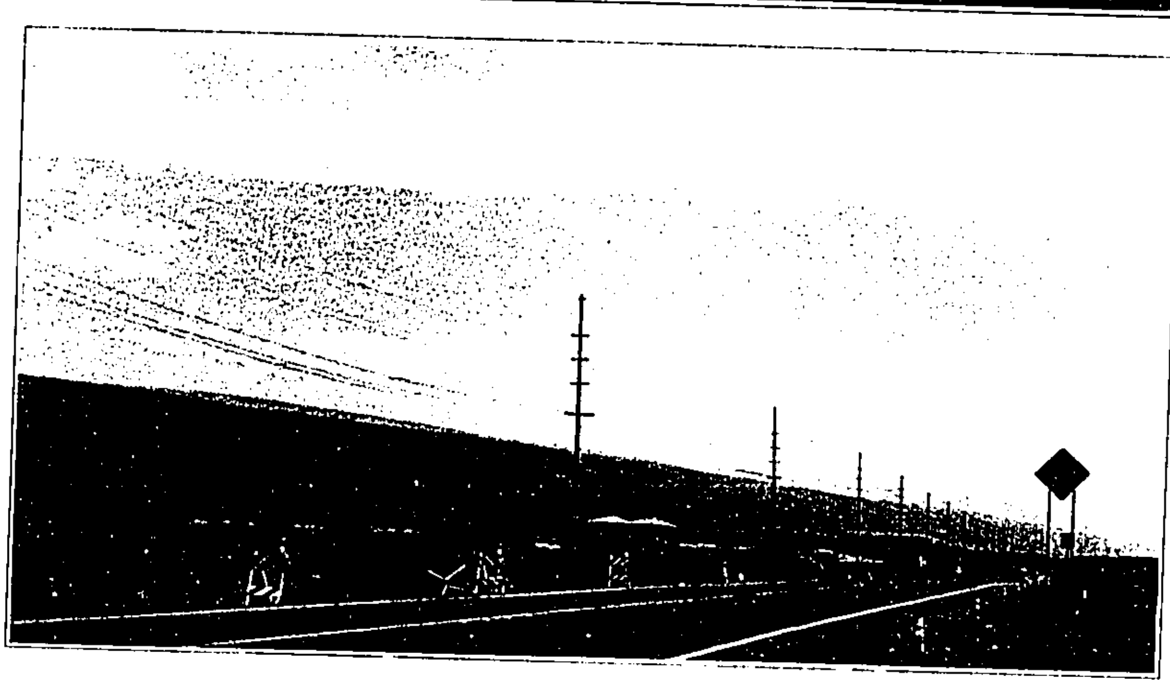
The extent of the visual impact of overhead transmission lines depends largely on the capability of the natural landforms to absorb introduced features. The relatively barren mauka slopes of Hualalai and the uninterrupted grassy coastal plains provide expansive views that are characteristically sensitive to visual intrusions. These circumstances make overhead transmission lines a dominant feature at close range and less dominant from a distance. How the project is viewed (for example, from across a broad plain, looking downslope, or looking upslope) also affects the degree of visual impact experienced.



Existing conditions



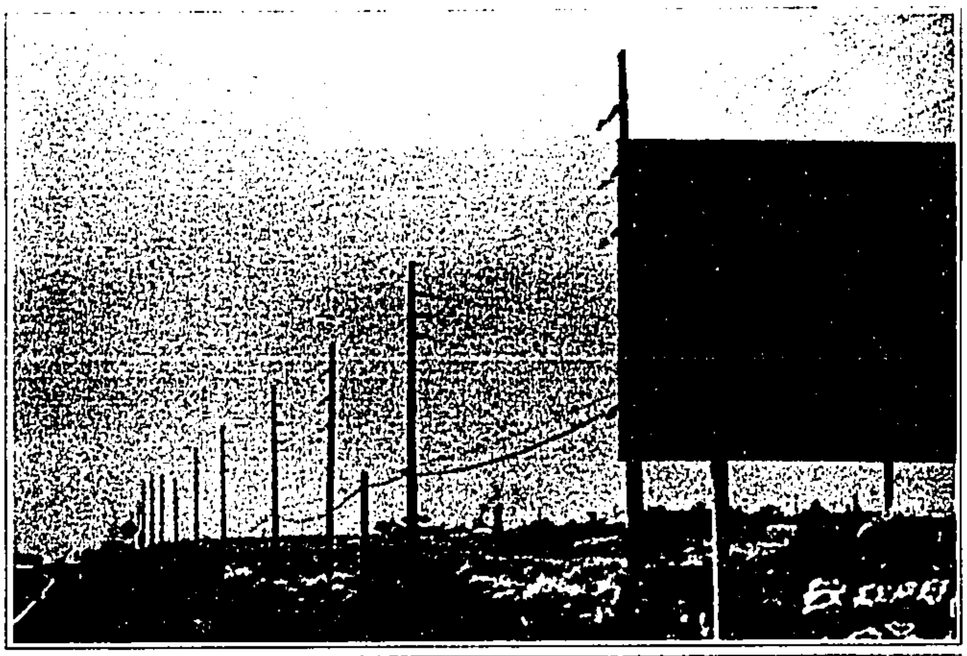
Simulation of proposed project. Double circuit 69 kV transmission lines on one side of the pole (Configuration number 1)



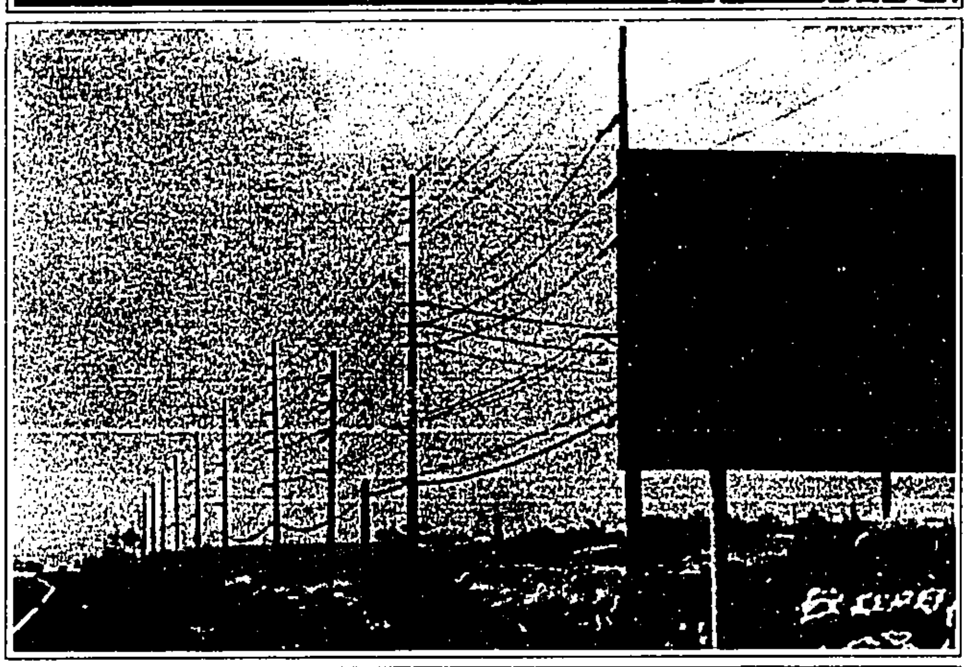
Simulation of proposed project. Double circuit 69 kV transmission lines with one circuit on each side of the pole (Configuration number 2)

FIGURE 5-3

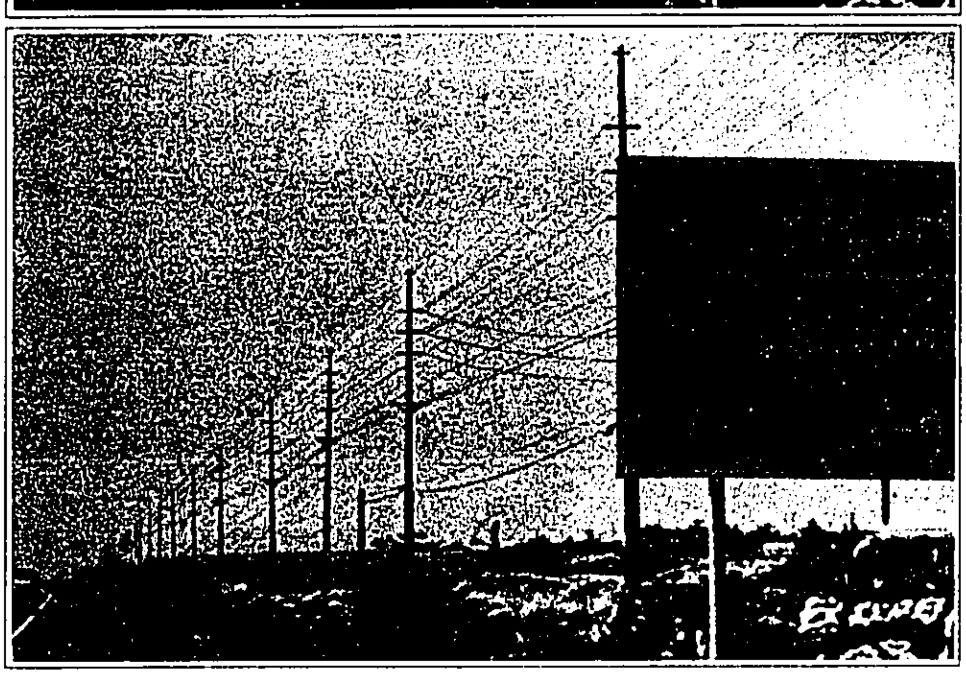
VIEW LOOKING SOUTH ON QUEEN KAAHUMANU HIGHWAY



Existing conditions



Simulation of proposed project.
Double-circuit 69 kV transmission lines on one side of the pole
(Configuration number 1)



Simulation of proposed project.
Double-circuit 69 kV transmission lines with one circuit on each side of the pole.
(Configuration number 2)

FIGURE 5-4

VIEW LOOKING NORTH ON QUEEN KAAHUMANU HIGHWAY

Automobile drivers heading north or south on the Queen Kaahumanu Highway would experience a slight increase in the degree of visual impact from the proposed project compared with the existing poles. The proposed wood or steel transmission line poles would be positioned in about the same locations as the existing poles but would be taller and would support an additional circuit of three conductors. The existing wood poles are about 55 to 65 feet high. The proposed Configuration No. 1 pole, with both existing and proposed circuits on the same side, would be 70 to 85 feet tall and would average 80 feet in height. The proposed Configuration No. 2 pole, with existing and proposed circuits on opposite sides of the pole, would be 60 to 75 feet tall and would average 70 feet in height. Figures 5-3 and 5-4 show two existing views along Queen Kaahumanu Highway and a photosimulation of the same views with two different configurations of the proposed wood poles in place. Steel poles would be identical to the wood poles in dimensions but would be a nonreflecting gray color.

Viewed from the Kona Palisades, the proposed project would be an insignificant element of the expansive backdrop of the Pacific Ocean. The new line, like the existing line, would be barely visible.

The project would cause minimal visual impact when viewed from Kaloko-Honokohau National Historical Park because it would be viewed in the context of other existing and planned artificial structures. Views of the project from Kaloko-Honokohau National Historical Park would be seen against the backdrop of Kaloko Industrial Park, the Kaloko Substation, and the quarry operations, which are all located at a higher elevation on the mauka side of Queen Kaahumanu Highway.

The project would cause very little change to the existing view because the existing wood poles would be replaced with slightly taller wood or steel poles. When viewed from the historic park, the existing poles have a small impact, given the artificial structures in the industrial park. The same would be true of the new poles and lines when viewed from the historic park. Increased urban development in the area of the existing quarry operations would lessen the impact of the project when viewed from the historic park. The mixed-use Lanihau Residential Community is being planned for that location; commercial and light industrial areas are to be located adjacent to the highway, and high-density residential uses are to be located farther mauka.

Impacts to the mauka and makai views from Queen Kaahumanu Highway are discussed above. Other sites of natural beauty and views of interest cited in the *Hawaii County General Plan* and the *Keahole to Kailua Development Plan* would not be affected by the proposed project because of their distance from the project. These areas are all located on or near the shoreline; the proposed project would almost always be obscured when viewed from these areas. Even if the project were not obscured, its distance would diminish its apparent size and would make it an insignificant part of the view.

Minimal new visual impacts would occur when viewing the project from the existing Keahole Airport view of interest because the poles will be only slightly taller. Looking mauka from the existing Keahole Airport access road, the view of interest subtends a narrow angle a little greater than 45 degrees. Relocating the airport's main access road several hundred feet to the north would remove the Keahole Airport's view of interest from the project area.

S-1 Mauka Underground Alternative

The underground alternative will have no adverse visual impacts.

Mitigation

The contrast of the transmission line poles against the barren backdrop of Hualalai could be softened by placing landscape plantings intermittently along the proposed alignment.

However, future plans by the State of Hawaii Department of Transportation call for the eventual widening of Queen Kaahumanu Highway from its current two lanes to a four-lane divided highway with frontage roads on both the mauka and makai sides of the highway. Because the ultimate highway design will involve grading that would remove or destroy any plantings from this project, the planting of any landscaping materials would be temporary at best.

Therefore, no landscaping mitigation is proposed as a part of this project. It is more appropriate that landscaping along this alignment be accomplished in conjunction with the planned widening of Queen Kaahumanu Highway.

Geological and Biological Resources

Environmental Setting

Geological Resources

Masa Fujioka & Associates prepared geological and geotechnical reports for the regional study area and for the preferred corridors. The information and analysis presented in this section is based on those reports; the complete reports are provided in Appendix C.

Geology and Soils. The project area is located on the western coastal slopes of the Hualalai volcano. Hualalai last erupted in 1801 from two vents along the northwest-trending rift zone. The northwest rift represents the major geologic structure in the area. The most recent activity at Hualalai occurred in 1929, when a series of earthquakes shook the area for more than a month. These quakes have been attributed to a localized intrusion of lava and subsequent readjustment of the surrounding rock. The topography is relatively flat to gently sloping throughout most of the area. The ground surface varies from approximately 40 feet to 230 feet above mean sea level.

The surface consists of aa and pahoehoe lava that slopes to the west in the direction of the coastline. The lava bedrock is at or near the surface throughout the area. Lava tubes and pressure ridges are characteristic features of the pahoehoe flows throughout the area (see Figure 5-5). There are tube systems in about 40 percent of the pahoehoe flows in the area; these tubes appear to be about 10 to 15 feet in diameter. It is likely that there are additional tube systems on the subsurface that are not indicated on the surface. Pressure ridges can be up to 20 feet high, 50 feet wide, and several hundred feet long. Pressure ridges observed in the project area are fractured extensively and have cavities associated with them. In some places, cavities in the pahoehoe are as deep as 30 feet. There are pressure ridges in four locations in the project area. One, which lies between the Keahole Generating Station and Kaiminani Drive, is 40 feet wide and 5 feet high with 3-foot-deep cavities. Three other pressure ridges cross Queen Kaahumanu Highway at perpendicular angles in three different places.

Aa lava covers approximately 40 percent of the project area. Aa flows normally consist of a surface layer of loose clinker overlying a dense basalt core. In the project area, aa lava consists of clinker and large boulders, with the boulders averaging 2 to 3 feet in diameter. Aa rarely, if ever, forms the voids and tubes observed in pahoehoe because of aa lava's high viscosity and slow flow rate. These flows exhibit more relief than the pahoehoe, with heights of up to 20 feet.

Soils in the area consist of thin windblown silt and sand that accumulate in cracks and crevices of the lava flows. The thickness of the soil is less than 1 foot, and generally less than 4 inches. The soil is very rocky and friable and has an abundance of roots and very fine pores. The permeability of the soil is high, runoff is low, and the erosion hazard is minimal.

There is an area of near-shore lava flows consisting of loose sand and gravel near the project area inland from Honokohau Bay.

Volcanic Hazards. The island of Hawaii was formed by five shield volcanoes: Kohala, Mauna Kea, Hualalai, Mauna Loa, and Kilauea. Kohala (5,480 feet) is at the northern end of the island and is the oldest. To the east, Mauna Kea (13,796 feet) erupted first approximately 4,500 years ago. The Kohala Range and Mauna Kea have not erupted in historic time and are considered inactive. Hualalai (8,271 feet), on the western part of the island, has erupted once in historic time—in 1801. One of the flows covered the northern part of the current site of Keahole Airport, approximately 1 mile north of the Keahole Generating Station site. The two southernmost volcanoes—Mauna Loa (13,679 feet) and Kilauea (4,093 feet)—have been active frequently throughout historic time. The last recorded lava flow from Mauna Loa to reach the North Kona district was the lava flow of 1859.

The project area is situated on the western coastal slope of the Hualalai volcano; the crest of Hualalai is located 10 miles east of the site. Mauna Loa is located 30 miles southeast of the site, and Kilauea is located 50 miles southeast of the site. The Kohala Range is located 33 miles northeast of the site, and Mauna Kea is 38 miles east of the site.

Volcanic hazard zones have been established for the island of Hawaii for long-term planning purposes. Lava flow hazard zones are based on the percentage of the potential flow area that has been covered by lava flows during specific time periods, the frequency of past eruptive events, and the assumption that the rate of current volcanic activity will continue for the next several decades. On a rating scale where Zone 1 reflects the greatest volcanic hazard and Zone 9 the least, the project area is located within Lava Flow Hazard Zone 4, which indicates a moderate risk of coverage by lava.

Hazard zones for tephra (i.e., airborne volcanic material produced by lava fountains) have also been established. They are based on eruption frequency, proximity to potential vents, and prevailing wind direction. The rating scale is divided into three zones, with Zone 1 indicating the greatest tephra falling hazard and Zone 3 the least. The project area is located within Tephra Fall Hazard Zone 2. There have been no known tephra eruptions on Hualalai in historical time. However, a potential exists for coverage by a thin layer (0.5 to 4 inches) of volcanic cinders from an eruption in Zone 1. Zone 1 is located along the Mauna Loa rift zone that separates the South Kona and Kau districts. At its closest, this zone is at least 30 miles from the project area.

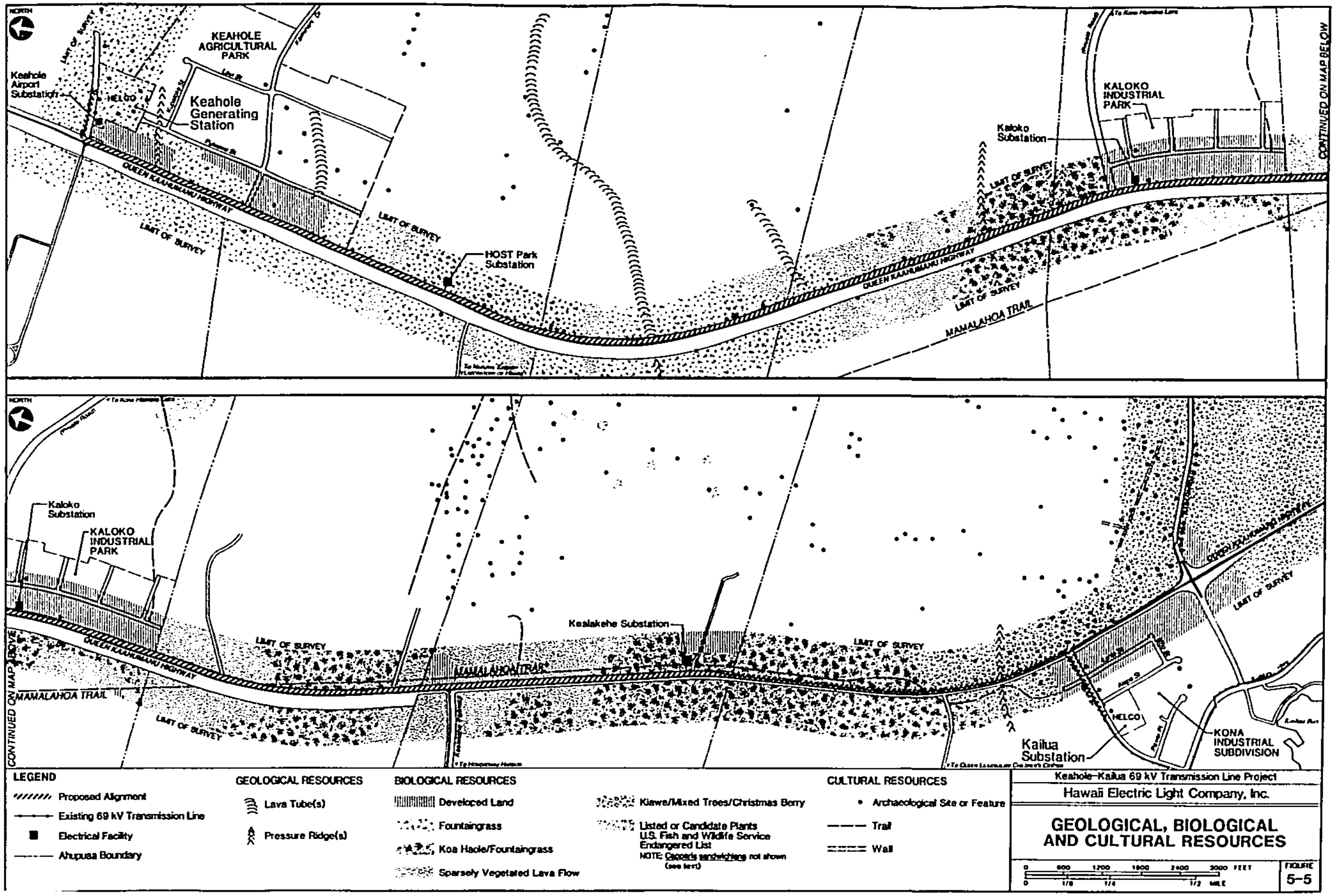
Four hazard zones for potential ground fractures and subsidence have been identified on the island of Hawaii. The area of highest hazard is Zone 1, and Zone 4 is subjected to the least hazard. The project area is located within Zone 4 for ground fractures and surface subsidence. The entire island is subsiding at a rate of 1 to 2 feet per century because of the cumulative effect of a worldwide rise in sea level and the down-warping of the sea floor around the island.

Groundwater. All of Kona's groundwater resources come from rainfall on the upper slopes of Kona above the elevation of 2,500 feet. This rainfall, which averages 40 to 75 inches a year, percolates quickly into the ground to become groundwater. There is little, if any, runoff to the sea, even during times of heavy rainfall. Consequently, there are no perennial streams in Kona.

The project area is located within the Keauhou aquifer system, which encompasses the southern half of the Hualalai volcano. Groundwater in the coastal area is referred to as the "basal" lens and occurs as a thin, buoyant, unconfined lens of brackish water floating on saltwater. Groundwater in the project area moves west toward the coast, and as this occurs, the brackish basal lens thins appreciably and becomes more saline as it gets closer to the ocean. The proposed project would be located above this basal lens. The basal lens is dynamic, being affected by drought, ocean tides, and the withdrawal of groundwater from wells. In the vicinity of the project area, the groundwater lens is approximately 100 feet below the surface of the ground.

Biological Resources

A regional biological resources study and a detailed biological resources survey of the preferred corridors were conducted by the Applied Research Group of the Life Sciences Division of the Bishop Museum. The information and analysis presented in this section is based on these studies. The studies themselves are provided in Appendix D.


NORTH
KEAHOLE AGRICULTURAL PARK
Keahole Airport Substation
HELCO
Keahole Generating Station
LIMIT OF SURVEY
QUEEN KAAHUMANU HIGHWAY
HOST Park Substation
MAMALAHOA TRAIL
KALOKO INDUSTRIAL PARK
Kaloko Substation
CONTINUED ON MAP BELOW
CONTINUED ON MAP ABOVE
Kealakehe Substation
Kailua Substation
KONA INDUSTRIAL SUBDIVISION
LEGEND
Proposed Alignment
Existing 69 kV Transmission Line
Electrical Facility
Ahupua'a Boundary
GEOLOGICAL RESOURCES
Lava Tube(s)
Pressure Ridge(s)
BIOLOGICAL RESOURCES
Developed Land
Fountaingrass
Koa Haole/Fountaingrass
Sparsely Vegetated Lava Flow
Kiawe/Mixed Trees/Christmas Berry
Listed or Candidate Plants U.S. Fish and Wildlife Service Endangered List
NOTE: Capparis sandwichiana not shown (see text)
CULTURAL RESOURCES
Archaeological Site or Feature
Trail
Wall
Keahole–Kailua 69 kV Transmission Line Project
Hawaii Electric Light Company, Inc.
GEOLOGICAL, BIOLOGICAL AND CULTURAL RESOURCES
0 600 1200 1800 2400 3000 FEET
0 1/8 1/4 1/2 MILE
FIGURE 5-5

Vegetation. The project area consists mostly of privately owned urban or undeveloped land (see Figure 5-1). Biological surveys conducted in and near the project area reveal that it has both non-native and native plant species (see Figure 5-5). The land between the Keahole and Kailua Substations within the project area is largely dominated by non-native vegetation. Non-native fountain grass (*Pennisteum setaceum*) and koa haole (*Leucaena leucocephale*) occur extensively throughout the project area, while the southern portion is dominated by non-native tree species, including kiawe (*Prosopos pallida*), monkeypod (*Samanea saman*), Christmas berry (*Schinus terebinthifolius*), opiuma (*Pithecellobium dulce*), and kukui (*Aleurites moluccana*). Keahole Agricultural Park is located in the northern section of the project area mauka of Queen Kaahumanu Highway, where several nursery plants are grown. Ornamental and landscaped species characterize the vegetation along both sides of Queen Kaahumanu Highway in commercial and industrial areas. Native species persist throughout the areas dominated by non-native plants, including a candidate for federal listing: *Capparis sandwichiana*, a bush that grows on sparsely vegetated lava flows scattered throughout the project area.

Lava tubes in Hawaii may support significant native subterranean ecosystems, including candidate endangered invertebrates. A preliminary aerial survey was conducted to identify areas where there may be extensive lava tubes. Figure 5-5 shows that there may be extensive lava tubes in five areas of the study area. Many, but not all, of the lava tubes sighted during the aerial survey were field checked for their potential significance. Smaller and discontinuous lava tubes were also discovered but not mapped. A field survey of the S-1 mauka corridor area identified one lava tube system that was not field checked; it appears to pass underneath Queen Kaahumanu Highway near Kaiminani Drive.

Two small areas of predominantly native vegetation were found within one-half to 1 mile mauka of the project area, within the Kealakehe ahupuaa and the Kaloko-Honokohau aa flow. These areas support two native natural communities: ohia (*Metrosideros polymorpha*) lowland dry forest and aalii (*Dodonaea viscosa*) lowland dry shrubland. Together, both communities support nine native Hawaiian plants, including one federally listed endangered tree (uhiuhi [*Caesalpimia kavaiensis*]), three taxa proposed for endangered status (aupaka [*Isodendrion pyrifolium*], *Mariscus fauriei*, and aiea [*Nothocestrum breviflorum*]), and five candidates for endangered or threatened status (kokoolau [*Bidens micrantha*], pua pilo or maiapilo [*Capparis sandwichiana*], *Fimbristylis hawaiiensis*, maaloa [*Nerudua ovata*], and halapepe [*Pleomele hawaiiensis*]).

Wildlife. When humans established themselves on the islands, the wildlife habitat was modified through the introduction of numerous non-native animal species. In time, the non-native species dominated the habitat previously supporting the native species, with many of the original native species becoming extinct. Some of the remaining endemic species are now considered in danger of extinction. The project area supports populations of both native and non-native vertebrates and invertebrates.

The federally listed endangered native Hawaiian hoary bat, or opeapea (*Lasiurus cinereus semotus*), was not detected during a project field survey, but it has been previously detected in two nearby locations. In 1992, one to four bats were sighted flying over Aimakapa Fish Pond and Kailua Bay (R. David, personal communication, October 28, 1992), and in 1991, one bat was sighted at the Kona Inn Restaurant in Kailua (M. Fulton, personal communication, October 28, 1992). It is thought that the bats live in more forested areas mauka of Queen Kaahumanu Highway and feed on insects along the coast.

The kolea, or Pacific golden plover (*Pluvialis fulva*), and the pueo, or short-eared owl (*Asio flammeus sandwichensis*), two native vertebrates, were detected near the project area during the field survey. Neither are proposed as candidates for federal status. Kolea were detected once between Queen Kaahumanu Highway and the Mamalahoa Trail in the Kohanaiki land section and once near the Kealakehe Landfill, approximately one-half mile mauka of the project area. One pueo was detected approximately one-half mile mauka of the Keahole Generating Station near the existing 69 kV power line.

Approximately 11 native invertebrates were detected during the field survey in or near the project area. These invertebrates included flies, cinch bugs, bees, moths, and dragonflies; none are proposed candidates for endangered status.

Several non-native vertebrates were detected in or near the project area. These included eight taxa of game birds, all used for recreational hunting purposes; 12 types of passerines (songbirds); small mammals, such as rodents, the Indian mongoose, and feral cats; and feral goats. Approximately 70 species of non-native invertebrates were found in the project area. They included cockroaches, beetles, flies, bees, wasps, ants, butterflies, moths, mantids, dragonflies, grasshoppers, crickets, and katydids.

Probable Impacts

S-1 Mauka Overhead Alternative

Geological Resources. No geotechnical concerns were identified that would make the S-1 mauka alignment unsuitable for a new transmission line. Both aa and pahoehoe lava can adequately support pier foundation; however, pahoehoe lava may contain cavities that require excavation, backfilling, and compaction to support loads. Although there appears to be a substantial lava tube system transecting the project area near Kaiminani Drive, it is very unlikely that the lava tube system would be disturbed because the new poles will be placed very close to the existing, previously disturbed foundations. Because poles are placed approximately 300 to 500 feet apart from each other, it is fairly easy to locate poles far enough away from a lava tube to avoid impact.

The project area has a moderate potential for volcanic hazard because of lava flows (it has been designated Zone 4); however, U.S. Geological Survey personnel at the Hawaii Volcano Observatory indicated that the prediction of lava flow paths is unreliable at best, and that lava flow potential should not be a consideration for transmission line siting in the North

Kona district. The project area has a low hazard potential for tephra impacts and negligible potential for ground fractures and subsidence. Erosion is not a significant problem in the thin soils of the area because of the soil's high permeability and low runoff potential in the arid climate. Because the closest groundwater is approximately 100 feet below the ground surface, the probability of the lens being penetrated by means of foundation excavations is remote.

Overall, the project should create no new geological hazards and will have negligible impacts on geological and groundwater resources.

Biological Resources. There should be no significant impacts on biological resources from either the construction or operation of the proposed transmission line in the S-1 mauka overhead alternative. No listed endangered or proposed candidate species or habitat for such species have been identified within the corridor. Also, the Bishop Museum did not identify any lava tube or pressure ridge openings in the project area that may have biological resource elements of concern.

Pua pilo (also known as maiapilo, *Capparis sandwichiana*) is a candidate taxon for which there is some evidence of vulnerability, but for which there are not enough data to support proposals to list it as an endangered or threatened species. It is relatively abundant throughout the study area. Depending on the location of individual poles, individual pua pilo shrubs and other, non-native grasses and trees may need to be removed during the construction of pole foundations. The potential impact to this plant species is likely to be insignificant.

This alternative should not adversely affect the federally listed endangered Hawaiian hoary bat. No bats have been sighted within the project study area, and the area appears not to be optimal habitat for the species. Although the species is mobile and probably flies through the project area to feed at the coast, the fact that the bat has been sighted in developed areas at Kailua indicates that the bat can tolerate areas that have transmission lines.

S-1 Mauka Underground Alternative

Geological Resources. Construction of the underground cable alternative may require excavating a 4-foot-wide by 8-foot-deep trench along the entire length of the alignment. Most of this excavating would be through aa and pahoehoe lava flows. A continuous trench for the transmission line may impact the lava tube system that appears to go under the highway near Kaiminani Drive. Further investigations would be required to determine the depth of the tube below the surface, to know if it would be affected by a trench. Although the costs and difficulties of excavation would be greater for this alternative than for the overhead alternative, no adverse impacts to geological or groundwater resources would be likely.

Biological Resources. The potential for impacts to biological resources would be higher for the underground than for the overhead alternative because of the greater amount of soil disturbance. However, overall construction impacts should be minimal because much of the alignment has been disturbed previously by the construction of the existing 69 kV transmission line. The continuous trench required for this alternative could lead to the removal of individual plants of the pua pilo (or maiapilo) shrub; however, the number of plants removed would be small, and there would be no significant long-term adverse impacts to the population of shrubs in the project area.

Mitigation

S-1 Mauka Overhead Alternative

Geological Resources. In areas of pahoehoe lava, cavities should be checked by probing individual footing locations. Large cavities should be excavated, backfilled, and compacted, if possible. If a foundation is to be installed in an area where a thin aa flow overlies pahoehoe, the geotechnical aspects of the underlying pahoehoe should be investigated.

Biological Resources. A field check will be scheduled for the lava tube that appears to be near Kaiminani Drive to determine if it is a substantial system and if it is located beneath Queen Kaahumanu Highway, as suggested by the biologist's report. If results show the presence of a lava tube system, a biologist will be hired to design appropriate mitigation measures and to attend preconstruction meetings with site engineers to ensure that lava tube impacts will be avoided. Individual pole locations should be surveyed by a biologist familiar with the resources of the area so that the native pua pilo shrub can be avoided. The biologist should also be present at preconstruction meetings with site engineers, in order to help identify pua pilo shrubs and to clarify any biological resource issues or questions. To the maximum extent possible, the construction site should be accessed from Queen Kaahumanu Highway, and any construction staging or pole assembly areas should use existing disturbed areas. To minimize ground disturbance during construction, helicopter-assisted stringing of conductors and the use of low-impact directed charges for excavating holes should be considered.

S-1 Mauka Underground Alternative

Geological Resources. Large cavities in pahoehoe lava may need to be excavated, backfilled, and compacted in order to provide a firm bed for the underground cable.

Biological Resources. Mitigation measures for the underground alternative would be comparable to those suggested for the overhead alternative; however, because of the greater ground disturbance involved, more time and care would be required for preconstruction surveys to identify an alignment that would minimize impacts to lava tubes and the pua pilo (or maiapilo) shrub.

Cultural and Historic Resources

Environmental Setting

Paul H. Rosendahl, Ph.D., Inc. (PHRI), conducted archaeological studies that identified and mapped areas of archaeological sensitivity within the region and within the proposed alignment. Specific sites of archaeological significance within the preferred corridor were identified. The objective of the studies was to satisfy possible regulatory review requirements of the Hawaii County Planning Department and the State Historic Preservation Division of the Department of Land and Natural Resources (DLNR–SHPD). The information and analysis presented in this section is based on these studies; the complete studies are provided in Appendixes E and F. Figure 5-5 shows archaeological site locations for the area between and within the preferred corridors.

Previous archaeological research conducted in the project area includes field inspections, inventory surveys, and mitigation projects; these are listed in Appendixes E and F.

National Register, Historic District, and National Historic Sites

The Historic Preservation Division of the Hawaii Department of Land and Natural Resources (Ross Cordy, personal communication, January 22, 1993) provided the following information regarding state and nationally designated historic sites and districts within or near the Keahole-Kailua project area.

The Kaloko-Honokohau National Historic Park extends from makai of Queen Kaahumanu Highway to the ocean in the Kaloko and Honokohau ahupuaa and portions of the Kealakehe ahupuaa. The park is a national historic landmark and is listed on the National Register of Historic Places.

The southern extent of the project area is within one-quarter mile of the northern extent of the Kona Field System, a National Register district. The Kona Field System is an area of prehistoric agricultural fields with associated houses, burial sites, religious structures, and trails. The National Register of Historic Places shows that the shape of the Kona Field System approximates a rectangle, with its northern extent at the intersection of Mamalahoa Highway and Palani Road and its southern extent near Hookena. Generally, the 200-foot elevation marks its makai boundary, and the 2,000-foot elevation marks the mauka boundary. According to DLNR–SHPD, the Kona Field System district has proven to be much larger, extending north to the Huehue Ranch. However, no part of the project area is within the current or proposed future boundary of the Kona Field System. A list of the sites and districts that are on the Hawaii and National Registers of Historic Places in the regional study area is shown in Table 5-1.

Table 5-1
Sites and Districts Listed on the Hawaii and National Registers of Historic Places

Site/District	Description	Status
Kamakahonu (Site 7002)	Residence of Kamehameha I, Lanihau ahupuaa (grounds of former King Kamehameha Hotel)	National Historic Landmark; National Register
Great Wall of Kuakini (Site 6302 and 7276)	Large wall extending behind Kailua	National Register
Site 2001	Lanihau papamu	Hawaii Register
Site 2002	House, Lanihau ahupuaa	Hawaii Register
Site 1896	Haleokane Heiau, Kealakehe ahupuaa	Hawaii Register
Site 4138	Kaloko-Honokohau National Historic Park (Honokohau Settlement), Kaloko and Honokau ahupuaa and parts of Kealakehe	National Historic Landmark, National Register
Site 1918	Wawaloi habitation, Ooma 1 ahupuaa	Hawaii Register
Site 10,205	Kalaoa Permanent House Site 10,205; Kalaoa ahupuaa	National and Hawaii Register
Site 1897	Habitation site	Hawaii Register
Site 1917	Shelter and pen, Ooma 1 ahupuaa	Hawaii Register
Site 1920	Habitation cluster	Hawaii Register
Site 6601	Kona Field System; multiple ahupuaa; district of prehistoric agricultural fields with associated houses, burials sites, religious structures, and trails	National Register

Cultural Resource Potential of Surveyed and Unsurveyed Areas

The archaeological studies conducted for this project identified areas of high, medium, or low cultural resource potential within the overall study area. The study identified a close correlation between the presence of cultural resources and the "environmental zone" of the area. Three environmental zones were identified for the study area: coastal, transitional, and upland. The coastal zone and the makai portion of the transitional zone extending 1,500 to 2,000 feet inland from shore were considered as having high sensitivity based on the high density of sensitive and significant cultural remains documented by numerous surveys. Prehistoric sites or features considered to be of high sensitivity include trails, burial sites, refuge caves, fish ponds, and petroglyphs. Historic period sites and features include burial sites, trails, and petroglyphs. The upper portion of the transitional zone and the entire upland zone were considered areas of moderate sensitivity, based on the low site density and the low overall probability that these areas would contain clusters of significant sites or features. Areas considered to be of low sensitivity include the recent lava flows from Mauna Loa and Mt. Hualalai, which would have destroyed any evidence of cultural use in the area.

Inventory

The Hawaii and National Registers of Historic Places protect resources after they have been listed. The presence of existing cultural and historic sites that may be significant and have not yet been listed is of critical importance when planning projects of this nature. Most of the sites in the preferred corridor are not listed on the state and national registers but may eventually be considered for inclusion on the Hawaii Register of Historic Places. These sites are discussed below.

The northern portion of the project area (from Kalaoa 1-4 to the northern boundary of Kealakehe) lies in an area that has been termed the "barren zone," which appears to have offered few resources to either prehistoric or historic inhabitants. For the most part, this area has not undergone inventory level surveys. In the northern project area there are two cave sites that have not been assessed: one in the Kalaoa 1-4 ahupuaa adjacent to the makai edge of Queen Kaahumanu Highway and one in the Ooma 2 ahupuaa along the mauka edge of Queen Kaahumanu Highway. Inventory level surveys were conducted on the Keahole Generating Station property (Paul H. Rosendahl, Ph.D., Inc., August 1992). Feature types were limited to pahoehoe excavations that were interpreted as quarry areas and were assessed as not significant using the standards for eligibility for state or national register designation.

In the southern portion of the project area, inventory-level surveys have been conducted and sites have been identified and assessed. There are two sites close to the mauka edge of Queen Kaahumanu Highway within the Kealakehe ahupuaa. One contains two historic cairns and is not considered significant, according to State of Hawaii or national register criteria. The other is a burial complex (Site 13253) that is considered significant according to the federal and state criteria; this site is recommended for preservation "as is." A burial site has been identified in the Honokohau 1-2 ahupuaa along the mauka edge of Queen Kaahumanu Highway but has not been assessed for its eligibility for the Hawaii or National Registers of Historic Places. Within the Keahuolu land section, an agricultural terrace (Site 13312) and an area containing peck marks (Site 13313) have been previously assessed as not significant and do not require further work. Another agricultural terrace (Site 13334) has been recommended for further work to determine its significance. As indicated above, portions of the Mamalahoa Trail are located near Queen Kaahumanu Highway in the Honokohau 1-2, Kealakehe, and Keahuolu ahupuaa.

Fieldwork for Phase I of a phased archaeological inventory survey was conducted by PHRI in February 1993 along the proposed alignment (Paul H. Rosendahl, Ph.D., Inc., March 1993) (See Appendix F). The area subjected to Phase I of the phased archaeological inventory survey included the relatively undisturbed area between the mauka edge of the pavement of Queen Kaahumanu Highway and the mauka edge of the highway right-of-way, where the existing transmission lines are now located. The purpose of the Phase I work was to provide inventory-level information sufficient for assessing the general significance of the archaeological resources present and for making recommendations of appropriate mitigation measures if an overhead or underground transmission line were constructed in the proposed alignment.

Twenty-five sites were identified during the Phase I work, and 60 component features were identified among those 25 sites. Within the previously unsurveyed areas, 22 sites and 34 component features were identified. Nearly 70 percent of the identified features were interpreted as agricultural but are unlikely to have been central components of an agricultural field system. Because of the limited size of the surveyed area, it is nearly certain that all major cultural sites within the proposed alignment have been located as a result of this Phase I work.

Twenty-three of the 25 sites identified were assessed as significant solely for information content; 21 of these 23 sites were recommended for further data collection only. The two remaining sites, Site 13194 (a trail in the Kealakehe ahupuaa) and Site 13195 (a historic *ahu*, a cairn marker in the Kealakehe ahupuaa) have been documented to the extent that no further work is recommended. The two final sites, Site 00002 (Old Mamalahoa Trail) and Site 15324 (a trail in the Kohanaiki ahupuaa), have been recommended for further data collection and for preservation "as is."

Probable Impacts

S-1 Mauka Overhead Alternative

Overall, the impacts on cultural resources from an overhead line in this alignment would be low because the existing transmission alignment would be followed. The new line could be constructed and maintained from Queen Kaahumanu Highway, and new access roads would probably not have to be constructed. Identified cultural sites may be avoided by carefully locating the individual pole sites and the construction staging areas.

The southern portion of the alignment (in the Honokohau 1-2, Kealakehe, and Keahuolu ahupuaa) has been thoroughly inventoried, and the likelihood of encountering previously unidentified cultural sites is low. However, the Mamalahoa Trail is located adjacent to and under Queen Kaahumanu Highway in portions of this area.

The northern two-thirds of the alignment (in the Kalaoa 1-4, Kalaoa-Ooma, Ooma 2, Kohanaiki, Kaloko, and Honokohau 1-2 ahupuaa) are part of what archaeologists have named the "barren zone." Thorough inventory surveys have not been conducted in this "barren zone," except for the Phase I work done by PHRI in February 1993. If the poles of the proposed line are located adjacent to the existing transmission poles on the makai side (i.e., the highway side) of the existing poles, the potential for impacts to unidentified cultural resources should be minimal. However, the trail in the Kohanaiki ahupuaa (Site 15324) is located mauka of Queen Kaahumanu Highway.

S-1 Mauka Underground Alternative

Because of the far greater ground disturbance required for the excavation of an underground transmission line, the potential for impacts to surface cultural resources is higher for an underground transmission line than for an overhead transmission line.

Mitigation

S-1 Mauka Overhead Alternative

In order to meet current DLNR–SHPD and Hawaii County Planning Department requirements, it is recommended that individual pole locations and areas where construction activities may occur should be reviewed by an archaeologist before work begins to ensure that impacts to Mamalahoa Trail, the trail in the Kohanaiki ahupuaa, and other identified cultural sites and features are avoided. In the Kalaoa 1-4, Kalaoa-Ooma, Ooma 2, Kohanaiki, Kaloko, and Honokohau 1-2 ahupuaa, the focus of the review should be on identifying Site 15324, the trail in the Kohanaiki ahupuaa. In the Honokohau 1-2, Kealakehe, and Keahuolu ahupuaa, the focus of the review should be on identifying remnants of the Mamalahoa Trail. Construction activities that may affect these two trails and identified cultural sites and features, including such activities as the building or modification of an access road, should be monitored by a qualified archaeologist.

S-1 Mauka Underground Alternative

Because of the more extensive ground disturbance required for an underground alternative, if this alternative is selected, a thorough field survey should be conducted of the entire underground alignment. In addition, an archaeologist should be present during excavation to identify and evaluate any buried cultural resources that are found.

Transportation Facilities and Traffic

Environmental Setting

Existing Regional Transportation Facilities

Queen Kaahumanu Highway is the primary arterial in the project area. Currently, it is a two-lane, two-way undivided state highway between Kawaihae, north of the project area, and Kailua Village. Queen Kaahumanu Highway is currently unsignalized at its intersections with Keahole Airport Road and Kaiminani Drive. The intersection of Queen Kaahumanu Highway at Palani Road in Kailua Village is signalized. The posted speed limit on Queen Kaahumanu Highway along most of its length ranges from 35 to 55 miles per hour.

Mamalahoa Highway is an older, secondary arterial highway serving the project area and is located mauka of Queen Kaahumanu Highway. Mamalahoa Highway branches into two separate arterials at Palani Junction: Mamalahoa Highway continues south in the upland portion of the project area while Palani Road eventually intersects Queen Kaahumanu Highway in Kailua Village. The only other existing connection between Queen Kaahumanu and Mamalahoa Highways in the project area is Kaiminani Drive, a residential collector roadway located about 2,500 feet south of Keahole Airport.

Access to Keahole Switching Station and Keahole Generating Station is provided by a two-lane collector roadway near the intersection of Keahole Airport Road and Queen Kaahumanu Highway. Access to Kailua Substation is from Kaiwi Street, a two-lane collector in Kailua that extends makai from Queen Kaahumanu Highway to the shoreline.

Proposed Transportation Facilities

The Hawaii Department of Transportation currently is in the process of preparing a master plan for Queen Kaahumanu Highway. This two-lane highway is proposed to be widened to a four-lane divided freeway between Kailua and Kawaihae. An interchange is proposed for Keahole Airport Access Road, north of the existing access. A second interchange is proposed at the intersection of Queen Kaahumanu Highway and Kealakehe Parkway. A series of two-lane frontage roads would also be provided both makai and mauka of Queen Kaahumanu Highway to provide access between properties fronting this highway and adjacent interchanges. The Hawaii Department of Transportation is also examining new right-of-way alignments along Queen Kaahumanu Highway. However, plans for future improvements have not been finalized at this time. HELCO will coordinate design of its 69 kV transmission line project with state agencies to minimize conflicts with proposed transportation improvements along Queen Kaahumanu Highway.

When completed, Kealakehe Parkway and the road through Kaloko Industrial Park will provide two additional mauka-makai roadways between Queen Kaahumanu and Mamalahoa Highways. These two roadways are located south of Kaiminani Drive and are expected to divert through traffic on Kaiminani Drive between the mauka and makai areas of North Kona.

The county's *Keahole to Kailua Development Plan* indicates that one minor arterial, referred to as the "Mid-Level Arterial," and two collectors, Waena Drive and Kealakaa Street, are proposed to be located parallel to and mauka of Queen Kaahumanu Highway.

Traffic Conditions

About 6.8 miles of Queen Kaahumanu Highway pass through the study area from Keahole Switching Station to Kailua Substation. Table 5-2 lists 24-hour and morning and evening peak 1-hour traffic volumes recorded in 1992 for segments of Queen Kaahumanu Highway in the study area. This table shows that the heaviest traffic volumes occurred in the segment of Queen Kaahumanu Highway between Kealakehe Parkway and Palani Road. The average 24-hour volume for this segment was 19,335 vehicles.

Probable Impacts

S-1 Mauka Overhead Alternative

Because the new transmission line would principally follow the existing highway right-of-way, construction activities would temporarily disrupt traffic in some locations along Queen Kaahumanu Highway. Work on public roads must follow traffic control procedures prescribed by the Federal Highway Administration and the Highways Division of the Hawaii Department of Transportation. Work adjacent to Queen Kaahumanu Highway requires a Permit to Perform Work on State Highways. HELCO will prepare and submit a Traffic Control Plan to be approved by the Hawaii Department of Transportation Highways Division as part of this Permit to Perform Work.

According to state highway regulations, lanes of adequate width in both directions must be provided on a two-lane highway such as Queen Kaahumanu Highway. All lanes must remain open to traffic during the morning and afternoon peak hours, generally defined as between 6:00 to 8:30 a.m. and 3:00 to 6:00 p.m., respectively. All work that requires temporary lane closure or coning off a lane of traffic will occur during off-peak traffic hours. To the extent feasible, work on the transmission line will be scheduled to maximize the use of non-peak traffic periods, including weekends, nights, and other periods when traffic disruption can be minimized. Construction activities will be restricted to periods when noise impacts do not interfere with nearby sensitive receptors. Finally, construction workers and contractors shall comply with state laws and regulations regarding vehicle safety, including marking, signing, flagging, and lighting.

Table 5-2
24-Hour and Morning and Evening Peak-Hour Traffic Volumes, Queen Kaahumanu Highway, 1992

	Keahole Airport Road to 3.5 Miles North of Kealakehe Parkway	3.5 Miles North of Kealakehe Parkway to Kealekehe Parkway	Kealakehe Parkway to Palani Road
24-Hour Volume	12,235	13,683	19,335
Morning Peak 1-Hour	809	948	1,334
Northbound	256	422	826
Southbound	553	526	508
Evening Peak 1-Hour	990	1,153	1,664
Northbound	234	447	611
Southbound	756	706	1,053

Source: State of Hawaii Department of Transportation, Highways Division, 1992.

Temporary traffic impacts on roads and highways in the project area would result during project construction. Construction crews would use Queen Kaahumanu Highway and adjacent existing roadways to access all segments of the S-1 mauka overhead alignment. Part of the road surface, in addition to the shoulder, may also be used to temporarily store equipment used in installing foundations, poles, and conductors.

If new poles are installed in the same alignment as existing poles, a safe distance must be maintained between the existing conductors of the existing poles and the crews installing the new poles and lines. This safe separation distance can be created by slightly tilting the original existing poles. With a safe separation distance established, the new poles can be installed in the same alignment while the conductors on the original existing poles remain energized.

The first construction activity that may require coning off a lane of traffic will be the tilting and bracing of existing wood poles. About three poles can be tilted and braced per day; this activity will last approximately 6 to 8 weeks. Next, additional drilling will be required or new pier foundations will be constructed to accommodate new poles. Typically, several pier foundations can be drilled at one time over a distance of about 1,000 to 1,500 feet. If the poles are located adjacent to a roadway, foundation installation requires coning off a single lane of traffic. Foundation installation would last for up to 6 months. Pole installation will require coning off a lane of traffic for sections approximately 700 to 1,300 feet long at a time. Typically, two to four poles can be installed per day. For the Keahole-Kailua transmission line, this process would require from 2 to 5 months to complete. Conductor installation is performed in sections of 1- to 2-mile intervals. In pole locations adjacent to roadways, one lane may be closed to traffic during conductor installation operations. Approximately 2 weeks is required to complete each mile of conductor installation. Conductor installation can take from 3 to 4 months to complete. Construction may be performed in a staggered manner; the entire construction process for the S-1 mauka overhead alternative is anticipated to last about 8 months. After the new poles and conductors are installed in the same alignment as the original poles, cleanup work will include removing the conductors from the original poles, transferring telephone and television cables to the new poles, removing the original poles, and backfilling the pole holes. The transfer of the telephone and television cables would be done by the utility companies responsible for those lines. Cleanup activities would last at least 6 to 8 weeks, depending on the coordination with the telephone and television cable companies.

Traffic disruption will also occur in the area near Kaiwi Street where traffic volumes are heavier than along other segments of Queen Kaahumanu Highway.

Depending on the timing of proposed traffic improvements, construction of the S-1 mauka overhead alternative could also contribute to traffic disruption caused during construction of future interchanges and additional lanes along Queen Kaahumanu Highway.

Semiannual routine maintenance typically consists of drive-by inspections. More thorough inspections are performed once every five years. These inspections may require coning off a lane of traffic for a few hundred yards near the pole being inspected. Typically, one pole is inspected per day.

S-1 Mauka Underground Alternative

This alternative would require the installation of approximately 6.8 miles of underground cable; construction would take up to 24 months to complete. Construction-related impacts on transportation facilities and traffic would be similar to those described for the overhead alternative; however, traffic would be disrupted over a longer period of time because of the need to trench and install the underground cable. Although underground cable systems have good reliability records, as described above, when outages do occur, locating the fault and completing repairs can take substantially more time than is the case with an overhead line. Therefore, any required repairs would involve longer periods of traffic interruptions than the overhead alternative would.

Mitigation

Because Hawaii Department of Transportation regulations prescribe how construction projects must be carried out in order to reduce traffic impacts to acceptable levels, no additional mitigation would be required for either the overhead or underground alternative.

Electric and Magnetic Fields

Environmental Setting

High-voltage transmission or bulk power lines form the backbone of the electric energy distribution system. A network of about 338,000 circuit miles of transmission lines is in service in the United States. On Hawaii, more than 500 miles of 69 kV lines form the island's transmission system. The proposed Keahole-Kailua line will be operated at 69 kV, the second-highest voltage classification used in Hawaii. The 69 kV voltage is, however, in the lowest voltage classification of transmission lines in operation in the mainland United States, where lines range up to 765 kV.

Electric Fields

Electric fields are a result of the voltage or electric potential on an object. Any object with an electric charge on it has a voltage at its surface caused by the accumulation of more electrons on that surface compared with another object or surface. The voltage effect is not limited to the surface but exists in the space surrounding the object. The change in voltage over distance is known as the electric field. The units describing an electric field are volts per meter (V/m) or kilovolts per meter (kV/m). The electric field is stronger near a charged object and decreases rapidly with distance from the object.

Electric fields are a common phenomenon. Static electric fields can result from taking off a sweater or walking across a carpet. Most household appliances and other devices that operate on electricity create electric fields. The electric field is a result of the voltage on the appliance, and the field decreases rapidly with distance. The fields that result from point-source household appliances generally decrease more rapidly with distance than fields from line sources such as power lines. Appliances need not be in operation to create an electric field; an electric field occurs whenever an appliance is connected to an electrical outlet. Typical values measured at 12 inches from some common appliances are shown in Table 5-3.

Table 5-3 Typical Electric Field Values for Household Appliances (at 12 inches)	
Appliance	Electric Field (kilovolts/meter)
Electric blanket	0.25*
Broiler	0.13
Stereo	0.09
Refrigerator	0.06
Iron	0.06
Hand mixer	0.05
Phonograph	0.04
Coffee pot	0.03

*1 to 10 kV/m next to blanket wires (Enertech Consultants, 1985).
Source: Carstensen, 1985.

Magnetic Fields

An electric current flowing in any conductor (such as electric equipment or household appliances) creates a magnetic field. The most commonly used unit for measuring magnetic fields is the Gauss, which is a measure of the magnetic flux density (intensity of magnetic field attraction per unit area). The unit mG (or milliGauss) is equal to one-thousandth of a Gauss.

The magnetic field under transmission lines is relatively low compared with the magnetic fields near many household appliances and other equipment. The magnetic fields of a large number of typical household appliances were recently measured by the Illinois Institute of Technology Research Institute (IITRI) for the U.S. Navy (Gauger, 1985) and by Enertech Consultants (Silva, 1988) for the Electric Power Research Institute (EPRI). Typical values of magnetic fields associated with household appliances are shown in Table 5-4.

Magnetic field measurements were made in January 1990 at several public locations on the island of Hawaii to characterize everyday magnetic field levels. These measurements were made using an EMDEX II magnetic field meter. This meter can be worn at the waist; the meter automatically records data every 1.5 seconds and stores the results for readout to a personal computer. The measurement results are summarized in Table 5-5.

Table 5-4 **Typical Magnetic Field Values for Household Appliances**		
Appliance	**Magnetic Field (mG)**	
	At 12 Inches	**Maximum**
Electric range	3-30	100-1,200
Electric oven	2-5	10-50
Garbage disposal	10-20	850-1,250
Refrigerator	0.3-3	4-15
Clothes washer	2-30	10-400
Clothes dryer	1-3	3-80
Coffee maker	0.8-1	15-250
Toaster	0.6-8	70-150
Crock pot	0.8-1	15-80
Iron	1-3	90-300
Can opener	35-250	10,000-20,000
Mixer	6-100	500-7,000
Blender, popper, processor	6-20	250-1,050
Vacuum cleaner	20-200	2,000-8,000
Portable heater	1-40	100-1,100
Fans/blowers	0.4-40	20-300
Hair dryer	1-70	60-20,000
Electric shaver	1-100	15-15,000
Color television	9-20	150-500
Fluorescent fixture	2-40	140-2,000
Fluorescent desk lamp	6-20	400-3,500
Circular saw	10-250	2,000-10,000
Electric drill	25-35	4,000-8,000
Source: Gauger, 1985.		

Table 5-5 Summary of Everyday Magnetic Field Levels	
Location	**Magnetic Field (mG)**
Hilo: McDonald's Restaurant	1-32
Post Office	0.5-34
State Building	0.2-12
Sure Save Supermarket	0.2-57
Ben Franklin Department Store	0.5-70
J. C. Penney Department Store	0.2-5
7-11 Convenience Store	0.5-8
Liberty House Department Store	0.1-3
Tilt-Video Arcade	1-40
Kay-Bee Toy Store	0.5-28
Puna: Pahoa Post Office	0.3-10
Dairy Queen Restaurant	0.5-12
DA Store–Convenience Shop	0.5-5
Walking past stores on Highway No. 130	0.2-7

Probable Impacts

HELCO supplied a set of load currents, line design details (i.e., pole configurations), and phasing to prepare the electric and magnetic field calculations (see Appendix G, Figures 1 through 12) of the alternative alignments. The numerical values of these currents and the direction of flow are part of the assumptions supplied by HELCO. The currents were assumed to be balanced (i.e., numerically equal for both of the double-circuit lines) and in the same direction. Conditions differing from these assumptions (e.g., unequal loading of the circuits and/or opposite directions of power flow) would result in less cancellation from unlike phasing and, hence, higher fields. A system load flow study was conducted to validate these general assumptions and finalize the optimum phasing for reduced field levels. HELCO proposes to use optimum phasing.

Electric Field Levels

Electric field values were calculated for the existing pole configuration and the two proposed pole configurations. Figure 5-6 illustrates the typical pole configurations.

The calculated electric field values for the existing pole configuration and the two proposed pole configurations are shown in Table 5-6. The results are presented as electric field levels as a function of distance away from the lines on either side at midspan (i.e., the point at which the lines are nearest to the ground) (Figures G-1 through G-5 in Appendix G graphically illustrate the electric field levels).

Because two 69 kV circuits are to be installed on the same pole, some arrangements of conductors (i.e., "low-reactance phasing") can reduce electric field strengths because the interaction of the different opposite (or "unlike") phases can reduce electric field strengths. Figure 5-7 illustrates like and unlike phasing. Table 5-7 illustrates estimated electric field values for the power lines using low-reactance phasing. HELCO proposes using low-reactance phasing.

Magnetic Field Levels of Underground Cables

A conventional solid (or extruded) dielectric cable system (Figure 5-8) would be used for the underground alternative. This is the preferred underground alternative because it is the most commonly used cable type at the 69 kV system voltage level, and it is the lowest-cost option for underground alternatives. The placement of a neutral continuity conductor as shown in Figure 5-8 is standard construction practice for single-point grounded systems. A neutral continuity conductor would not be needed when the cables are in a metallic pipe because the pipe serves as the neutral continuity conductor (that is, it is multi-point grounded). Underground transmission cables do not create an electric field above the surface of the ground because the metallic sheath that surrounds each cable will be at zero or very low potential. The somewhat conductive earth and concrete around the cables further ensure that the cables do not produce an electric field aboveground. Therefore, additional electric field calculations were not necessary for the underground alternative, and only magnetic field levels were calculated.

The aboveground magnetic fields produced by solid (or extruded) dielectric cables installed in concrete-encased duct banks (as shown in Figure 5-8) are calculated in the same way as the magnetic field produced by the overhead lines because the soil and concrete have no effect on the magnetic field produced by the cables. In general, induced shield or sheath currents must be taken into account when calculating the magnetic fields produced by underground transmission cables. However, this additional calculation step is not necessary in this case because the cable system would have to be designed with single-point grounded or cross-bonded shields to obtain the required current rating.

The magnetic field levels presented in Table 5-8 were calculated as follows:

1. Assume normal loading and all circuits energized with balanced (i.e., positive sequence) phase currents, as follows:

   - Existing overhead line: Single-circuit 69 kV
     Single-circuit 12 kV underbuild

   - Proposed Configuration No. 1: Double-circuit, single-sided 69 kV low-reactance (unlike) phasing
     Single-circuit 12 kV underbuild

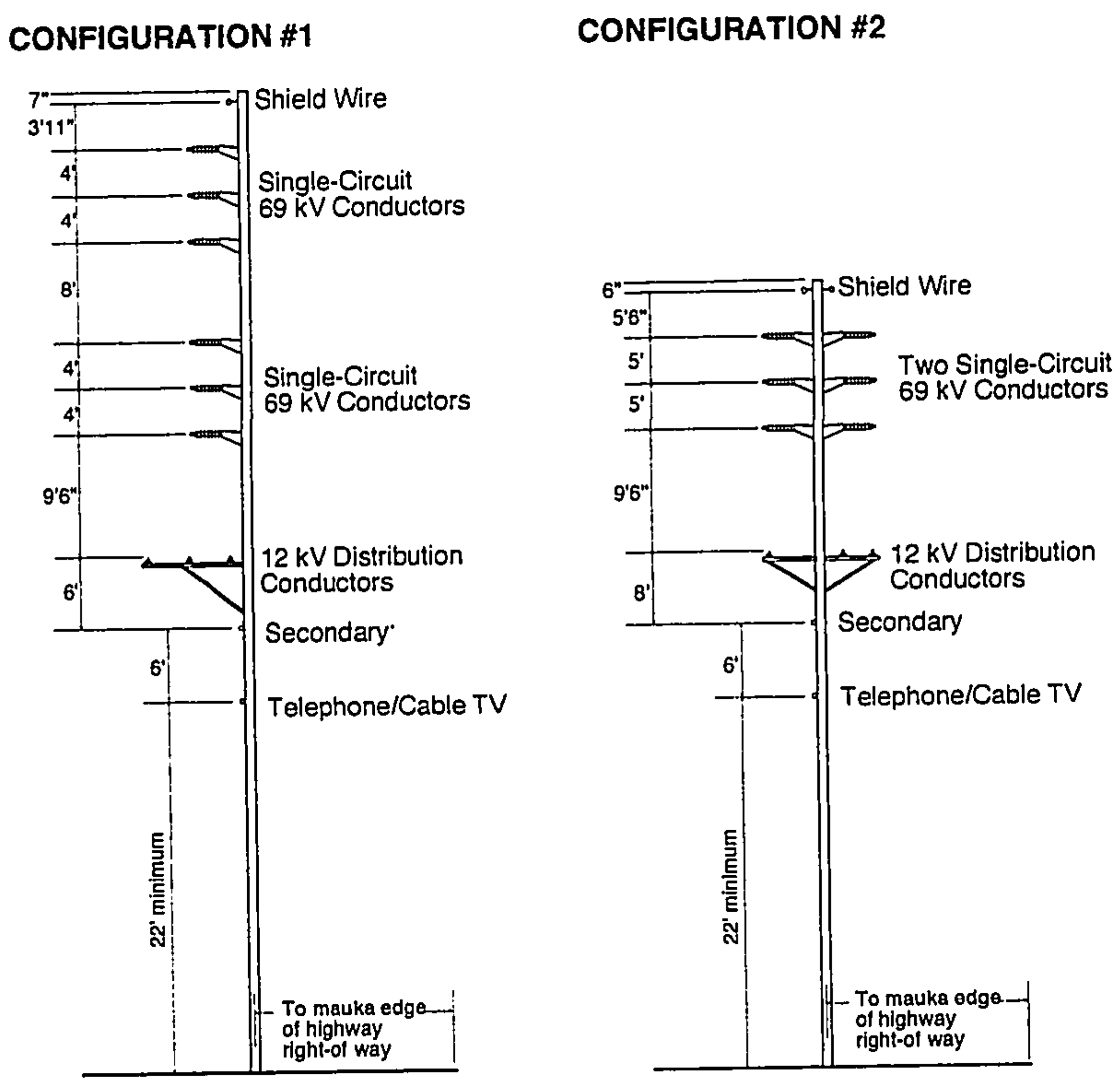
   - Proposed Configuration No. 2: Double-circuit, double-sided 69 kV low-reactance (unlike) phasing
     Single-circuit 12 kV underbuild

   - Proposed underground circuit with existing overhead line: Three single-conductor solid (or extruded) dielectric-type cables (with 8-inch vertical phase spacing) in PVC ducts
     Single-circuit 69 kV (existing overhead circuit)
     Single-circuit 12 kV underbuild (existing overhead circuit)

2. Calculate the maximum magnetic field (along the semi-major axis of the field ellipse) at 1 meter above ground at midspan for overhead lines (existing configuration, Configuration No. 1, and Configuration No. 2) and 1 meter above the ground for the existing configuration with underground circuits (cables are approximately 5 feet below the surface).

3. Use overhead line field values, as calculated.

In this analysis, the trench holding the underground cables was set 20 feet away from the pole. Qualitatively, the results demonstrate that, although underground cables will produce higher magnetic fields directly above them, the field attenuation is such that, at more than 50 feet away from the poles, the level will be equal to or below that for the existing overhead configuration. This finding is consistent with other information available on underground cables. These data are plotted as lateral comparison profiles for the underground alternative versus the existing overhead configurations in Figures G-12 and G-6 in Appendix G.



KEAHOLE-KAILUA TRANSMISSION LINE PROJECT

FIGURE 5-6

TYPICAL POLE CONFIGURATIONS

NOT TO SCALE

CH2M HILL

Table 5-6
Estimated Electric Field Levels for Typical Configurations
Normal (Like) Phasing

Typical Configurations	Electric Field (kV/m) — Distance from Center Line (feet): 0	10	20	30	40	50
Existing Overhead Line Configuration Single-circuit 69 kV Single-circuit 12 kV underbuild	0.103	0.164	0.140	0.078	0.030	0.016
Proposed Overhead Line Configuration No. 1 Double-circuit, single-sided 69 kV Single-circuit 12 kV underbuild	0.119	0.110	0.077	0.041	0.018	0.016
Proposed Overhead Line Configuration No. 2 Double-circuit, double-sided 69 kV Single-circuit 12 kV underbuild	0.229	0.223	0.153	0.074	0.029	0.030

Note: All values calculated for 1 meter above ground. Assumes equalization of currents in each of the three conductors in a circuit, with grounded shields and neutral conductors. Assumes that amperage of 69 kV circuit is 73 amperes, and amperage of 12 kV circuit is 5 amperes.
Source: Enertech Consultants

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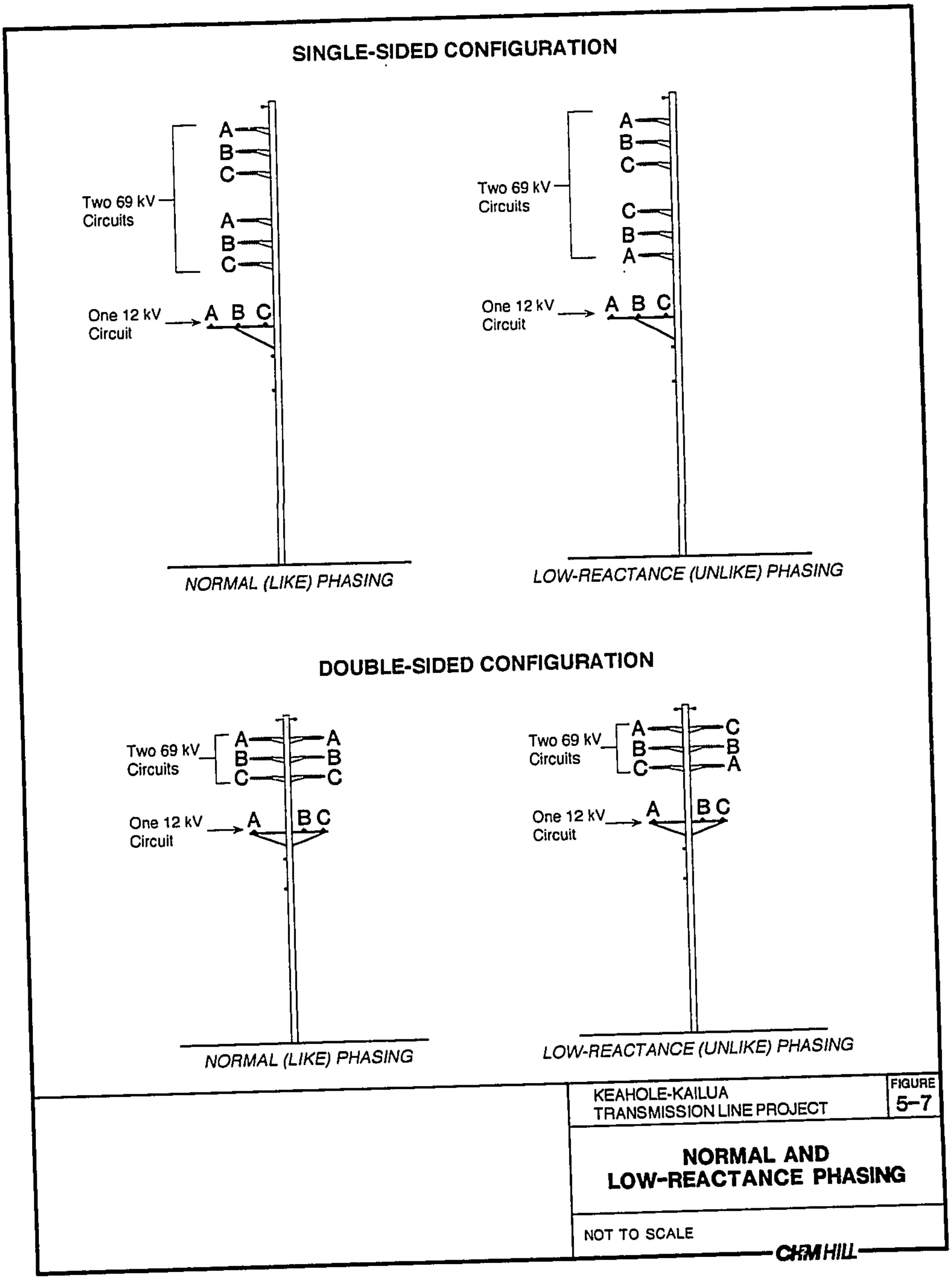
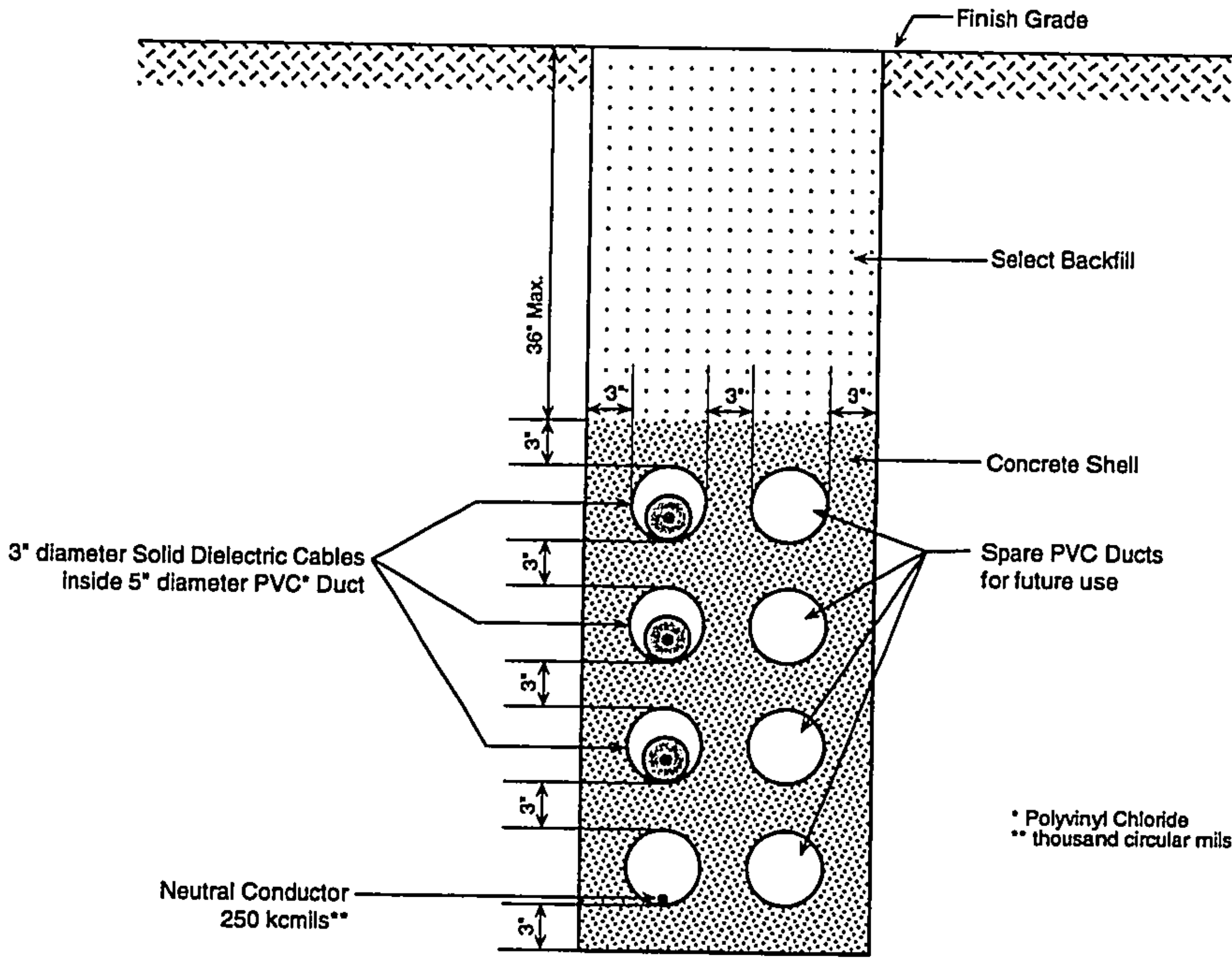

SINGLE-SIDED CONFIGURATION
Two 69 kV Circuits
A
B
C
A
B
C
One 12 kV Circuit
A B C
NORMAL (LIKE) PHASING
Two 69 kV Circuits
A
B
C
C
B
A
One 12 kV Circuit
A B C
LOW-REACTANCE (UNLIKE) PHASING
DOUBLE-SIDED CONFIGURATION
Two 69 kV Circuits
A A
B B
C C
One 12 kV Circuit
A B C
NORMAL (LIKE) PHASING
Two 69 kV Circuits
A C
B B
C A
One 12 kV Circuit
A B C
LOW-REACTANCE (UNLIKE) PHASING
KEAHOLE-KAILUA
TRANSMISSION LINE PROJECT
FIGURE
5-7
NORMAL AND
LOW-REACTANCE PHASING
NOT TO SCALE
CH2M HILL

Table 5-7
Estimated Electric Field Levels for Typical Configurations
Low-Reactance (Unlike) Phasing

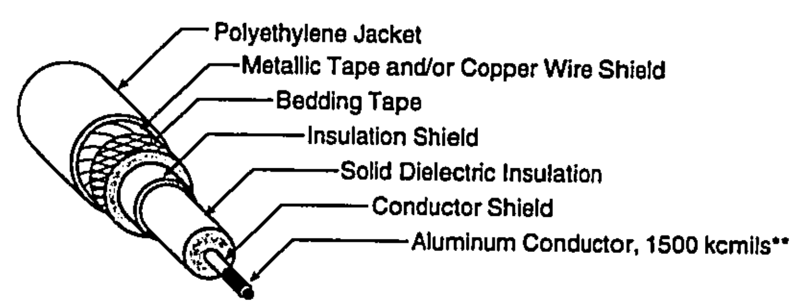
Typical Configurations	Electric Field (kV/m)					
	Distance from Center Line (feet)					
	0	10	20	30	40	50
Existing Overhead Line Configuration Single-circuit 69 kV Single-circuit 12 kV underbuild	0.103	0.164	0.140	0.078	0.030	0.016
Proposed Overhead Line Configuration No. 1 Double-circuit, single-sided 69 kV Single-circuit 12 kV underbuild	0.115	0.036	0.019	0.020	0.016	0.012
Proposed Overhead Line Configuration No. 2 Double-circuit, double-sided 69 kV Single-circuit 12 kV underbuild	0.082	0.075	0.064	0.044	0.028	0.022

Note: All values calculated for 1 meter above ground. Assumes equalization of currents in each of the three conductors in a circuit, with grounded shields and neutral conductors. Assumes that amperage of 69 kV circuit is 73 amperes, and amperage of 12 kV circuit is 5 amperes.
Source: Enertech Consultants

DUCT ENCASEMENT DETAIL



69 kV SOLID DIELECTRIC CABLE



KEAHOLE-KAILUA
TRANSMISSION LINE PROJECT

FIGURE
5-8

TYPICAL 69kV UNDERGROUND CABLE SYSTEM

NOT TO SCALE

CH2M HILL

Table 5-8
Comparison of Magnetic Field Levels
for Overhead Lines and Underground Cables

	Magnetic Field (mG)			
Location (Distance from Center Line of Pole) (ft)	Existing Overhead Line, Single-Circuit 69/12 kV[a]	Proposed Overhead Line, Configuration No. 1, Double-Circuit, Single-Sided 69/12 kV[b]	Proposed Overhead Line, Configuration No. 2, Double-Circuit, Double-Sided 69/12 kV[b]	Proposed Underground Three Single-Conductor 69 kV Cables in PVC Ducts with Existing Overhead Line[c]
-20	2.27	1.03	0.69	10.44
-10	2.89	1.24	0.91	5.89
0	3.40	1.29	1.01	2.81
10	3.43	1.14	0.93	2.62
20	2.95	0.92	0.73	2.42
30	2.32	0.72	0.52	2.01
40	1.76	0.57	0.36	1.58
50	1.34	0.45	0.25	1.23

Note: The values in this table assume summer peak load and equalization of currents in each of the three conductors in a circuit, with grounded shields and neutral conductors.

[a]Normal (like) phasing of conductors is assumed for the existing overhead line. Assumes 73 amperes for the overhead 69 kV circuit and 5 amperes for the overhead 12 kV underbuild.

[b]The proposed overhead line assumes low-reactance (unlike) phasing of the conductors. Assumes 73 amperes for each overhead 69 kV circuit and 5 amperes for the overhead 12 kV circuit underbuild.

[c]Underground three single-conductor 69 kV cables buried at -20 feet from existing pole, with single-point grounded cables, and with the assumption of no induced sheath currents. Assumes 73 amperes for the underground 69 kV circuit, 73 amperes for the overhead 69 kV circuit, and 5 amperes for the overhead 12 kv circuit underbuild.

Source: Enertech Consultants and Power Delivery Consultants, Inc.

Health Effects of Electric and Magnetic Fields

Overview. A number of studies in the 1960s and early 1970s found no obvious harmful effects from typical transmission line electric and magnetic fields. Some studies during this period did report the potential for harmful effects. More recent reports (since about 1979) have suggested a possible association between occupational and residential exposure to magnetic fields and adverse health effects, including cancer. The evidence for such an association is still inconclusive, and studies are under way to obtain more definitive information on this subject. Although most of the research has been prompted by concern about the effects of large (i.e., extra-high-voltage) 765 kV transmission lines, some recent research results are of interest in assessing potential health concerns related to 69 kV lines.

New York State Power Lines Project. One of the most comprehensive recent research two programs involved 16 studies and two follow-up projects conducted from 1985 through 1987. These studies, administered by the New York State Power Lines Project, were undertaken "to determine whether there are health hazards associated with electric and magnetic fields produced by 60 Hz [hertz] power transmission lines (especially 765 kV lines)." (New York State Power Lines Project, 1987) The $5 million research effort was funded by electric utilities that serve the state of New York and was supervised by a scientific advisory panel reporting to the New York State Health Department. In general, the field levels used in the laboratory studies were larger than typical fields because of the 765 kV lines.

The studies fall into the broad areas of epidemiology, laboratory animal, and cellular research. None of the studies showed significant adverse effects on reproduction, growth, or development because of the laboratory-created fields. The studies also showed no significant evidence of genetic or chromosomal damage that might lead to inherited effects or that might cause cancer. Two of the project's epidemiological studies, however, also examined the effects of lower-voltage distribution lines. These two studies (of childhood cancer in Denver and adult cancer in Seattle) have generated much public interest.

The Denver Study. The Denver study evaluated the incidence of cancer among children living in homes near different kinds of electric power lines. Measurements were taken inside each home with appliances turned off (low-power condition) and turned on (high-power condition). Distribution "wiring configuration codes" were used as a surrogate for likely magnetic field exposures over time in the home from external power lines. The wiring code is an index loosely based on the type, number, and diameter of conductors; the distance from house to power line; and the number of nearby service drops.

The New York Scientific Advisory Panel interpreted the Denver study to show an association between the household wiring codes and street addresses of the childhood cancer cases. The panel reported that the study appeared to show an increase in the frequency of childhood cancer in Denver from about 1 in 10,000 children per year to about 1.7 in 10,000. However, the study results were puzzling in several respects. There appeared to be no correlation when high-power condition measurements were used (that is, with many electrical appliances turned on). No clear relationship between the level of exposure and the increased incidence of cancer could be discovered for the low-power conditions (that is, with appliances turned off) for which a correlation with childhood cancer was found. The New York Scientific Advisory Panel was also concerned about the study's low interview response rate and possible coincidental factors, such as traffic density, that could also affect the incidence of cancer.

The Seattle Study. The other epidemiological cancer study funded by the New York State Power Lines Project was conducted in the Seattle area. The design of this study shared many features with the Denver study; for example, exposure to magnetic fields was assessed by field measurements and by the same wiring code system. In the Seattle study, the New York Scientific Advisory Panel found that "regardless of how exposure was characterized, no relationship with cancer incidence was disclosed." In other words, the results of this study were negative—there was no association between cancer and magnetic field exposure (as estimated by the wiring code system).

In evaluating the research results, the New York Scientific Advisory Panel cautioned that research has not found any biological mechanisms that could explain the role of magnetic fields in the development of cancer. The panel also noted that methodological uncertainties exist in quantifying magnetic field exposure levels. The panel concluded that the findings to date could not and should not be translated into specific recommendations for regulating right-of-way widths, line heights, or the location of transmission lines near homes.

The Los Angeles Study. A new residential epidemiology study funded by EPRI in an attempt to replicate the Denver study was completed in 1990 in Los Angeles, California. The results generally confirm the results of the Denver study. There was an increased risk of cancer with certain wiring codes, but not with direct field measurements.

This study was essentially a replication of the Denver study, but in a different location. The researcher concluded that: "our data offer no support for a relationship between measured electric field and leukemia risk, little support for the relationship between measured magnetic field exposure and leukemia risk, some support for a relationship between wiring configuration and leukemia risk, and considerable support for a relationship between children's electrical appliance use and leukemia risk." (University of Southern California, Department of Preventive Medicine, 1991) The reason that wiring configuration correlates with leukemia risk better than measured exposure does is not clear.

It remains unresolved why an indirect magnetic field measurement (such as wiring code) is associated with a positive finding, while direct field measurements are not. This is even more perplexing because this Los Angeles study had the most sophisticated direct measurements of magnetic fields to date. Possible explanations for these apparently contradictory research findings are:

- Wiring configuration codes are better predictors of long-term average magnetic field exposure than 24-hour measurements are.

- Wiring code categories are markers for some as-yet-unidentified biologically effective characteristics of the magnetic field (e.g., transient pulses or intermittent fields).

- Some wiring code categories are associated with some confounding factor or set of factors in the urban environment that are the true cause of the increased risk but that are unrelated to magnetic fields.

- Relatively subtle biases in subject selection (especially for the controls) have produced a spurious association between wiring codes and leukemia risk in the Denver and Los Angeles studies.

The Swedish Studies. Two new epidemiological studies were released in September 1992, in Sweden. The first study, *Magnetic Fields and Cancer in People Residing Near Swedish High Voltage Power Lines*, was a residential study of children and adults who live within 300 meters of 220 kV and 400 kV transmission lines in Sweden. The authors are Dr. Maria Feychting and Dr. Anders Ahlbom. This residential study evaluated average magnetic field exposure via actual measurements and magnetic field calculations (for both contemporary and historical line loadings). The study also included an evaluation based on various distances from the power lines. The study found a statistical association between childhood leukemia and calculated historical fields (the main exposure metric was selected as the annual average of the calculated magnetic field generated by the power line). The study also found an association with distance from the power lines. No association was found with actual magnetic field measurements. For brain tumors and all childhood cancers together, there was little support for an association. The findings of an association with a surrogate (namely, calculated historical magnetic fields) but not with actual field measurements, are consistent with earlier studies in Denver and Los Angeles. Similar results are achieved in this study by using distance from the power line. In this respect, this study is another "wire code" study because a distance criterion is used as the surrogate for magnetic field exposure.

The second study, *Occupational Exposure to Electromagnetic Fields in Relation to Leukemia and Brain Tumors: A Case-Control Study*, is an occupational study of adult males. The authors are Dr. Birgitta Floderus, Dr. Tomas Persson, et al. Based on the job held longest during the 10-year period before diagnosis, a statistical association was observed between a certain subtype of leukemia and estimated magnetic field exposure. (No association was found with the leukemia subtype most often discussed in other occupational EMF studies.) The exposure assessment details were not sufficiently reported to allow a complete evaluation, but in general, some contemporary magnetic field exposure measurements were used as a surrogate to estimate historical exposure for selected job categories. In the occupational study, the exposure metrics included the mean field exposure value, median, standard deviation, and time above 0.2 μT (0.2 μT is equal to 2 mG) for exposure categories that included quartiles of exposure intensity and the 90th percentile.

Both studies reported that they have essentially confirmed earlier residential and occupational study findings, with some exceptions (e.g., in the residential study there were no positive findings for brain tumors). The most interesting features of these new studies are the exposure assessment, which includes contemporary measurements and historical field calculations for the residential study, and job category personal exposure measurements for the occupational study. An important issue for both studies is that if the exposure surrogates prove to be accurate in estimating historical exposure, then this may suggest that future exposure assessment attention is directed to average magnetic field values. In any event, these studies add to our overall scientific knowledge, would seem to confirm portions of earlier work, and will direct future research to understand what aspect of wire codes and other surrogates are related to health risk.

U. S. Environmental Protection Agency (EPA) Preliminary Draft Report. (This report has been under review by the EPA Science Advisory Board. It will be rewritten and submitted for further scientific review before it is published again.) EPA prepared a preliminary draft report in 1990 on electric and magnetic fields based on a review of existing scientific literature. The preliminary draft report evaluated the likelihood that electric and magnetic fields pose a risk for the development of cancer in humans. In this preliminary draft report, EPA concluded that "with our current understanding, we can identify 60 Hz magnetic fields from power lines and perhaps other sources in the home as a possible, but not proven, cause of cancer in people." One problem cited by EPA is a poor understanding of the basic nature of the interaction between magnetic fields and biological processes. The EPA preliminary draft report states, "For example, a real possibility exists that exposure to higher field strengths is actually less hazardous than exposure to low field strengths. Because of this uncertainty, it is inappropriate to make generalizations about the carcinogenicity of EM [electromagnetic] fields."

EPA has also reviewed the research needs for electric and magnetic fields and published a report that identifies the major research topics and their relative priorities. Exposure assessment research and research into possible biophysical mechanisms were listed as two "high-priority" areas of future study. Definitive exposure data will be necessary in order to judge the validity of the suggested causal link between magnetic field exposure and cancer. A better understanding of possible biophysical mechanisms is needed to quantify which, if any, aspect of magnetic field exposure might be related to adverse health outcomes.

EPA Science Advisory Board. On January 29, 1992, the Nonionizing Electric and Magnetic Fields Subcommittee of the Science Advisory Board's Radiation Advisory Committee submitted to the EPA Administrator its report, *Potential Carcinogenicity of Electromagnetic Fields*, on the EPA's preliminary draft report on electric and magnetic fields. In its report, the Science Advisory Board (SAB) Subcommittee concluded that "there is insufficient information to designate specific values of magnetic-field strength that may be hazardous to human health." The SAB Subcommittee made two specific policy recommendations:

Policy Recommendation No. 1. The subcommittee is unanimous in its belief that the question of electric and magnetic field effects on biological systems is important and exceptionally challenging, and that the subcommittee's advice to the EPA should be that the report should be rewritten by EPA and then reviewed by the Science Advisory Board.

Policy Recommendation No. 2. EPA should complete its efforts with regard to radio frequency (RF) electromagnetic fields (including microwaves) and issue exposure guidelines independent of current issues pertaining to lower frequencies. The current EPA report inadvertently leads even the careful reader to conclude that the potential carcinogenicity of electric and magnetic fields of extremely low frequency (ELF) (i.e., power line frequencies) is the only—or at least the principal—subject of concern with regard to nonionizing fields. Such a conclusion would reinforce the skewed and somewhat sensationalized picture presented to the public in recent years by the news media and government agencies responding to this publicity. The report should therefore declare explicitly that the attention given to nonionizing electric and magnetic fields derives in the first place from long-standing concern over the hazards of RF (including microwave) radiation. EPA has expended substantial resources on the study of such radiation over a period dating back to the EPA's inception, and EPA should complete its efforts directed toward the issuance of RF exposure guidelines. RF fields present long-known and well-understood hazards such as temperature elevation in tissue and heat stress resulting from acute exposures against which users and the general public must be warned and protected. Any published exposure guideline should specifically identify the hazards from RF exposure.

Office of Technology Assessment—Background Paper. A comprehensive background paper on the biological effects of electric and magnetic fields was prepared for the U.S. Congress Office of Technology Assessment (Carnegie Mellon University, 1989a). The paper discusses the current state of knowledge on the health effects of extremely low-frequency (i.e., 60 Hz) electric and magnetic fields. A small brochure (Carnegie Mellon University, 1989b) was also prepared that more concisely summarizes the background paper and various policy options.

The background paper provides a good overview of the sources and nature of electric and magnetic field exposure. It points out that we do not yet know what field attribute or combination of attributes, if any, could produce public health effects. This means that the simple assumption that "more is worse" may not be true. Because of this, simple field strength standards "cannot be adequately supported by the science that is now available."

The background paper also provides a summary of the basic areas for research: cellular experiments, whole animal experiments, exposure assessment, and epidemiological studies. Using the review of the scientific literature, the report states that:

> As recently as a few years ago, scientists were making categorical statements that on the basis of all available evidence there are no health risks from human exposure to power-frequency fields. In our view, the emerging evidence no longer allows one to categorically assert that there are no risks. But it does not provide a basis for asserting that there is a significant risk.
>
> If exposure to fields does turn out to pose a health risk, it is unlikely that high voltage transmission lines will be the only sources of concern. Power-frequency fields are also produced by distribution lines, wall wiring, appliances, and lighting fixtures. These nontransmission lines could play a far

greater role than transmission lines in any public health problems. (Carnegie Mellon University, 1989a)

The background paper and brochure also consider the public policy question of what should be done, given our present knowledge. Three basic approaches are suggested:

- **Do nothing.** Conclude that there is not yet enough evidence to warrant any action.

- **Prudent avoidance.** Adopt strategies that can limit field exposures with small investments of money and effort. Do nothing drastic or expensive until research provides a clear picture of whether there is any risk at all.

- **Aggressive regulation.** Conclude that there is a problem and spend some serious time and money on an aggressive program to limit field exposure, while recognizing that we may eventually learn that some or all of this effort and money has been wasted.

Continuing Research. Almost all researchers are careful to point out that it is difficult to identify health hazards that may be subtle to detect or that are evident only after long periods of time. The converse is also true: no experiment, no matter how well designed, can prove no health hazards at all from any source studied. The studies that do suggest a health effect are usually repeated to verify the results. Because any one study can be fallible, a study needs to be replicated before any conclusions can be reached about health hazards.

Because of the difficulty of reaching any meaningful conclusions about health hazards from the current studies, most researchers (including the New York Scientific Advisory Panel and EPA) recommend carrying out additional research. Several areas in particular merit further research:

- So far, research has not been able to discover the biological mechanism by which electric or magnetic fields might cause adverse health effects. Additional basic laboratory research is needed to determine whether physiological changes result from exposure to electric or magnetic fields, and how such changes might affect health.

- Another subject deserving further research is the effect of the fields typically experienced in homes–fields caused by televisions, electric blankets, hair dryers, other appliances, and electric wiring in house walls. As noted earlier in this section, although field strengths near some of the larger transmission lines may be larger than field strengths at home, most people experience significant exposure to electric and magnetic fields at home. The Denver and Los Angeles studies found evidence of an association between the incidence of childhood cancer and the configuration of electric power line wiring outside the home. Further study will help clarify the relative risk, if any, from fields at home and near transmission or distribution lines.

Electric and Magnetic Field Standards. General transmission line safety standards are imposed by the State of Hawaii Public Utilities Commission General Order No. 6 (Rules for Overhead Electric Line Construction) and the National Electrical Safety Code (NESC). The Keahole-Kailua 69 kV transmission line will be designed to comply with these codes and standards. These documents do not currently address concerns about the potential for health effects of electric and magnetic fields.

On April 3, 1991, the State of Hawaii Department of Health issued a policy relating to electromagnetic fields from electric power lines. The policy states:

> A prudent approach is needed at this time to regulate electric and magnetic fields around low-frequency electric power facilities, including high-voltage transmission lines. The existing research data are inconclusive and not sufficient enough for adequate, accurate risk assessment. However, the data suggest that a "prudent avoidance" approach to siting new facilities is appropriate. Where technically feasible and practical, public exposures should be minimized. Too little is presently known to be able to determine where or what rules would provide useful public-health protection.
>
> Implementing actions:
>
> (a) All newly-installed power lines should be constructed with engineering controls to reduce exposure (for example, the "delta" configuration).
>
> (b) The Department of Health will continue to collect and evaluate research data on electromagnetic fields in order to be aware of significant findings with public-health implications (State of Hawaii, Department of Health, 1991).

There are no national standards in the United States for electric or magnetic field exposure. A few states have some type of electric field guideline and two states have a magnetic field standard. These standards were compiled and are summarized in Table 5-9. The purpose of most of the standards is to make the field levels from new lines similar to the field levels from existing lines. The Keahole-Kailua transmission line's field values are far below any of the levels in this table.

Table 5-9 State Regulations That Limit Field Strengths on Transmission Line Rights-of-Way	
State	**Field Limit**
Montana	1 kV/m at edge of ROW in residential areas
Minnesota	8 kV/m maximum in ROW
New Jersey	3 kV/m at edge of ROW
New York	1.6 kV/m at edge of ROW
	200 mG at edge of ROW
North Dakota	9 kV/m maximum in ROW
Oregon	9 kV/m maximum in ROW
Florida	10 kV/m maximum for 500 kV lines in ROW
	2 kV/m maximum for 500 kV line at edge of ROW
	8 kV/m maximum for 230 kV and smaller lines in ROW
	3 kV/m maximum for 230 kV and smaller lines at edge of ROW
	200 mG for 500 kV lines at edge of ROW
	250 mG for double-circuit 500 kV lines at edge of ROW
	150 mG for 230 kV and smaller lines at edge of ROW
Source: Carnegie Mellon University, 1989a and 1989b.	

The International Nonionizing Radiation Committee of the International Radiation Protection Association has published "Interim Guidelines on Limits of Exposure to 50/60-Hz Electric and Magnetic Fields" in the January 1990 issue of *Health Physics*. The guidelines were approved by the Executive Council of the International Radiation Protection Association on May 3, 1989, and those guidelines relating to the general public are summarized in Table 5-10.

Table 5-10 Summary of Electric and Magnetic Field Guidelines Relating to the General Public		
General Public Exposure Characteristics	**Electric Field Strength (kV/m)**	**Magnetic Flux Density (mG)**
Up to 24 hours/day	5	1,000
Few hours/day	10	10,000

As with the state standards, the Keahole-Kailua transmission line's field values are far below the values cited in Table 5-10.

Other Transmission Line Electrical Effects

Corona. One of the more interesting phenomena associated with all energized devices, including high-voltage transmission lines, is corona. Corona is the physical manifestation of energy loss, and can transform energy into very small amounts of light, sound, radio noise, chemical reaction, and heat. Because power loss is uneconomical, corona has been studied since the early part of this century. Consequently, it is well understood by engineers, and steps to minimize it are one of the major factors in line design. The line designer can control corona with good design practices, and it is usually not a problem for lines rated at 230 kV and lower.

When significant corona activity occurs on transmission lines it is usually on high-voltage lines of 345 kV and above, and then mostly during inclement weather. The effects are local and should be considered a nuisance rather than a serious problem or hazard. For example, although radio noise in the AM range can be generated by corona discharge, it is usually of such low intensity that it cannot be detected outside the right-of-way.

The same is true of television interference and audible noise. The engineering design of the proposed Keahole-Kailua transmission line will produce very low conductor surface gradients (because of the lower 69 kV line voltage and the use of bundled conductors). The corona performance of the proposed 69 kV lines will be as good as or better than other lines in this voltage classification. In summary, the proposed 69 kV lines are expected to have little or no corona activity under most operating conditions.

Audible Noise. During corona activity, transmission lines (mainly 345 kV and above) generate a small amount of sound energy. This audible noise from the line can barely be heard in fair-weather conditions on the higher-voltage lines and usually not at all on lines at 69 kV. During inclement weather, water drops collect on the conductor and increase corona activity so that a crackling or humming sound may be heard near the line. This noise is caused by small electrical discharges from the water drops. Audible noise decreases with distance away from the line. Noise levels on typical 69 kV systems are low and have not been a problem; in fact, audible noise is almost never reported on transmission lines below 230 kV (this will be especially true for the Keahole-Kailua project because the 69 kV design will use bundled conductors). Audible noise levels for the proposed Keahole-Kailua transmission line, calculated for the edge of the ROW during foul weather, are about 10 to 13 A-weighted decibels (dBA), a very low level.

Radio and Television Interference. As a general rule, overhead transmission lines do not interfere with normal radio or television reception. As described earlier, corona discharges can sometimes generate unwanted electrical signals. There are two potential sources of interference: corona and gap discharges. Corona may affect AM radios, while gap discharge can affect television as well as radio reception. Corona activity is lessened through proper line design and is almost never a source of interference, especially on lines smaller than

230 kV. Corona-generated interference decreases rapidly with distance, and beyond the edge of the right-of-way it decreases to very low values. For the proposed 69 kV line design, the radio noise level, calculated for the edge of the ROW during foul weather, is about 27 dBμV/m (decibels above a 1 μV/m [microvolt per meter] reference value). This level will meet the Federal Communications Commission level for satisfactory service. The bundled conductor design of the 69 kV lines is such that TV interference levels will be extremely low, lower than on many 69 kV lines on the mainland where TV interference has not been a problem.

Gap discharges are a very different problem. They are caused by electrical discharges between broken or poorly fitting hardware, such as insulators, clamps, or brackets. Hardware is designed and installed to be problem-free, but wind motion, corrosion, gunshot damage, and other factors can sometimes create a gap discharge condition. When this condition develops, intermittent gaps at connection points between hardware items allow small electrical discharges to occur. This phenomenon is not limited to transmission lines and can often be found on distribution lines. The discharges act as small "transmitters" at frequencies that may be received on some radio and TV receivers. Gap discharge sources can be located and repaired by electric utility engineers. The severity of interference depends on the strength and quality of the transmitted radio or TV signal, the quality of the radio or TV set and antenna system, and the distance between the set and the interference source. It should be obvious that radios and TV sets are influenced more by interference sources in the home itself—because of their proximity—than from transmission lines. The large majority of interference complaints are found to be attributable to sources other than transmission lines (e.g., poor signal, poor antenna, heating pad, doorbell, sewing machine, freezer, ignition system, aquarium thermostat, appliances, fluorescent lights).

Transmission line engineers commonly design all transmission lines to be as free as possible from corona and other sources of interference. Radio and television interference complaints are recorded, evaluated, and investigated when necessary; corrective measures are taken as required.

Ozone. Ozone (O_3) is another possible by-product of the higher-voltage (345 kv and above) transmission lines that has raised some concern. Ozone is formed when three oxygen molecules combine with each other. This can happen when air molecules are charged. Ambient ozone levels in rural areas are typically around 10 to 30 parts per billion (ppb) at night and may peak during the day at around 100 ppb. In urban areas, concentrations greater than 100 ppb are common. Cities such as Los Angeles may peak at 500 ppb. The National Ambient Air Quality Standard for Oxidants (of which ozone is usually 90 to 95 percent) is 120 ppb, not to be exceeded as a peak concentration on more than one day per year.

What kind of ozone level increase can be expected in the vicinity of a transmission line? A theoretical "worst case" would be provided by 10 or more continuous hours of heavy rains and light winds blowing exactly parallel to the lines. In this situation, close to the Keahole-Kailua transmission line, calculated ozone levels would be about 0.007 ppb. Concentrations below about 1.0 ppb are impossible to measure with even the most sensitive instrumentation. Nitrogen oxides can also be generated by transmission lines but on a scale much smaller than ozone, thus presenting a problem even less significant. Neither ozone nor nitrogen oxide is a problem associated with 69 kV transmission lines.

Cardiac Pacemakers. One area of concern related to the electric fields of the 345 kV and larger lines has been the possibility of interference with cardiac pacemakers. There are two general types of pacemakers: asynchronous and synchronous. The asynchronous pacemaker pulses at a predetermined rate. It is practically immune to interference because it has no sensing circuitry and is not exceptionally complex. The synchronous pacemaker, on the other hand, pulses only when its sensing circuitry determines that pacing is necessary. Interference resulting from the transmission line electric field can cause a spurious signal in the pacemaker's sensing circuitry. However, when these pacemakers detect a spurious signal, such as a 60 Hz signal, they are programmed to revert to an asynchronous or fixed pacing mode of operation and return to synchronous operation within a specified time after the signal is no longer detected. Cardiovascular specialists do not consider prolonged asynchronous pacing a problem. As mentioned before, some pacemakers are designed to operate that way. Periods of operation in this mode are commonly induced by cardiologists to check pacemaker performance. So, while the transmission line electric field may interfere with the normal operation of some pacemakers, the result of the interference is not harmful and is of short duration.

In any event, the electric fields associated with the Keahole-Kailua transmission lines (about 0.23 kV/m) are far below levels that are reported as capable of affecting pacemaker operation (about 2 to 9 kV/m) and would, therefore, pose no hazards for pacemaker operation.

Mitigation

Research to date has not demonstrated conclusive evidence of health hazards from 69 kV transmission lines similar to those proposed for the Keahole-Kailua transmission project. Nevertheless, HELCO has adopted strategies consistent with the "prudent avoidance" approach in routing and designing transmission lines. Evaluating land use along the alternative alignments and using different engineering design options are consistent with this prudent avoidance approach.

Electric fields are related to voltage level. Higher voltages result in stronger electric fields. Electric fields can be blocked through the use of shielding and grounding techniques, especially with underground lines. Magnetic fields, on the other hand, are related to the flow of current through a conductor. The higher the current flow, the stronger the magnetic field. Magnetic fields cannot be blocked with shielding, as electric fields can. However, magnetic fields can be lowered by using specific engineering design measures and operating procedures.

HELCO is committed to designing and operating an overhead 69 kV transmission line in a way that minimizes public exposure to both electric and magnetic fields measurable at ground level. HELCO will use the following engineering design measures and operating procedures for its proposed overhead line:

- **Equal current distribution.** HELCO will equalize the currents in each of three conductors in the proposed overhead 69 kV transmission line circuit. This arrangement results in minimization of magnetic fields.

- **Low-reactance phasing.** HELCO will use reverse phasing of the proposed overhead 69 kV transmission line circuit with the existing 69 kV transmission line circuit and with the existing underbuilt 12 kV distribution line circuits, wherever these 12 kV distribution line circuits occur. This reverse phasing allows electric and magnetic fields from one circuit to cancel the fields in the others. This arrangement of circuits is called the low-reactance (or unlike) phasing configuration. Installing the proposed overhead 69 kV transmission line with the new line adjacent to the existing overhead 69 kV transmission line will reduce the proposed line's electric and magnetic field levels.

- **Maximize distance to existing residential area.** HELCO will install the 69 kV transmission line circuit as high above ground as possible, and as far away from existing neighboring residential areas as is possible, subject to airport flight hazard regulations, state highway requirements for use of the highway right-of-way, and visual considerations. This will minimize public exposure to electric and magnetic fields because the field intensity decreases with increasing distance from the line. Like the existing overhead 69 kV transmission line, the proposed 69 kV transmission line will be approximately 300 feet from six dwelling units adjacent to Queen Kaahumanu Highway and within Keahole Agricultural Park. Table 5-11 shows the electric and magnetic field levels at 1 meter above ground level at the center of the transmission line alignment and 300 feet away from the center of the alignment.

Placing a 69 kV transmission line circuit underground does not necessarily reduce the magnetic fields at ground level because magnetic fields readily penetrate rock and soil. The magnetic field values produced by an underground transmission line are reduced at a given distance from the line because the conductors are much closer together than for an overhead line; however, it is possible to get much closer to the lines. The net result is that the magnetic field values at the center of the line and 3 to 4 feet aboveground are similar for overhead lines and for solid (or extruded) dielectric underground 69 kV transmission cables.

For underground transmission lines, two factors affect the magnetic fields measured near ground level. These factors tend to counter each other and do not necessarily result in higher or lower magnetic field levels. First, magnetic field levels of underground lines are reduced more than the magnetic field levels of overhead transmission lines, as a result of the higher phase cancellation of the magnetic fields. Phase cancellation is higher because the three conductors of an underground circuit are closer together than the three conductors of an overhead circuit. Second, magnetic field levels from underground transmission lines measured near ground level directly above the underground lines are higher than magnetic field levels measured near ground level directly beneath overhead transmission lines. The magnetic field at ground level is higher because the distance from the underground transmission line to ground level (i.e., 3 to 4 feet) is less than the distance from an overhead transmission line to ground level (i.e., 30 to 40 feet).

Distance from the transmission line conductors is the main factor in reducing magnetic field levels in most cases. One exception is the magnetic field shielding or reduction that occurs when the cables are placed in steel pipes.

Solid (or extruded) dielectric cables are not normally installed in steel pipes (except for certain special construction situations such as highway crossings, where access is limited) because of increased losses and heating that are created in the steel pipe and because it is usually more expensive to install cables in a steel pipe. However, installing cables in a steel pipe is one method of magnetic field mitigation. Placing the cables in a steel pipe can reduce the magnetic fields outside of the pipe by two means. First, it is easier for magnetic flux to flow in ferromagnetic metals (such as steel) than in air. This means that most of the magnetic flux produced by the cables would flow in the low-reluctance path provided by a steel pipe. The second reason that a steel pipe reduces magnetic fields outside of the pipe is that eddy currents are induced in the steel pipe which oppose the magnetic field produced by the current in the cables.

An analysis of possible magnetic field mitigation methods indicated that the value of the magnetic field at 1 meter aboveground could be reduced from approximately 11 mG to between 1 and 2 mG for the 73-ampere circuit current (during the summer peak load) if the three cables were installed in a single 8-inch steel pipe with a 0.25-inch wall thickness (Figure 5-9). However, the analysis showed that this mitigation method would result in an incremental cost of approximately 15 percent above the preferred concrete-encased duct bank installation shown in Figure 5-8. This is due to the fact that a larger cable conductor size (1,750-kcmil aluminum conductor as compared to the 1,500-kcmil aluminum conductor assumed for use in this analysis) would be required to obtain the necessary ampacity rating, and because steel pipes would be used rather than PVC ducts. The larger cable is required to accommodate the loss induced heating in the pipe and because the air in the pipe makes it more difficult for heat to travel from the cable to the surrounding earth. There are also other operational and maintenance considerations. If three cables were installed in a single pipe, it would be more difficult to repair a cable failure by pulling out the failed cable and replacing it with a new one.

A second underground cable mitigation method was also considered but discarded. This second underground cable mitigation method investigated the reduction of magnetic fields that occurs with the preferred concrete-encased PVC duct bank installation shown in Figure 5-8 when the cable shield or sheath is multi-point grounded. In this case the magnetic field is reduced by the induced sheath current because the induced current flows in the opposite direction to the current in the high-voltage conductor. The magnetic field could be reduced from about 11 mG to approximately 3 mG for the 73-ampere circuit current (during the summer peak load) if a cable were constructed with a special low-resistance shield or sheath. However, a cable with a much larger conductor size (2,500-kcmil copper) would be required to accommodate the significantly higher losses created by the induced shield current. It was estimated that the specially manufactured cables would cost approximately

Table 5-11
Electric and Magnetic Field Levels

	Electric Field (kV/m)					Magnetic Field (mG)				
	Distance from center line of pole near ground level (feet)					Distance from center line of pole near ground level (feet)				
Typical Configurations	**-20**	**0**	**100**	**200**	**300**	**-20**	**0**	**100**	**200**	**300**
Existing Overhead Line[a] Single-circuit 69 kV Single-circuit 12 kV underbuild (Summer peak load)	0.052	0.103	0.022	0.008	0.004	2.27	3.40	0.45	0.13	0.07
Proposed Overhead Line Configuration No. 1[b] Double-circuit, single-sided 69 kV Single-circuit 12 kV underbuild Low-reactance (unlike) phasing (Summer peak load)	0.149	0.115	0.004	0.003	0.002	1.03	1.29	0.19	0.08	0.05
Proposed Overhead Line Configuration No. 2[b] Double-circuit, double-sided 69 kV Single-circuit 12 kV underbuild Low-reactance (unlike) phasing (Summer peak load)	0.079	0.082	0.011	0.003	0.001	0.69	1.01	0.07	0.03	0.02
Proposed Underground Three Single-Conductor 69 kV Cables in PVC Ducts[c] With existing overhead line configuration (Summer peak load)	0.052	0.103	0.022	0.008	0.004	10.44	2.81	0.42	0.08	0.05

Notes: All values calculated for 1 meter aboveground. Assumes equalization of currents in each of the three conductors in a circuit. Underground three single-conductor 69 kV cables buried at -20 feet from existing pole, shielded to eliminate any measurable electric field outside of cable, with single-point grounded cables, and with the assumption of no induced sheath currents.

[a]Assumes 73 amperes for the overhead 69 kV circuit and 5 amperes for overhead 12 kV underbuild.

[b]Assumes 73 amperes for each overhead 69 kV circuit and 5 amperes for the overhead 12 kV circuit underbuild.

[c]Assumes 73 amperes for the underground 69 kV circuit, 73 amperes for the overhead 69 kV circuit, and 5 amperes for the overhead 12 kV circuit underbuild.

Source: Enertech Consultants and Power Delivery Consultants.

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50 percent more than the 1,500-kcmil cables shown in Figure 5-8. Therefore, this second underground cable mitigation method using the preferred concrete-encased PVC duct bank installation shown in Figure 5-8 with multi-point grounding of the cable's shields or sheaths was discarded because it is less economically practical and less effective in reducing magnetic field values than the mitigation method described earlier.

A third underground cable mitigation method was considered but also discarded. This mitigation method involved the preferred concrete-encased PVC duct bank installation shown in Figure 5-8, with the PVC ducts replaced by steel pipes.

Theoretically, the magnetic field values produced by 69 kV solid (or extruded) dielectric cables can be reduced by a factor of at least 25 to 1 (compared to the cables placed in the same configuration with no steel pipe) by placing the three cables of a three-phase circuit in a single steel pipe with a 0.25-inch-thick wall.

However, this is not appropriate in this case, since placing each cable of a three-phase circuit in a separate steel pipe or steel conduit is not conducive to reducing magnetic field values, produces high heat losses that reduce the circuit's current-carrying capacity, and is contrary to the National Electrical Code. It has been shown that a steel pipe is not effective in reducing the magnetic field if only one single cable is placed in a single steel pipe. Steel pipes are most effective in reducing the magnetic field if the vector sum of the currents in the cables placed in a single steel pipe is equal to zero. Very high eddy current and hysteresis losses are produced in a ferromagnetic pipe if only a single current-carrying conductor is placed inside of it. These eddy current and hysteresis losses are so high that the current-carrying capacity of the cable is drastically reduced. Finally, Section 300-20 of the National Electrical Code states that placing a single cable within a steel pipe is not an acceptable practice. Therefore, this third underground cable mitigation method, which would have involved the preferred concrete-encased PVC duct bank installation shown in Figure 5-8 with the PVC ducts replaced by steel pipes, was discarded.

In the analysis of possible underground alternatives, HELCO engineers indicated that the underground transmission line's ability to accommodate the normal maximum amperage and emergency maximum amperage should be comparable to that of the overhead transmission line. For the overhead transmission line, the normal maximum amperage is 900 amperes, and the emergency maximum amperage is 1,035 amperes. HELCO engineers determined that in order for the underground transmission line to be comparable to the overhead transmission line, its normal maximum amperage would need to be 890 amperes and the emergency amperage would need to be 1,020 amperes.

In the course of the analysis, it was clear that the design shown in Figure 5-8, which used the preferred concrete-encased PVC duct bank with solid dielectric (or extruded) cables with 1,500-kcmil conductors, could accommodate the normal maximum amperage and the emergency amperages. However, the underground transmission cable configuration consisting of three solid (or extruded) dielectric cables with 1,750-kcmil aluminum conductors in a single 8-inch steel pipe could not accommodate the normal maximum and emergency maximum amperages. HELCO's underground transmission line engineering consultant, Power Delivery Consultants, determined that if an underground cable configuration used three solid (or extruded) dielectric cables in a single steel pipe, the cables conductor would need to be tremendously large, in the order of 4,000 kcmil or larger to be able to accommodate the design emergency amperage of 1,020 amperes. Power Delivery Consultants determined that a solid dielectric (or extruded) cable with a 4,000-kcmil or larger conductor would not be practical.

Power Delivery Consultants recommended two possible underground transmission line options that would be able to meet the design requirements for the normal maximum amperage of 890 amperes and the emergency maximum amperage of 1,020 amperes. The first option consists of two three-phase circuits (two cables per phase) in a concrete-encased PVC duct bank with reverse phasing. The second option consists of two three-phase circuits (two cables per phase) in two separate 8-inch steel pipes. These options are described below.

The first option (Figure 5-9) consists of two three-phase circuits (two cables per phase) in a concrete-encased PVC duct with reverse (unlike) phasing between the two circuits, installed in the same concrete-encased PVC duct bank shown in Figure 5-8. Each circuit would consist of three cables, one for each phase. Each phase would consist of two solid (or extruded) dielectric cables, with 750-kcmil aluminum conductors. The two cables of each phase would be separated, with one cable of each phase in one of the two vertical columns of PVC ducts. This system would be single-point grounded. This option has greater costs than HELCO's basic underground option, shown in Figure 5-8. Power Delivery Consultants estimated that this option would cost about 1.5 times the cost of the basic underground option shown in Figure 5-8, based on the work in the EPRI report *Transmission Cable Magnetic Field Management*, but has improved reliability (because of the redundancy) and lower magnetic fields than the basic underground option.

The second option (Figure 5-10) consists of two three-phase circuits (two cables per phase) installed in two separate side-by-side 8-inch steel pipes, placed 24 inches apart. Each circuit would consist of three cables, one cable for each phase. In this option, the two cables of each phase would consist of solid (or extruded) dielectric cables, with 750-kcmil aluminum conductors. The two cables of each phase would be separated, with one cable of each phase in each of the steel pipes. Similar to the first option, this system would be single-point grounded. This option is the most expensive of the three underground options and has increased costs of about 1.6 to 1.7 times the cost of the basic underground option shown in Figure 5-8, again based on the work in the EPRI report *Transmission Cable Magnetic Field Management*, but has improved reliability (because of the redundancy) and lower magnetic fields than the basic underground option.

Table 5-11 compares the electric and magnetic field values for the overhead transmission line and underground transmission line alternatives that HELCO believes are the most practical to construct. Table 5-12 expands on the alternatives compared in Table 5-11 by adding the two underground options suggested by Power Delivery Consultants. Table 5-12 compares the magnetic field values for all overhead and underground configurations with the following:

- The assumed existing amperage (73 amperes)

- The normal maximum amperage (900 amperes for the overhead configurations and 890 amperes for the underground configurations)

- The emergency maximum amperages (1,035 amperes for the overhead configurations and 1,020 amperes for the underground configurations

Electric field values are not included in Table 5-12 because the metallic sheath or steel pipe that surrounds the cables would shield the electric fields so that the electric field potential outside the pipe would be zero or very low; thus, the electric field coming from the underground transmission lines would not be measurable above ground level. The electric field values are identical to those of the "existing overhead line" and the "proposed underground three single-conductor 69 kV cables in PVC ducts" shown in Table 5-11.

Table 5-12 shows that, for underground transmission line configurations, the greatest degree of magnetic field attenuation occurs with underground transmission line Option 1, which consists of two three-phase circuits (two cables per phase) in a concrete-encased PVC duct with reverse (unlike) phasing between the two circuits, installed in a concrete-encased PVC duct bank (Figure 5-9). For the overhead transmission line configurations, the greatest degree of magnetic field attenuation occurs with overhead Configuration 2, the double-circuit, double-sided overhead transmission line (see Figures 5-6 and 5-7).

In comparing the overhead configurations with the underground configurations, the highest degree of magnetic field attenuation occurs with overhead Configuration 2, the double-circuit, double-sided overhead transmission line.

Air Quality and Noise

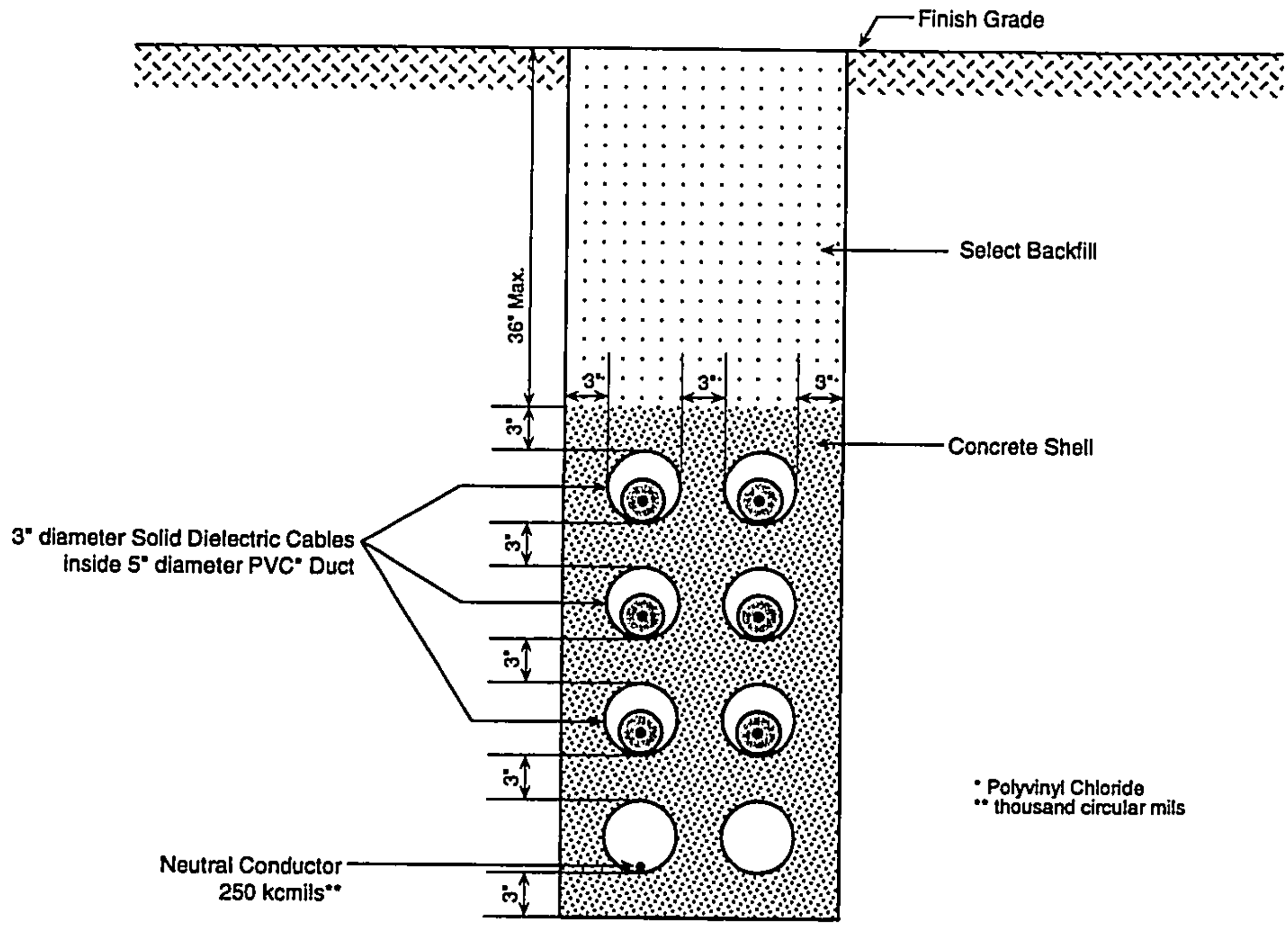
Environmental Setting

Air Quality

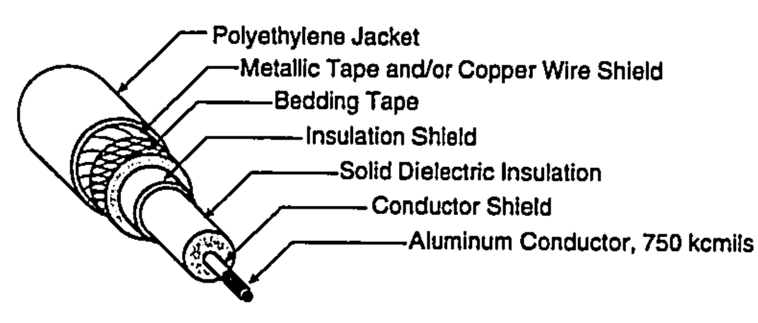
Topography. The project area for the proposed transmission line alternatives is located in terrain that slopes gently downward from the mountains to the ocean. The elevation of the project area ranges from between approximately 35 to 230 feet above mean sea level. There are no significant terrain features such as cliffs, bluffs, or hills in the project area.

Meteorology/Climate. The island of Hawaii is located in the tradewind band. During most of the year, winds are predominantly from the east by northeast. These tradewinds flow around the high volcanic mountains on the island and are redirected along the North Kona coast from the east by southeast direction. Average monthly temperatures range from the low 70s in February, the coldest month, to the upper 70s in August and September. Annual rainfall is approximately 10 to 20 inches per year. About 60 percent or more of the annual rainfall occurs in the winter months between November and February.

DUCT ENCASEMENT DETAIL



69 kV SOLID DIELECTRIC CABLE



KEAHOLE-KAILUA
TRANSMISSION LINE PROJECT

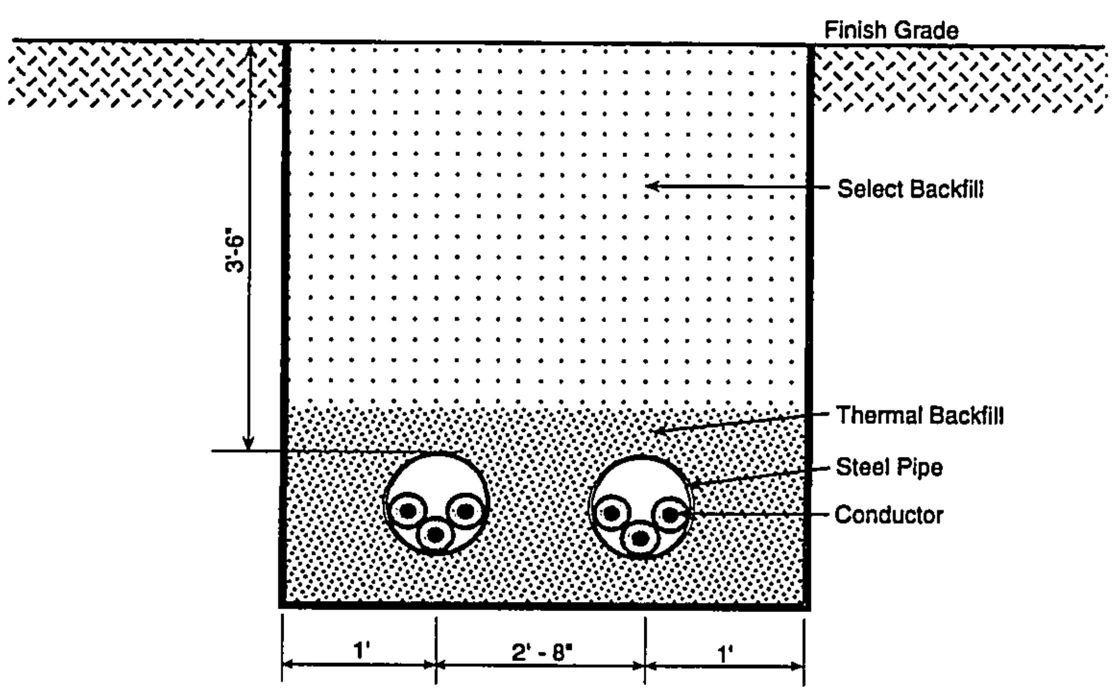
FIGURE 5-9

CONCEPTUAL DESIGN OF A 69kV UNDERGROUND CABLE SYSTEM IN CONCRETE ENCASED PVC DUCT BANK

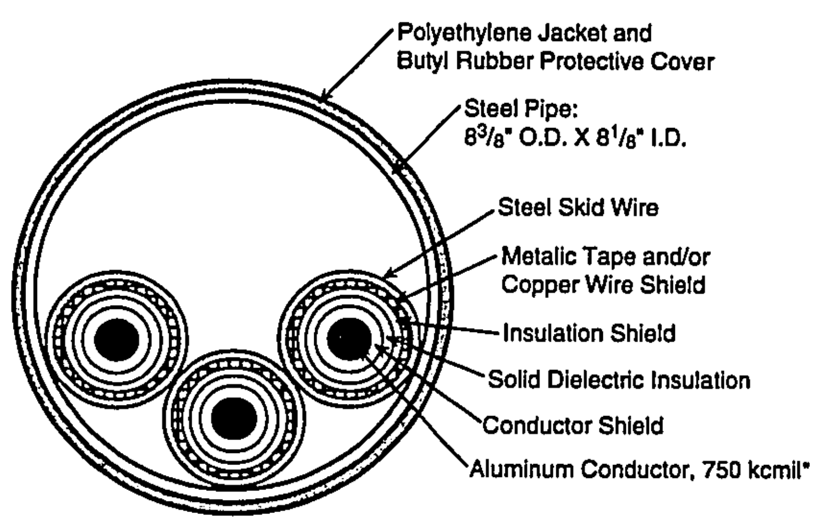
NOT TO SCALE

CH2M HILL

TYPICAL STEEL PIPE UNDERGROUND CABLE TRENCH



69 kV SOLID-DIELECTRIC CABLE FOR USE IN STEEL PIPE



*thousand circular mils

KEAHOLE-KAILUA TRANSMISSION LINE PROJECT

FIGURE 5-10

CONCEPTUAL DESIGN OF A 69 kV UNDERGROUND CABLE IN STEEL PIPE SYSTEM

NOT TO SCALE

CH2M HILL

Table 5-12
Magnetic Field Levels with Optional Underground Configurations

Page 1 of 2

Typical Configurations	Description	Magnetic Field (mG) Distance from Centerline of Pole Near Ground Level (feet) -20	0	100	200	300
Existing Overhead Line	Assumed existing amperage (73 A)	2.27	3.40	0.45	0.13	0.07
Single-circuit 69 kV	Normal maximum amperage (900 A)	28.56	40.87	5.42	1.61	0.84
Single-circuit 12 kV underbuild	Emergency maximum amperage (1,035 A)	32.85	46.99	6.23	1.86	0.97
Proposed Overhead Line Configuration No. 1						
Double-circuit, single-sided 69kV	Assumed existing amperage (73 A/73 A)	1.03	1.29	0.19	0.08	0.05
Single-circuit 12 kV underbuild	Normal maximum amperage (900 A/900 A)	12.23	14.52	2.15	0.90	0.56
Low-reactance phasing	Emergency maximum amperage (1,035 A/1,035 A)	14.06	16.69	2.47	1.03	0.65
Proposed Overhead Line Configuration No. 2						
Double-circuit, double-sided 69 kV	Assumed existing amperage (73 A/73 A)	0.69	1.01	0.07	0.03	0.02
Single-circuit 12 kV underbuild	Normal maximum amperage (900 A/900 A)	10.93	16.43	0.95	0.36	0.23
Low-reactance phasing	Emergency maximum amperage (1,035 A/1,035 A)	12.61	18.95	1.09	0.42	0.27
Proposed Underground Three Single Conductor 69 kV Underground Cables in PVC Ducts						
With existing overhead line configuration	Assumed existing amperage (UG 73 A/OH 73 A)	10.44	2.81	0.42	0.08	0.05
	Normal maximum amperage (UG 890 A/OH 890 A)	127.28	34.26	5.12	0.98	0.61
	Emergency maximum amperage (UG 1,020 A/OH 1,020 A)	145.88	39.26	5.87	1.12	0.70

Table 5-12
Magnetic Field Levels with Optional Underground Configurations

Typical Configurations	Description	Magnetic Field (mG) — Distance from Centerline of Pole Near Ground Level (feet) -20	0	100	200	300
Underground Option 1						
Six UG single-conductor cables, two cables per phase	Assumed existing amperage (UG 73 A/OH 73 A)	0.82	3.19	0.40	0.10	0.05
Low-reactance phasing	Normal maximum amperage (UG 890 A/OH 890 A)	10.00	38.89	4.88	1.22	0.61
One cable in each of 6 PVC ducts	Emergency maximum amperage (UG 1,020 A/OH 1,020 A)	11.46	44.57	5.59	1.40	0.70
With existing overhead line configuration						
Underground Option 2						
Six UG single-conductor cables, two cables per phase	Assumed existing amperage (UG 73 A/OH 73 A)	2.02	3.22	0.40	0.10	0.05
Three cables in each of two steel pipes	Normal maximum amperage (UG 890 A/OH 890 A)	24.63	39.26	4.88	1.22	0.61
With existing overhead line configuration	Emergency maximum amperage (UG 1,020 A/OH 1,020 A)	28.23	44.99	5.59	1.40	0.70

Notes: All values calculated for 1 meter aboveground. Assumes equalization of currents in each of the three conductors in a circuit. Underground 69 kV cables buried at -20 feet from existing pole, shielded to eliminate any measurable electric field outside of cable, with single-point grounded cables, and with the assumption of no induced sheath currents.

Key: UG = underground circuit's total amperage
OH = overhead circuit's amperage

Source: Enertech Consultants and Power Delivery Consultants.

Air Quality Monitoring. HELCO operates an air quality monitoring station approximately 0.8 mile southeast of Keahole Generating Station. The Hawaii State Department of Health also maintains a station located at the Kona Health Center at Kealakekua about 25 miles south of Keahole. Table 5-13 shows maximum background concentrations using data from these two monitoring stations for sulfur dioxide (SO_2), particulate matter less than 10 microns in diameter (PM_{10}), total suspended particulate matter (TSP), and nitrogen dioxide (NO_2).

Table 5-13
Maximum Background Concentrations of Selected Pollutants

Pollutant	Averaging Period	Maximum Background Concentration ($\mu g/m^3$)	Monitoring Location[a]
Sulfur dioxide	3-hour 24-hour Annual	110.0 20.4 0.3	1 1 1
PM_{10} (particulate matter less than 10 microns in diameter)	24-hour Annual	38 14	2 2
TSP (total suspended particulate matter)	24-hour Annual	28 14	2 2
Nitrogen dioxide	Annual	2	1

[a]Monitoring locations: (1) Keahole air quality monitoring station, and (2) Department of Health station located at the Kona Health Center at Kealakekua, about 25 miles south of Keahole.

Note: $\mu g/m^3$=microgram per cubic meter.
Source: Ogden Environmental and Energy Services, October 1992.

Applicable Air Quality Regulations. Air quality standards that apply to this project are the National Ambient Air Quality Standards (NAAQS) (EPA, 40 Code of Federal Regulations [CFR] 50, as amended), and Hawaii Administrative Rules [HAR], Title 11, Chapters 59 and 60, "Hawaii Ambient Air Quality Standards" and "Hawaii Air Pollution Control Rules," respectively. The Environmental Management Division of the State of Hawaii Department of Health (DOH), Clean Air Branch (CAB), is responsible for implementing and enforcing both state and federal air quality regulations. No air quality standards have been adopted specific to the island of Hawaii.

NAAQS standards represent the maximum pollution levels considered to be acceptable, with an adequate margin of safety, to protect public health and welfare. NAAQSs have been established for the following six criteria pollutants: sulfur dioxide (SO_2), nitrogen dioxide (NO_2), carbon monoxide (CO), ozone (O_3), particulate matter less than 10 microns in diameter (PM_{10}), and lead (Pb).

State standards are more stringent than the comparable national standards for carbon monoxide, ozone, and nitrogen dioxide. Hawaii also has standards for hydrogen sulfide (H_2S). However, Hawaii's ambient air quality standards have not yet been modified to conform to NAAQSs, which, since 1987, have used PM_{10} instead of TSP. Table 5-14 shows both federal and state ambient air quality standards. A comparison of Table 5-14 with Table 5-13 shows that the project area and surrounding region are well below both national and state air quality standards for designated criteria pollutants.

Attainment areas are defined as areas that have air quality better than the national standards. Areas with air quality worse than these standards are designated as nonattainment areas. EPA has classified the Keahole area as either attainment or unclassifiable for all NAAQS.

Noise

Background and Regulations. The unit commonly used for describing the magnitude of a sound is the "decibel" (dB). Because the human ear is less sensitive to sounds in the high and low frequency ranges, a weighting scale is sometimes used to approximate the response of the ear. This is called "A-weighting" and is abbreviated "dBA."

Sound levels vary with time, and several methods are used to quantify the loudness of sound over a given time period. The equivalent sound level (L_{eq}) is the energy average of the sound pressure level over a predetermined period of time (usually an hour). The day-night sound level (L_{dn}) is a 24-hour average sound level with an additional 10 dBA added to nighttime sound levels to account for increased human sensitivity to nighttime noise.

The percentile exceeded sound level (L_{xx}) denotes the sound level that is exceeded for that percentage of time. For example, an L_{10} of 60 dBA means that the sound level equals or exceeds 60 dBA 10 percent of the time.

Table 5-14
Summary of State of Hawaii and Federal Ambient Air Quality Standards

Pollutant	Hawaii State Standard	Federal Primary Standard[a]	Federal Secondary Standard[b]
Carbon Monoxide			
1 hour	10 mg/m³	40 mg/m³	40 mg/m³
8 hour	5 mg/m³	10 mg/m³	10 mg/m³
Nitrogen Dioxide			
Annual (arithmetic)	70 μg/m³	100 μg/m³	100 μg/m³
TSP (Total Suspended Particulate Matter)			
24-hour	150 μg/m³	—	—
Annual (arithmetic)	60 μg/m³	—	—
PM_{10} (particulate matter less than 10 microns in diameter)			
24-hour	—	150 μg/m³	150 μg/m³
Annual (arithmetic)	—	50 μg/m³	50 μg/m³
Ozone			
1-hour	100 μg/m³	235 μg/m³	235 μg/m³
Sulfur dioxide			
3-hour	1,300 μg/m³	—	1,300 μg/m³
24-hour	365 μg/m³	365 μg/m³	—
Annual (arithmetic)	80 μg/m³	80 μg/m³	—
Hydrogen sulfide			
1-hour	35 μg/m³	—	—
Lead			
3 months (arithmetic)	1.5 μg/m³	1.5 μg/m³	1.5 μg/m³

[a]Designed to prevent adverse effects on public health.
[b]Designed to prevent adverse effects on public welfare, which include effects on comfort, visibility, vegetation, animals, aesthetics, and soiling and deterioration of materials.

Notes: mg/m³ = milligrams per cubic meter
μg/m³ = micrograms per cubic meter

Source: Ogden Environmental and Energy Services, October 1992.

The minimum change in sound level that can be detected by most people is 3 dBA. An increase of 10 dBA is usually perceived as a doubling in loudness.

The neighbor islands, including the island of Hawaii, currently do not have any noise regulations or standards. On the island of Oahu, Community Noise Control for Oahu sets guidelines for analyzing noise impacts (Title 11, Hawaii Administrative Rules, Department of Health, Chapter 43). For purposes of this noise section, Oahu's noise standards are used. Table 5-15 lists allowable noise levels under these standards for the types of sensitive receptors in and near the project area.

Table 5-15
Allowable Noise Levels
(dBA)

Time	**Zoning**	
	Residential and Preservation	**Hotel, Apartment, and Business**
Daytime (7 a.m. to 10 p.m.)	55	60
Nighttime (10 p.m. to 7 a.m.)	45	50

Notes: Noise levels should not exceed the allowable levels for more than 10 percent of the time (L_{10}) within any 20-minute period, except by permit issued under S11-43-6 of Hawaii Administrative Rules.

The allowable noise level for impulsive sound shall be 10 dBA above the values in this table.

Permitted activities that can exceed the noise levels listed in Table 5-15 for a specified time include noise generated by construction activities. However, permit restrictions for construction activities limit the days and times that construction can take place. These restrictions include:

- No construction activities that produce noise levels in excess of the values in Table 5-14 at or beyond the property line are allowed before 7:00 a.m. or after 6:00 p.m.

- Construction activities that produce noise levels in excess of 95 dBA at or beyond the property line are allowed only between the hours of 9:00 a.m. and 5:30 p.m.

- No construction activities that exceed the noise levels specified in Table 5-14 are allowed on Sundays, New Year's Day, Presidents' Day, Memorial Day, Kamehameha Day, Independence Day, Labor Day, Discoverer's Day, Veterans Day, Thanksgiving Day, or Christmas Day.

- No activities that produce noise levels in excess of 95 dBA at or beyond the property line are allowed on Saturdays.

Existing Conditions. The project area and surrounding region are located on lands zoned by the county as Unplanned, Industrial, Open Space, and Agricultural. Primary noise sources in the project area include Keahole Generating Station, aircraft traffic at Keahole Airport, and vehicular traffic along the entire length of Queen Kaahumanu Highway.

The closest existing noise-sensitive receptor that would be affected by this project is located in Keahole Agricultural Park, a subdivision of approximately 5-acre lots used for diversified agriculture. Single-family dwelling units have been developed on 21 of the 34 lots. The closest distance between the existing residences at Keahole Agricultural Park and the S-1 mauka transmission line alternative is approximately 300 feet.

Probable Impacts

Air Quality

Construction activities will generate two types of emissions: exhaust from vehicles and construction equipment, and dust produced during subsurface excavation and equipment movement. Air quality impacts associated with these construction activities would be temporary and short-term. Ambient air quality would be affected in areas immediately surrounding each excavation site. Equipment exhaust emissions will be small, localized, and transient. Particulate emissions are not expected to be significant. Air quality impacts associated with maintenance vehicle emissions would not be significant.

S-1 Mauka Overhead Alternative. Subsurface construction associated with implementation of this alternative would be limited to the removal of existing poles and placement of new transmission line poles in either existing or new subsurface foundations. Minor amounts of two types of air emissions may result from construction activities—particulates from soil disturbance and emissions from heavy construction equipment. Ambient air quality at and surrounding each excavation site will be affected temporarily during construction and regrading. Because construction activities will continually move from one section of the line to the next, particulate levels should not be highly concentrated in any one area. The contractor will be required to minimize airborne particulates through wind erosion control measures if soil and wind conditions indicate that this could become a problem. Emissions of pollutants from heavy vehicles and equipment used to excavate, transport equipment and supplies, and set piles will be controlled through proper maintenance of emission control devices in these vehicles and equipment. Air quality impacts resulting from these construction activities would be short-term and would not be significant.

S-1 Mauka Underground Alternative. Air quality impacts generated by construction activities with the S-1 mauka underground alternative would be comparable to but of longer duration than the overhead alternatives, and the impacts would also not be significant.

Noise

Construction equipment would be the principal generator of noise for the proposed transmission line alternatives. Noise from construction equipment would vary significantly during construction. Variations would result from the different types and numbers of equipment operating at any one time, the level of noise generated by each piece of equipment, the distance between the equipment and the listener, and meteorological and topographical conditions.

General construction procedures for an overhead transmission line include foundation installation, pole erection, insulator installation, and conductor stringing. Construction of an underground transmission line requires trenching and laying pipes along the entire length of the route. These activities would temporarily increase noise levels in the immediate vicinity of construction. In addition, some traffic noise will be generated by construction workers and materials moving along the length of the line. However, noise levels would decrease with distance from the construction site and these noise impacts would be short-term and intermittent.

Table 5-16 lists typical sound levels for construction equipment compared to common noise sources. A comparison of construction equipment sound levels in Table 5-16 with the current Oahu noise standards in Table 5-16 indicates that, for some periods, certain construction activities are anticipated to exceed the noise standard specified for nearby land uses.

Long-term operational noise impacts are not anticipated. Transmission lines, particularly lines energized at 345 kV and above, generate a small amount of audible noise. This operational noise is caused by corona activity. Increased corona activity during wet weather sometimes causes a crackling or humming sound near the line. This noise is caused by small electrical discharges from water drops that collect on the conductor. However, this type of noise is not normally audible on 69 kV lines.

S-1 Mauka Overhead Alternative. This alternative requires a minimum of subsurface construction. Foundation installation, pole erection, and insulator and conductor stringing will increase noise levels in the immediate vicinity of the activity.

The noise impacts of the construction activities will be short-term and periodic. Noise impacts at any one location will last only a few days at a time as various stages of the construction sequence are completed along each portion of the line. The alternative is located along the Queen Kaahumanu Highway corridor, which is itself an existing noise source. Noise impacts from construction and operation of this alternative would be negligible.

Table 5-16 Comparison of Transmission Line Construction Equipment Noise with Other Common Sound Levels	
Equipment	A-Weighted Sound Level at 50 Feet, Unless Otherwise Specified (dBA)
Broadcasting studio	20
Human voice—soft whisper (15 feet)	0
Light auto traffic (50 feet)	50
Air conditioning unit (20 feet)	60
Air compressor	67
Freeway traffic	70
*Crawler tractor (20 to 199 horsepower)	72
*Wheeled tractor	72
Freight train	75
*Truck, pickup, and four-wheel drive	77
*Concrete mixer, truck-mounted	78
*Crawler tractor (200 to 450 horsepower)	78
*Pulling machine	78
*Tensioning machine	78
*Truck, mounted with boring equipment	78
*Truck, flatbed	78
*Truck, rear dump	78
*Dozer	82
*Crane, mobile (15- to 20-ton)	83
*Paving breaker	85
*Pneumatic tools	85
*Crane, mobile (50-ton)	88
Human voice—shout (0.5 foot)	100
Jet takeoff (2,000 feet)	105
*Single-action air compressor for pile driver	105
Auto horn (3 feet)	115
Jet takeoff (200 feet)	120

*Construction equipment.
Adapted from Shell California Production, Inc., 1982, and Tomlinson, 1977.

S-1 Mauka Underground Alternative. With this alternative, noise impacts from construction activities would be of longer duration than for the S-1 overhead alternatives and are related to underground construction. However, these impacts would be negligible.

Mitigation

Air Quality

Mitigation for air quality impacts would be comparable for both the S-1 mauka overhead and underground alternatives. Wind erosion control and dust suppression measures (including proper maintenance and use of watering equipment) should be implemented during construction to minimize dust. Proper maintenance of construction vehicles and equipment can reduce combustion emissions.

Noise

Mitigation for noise impacts would be comparable for both the S-1 mauka overhead and underground alternatives. Properly muffled equipment should be used during construction, and contract provisions should specify acceptable hours for construction and identify enforcement provisions. Particular attention should be given to controlling noise and the hours of construction near residences (e.g., near the Keahole Agricultural Park).

Utilities and Pipelines

Environmental Setting

Existing Utilities and Pipelines

Electric Utilities. An existing 69 kV transmission line is located within the mauka edge of the Queen Kaahumanu Highway right-of-way between the Keahole Generating Station and Kailua Substation. The existing 69 kV transmission line poles also carry cable television and telephone lines and provide an overbuild opportunity for the proposed 69 kV line. The proposed 69 kV line can occupy the same alignment as the existing 69 kV transmission line, cable television lines, and telephone lines.

Water and Sewer Infrastructure. In addition to the electrical utility lines described above, each of the proposed alignments crosses and/or is located adjacent to water and sanitary sewer lines.

An existing 16-inch water main extends northward from Palani Road in Kailua within the mauka edge of the Queen Kaahumanu Highway right-of-way for a distance of approximately 2 miles to Honokohau Harbor. From Honokohau Harbor northward, the water main reduces to a 12-inch water main until it reaches Keahole Airport. A 12-inch main connects into the main within Queen Kaahumanu Highway at Keahole Airport Road, and it also connects to a 0.5-million-gallon water tank mauka of the Keahole Generating Station. Other water lines in the project area tap into the line within Queen Kaahumanu Highway. These lines include a 12-inch main extending along Kaiminani Drive and a 12-inch main extending makai from Queen Kaahumanu Highway along the access road to Honokohau Harbor.

Wastewater disposal for most of the existing developments in the Keahole-Kailua study area is provided by septic tanks and/or cesspools.

An existing sewer force main extends mauka from the Kealakehe Wastewater Treatment Plant across Queen Kaahumanu Highway to the proposed Kealakehe Residential Community golf course. This sewer force main will convey treated effluent to be used for golf course irrigation.

Oil and Gas Pipelines. There are no existing oil or gas pipelines located in the study area.

Proposed Utilities and Pipelines

Water and Sewer Infrastructure. A new 16-inch water line mauka of Queen Kaahumanu Highway parallel to the existing 12- or 16-inch water lines is planned. New 20-inch and 16-inch mauka-makai water mains are planned along Hina Lani Drive and Kealakehe Parkway, respectively. A new 2.0-million-gallon water reservoir is also planned adjacent to the existing water tank near Keahole Generating Station.

A second municipal wastewater treatment plant is proposed about 2.5 miles north of Keahole Airport. The proposed Ooma and Kohanaiki developments, as well as Keahole Airport, plan to use small sewage treatment plants.

Two effluent disposal mains that would convey flows into the Kealakehe Wastewater Treatment Plant are proposed along the mauka edge of Queen Kaahumanu Highway between Kailua and the Keahole Agricultural Park. A 16-inch sewer main would convey flows into the Kealakehe Wastewater Treatment Plant from the north, and a 12-inch sewer main would convey flows into the plant from the south.

Oil and Gas Pipelines. The Airports Division of the State of Hawaii Department of Transportation plans to develop an energy corridor right-of-way following Queen Kaahumanu Highway for construction of a fuel pipeline from Kawaihae Harbor to Keahole Airport, a distance of approximately 27 miles. This 12-inch multiproduct pipeline would transport gasoline, jet fuel, aviation gas, and diesel fuel. A preliminary study for this project indicates that the proposed fuel pipeline is feasible. However, this corridor will not be constructed until the economics of increased air traffic make the project economically feasible. No further action on this project is anticipated within the next 5 years.

Probable Impacts

S-1 Mauka Overhead Alternative

This alternative would involve replacing existing 69 kV transmission line poles with new poles at or near the existing alignment and would therefore have a low potential for significant adverse impacts or conflicts with utilities. Complete surveys would be conducted prior to construction to locate all utilities within the proposed alignment, and all contractors would be responsible for installing below-ground foundations without damaging existing utility lines. Owners of adjacent utilities would be consulted regarding construction schedules and methods. Construction plans would be submitted to the County of Hawaii Department of Public Works and other relevant agencies before construction proceeds.

S-1 Mauka Underground Alternative

Impacts would be comparable to the overhead alternative, except that more effort would have to be given to planning the trenching to avoid impacts to existing utilities.

Mitigation

Because standard construction practices and required permits would assure that no significant adverse impacts to utilities would occur from either the overhead or underground alternative, no additional mitigation has been identified.

Public Services

Environmental Setting

Public services located in the vicinity of the project area are shown in Figure 5-1. The most significant issue regarding existing and/or proposed public services—including police protection, fire protection, schools, solid waste facilities, and hospitals and clinics—is their proximity and sensitivity to the proposed transmission line. A more detailed description of existing and proposed public services within and near the project area is provided below.

Existing Public Services

Police Protection. The Hawaii County Police Department has a staff of 60 officers serving the North Kona district. The North Kona District Police Station is located about 800 feet mauka of Queen Kaahumanu Highway near the Kealakehe Landfill and approximately 5 miles south of Keahole Generating Station.

Fire Protection. The Kailua Fire Station, located on Palani Road mauka of Queen Kaahumanu Highway, provides fire protection service to the North Kona district. The Kailua station has a staff of 33. Existing equipment used at this station includes one ladder truck, one fire engine, one tanker, one rescue boat, and one ambulance unit.

Schools. There are no schools in the vicinity of the proposed transmission line alternatives.

Solid Waste. Solid waste generated in the West Hawaii area is currently disposed of at the 15-acre county-operated Kealakehe Landfill, located about 1 mile north of Kailua and approximately 1,500 feet mauka of Queen Kaahumanu Highway. Closure of the Kealakehe

Landfill will commence when the new county landfill near Puu Anahulu begins operating sometime in 1993 or 1994. The landfill closure process may take 15 to 30 years.

Hospitals and Clinics. Kona Hospital is located in Kealakekua approximately 16 miles south of Kailua and provides emergency care in the study region. The only medical-related facility near the project area is the Pregnancy Problem-Free Test Center of Kona on Kaiwi Street in Kailua.

Proposed Public Services

Schools. The *Keahole to Kailua Development Plan* shows development proposals for several education centers—including a high school, a middle school, and two new elementary schools—mauka of the project area. The plan shows conceptual locations for schools near the proposed residential villages mauka of the S-1 mauka overhead transmission line alternative. The development plan calls for more detailed site location studies before new school facilities are sited.

Solid Waste. The county's new 300-acre West Hawaii Sanitary Landfill is being developed at Puu Anahulu approximately 7.5 miles northeast of the Keahole Generating Station. The new county landfill will include recycling and resource recovery facilities to serve the North and South Kona and Kohala districts. The proposed landfill is expected to begin operation in 1993 or 1994 and is projected to accommodate an initial solid waste volume of 70,300 tons per year.

Probable Impacts

S-1 Mauka Alternatives

No significant impacts to public services are anticipated from the S-1 mauka overhead or underground alternatives. Project construction would generate negligible demand for temporary housing or other services for construction workers. No public services would be required by HELCO for its maintenance operations.

The only public service facilities near the proposed alignment are Kealakehe Landfill and the North Kona District Police Station, which are located mauka of Queen Kaahumanu Highway. No construction or long-term impacts are expected to these public service facilities.

Mitigation

No mitigation measures are required because no significant impacts to public services have been identified.

CHAPTER 6

Chapter 6
Relationship of the Proposed Project to Land Use Plans, Policies, and Controls

Land Use Designations

State Land Use Designation

The two proposed transmission line alternatives are located within the state land use Urban, Agricultural, and Conservation (General Subzone) Districts.

Urban district land within the project area includes those portions of the Queen Kaahumanu Highway right-of-way adjacent to Kaloko Industrial Park and within the Kaiwi Street right-of-way in the Kona Industrial Subdivision area. State Agricultural District lands include those portions of the Queen Kaahumanu Highway right-of-way adjacent to the area of the proposed Keahuolu Lands project near the Queen Liliuokalani Children's Center. Most of the land within the project area includes those portions of the Queen Kaahumanu Highway right-of-way that are designated Conservation District, General Subzone.

According to state land use law (Chapter 205, Hawaii Revised Statutes [HRS]), a transmission line is a permitted use in the Urban and Agricultural Land Use Districts. Approval of a Conservation District Use Application (CDUA) is required for construction of a transmission line in a state Conservation District. However, of the four Conservation District subzones (General, Limited, Resource, and Protective), the General Subzone is the least restrictive, and siting a transmission line within this subzone is normally permitted. The S-1 mauka overhead and underground alternative alignments pass through areas designated Conservation Land Use District General Subzone.

County Zoning

Four County of Hawaii zoning designations cover the project area traversed by the two proposed transmission line alternatives: Open Space, Unplanned, Industrial, and Agriculture.

The Open Space zoning designation covers the majority of land immediately mauka of the paved area of Queen Kaahumanu Highway within the highway's right-of-way. Kaiwi Street within the Kona Industrial Subdivision is zoned Industrial. Areas zoned Unplanned are located mauka of the paved area of Queen Kaahumanu Highway near the proposed Keahuolu Lands project, the Queen Liliuokalani Children's Center, and Kona Industrial Park.

Transmission lines are allowable uses in all County of Hawaii zoning districts. No County of Hawaii zoning approvals are required for implementation of the S-1 mauka overhead alternative or the S-1 mauka underground alternative.

Conformance to Land Use Laws, Plans, and Policies

The following laws, plans, and policies apply to the Keahole to Kailua 69 kV transmission line project:

- State Land Use Law, Chapter 205, HRS
- Hawaii Coastal Zone Management Program and Special Management Area, Chapter 205A, HRS
- Hawaii State Plan, Chapter 226, HRS
- *State Energy Functional Plan*
- The State of Hawaii's *West Hawaii Regional Plan*
- *County of Hawaii General Plan*
- *Keahole to Kailua Development Plan*

The State of Hawaii and the County of Hawaii have adopted these plans to guide the physical, social, and economic development of the islands. They contain general goals, objectives, and policies that encourage the controlled development of natural resources. The following paragraphs describe how the proposed project conforms with these plans and policies.

State Land Use Law (Chapter 205, HRS)

The State of Hawaii Land Use Commission, pursuant to HRS Chapter 205, has established Land Use Districts (LUDs) throughout the state. Three LUD designations–Urban, Agricultural, and Conservation–apply to lands within the Keahole-Kailua project area. According to state land use law (Chapter 205, HRS), overhead transmission lines are a permitted use within Urban and Agricultural LUDs, but siting new lines in a Conservation LUD requires a CDUA with review and approval by the Board of Land and Natural Resources.

Submittal of a CDUA triggers the Chapter 343 HRS environmental reporting requirements that mandate either an environmental impact statement (EIS) or environmental assessment (EA) be prepared on the project. This EIS for the Keahole-Kailua project is being prepared pursuant to Chapter 343 HRS requirements because the proposed transmission line would be located on state land and is in a designated Conservation District. The Department of Land and Natural Resources is the accepting authority for this EIS.

Hawaii Coastal Zone Management Program and Special Management Area (Chapter 205A, HRS)

The purpose of the Hawaii Coastal Zone Management Program (HCZMP) is to establish guidelines for the use, protection, and development of the resources in the coastal zone. Development activities in the coastal zone must conform to the HCZMP objectives and policies, as outlines in Chapter 205A of the Hawaii Revised Statutes.

As part of the HCZMP, the County of Hawaii Planning Department designates and administers the SMA that controls development along the shoreline. Activities in the SMA that exceed $125,000 in value or that may have a significant adverse effect on the environment generally require a permit issued by the County of Hawaii Planning Department and approved by the Planning Commission.

The proposed transmission line alternatives are on the mauka side of Queen Kaahumanu Highway and along the north edge of Kaiwi Street in the Kona Industrial Subdivision area. Because the SMA is on the makai side of Queen Kaahumanu Highway's center line and north of the Kona Industrial Subdivision area, the objectives and policies of the HCZMP do not apply to this project.

Hawaii State Plan (Chapter 226, HRS)

The portion of the Hawaii State Plan that is most directly relevant to the proposed project is Section 226-18, "Objectives and Policies for Facility Systems—Energy/Telecommunications," which reads as follows:

(a) Planning for the State's facility systems with regard to energy/ telecommunications shall be directed towards the achievement of the following objectives:

  (1) Dependable, efficient, and economical statewide energy and telecommunication systems capable of supporting the needs of the people.

(b) To achieve the energy/telecommunication objectives, it shall be the policy of this State to ensure the provision of adequate, reasonably priced, and dependable power and telecommunication services to accommodate demand. (State of Hawaii, Office of State Planning, 1991)

The proposed project supports these policies because the principal goal of the Keahole-Kailua 69 kV transmission line project is to ensure the dependable, efficient, and economic provision of electricity to growing electrical demands on the west side of Hawaii.

Section 226-18(C)(4) states that:

(c) To further the energy objectives, it shall be the policy of this State to:

> (4) Ensure that the development or expansion of power systems and sources adequately consider environmental, public health and safety concerns, and resource limitations. (State of Hawaii, Office of State Planning, 1991)

Comprehensive planning and analysis support HELCO's development of the project. This EIS records the environmental, public health and safety, and other resource considerations that are fundamental to the planning of the project, the evaluation of alignment alternatives, and the selection of the preferred alignment.

This EIS also documents that the project complies with Section 226-11(b)(2-4), "Objectives and Policies for the *Physical Environment—Land-Based, Shoreline, and Marine Resources*":

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

> (2) Ensure compatibility between land-based and water-based activities and natural resources and ecological systems.
>
> (3) Take into account the physical attributes of the areas when planning and designing activities and facilities.
>
> (4) Manage natural resource and environs to encourage their beneficial and multiple use without generating costly or irreparable environmental damage. (State of Hawaii, Office of State Planning, 1991)

During the corridor selection process, water-based activities and natural areas along the shorelines were avoided; instead, existing physical features of the study area were considered. For example, existing rights-of-way and linear facilities were considered an opportunity for siting the new line in order to minimize impacts on existing land uses.

State Functional Plan for Energy

The state functional plan for energy (State of Hawaii, Department of Business, Economic Development and Tourism, 1991) addresses objectives, policies, and implementing actions in the following areas:

- Energy conservation and efficiency

- Alternate and renewable energy
- Energy education
- Legislation
- Integrated energy management
- Energy emergency preparedness

The proposed project does not conflict with any of the objectives, policies, or implementing actions of the *State Energy Functional Plan*, which addresses generation and conservation rather than transmission issues.

The State of Hawaii's West Hawaii Regional Plan

The *West Hawaii Regional Plan* (State of Hawaii, Office of State Planning, 1989) is intended to complement the County of Hawaii's plans and provides guidelines for the development of the West Hawaii area. The section that applies to this project is "Energy and Power Facilities." This section states that the West Hawaii area is expected to have a large amount of growth, primarily from resort developments. According to the report, total electricity requirements for each resort development are typically 5 to 10 megawatts, or about the same as the entire island of Molokai. These power requirements do not include the demands of population growth, increased residential and commercial activities, and associated developments such as marinas.

The *West Hawaii Regional Plan* states that, to meet the increasing demands of the region, new power lines will need to be constructed or improvements made to existing power lines. The plan asserts that power line impacts on the projected resort communities as well as existing residential communities should be assessed. Public concerns about new power line construction to be assessed include the possibility of lower property values, the effect on view planes, and the health effects of electromagnetic fields. The plan suggests that disruption of established communities can be reduced by establishing utility corridors to accommodate projected electrical demand prior to projected development.

The following strategies and actions in the *West Hawaii Regional Plan* apply to this project:

Strategies

- Minimize the negative impacts of changes in the fuel and power generation and delivery systems on existing and new communities of residents and visitors. (State of Hawaii, Office of State Planning, 1989)

The route selection process analyzed in this EIS was undertaken to identify the most environmentally benign alternative alignments for siting and constructing the Keahole-Kailua 69 kV transmission line. Therefore, implementation of the preferred alignment would minimize negative impacts on both existing and future communities of residents and visitors resulting from this project.

Actions

- Devise a long-term integrated resource plan that provides for the energy needs of West Hawaii residents, workers, guests and businesses in the most economical and environmentally acceptable manner. (State of Hawaii, Office of State Planning, 1989)

The objective of the Keahole-Kailua transmission line is to meet the long-term energy needs of the West Hawaii communities. According to HELCO's 1991 application to the PUC, more than half of HELCO's forecasted demand between 1990 and 1994 for the island of Hawaii is expected to occur in the West Hawaii area (PUC Docket No. 7040). This EIS supports the conclusion that the preferred alignment represents the most environmentally sound and economically feasible solution to providing the Keahole-Kailua area with the capability of carrying sufficient electrical energy to accommodate recent population growth, as well as the demands of future growth.

- Encourage early communication between the electric utility and potentially affected communities regarding power plant siting, power line corridors, likely emission levels, and other concerns in planning for the region. (State of Hawaii, Office of State Planning, 1989)

As part of the route selection process and environmental analysis for the proposed Keahole-Kailua transmission line project, HELCO has developed a comprehensive public involvement plan that established a forum for public participation and ensured that the public's concerns and values regarding transmission line corridors were considered throughout the corridor and alignment selection planning process (see Chapter 12, "Public Involvement"). Public involvement activities for this project began early in the corridor selection process when agencies, landowners, governmental decision makers, and other key individuals were informally consulted during the regional study. Workshops were also conducted to solicit opinions and identify public concerns before selecting a preferred transmission line corridor and a preferred alignment.

- Establish utility rights-of-way in new or proposed urban and residential developments to facilitate the expansion of water, gas and electric services while minimizing disruptions to established communities. (State of Hawaii, Office of State Planning, 1989)

The proposed alignment is located within the existing right-of-way of Queen Kaahumanu Highway. Placement of the new line within this existing transportation and utility right-of-way would serve future developments planned in the areas both mauka and makai of Queen Kaahumanu Highway while minimizing disruptions to existing developments in the study region.

Hawaii County General Plan

The *Hawaii County General Plan* (Hawaii County, Department of Planning, 1989) has goals, policies, and standards for 13 issues: economics, energy, environmental quality, flood control and drainage, historic sites, natural beauty, natural resources and shoreline, housing, public facilities, public utilities, recreation, transportation, and land use. The applicable goals, policies, and standards that apply to this project are listed below:

B. Energy

Policies

- The County shall strive to assure a sufficient supply of energy to support present and future demands. (Hawaii County, Department of Planning, 1989)

The Keahole-Kailua 69 kV transmission line project is designed to increase the reliable supply of electrical service to existing and future electrical customers in the West Hawaii region; therefore, the project supports this policy of the general plan.

J. Public Utilities

Goals

- Ensure that adequate, efficient and dependable public utility services will be available to users.
- Maximize efficiency and economy in the provision of public utility services. (Hawaii County, Department of Planning, 1989)

The proposed transmission line supports these goals because it would be designed to provide efficient and reliable electrical service to the West Hawaii region at a minimal cost to existing and future electrical consumers. (See Table 4-2 for a comparison of relative capital costs among different transmission line technologies and the costs associated with the overhead and underground alignments).

- To have public utility facilities which are designed to fit into their surroundings or concealed from public view. (Hawaii County, Department of Planning, 1989)

No landscape mitigation is proposed for the S-1 mauka overhead alternative (see the visual resources section of Chapter 5) because any landscaping would be incompatible with the Hawaii Department of Transportation's long-range plan for widening Queen Kaahumanu Highway from its present two lanes to its ultimate configuration of four lanes with additional frontage roads on both the mauka and makai sides of the highway. It would be more appropriate to develop landscape mitigation in conjunction with the proposed widening of the highway.

As the proposed developments within the study area are built, the existing poles and the slightly taller poles in the S-1 mauka overhead alignment will blend in more and more with the urban texture of the area. Implementation of the S-1 mauka underground alternative would not result in any visual impacts.

Policies

- Public utility facilities shall be designed so as to complement adjacent land uses and shall be operated so as to minimize pollution or disturbance. (Hawaii County, Department of Planning, 1989)

As described in the land use, demographics, and employment section of Chapter 5 of this EIS, the proposed overhead or underground transmission line alternatives would not significantly interfere with either existing or proposed land uses in the planning area. In addition, potential pollution or disturbance in the project area would occur primarily during construction, and any air quality impacts would be intermittent and temporary.

- Provide utilities and service facilities which minimize total cost to the public and effectively service the needs of the community. (Hawaii County, Department of Planning, 1989)

The estimated capital costs associated with each of the proposed alternative alignments are shown in Table 4-2. Table 4-2 indicates that the S-1 mauka underground alternative would be four to eight times more expensive than the S-1 mauka overhead alternative alignment. Implementation of the S-1 mauka overhead alternative would serve the growing electrical demands of the community at a considerably lower total cost.

- Utility facilities shall be designed to minimize conflict with the natural environment and natural resources. (Hawaii County, Department of Planning, 1989)

This EIS documents the extensive analysis of the natural environmental factors and natural resources of the proposed alternative alignments (including biological, geological, and water resources) that contributed to selection of the preferred alignment in an area that minimizes conflicts with these and other resources.

- Improvement of existing utility services shall be encouraged to meet the needs of users. (Hawaii County, Department of Planning, 1989)

As a result of recent and projected electrical load growth in West Hawaii, HELCO must expand and improve the West Hawaii transmission system to accommodate increasing electrical demand. In addition, recent blackouts have raised concerns regarding the reliability of electrical service in the region. In order to meet future system load projections and provide for transmission system reliability, the proposed Keahole-Kailua 69 kV line would improve the existing quality of electrical service to consumers in West Hawaii.

(3) Electricity

Policies

- Power distribution shall be placed underground when and where feasible. The County shall encourage developers of new urban areas to place utilities underground. (Hawaii County, Department of Planning, 1989)

Although distribution lines (i.e., 12 kV lines delivering power from substations to customers) are commonly placed underground in new subdivisions and urban areas; transmission lines (on Hawaii, 69 kV lines delivering power from power plants to substations or from one substation to another) are rarely placed underground. The proposed Keahole-Kailua transmission line would be a 69 kV transmission line, rather than a distribution line, and therefore this policy does not apply to the proposed line.

- Route selection for high voltage transmission lines should include consideration for setbacks from major thoroughfares and residential areas. (Hawaii County, Department of Planning, 1989)

The proposed S-1 mauka overhead or S-1 mauka underground alternative would be sited an appropriate distance from the center line of Queen Kaahumanu Highway to minimize potential risks involving automobile accidents or other dangers. The S-1 mauka alternatives would be located along nearly the same alignment as the existing 69 kV transmission line.

As part of the corridor and alignment selection process, existing residential areas were rated high constraint because people spend a significant amount of time in their residences and are concerned about the potential health and aesthetic effects of transmission lines. Proposed residential land uses were rated medium constraint because these projects provide opportunities for siting transmission lines into or around proposed development before the project is constructed. During the corridor selection process, high-constraint areas were avoided as much as possible, except where opportunities were created by a transportation system such as the Queen Kaahumanu Highway.

- The County should encourage electrical utility companies to develop a comprehensive plan for the generation, transmission, and distribution of electrical power to the various parts of the island. (Hawaii County, Department of Planning, 1989)

Plans to construct a new 69 kV transmission line between the Keahole Switching Station and Kailua Substation are consistent with the goals, policies, and standards of the 1989 *Hawaii County General Plan*. In addition, the *Keahole to Kailua Development Plan* prepared by the County of Hawaii states that full development planned for this region would require construction of one or two additional 69 kV lines within the study area. Implementation of this project is consistent with future plans for regional development articulated in the *Keahole to Kailua Development Plan.*

- Safety standards for power systems shall conform to safety standards as established by appropriate regulatory authority. (Hawaii County, Department of Planning, 1989)

Both the S-1 mauka overhead and the S-1 mauka underground alignment alternatives would support this policy because they would be designed to conform to all applicable safety standards established by the appropriate regulatory authorities governing siting and construction of a new transmission line.

Standards

- There shall be a minimization of obstruction of scenic views and vistas by electrical facilities. (Hawaii County, Department of Planning, 1989)

As described above, no landscape mitigation is recommended for the S-1 mauka overhead alignment (see the visual resources section of Chapter 5 of this EIS). Mauka views from Queen Kaahumanu Highway will eventually be of the proposed developments in the area. The backdrop of the mauka views of the poles would eventually be of this intensely developed urban area. Makai scenic views and vistas are of primary importance and will not be affected by the S-1 mauka overhead alignment. No visual impacts would result from implementation of the S-1 mauka underground alternative.

Hawaii County's Keahole to Kailua Development Plan

The *Keahole to Kailua Development Plan* (Hawaii County, Department of Planning, 1991), prepared by the County of Hawaii, is a land use plan for implementing the goals, policies, and standards of the *County of Hawaii General Plan*, which creates a plan for development in the Keahole to Kailua region. The approximately 17,000-acre planning area covered in the development plan is bounded by the Pacific Coast shoreline to the west, the northern boundary of the Kau ahupuaa on the north, Mamalahoa Highway on the east, and Palani Road and Kailua Village to the south. Approximately 14,000 acres or 82 percent of the study area is undeveloped.

The goal of the *Keahole to Kailua Development Plan* is to "develop a mixed residential, commercial, resort, industrial and recreational community, with approximately 8,000 or more residential units, in a functional, attractive, and financially viable manner. The community will include appropriate shoreline uses, public facilities, and infrastructure and will be built out over the next 20 years."

The *Keahole to Kailua Development Plan* includes a land use plan that provides a framework for future growth and development. Infrastructure plans were also developed for roadways, water supply, sewage, drainage, solid waste, regional parks and open space, and landscaping. The development plan recognizes that expansion of electrical services would be required to meet the future needs of this planned development. According to the development plan, "should full development occur, one or two additional 69 kV lines would be required within the planning area." The proposed Keahole-Kailua 69 kV transmission line would meet this plan's electrical infrastructure needs.

National Flood Insurance Program

The Federal Emergency Management Agency (FEMA) prepared a flood insurance study for the County of Hawaii in 1990 to address flood hazards. Countywide flood insurance rate maps (FIRMs) are included in Hawaii County's Flood Plain Management Program and are codified in Chapter 27 of the Hawaii County Code, Flood Control. The FIRMs delineate base flood elevation lines and special flood hazard areas inundated by 100-year and 500-year floods.

The distance between the shoreline and the S-1 mauka overhead and S-1 mauka underground alignments range from between 2,600 feet at Honokohau Harbor to approximately 2 miles at Keahole Generating Station. These two alignments are located in Zone X. According to the FIRMs, Zone X is an area outside of the 500-year floodplain. Therefore, flood requirements and restrictions do not apply to this project.

Agricultural Lands of Importance to the State of Hawaii

The Soil Conservation Service of the U.S. Department of Agriculture has classified the agricultural lands of the Hawaiian Islands. According to the Agricultural Lands of Importance to the State of Hawaii (ALISH) classification maps, the area of the proposed transmission line alternatives is not designated as Prime Agricultural or Other Important Agricultural Land.

Potential Permits and Approvals

This section discusses the potential federal, state, and county discretionary permits or authorizations that may be required because of the location or design of the Keahole-Kailua 69 kV transmission line project. Potential permits or approvals required for the two proposed transmission line alternatives are listed in Table 6-1. Routine construction permits are not discussed here.

Federal Permits and Approvals

Notice of Proposed Construction or Alteration

Assuming that the height of the transmission line poles in the S-1 mauka overhead alternative would range from 70 to 85 feet, new poles constructed in the vicinity of Keahole Generating Station could penetrate the aircraft navigation airspace of the Keahole Airport. This is defined as the airspace above a plane extending outward and upward at a slope of 100 to 1 for a horizontal distance of 20,000 feet from the nearest point of the nearest runway. According to the Federal Aviation Regulations, Part 77 ("Objects Affecting Navigable Airspace"), the proposed alternative alignments may require a Notice of Proposed Construction or Alteration/Determination of No Hazard to Air Navigation promulgated under Federal Aviation Administration (FAA) Advisory Circular 70/7460-1G, Chapters 4, 5, and 9. The agency responsible for this approval is the U.S. Department of Transportation, Federal Aviation Administration.

Table 6-1
Potential Permits or Approvals Required for Transmission Line Alternatives

Authorizing Agency	Permit/ Approval	S-1 Mauka Overhead	S-1 Mauka Underground
Federal			
Department of Transportation, Federal Aviation Administration	Notice of Proposed Construction or Alteration	Y	N
State			
Department of Land and Natural Resources	Environmental Impact Statement Approval	Y	Y
	Use of State Lands	Y	Y
	Conservation District Use Application	Y	Y
	Historic Site Review	P	P
Department of Transportation, Highways Division	Permit to Perform Work	Y	Y
Department of Transportation, Airport Division	Permit to Construct Within Airport Hazard Area Zone	Y	N
Public Utilities Commission	Approval of Capital Expenditure Exceeding $500,000	Y	Y

Y = Yes, permit required or probably required.
P = Permit potentially required, depending on location of alignment.
N = No, permit not required.
Note: A County of Hawaii Special Management Area Use Permit (SMP) is not required because no part of the proposed alignment is within the Special Management Area (SMA).

State Permits and Approvals

Environmental Impact Statement

The use of state lands and lands within a state Conservation District requires compliance with Chapter 343, HRS, the State of Hawaii's environmental impact statement law. This EIS is being prepared in conformance with Chapter 343, HRS. The accepting authority for this EIS is the State of Hawaii Department of Land and Natural Resources.

Use of State Lands

Because Keahole Switching Station (which forms one end-point of the proposed transmission line) and portions of the Queen Kaahumanu Highway right-of-way are located on state-owned land, the proposed project would require an application to the Department of Land and Natural Resources, Division of Land Management, for use of state lands pursuant to Chapter 171, HRS. The Division of Land Management recommends action on the application to the Board of Land and Natural Resources, the permitting body.

Conservation District Use Application

Because Keahole Switching Station (which forms one end-point of the proposed transmission line) and portions of the Queen Kaahumanu Highway right-of-way are both located in the state's Conservation Land Use District, a Conservation District Use Application would be required pursuant to Chapters 205 and 183 of the Hawaii Revised Statutes. A Conservation District Use Application requires review and approval by the Board of Land and Natural Resources.

Historic Site Review

The Historic Preservation Program of the Department of Land and Natural Resources is responsible for the review of construction in the vicinity of a site that is listed on either the Hawaii or National Register of Historic Places. The state's review requires that notice of intention to work on a site and plans depicting the nature of the proposed construction and location with respect to any sites on the Hawaii or National Register of Historic Places be submitted 90 days in advance to the Department of Land and Natural Resources for review and comment. No portions of the project are located within or near sites that are on the Hawaii or National Register of Historic Places.

Permit to Perform Work

The transmission line would require a Permit to Perform Work within a State Highway pursuant to Chapter 264 of the Hawaii Revised Statutes and the Department of Transportation Administrative Rules, Chapter 105, Title 19. This permit is an administrative authorization issued by the Highways Division of the Hawaii Department of Transportation and is required for any work within the state highway right-of-way. Published notice and a public hearing are not required.

Permit to Construct Within Airport Hazard Area Zones

The S-1 mauka overhead alternative would be subject to state regulations comparable to the federal aviation regulations regarding obstruction of navigable air space. A Permit to Construct or Alter a Structure Within Airport Hazard Area Zones issued by the Airports Division of the Hawaii Department of Transportation is required for structures more than 35 feet in height, pursuant to Chapter 262-3 of the Hawaii Revised Statutes.

Hawaii Public Utilities Commission Authorization

Hawaii Public Utilities Commission authorization under PUC General Order No. 7 is required for the project because construction costs would exceed $500,000. The PUC may also need to grant an exemption from General Order No. 6 requirements relating to conflicting transmission or distribution lines. The PUC's consideration of the project would follow all other federal, state, and county approvals affecting the design and location of the project.

County Permits and Approvals

The S-1 mauka overhead and S-1 underground alternatives have appropriate Hawaii County land use designations, and the proposed project would not require any amendments to the county's general plan or zoning ordinance.

A County of Hawaii Special Management Area Use Permit (SMP) is not required because no part of the proposed alignment is within the Special Management Area (SMA).

Chapter 7

Chapter 7
Irreversible and Irretrievable Commitments of Resources and the Relationship Between Local Short-Term Uses of the Environment and the Maintenance and Enhancement of Long-Term Productivity

Irreversible and Irretrievable Commitments of Resources

The proposed Keahole-Kailua transmission line will require the irreversible and irretrievable commitments of a number of resources, including the materials, capital, labor and energy needed to plan, construct, operate, and maintain the transmission line.

The proposed transmission line alignment is located within the right-of-way of Queen Kaahumanu Highway, and the new line would be placed alongside or above an existing 69 kV line. Because the proposed transmission line alignment would be restricted to within the highway right-of-way or, in all likelihood, to easements already established for transmission lines, the construction of the new transmission line would not require any new commitment of land resources.

The Relationship Between Local Short-Term Uses of the Environment and the Maintenance and Enhancement of Long-Term Productivity

Electricity is essential to the long-term productivity of the West Hawaii economy. Transmission lines are an essential link between power generation and the customers who use electricity. The construction of this project would ensure that electricity can continue to be provided reliably and efficiently. Because the availability of reliable electricity is critical to so many activities, there is a direct relationship between a properly functioning electrical transmission system and long-term productivity. In addition, the project would involve no significant loss of environmental resources.

CHAPTER 8

Chapter 8
Unavoidable Adverse Impacts

Each of the alternatives evaluated in this EIS has some adverse impacts associated with it. Many of these impacts can be mitigated. Table 8-1 shows a summary of the unavoidable adverse impacts associated with each alternative.

Table 8-1 Summary of Unavoidable Adverse Impacts			
Resource or Impact	**S-1 Mauka Overhead Alternative**	**S-1 Mauka Underground Alternative**	**No-Action Alternative**
Views from Automobiles on Queen Kaahumanu Highway	X		
Views from Existing and Proposed Residential/Recreational Areas	X		
Potential Impact to Sensitive Plant Species (*Capparis sandwichiana*)	X	X	
Potential for Cultural Resource Discovery	X	X	
Interference with Traffic on Queen Kaahumanu Highway	X	X	
Potential for Interruption of Power; Blackouts			X

CHAPTER 9

Chapter 9

Summary of Unresolved Issues

Electric and Magnetic Fields

According to a comprehensive background paper on the biological effects of 60-Hz magnetic fields (Carnegie Mellon University, 1989), scientists do not yet know what attributes of magnetic fields could produce adverse public health effects.

The 1989 paper noted that the simple assumption that "more is worse" may not be true, and, consequently, a simple standard for a maximum limit to magnetic field strengths "cannot be adequately supported by the science that is now available." The paper also stated:

> As recently as a few years ago, scientists were making categorical statements that on the basis of all available evidence there are no health risks from human exposure to power-frequency fields. In our view, the emerging evidence no longer allows one to categorically assert that there are no risks. But it does not provide a basis for asserting that there is a significant risk. (Carnegie Mellon University, 1989).

The paper considered the question of public health policy and what should be done given our present knowledge. The paper suggested three possible courses of action:

- **Do Nothing.** Conclude that there is not yet enough evidence to warrant any action.
- **Prudent Avoidance.** Adopt strategies that limit field exposures with small investments of money and effort. Do nothing drastic or expensive until research provides a clear picture of whether there is any risk at all.
- **Aggressive Regulation.** Conclude that there is a problem and spend some serious time and money on an aggressive program to limit field exposure, while recognizing that we may eventually learn that some or all of this effort and money has been wasted.

On April 3, 1991, the State of Hawaii Department of Health issued a policy relating to electromagnetic fields from electric power lines. The policy states:

> A prudent approach is needed at this time to regulate electric and magnetic fields around low-frequency electric power facilities, including high-voltage transmission lines. The existing research data are inconclusive and not sufficient enough for adequate, accurate risk assessment. However, the data suggest that a "prudent avoidance" approach to siting new facilities is

appropriate. Where technically feasible and practical, public exposures should be minimized. Too little is presently known to be able to determine where or what rules would provide useful public-health protection.

Implementing Actions:

(a) All newly-installed power lines should be constructed with engineering controls to reduce exposure (for example, the "delta" configuration).

(b) The Department of Health will continue to collect and evaluate research data on electromagnetic fields in order to be aware of significant findings with public-health implications (State of Hawaii, Department of Health, 1991).

HELCO has adopted strategies consistent with the "prudent avoidance" approach in routing and designing the Keahole-Kailua transmission line project. Land uses along the alternatives were evaluated with the prudent avoidance strategy in mind. For example, residential areas were avoided to the extent practical.

Placement of lines underground would eliminate public exposure to electric fields but would not necessarily eliminate magnetic fields near ground level—the principal field of concern in relationship to human health (see the section on electric and magnetic fields in Chapter 5). Magnetic fields are not necessarily eliminated because magnetic fields readily penetrate rock and soil.

Distance from the transmission line conductors is the main factor in reducing magnetic field levels in most cases, although there are exceptions. Magnetic field levels can be reduced in one of the following ways:

- The cables of two three-phase circuits are configured so that there is a low-reactance (unlike) phasing arrangement between the two circuits. Low-reactance (unlike) phasing can occur with overhead or underground lines. For underground lines, low-reactance (unlike) phasing is possible only if each cable is placed in a duct made from a non-ferromagnetic material, such as PVC.

- The cables of a three-phase circuit are placed in a steel pipe, usually underground.

HELCO analyzed the magnetic field values associated with the normal method of constructing an underground 69 kV transmission line. HELCO, in an attempt to determine whether other underground options could further reduce magnetic field values, analyzed the magnetic field values associated with two underground options suggested by the two methods described above.

Two underground options emerged that had ampacity characteristics comparable to those associated with the normal method of constructing a 69 kV transmission line underground. These options are depicted and described fully in the mitigation portion of the electric and magnetic fields section of Chapter 5; briefly, these options are as follows:

- Underground Option 1: an underground 69 kV transmission line consisting of two three-phase circuits, with low-reactance phasing between the two circuits and one cable in each of the six separate PVC ducts.

- Underground Option 2: an underground 69 kV transmission line consisting of two three-phase circuits, with three cables in each of two separate steel pipes.

In comparing the magnetic field values associated with the normal method of constructing an underground transmission line and those associated with Underground Option 1 and Underground Option 2, it is clear that, when considering only the underground options, Underground Option 1 had the lowest magnetic field values. In evaluating the magnetic field values of the overhead transmission line alternatives, it is evident that, when considering only the proposed overhead line configurations, Overhead Line Configuration 2 (the double-sided, double-circuit 69 kV configuration) has the lowest magnetic field values.

It is notable that when comparing all of the overhead and underground transmission line alternatives, the highest degree of magnetic field attenuation (at 1 meter above ground level) occurs with Overhead Line Configuration 2. In this case, it is clear that placing the lines underground would not be the most effective means of reducing public exposure to magnetic fields, and that placing the lines overhead in Overhead Line Configuration No. 2 (the double-sided, double-circuit 69 kV configuration) would be the most effective means of reducing public exposure to magnetic fields.

The issue of public health impacts from the magnetic fields of the proposed project remains an unresolved issue, as does the larger issue of health effects from the magnetic fields produced by existing distribution lines, wall wiring, appliances, and lighting fixtures.

Placing the Proposed 69 kV Transmission Line Underground

Two considerations are most often expressed by the public as the reasons why a transmission line, such as the 69 kV transmission line proposed in this EIS, should be placed underground:

- Aesthetics
- Potential for health risks from human exposure to electric and magnetic fields

From the preceding section (and from the electric and magnetic field section of Chapter 5), it is clear that the most effective underground transmission line option in reducing magnetic field values would not be as effective as the overhead transmission line with a double-circuit, double-sided configuration with low-reactance (unlike) phasing. Thus, in this case, the argument for placing this 69 kV transmission line underground to reduce public exposure to electric and magnetic fields is not valid.

The issue of whether it is justifiable for the ratepayer to bear additional cost for placing a transmission line underground for aesthetic reasons will have to be determined by the Public Utilities Commission. Similarly, the Hawaii State Legislature or the County of Hawaii Council would need to weigh the additional public costs that will be incurred if legislation is enacted to require placing transmission lines underground.

Whether to place a transmission line underground for aesthetic reasons and the issue of its higher costs to the ratepayer or to the public will remain unresolved.

CHAPTER 10

Chapter 10

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CHAPTER 11

Chapter 11
Public and Agency Comments and Consultation

Consulted Parties

The Environmental Impact Statement Preparation Notice (EISPN) for the proposed Keahole-Kailua 69 kV transmission line project was published in the Hawaii Office of Environmental Quality Center's *OEQC Bulletin* on October 8, 1992. The 30-day review period, announced in the *OEQC Bulletin*, ended on November 7, 1992.

The Kona Outdoor Circle and Waimana Enterprises, Inc., responded to the EISPN within the 30-day review period. The Land Use Commission of the State Department of Business, Economic Development, and Tourism responded after the 30-day review period. Below is a list of the organizations that responded; their letters and the responses to them are presented in Appendix H.

- Federal: none
- State: the Land Use Commission of the Department of Business, Economic Development, and Tourism
- County of Hawaii: none
- Individuals and organizations: Kona Outdoor Circle
Waimana Enterprises, Inc.

There were no responses received within the 30-day review period that indicated "no comment."

Other Public and Agency Consultation

An extensive public and agency consultation process began in May 1992. This consultation process included contacting and meeting with elected officials; community and service organizations; major landowners; federal, state, and County of Hawaii personnel; the media; and the general public. A description of the public and agency consultation program, and the concerns that surfaced during this process, is included in Chapter 12 and Appendix B.

Summary of EISPN Consultation Comments

The following list summarizes those substantive comments received in response to the EISPN that were related to the scope of this EIS:

- Discuss the visual impact of the proposed transmission line on the view plane along Queen Kaahumanu Highway.

- Discuss an additional alternative that would relocate the existing overhead 69 kV transmission line in an underground trench.

- Compare the alternatives in terms of the projected rate increases for each class of rate payer.

Responses to EISPN Consultation Comments

Visual impacts of the proposed project are described in the visual resources section of Chapter 5.

Underground cable systems are discussed in the electric power transmission line technologies section of Chapter 4.

The comparative costs of the various alternative transmission technologies are listed in the section in Chapter 4 on comparison of electric power transmission line technologies and environmental considerations. It is difficult to estimate the effect on rates of individual construction projects. Rates are established based on HELCO's total company costs. The total company costs comprise some costs that are increasing and other costs that are decreasing. The impact of a specific project on rates will vary over the life of the project. Also, the costs will be borne by all HELCO ratepayers, regardless of whether the ratepayers are served by these lines. Appendix H includes a response to the community organization that asked that this topic be addressed.

CHAPTER 12

Chapter 12
Public Involvement

Public Information Program

A public involvement program outlining the major public participation activities and schedule to be implemented by the project team, consisting of HECO, HELCO, and CH2M HILL, was prepared in February 1992 for the Keahole-Kailua 69 kV transmission line project. As stated in the plan, the major public involvement activities for the Keahole-Kailua project were designed to achieve the following objectives:

- Inform the public—including potentially affected agencies, interest groups, individuals, and elected officials—about the project and their opportunities to participate
- Ensure that the public's views and issues of concern were addressed in the route selection process
- Provide timely information to the project team and to HECO and HELCO's decisionmakers about the public's views and concerns regarding selection of a preferred corridor and alignment
- Alert the project team to potential conflicts and provide mechanisms for resolving them
- Meet the consultation requirements of permitting agencies

The public involvement activities included dissemination of information (e.g., newsletters, newspaper articles, and public service announcements), as well as opportunities for direct public involvement. Principal activities included a meeting with the Community Advisory Group and two public workshops that were conducted to discuss selection of alternative corridors and alternative alignments for the project. The principal objectives of these workshops were to:

- Facilitate and maintain open communications between the project team and affected or interested parties throughout the siting process
- Provide project information and an update of project activities to participants
- Obtain information on agency and local public concerns regarding selection of a preferred corridor and alternative alignments

Other public and agency meetings were held on a more informal, ongoing basis throughout the project. These included information meetings with local community and interest groups.

Before the public workshops, HELCO met with the Community Advisory Group on December 3, 1992, at the Kaulana Community Center in Keauhou to discuss the need for the project, the corridors selected for analysis, and the analytical process used to evaluate and rank the corridors. About 15 people attended this meeting. The advisory group assisted HELCO in gauging the depth and diversity of possible public concerns and helped HELCO prepare the appropriate subjects for discussion at the upcoming workshops. The advisory group recommended that HELCO's presentations to the public clearly identify the need for the project. Other concerns raised by the advisory group involved other projects being proposed by HELCO that were not directly related to the proposed Keahole-Kailua 69 kV transmission line.

Public Workshop on Alternative Corridors and Selection of Preferred Corridor

Publicity, Schedule, Format, and Attendance

HELCO mailed the first newsletter on the Keahole-Kailua 69 kV transmission line project on December 3, 1992. About 250 copies were sent to federal, state, and local elected officials; state and local agencies; newspaper, radio, and television media; nongovernmental agencies; libraries; community organizations; and major landowners. The following information was presented in the newsletter:

- Introduction and major project benefits
- Route selection process
- Identification of alternative corridors
- Project status
- Issues and answers
- Community involvement, including the scheduled December 15, 1992, public workshop

Federal, state, and local elected officials, as well as major landowners, were also contacted by telephone to notify them of the project, invite them to the workshops, and solicit their input and concerns. Newspaper advertisements announcing the first public workshop were published in the *West Hawaii Today* on December 13 and 15, 1992.

The workshop was held at the King Kamehameha Hotel in Kailua-Kona on December 15, 1992, to obtain public comment on the preliminary alternative corridors and to identify the public's preferences (if any) for a preferred corridor. The workshop started with a 1-hour informal open house during which attendees could look at project materials and talk with

HELCO and CH2M HILL staff. Following a presentation by CH2M HILL on the purpose and need for the project, routing methodology, and preliminary preferred corridors, attendees were given the opportunity to ask questions. A total of 25 people attended this meeting. The input received at this first public workshop lead HELCO to the selection of the S-1 mauka overhead and S-1 mauka underground alternative alignments for more detailed study.

Summary of Comments

Generally, comments received during the public workshop on alternative corridors addressed four main issues: routing methodology, placing transmission lines underground, health effects, and radio interference. In addition, several attendees addressed issues outside the scope of the transmission line project but related to other HELCO projects in the vicinity.

Routing Methodology

One person expressed concern about the route selection methodology used to identify alternative corridors. This person suggested that the methodology was not quantitative enough to constitute an objective route selection process.

Placing Transmission Lines Underground

Several people advocated that the proposed transmission line should be placed underground to protect the region's unique aesthetic resources for both residents and visitors alike. One attendee commented that HELCO's preferred corridor, the S-1 corridor along Queen Kaahumanu Highway, would be acceptable as long as the line was buried underground. Another person suggested that the proposed line be bermed.

Health Effects

One attendee was interested in learning more about the health effects of transmission lines. HELCO responded that the issue of electric and magnetic fields and their effects on human health will be discussed as part of the EIS.

Radio Interference

One attendee asked HELCO to address the potential effects that a transmission line could have on radio reception both in homes and in automobiles. HELCO responded that, in general, radio interference is caused by faulty hardware and not transmission lines.

Public Workshop on Alternative Alignments and Selection of Preferred Alignment

Publicity, Schedule, Format, and Attendance

HELCO mailed the second newsletter on the Keahole-Kailua 69 kV transmission line project on January 4, 1993. About 250 copies were sent to federal, state, and local elected officials; state and local agencies; newspaper, radio, and television media; nongovernmental agencies; libraries; community organizations; and major landowners. The newsletter described the following information:

- Completion of the route selection process
- Identification of the preliminary preferred corridors and the preliminary preferred alignment
- Project status
- Issues and answers
- Community involvement, including the scheduled February 9, 1993, public workshop

Federal, state, and local elected officials, as well as major landowners, were also contacted by telephone to notify them of the project, invite them to the workshop, and solicit their input and concerns. Newspaper advertisements announcing the second public workshop were published in the *West Hawaii Today* on February 7 and 9, 1993. The workshop was held at the King Kamehameha Hotel in Kailua-Kona on February 9, 1993, to obtain public comment on the preliminary alternative alignment and to identify the public's preferences (if any) for a preferred alignment. The workshop started with a 1-hour informal open house during which attendees could look at project materials and talk with HELCO and CH2M HILL staff. Following a presentation by CH2M HILL reviewing the purpose and need for the project, routing methodology, preliminary preferred corridors, preferred corridors, and the preliminary preferred alignment, attendees were given the opportunity to ask questions. A total of 20 people attended this meeting. The input received at this second public workshop lead HELCO to the selection of the S-1 mauka overhead alignment as the preferred alignment.

Summary of Comments

Impact of Plans to Widen Queen Kaahumanu Highway

Several attendees asked how plans to widen Queen Kaahumanu Highway would affect the placing of poles within the highway right-of-way. HELCO responded that there were ongoing discussions with the Hawaii Department of Transportation to determine if the double-circuit double-sided conductor arrangement on the pole was possible. The preliminary response has been that the double-circuit double-sided conductor arrangement on the pole, in which poles would be set about 20 feet from the mauka edge of the right-of-way, would be possible, but could be allowed only on a temporary basis, until such time as the ultimate configuration of the Queen Kaahumanu Highway is constructed.

The Hawaii Department of Transportation plans to widen the current two-lane highway to a four-lane divided highway with a median strip. Ultimate plans call for frontage roads—one on the mauka edge and one on the makai edge of the highway. Construction of the frontage roads would require the removal of the poles with the double-circuit double-sided conductor arrangement.

HELCO also indicated that poles with the double-circuit single-sided conductor arrangement could be placed at the extreme mauka edge of the highway right-of-way. Although the poles would not be within the area proposed for the frontage road itself, they would still need to be reset with the ultimate highway configuration. The ultimate highway configuration will require grading or filling to bring the proposed frontage roads to nearly the same elevation as that of the four-lane highway and thus will require substantial changes to the existing terrain along the mauka edge of the highway right-of-way. Proposed and existing poles along the extreme mauka edge of the highway right-of-way will need to be moved or have their foundations reset when the ultimate highway configuration is implemented.

Configuration of Overhead Transmission Line

Several people asked whether the pole with the double-circuit double-sided conductor arrangement was preferable to the pole with the double-circuit single-sided conductor arrangement, and if the choice for construction of double-circuit double-sided conductor arrangement on the pole was contingent on other factors.

HELCO responded that its preference was for the double-circuit double-sided conductor arrangement because poles for this arrangement would be 10 to 15 feet shorter than poles for the double-circuit single-sided conductor arrangement. However, because insulators and conductors would extend out from the two sides of the poles, the alignment's width would be a wider area than with the double-circuit single-sided conductor arrangement, and the poles could not be placed extremely close to the mauka edge of the highway right-of-way.

The pole with the double-circuit double-sided conductor arrangement would be practical only if the Hawaii Department of Transportation would allow the pole to be placed temporarily within the Queen Kaahumanu Highway right-of-way in the area where the proposed frontage road would eventually be located.

Bermed Transmission Line

One attendee asked if the proposed line could be placed on the surface of the ground and covered with a berm.

HELCO responded that, although the PUC had guidelines for approving underground cable systems, the PUC did not have any guidelines for permitting berming. HELCO would find it difficult to advocate any nonstandard technology unfamiliar to the PUC.

The implementation of bermed transmission line would require HELCO to develop and establish technical standards and advocate to the PUC new regulatory standards for this berming technology. HELCO's use of a standard technology would allow completion of the project within the time period required to meet projected electrical load conditions; advocating the use of a bermed transmission line, which would rely on a technology that is not standard and that is uncommon in the United States, would not.

HELCO also indicated that, because of the plans to widen the highway, a bermed transmission line or underground transmission line would both be temporary and would have to be moved when the ultimate highway configuration is implemented.

Visual Impacts

One person asked if landscaping with trees or planting materials would be possible.

HELCO responded that any landscaping put in with the proposed poles would be temporary and would have to be removed when the ultimate highway configuration is implemented.

HELCO indicated that there would be a subsequent meeting where additional photo simulations of the proposed overhead transmission lines would be shown.

Acquisition of Easements Outside of the State Highway Right-of-Way

One person advocated that HELCO acquire easements outside of the highway right-of-way, to avoid eventual relocation of poles.

HELCO responded that landowners adjacent to the highway right-of-way were reluctant to give easements. While it is true that HELCO could condemn lands for an easement, the condemnation process would be too lengthy to allow HELCO to install the line before its needed service date of December 1994. Further, HELCO could not condemn State of Hawaii lands, which make up a large amount of the land mauka of the highway.

Need for the Project

One person questioned the need for the project and asked if the existing 69 kV transmission line could be reconductored (with larger conductors) to increase the system's ability to carry the increased load in Kailua-Kona.

HELCO responded that reconductoring could accommodate the projected load conditions under normal conditions, but that the proposed line is also needed to increase the system's reliability. In the event that the reconductored line drops out of service, the remaining lines into Kailua-Kona would not be able to carry the load without voltages dropping to unacceptable levels.

Electric and Magnetic Fields

HELCO indicated that there would be a subsequent meeting where the results of the electric and magnetic field analysis would be presented. The results of the analysis will also be included in the EIS.

CHAPTER 13

Chapter 13
Works Cited

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APPENDIX I

Appendix I

Draft Environmental Impact Statement (DEIS) Comment Letters

Sixty-one copies of the Draft Environmental Impact Statement (DEIS) were mailed on April 21, 1993, to State of Hawaii agencies, centers and programs at the University of Hawaii, federal agencies, County of Hawaii agencies, the news media, and those who requested to be consulted parties, according to a listing approved by the State of Hawaii Office of Environmental Quality Control (OEQC). Notice of the availability of the DEIS was published in the April 23, 1993, issue of the *OEQC Bulletin*. Written responses to the DEIS were received from the agencies and organizations listed below. Comments postmarked after the review period deadline on June 7, 1993, are indicated by an asterisk after the reviewer's name. A double asterisk indicates no substantive comments.

Federal
- Dept. of Agriculture, Soil Conservation Service
- Dept. of Army, Director of Engineering
- Dept. of Interior, U.S. Geological Survey**
- Dept. of Navy, Facilities Engineer**

State of Hawaii
- Dept. of Accounting and General Services, Division of Public Works**
- Dept. of Agriculture
- Dept. of Budget and Finance, Housing Finance and Development Corporation (HFDC)
- Dept. of Business, Economic Development and Tourism (DBEDT), Energy Division**
- Dept. of Business, Economic Development and Tourism (DBEDT), Land Use Commission
- Dept. of Defense, Office of Civil Defense
- Dept. of Education
- Dept. of Hawaiian Home Lands**
- Dept. of Land and Natural Resources
- Dept. of Transportation
- Office of Environmental Quality Control**
- University of Hawaii at Manoa, Environmental Center

County of Hawaii
- Dept. of Public Works
- Dept. of Water Supply

Others
- Kona Outdoor Circle*
- Waimana Enterprises, Inc.

RECEIVED AS FOLLOWS

SENT BY:Xerox Telecopier 7021 ; 6- 9-93 ; 2:34PM ; DLNR / OCEA- 808 941 8225;# 6

UNITED STATES DEPARTMENT OF AGRICULTURE

SOIL CONSERVATION SERVICE

P. O. BOX 50004
HONOLULU, HI 96850-0001

RECEIVED
93 JUN 1 A8:28
DEPT. OF LAND & NATURAL RESOURCES STATE OF HAWAII

May 27, 1993

Keith W. Ahue, Chairperson
Board of Land and Natural Resources
P.O. Box 621
Honolulu, HI 96809

DH?

Dear Mr. Ahue:

We have reviewed the proposed overhead electrical line in relation to our proposed Waimea II Reservoir Project and we do not find any conflict.

Thank you for the opportunity to review this proposal.

Sincerely,

Nat Conner

NATHANIEL R. CONNER
State Conservationist

RECEIVED
93 JUN 1 AM 9:23
DLNR OCEA

Engineers
Planners
Economists
Scientists

January 31, 1994

OPE33045.D2

Mr. Nathanial R. Conner
State Conservationist
United States Department of Agriculture
Soil Conservation Service
P.O. Box 50004
Honolulu, Hawaii 96850-0001

Dear Mr. Conner:

Subject: Keahole-Kailua 69 kV Transmission Line Project Draft Environmental Impact Statement (DEIS)

Thank you for your review of the DEIS for the Keahole-Kailua 69 kV Transmission Line Project, where you indicated that there was no conflict with your proposed Waimea II Reservoir Project.

If there any further questions, please feel free to contact me or assistant project manager Bennett Mark at (808) 943-1133.

Sincerely,

CH2M HILL

Albert Lono Lyman
Senior Project Manager

cc: Dennis Tanigawa, HELCO
Ed Lagundimao, HECO
Don Horiuchi, DLNR

Honolulu Office 1585 Kapiolani Blvd., Suite 1420 Honolulu, HI 96814-4530 808 943-1133 Fax No. 808 941-8225

HNL87\021.51

SENT BY:Xerox Telecopier 7021 : 6- 9-93 : 2:32PM : DLNR / OCEA→ 808 941 8225:# 1

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

May 21, 1993

REPLY TO
ATTENTION OF:

'93 MAY 24 AM 11:38
RECEIVED
DLNR
OCEA

Planning Division

Mr. Don Horiuchi
State of Hawaii
Department of Land and Natural Resources
1151 Punchbowl Street
Honolulu, Hawaii 96813

DH

Dear Mr. Horiuchi:

Thank you for the opportunity to review and comment on the Draft Environmental Impact Statement for the Keahole-Kailua 69KV Transmission Line Project, Hawaii. The following comments are provided pursuant to Corps of Engineers authorities to disseminate flood hazard information under the Flood Control Act of 1960 and to issue Department of the Army (DA) permits under the Clean Water Act; the Rivers and Harbors Act of 1899; and the Marine Protection, Research and Sanctuaries Act.

a. The project does not include work in waters of the U.S.; therefore, a DA permit will not be required.

b. The flood hazard information provided on page 6-11 of the report is correct.

Sincerely,

Kisuk Cheung, P.E.
Director of Engineering

Copies Furnished:

Mr. Dennis Tanigawa, HELCO
P.O. Box 1027
Hilo, Hawaii 96721-1027

Mr. Al Lono Lyman, CH2M Hill
1585 Kapiolani Boulevard, Suite 1420
Honolulu, Hawaii 96814

CH2M HILL
Engineers
Planners
Economists
Scientists

January 31, 1994

OPE33045.D2

Mr. Kisuk Cheung, P.E.
Director of Engineering
Department of the Army
U.S. Army Engineer District, Honolulu
Building 230
Fort Shafter, Hawaii 96858-5440

Dear Mr. Cheung:

Subject: Keahole-Kailua 69 kV Transmission Line Project Draft Environmental Impact Statement (DEIS)

Thank you for reviewing the DEIS for the Keahole-Kailua 69 kV Transmission Line Project.

If you should have any questions on this project in the future, please feel free to contact me or assistant project manager Bennett Mark at (808) 943-1133.

Sincerely,

CH2M HILL

Albert Lono Lyman
Senior Project Manager

cc: Dennis Tanigawa, HELCO
Ed Lagundimao, HECO
Don Horiuchi, DLNR

Honolulu Office 1585 Kapiolani Blvd., Suite 1420 Honolulu, HI 96814-4530 808 943-1133 Fax No. 808 941-8225

United States Department of the Interior

TAKE PRIDE IN AMERICA

GEOLOGICAL SURVEY
WATER RESOURCES DIVISION
677 Ala Moana Blvd., Suite 415
Honolulu, Hawaii 96813

May 13, 1993

Mr. Don Horiuchi
State of Hawaii
Department of Land and Natural Resources
1151 Punchbowl Street
Honolulu, Hawaii 96813

Dear Mr. Horiuchi:

Subject: Keahole - Kailua 69 kV Transmission Line Project, Draft Environmental Impact Statement (DEIS), Kona, Hawaii

We are in receipt of the subject DEIS. We regret that due to prior commitments, we are unable to review the DEIS by the June 7th deadline.

We are returning the DEIS to your office for your future use.

Sincerely,

William Meyer
District Chief

Enclosure

cc: Mr. Dennis Tanigawa
Hawaii Electric Light Company, Inc.
P.O. Box 1027
Hilo, Hawaii 96721-1027

Mr. Al Lono Lyman
CH2M Hill
1585 Kapiolani Blvd., Suite 1420
Honolulu, Hawaii 96814

CH2M HILL
Engineers
Planners
Economists
Scientists

January 31, 1994

OPE33045.D2

Mr. William Meyer, District Chief
Geological Survey
Water Resources Division
U.S. Department of Interior
677 Ala Moana Boulevard, Suite 415
Honolulu, Hawaii 96813

Dear Mr. Meyer:

Subject: Keahole-Kailua 69 kV Transmission Line Project Draft Environmental Impact Statement (DEIS)

Thank you for your response letter indicating that, because of prior commitments, you were unable to review the DEIS for the Keahole-Kailua 69 kV Transmission Line Project before the deadline for comments.

If however, you should have any questions on this project in the future, please feel free to contact me or assistant project manager Bennett Mark at (808) 943-1133.

Sincerely,

CH2M HILL

Albert Lono Lyman
Senior Project Manager

cc: Dennis Tanigawa, HELCO
Ed Lagundimao, HECO
Don Horiuchi, DLNR

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

IN REPLY REFER TO:
5090
Ser N4(235)/1782
14 MAY 1993

Mr. Don Horiuchi
Department of Land and Natural Resources
State of Hawaii
1151 Punchbowl Street
Honolulu, HI 96813

Dear Mr. Horiuchi:

DRAFT ENVIRONMENTAL IMPACT STATEMENT (DEIS)
KEAHOLE - KAILUA 69 KV TRANSMISSION LINE PROJECT

Thank you for the opportunity to comment on the subject DEIS dated April 1993. The Navy has no comments to offer at this time.

Our point of contact is the Naval Base Facilities Engineer at 471-3324.

Sincerely,

W. K. Liu

W. K. LIU
FACILITIES ENGINEER
BY DIRECTION OF
THE COMMANDER

Copy to:
Mr. Dennis Tanigawa
Hawaii Electric Light
Company, Inc.
P.O. Box 1027
Hilo, HI 96721-1027

Mr. Al Lono Lyman
CH2M-HILL
1585 Kapiolani Boulevard
Suite 1420
Honolulu, HI 96814

Engineers
Planners
Economists
Scientists

January 31, 1994

OPE33045.D2

Mr. W. K. Liu
Facilities Engineer
Department of the Navy
Naval Base Pearl Harbor
Box 110
Pearl Harbor, Hawaii 96860-5020

Dear Mr. Liu:

Subject: Keahole-Kailua 69 kV Transmission Line Project Draft Environmental Impact Statement (DEIS)

Thank you for reviewing the DEIS for the Keahole-Kailua 69 kV Transmission Line Project.

If you should have any questions on this project in the future, please feel free to contact me or assistant project manager Bennett Mark at (808) 943-1133.

Sincerely,

CH2M HILL

Albert Lono Lyman
Senior Project Manager

cc: Dennis Tanigawa, HELCO
Ed Lagundimao, HECO
Don Horiuchi, DLNR

Honolulu Office 1585 Kapiolani Blvd., Suite 1420 Honolulu, HI 96814-4530 808 943-1133 Fax No. 808 941-8225

(P)1361.3

MAY 28 1993

State Department of Land
and Natural Resources
Division of Land Management
1151 Punchbowl Street
Honolulu, Hawaii

Attention: Mr. Don Horiuchi

Gentlemen:

Subject: Keahole - Kailua
69 kV Transmission Line Project
DEIS

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

If there are any questions, please have your staff contact Mr. Ralph Yukumoto of the Planning Branch at 586-0488.

Very truly yours,

GORDON MATSUOKA
State Public Works Engineer

RY:jy
cc: OEQC
Hawaii Electric Light Company, Inc.
✓CH2M Hill, Inc.

Engineers
Planners
Economists
Scientists

January 31, 1994

OPE33045.D2

Mr. Gordon Matsuoka, State Public Works Engineer
State of Hawaii
Department of Accounting and General Services
Division of Public Works
P.O. Box 119
Honolulu, Hawaii 96810

Dear Mr. Matsuoka:

Subject: Keahole-Kailua 69 kV Transmission Line Project Draft Environmental Impact Statement (DEIS)

Thank you for reviewing the DEIS for the Keahole-Kailua 69 kV Transmission Line Project.

If you should have any questions on this project in the future, please feel free to contact me or assistant project manager Bennett Mark at (808) 943-1133.

Sincerely,

CH2M HILL

Albert Lono ~~Lyman~~
Senior Project Manager

cc: Dennis Tanigawa, HELCO
Ed Lagundimao, HECO
Don Horiuchi, DLNR

Honolulu Office
1585 Kapiolani Blvd., Suite 1420
Honolulu, HI 96814-4530
808 943-1133
Fax No. 808 941-8225

HNL87/007.51

JOHN WAIHEE
Governor

YUKIO KITAGAWA
Chairperson, Board of Agriculture

ILIMA A. PIIANAIA
Deputy to the Chairperson

State of Hawaii
DEPARTMENT OF AGRICULTURE
1428 So. King Street
Honolulu, Hawaii 96814-2512

FAX: 973-9613

Mailing Address:
P. O. Box 22159
Honolulu, Hawaii 96823-2159

June 7, 1993

TO: Keith Ahue, Chairperson
Board of Land and Natural Resources

Attn: Don Horiuchi

FROM: Yukio Kitagawa, Chairperson
Board of Agriculture

SUBJECT: Draft Environmental Impact Statement (DEIS)
Keahole-Kailua 69kV Transmission Line Project
Hawaii Electric Light Company, Inc.
TMK: 7-3 and 7-4, Various
North Kona, Hawaii

The Department of Agriculture has reviewed the subject DEIS and offers the following comments.

According to the document, Corridor S-1 (mauka) is the preferred corridor (page 4-66). This corridor runs along the mauka side of Queen Kaahumanu Highway from the Keahole Generating Station to Kailua. The document also states that this alternative will be adjacent to but not adversely impact the Keahole Agricultural Park (pages 5-10 and 5-11).

The Department of Agriculture has been considering expansion of the Keahole Agricultural Park by approximately 200 acres on its southern and/or eastern boundaries. This intention is in consonance with the West Hawaii Regional Plan (page 25).

Should you desire any further clarification or additional information, please call me at 973-9550 or Dr. Paul Schwind, Planning Program Administrator, at 973-9469.

c: Hawaii Electric Light Company, Inc.
Attn: Dennis Tanigawa

CH2M HILL
Attn: Al Lono Lyman

JOHN WAIHEE
Governor

State of Hawaii
DEPARTMENT OF AGRICULTURE
1428 So. King Street
Honolulu, Hawaii 96814-2512

YUKIO KITAGAWA
Chairperson, Board of Agriculture

ILIMA A. PIIANAIA
Deputy to the Chairperson

FAX: (808) 973-9613

Mailing Address:
P. O. Box 22159
Honolulu, Hawaii 96823-2159

June 15, 1993

CH2M HILL
1585 Kapiolani Boulevard
Suite 1420
Honolulu, Hawaii 96814-4530

Attention: Mr. Bennett Mark

Dear Bennett:

Subject: Map Showing Potential Expansion Area for Keahole Agricultural Park
TMK: 7-3-49 Kalaoa, Hawaii

The attached map shows the approximate sites of our contemplated expansion of the Keahole Agricultural Park. The red slashed area represents the "eastern" option and the black slashed area with the "C to A" printed in the middle is the "southern" option.

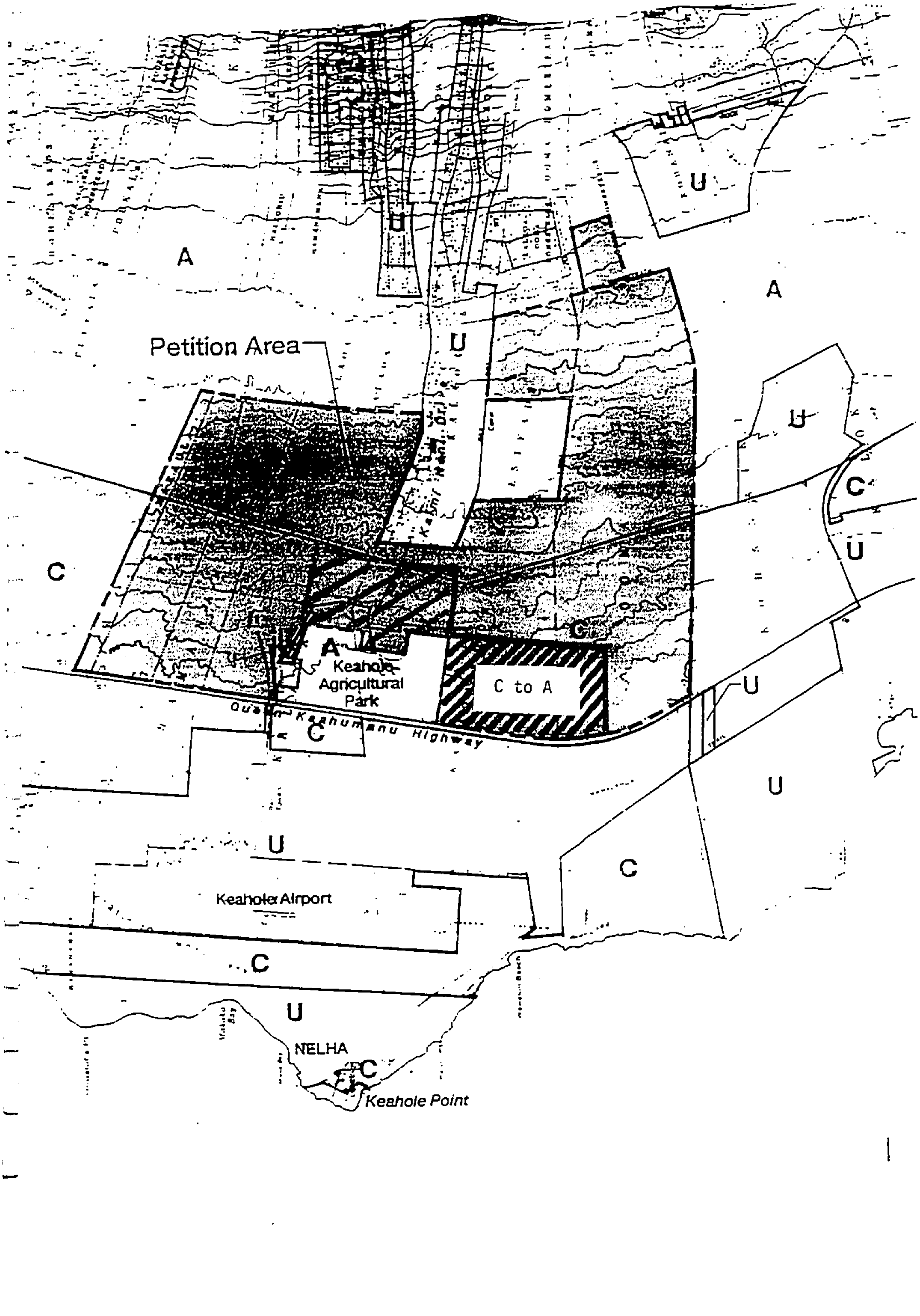
Should you have any further questions, give me a call at 973-9466.

Sincerely,

EARL YAMAMOTO
Planning and Development Office

Attachment

RECEIVED AS FOLLOWS



CH2M HILL

Engineers
Planners
Economists
Scientists

January 31, 1994

OPE33045.D2

Mr. Yukio Kitagawa, Chairperson
Board of Agriculture
State of Hawaii
Department of Agriculture
1428 South King Street
Honolulu, Hawaii 96814-2512

Dear Mr. Kitagawa:

Subject: Keahole-Kailua 69 kV Transmission Line Project Draft Environmental Impact Statement (DEIS)

Thank you for reviewing the DEIS for the Keahole-Kailua 69 kV Transmission Line Project.

We acknowledge that your department is contemplating a 200-acre expansion to the south and/or east (mauka) of the existing Keahlole Agricultural Park. The proposed Keahole-Kailua 69 kV transmission line will not affect your present plans for expanding the Keahole Agricultural Park.

The areas that your department is contemplating for the agricultural park expansion are located entirely east (mauka) of the Queen Kaahumanu Highway right-of-way. Since the proposed Keahole-Kailua 69 kV transmission line is proposed to be located completely within the Queen Kaahumanu Highway right-of-way, your agricultural park expansion proposals will be outside of the area being considered for the Keahole-Kailua 69 kV transmission line alignment.

The map provided to us by your staff showing your proposal for the Keahole Agricultural Park expansion will be made a part of the Final EIS.

Honolulu Office 1585 Kapiolani Blvd., Suite 1420 Honolulu, HI 96814-4530 808 943-1133 Fax No. 808 941-8225

Thank you for your assistance in reviewing this project. If there are any questions on this project in the future, please feel free to contact me or assistant project manager Bennett Mark at (808) 943-1133.

Sincerely,

CH2M HILL

Albert Lono Lyman
Senior Project Manager

cc: Dennis Tanigawa, HELCO
Ed Lagundimao, HECO
Don Horiuchi, DLNR

HNL87/002.51

JOHN WAIHEE
GOVERNOR

JOSEPH K. CONANT
EXECUTIVE DIRECTOR

STATE OF HAWAII
DEPARTMENT OF BUDGET AND FINANCE
HOUSING FINANCE AND DEVELOPMENT CORPORATION
677 QUEEN STREET, SUITE 300
HONOLULU, HAWAII 96813
FAX (808) 587-0600

IN REPLY REFER TO:
93:PPE/2097

May 3, 1993

TO: The Honorable Keith Ahue, Chairperson
Department of Land and Natural Resources

ATTN: Don Horiuchi

FROM: Joseph K. Conant, Executive Director
Housing Finance and Development Corporation

SUBJECT: Draft Environmental Impact Statement
Keahole - Kailua 69 kV Transmission Line Project

We have reviewed the subject document and our comments are as follows:

1. Page 5-2 states the Kealakehe Residential Community "includes a total of 4,158 residential dwelling units on approximately 589 acres." This statement is incorrect. The Villages of La'i'opua will consist of approximately 4,200 dwelling units on approximately 968 acres of land.

2. The Kealakehe Master Planned Community site area has been altered from the base version used in Figures 4-7, 4-9, and 4-13. Attached for your information is the revised site boundary.

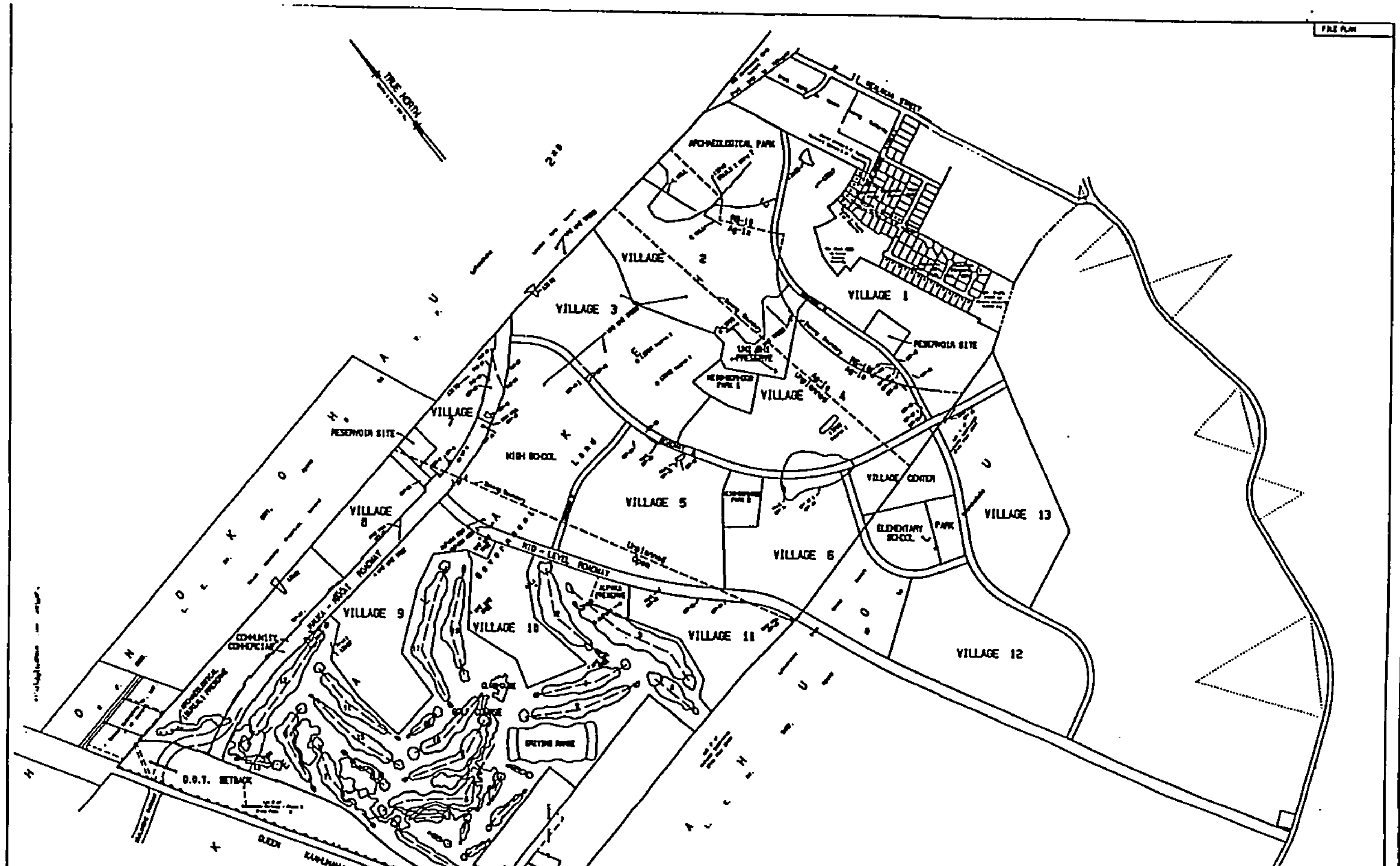
3. If the main corridor S-2 is considered, along the Mid-Level Road, this corridor should be placed underground. The County of Hawaii is requiring all underground utilities for the Villages of La'i'opua. This requirement should remain consistent along this roadway.

We have no other comments to offer at this time. Thank you for the opportunity to review this document.

If you should have further question, please contact Michele Otake of our Planning office at 587-0637.

Attachment

c: Mr. Dennis Tanigawa, HECO
Mr. Al Lono Lyman, CH2M HILL



VILLAGES OF LA'I'OPUA

AT KEALAKEHE, NORTH KONA, ISLAND OF HAWAII, HAWAII

CH2M HILL
Engineers
Planners
Economists
Scientists

January 31, 1994

OPE33045.D2

Mr. Joseph K. Conant
Executive Director
Housing Finance and Development Corporation
State of Hawaii
Department of Budget and Finance
677 Queen Street, Suite 300
Honolulu, Hawaii 96813

Dear Mr. Conant:

Subject: Keahole-Kailua 69 kV Transmission Line Project Draft Environmental Impact Statement (DEIS)

Thank you for your letter clarifying the number of residential units and total acreage of the proposed Kealakehe Residential Community project, and for providing us with a revised project site map for the project. Your letter, your revised project site map, and this response will be included in the Final EIS.

The text of the Final EIS will be revised to note that the Kealakehe Residential Community project's Villages of La'i'opua will consist of approximately 4,200 dwelling units on a total of approximately 968 acres of land.

The map figures in Chapter 4 that you referred to in your letter were based on data gathered and analyzed in mid-1992. These data were used in our analysis of eight corridor alternatives. In the course of this analysis, the S-2 mid-level corridor, which crosses through the Kealakehe Residential Community project, was selected as one of the preliminary preferred corridors. For this project, the S-2 mid-level corridor was eliminated from consideration in favor of the S-1 mauka corridor as the preferred corridor. The S-1 mauka corridor follows within the mauka edge of Queen Kaahumanu Highway right-of-way.

We note that your revised site map of your project includes areas which were previously part of the proposed Keahuolu Lands project, and that these former Keahuolu Lands project areas were recently sold to the State of Hawaii for inclusion into the Kealakehe Residential Community project.

Honolulu Office 1585 Kapiolani Blvd., Suite 1420 Honolulu, HI 96814-4530 808 943-1133 Fax No. 808 941-8225

The expansion of Kealakehe Residential Community project's boundary and the corresponding reduction of the Keahuolu Lands project's boundary does not affect the ranking of the preliminary corridor alternatives and the resultant selection of the S-1 mauka corridor as the preferred corridor.

If there are any further questions, please feel free to contact me or assistant project manager Bennett Mark at (808) 943-1133.

Sincerely,

CH2M HILL

Albert Lono Lyman
Senior Project Manager

cc: Dennis Tanigawa, HELCO
Ed Lagundimao, HECO
Don Horiuchi, DLNR/OCEA

JOHN WAIHEE
Governor
MUFI HANNEMANN
Director
BARBARA KIM STANTON
Deputy Director
RICK EGGED
Deputy Director
TAKESHI YOSHIHARA
Deputy Director

DEPARTMENT OF BUSINESS, ECONOMIC DEVELOPMENT & TOURISM

ENERGY DIVISION, 335 MERCHANT ST., RM. 110, HONOLULU, HAWAII 96813 PHONE: (808) 587-3800 FAX: (808) 587-3820

May 6, 1993

MEMORANDUM

TO: Mr. Don Horiuchi, Planner
Department of Land and Natural Resources

FROM: Maurice H. Kaya, Energy Program Administrator

SUBJECT: Draft Environmental Impact Statement (DEIS), Keahole - Kailua 69 kV Transmission Line Project

We have reviewed the subject DEIS and have no comments.

cc: Office of Environmental Quality Control w/enclosure
Mr. Dennis Tanigawa, Hawaii Electric Light Company, Inc.
Mr. Al Lono Lyman, CH2M Hill

MHK:SCA

Engineers
Planners
Economists
Scientists

January 31, 1994

OPE33045.D2

Mr. Maurice H. Kaya
Energy Program Administrator
State of Hawaii
Department of Business,
Economic Development and Tourism
Energy Division
335 Merchant Street, Room 110
Honolulu, Hawaii 96813

Dear Mr. Kaya:

Subject: Keahole-Kailua 69 kV Transmission Line Project Draft Environmental Impact Statement (DEIS)

Thank you for reviewing the DEIS for the Keahole-Kailua 69 kV Transmission Line Project.

If you should have any questions on this project in the future, please feel free to contact me or assistant project manager Bennett Mark at (808) 943-1133.

Sincerely,

CH2M HILL

Albert Lono-Lyman
Senior Project Manager

cc: Dennis Tanigawa, HELCO
Ed Lagundimao, HECO
Don Horiuchi, DLNR

Honolulu Office 1585 Kapiolani Blvd., Suite 1420
Honolulu, HI 96814-4530 808 943-1133
Fax No. 808 941-8225

HNL87/012.51

JOHN WAIHEE
GOVERNOR

ESTHER UEDA
EXECUTIVE OFFICER

STATE OF HAWAII
DEPARTMENT OF BUSINESS, ECONOMIC DEVELOPMENT & TOURISM
LAND USE COMMISSION
Room 104, Old Federal Building
335 Merchant Street
Honolulu, Hawaii 96813
Telephone: 587-3822

April 28, 1993

Mr. Don Horiuchi
Department of Land and
Natural Resources
1151 Punchbowl Street
Honolulu, Hawaii 96813

Dear Mr. Horiuchi:

SUBJECT: Draft Environmental Impact Statement (DEIS) for Keahole-Kailua 69kV Transmission Line Project

We have reviewed the DEIS for the subject project and have the following comments:

1) In the Appendixes of the DEIS, page A-3, paragraph 1, reference to the designation of the Protective Subzone within the Conservation District by the Land Use Commission is incorrect. For your information, the Board of Land and Natural Resources is responsible for designating Conservation District subzones. Also, paragraph 4 of the same page as well as page 6-2 of the DEIS (paragraph 3) should reference Chapter 205, rather than Chapter 183, of the Hawaii Revised Statutes, as amended, as the statutory authority governing the Land Use Commission.

2) As stated in our letter of November 20, 1992, the Office of State Planning has filed a boundary amendment petition with the Commission (LUC Docket No. A92-685) for approximately 2,640 acres for urban expansion. Included in this petition for State-owned lands is the West Hawaii Campus of the University of Hawaii. Other proposed uses include housing, parks, commercial, light industrial and public facilities.

We have no other comments to offer at this time. We appreciate the opportunity to comment on this matter.

Should you have any questions on this matter, please feel free to call me or Bert Saruwatari of our office at 587-3822.

Sincerely,

ESTHER UEDA
Executive Officer

cc: DBEDT
Dennis Tanigawa, HELCO
Al Lono Lyman, CH2M Hill

CH2M HILL Engineers Planners Economists Scientists

January 31, 1994

OPE33045.D2

Ms. Esther Ueda, Executive Officer
Land Use Commission
State of Hawaii
Department of Business, Economic Development & Tourism
Room 104, Old Federal Building
335 Merchant Street
Honolulu, Hawaii 96813

Dear Ms. Ueda:

ATTENTION: Mr. Bert Saruwatari

Subject: Keahole-Kailua 69 kV Transmission Line Project Draft Environmental Impact Statement (DEIS)

Thank you for your letter clarifying the responsibility of the Land Use Commission and the State Board of Land and Natural Resources in regards to the Conservation District Protective Subzones. By reference, the appendix to this EIS is amended to note the following:

- The Board of Land and Natural Resources designates the State Land Use Conservation District, Protective Subzone.

- The Land Use Commission, pursuant to Chapter 205, Hawaii Revised Statutes, has established the State Land Use Districts throughout the state.

The final EIS will note that these amendments to the appendix are incorporated by reference. These changes will also be made directly in the main body of the final EIS.

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Ms. Esther Ueda, Executive Officer
January 31, 1994
Page 2

We are aware of the boundary amendment petition to change 2,640 acres of State Land Use Conservation and Agricultural Districts to Urban District, for the area mauka of the Keahole Agricultural Subdivision. A map of the area proposed to be changed to State Urban District, which was taken from the Draft EIS prepared for the boundary amendment petition, is attached to this letter. This letter and the accompanying map will be included in the Final EIS. We would also note that this amendment has been approved by the Land Use Commission.

If there are any further questions, please feel free to contact me or assistant project manager Bennett Mark at (808) 943-1133.

Sincerely,

CH2M HILL

Albert Lono Lyman
Senior Project Manager

cc: Dennis Tanigawa, HELCO
Ed Lagundimao, HECO
Don Horiuchi, DLNR

Enclosure

HNL87/013.51

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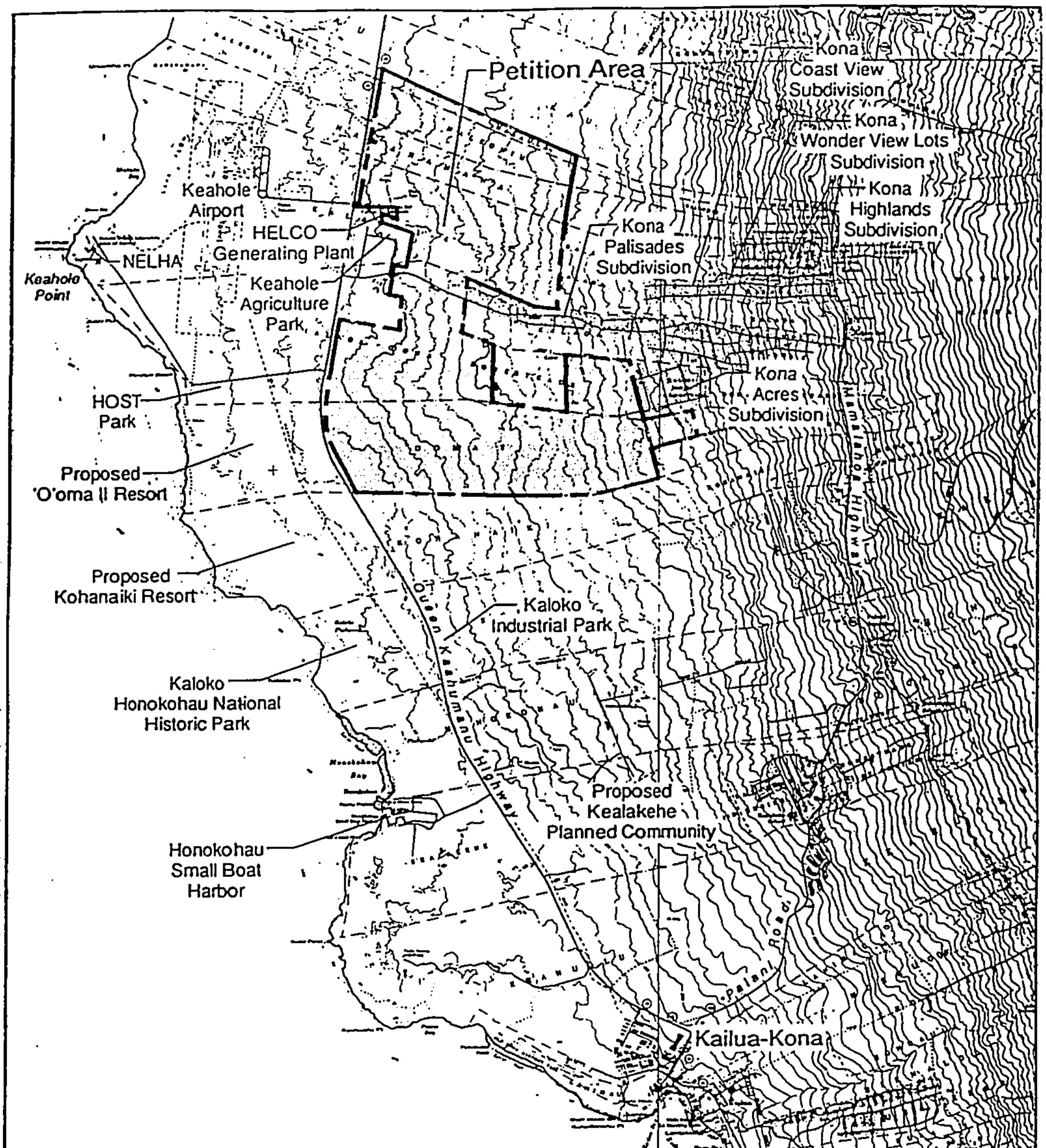

Regional Location Map

URBAN EXPANSION STATE LANDS

Keahole to Kailua Region

Figure: 1

Feet 0 2500 5000

Prepared for: Office of State Planning, State of Hawaii

Prepared by: Helber Hastert & Fee, Planners

JOHN WAIHEE
GOVERNOR

MAJOR GENERAL EDWARD V. RICHARDSON
DIRECTOR OF CIVIL DEFENSE

ROY C. PRICE, SR.
VICE DIRECTOR OF CIVIL DEFENSE

PHONE (808) 734-2161

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

June 2, 1993

TO: Mr. Don Horiuchi
Department of Land and Natural Resources
State of Hawaii

FROM: Roy C. Price, Sr.
Vice Director of Civil Defense

SUBJECT: DRAFT ENVIRONMENTAL IMPACT STATEMENT (DEIS); KEAHOLE-KAILUA 69 kV TRANSMISSION LINE PROJECT

State Civil Defense (SCD) appreciates this opportunity to comment on the DEIS by the Hawaii Electric Light Company, Inc., on the island of Hawaii, Kona District, Keahole-Kailua 69 kV transmission line. We do not have negative comments directed specifically at the DEIS. However, we do have a concern that the installation of the 69 kV transmission line could adversely impact the proper operation of the siren warning system located along Corridor S-1 Mauka. Corridors S-1 Makai, S-2, and S-3 and its variations are being eliminated from consideration.

Corridor S-1: Mauka Overhead Alternative (Queen Kaahumanu Highway)

State Civil Defense has one siren simulator that may be directly impacted by this alignment. SCD's concern is that the electromagnetic field generated by the 69 kV transmission line may interfere with the normal operation of the siren simulator. Should this concern be verified at a later date, the impacted siren simulator may have to be resited and relocated in the vicinity of its present location. The cost of this move should be treated as support of siren infrastructure and coordinated with the Office of State Planning. The cost is to be borne by the applicant/ requestor.

Corridor S-1: Mauka Underground Alternative (Queen Kaahumanu Highway)

No comments.

Corridor S-1: Makai (Queen Kaahumanu Highway). Eliminated

State Civil Defense has one siren simulator that may be directly impacted by this alignment.

Corridor S-2: Midlevel. Eliminated

No comments.

Corridor S-3: Mamalahoa Highway/Palani Road. Eliminated

No comments.

Our SCD planners and technicians are available to discuss this further if there is a requirement. Please have your staff call Mr. Mel Nishihara of my staff at 734-2161.

Enc:

c: Mr. Dennis Tanigawa
Hawaii Electric Light Company, Inc.

Mr. Al Lono Lyman
CH2M Hill

Office of Environmental Quality Control

CH2M HILL Engineers Planners Economists Scientists

January 31, 1994

OPE33045.D2

Mr. Roy C. Price, Sr.
Vice Director of Civil Defense
State of Hawaii
Department of Defense
Office of the Director of Civil Defense
3949 Diamond Head Road
Honolulu, Hawaii 96816-4495

Dear Mr. Price:

Subject: Keahole-Kailua 69 kV Transmission Line Project Draft Environmental Impact Statement (DEIS)

Thank you for reviewing the DEIS for the Keahole-Kailua 69 kV Transmission Line Project.

In your letter, you expressed a concern regarding that the impact the proposed Keahole-Kailua 69 kV Transmission Line may have on the operation of the State's siren warning system. Our discussions with Mr. Mel Nishihara of your staff have indicated that your primary concern is the possibility that the proposed Keahole-Kailua 69 kV transmission line may interfere with the VHF (very high frequency) high-band receivers in the 150-160 MHz range that are used to remotely control the siren warning system.

As a general rule, overhead transmission lines do not interfere with normal radio reception. However, corona and gap discharges could be potential sources of unwanted electrical signals which could interfere with radio reception, especially during foul weather. Corona and gap discharges are described in the "Electric and Magnetic Fields" section of the EIS.

HELCO engineers will design the proposed transmission line to meet Federal Communications Commission (FCC) standards for radio noise levels, and will take every precaution to insure that during foul weather conditions the transmission lines will be as free as possible from corona and gap discharges in the vicinity of the State Civil Defense VHF receivers that control the siren warning system.

Mr. Roy C. Price, Sr.
January 31, 1994
Page 2

Thank you for your assistance. If you should have any questions on this project in the future, please feel free to contact me or assistant project manager Bennett Mark at (808) 943-1133.

Sincerely,

CH2M HILL

Albert Lono Lyman
Senior Project Manager

cc: Dennis Tanigawa, HELCO
Ed Lagundimao, HECO
Don Horiuchi, DLNR/OCEA

JOHN WAIHEE
GOVERNOR

FACILITIES' COPY
CHARLES T. TOGUCHI
SUPERINTENDENT

STATE OF HAWAII
DEPARTMENT OF EDUCATION
P. O. BOX 2360
HONOLULU, HAWAII 96804

OFFICE OF THE SUPERINTENDENT

April 29, 1993

Mr. Don Horiuchi
State of Hawaii
Department of Land
and Natural Resources
1151 Punchbowl Street
Honolulu, Hawaii 96813

Dear Mr. Horiuchi:

SUBJECT: Draft Environmental Impact Statement (DEIS)
Keahole - Kailua 69 KV Transmission Line Project

We have reviewed the subject DEIS and have no comment on the proposed 69 kV transmission line since no school sites are projected along the corridor at this time. The Department of Education is concerned about high voltage transmission lines located next to schools because of the possible health risks associated with electric and magnetic fields (EMF).

Should there be any questions, please call the Facilities Branch at 737-4743.

Sincerely,

Charles T. Toguchi
Superintendent

CTT:hy

cc: A. Suga, Asst. Supt.
A. Garson, HIDO
D. Tanigawa, HELCO
A. Lyman, CH2M Hill

CH2M HILL
Engineers
Planners
Economists
Scientists

January 31, 1994

OPE33045.D2

Mr. Charles T. Toguchi
Superintendent
State of Hawaii
Department of Education
P.O. Box 2360
Honolulu, Hawaii 96804

Dear Mr. Toguchi:

Subject: Keahole-Kailua 69 kV Transmission Line Project Draft Environmental Impact Statement (DEIS)

Thank you for reviewing the DEIS for the Keahole-Kailua 69 kV Transmission Line Project.

If there any further questions, please feel free to contact me or assistant project manager Bennett Mark at (808) 943-1133.

Sincerely,

CH2M HILL

Albert Lono-Lyman
Senior Project Manager

cc: Dennis Tanigawa, HELCO
Ed Lagundimao, HECO
Don Horiuchi, DLNR

Honolulu Office
1585 Kapiolani Blvd., Suite 1420
Honolulu, HI 96814-4530
808 943-1133
Fax No. 808 941-8225

HNL87/015.51

JOHN WAIHEE
GOVERNOR
STATE OF HAWAII

HOALIKU L. DRAKE
CHAIRMAN
HAWAIIAN HOMES COMMISSION

STATE OF HAWAII
DEPARTMENT OF HAWAIIAN HOME LANDS
P. O. BOX 1879
HONOLULU, HAWAII 96805

May 4, 1993

MEMORANDUM

TO: The Honorable Keith Ahue, Chairperson
Board of Land and Natural Resources

FROM: Hoaliku L. Drake, Chairman
Hawaiian Homes Commission

SUBJECT: Keahole - Kailua 69kV Transmission Line Project, Draft Environmental Impact Statement

Thank you for the opportunity to review the April 1993 draft environmental impact statement (EIS) for the subject Keahole - Kailua 69kV Transmission Line Project.

We do not anticipate any adverse effects from this proposal on programs of this department.

HLD/BH/JC:asy/2832L

cc: Office of Environmental Quality Control
Dennis Tanigawa, Hawaii Electric Light Company, Inc.
Al Lono Lyman, CH2M HILL

CH2M HILL Engineers Planners Economists Scientists

January 31, 1994

OPE33045.D2

Ms. Hoaliku L. Drake, Chairman
Hawaiian Homes Commission
State of Hawaii
Department of Hawaiian Home Lands
P.O. Box 1879
Honolulu, Hawaii 96805

Dear Ms. Drake:

Subject: Keahole-Kailua 69 kV Transmission Line Project Draft Environmental Impact Statement (DEIS)

Thank you for reviewing the DEIS for the Keahole-Kailua 69 kV Transmission Line Project.

If you should have any questions on this project in the future, please feel free to contact me or assistant project manager Bennett Mark at (808) 943-1133.

Sincerely,

CH2M HILL

Albert Lono Lyman
Senior Project Manager

cc: Dennis Tanigawa, HELCO
Ed Lagundimao, HECO
Don Horiuchi, DLNR

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SENT BY:Xerox Telecopier 7021 : 6- 9-93 : 2:34PM : DLNR / OCEA- 808 941 8225:# 7

DEPARTMENT OF LAND & NATURAL RESOURCES
DIVISION OF FORESTRY & WILDLIFE

May 19, 1993

DH

M E M O R A N D U M

TO: Ed Henry
Office of Conservation & Environmental Affairs

FROM: Michael Buck, Administrator
Division of Forestry & Wildlife M. Buck

SUBJECT: Draft EIS Keahole-Kailua 69 kV Transmission Line Project

Both Corridors S2 and S3 have rare and endangered plants or animals. The corridors along Queen Kaahumanu Highway biologically should affect the fewest rare biological elements.

Before this Keahole to Kailua area is developed, more intensive biological surveys are recommended to avoid areas with rare and endangered plants and animals. Based upon our experience within the Kealakehe parcel, new rare and endangered plants will continue to be discovered as the project proceeds. It will be much cheaper in the long run to invest in a thorough survey and address protection and mitigation activities on a total project basis - not on a case-by-case situation as the project progresses. Areas where more intensive biological survey will likely turn up these species are a'a lava flows, particularly within the Kaloko area and the proposed U.H. campus area. Historical data shows the Kaloko area with a number of rare plant species. The botanical reconnaissance of the corridor S-2, already has three additional rare plant species not seen at Kealakehe. A white flowered form of mamane, Sophora chrysophylla, not mentioned within the corridor, was also recently discovered in this area.

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OCEA

Engineers
Planners
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January 13, 1994

OPE33045.D2

Mr. Keith W. Ahue, Director
State of Hawaii
Department of Land and Natural Resources
1151 Punchbowl Street
Honolulu, Hawaii 96813

Dear Mr. Ahue:

Attention: Mr. Don Horiuchi, Office of Conservation and Environmental Affairs

Subject: Keahole-Kailua 69 kV Transmission Line Project Draft Environmental Impact Statement (DEIS)

Thank you for reviewing the DEIS for the Keahole-Kailua 69 kV Transmission Line Project. We are in agreement with the Division of Forestry and Wildlife that a transmission line corridor along the edge of Queen Kaahumanu Highway should affect the fewest biological elements.

The Division of Forestry and Wildfire noted that the native mamane (*Sophora chrysophylla)* was recently discovered in the area. The native mamane would typically be found in the Ohia Lowland Dry Forest and Aalii Lowland Dry Shrubland areas in the upland areas of Kaloko-Honokohau, in the vicinity of mid-level Corridor S-2. See Chapter 5, "Geological and Biological Resources," Appendix D, and Figures 2A and 2B in Appendix D.

The native mamane is not listed as a State or Federally Endangered Plant Taxa, as a Proposed Endangered Plant Taxa, or as a Candidate Category 2 for Endangered Plant Taxa. However, since the S-2 mid-level corridor was eliminated from consideration in favor of the S-1 Corridor along the mauka edge of the Queen Kaahumanu Highway, the native mamane in the upland areas of Kaloko-Honokahau would not be affected by this project.

HNL87\022.51

Thank you for your and your staff's assistance with this project.

If there any further questions, please feel free to contact me or assistant project manager Bennett Mark at (808) 943-1133.

Sincerely,

CH2M HILL

Albert Lono Lyman
Senior Project Manager

cc: Dennis Tanigawa, HELCO
Ed Lagundimao, HECO
Don Horiuchi, DLNR/OCEA
Michael Buck, DLNR/DOF&W

HNL87\022.51

JOHN WAIHEE
GOVERNOR

REX D. JOHNSON
DIRECTOR

DEPUTY DIRECTORS
JOYCE T. OMINE
AL PANG
JEANNE K. SCHULTZ
CALVIN M. TSUDA

STATE OF HAWAII
DEPARTMENT OF TRANSPORTATION
869 PUNCHBOWL STREET
HONOLULU, HAWAII 96813-5097

IN REPLY REFER TO:
STP 8.5224

May 27, 1993

TO: Mr. Don Horiuchi
Conservation & Environmental Affairs
Department of Land and Natural Resources

FROM: Rex D. Johnson
Director of Transportation

SUBJECT: DRAFT ENVIRONMENTAL IMPACT STATEMENT (DEIS)
KEAHOLE-KAILUA 69 kV TRANSMISSION LINE PROJECT

Since HELCO's preferred alternative envisions utilizing the Queen Kaahumanu Highway right-of-way, they must make the necessary adjustments to their circuits and infrastructure when the widening of the highway and the construction of the frontage roads are implemented. The cost of the original installation of the proposed transmission lines and for any future utility adjustments will be borne by HELCO. At the time when the highway is widened and frontage roads constructed, the alternative of placing portions or all of the transmission lines underground should be considered. Plans for construction work within the State highway right-of-way must be submitted for our review and approval.

As the DEIS indicates, in the proximity of the Keahole Airport, HELCO will be also required to submit: 1) a Notice of Proposed Construction or Alteration/Determination of No Hazard to Air Navigation, issued by the Federal Aviation Administration, and 2) a Permit to Construct or Alter a Structure Within Airport Hazard Area Zones issued by our Airports Division for structures more than 35 feet high, pursuant to Chapter 262-3, HRS (since the proposed utility poles will range from 70 to 85 feet in height).

We appreciate the opportunity to provide comments.

c: Mr. Dennis Tanigawa - Hawaii Electric Light Company, Inc.
Mr. Al Lono Lyman - CH2M HILL
Mr. Brian J. J. Choy - OEQC

CH2M HILL
Engineers
Planners
Economists
Scientists

January 31, 1994

OPE33045.D2

Mr. Rex D. Johnson
Director of Transportation
State of Hawaii
Department of Transportation
869 Punchbowl Street
Honolulu, Hawaii 96813-5097

Dear Mr. Johnson:

Subject: Keahole-Kailua 69 kV Transmission Line Project Draft Environmental Impact Statement (DEIS)

Thank you for reviewing the DEIS for the Keahole-Kailua 69 kV Transmission Line Project.

We understand that the plans for the widening of the Queen Kaahumanu Highway right-of-way, and the construction of grade-separated interchanges and frontage roads, when implemented, will necessitate the relocation of the proposed Keahole-Kailua 69 kV transmission line.

For the preferred route following the mauka edge of the Queen Kaahumanu Highway right-of-way, the underground 69 kV transmission line alternative was analyzed on an equal basis with the overhead 69 kV transmission line alternative. Although the stated preference of the Hawaii Electric Light Company, Inc. (HELCO) is the overhead alternative, HELCO analyzed the underground alternative.

As a result of our consultation with your department, it is clear to HELCO that, for the proposed 69 kV transmission line along the mauka edge of the Queen Kaahumanu Highway right-of-way, the underground alternative would not be a cost effective choice. The proposed Keahole-Kailua 69 kV transmission line must be installed and energized by December 1994 in order to maintain an acceptable level of reliability to the system. Our consultations with your staff indicated that the portion of Queen Kaahumanu Highway

Honolulu Office 1585 Kapiolani Blvd., Suite 1420 Honolulu, HI 96814-4530 808 943-1133 Fax No. 808 941-8225

between Keahole and Kailua may be expanded to a four-lane divided-highway as early as 1995, and that frontage roads and grade-separated interchanges would be developed at an unspecified future date. Our consultations indicated that portions of the proposed Keahole-Kailua 69 kV transmission line, whether it be overhead or underground, would require relocation when the frontage roads and grade-separated interchanges are constructed.

Once plans for the widening of Queen Kaahumanu Highway into a four-lane divided-highway with frontage roads and grade-separated interchanges are finalized, HELCO will work with your department to finalize the appropriate location of its 69 kV transmission lines along the highway right-of-way.

Thank you and your staff's generous assistance with this project. When the time comes, HELCO will work with your staff to assure that all requires permits are obtained.

If you should have any questions on this project in the future, please feel free to contact me or assistant project manager Bennett Mark at (808) 943-1133.

Sincerely,

CH2M HILL

Albert Lono Lyman
Senior Project Manager

cc: Dennis Tanigawa, HELCO
Ed Lagundimao, HECO
Don Horiuchi, DLNR/OCEA

JOHN WAIHEE
GOVERNOR

BRIAN J. J. CHOY
Director

STATE OF HAWAII
OFFICE OF ENVIRONMENTAL QUALITY CONTROL
220 SOUTH KING STREET
FOURTH FLOOR
HONOLULU, HAWAII 96813
TELEPHONE (808) 586-4186

June 3, 1993

Mr. Don Horiuchi
Office of Conservation and Environmental Affairs
Department of Land and Natural Resources
1151 Punchbowl Street
Honolulu, Hawaii 96813

Dear Mr. Horiuchi:

Subject: Draft Environmental Impact Statement for the Keahole to Kailua 69 kV Transmission Line Project, North Kona, Hawaii

Thank you for the opportunity to review the subject document. We do not have any comments to offer.

Sincerely,

Brian J. J. Choy
Director

BC:jt

c: Hawaii Electric Light Company
CH2M Hill

CH2M HILL Engineers Planners Economists Scientists

January 31, 1994

OPE33045.D2

Mr. Brian J.J. Choy, Director
State of Hawaii
Office of Environmental Quality Control
222 South King Street, Fourth Floor
Honolulu, Hawaii 96813

Dear Mr. Choy:

Subject: Keahole-Kailua 69 kV Transmission Line Project Draft Environmental Impact Statement (DEIS)

Thank you for reviewing the DEIS for the Keahole-Kailua 69 kV Transmission Line Project.

If you should have any questions on this project in the future, please feel free to contact me or assistant project manager Bennett Mark at (808) 943-1133.

Sincerely,

CH2M HILL

Albert Lono Lyman
Senior Project Manager

cc: Dennis Tanigawa, HELCO
Ed Lagundimao, HECO
Don Horiuchi, DLNR

Honolulu Office 1585 Kapiolani Blvd., Suite 1420 Honolulu, HI 96814-4530 808 943-1133 Fax No. 808 941-8225

HNL87/006.51

University of Hawaii at Manoa

Environmental Center
A Unit of Water Resources Research Center
Crawford 317 • 2550 Campus Road • Honolulu, Hawaii 96822
Telephone: (808) 956-7361

June 7, 1993
RE:0631

Mr. Don Horiuchi
Department of Land and Natural resources
1151 Punchbowl Street
Honolulu, Hawaii 96813

Dear Mr. Horiuchi:

Draft Environmental Impact Statement
Keahole-Kailua 69 kV Transmission Line Project
Kona, Hawaii

The above cited project involves the construction of a 69 kV transmission line between the Keahole Switching Station and the Kailua Substation in Kailua-Kona Hawaii. The line is needed to accommodate the current and new growth in the vicinity and is proposed to extend some 6.8 miles along the mauka edge of Queen Kaahumanu Highway.

The Environmental Center review of this Draft EIS has been prepared with the assistance of Peter Flachsbart, Urban and Regional Planning; and John Harrison, Environmental Center.

In general, our reviewers have found the document to be well organized and to adequately cover the content requirements of a Draft EIS. Areas of special concern included (but were not limited too) the following: Electromagnetic radiation, Archaeology, Visual aesthetics, Natural Hazards, and Endangered/threatened species.

Electromagnetic radiation is an ongoing issue of great public concern. The topic was addressed in the Draft EIS and a number of references cited, however, it continues to be a controversial subject and one with which the public health issues are as yet uncertain. Hence, it is highly appropriate that a full discussion of the topic be included in the Final EIS.

The Draft EIS includes several tables (5-6,7,8) that compare the magnetic field levels for overhead lines and underground cables. It is not clear if the figures given in table 5-8 for underground cable and "existing overhead line" reflect the value for the overhead line remaining "overhead"? If this is the case then the magnetic field for placing all the cables underground, including the existing as well as the proposed, using low-reactance (unlike) phasing should be given.

It has been our observation that undergrounding cables is always discarded on the basis of the apparently higher costs. However, no breakdown is provided as to why the costs are so much greater and no indication is given as to the cost of maintenance or life expectancy of underground cables vs. overhead wires. Given proper design it would appear that undergrounding would have many significant advantages over aboveground wires. With adequate design for future needs, additional cables could be added as required with no increase in tunnel construction and thus minimal expense. Cables would not be exposed to weather conditions hence would be less likely to be affected by storms. Modern equipment lets you rapidly localize the location of line failures and inclusion of the access caverns every 1000 feet, as cited in the Draft EIS), would permit relatively easy access to the damaged cable. The Final EIS should include an estimate of the life expectancy, maintenance and repair costs of an above ground installation as compared to an existing underground system.

The cost of re-setting the poles to accommodate the proposed highway expansion is yet another "cost" to factor in to the above ground installation that might be avoided with undergrounding and proper planning.

A "walk-through" Archaeological survey was conducted and sites recorded. It is not clear if any of the numerous lava tubes were included in the Archaeological investigations. If not, it would be well to survey any lava tubes encountered during the drilling operations for the new poles.

Visual impacts are very well addressed with the photograph images shown in Figures 5-3, 5-4. To be consistent, we suggest that the fully underground option also be so illustrated (by blanking out the existing wires and poles altogether!).

The discussion of the Natural Hazards of the area and in particular volcanic hazards is quite complete. One "hazard" not addressed that should be given some consideration are hazards due to earthquakes. Since the Big Island is the most seismically active area in the United States, it would be prudent to consider the seismic history of this area in the design of this project.

We appreciate the opportunity to comment on this Draft EIS and hope you will find our comments helpful in the formulation of the Final EIS.

Sincerely,

Jacquelin N. Miller
Associate Environmental Coordinator
Environmental Center

cc: OEQC
Al Lono Lyman, CH2M Hill
Dennis Tanigawa, HELCO
Roger Fujioka, WRRC
John Harrison
Peter Flachsbart

CH2M HILL
Engineers
Planners
Economists
Scientists

January 31, 1994

OPE33045.D2

Ms. Jacqueline N. Miller
Associate Environmental Coordinator
University of Hawaii at Manoa
Environmental Center
Crawford 317
2550 Campus Road
Honolulu, Hawaii 96822

Dear Ms. Miller:

Subject: Keahole-Kailua 69 kV Transmission Line Project Draft Environmental Impact Statement (DEIS)

Thank you for reviewing the DEIS for the Keahole-Kailua 69 kV Transmission Line Project. We appreciate the time and effort that you and your associates at the Environmental Center have spent in preparing your review. The following are our responses to your questions and comments.

1. Electric and Magnetic Field Values

As you have indicated in your comment letter, the issue of electric and magnetic fields (EMFs) is one of ongoing public concern. While research to date has not demonstrated conclusive evidence of public health hazards from EMF from lines similar to the proposed Keahole-Kailua 69 kV transmission line, HELCO is committed to disclosing all pertinent information on EMF from this transmission line.

In DEIS Table 5-8, "Comparison of Magnetic Field Levels for Overhead Lines and Underground Cables," the column on the right shows the values for the "Proposed Underground Three-Conductor 69 kV Cable with Existing Overhead Line." The magnetic field values shown in this column are for a new underground transmission line installed with the existing overhead transmission line system remaining in place. As was indicated in the text, the trench holding the underground cables was assumed to be set approximately 20 feet away from the poles supporting the existing 69 kV single-circuit overhead transmission line and the existing underbuild of 12 kV distribution lines.

If the existing overhead 69 kV transmission line were completely removed and replaced with two underground 69 kV transmission line circuits, it would be configured so that one circuit would be placed as shown in DEIS Figure 5-8 and the second circuit would be placed within one of the "spare PVC ducts for future use." Power Delivery Consultants, Inc., calculated the magnetic field values for two underground 69 kV circuits arranged in this manner with low-reactance phasing. The tabulated results are attached to this letter. Magnetic field calculations were made for the scenarios assuming that both underground circuits would: 1) conduct the same amperage as the existing overhead 69 kV circuit (73 amperes), 2) conduct the normal maximum amperage (890 amperes), and 3) conduct the emergency maximum amperage (1020 amperes). Because removing the existing overhead 12 kV (5 ampere) circuit may not be practical, the magnetic field values were calculated with and without the overhead 12 kV circuit remaining in place.

2. Placing All Overhead Lines Underground

The purpose of this project was limited to adding an additional 69 kV transmission line from Keahole to Kailua, and did not encompass the greater statewide issue of placing existing electric and communication facilities underground. That issue, and the issue of the resulting additional costs, should more appropriately be addressed by the State Legislature and the Public Utilities Commission. The reasons why underground transmission lines are impractical for this project are explained further in "Visual Impact Simulation" later in this letter.

3. Long-Term Operations and Maintenance Cost Comparisons of Overhead Versus Underground Transmission Lines

We agree that the long-term operations and maintenance costs of overhead and underground transmission lines are important factors in the evaluation of the alternative transmission line technologies. In order to compare the overhead and underground alternatives, HELCO compared the operations and maintenance costs of both alternative technologies over an assumed 20-year life expectancy period, and assumed the following:

a. The overhead transmission line alternative would consist of two 69 kV circuits on 125 steel poles.

b. The underground transmission line alternative would consist of two 69 kV circuits in ducts encased in concrete with 40 manholes.

c. The overhead transmission line and the underground transmission line alternatives would have identical lengths, of approximately 7 miles.

d. The overhead transmission line and the underground transmission line alternatives would have nearly identical drive-by inspection schedules, involving one 1/2-hour inspection per month.

e. The underground transmission line alternative would involve additional substation termination inspections, involving one 3/4-hour inspection every three months.

f. The overhead transmission line and the underground transmission line alternatives would have identical operational requirements, involving 4 man-hours per year by a troubleman for switching operations.

g. Maintenance for the overhead transmission line would involve the touch-up painting of 10 percent of the steel poles annually after 10 years. The touch-up painting would involve 6 man-hours per pole for 12 poles each year, in addition to $50 of painting material costs per pole. Maintenance of the overhead transmission line would also involve the replacement of insulators and hardware of 5 percent of the steel poles annually after 10 years. The replacement of insulators and hardware would involve 24 man-hours per pole for six poles per year, in addition to $500 per pole of material costs.

h. Maintenance for the underground transmission line would involve the pumping out and cleaning of 10 percent of the manholes annually. This would involve 8 man-hours per manhole for four manholes annually, in addition to $250 of equipment costs per manhole. Maintenance for the underground transmission line would also involve the replacement of racks and hangers as required for 10 percent of the manholes after 5 years. The replacement of racks and hangers would involve 16 man-hours per manhole for four manholes annually, in addition to the material costs of $200 per manhole.

i. All costs are expressed in current dollars; projections for costs assume an escalation (inflation) factor of 4 percent annually.

The major operations and maintenance cost differential between the overhead transmission line and the underground transmission line alternatives is due to the difference in the scheduling of significant maintenance and hardware replacement. For the overhead transmission line, significant annual maintenance and replacement of hardware is delayed for 10 years. For the underground transmission line, substantial maintenance is required annually beginning immediately with the first year of service, and substantial annual replacement of hardware begins after 5 years of service.

The time value of money must be considered in comparing the operations and maintenance costs of the overhead to the underground alternative because of the marked differences of when these costs would be incurred. When the time value of money is considered, it is clear that the net present value of all of the future operations and maintenance costs for the underground transmission line alternative is higher than the net present value of all of the future operations and maintenance costs of the overhead transmission line. If the time value of money is assumed to be 8 percent, the ratio of the underground transmission line's operations and maintenance costs to the overhead transmission line's operations and maintenance cost would be 1.3:1; if the time value of money were considered to be 16 percent the ratio would rise to 1.7:1.

4. Visual Impact Simulation

The DEIS analyzed the most reasonable alternatives for an additional 69 kV transmission line. In this regard, only those overhead and underground alternatives that we considered reasonable and practical were analyzed in detail in this DEIS.

There is no question that an all-underground option would have less visual impact than options with overhead lines. However, an alternative for a proposed underground transmission line, in conjunction with the removal of an existing 69 kV overhead transmission line, and the placing of that existing overhead transmission line underground together with a proposed underground transmission line, would still not completely eliminate the existing visual impact of the poles along the highway. If the existing 69 kV transmission line were removed from the existing poles, the poles could be shortened, but would still need to support 12 kV distribution lines, electric distribution transformers, secondary distribution lines, and the telephone and cable television lines. We did not consider this alternative to be a viable one and did not analyze it in the DEIS.

Furthermore, our discussions with the State Department of Transportation, Highway Division (DOT-H) have led us to the conclusion that placing the existing line underground is not prudent as it would have to be relocated in conjunction with the work to improve Queen Kaahumanu Highway. The discussions with DOT-H indicated that the State plans to widen the two-lane Queen Kaahumanu Highway into a four-lane divided highway with a median strip, frontage roads along each edge of the highway, and grade-separated interchanges at selected points along the highway. According to DOT-H, the work will be phased over an extended period of time. Between the Keahole Airport and Kailua, the four-lane divided highway construction work may begin sometime in 1994. No construction schedule is set for the frontage roads and the two grade-separated interchanges that are proposed between the airport and Kailua; DOT-H indicated that the frontage road construction may not take place for two or more decades.

HELCO's objective is to complete construction and energize the Keahole-Kailua 69 kV transmission line by December 1994 in order to accommodate load growth and maintain system reliability. Segments of the transmission lines installed along the edge of the highway, whether they are overhead or underground, must be relocated in conjunction with the Queen Kaahumanu Highway work, which will include new frontage roads and grade-separated interchanges. The DOT-H has advised HELCO that if underground lines are installed before all the highway construction plans are finalized, the portions of underground transmission line would, in all likelihood, need to be relocated after the elevations (vertical) and the locations (horizontal) of the frontage roads and grade-separated interchanges are finalized. Highway construction plans for the new frontage roads and grade-separated interchanges will not be finalized by the time construction of the Keahole-Kailua 69 kV transmission line is scheduled to begin.

The underground lines and their maintenance accesses, if installed now, would need to be impractically deep in order to avoid being affected by eventual (vertical) grade changes. Furthermore, there would still be uncertainty as to where an eventual underground transmission line trench could be (horizontally) located. Our discussions with DOT-H have indicated that portions of an overhead transmission line would eventually also need to be reset, and that the alternative acceptable to DOT-H would be an overhead configuration.

5. Archaeology

A walk-through archaeological survey of the selected alignment was conducted by Paul H. Rosendahl, Ph. D., Inc. (PHRI). PHRI identified one lava tube that may have been a habitation site. See Appendix F, "Findings" and Appendix F, Table 3.

If any additional archaeological sites are encountered during the construction of the line, they will be dealt with in a manner that meets all applicable state and county requirements.

6. Natural Hazards

According to "Seismicity of Hawaii, 1962-1985," a map produced by Susan K. Goter of the National Earthquake Information Center in 1988, the U.S.G.S.

Hawaiian Volcano Observatory recorded 330 earthquakes of magnitude 4.0 or greater in the Hawaiian Islands from January 1962 to December 1985. During this time period, the bulk of the earthquake activity occurred in the rift zones of Mauna Loa and Kilauea, and in the area near Kalalua. Three ranges of earthquake magnitude categories were used: 4.0 to 4.4, 4.5 to 5.4, and 5.5 and over. Only four earthquakes with the highest magnitude of 5.5 and over were recorded, with two of the earthquake epicenters occurring in the Mauna Loa rift zone, one near Kalapana, and one near Honomu. Within the Keahole to Kailua study area, only one earthquake epicenter with the lowest magnitude category of 4.0 to 4.4 is shown at Honokohau. Within a few miles of the study area, five offshore earthquake epicenters are shown, four in the 4.0 to 4.4 magnitude category, and one in the 4.5 to 5.4 magnitude category.

The potential for ground fractures and surface subsidence is related to the potential for earthquakes and was analyzed by Masa Fujioka and Associates (MFA). Ground fractures and surface subsidence is discussed in the Volcanic Hazards section of the DEIS and in Appendix C. The area of highest ground hazard and subsidence hazard is Zone 1, with Zone 4 being the area of least hazard. Zone 1 consists of the summit areas and rift zones of Mauna Loa and Kilauea. Zone 2 consists of the south flank of Kilauea where fracturing and subsidence occur along northeast-trending fault systems. Zone 3 consists of the less active Kaoiki and Kealakekua fault systems along the southeast and southwest flanks of Mauna Loa. Zone 4, where the hazard is the least, covers the remainder of the island. The Keahole-Kailua 69 kV transmission line project area is located in Zone 4, the least hazard zone for ground fractures and surface subsidence.

Under the Uniform Building Code (UBC), seismic zone 4 has the highest potential and seismic zone 3 has the second-highest potential for significant ground motion created by seismic events. The most active seismic zones are located within seismic zone 4. In the United States, seismic zone 4 occurs in most of western California, southern Alaska and the Aleutian islands, portions of western Nevada, and portions of Puerto Rico. Seismic zone 3 occurs in the remainder of California, and portions of Alaska, Idaho, Montana, Wyoming, Missouri, Arkansas, Mississippi, Tennessee, Kentucky, and Illinois. The island of Hawaii is designated as seismic zone 3. The UBC establishes minimum design criteria for structures to resist the effects of seismic ground motion, in accordance with the standards for the seismic zone in which the structure is to be built. All structures that will be built as a part of this project will be designed in accordance with the UBC standards for seismic zone 3.

Thank you for your comments. If you should have any questions on this project in the future, please feel free to contact me or assistant project manager Bennett Mark at (808) 943-1133.

Sincerely,

CH2M HILL

Albert Lono Lyman
Senior Project Manager

cc: Dennis Tanigawa, HELCO
Ed Lagundimao, HECO
Don Horiuchi, DLNR/OCEA

attachments

Attachment 1

MAGNETIC FIELD CALCULATION RESULTS WITH NO OVERHEAD 69 KV CIRCUITS
KEAHOLE-KAILUA 69 KV TRANSMISSION LINE PROJECT

TWO UNDERGROUND 69 KV CIRCUITS IN DUCT BANK
UNLIKE PHASING–73 AMPERES IN BOTH CIRCUITS

Location (Distance from Center Line of Pole) (ft)*	Magnetic Field (mG)	
	With 12 kV Overhead Circuit	Without 12 kV Overhead Circuit
-100	0.0	0.0
-90	0.0	0.0
-80	0.0	0.0
-70	0.0	0.0
-60	0.0	0.0
-50	0.0	0.0
-40	0.1	0.0
-30	0.5	0.1
-20	1.9	0.5
-10	0.6	2.0
0	0.4	0.4
10	0.3	0.1
20	0.2	0.0
30	0.1	0.0
40	0.1	0.0
50	0.1	0.0
60	0.0	0.0
70	0.0	0.0
80	0.0	0.0
90	0.0	0.0
100	0.0	0.0

* Underground cable duct bank set approximately -20 feet from pole supporting overhead lines. Five amperes assumed for 12 kV overhead circuit.

Source: Power Delivery Consultants, Inc.

Attachment 2

MAGNETIC FIELD CALCULATION RESULTS WITH NO OVERHEAD 69 KV CIRCUITS
KEAHOLE-KAILUA 69 KV TRANSMISSION LINE PROJECT

TWO UNDERGROUND 69 KV CIRCUITS IN DUCT BANK
UNLIKE PHASING–890 AMPERES IN BOTH CIRCUITS

Location (Distance from Center Line of Pole) (ft)*	Magnetic Field (mG)	
	With 12 kV Overhead Circuit	Without 12 kV Overhead Circuit
-100	0.0	0.0
-90	0.0	0.0
-80	0.0	0.0
-70	0.1	0.1
-60	0.1	0.2
-50	0.3	0.4
-40	1.0	1.1
-30	5.6	5.6
-20	23.9	23.9
-10	5.0	4.9
0	1.3	1.0
10	0.5	0.3
20	0.2	0.1
30	0.1	0.1
40	0.1	0.0
50	0.1	0.0
60	0.0	0.0
70	0.0	0.0
80	0.0	0.0
90	0.0	0.0
100	0.0	0.0

* Underground cable duct bank set approximately -20 feet from pole supporting overhead lines. Five amperes assumed for 12 kV overhead circuit.

Source: Power Delivery Consultants, Inc.

Attachment 3

MAGNETIC FIELD CALCULATION RESULTS WITH NO OVERHEAD 69 KV CIRCUITS
KEAHOLE-KAILUA 69 KV TRANSMISSION LINE PROJECT

TWO UNDERGROUND 69 KV CIRCUITS IN DUCT BANK
UNLIKE PHASING – 1020 AMPERES IN BOTH CIRCUITS

Location (Distance from Center Line of Pole) (ft)*	Magnetic Field (mG)	
	With 12 kV Overhead Circuit	Without 12 kV Overhead Circuit
-100	0.0	0.0
-90	0.0	0.0
-80	0.0	0.1
-70	0.1	0.1
-60	0.1	0.2
-50	0.3	0.4
-40	1.2	1.3
-30	6.4	6.4
-20	27.4	27.4
-10	5.7	5.6
0	1.5	1.1
10	0.5	0.4
20	0.2	0.2
30	0.1	0.1
40	0.1	0.1
50	0.1	0.0
60	0.0	0.0
70	0.0	0.0
80	0.0	0.0
90	0.0	0.0
100	0.0	0.0

* Underground cable duct bank set approximately -20 feet from pole supporting overhead lines. Five amperes assumed for 12 kV overhead circuit.

Source: Power Delivery Consultants, Inc.

Stephen K. Yamashiro
Mayor

Donna Fay K. Kiyosaki
Chief Engineer

Riley W. Smith
Deputy Chief Engineer

County of Hawaii
DEPARTMENT OF PUBLIC WORKS
25 Aupuni Street, Room 202 • Hilo, Hawaii 96720-4252
(808) 961-8321 • Fax (808) 969-7138

May 7, 1993

MR DON HORIUCHI
STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
1151 PUNCHBOWL STREET
HONOLULU HI 96813

SUBJECT: DRAFT ENVIRONMENTAL IMPACT STATEMENT
Keahole-Kailua 69KV Transmission Line Project
Hawaii Electric Light Company
Report Dated April, 1993

We have reviewed the subject DEIS report and provide you with our comments as follows:

1. Transmission tower /utility poles shall conform to all requirements of code and statutes pertaining to building construction.

2. All generated runo f shall be disposed of properly and shall not be directed toward an adjacent properties.

3. All earthwork and ading shall conform to requirements of Chapter 10 of the Hawaii Coun / Code.

4. The required permi under Chapter 22, Article 3, Section 22-44 of the Hawaii County Code shall be obtained from the Department of Public Works by the Contractor for work within the County right-of-way.

Should there be any questions concerning this matter, please feel free to contact Mr. Casey Yanagihara in our Engineering Division at 961-8327.

GALEN M. KUBA, Acting Division Chief
Engineering Division

CKY:byf

cc: Office of Environmental Quality Control
Hawaii Electric Light Company
CH2M Hill

CH2M HILL
Engineers
Planners
Economists
Scientists

January 31, 1994

OPE33045.D2

Mr. Galen M. Kuba,
Acting Division Chief
Engineering Division
County of Hawaii
Department of Public Works
25 Aupuni Street, Room 202
Hilo, Hawaii 96720-4552

Dear Mr. Kuba:

Subject: Keahole-Kailua 69 kV Transmission Line Project Draft Environmental Impact Statement (DEIS)

Thank you for reviewing the DEIS for the Keahole-Kailua 69 kV Transmission Line Project.

When construction plans are available for the transmission line and poles, they will be forwarded to your Department for review and approval prior to construction. Construction plans will conform to all County of Hawaii code and statutory requirements for pole construction, storm water runoff, earthwork and grading, and for the use of County rights-of-way.

If there are any further questions, please feel free to contact me or assistant project manager Bennett Mark at (808) 943-1133.

Sincerely,

CH2M HILL

Albert Lono Lyman
Senior Project Manager

cc: Dennis Tanigawa, HELCO
Ed Lagundimao, HECO
Don Horiuchi, DLNR/OCEA

Honolulu Office 1585 Kapiolani Blvd., Suite 1420 Honolulu, HI 96814-4530 808 943-1133 Fax No. 808 941-8225

HNL87/017.51

DEPARTMENT OF WATER SUPPLY • COUNTY OF HAWAII
25 AUPUNI STREET • HILO, HAWAII 96720
TELEPHONE (808) 969-1421 • FAX (808) 969-6996

April 29, 1993

Mr. Don Horiuchi
State of Hawaii
Department of Land and Natural Resources
1151 Punchbowl Street
Honolulu, HI 96813

ENVIRONMENTAL IMPACT STATEMENT (EIS)
KEAHOLE-KAILUA 69 kV TRANSMISSION LINE PROJECT
APPLICANT - HAWAII ELECTRIC LIGHT COMPANY, INC.
TAX MAP KEY 7-3-9:VARIOUS; 7-3-51:VARIOUS;
7-4-08:VARIOUS; 7-4-10:VARIOUS; 7-4-15:VARIOUS

We have reviewed the subject draft EIS for the proposed electrical transmission line.

Inasmuch as the transmission line may affect the existing water system facilities, it is requested the construction plans be reviewed and approved by our Department.

Should the transmission line be contingent on the completion of the Keahole Generating Plant Expansion, then it should be noted that certain water system improvements must constructed. Required improvements were described during the review of the draft EIS for the generating plant expansion.

William Sewake
H. William Sewake
Manager

WA

cc - Hawaii Electric Light Company, Inc., Mr. Dennis Tanigawa
CH2M Hill, Mr. Al Lono Lyman

... Water brings progress...

CH2M HILL

Engineers
Planners
Economists
Scientists

January 31, 1994

OPE33045.D2

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

Dear Mr. Sewake:

Subject: Keahole-Kailua 69 kV Transmission Line Project Draft Environmental Impact Statement (DEIS)

Thank you for reviewing the DEIS for the Keahole-Kailua 69 kV Transmission Line Project.

As you have requested, when detailed plans are available for the transmission line and poles, they will be forwarded to your Department for your review and approval prior to construction.

The Keahole-Kailua 69 kV Transmission Line Project is not contingent upon the completion of the Keahole Generating Plant. The Keahole-Kailua 69 kV transmission line will be required to maintain system reliability even if additional generating capacity is not installed at Keahole.

If there are any further questions, please feel free to contact me or assistant project manager Bennett Mark at (808) 943-1133.

Sincerely,

CH2M HILL

Albert Lono Lyman
Senior Project Manager

cc: Dennis Tanigawa, HELCO
Ed Lagundimao, HECO
Don Horiuchi, DLNR

File:KOC-6213.DOC

KONA OUTDOOR CIRCLE

76-6280 Kuakini Highway
Kailua-Kona, Hawaii 96740

21 June 1993

Department of Land and Natural Resources
1151 Punchbowl Street
Honolulu, HI 96813

Attn: Mr. Don Horiuchi

Dear Sir:

Subject: Keahole-Kailua Transmission Line

References: (1) KOC letter to DLNR dated 10/12/93
(2) B. Houser letter to DLNR dated 12/5/93

Thank you for the copy of the draft Environmental Impact Statement, prepared by CH2M Hill, dated April 1993, titled "Keahole - Kailua 69 kV Transmission Line Project.

We were pleased to see consideration of an underground transmission line alternative. However, both references (1) and (2) suggested that the most desirable alternative would be underground trench for both the existing line and the new proposed transmission line. For the reasons given in those references we still believe this to be the preferred approach.

Table 1-1, page 2 of 2, of the E.I.S. shows a 4' x 8' trench. This is inconsistent with the text and Figure 5-8. Is the construction cost of $1.0 - 3.8 million based upon the incorrect trench size? Also, a cost estimate of whose range is so large needs to be refined.

All costs associated with this project should be included. See page 3-13, "...not including the costs of land acquisition and switching station and substation construction." Furthermore, as previously requested these cost estimates should be presented in terms of their impact upon rates (e.g. cents per kwh) for the overhead and underground alternatives.

Our information, unlike the assertions in this report, show that underground lines require less maintenance and are more reliable than overhead transmission lines. Partly this is because they are less vulnerable to man induced and natural damage. The design criteria for the overhead towers and lines of a 80 mph gust is far too low for our environment. If this is not changed then figures for its reliability and maintenance must be increased. On the other hand, if the design criteria is increased, than the cost for construction would naturally increase.

Since the plan is to relocate the transmission lines when Queen Kaahumanu Highway is widened, the project cost should reflect this additional step. However, we believe this multi-step planning does not appear prudent and will result in more overall noise, dust and traffic disruption. Please re-examine this approach and consider installing the lines in their final location instead of a multi-step installation approach.

As B. Houser is the energy advisor to the Kona Outdoor Circle, we would appreciate receiving answers to his technical questions in reference (2) letter.

Your consideration of these comments and requests is appreciated.

Sincerely,

Brad Houser, for

Barbara Kassow, President
Kona Outdoor Circle

cc. CH2M Hill, HELCO, The OUtdoor Circle,
WOC, KKCC, PUC, Mayor, V. Isbell,
A. Levin, J. Rath, K. Childs, HCA

CH2M HILL
Engineers
Planners
Economists
Scientists

January 31, 1994

OPE33045.D2

Ms. Barbara Kassow, President
Kona Outdoor Circle
76-6280 Kuakini Highway
Kailua-Kona, Hawaii 96740

Dear Ms. Kassow:

Subject: Keahole-Kailua 69 kV Transmission Line Project Draft Environmental Impact Statement (DEIS)

Thank you for reviewing the DEIS for the Keahole-Kailua 69 kV Transmission Line Project.

Your DEIS comment letter was dated and postmarked June 21, 1993, two weeks after the 45-day review period for comments had expired on June 7, 1993. While your comment letter is untimely, HELCO is committed to being responsive to citizen groups.

Our responses are as follows:

1. Placing Both the Existing 69 kV Transmission Line along Queen Kaahumanu Highway and the Proposed 69 kV Transmission Line Underground

   We understand from your June 21, 1993, letter and Kona Outdoor Circle's earlier letter of October 12, 1992, that your organization is concerned with the visual aspects of the transmission lines, both existing and proposed, along Queen Kaahumanu Highway.

   The proposal to place all of the transmission lines along Queen Kaahumanu Highway underground would not completely eliminate the existing visual impact of the poles along the highway. If the existing 69 kV transmission line were removed from the existing poles, the poles could be shortened, but would still need to support 12 kV distribution lines, electric distribution transformers, secondary distribution lines, and the telephone and cable television lines. We did not consider this alternative to be a viable one and did not analyze it in the DEIS.

Honolulu Office 1585 Kapiolani Blvd., Suite 1420 Honolulu, HI 96814-4530 808 943-1133 Fax No. 808 941-8225

The DEIS was prepared for a new 69 kV transmission line from Keahole to Kailua, and did not encompass the greater statewide issue of placing all electric and communications facilities underground. That issue and the problem of the resulting additional costs is a question that would have to be addressed by the State Legislature and the Public Utilities Commission.

2. Underground Cable System Trench Dimensions and Cost Basis

Figure 5-8 in the DEIS was meant to serve as a schematic "conceptual" diagram of a 69 kV solid dielectric underground cable system, and was not intended to be a detailed engineering construction drawing.

The 4-foot-wide and 8-foot-deep dimensions found in Table 1-1 are correct and are typical for trench excavation work. The trench dimensions are consistent with those in Figure 5-8. A trench must by necessity be larger than what will be installed within it. In this case the trench must be larger than the concrete shell shown in Figure 5-8. This is necessary to allow construction crews adequate access to prepare the bottom of the trench, to shore the sides of the trench, and to lay the concrete forms for the concrete shell, to set the duct lines, and to pour the concrete.

The range of cost estimates for the underground cable system is based on the experiences of utility companies in the United States, and assumes typical construction techniques.

3. Capital Cost Estimates for the Various Alternatives and Impact on Ratepayer

In our letter to the Kona Outdoor Circle dated March 30, 1992, which is found in Appendix H of the DEIS, we responded to your specific request for cost and rate increase information for various alternatives utilizing HELCO's preferred route from Keahole to Kailua along Queen Kaahumanu Highway and Kaiwi Street. The $2.5 million capital cost estimate used in this analysis is for a new overhead alignment utilizing wooden poles. These responses are repeated in the following table in column one, "Capital Cost," and column two, "Increase to Monthly Bill for a Typical Residential Household Using 600 kwh/month." As you have requested, the third column shows the "Increase to Rate/kwh for a Typical Residential Household Using 600 kwh/month."

Keahole-Kailua 69 kV Transmission Line Capital Cost Estimate and Impact to Ratepayer			
Alternative	Capital Cost	Increase to Monthly Bill for a Typical Residential Household Using 600 kwh/month	Increase to Rate/kwh for a Typical Residential Household Using 600 kwh/month
New Overhead Alignment	$2,500,000	$0.26	0.04¢/kwh
New Underground Alignment	$11,900,000	$1.06	0.18¢/kwh
Place Existing Overhead 69 kV and 12 kV Lines Underground Together with New Underground Alignment	$16,700,000	$1.49	0.25¢/kwh

4. <u>Costs of Land Acquisition and Switching Station and Substation Construction</u>

Because the Queen Kaahumanu Highway and Kaiwi Street rights-of-way will be utilized for most of the transmission line route, land acquisition would be minimal for both the overhead and underground alternatives. Easement acquisition is discussed in Chapter 3 of the DEIS.

No additional land acquisition would be required for the Keahole Switching Station and the Kailua Substation since both are located on HELCO property.

HELCO has allocated $400,000 of Keahole Switching Station's improvements and $946,000 of Kailua Substation's improvements to the Keahole-Kailua transmission line project.

5. <u>Maintenance and Reliability Comparisons of Overhead and Underground Transmission Lines</u>

Maintenance and repair considerations for overhead and underground lines are discussed in Chapter 4 of the DEIS. There is relatively little experience in the State of Hawaii on the long-term reliability of 69 kV solid dielectric underground transmission cables. Most underground transmission line cables in the United States with voltages of 115 kV and higher are high-pressure fluid-filled pipe systems. For lower voltages, such as the 69 kV of the proposed Keahole-Kailua line, solid dielectric cables are used more often because of their lower cost and simpler construction techniques.

Although the reliability of an underground system may be greater because it is less susceptible to storm damage than an overhead transmission line system, reliability is also related to the ease and speed with which repairs can be made. As was indicated in Table 4-1 of the DEIS, the repair and access to an overhead line is relatively easy, with faults usually identified within hours and repairs possible within hours. Repair of an underground line is more difficult, with fault identification taking hours to days and repairs possibly taking days.

Long-term operations and maintenance costs of overhead and underground transmission lines are important factors in the evaluation of the alternative transmission line technologies. In order to compare the overhead and underground alternatives, HELCO compared the operations and maintenance costs of both alternative technologies over an assumed 20-year life expectancy period, and assumed the following:

a. The overhead transmission line alternative would consist of two 69 kV circuits on 125 steel poles.

b. The underground transmission line alternative would consist of two 69 kV circuits in ducts encased in concrete with 40 manholes.

c. The overhead transmission line and the underground transmission line alternatives would have identical lengths, of approximately 7 miles.

d. The overhead transmission line and the underground transmission line alternatives would have nearly identical drive-by inspection schedules, involving one 1/2-hour inspection per month.

e. The underground transmission line alternative would involve additional substation termination inspections, involving one 3/4-hour inspection every three months.

f. The overhead transmission line and the underground transmission line alternatives would have identical operational requirements, involving 4 man-hours per year by a troubleman for switching operations.

g. Maintenance for the overhead transmission line would involve the touch-up painting of 10 percent of the steel poles annually after 10 years. The touch-up painting would involve 6 man-hours per pole for 12 poles each year, in addition to $50 of painting material costs per pole. Maintenance of the overhead transmission line would also involve the replacement of insulators and hardware of 5 percent of the steel pole annually after 10 years. The replacement of insulators and hardware would involve 24 man-hours per pole for six poles per year, in addition to $500 per pole of material costs.

h. Maintenance for the underground transmission line would involve the pumping out and cleaning of 10 percent of the manholes annually. This would involve 8 man-hours per manhole for four manholes annually, in addition to $250 of equipment costs per manhole. Maintenance for the underground transmission line would also involve the replacement of racks and hangers as required for 10 percent of the manholes after 5 years. The replacement of racks and hangers would involve 16 man-hours per manhole for four manholes annually, in addition to the material costs of $200 per manhole.

i. All costs are expressed in current dollars; projections for costs assume an escalation (inflation) factor of 4 percent annually.

The major operations and maintenance cost differential between the overhead transmission line and the underground transmission line alternatives is due to the difference in the scheduling of significant maintenance and hardware replacement. For the overhead transmission line, significant annual maintenance and replacement of hardware is delayed for 10 years. For the underground transmission line, substantial maintenance is required annually beginning immediately with the first year of service, and substantial annual replacement of hardware begins after 5 years of service.

The time value of money must be considered in comparing the operations and maintenance costs of the overhead to the underground alternative because of the marked differences of when these costs would be incurred. When the time value of money is considered, it is clear that the net present value of all of the future operations and maintenance costs for the underground transmission line alternative is higher than the net present value of all of the future operations and maintenance costs of the overhead transmission line. If the time value of money is assumed to be 8 percent, the ratio of the underground transmission line's operations and maintenance costs to the overhead transmission line's operations and maintenance cost would be 1.3:1; if the time value of money were considered to be 16 percent, the ratio would rise to 1.7:1.

6. Basic Wind Speed Factor

Under the Uniform Building Code (UBC), the basic wind speed designated for the State of Hawaii is 80 miles per hour. The basic wind speed is the fastest-mile wind speed associated with an annual probability of 2 percent for an area having an exposure category C. Exposure category C relates to terrain that is flat and generally open, and extending 1/2 mile or more from the project site. The fastest-mile wind speed is the wind speed obtained from wind velocity maps prepared by the National Oceanographic and Atmospheric Administration (NOAA) and is the highest sustained average wind speed based on the time required for a mile-long sample of air to pass a fixed point. Special Wind Regions are areas designated in the UBC where local records and terrain features indicate that the 50-year (2 percent probability) fastest-mile basic wind speed is higher than the basic wind speed designated in the UBC. Hawaii has not been designated a Special Wind Region in the UBC and retains its basic wind speed of 80 miles per hour.

The UBC establishes minimum design standards for structures to resist wind effects in accordance to basic wind speed. HELCO has adopted design criteria so that all structures that will be built as a part of this project will be designed for a basic wind speed of 100 miles per hour; this will exceed the minimum UBC standards for the basic wind speed of 80 miles per hour.

7. Impact of the Plans to Widen Queen Kaahumanu Highway on the Underground Alternative

Our consultations with the State Department of Transportation (DOT) have revealed that the State plans to widen the two-lane Queen Kaahumanu Highway into a four-lane divided highway with a median strip, frontage roads along each edge of the highway, and grade-separated interchanges at selected points. Between the Keahole Airport and Kailua-Kona, DOT indicated that construction for the four-lane highway widening may begin sometime in 1994, but that the frontage road and grade-separated interchange construction schedules are not as yet set.

HELCO's objective is to complete construction and energize the Keahole-Kailua 69 kV transmission line by December 1994 in order to accommodate load growth and maintain system reliability. This will require that segments of the transmission line along the edge of the highway, whether the line is overhead or underground, be reset once the frontage roads and grade-separated interchanges along Queen Kaahumanu Highway are constructed.

The DOT has cautioned HELCO that if underground lines are installed before the highway widening is completed, portions of the underground transmission line would need to be relocated when the elevations (vertical) and the locations (horizontal) of the frontage roads and grade-separated interchanges are finalized.

Highway construction plans will not be finalized by the time construction of the Keahole-Kailua 69 kV transmission line is scheduled to begin.

The underground lines and their maintenance accesses, if installed now, would need to be impractically deep in order to avoid being affected by eventual (vertical) grade changes. Furthermore, there would still be uncertainty as to where an eventual underground transmission line trench could be (horizontally) located. Our discussions with the DOT have indicated that portions of an overhead transmission line would eventually also need to be reset and that the alternative acceptable to the State Department of Transportation would be an overhead configuration.

Thank you for your assistance. If you should have any questions on this project in the future, please feel free to contact me or assistant project manager Bennett Mark at (808) 943-1133.

Sincerely,

CH2M HILL

Albert Lono Lyman
Senior Project Manager

cc: Dennis Tanigawa, HELCO
Ed Lagundimao, HECO
Don Horiuchi, DLNR/OCEA

WAIMANA ENTERPRISES, INC.

June 7, 1993

Mr. Don Horiuchi
State of Hawaii
Department of Land and Natural Resources
1151 Punchbowl Street
Honolulu, HI 96813

Re: DEIS for HELCO's Keahole - Kailua 69 kV Transmission Line Project

Dear Mr. Don Horiuchi:

After reviewing the DEIS for HELCO's Keahole - Kailua 69 kV Transmission Line Project, Waimana Enterprises, Inc. ("Waimana") has the following comments and questions:

The DEIS states that, "The two major reasons for the Keahole-Kailua transmission line project are system reliability and load growth." It is unclear in the DEIS whether this Project is necessary if HELCO's proposal to expand the Keahole power plant is denied. In light of the current obstacles that are facing HELCO's proposal to expand its Keahole generating station; i.e. pending contested case hearing, PUC approval to build CT-4, and obtaining air permits from the Department of Health, it would seem prudent to postpone this project until it is definitely determined where the next site for power generation for West Hawaii will be located.

Thank you for the opportunity to summit comments. I look forward to receiving responses from HELCO.

Sincerely,

Sandi

Sandra-Ann Y.H. Wong

cc: OEQC
Al Lono Lyman ✓
CH2M Hill
Dennis Tanigawa
HELCO

Pauahi Tower Suite 1520 • 1001 Bishop Street • Honolulu, Hawaii 96813
(808) 599-4441 Facsimile (808) 599-4653

CH2M HILL
Engineers
Planners
Economists
Scientists

January 31, 1994

OPE33045.D2

Ms. Sandra-Ann Y.H. Wong
Waimana Enterprises, Inc.
Pauahi Tower, Suite 1520
1001 Bishop Street
Honolulu, Hawaii 96813

Dear Ms. Wong:

Subject: Keahole-Kailua 69 kV Transmission Line Project Draft Environmental Impact Statement (DEIS)

Thank you for reviewing the DEIS for the Keahole-Kailua 69 kV Transmission Line Project.

The Keahole-Kailua 69 kV Transmission Line Project is not contingent upon the completion of the expansion HELCO proposes to the Keahole Generating Station. The proposed Keahole-Kailua 69 kV transmission line project is needed for system reliability and to meet load growth. These needs are independent of whether or not additional power generating facilities, including those that might occur at the Keahole Generating Station site or any other site in West Hawaii, are added to the island-wide system.

In the "Purpose and Need" chapter of the DEIS, the existing island-wide and regional transmission line system (Figure 2-2 and 2-3) is described together with electrical load demand forecasts for the island (Figure 2-4) and for regions within the island (Table 2-1).

HELCO's transmission planning engineers evaluated a number of contingency scenarios for the Keahole-Kailua region with its existing transmission line system and various segments taken out of service in order to simulate normal maintenance or emergency situations. The evaluations used for this analysis were for the existing transmission line system with no additional power generation facilities added. Based on the analysis of this existing system with the predicted future loads, HELCO transmission planning engineers concluded that if existing lines were taken out of service, elevated loadings with

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unacceptably low voltage would occur on the remaining transmission lines. In order to avoid this, HELCO transmission planning engineers concluded that an additional 69 kV transmission line between Keahole and Kailua would need to be put in place and energized by December 1994 in order to maintain service quality and reliability.

We appreciate your comments on this project. If you have any further questions, please feel free to contact me at (808) 943-1133.

Sincerely,

CH2M HILL

Albert Lono Lyman
Senior Project Manager

cc: Dennis Tanigawa, HELCO
Ed Lagundimao, HECO
Don Horiuchi, DLNR/OCEA

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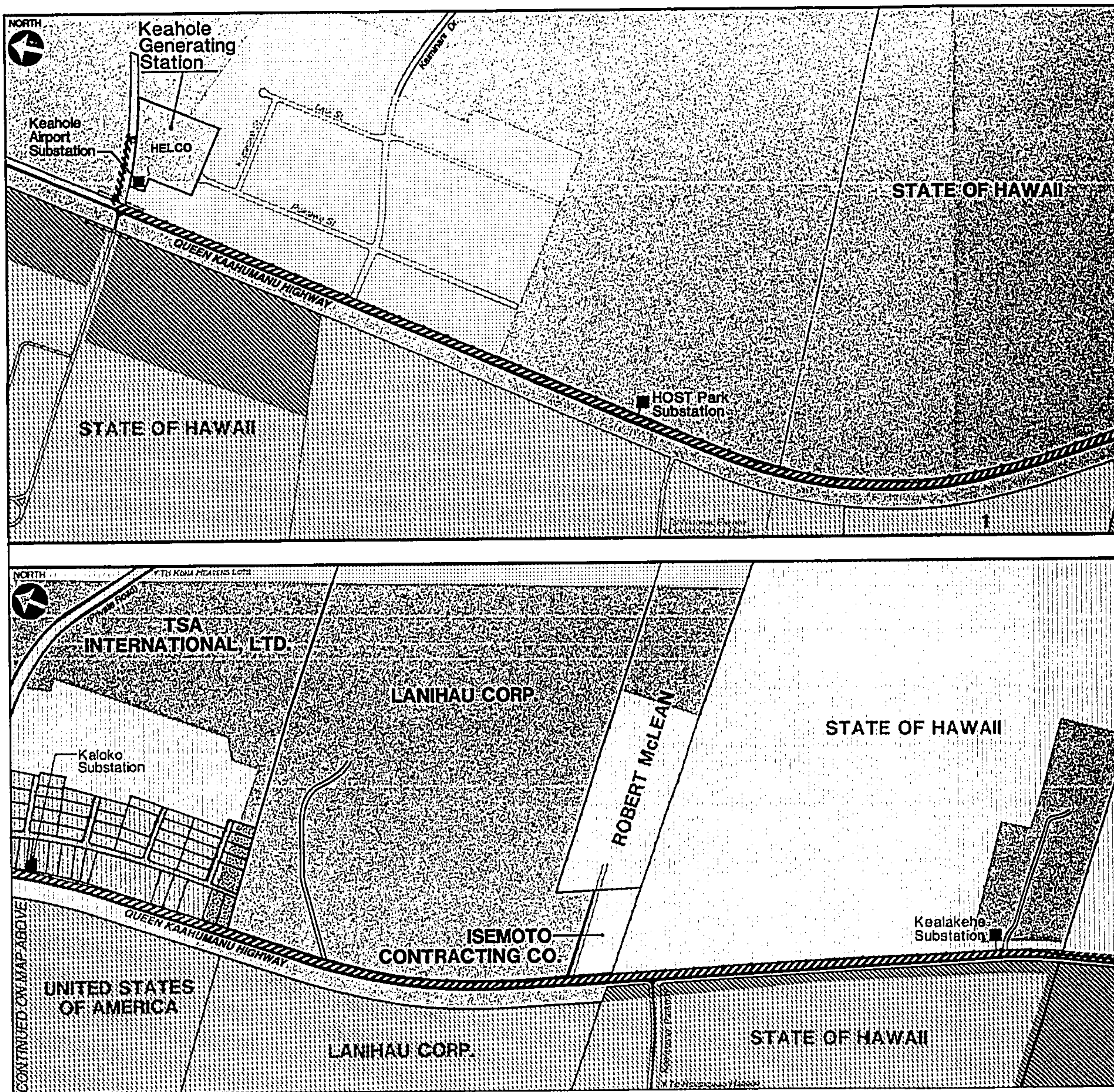


LEGEND

- Proposed Alignment
- Existing 69 kV Transmission Line
- Electrical Facility
- Ahupuaa Boundary

LAND REGULATION

State Land Use Districts

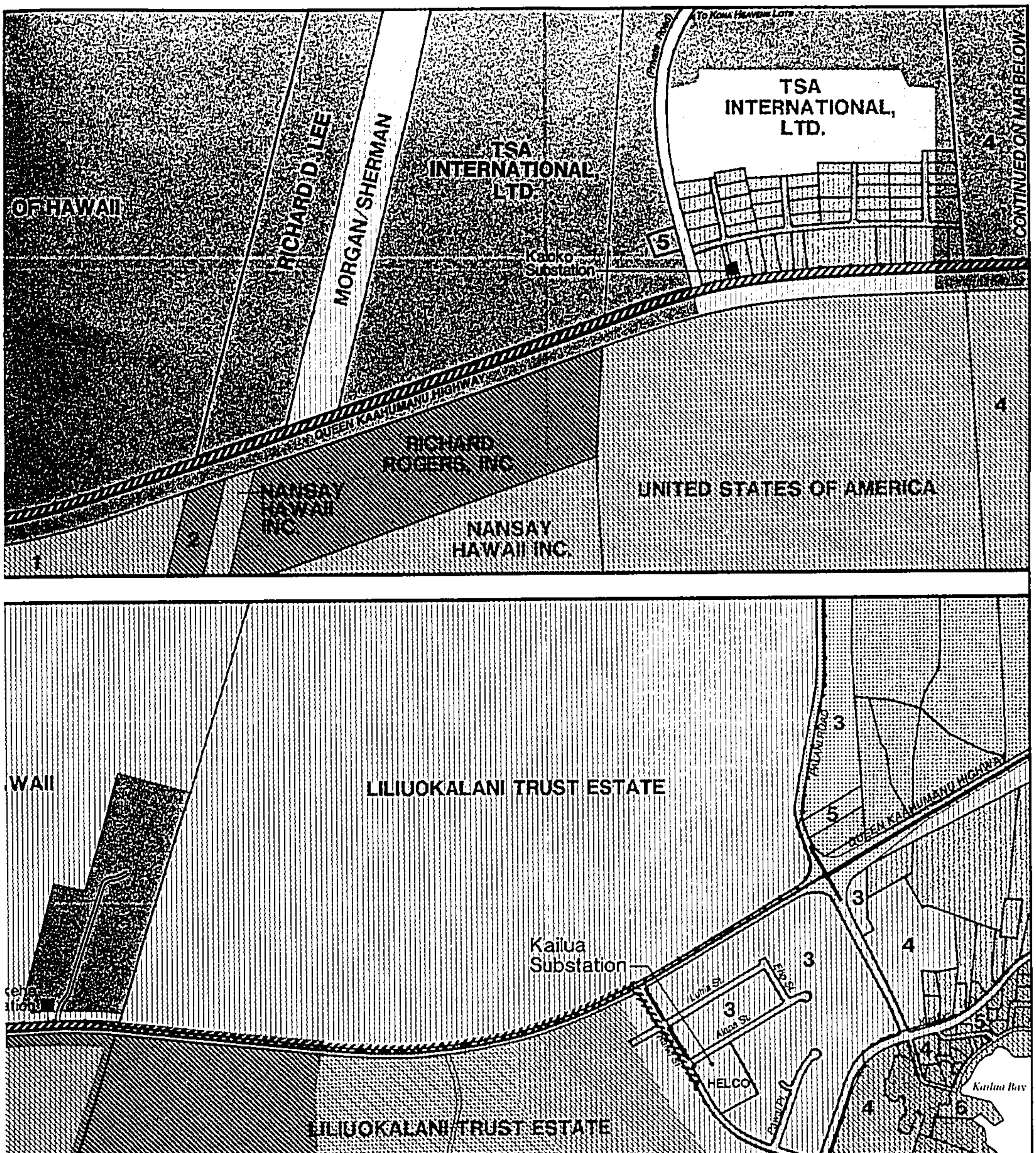
- Urban
- Agricultural
- Conservation – General Subzone

County

- Special Management Area

LAND OWNERS

- Small Private Landowners
- 1 American Trust Company of Hawaii
- 2 Richard D. Lee
- 3 Liliuokalani Trust Estate



ers

ıny of Hawaii

e

4 Lanihau Corp.

5 County of Hawaii

6 State of Hawaii

Keahole–Kailua 69 kV Transmission Line Project

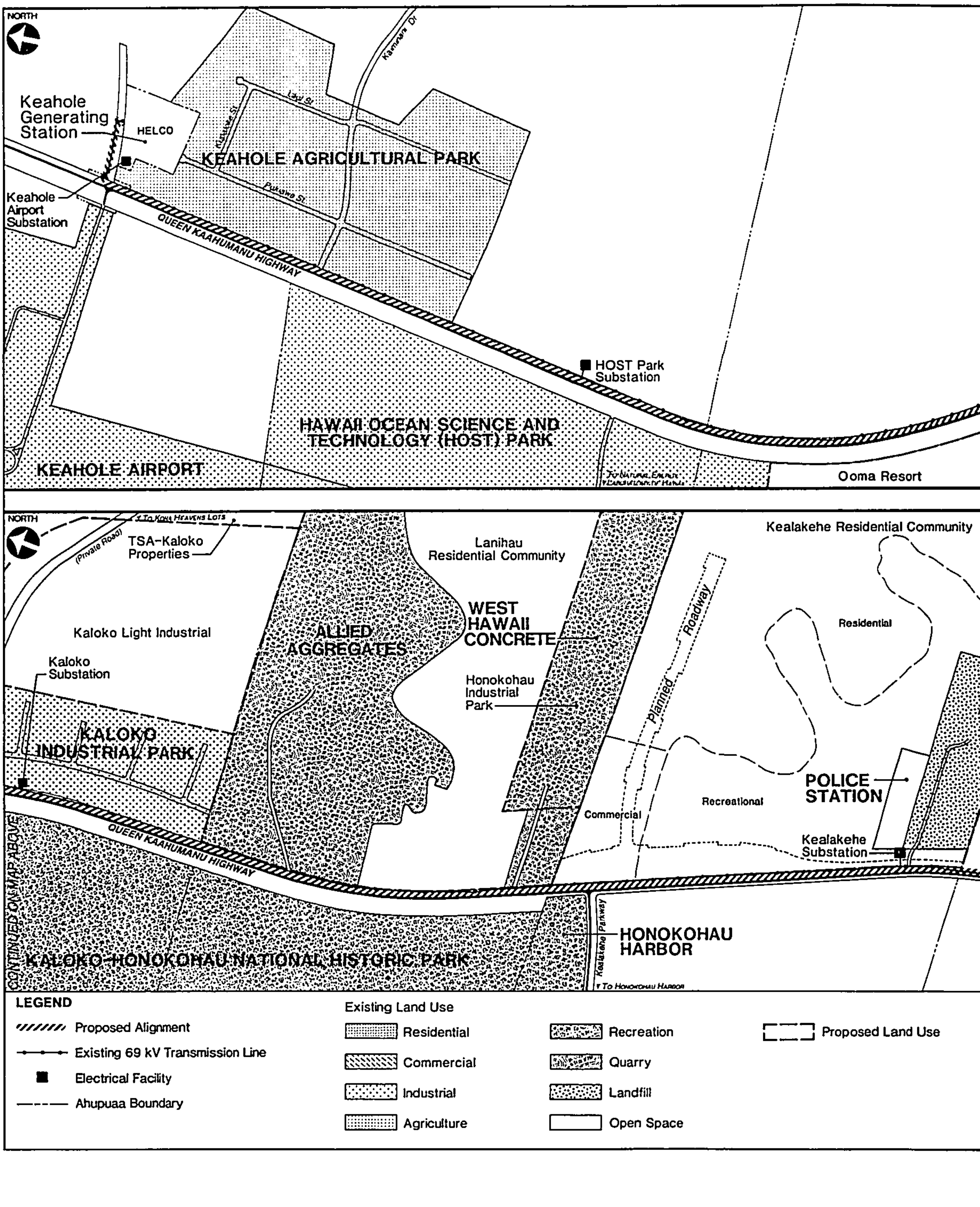
Hawaii Electric Light Company, Inc.

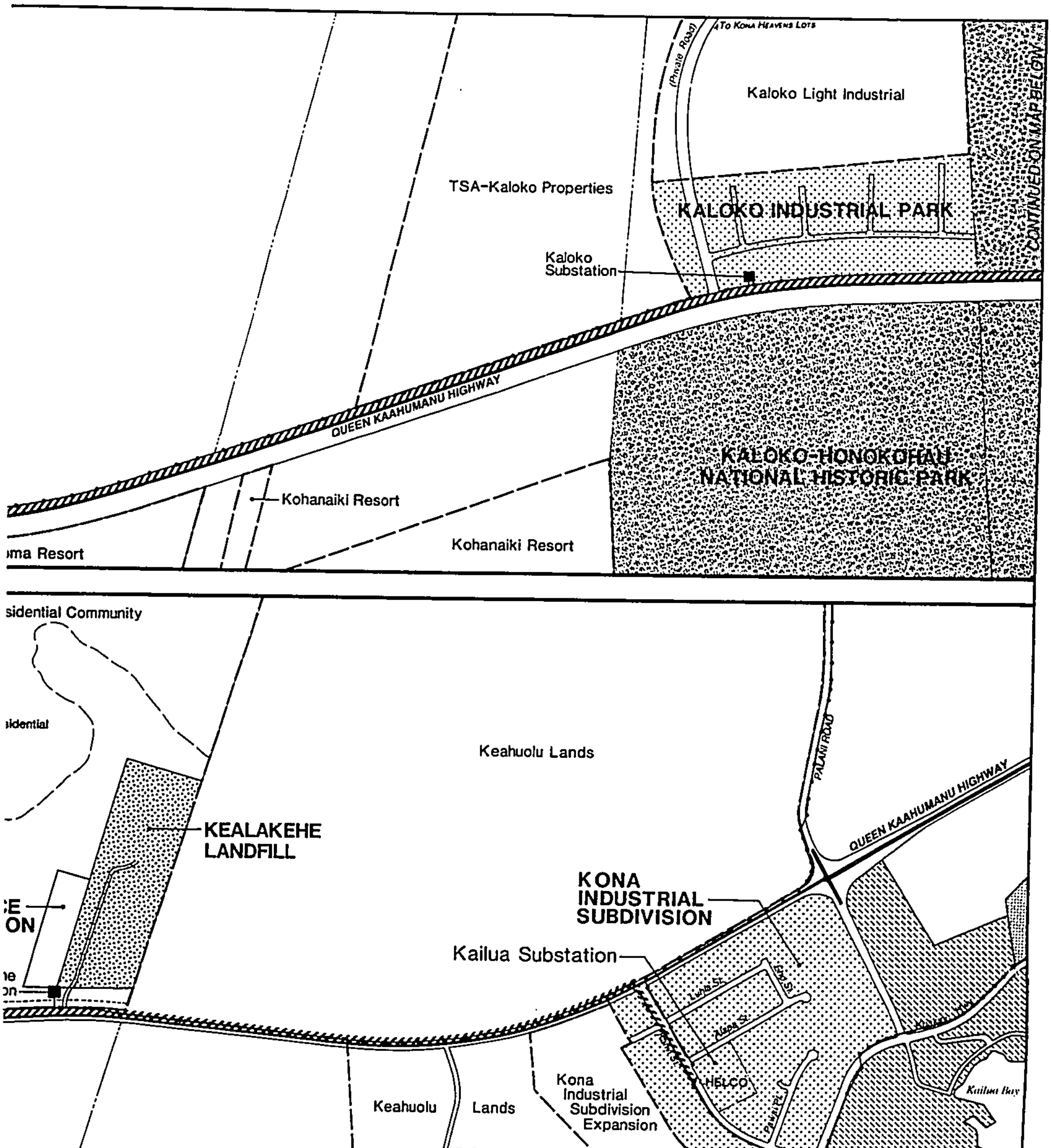
LAND OWNERSHIP AND REGULATION

0 600 1200 1800 2400 3000 FEET

0 1/8 1/4 1/2 MILE

FIGURE 5–1


NORTH
Keahole Generating Station
HELCO
KEAHOLE AGRICULTURAL PARK
Keahole Airport Substation
QUEEN KAAHUMANU HIGHWAY
HOST Park Substation
HAWAII OCEAN SCIENCE AND TECHNOLOGY (HOST) PARK
KEAHOLE AIRPORT
Ooma Resort
NORTH
TSA-Kaloko Properties
(Private Road)
Lanihau Residential Community
Kealakehe Residential Community
WEST HAWAII CONCRETE
ALLIED AGGREGATES
Kaloko Light Industrial
Kaloko Substation
Honokohau Industrial Park
Planned Roadway
Residential
KALOKO INDUSTRIAL PARK
POLICE STATION
Recreational
Commercial
Kealakehe Substation
QUEEN KAAHUMANU HIGHWAY
CONTINUED ON MAP ABOVE
HONOKOHAU HARBOR
Kealakehe Parkway
KALOKO-HONOKOHAU NATIONAL HISTORIC PARK
LEGEND
Proposed Alignment
Existing 69 kV Transmission Line
Electrical Facility
Ahupuaa Boundary
Existing Land Use
Residential
Commercial
Industrial
Agriculture
Recreation
Quarry
Landfill
Open Space
Proposed Land Use



ısed Land Use

Keahole-Kailua 69 kV Transmission Line Project

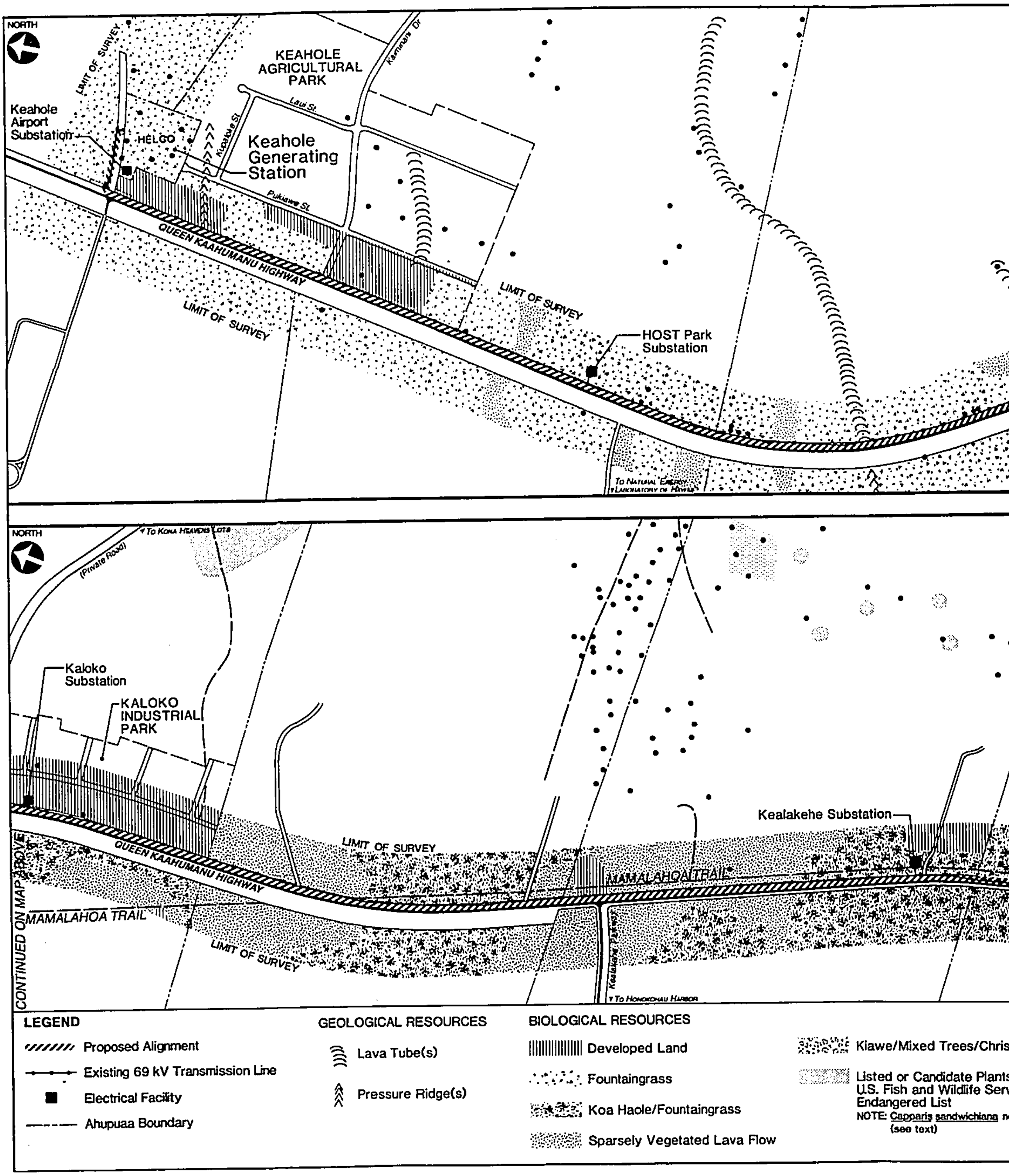
Hawaii Electric Light Company, Inc.

EXISTING AND PROPOSED LAND USE

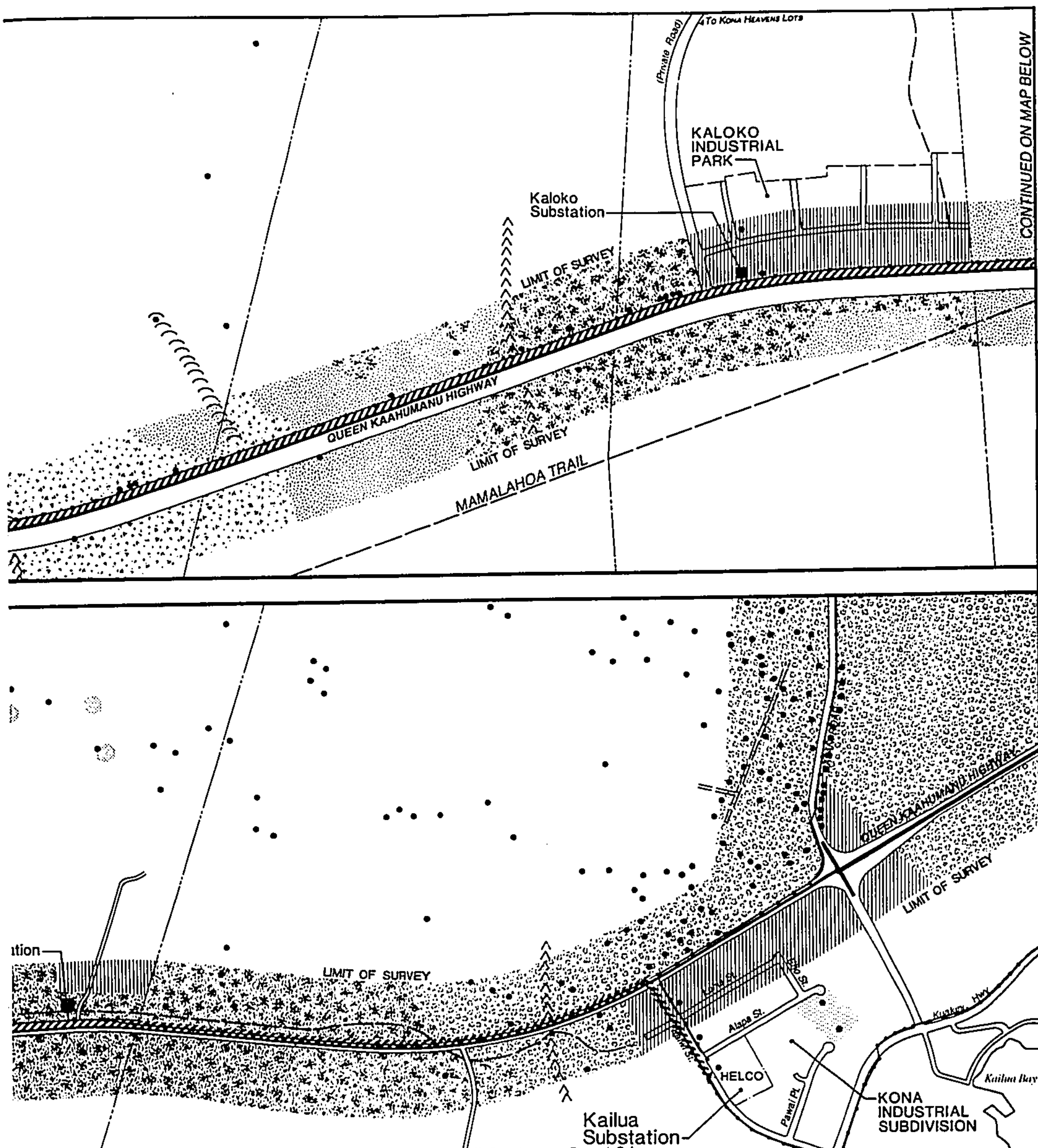
0 600 1200 1800 2400 3000 FEET

0 1/8 1/4 1/2 MILE

FIGURE 5-2



NORTH
LIMIT OF SURVEY
Keahole Airport Substation
HELCO
KEAHOLE AGRICULTURAL PARK
Keahole Generating Station
Laui St
Pukiawe St
Kaiminani Dr
Kupalele St
QUEEN KAAHUMANU HIGHWAY
HOST Park Substation
NORTH
(Private Road)
Kaloko Substation
KALOKO INDUSTRIAL PARK
Kealakehe Substation
MAMALAHOA TRAIL
CONTINUED ON MAP ABOVE
LEGEND
Proposed Alignment
Existing 69 kV Transmission Line
Electrical Facility
Ahupuaa Boundary
GEOLOGICAL RESOURCES
Lava Tube(s)
Pressure Ridge(s)
BIOLOGICAL RESOURCES
Developed Land
Fountaingrass
Koa Haole/Fountaingrass
Sparsely Vegetated Lava Flow
Kiawe/Mixed Trees/Chris
Listed or Candidate Plants
U.S. Fish and Wildlife Serv
Endangered List
(see text)



awe/Mixed Trees/Christmas Berry

ısted or Candidate Plants
S. Fish and Wildlife Service
ıdangered List
)TE: Capparis sandwichiana not shown
(see text)

CULTURAL RESOURCES

• Archaeological Site or Feature

—— Trail

==== Wall

Keahole-Kailua 69 kV Transmission Line Project

Hawaii Electric Light Company, Inc.

GEOLOGICAL, BIOLOGICAL AND CULTURAL RESOURCES

0 600 1200 1800 2400 3000 FEET
0 1/8 1/4 1/2 MILE

FIGURE
5-5