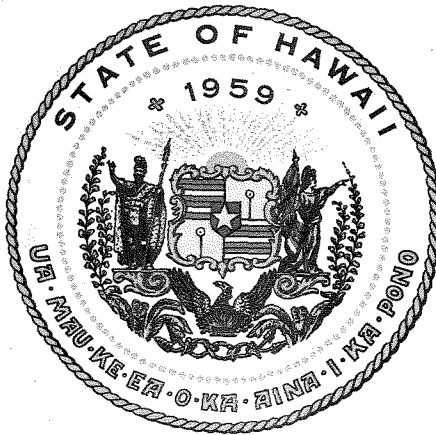


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HAWAII DEEP WATER CABLE PROGRAM

PHASE II-C

TASK 5

OVERLAND TRANSMISSION LINE CORRIDOR STUDY

PUNA TO KOHALA, ISLAND OF HAWAII

TK3351
H35
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T5

Department

Economic Development

1988/9

HAWAII DEEP WATER CABLE PROGRAM
PHASE II-C

TASK 5

OVERLAND TRANSMISSION LINE CORRIDOR STUDY
PUNA TO KOHALA, ISLAND OF HAWAII

Prepared by
DHM PLANNERS, INC.

for
Parsons Hawaii
Hawaiian Electric Company, Inc.
and the
State of Hawaii
Department of Business and Economic Development

April 1988

SUMMARY

This report is supplemental to a previous report (Hawaii Deep Water Cable Program, Overland Transmission Corridor Study, July 1985) which described potential right-of-way corridors on land for a 300 kVdc power line between the Islands of Hawaii and Oahu with a link on Maui. In the 1985 report, potential corridors were identified within the Kohala region on the island of Hawaii and on Maui and Oahu. This report describes the remaining area of the Island of Hawaii, namely the area between the geothermal resource area in the Puna region and the Kohala region.

Delineation of these corridors was based on an analysis of various environmental, social and economic factors. Fifteen data factors and their respective degree of constraint and five exclusion factors were mapped and overlaid to show the composite effect of all constraints and exclusion areas. The composited maps highlight areas of opportunity which are delineated as potential corridors. The corridors identified in this report are the basis for future investigation of detailed alignments for electric transmission lines.

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Glossary

GLOSSARY

<u>TERM</u>	<u>DEFINITION</u> ¹
<u>A'a</u> (lava flow)	A rough-surfaced lava flow consisting of layers of glass-like fragments of lava. <u>Pahoehoe</u> lava flows often change to <u>a'a</u> as they advance downhill.
<u>Alternating current</u> (ac)	The voltage or current "alternates" between positive and negative polarity 60 times per second in the United States. Unlike direct current (dc), ac voltages may be easily and inexpensively raised or lowered by transformers, but cannot be economically underwater for long (15 miles or greater) distances.
<u>Alignment</u>	The actual right-of-way of a proposed transmission line.
<u>Arc</u>	A luminous discharge of electric current crossing a gap between two electrodes.
<u>Archaeological site</u>	Physical evidence of human habitation in Hawaii prior to the first recorded contact with Western explorers (i.e., A.D. 1778).
<u>Avifauna</u>	The birds or the kinds of birds of a region or environment.
<u>Avoided cost</u>	The cost an electrical utility would otherwise incur to generate power if it did not purchase the electricity from another source.
<u>Broadscale analysis</u>	A planning technique used in this report to identify generalized corridors for electric transmission line alignments.
<u>Conductor</u>	The wire or cable suitable for carrying electric current.

1. The definitions included here are for the terms as they are used in this report. In another context, the terms may be defined differently.

TERM

DEFINITION

Constraint

A condition which discourages, but not necessarily precludes, a transmission line route.

Converter

Equipment which changes alternating current to direct current or vice versa.

Corridor

A strip of land which provides ample space for delineating and studying several alternative alignments for a proposed transmission line.

Cultural resource

Anything which embodies or is reflective of the arts, customs, traditions, mores, and history of all of the various ethnic groups of Hawaii. Includes all historic properties and archaeological sites.

Direct current (dc)

The voltage or current has a constant positive or negative polarity which does not change. Unlike alternating current (ac), dc can be transmitted over long distances without special power booster stations. DC requires expensive facilities to raise or lower the voltage or to convert into ac.

Distribution

The act or process of delivering electrical energy from the generation and transmission system to the consumer.

Easement

An interest in land that entitles its holder to a specific land use, such as a transmission line.

Endemic species

Plants or animals whose natural range is restricted to a particular area or region and are found nowhere else.

Energy corridor

A wide right-of-way or easement, within which multiple utility lines or other energy transmission systems are located.

(This definition is not referring to energy corridors as authorized by Ch. 277, HRS.)

<u>TERM</u>	<u>DEFINITION</u>
<u>Exotic species</u>	Plants or animals which are not native to the area where found.
<u>Feral</u>	Existing in a wild or untamed state; having reverted to such a state from domestication.
<u>Firm power</u>	Power which can be supplied on a 24-hour, 365 day-per-year basis.
<u>Flashover</u>	An abnormal electrical discharge from the transmission conductors through the air to ground or to other conductors.
<u>Flood zone, 100-year</u>	An area where the probability of inundation of storm waters is greater than one percent in any given year.
<u>Fossil fuel</u>	A deposit of organic material containing stored solar energy that can be used as fuel. The most important are coal, natural gas, and petroleum.
<u>Geothermal energy</u>	Heat generated by natural processes within the earth.
<u>Generation</u>	The act or process of transforming other forms of energy into electric energy.
<u>Generation capacity</u>	The nominal power output of an electricity production facility, often measured in kilowatts or megawatts.
<u>Groundwater aquifer</u>	A saturated underground body of rock or similar material capable of storing water and transmitting it to wells or springs.
<u>Guy wire</u>	Wires from structure to ground for structural support.

<u>TERM</u>	<u>DEFINITION</u>
<u>Instantaneous peak load</u>	The maximum power output of a generating unit in any given year.
<u>Insulator</u>	Equipment which attaches a wire to a structure without conducting electrical current.
<u>Intermittent stream</u> (or water body)	Definite depressions, basins or channels where water is present on a periodic or seasonal basis, usually after a period of high rainfall.
<u>Kilovolt (kV)</u>	One thousand volts; a volt is a unit of electrical potential difference and electromotive force.
<u>Lava tube</u>	As the lava flow cools inward from the edges, the moving liquid portion becomes narrower until only a stream continues to flow through a "pipe" with solidified walls. At the end of the eruption, part or all of the liquid may drain away leaving a tube. Most lava tubes are less than a meter across, but a few are as much as 15 meters.
<u>Load</u>	The amount of electric power delivered or required at any specified point or points on a system. Load originates primarily at the power consuming equipment of the consumers.
<u>Megawatt (MW)</u>	One million watts.
<u>Native species</u>	Plants and animals which are present in an environment and were not introduced to that environment by humans.
<u>Nominal capacity</u> (of a transmission line)	The load which a line is expected to carry under normal conditions. Transmission lines are designed for a higher than nominal capacity in order to carry higher load under emergency conditions.

<u>TERM</u>	<u>DEFINITION</u>
<u>Opportunity</u>	A favorable juncture of conditions for a transmission line route.
<u>Pahoehoe</u> (lava flow)	A smooth-surfaced lava flow, often with wrinkles formed by the movement of liquid lava beneath a cooler but still-plastic crust. The liquid lava sometimes leaves subsurface hollow tubes (see "Lava tube").
<u>Peak load</u>	The highest portion of demand, usually that occurring less than 10% of the time.
<u>Perennial stream</u> (or water body)	Depressions, basins or channels where water is present year round in a volume sufficient to sustain aquatic animal and plant life on a continuous basis.
<u>Power</u>	The unit of measurement of electricity expressed in watts.
<u>Pu'u</u>	Hawaiian term for a hill, peak, or mound.
<u>Registered historic site</u>	The legal recognition of an historic property. The National and Hawaii Registers of Historic Places are planning tools used to assess, but not necessarily prevent, the potential impact of a publicly funded, licensed or permitted activity on the cultural resources or heritage of the State.
<u>Rift zone</u>	A system of fractures and faults in the earth's crust.
<u>Seismic</u>	Pertaining to an earthquake or earth vibration, including those that are artificially induced.
<u>Shield wire</u>	Wire which protects conductors from lightning.
<u>Substation</u>	A subsidiary station in which electric energy is transformed. It is often combined with a switching station. (See below)

TERM

DEFINITION

Subtransmission line

A conductor which transmits electric energy from a transmission substation or switching station to a distribution substation.

Switching station

A subsidiary station in which electrical energy is switched from one circuit to another. It is often combined with a substation. (See above)

Transmission

The act or process of transporting electrical energy in bulk from a source or sources of supply to other principal parts of the system or to another utility system.

Viewshed

The area which can be seen from a given point of view.

Volcanic hazard

Hazardous situations due to volcanic activities. No probability analysis or recurrence interval (forecast) is available because of the difficulty of estimating the likelihood of occurrence and its sensitivity.

Watershed

Areas contributing to stream flow and groundwater recharge.

Watt

A watt is the absolute unit of electrical power equal to the rate of work represented by a current of one ampere under a pressure of one volt.

Wetland

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

Chapter I

CHAPTER I. BACKGROUND AND STUDY AREA

A. BACKGROUND

The purpose of this report is to identify potential overland corridors between the geothermal area in the Puna region and the Kohala region on the Island of Hawaii for the proposed 300 kilovolt (kV) direct current (dc) transmission line which will transmit 500 megawatts of power. This is Phase II-C of the work sponsored by the State Department of Business and Economic Development (DBED, previously Department of Planning and Economic Development) as part of the Hawaii Deep Water Cable Program (HDWCP).¹

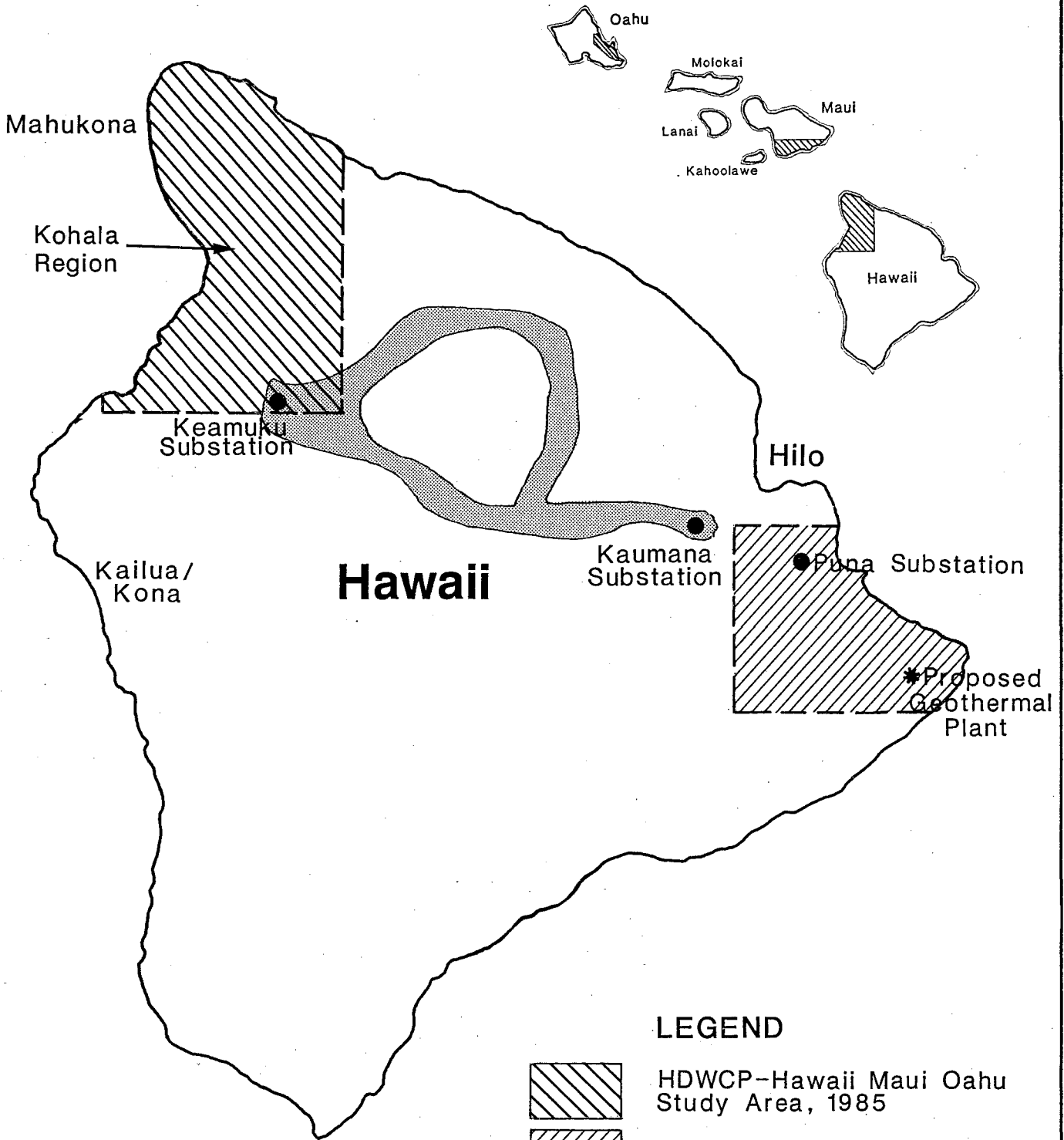
The initial Overland Transmission Corridor Study for the HDWCP² evaluated the land portions for the 300 kVdc line in the northwest (Kohala) region of Hawaii, the southern coast of Maui, and the northeast (windward) coast of Oahu. In the 1985 report, the study area on Hawaii was limited to the Kohala region because much of the remainder of the island was either being studied or had been studied in other programs using similar mapping and analysis techniques. The various study areas are shown on Exhibit I-1.

One study was completed in 1983³ for a 138 kVac (alternating current) transmission line originating at Kaumana near Hilo and terminating at the Keamuku substation near Kamuela. The study identified two potential land corridors, one south of Mauna Kea through the "saddle", the other to the north. (Exhibit I-1). After selection of the southern corridor (almost paralleling the existing Saddle Road), a specific alignment was determined. The analysis did not consider the possibility of construction of a 300 kVdc line or of creating an energy corridor of multiple transmission lines.

1. The objective of the HDWCP is to determine the technical feasibility of deploying and operating a submarine power transmission cable between Kohala, Hawaii, and Makapuu, Oahu, over a thirty year service life. After completion of the HDWCP, more detailed and specific investigations would be needed to implement the program for a commercial development. For detailed goals and objectives of the HDWCP see Parsons Hawaii, Characterization of Potential Routes and Route Option Selection, Honolulu, Hawaii, May, 1985.


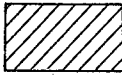

2. DHM Planners inc., Hawaii Deep Water Cable Program, Overland Transmission Corridor Study: Hawaii, Maui, Oahu for Parsons Hawaii et al., Honolulu, Hawaii, 1985.

3. EDAW inc., Transmission Line Routing Study: Kaumana to Keamuku, 138 KV Line for Hawaii Electric Light Company, Inc., Honolulu, Hawaii, February, 1983.




 No Scale

LEGEND

-  HDWCP-Hawaii Maui Oahu Study Area, 1985
-  Pohoiki Study by HELCO
-  Previously Identified Corridor (1983, Kaumana-Keamuku 138kV)

**Exhibit I-1:
Previous Transmission Corridor Investigations**

Another study is the Pohoiki transmission line study which is still in process for Hawaii Electric Light Company, Inc. It will identify transmission line alignments for two 69 kVac lines between a geothermal source at Pohoiki and the Puna substation near Keaau. (Exhibit I-1). These lines will each transmit 12.5 megawatts of power generated by a proposed geothermal power plant, for distribution to Big Island customers.

The criteria for the 1983 Kaumana-Keamuku and the 1985 Pohoiki-Puna studies do not include the characteristics of a 300 kVdc transmission line, and they do not consider the land area where the potential 300 kVdc line will originate.

B. STUDY AREA

This report discusses the corridor identification process for the land area between the potential geothermal development area (Geothermal Resource Subzones) and the previous HDWCP corridor study area. It covers the entire northeast portion of the Big Island, and completes the overland corridor analysis for the Big Island portion of the HDWCP 300 kVdc line. Exhibit I-2 shows the study area of this report in relation to the Geothermal Resource Subzones in Puna and the previous HDWCP study area in Kohala.

Due to the size of the study area, it was divided into four sections for mapping purposes. These sections correlate with U. S. Geological Survey quadrangle maps as shown on Exhibit I-3. For ease of reference, the study area sections have been termed the Puna Section, Hilo Section, Hamakua Section, and the Saddle Section.

C. CHARACTERISTICS OF THE OVERHEAD LINES

The overhead transmission lines would consist of two conductors (aluminum, up to two inches in diameter) suspended by insulators (approximately 9 feet long) from crossarms attached to steel poles or towers. The poles or towers may be of various designs and may be guyed or unguyed (Exhibit I-4). At the pole, the height from ground elevation to the crossarm would typically be 75 feet. The total height of the pole would be somewhat greater, perhaps 90 to 100 feet, depending upon its type.

The distance between poles would typically be between 600 and 1,300 feet, and the lines would sag about 19 to 24 feet from the horizontal depending upon the pole spacing (Exhibit I-5). At no point would the lines be less than 42 feet from the ground.

The typical right-of-way width (Exhibit I-6) for a 300 kVdc transmission line corridor would be 135 feet (see Appendix I, p. I-11). Multiple-line corridors would require wider rights-of-way.

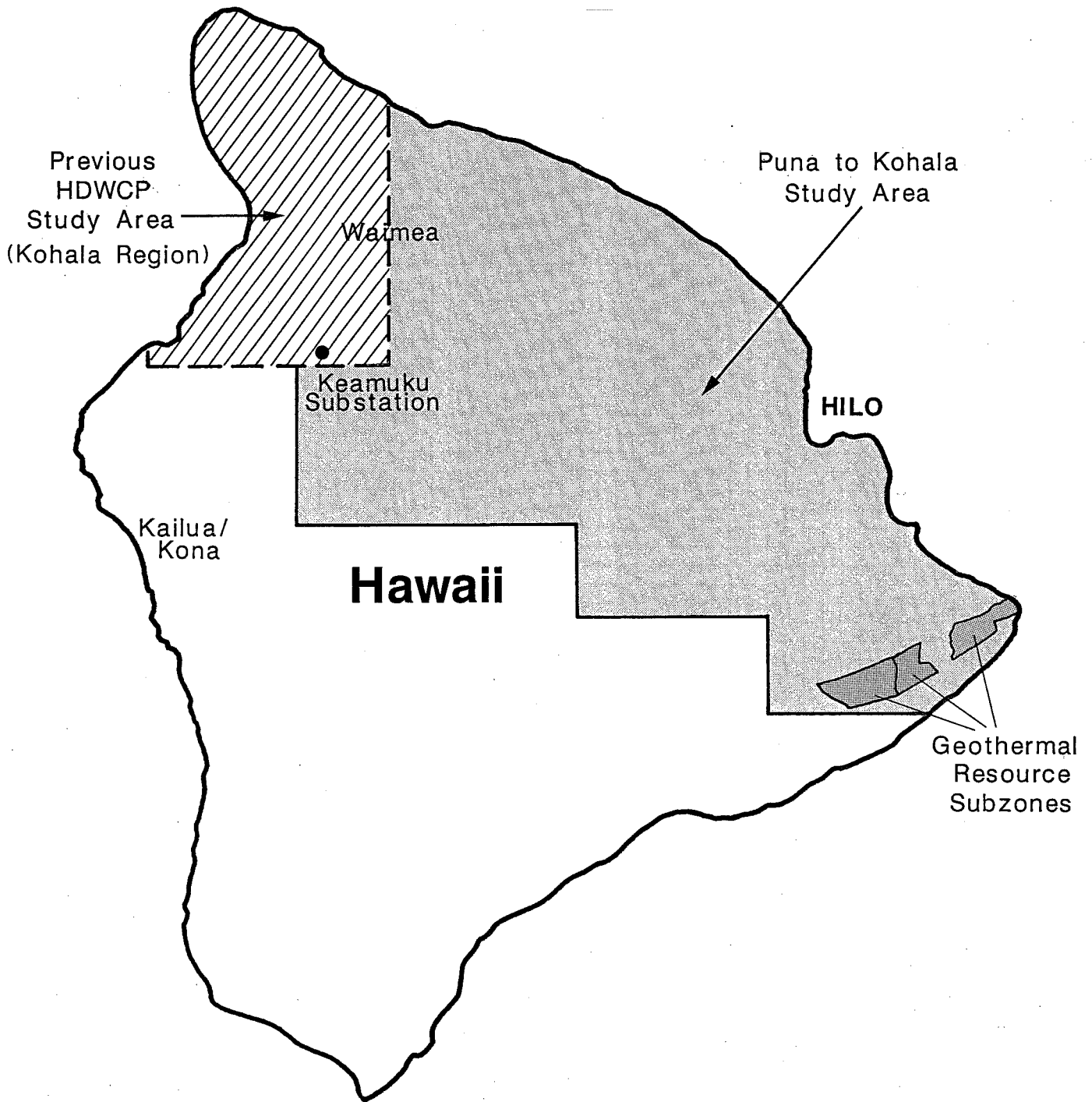
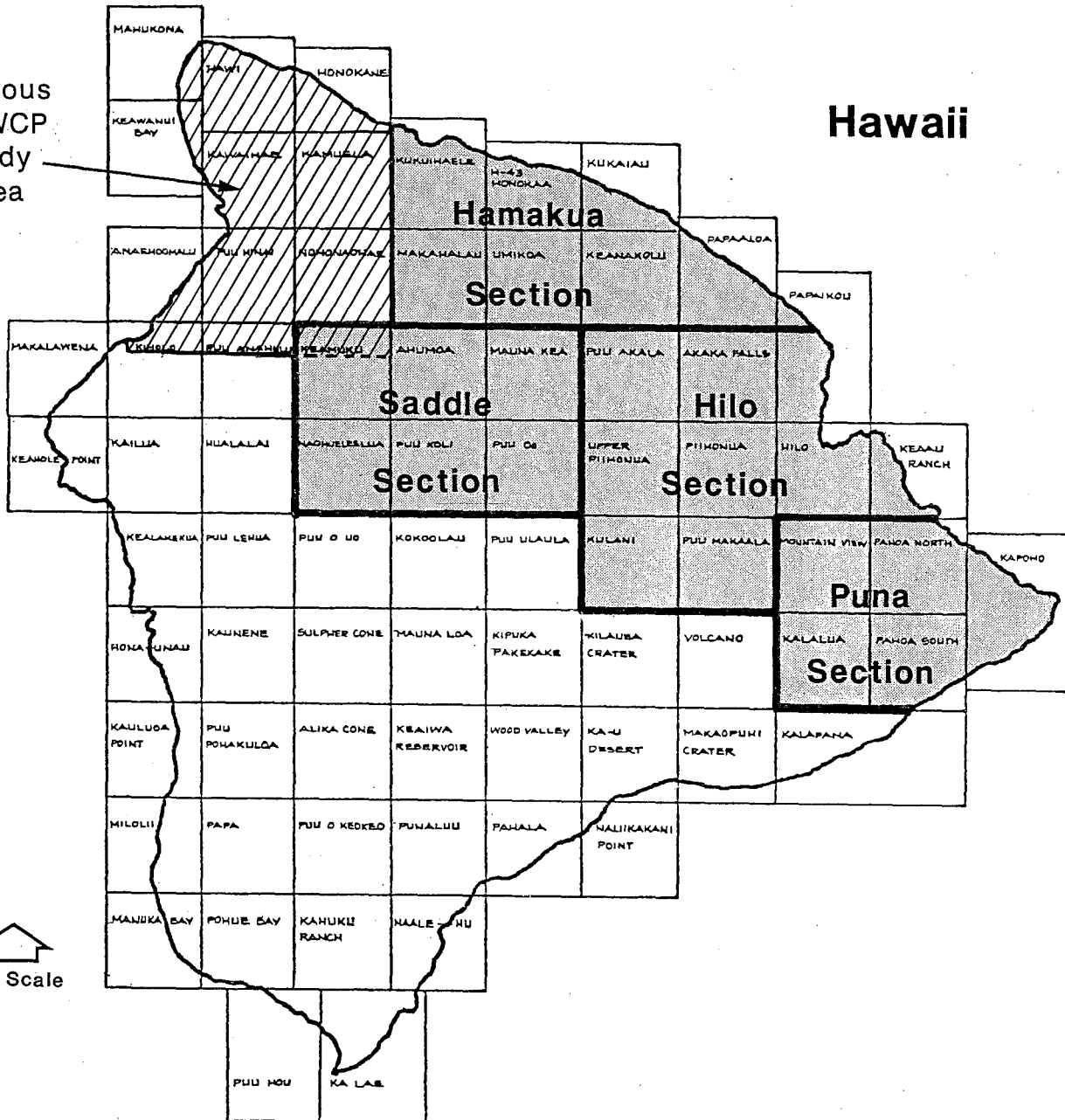


Exhibit I-2: Puna to Kohala Study Area

Previous HDWCP Study Area

Hawaii



No Scale

Puna Section

Mountain View
 Kalalua
 Pahoa North
 Pahoa South
 Kapoho

Hilo Section

Puu Akala
 Upper Piihonua
 Kulani
 Akaka Falls
 Piihonua
 Puu Makaala
 Papaikou
 Hilo
 Keaau Ranch

Hamakua Section

Kukuihaele
 Makahalau
 Honokaa
 Umikoa
 Kukuiiau
 Keanakolu
 Papaaloa

Saddle Section

Keamuku
 Naohueleelua
 Ahumoa
 Puu Koli
 Mauna Kea
 Puu Oo

Exhibit I-3: Study Area Sections & USGS Quads

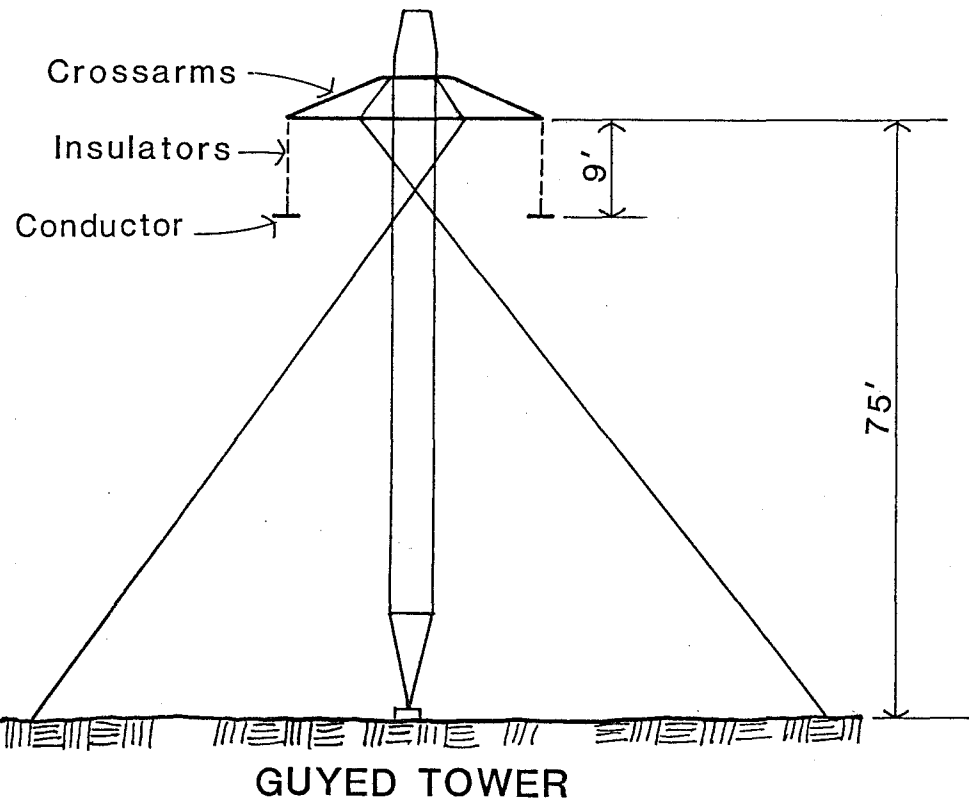
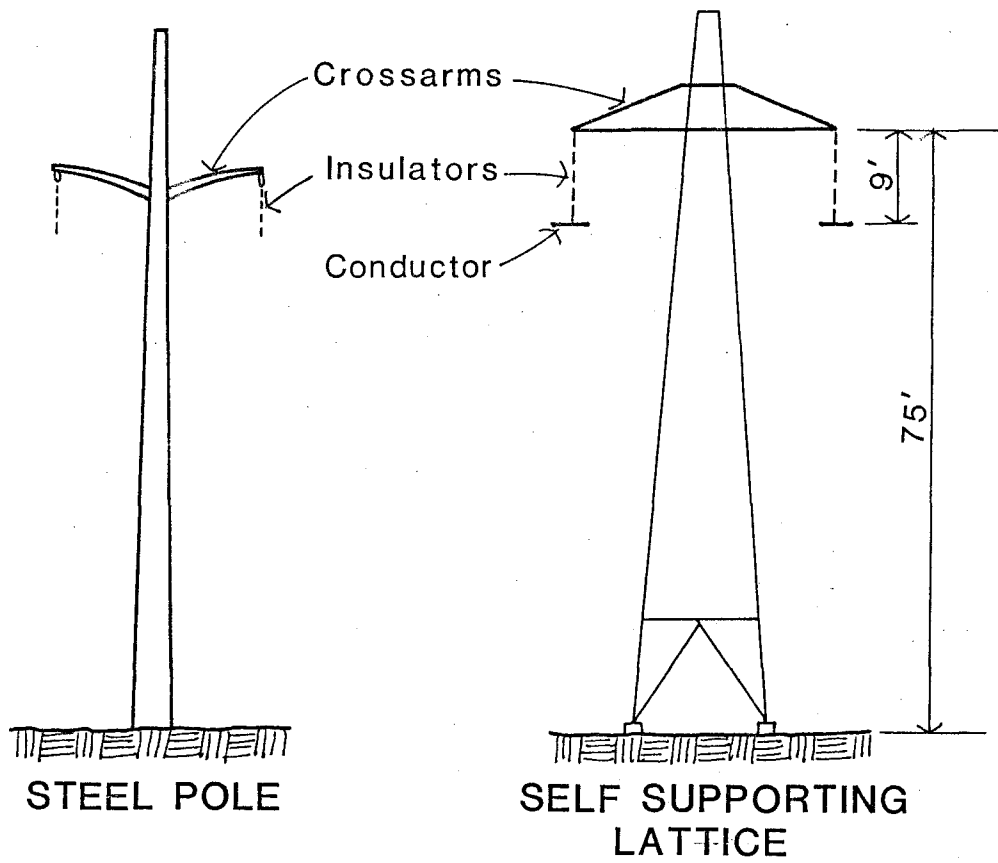


Exhibit I-4: Tower Types

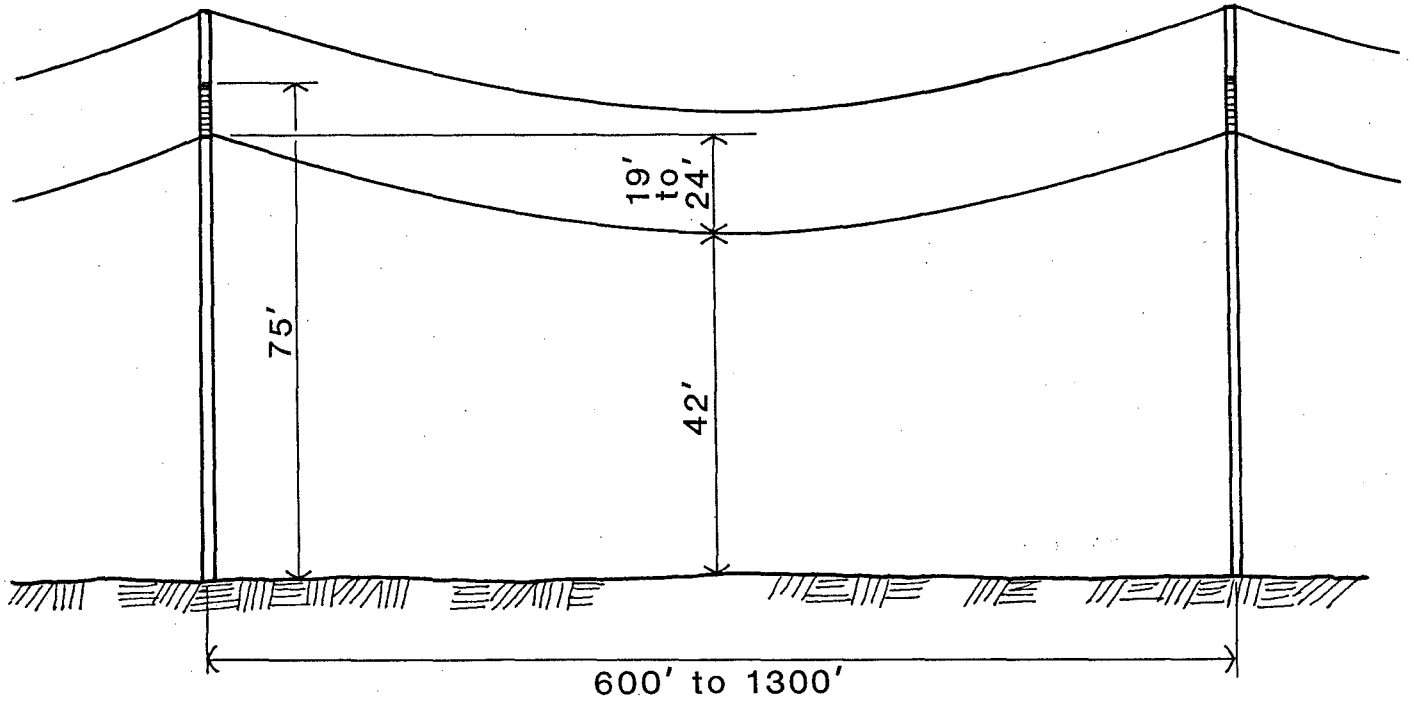
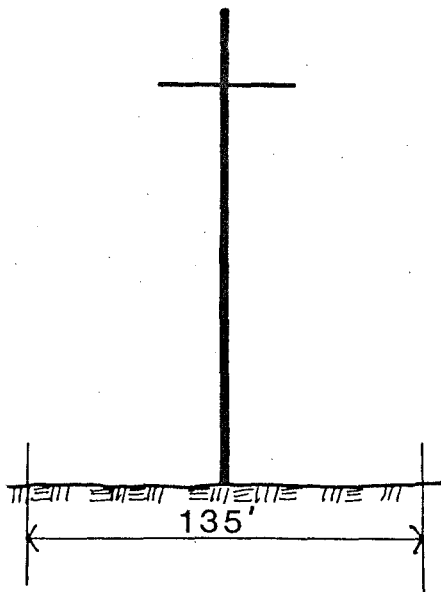
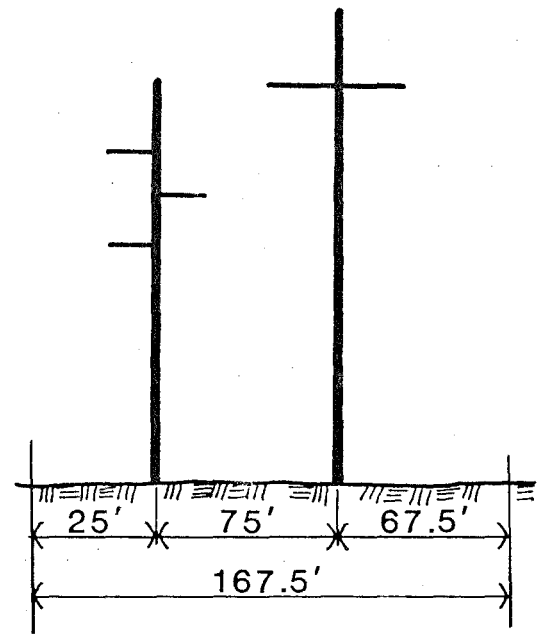


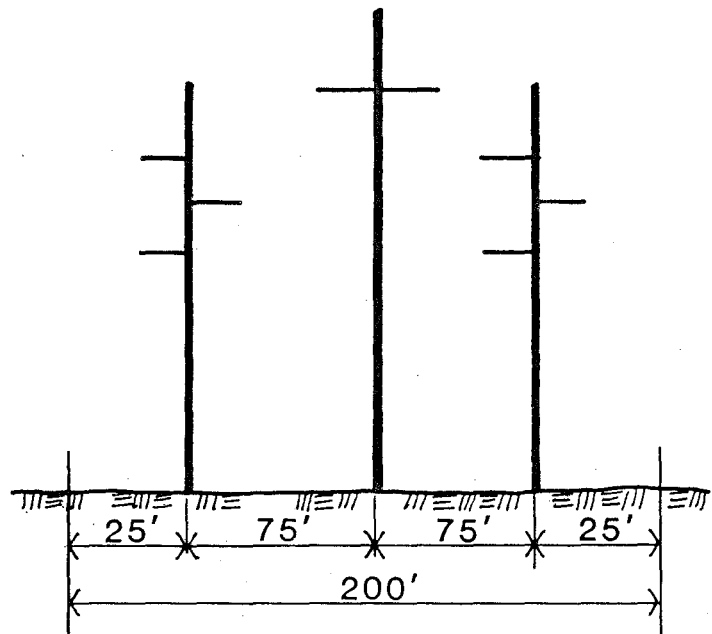
Exhibit I-5: Typical Pole Spacing & Line Sag



300 kVdc



300 kVdc & 69 or 138 kVac



300 kVdc & Two 69 or Two 138 kVac

Exhibit I-6: Typical Right-of-Way Width

Chapter II

CHAPTER II. BROADSCALE ANALYSIS

A. METHODOLOGY

The methodology used to identify potential corridors is a broadscale analysis of opportunities and constraints for a transmission line route. A comprehensive set of data factors is used to structure the analysis. The factors are grouped under five general categories: Exclusion Areas, Geophysical Factors, Biological Factors, Socio-Economic Factors and Cost Factors. Exhibit II-1 outlines the data categories and data factors used in this study.⁴

Under each data factor, with the exception of "Exclusion Areas," the conditions are evaluated in terms of degrees of constraint for the location of transmission lines. These constraints range in three degrees from "high" to "low" for each factor, with a description of the criteria used to rate the conditions.⁵ A constraint map accompanies the analysis of each data factor. The lower the constraints in a given area, the greater the opportunity for placing a transmission line corridor there.

In defining the constraint criteria, "transmission line impacts" are a major consideration. Impacts can be categorized as those created by the transmission line which affect the environment, as well as the effect of the environment on the transmission line. Impacts can also be short-term or long-term in nature, depending on their cause. For example, impacts caused by construction tend to be short-term while operation and maintenance impacts tend to be long-term, continuing over the life of the transmission lines. These differentiations are not made in this report, and all impacts are generally described as "transmission line impacts."

Each data factor is evaluated separately and equally with no weighting given to any factor. The objective is to analyze the constraints for each factor as if all other factors were equal. No single factor is a determinant of the route. The routing opportunities are identified through a composite view of the data factors provided by an overlay mapping process.

4. Although the relationship between transmission lines and humans is not mapped as an individual data factor, it is inherently considered in the socio-economic factors. Specific impacts of large transmission lines on human health and safety are still being researched, and these concerns must be identified and addressed during detailed alignment investigations.

5. The constraint criteria for this study are identical to those of the 1985 HDWCP study.

EXHIBIT II-1

DATA CATEGORIES AND FACTORS

<u>DATA CATEGORY</u>	<u>DATA FACTOR</u>
A. Exclusion Areas	1. Natural Area Reserves
	2. Protective Subzone excluding the Geothermal Resource Subzones
	3. Hawaii Volcanoes National Park
	4. Pohakuloa Training Area
B. Geophysical Factors	1. Slope and Soils
	2. Geologic Hazards
	3. Hydrology
C. Biological Factors	1. Vegetation
	2. Wildlife
D. Socio-Economic Factors	1. Recreation
	2. Land Use
	3. Transportation and Utilities
	4. Land Ownership
	5. Visual Quality
	6. History and Archaeology
	7. Land Regulation
E. Cost Factors	1. Land Value
	2. Maintenance
	3. Access

B. EXCLUSION AREAS

Certain areas were excluded from consideration because of extreme restrictions on land uses which would be likely to prohibit or to severely impede construction of transmission lines. These areas are described below:

1. Natural Area Reserves: These have been established in perpetuity by Executive Orders of the Governor of Hawaii for the purpose of natural preservation under the provisions of Chapter 195, Hawaii Revised Statutes. These lands are relatively pristine environmental zones where even the removal of plants or rocks is prohibited. The Reserves are considered exclusion areas because of the intent of the State to establish and protect them.

There are five Natural Area Reserves⁶ in the study area.

- Laupahoehoe has 7,694 acres and its primary feature is its 'ohi'a wet forest. (Exhibit II-4).
- Mauna Kea: Ice Age has 3,894 acres and its primary feature is its geological importance showing Ice Age moraines (debris from glacier gouges) and Lake Waiau which is the second highest lake in the United States. (Exhibit II-5).
- Waia Kea 1941 Lava Flow has 640 acres and has a fairly recent lava flow with developing wet forests of young 'ohi'a and tree fern and is considered representative of its type on the island of Hawaii. (Exhibit II-3).
- Pu'u Maka'ala has 12,106 acres and it has 'ohi'a and koa wet forests and is rich in native fauna. (Exhibit II-3).
- Kahau'alea is located west of the Puna Forest Reserve. It is part of the eastern rift zone and contains active volcano flow. Its designation as a Natural Area Reserve is pending an Executive Order from the Governor's office. (Exhibit II-2).

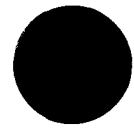
6. Board of Land and Natural Resources, State of Hawaii, Hawaii Natural Area Reserves System, and Robert Lee, Private Communication, Honolulu, Hawaii, May, 1987.

2. Protective Subzone excluding the Geothermal Resource Subzones: The Protective Subzone is designated by the State Board of Land and Natural Resources as the most restrictive subzone of the State Conservation District. (See the section on Land Regulation for a discussion of the Conservation District). It includes "...restricted watersheds, fish, plant and wildlife sanctuaries, significant historic, archaeological, geological and volcanological features and sites and other designated unique areas."⁷ For these reasons, the Protective Subzone is an Exclusion Area unless it is also designated a Geothermal Resource Subzone (GRS), within which geothermal resource development is allowed regardless of Conservation District subzone designation. For example, most of the Kilauea Middle East GRS is designated Protective, but is not mapped as Exclusion Area. (Exhibits II-2 through II-5).
3. Hawaii Volcanoes National Park: The Park is administered by the National Park Service (NPS) whose policies do not permit construction of a power transmission line within park boundaries. (Exhibit II-3).
4. Pohakuloa Training Area: Pohakuloa Training Area (PTA) is located in the Saddle section of the study area. U.S. Army personnel were contacted for input regarding land use requirements and restrictions of this installation.⁸ PTA has responded that "to preclude a negative impact on mission accomplishment and military readiness, ...the Army will not consent to the establishment of a 300 kVdc transmission line corridor within PTA. Any proposed corridor should run north of the existing 69 kV transmission line, or south of the PTA impact area." Therefore, all of PTA, except the small portion north of the 69 kV line, has been designated as Exclusion Area. (Exhibit II-5).

7. Department of Land and Natural Resources, State of Hawaii, Title 13, Chapter 2 (Regulation No. 4), Honolulu, Hawaii, June 12, 1981.

8. See Appendix II for copies of correspondence.

Exclusion Areas



Protective Subzones excluding the Geothermal Resource Subzone
Kahau'ale'a Natural Area Reserve

Source

- Dept. of Land & Natural Resources, *Conservation District Subzones*.
- Board of Land & Natural Resources, *Natural Area Reserves*.

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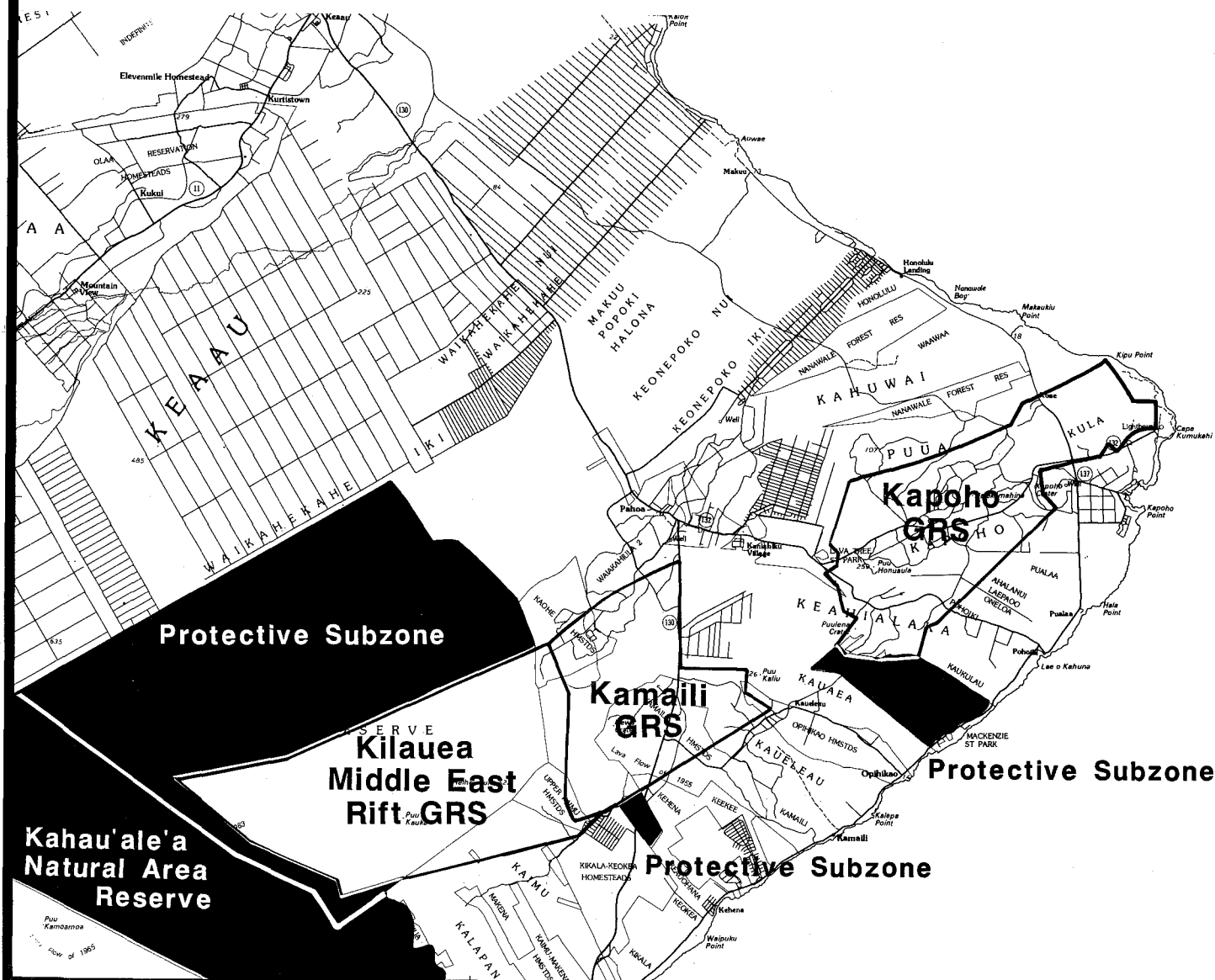


Exhibit II-2

EXCLUSION AREAS: Puna Section



0 1 2 3 4
SCALE IN MILES

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Exhibit II-3
**EXCLUSION AREAS:
Hilo Section**

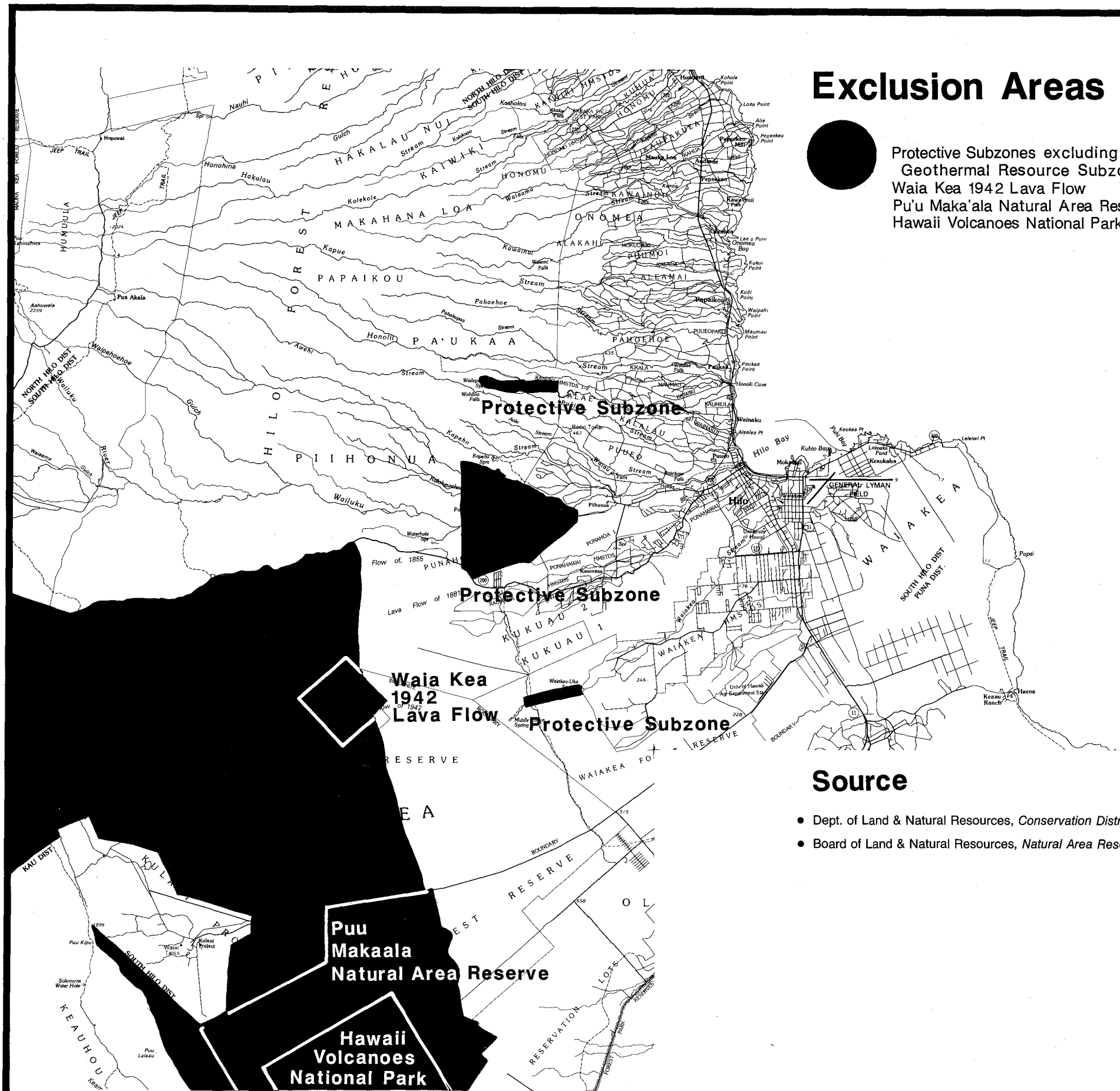
Exclusion Areas



Protective Subzones excluding the
Geothermal Resource Subzone
Waia Kea 1942 Lava Flow
Pu'u Maka'ala Natural Area Reserve
Hawaii Volcanoes National Park

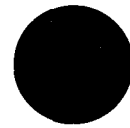
Source

- Dept. of Land & Natural Resources, *Conservation District Subzones*.
- Board of Land & Natural Resources, *Natural Area Reserves*.



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Exclusion Areas



Protective Subzones excluding the Geothermal Resource Subzone
Laupahoehoe Natural Area Reserve

Source

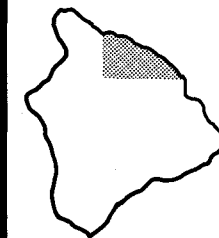
- Dept. of Land & Natural Resources, *Conservation District Subzones*.
- Board of Land & Natural Resources, *Natural Area Reserves*.

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PUNA TO KOHALA OVERLAND TRANSMISSION CORRIDOR STUDY

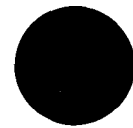
Exhibit II-4

EXCLUSION AREAS: Hamakua Section



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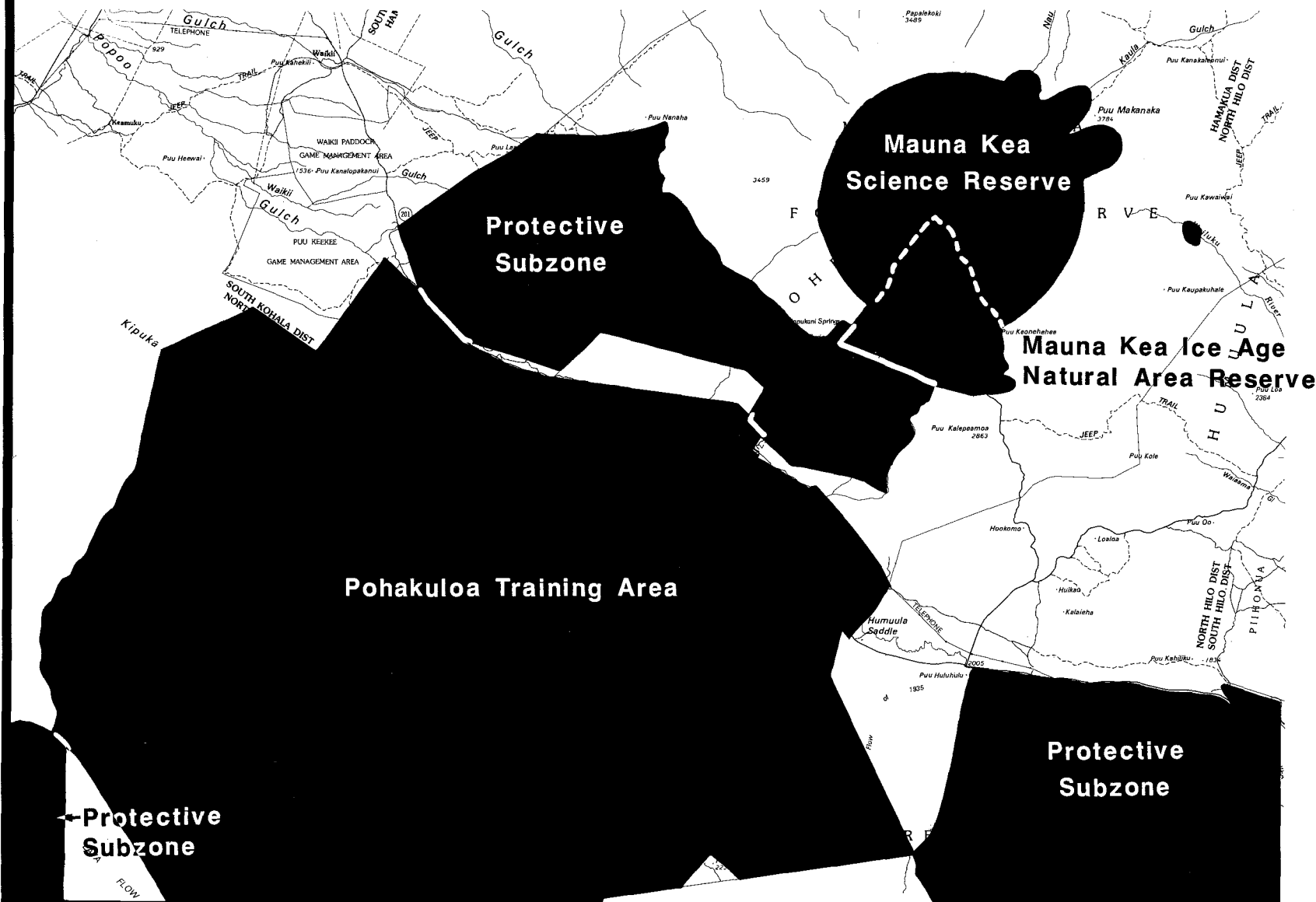
Exclusion Areas



Protective Subzones excluding the Geothermal Resource Subzone
 U.S. Army Pohakuloa Training Area South of the Saddle Road
 Mauna Kea Science Reserve
 Mauna Kea Ice Age Natural Area Reserve

Source

- Dept. of Land & Natural Resources, *Conservation District Subzones*.
- Board of Land & Natural Resources, *Natural Area Reserves*.



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Exhibit II-5 **EXCLUSION AREAS: Saddle Section**



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C. CONSTRAINT FACTORS

1. Geophysical Factors: The geophysical factors evaluated in the study area include slope and soils; geologic hazards, particularly volcanic and related seismic activity; and hydrology. These factors affect construction and maintenance costs, transmission line tower foundation stability and long-term operational reliability.

a. Slope and Soils

Slope and soils are interrelated, particularly where transmission line construction may cause soil erosion. Gentle slopes are desirable as are stable soils where erosion is less likely and where good pole or tower foundations can be established.

Traversing steep slopes may require longer transmission lines because of longer distances involved to go over ridges and may involve more complicated construction practices when installing poles, towers or structures. Steep slopes or highly gullied land may add to the difficulties of installing poles, towers and wires.

For the purpose of this report, land where the slope is 20 percent or greater⁹ is considered to have a "high" constraint while slopes of 10 to 20 percent are considered to be a "medium" constraint. The upper elevations of Mauna Kea, encircling the summit, have slopes of 20% or greater. 10 to 20% slopes are found at the mid-elevations of Mauna Kea and along the Hamakua coast.

For transmission line construction, it is desirable to have soils with low erosion hazards and which do not have the potential for hidden voids or sudden collapse such as may be exhibited by pahoehoe lava fields. The U. S. Soil Conservation Service has classified soils "severe," "moderate," and "slight" with respect to their erosion hazard.¹⁰ These classifications correspond to the constraints of "high," "medium," and "low" used here. Highly erodible soils are

9. Slope percentage estimates prepared by DHM Planners inc., Honolulu, May, 1987.

10. United States Department of Agriculture, Soil Conservation Service, Soil Survey of the Island of Hawaii, State of Hawaii, Washington, D.C., December, 1973.

located in the stream beds along the northeast shoreline of the island and around the upper elevations of Mauna Kea. Pahoehoe lava appears in the South Hilo/Puna area and on the slopes of Mauna Loa, south of Saddle Road.

Slope and Soils

<u>Degree of Constraint</u>	<u>Criteria</u>
High	Soil erosion hazard potential rated "severe;" slope 20 percent or greater.
Medium	Soil erosion hazard potential rated "moderate;" pahoehoe lava flows; slope between 10 and 20 percent.
Low	Soil erosion hazard potential rated "slight;" slope less than 10 percent.

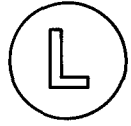
Constraints



Soil erosion hazard potential rated "severe"; or slope 20% or greater.



Soil erosion hazard potential rated "moderate"; pahoehoe lava flows; or slope between 10% and 20%.



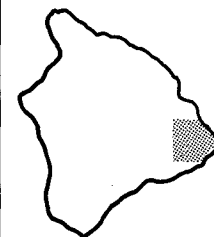
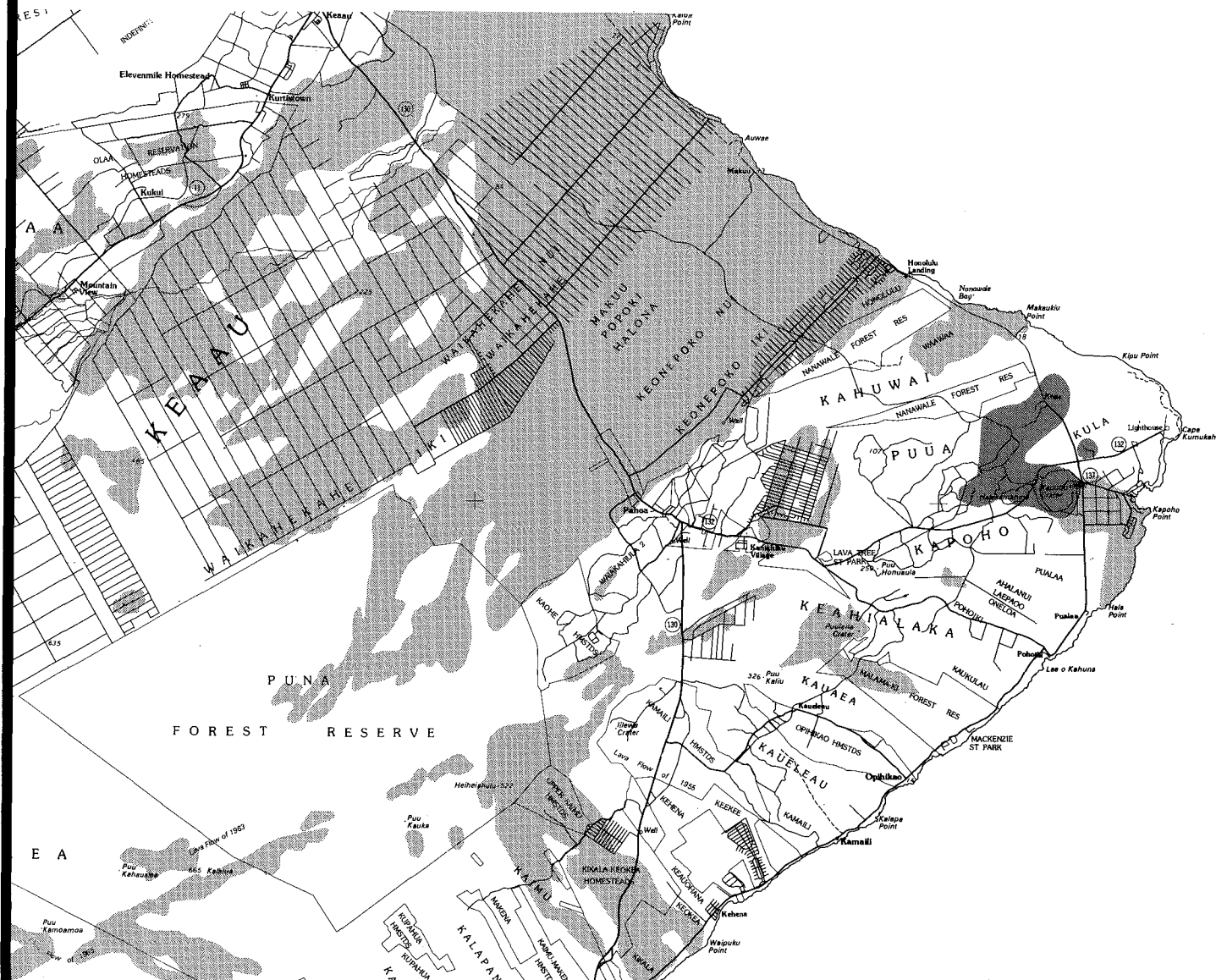
Soil erosion hazard potential rated "slight."

Source

- U.S. Dept. of Agriculture, Soil Conservation Service, *Soil Survey of Island of Hawaii*, State of Hawaii, Washington, D.C., 1973.
- DHM inc.

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Exhibit II-6 **SLOPE AND SOILS: Puna Section**



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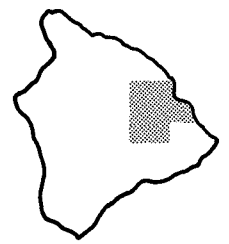
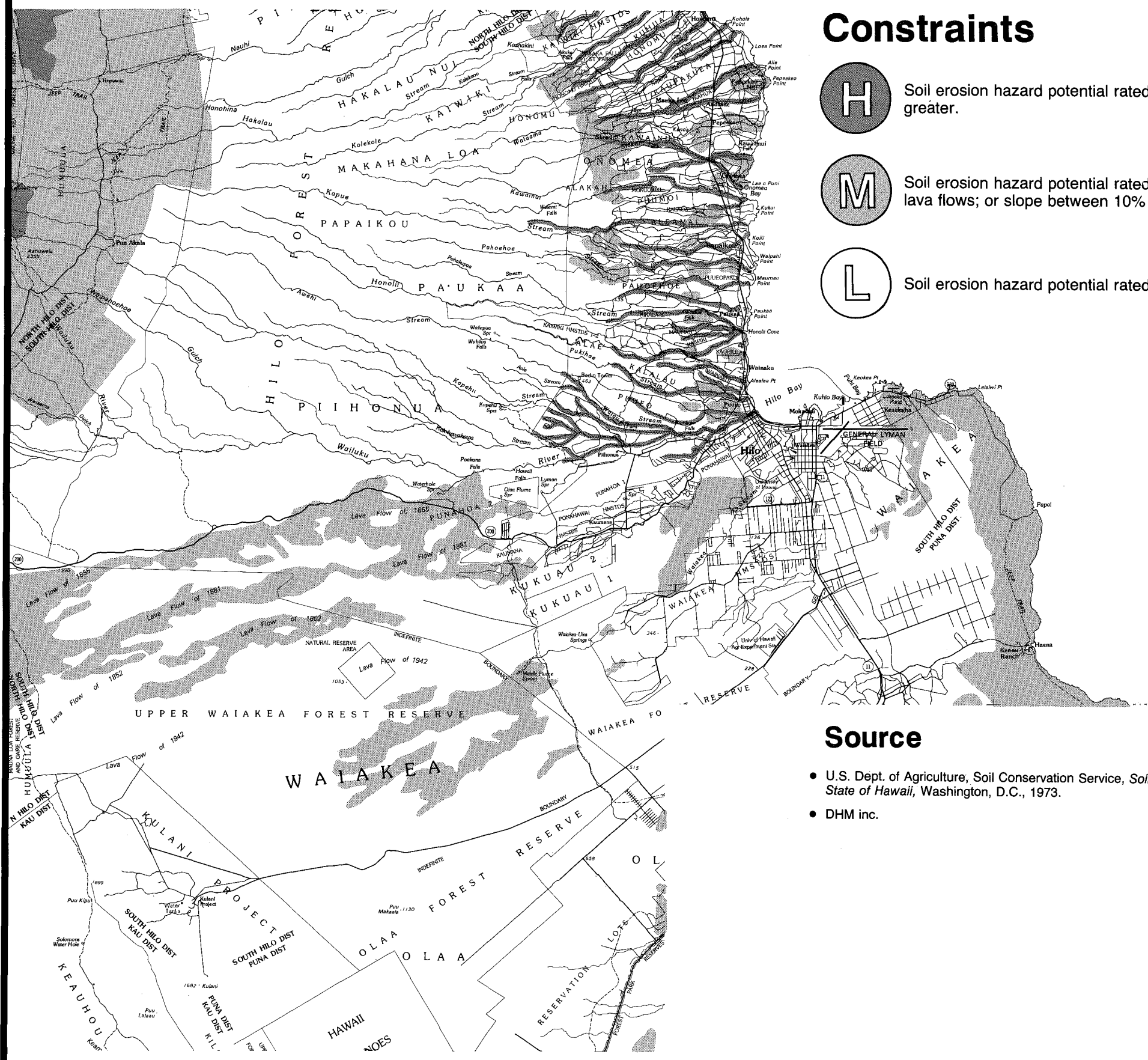
Exhibit II-7
**SLOPE AND SOILS:
Hilo Section**

Constraints

- H** Soil erosion hazard potential rated "severe"; or slope 20% or greater.
- M** Soil erosion hazard potential rated "moderate"; pahoehoe lava flows; or slope between 10% and 20%.
- L** Soil erosion hazard potential rated "slight."

Source

- U.S. Dept. of Agriculture, Soil Conservation Service, *Soil Survey of Island of Hawaii*, State of Hawaii, Washington, D.C., 1973.
- DHM inc.



DHM Planners inc.

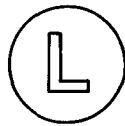
Constraints



Soil erosion hazard potential rated "severe"; or slope 20% or greater.



Soil erosion hazard potential rated "moderate"; pahoehoe lava flows; or slope between 10% and 20%.



Soil erosion hazard potential rated "slight."

Source

- U.S. Dept. of Agriculture, Soil Conservation Service, *Soil Survey of Island of Hawaii, State of Hawaii*, Washington, D.C., 1973.
- DHM inc.

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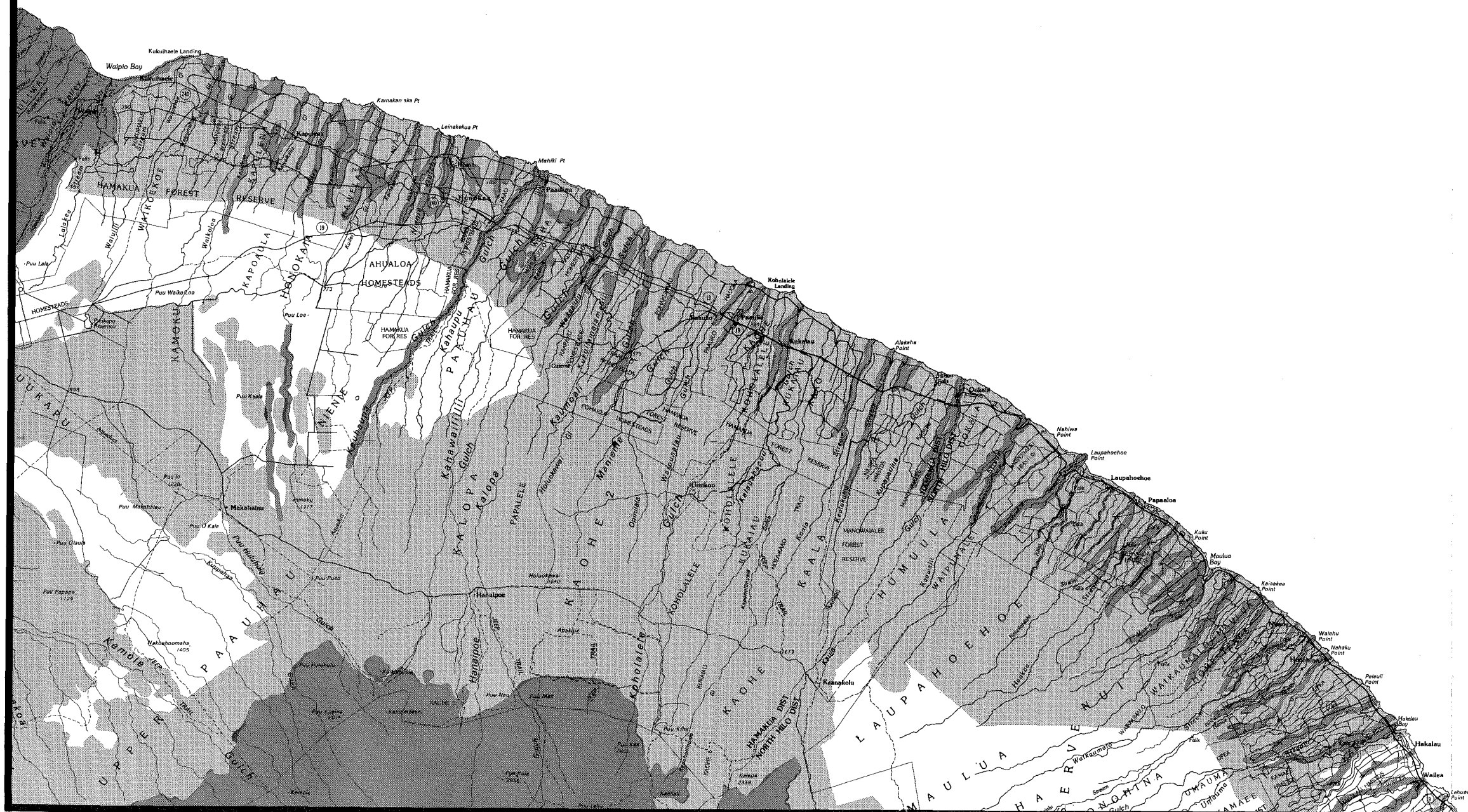
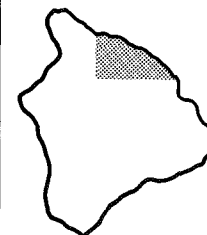


Exhibit II-8 SLOPE AND SOILS: Hamakua Section



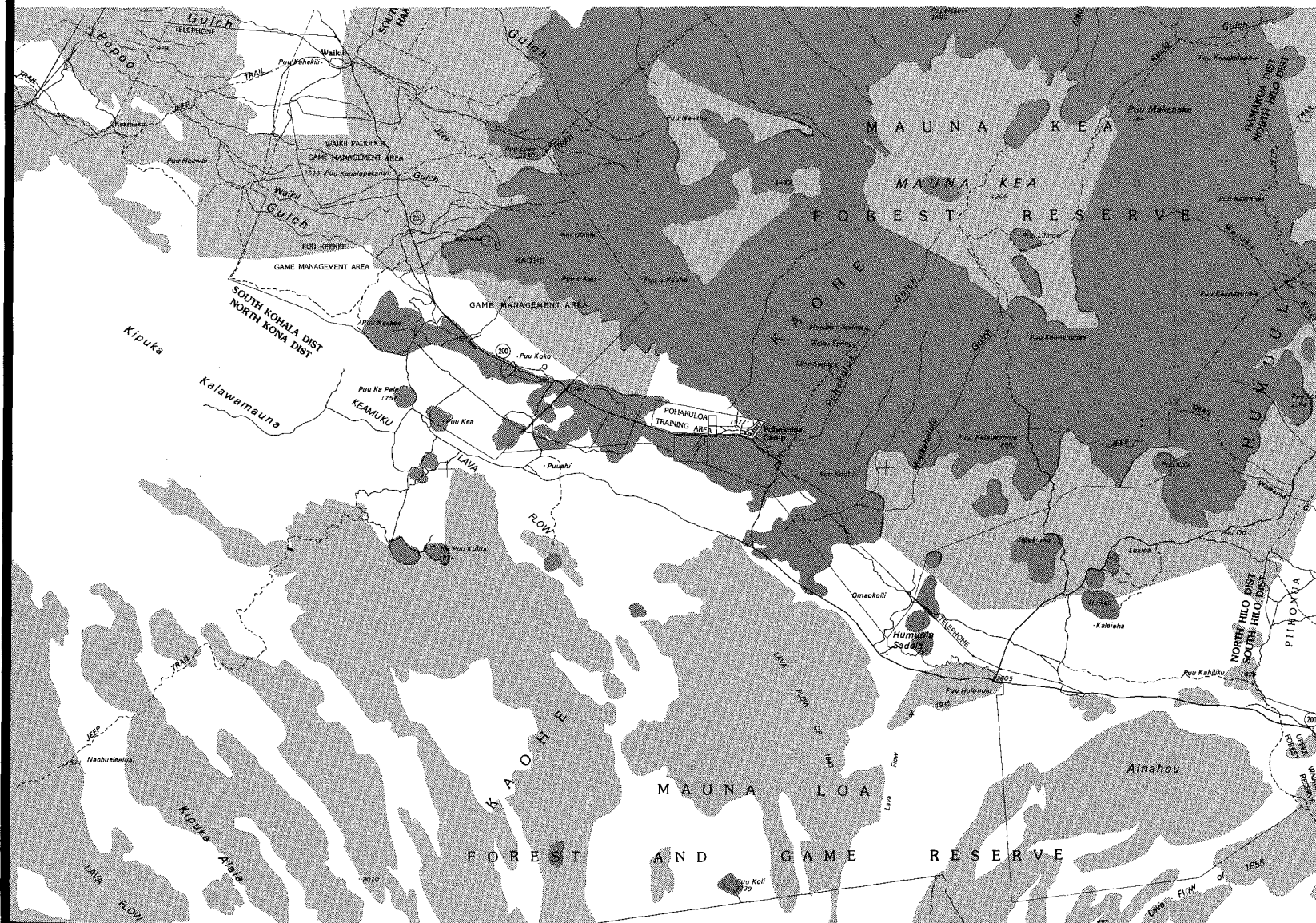
DHM Planners inc.

Constraints

- H** Soil erosion hazard potential rated "severe"; or slope 20% or greater.
- M** Soil erosion hazard potential rated "moderate"; pahoehoe lava flows; or slope between 10% and 20%.
- L** Soil erosion hazard potential rated "slight."

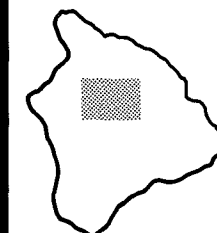
Source

- U.S. Dept. of Agriculture, Soil Conservation Service, *Soil Survey of Island of Hawaii, State of Hawaii*, Washington, D.C., 1973.
- DHM inc.



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Exhibit II-9 SLOPE AND SOILS: Saddle Section



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b. Geologic Hazards

This section discusses the potential hazards from volcanic eruptions, lava flows and related seismic activity in the study area.

Recent flows are those which have occurred since 1778. These historic flows have occurred on Hawaii¹¹ where there are active rift zones. Lands susceptible to lava flows or rifts are considered to have "high" constraints to transmission line construction. These lands are found in the Puna District from Kilauea Crater to Cape Kumukahi and Nanawale along the Kilauea east rift zone, and south of Saddle Road along the northeast rift zone.

The frequency of volcanic activity is less in areas where flows or rift zones were active between 200 and 5000 years ago. These areas are considered to have "medium" constraints to transmission line construction and are generally located south of Mauna Kea. Areas where flows are older than 5,000 years are considered to have a "low" constraint.

Geologic Hazards

<u>Degree of Constraint</u>	<u>Criteria</u>
High	Areas in which lava flows have occurred within the past 200 years.
Medium	Areas in which lava flows have occurred from 200 to 5,000 years ago.
Low	All remaining areas.

11. United States Department of the Interior, Geological Survey, Natural Hazards on the Island of Hawaii, Washington, D.C., 1977.

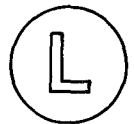
Constraints



Areas in which lava flows have occurred within the past 200 years.



Areas in which lava flows have occurred within the past 5,000 years.



All remaining areas.

Source

• USGS, *Natural Hazards on the Island of Hawaii*, Washington, D.C., 1977.

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Exhibit II-10 GEOLOGIC HAZARDS: Puna Section



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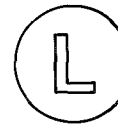
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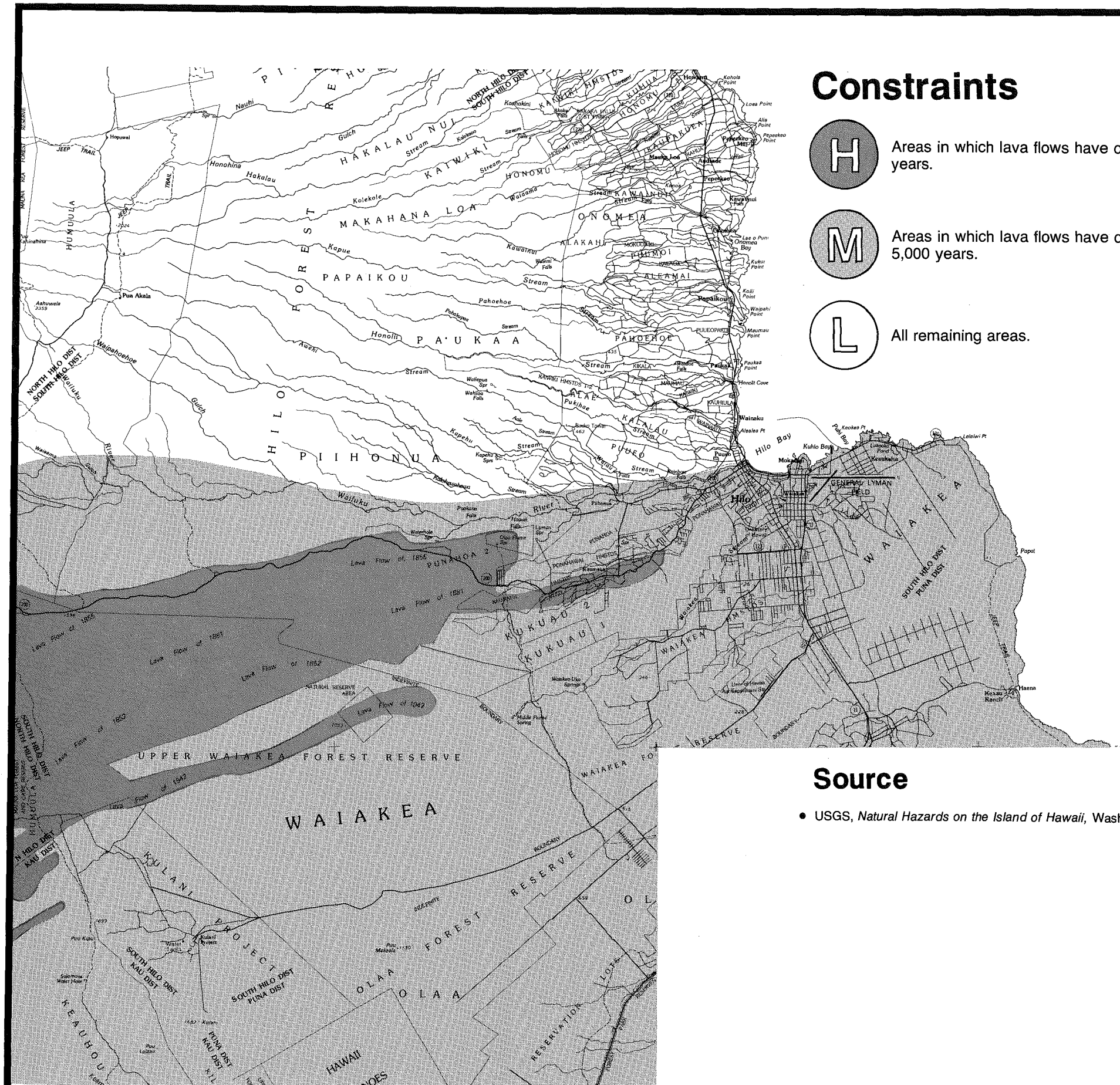
Areas in which lava flows have occurred within the past 200 years.



Areas in which lava flows have occurred within the past 5,000 years.



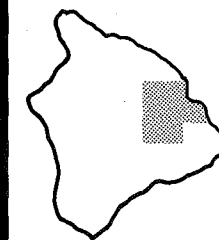
All remaining areas.



Source

• USGS, *Natural Hazards on the Island of Hawaii*, Washington, D.C., 1977.

Exhibit II-11
**GEOLOGIC
HAZARDS:
Hilo Section**



DHM Planners inc.

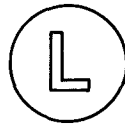
Constraints



Areas in which lava flows have occurred within the past 200 years.



Areas in which lava flows have occurred within the past 5,000 years.



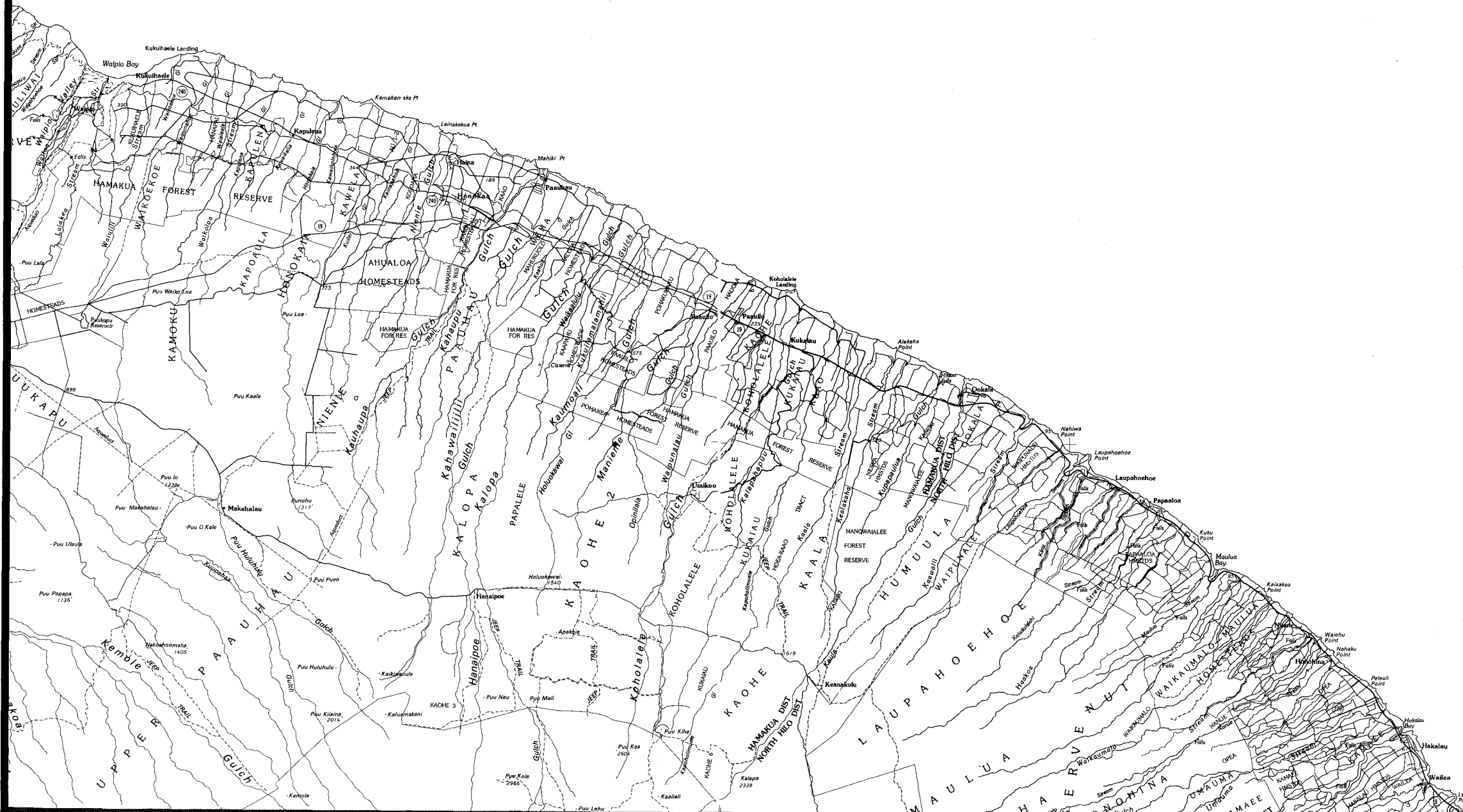
All remaining areas.

Source

• USGS, *Natural Hazards on the Island of Hawaii*, Washington, D.C., 1977.

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Exhibit II-12 GEOLOGIC HAZARDS: Hamakua Section



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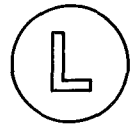
Constraints



Areas in which lava flows have occurred within the past 200 years.



Areas in which lava flows have occurred within the past 5,000 years.



All remaining areas.

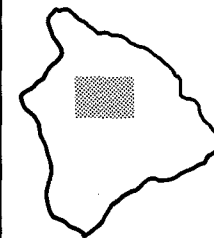
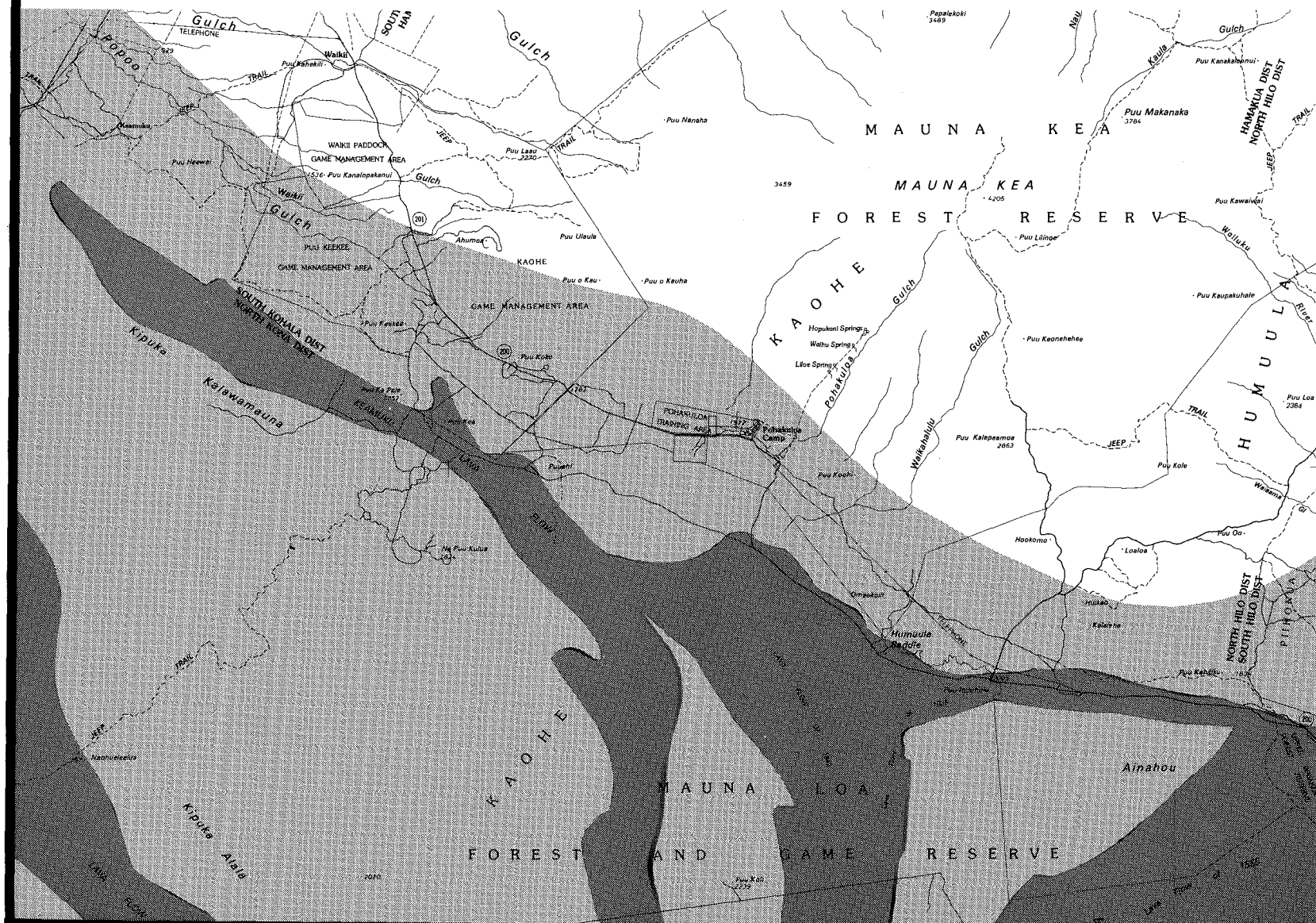
Source

- USGS, *Natural Hazards on the Island of Hawaii*, Washington, D.C., 1977.

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Exhibit II-13 GEOLOGIC HAZARDS: Saddle Section



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c. Hydrology

The hydrologic features, or water resources, of the study area are significant to agriculture, urban water supplies and the natural environment. This section discusses four distinct hydrologic factors and the relative constraints which they present for the construction of overhead power transmission lines. The four features are:

- Flooding
- Surface Water Resources
- Rainfall
- Groundwater Resource Areas

There are two principal types of floods - riverine and coastal. Riverine flooding occurs when high rainfall causes stream overflow or sheetflow (where drainage areas are poorly defined or undeveloped). Coastal flooding occurs due to high waves or tsunami inundation.

Major flood zones for both riverine and coastal floods are designated in the Flood Insurance Rate Maps prepared by the Federal Emergency Management Agency.¹² The "100 year" flood zones delineate areas where, annually, there is a one percent or greater chance of occurrence of a flood within the designated zone to the elevation at the zone's boundary. These zones present "high" constraints because high velocity streamflow or high waves could cause damage to utility poles, maintenance roads, and converter structures.

Surface water resources (including wetlands, lakes and streams) are significant aquatic habitats and are important for ground water recharge. Wetlands in the study area, such as those in Waipio Valley and Kuhio Bay near Hilo, are identified within the "100 year" flood zones. The study area contains no lakes of a mappable size.

Perennial streams include gulches or drainageways where water is present year-round, while intermittent streams carry water only after high rainfall periods. Streams are a constraint because poles installed in streambeds could be adversely affected by high velocity flows which occur during rain storms. However, the narrowness of the streambeds at this scale of mapping makes

12. United States Federal Emergency Management Agency, Flood Insurance Rate Map, Hawaii County (rev. May 3, 1982), Washington D.C.

it impractical to identify them in this mapping process. They occur primarily along the Hamakua coast, north of Hilo. Although the streambeds are a constraint, it is possible to avoid them when actually placing poles during construction. During definition of the transmission line alignment and final design, the streams would be more precisely located.

Rainfall patterns are closely related to soil erosion and vegetation growth as well as to the water resources of streams, groundwater and floods. In areas of high rainfall, the potential effects of powerline construction on soils and water resources may be intensified. Areas with an average annual rainfall of 75 inches¹³ and greater are classified as "medium" constraint areas, while areas with less average annual rainfall are "low" constraint areas.

Groundwater in its various forms (basal, diked or perched) is considered a "low" constraint because the effects of powerline construction on groundwater would be negligible providing erosion is minimized during construction. An exception to this is the restricted watersheds which the State Board of Land and Natural Resources has included within the Protective Subzone of the Conservation District, and these are classed as "Exclusion Areas."

Hydrology

<u>Degree of Constraint</u>	<u>Criteria</u>
High	"100 year" flood zones.
Medium	Areas with an average annual rainfall of 75 inches or greater.
Low	All remaining areas.

 13. Department of Land and Natural Resources, State of Hawaii, Conservation District Inventory: Hawaii, Honolulu, Hawaii, 1977.

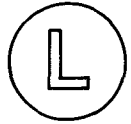
Constraints



"100 year" flood zones.



Areas with an average annual rainfall of 75 inches or greater.



All remaining areas.

Source

- U.S. Federal Emergency Management Agency, *Flood Insurance Rate Maps, Hawaii County*, 1982.
- DLNR, *Conservation District Inventory, Water Resources*, Map 4 of 8, Island of Hawaii, 1977.

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Exhibit II-14 HYDROLOGY: Puna Section



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Exhibit II-15
**HYDROLOGY:
Hilo Section**

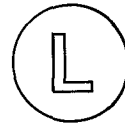
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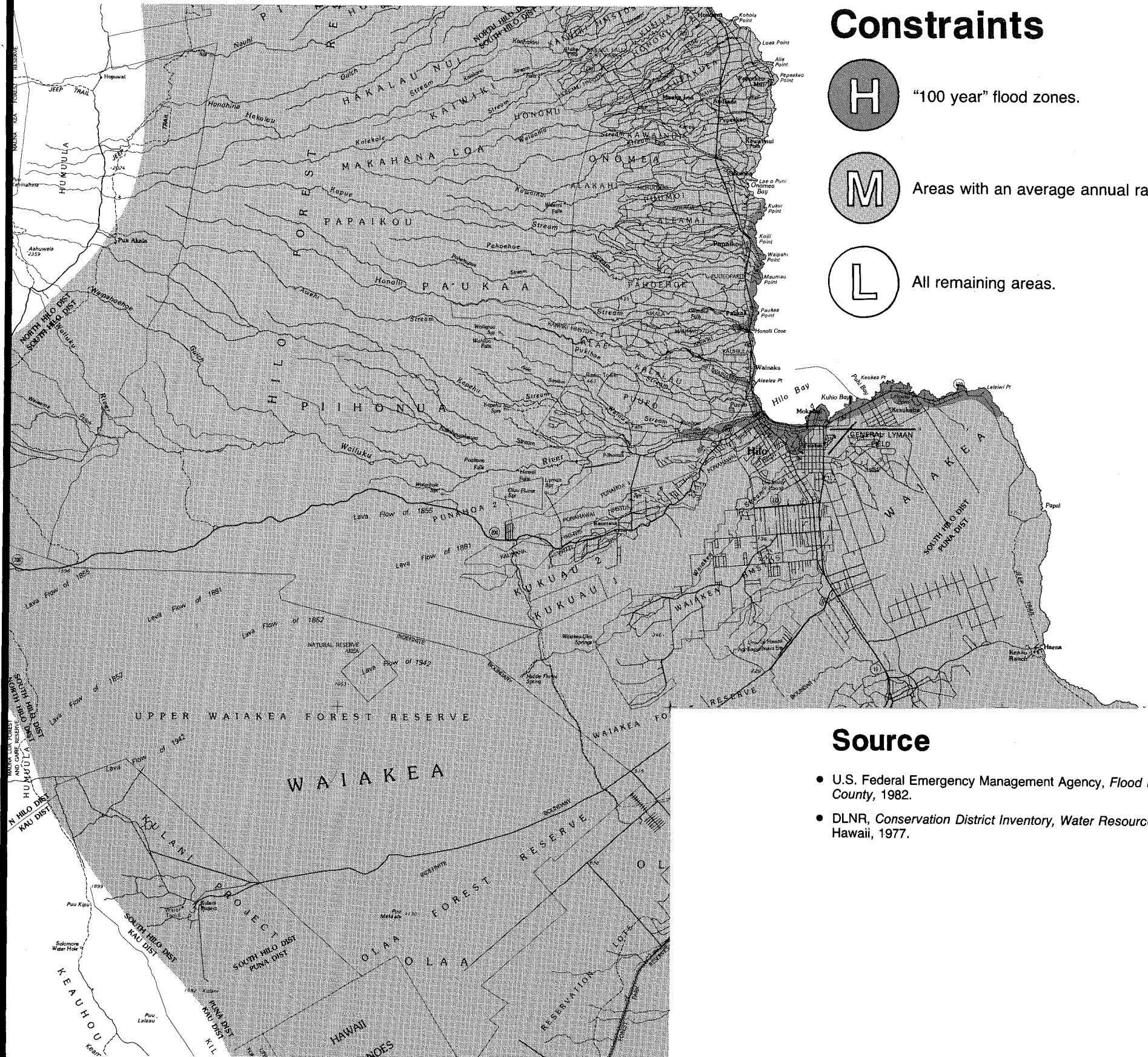
"100 year" flood zones.



Areas with an average annual rainfall of 75 inches or greater.

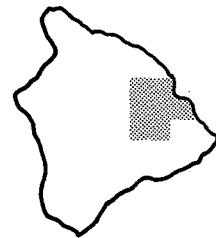


All remaining areas.



Source

- U.S. Federal Emergency Management Agency, *Flood Insurance Rate Maps, Hawaii County, 1982.*
- DLNR, *Conservation District Inventory, Water Resources, Map 4 of 8, Island of Hawaii, 1977.*



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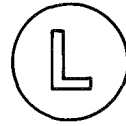
Constraints



"100 year" flood zones.



Areas with an average annual rainfall of 75 inches or greater.



All remaining areas.

Source

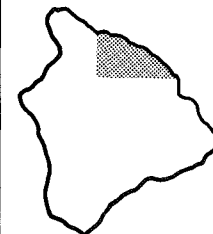
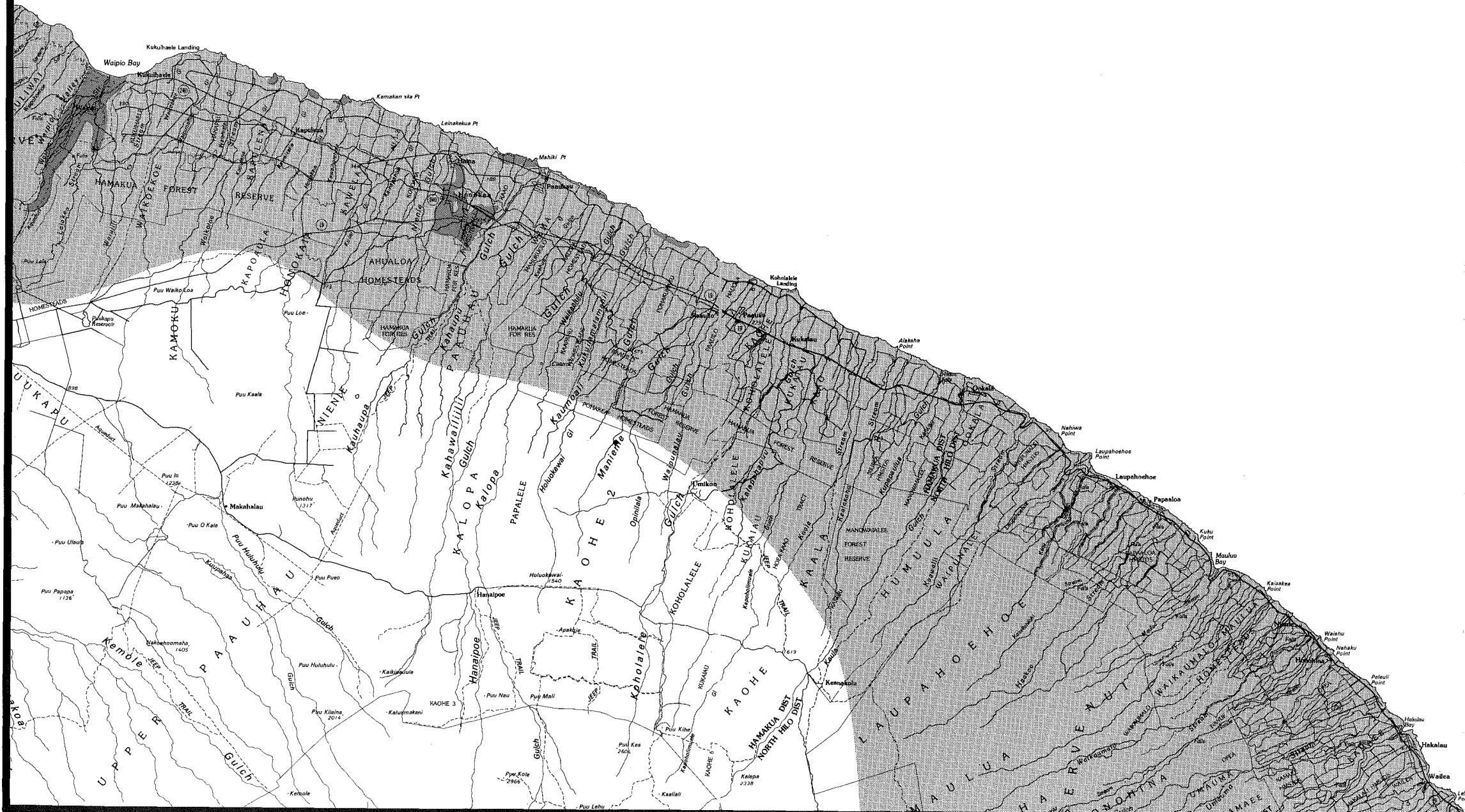
- U.S. Federal Emergency Management Agency, *Flood Insurance Rate Maps, Hawaii County, 1982.*
- DLNR, *Conservation District Inventory, Water Resources, Map 4 of 8, Island of Hawaii, 1977.*

HAWAII DEEP WATER CABLE PROGRAM

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Exhibit II-16

HYDROLOGY: Hamakua Section



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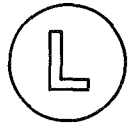
Constraints



"100 year" flood zones.



Areas with an average annual rainfall of 75 inches or greater.



All remaining areas.

Source

- U.S. Federal Emergency Management Agency, *Flood Insurance Rate Maps, Hawaii County, 1982.*
- DLNR, *Conservation District Inventory, Water Resources, Map 4 of 8, Island of Hawaii, 1977.*

HAWAII DEEP WATER CABLE PROGRAM

PUNA TO KOHALA OVERLAND TRANSMISSION CORRIDOR STUDY

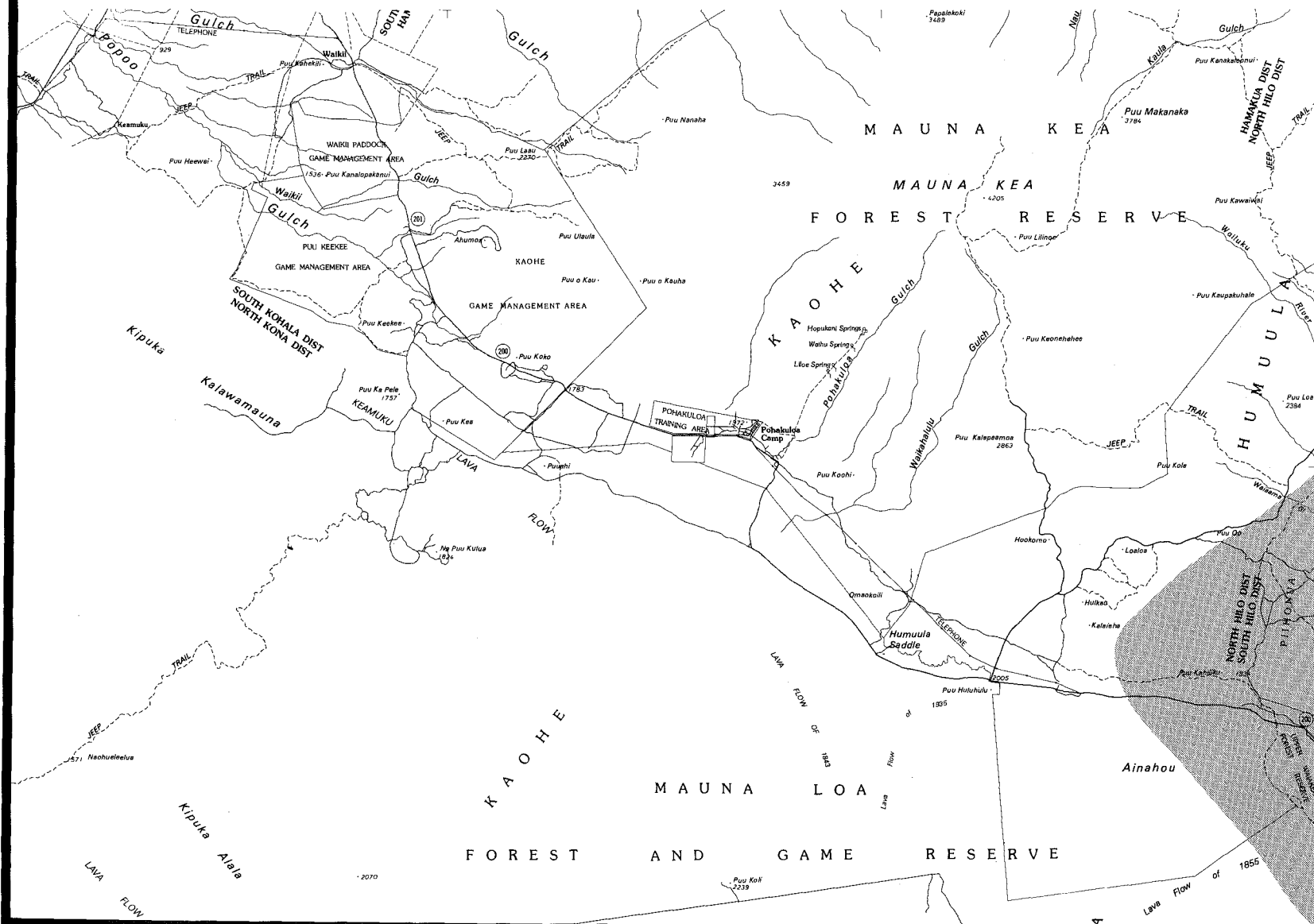
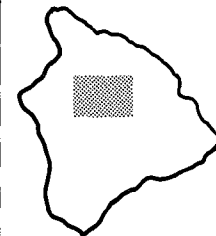


Exhibit II-17 HYDROLOGY: Saddle Section



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2. Biological Factors: This section addresses the effects of construction and the long-term operation and maintenance of a transmission line relative to vegetation and wildlife. (The human environment is discussed under Socio-Economic Factors.)

a. Vegetation

Construction and maintenance of transmission poles or towers would entail some disturbance to ground areas which may adversely affect plant life. The need to keep transmission lines clear of vegetation often requires the removal of some foliage in forest areas. If vegetative growth is kept very low or is cleared for ease of access and maintenance, these areas become vulnerable to invasions by exotic species of plants and are subject to disruptive activities of feral mammals and humans. This is especially important in the case of native forests which serve as important habitats for threatened and endangered species (in accordance with the list maintained by the United States Fish and Wildlife Service) of animal life, particularly forest birds.

The impact of a transmission line on vegetation depends upon the characteristics of the plant community and its degree of sensitivity to disturbance. In general, plant communities most sensitive are the relatively mature forests. These are the areas which support the greatest diversity and abundance of plant species and which also may require rather substantial clearance of vegetation both around and below a transmission line. Mature forests are characterized by dense tree cover and tall trees with dense undergrowth. Therefore, as depicted on the Jacobi mapping systems, all forests with a "closed" canopy (i.e. having greater than 60% tree cover), and more open-canopy forests (25-60% cover) with a typical canopy height greater than 15'¹⁴ are a "high"

14. Jacobi, James D., Mapping the Natural Vegetation of the Hawaiian Islands, Honolulu, Hawaii, March 7, 1983.
United States Department of the Interior, Fish and Wildlife Service, Jacobi System Vegetation Maps for Hawaii - Advance Prints, Honolulu, Hawaii, 1979-1984.

The Jacobi Vegetation Maps do not cover the entire study area. The U. S. Geological Service Land Use Land Cover maps are used for the remaining quadrangles. The evergreen forest category was used as a closed canopy forest unless it was immediately adjacent to an open canopy forest as mapped on the Jacobi Vegetation Maps.

constraint. Open-canopy forests with a typical canopy height less than 15' are considered a "medium" constraint.

Vegetation

<u>Degree of Constraint</u>	<u>Criteria</u>
High	All closed-canopy forests; open-canopy forests with typical tree height above 15'.
Medium	Open-canopy forests with typical tree height below 15'.
Low	All remaining areas including sparsely vegetated and range lands, agricultural and urban lands and barren lava flows.

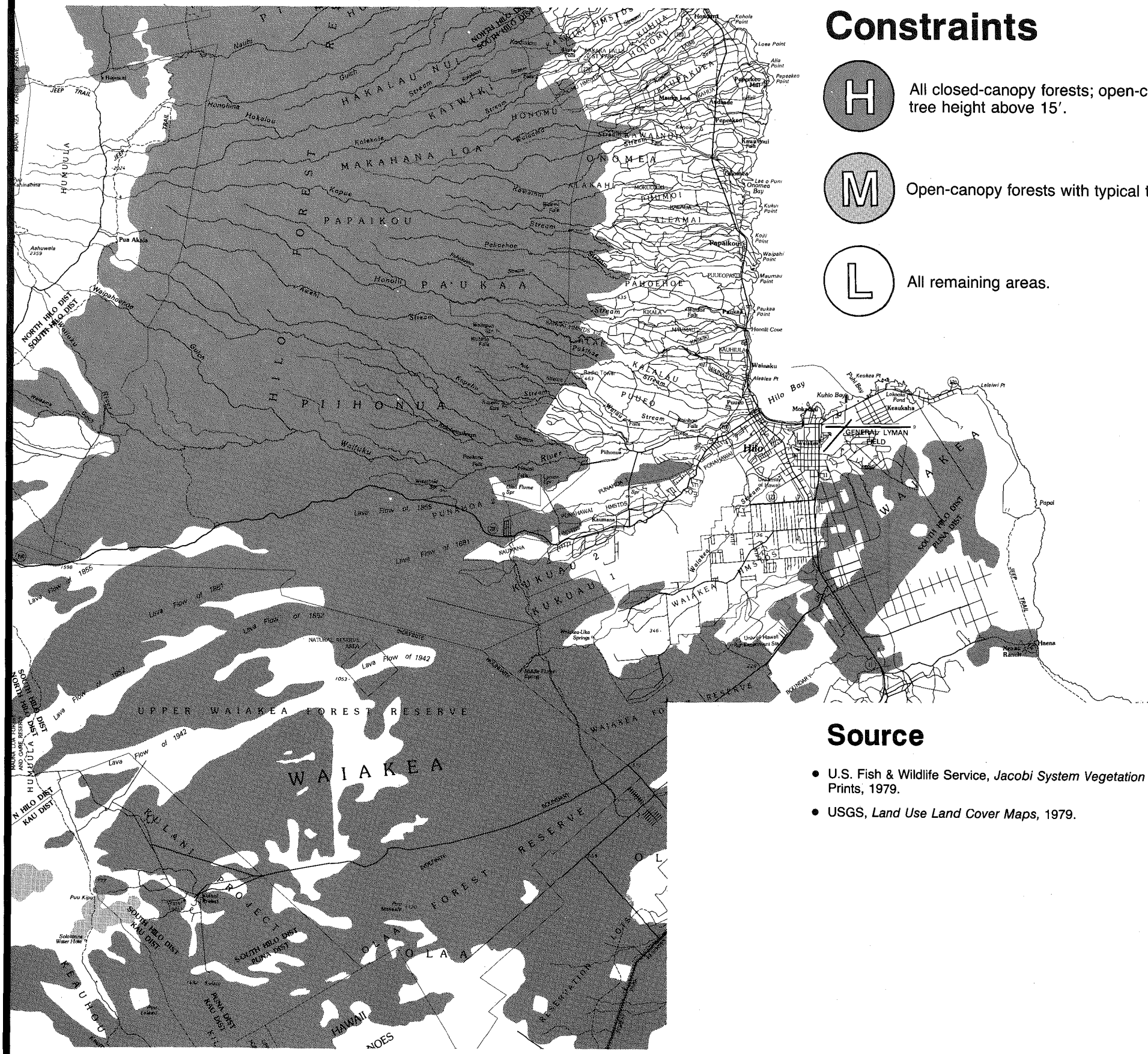
HAWAII
DEEP WATER
CABLE PROGRAM

**PUNA TO
KOHALA
OVERLAND
TRANSMISSION
CORRIDOR
STUDY**

Exhibit II-19
**VEGETATION:
Hilo Section**

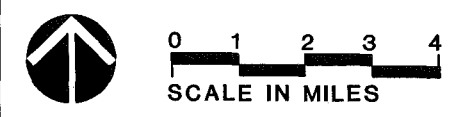
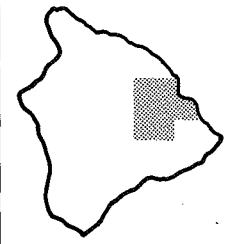
Constraints

- H** All closed-canopy forests; open-canopy forests with typical tree height above 15'.
- M** Open-canopy forests with typical tree height below 15'.
- L** All remaining areas.



Source

- U.S. Fish & Wildlife Service, *Jacobi System Vegetation Maps, Hawaii*, Advance Prints, 1979.
- USGS, *Land Use Land Cover Maps*, 1979.



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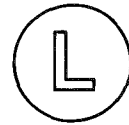
Constraints



All closed-canopy forests; open-canopy forests with typical tree height above 15'.



Open-canopy forests with typical tree height below 15'.



All remaining areas.

Source

- U.S. Fish & Wildlife Service, *Jacobi System Vegetation Maps, Hawaii, Advance Prints, 1979.*
- USGS, *Land Use Land Cover Maps, 1979.*

HAWAII DEEP WATER CABLE PROGRAM

PUNA TO KOHALA OVERLAND TRANSMISSION CORRIDOR STUDY



Exhibit II-18

VEGETATION: Puna Section



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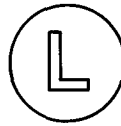
Constraints



All closed-canopy forests; open-canopy forests with typical tree height above 15'.



Open-canopy forests with typical tree height below 15'.



All remaining areas.

Source

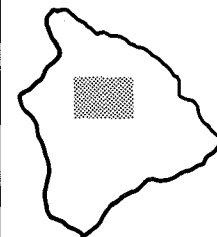
- U.S. Fish & Wildlife Service, *Jacobi System Vegetation Maps, Hawaii, Advance Prints, 1979.*
- USGS, *Land Use Land Cover Maps, 1979.*

HAWAII DEEP WATER CABLE PROGRAM

PUNA TO KOHALA OVERLAND TRANSMISSION CORRIDOR STUDY

Exhibit II-21

VEGETATION: Saddle Section



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b. Wildlife

The focus of wildlife concerns is on avifauna due to the existence of habitat and nesting areas for threatened and endangered forest birds and waterbirds in the study area. Common mammals such as the mongoose, feral pig, goat and sheep are found in these areas, and are noted for destroying some of the best bird habitats. They often prey on birds or compete with them for forage.¹⁵ Endemic insects and land snails are typically found in the same habitats as the native bird species, as both are dependent on the same resources.¹⁶

Construction and maintenance of a transmission line through forest areas which support avifauna would disturb the forest, and an opening in the canopy would promote the introduction of competing plant species and access by feral mammals and humans. This in turn would have a long-term adverse effect on the quality of the habitat.

Therefore, habitats known to support threatened and endangered species are considered a "high" constraint.

The endangered I'o or Hawaiian hawk (Buteo solitarius) is endemic to the Hawaiian Islands and is known to breed only on the Big Island. The range of the I'o is quite diverse, including windward forests as well as agricultural lands. In the study area, the known I'o habitat includes the Kohala Mountains' windward side, the northeast slope of Mauna Kea, and portions of the Hilo and Puna districts.¹⁷

15. Baker, J.K. and C.A. Russell, "Mongoose Predation on a Nesting Nene," 'Elepaio (40:51-52), Honolulu, Hawaii, 1979.

Mueller-Dombois, D. and G. Spatz, "The Influence of Feral Goats on the Lowland Vegetation in Volcanoes National Park," Phytocoelgia (3:1-29), 1975.

Spatz, G. and D. Mueller-Dombois, "Succession Patterns after Pig Digging in Grassland Communities on Mauna Loa, Hawai'i," Phytocoelgia (3:346-373), 1975.

16. An exception is unique cave adapted insects sometimes found in pahoehoe lava flow caves. Since the location and extent of such features are unknown, it is not a mappable constraint at this level of analysis.

17. United States Department of the Interior, Fish and Wildlife Service, Hawaiian Hawk Recovery Plan, Honolulu, Hawaii, May, 1984.

The following forest birds are considered endangered species and their habitats have been mapped as a "high" constraint.¹⁸

Hawaiian creeper	(<u>Loxops maculatus mana</u>)
Hawaiian akepa	(<u>Loxops coccineus coccineus</u>)
<u>Akiapola'au</u>	(<u>Hemignanthus wilsoni</u>)
<u>'O'u</u>	(<u>Psittirostra psittacea</u>)
Hawaiian crow, Alala	(<u>Corvus tropias</u>)
<u>Palila</u>	(<u>Psittirostra bailleui</u>)
Dark-rumped petrel	(<u>Pterodroma phaeopygia sandwichensis</u>)

The State bird of Hawaii, the Hawaiian goose, or the Nene (Branta sandvicensis), is also found on Hawaii. It has been raised in captivity at Pohakuloa and Volcanoes National Park and released in the wild into former or suitable habitat.¹⁹ Their present range within the study area includes their former upland habitat on the northwest and east slopes of Mauna Loa.

Wetlands, streams and ponds are important habitats and feeding areas for endangered species of waterbirds, including the Hawaiian duck known as the Koloa (Anas wyvilliana), the Hawaiian coot (Fulica americana alai), and the Hawaiian stilt or Ae'o (Himantopus himantopus knudseni).²⁰ Waipio Valley, Kuhio Bay and other wetlands have been mapped as "high" constraints.

The hoary bat or 'Ope'a pe'a is the only land mammal listed as an endangered species. Its specific habitat is undetermined since it is spread throughout the native forests and coastland of the study area, therefore its habitat was not mapped as a constraint.

18. Scott, J. Michael, et al., Forest Bird Communities of the Hawaiian Islands: Their Dynamics, Ecology and Conservation, Cooper Ornithological Society, Los Angeles, California, 1986, pp. 380-383.

19. United States Department of the Interior, Fish and Wildlife Service, Nene Recovery Plan, Honolulu, Hawaii, February, 1983.

20. Kramer, William, United States Department of the Interior, Fish and Wildlife Service, Telephone conversation, Honolulu, Hawaii, April 1987; and Thane Pratt, Department of Land and Natural Resources, State of Hawaii, Division of Forestry and Wildlife, Personal Interview, Honolulu, Hawaii, May, 1987.

In addition to known habitats of threatened and endangered avifauna, native forest areas with open and closed canopies (above 25% tree cover) offer a great diversity and volume of habitat for forage and are likely to support additional native birds. These forest areas are a "medium" constraint.

Wildlife

<u>Degree of Constraint</u>	<u>Criteria</u>
High	Known habitats and territories of threatened and endangered avifauna.
Medium	Native forests with greater than 25% tree cover and no known habitats.
Low	All remaining areas including sparsely vegetated and range lands, agricultural and urban lands, and barren lava flows.

Constraints



Known habitats and territories of threatened and endangered avifauna.



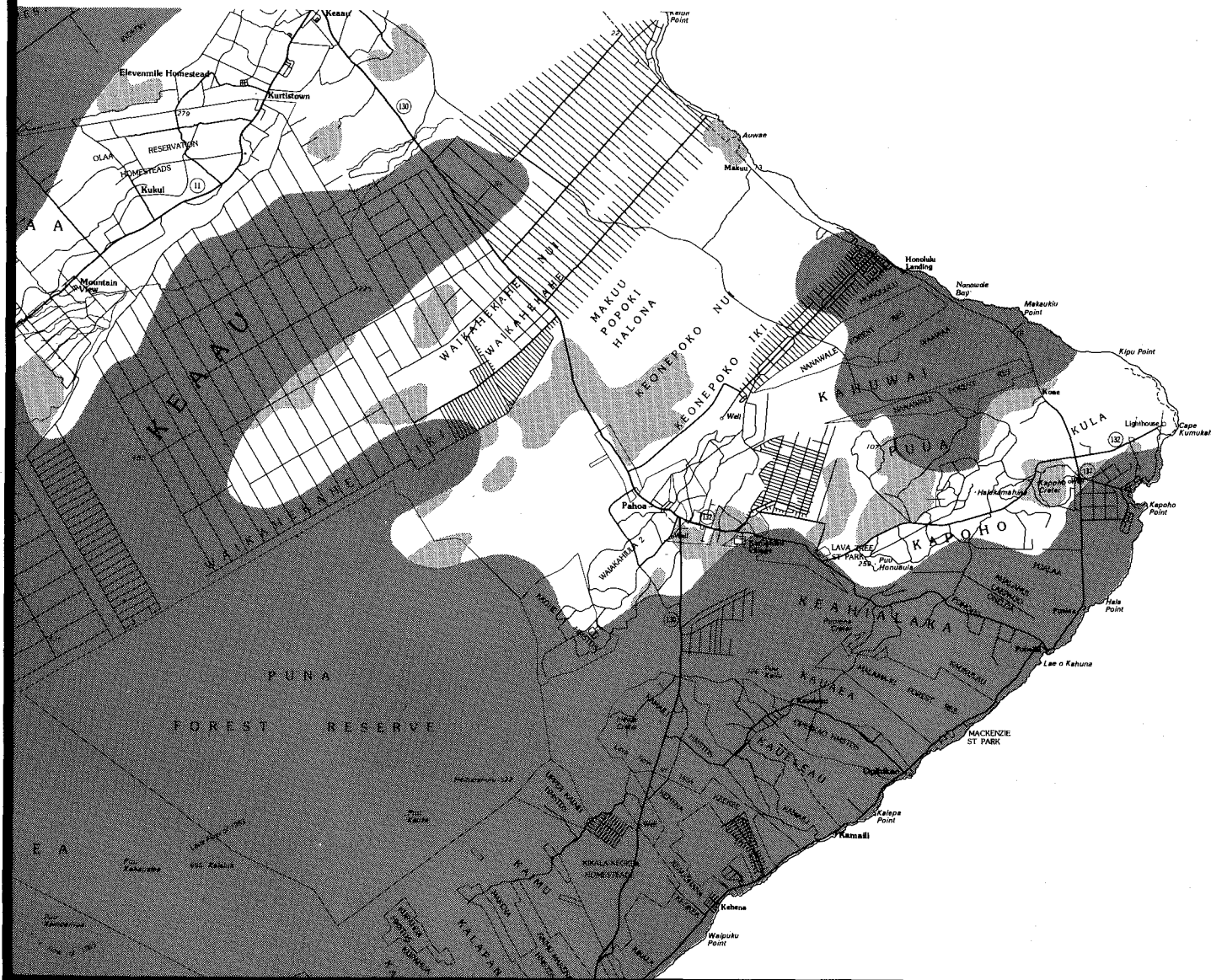
Native forests with greater than 25% tree cover and no known habitats.



All remaining areas.

Source

- U.S. Fish & Wildlife Service, *Hawaiian Hawk Recovery Plan*, 1984.
- U.S.F.W.S., *Jacobi System Vegetation Maps*, Hawaii, Advance Prints, 1979.
- Thane K. Pratt, DLNR, Div. of Forestry & Wildlife, Personal Interview, May 1987.
- *Forest Bird Communities of the Hawaiian Islands: their Dynamics, Ecology and Conservation*, J. Michael Scott, et. al., Cooper Ornithological Society, U. of California, 1986.
- U.S. Fish & Wildlife Service, *Hawaiian Waterbirds Recovery Plan*, 1984.
- William Kramer, U.S. Dept. of the Interior, Fish and Wildlife Service, Telephone Conversation, Honolulu, Hawaii, May 1987.



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PUNA TO KOHALA OVERLAND TRANSMISSION CORRIDOR STUDY

Exhibit II-22

WILDLIFE: Puna Section



0 1 2 3 4
SCALE IN MILES

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**PUNA TO
KOHALA
OVERLAND
TRANSMISSION
CORRIDOR
STUDY**

Exhibit II-23
**WILDLIFE:
Hilo Section**

Constraints

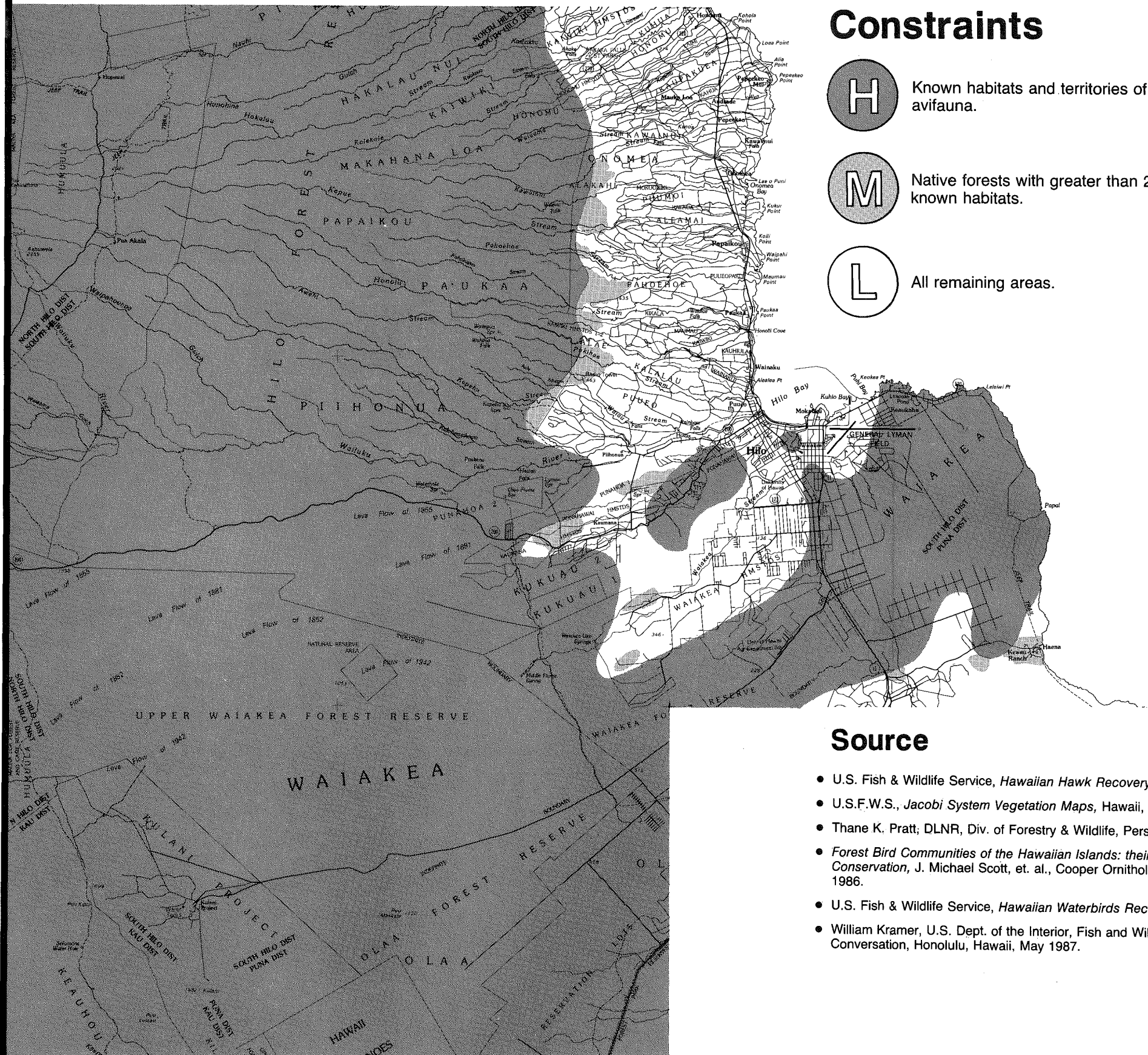
- H** Known habitats and territories of threatened and endangered avifauna.
- M** Native forests with greater than 25% tree cover and no known habitats.
- L** All remaining areas.

Source

- U.S. Fish & Wildlife Service, *Hawaiian Hawk Recovery Plan*, 1984.
- U.S.F.W.S., *Jacobi System Vegetation Maps*, Hawaii, Advance Prints, 1979.
- Thane K. Pratt, DLNR, Div. of Forestry & Wildlife, Personal Interview, May 1987.
- *Forest Bird Communities of the Hawaiian Islands: their Dynamics, Ecology and Conservation*, J. Michael Scott, et. al., Cooper Ornithological Society, U. of California, 1986.
- U.S. Fish & Wildlife Service, *Hawaiian Waterbirds Recovery Plan*, 1984.
- William Kramer, U.S. Dept. of the Interior, Fish and Wildlife Service, Telephone Conversation, Honolulu, Hawaii, May 1987.



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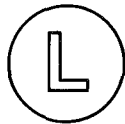
Constraints



Known habitats and territories of threatened and endangered avifauna.



Native forests with greater than 25% tree cover and no known habitats.



All remaining areas.

Source

- U.S. Fish & Wildlife Service, *Hawaiian Hawk Recovery Plan*, 1984.
- U.S.F.W.S., *Jacobi System Vegetation Maps*, Hawaii, Advance Prints, 1979.
- Thane K. Pratt, DLNR, Div. of Forestry & Wildlife, Personal Interview, May 1987.
- *Forest Bird Communities of the Hawaiian Islands: their Dynamics, Ecology and Conservation*, J. Michael Scott, et. al., Cooper Ornithological Society, U. of California, 1986.
- U.S. Fish & Wildlife Service, *Hawaiian Waterbirds Recovery Plan*, 1984.
- William Kramer, U.S. Dept. of the Interior, Fish and Wildlife Service, Telephone Conversation, Honolulu, Hawaii, May 1987.

HAWAII DEEP WATER CABLE PROGRAM

PUNA TO KOHALA OVERLAND TRANSMISSION CORRIDOR STUDY

Exhibit II-24

WILDLIFE: Hamakua Section



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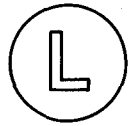
Constraints



Known habitats and territories of threatened and endangered avifauna.



Native forests with greater than 25% tree cover and no known habitats.



All remaining areas.

Source

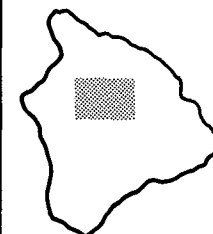
- U.S. Fish & Wildlife Service, *Hawaiian Hawk Recovery Plan*, 1984.
- U.S.F.W.S., *Jacobi System Vegetation Maps*, Hawaii, Advance Prints, 1979.
- Thane K. Pratt, DLNR, Div. of Forestry & Wildlife, Personal Interview, May 1987.
- *Forest Bird Communities of the Hawaiian Islands: their Dynamics, Ecology and Conservation*, J. Michael Scott, et. al., Cooper Ornithological Society, U. of California, 1986.
- U.S. Fish & Wildlife Service, *Hawaiian Waterbirds Recovery Plan*, 1984.
- William Kramer, U.S. Dept. of the Interior, Fish and Wildlife Service, Telephone Conversation, Honolulu, Hawaii, May 1987.



HAWAII DEEP WATER CABLE PROGRAM PUNA TO KOHALA OVERLAND TRANSMISSION CORRIDOR STUDY

Exhibit II-25

WILDLIFE: Saddle Section



0 1 2 3 4
SCALE IN MILES

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3. Socio-Economic Factors: Social and economic factors relate to the human use of land and the effect which a transmission line might have upon the use value of land. This section identifies the major factors which have a relationship to siting major power transmission lines and does not discuss the impacts to society and the economy resulting from the availability of a new electrical power source.

In many cases, socio-economic constraints are explicit in the form of laws, regulations and land use plans. These constraints inherently include areas of human density. In other cases, where there is a perceived notion of property value losses or of health and safety hazards, these concerns must be identified and accommodated during final corridor identification as well as during detailed alignment investigations.

a. Recreation

Recreational land uses pose varying constraints depending on the intensity of use, the type of activity and the physical features of the natural environment. The 1980 State Recreation Plan²¹ includes inventories of all recreation facilities and areas in the State. It describes the types of use and what is expected in the future. As such, it is extremely useful for transmission line alignment planning and it serves as the basis for this report's analysis of constraints related to recreation. The Plan's ratings for intensity of use are adopted here as follows: High and moderate intensities of use are considered to be "high" constraints; medium and low intensities of use are considered to be "medium" constraints.

"High" constraint recreation areas involve active and often urban or high-frequency use. Typical recreation areas of this kind include beach parks, state parks, boat harbors, or areas where there are special natural or cultural resources. Waipio Valley Lookout, Akaka Falls State Park, and Lava Tree State Monument are examples of high constraint recreation areas in the study region.

21. Department of Land and Natural Resources, State of Hawaii, State Recreation Plan, Technical Reference Document, Honolulu, Hawaii, September, 1980.

Dan Quinn, State of Hawaii Parks Division, stated in a May 1987 telephone conversation that the 1980 Recreation Plan maps were the most recent ones completed and that with the increased population since 1980 there would be increased use of the State Parks.

"Medium" constraint recreation areas include "back country" or naturally pristine lands where the use is dispersed or "controlled" and where nature or solitude may be enjoyed. Numerous forest reserves in the study area are included as "medium" constraint.

Recreation

<u>Degree of Constraint</u>	<u>Criteria</u>
High	High and moderate recreation use.
Medium	Medium and low recreation use.
Low	All remaining areas.

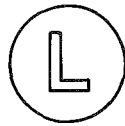
Constraints



High and moderate recreation use.



Medium and low recreation use.



All remaining areas.

Source

- DLNR, *State Recreation Plan, Technical Reference Document*, Honolulu, Hawaii, Sept. 1980.

HAWAII DEEP WATER CABLE PROGRAM PUNA TO KOHALA OVERLAND TRANSMISSION CORRIDOR STUDY

Exhibit II-26 RECREATION: Puna Section

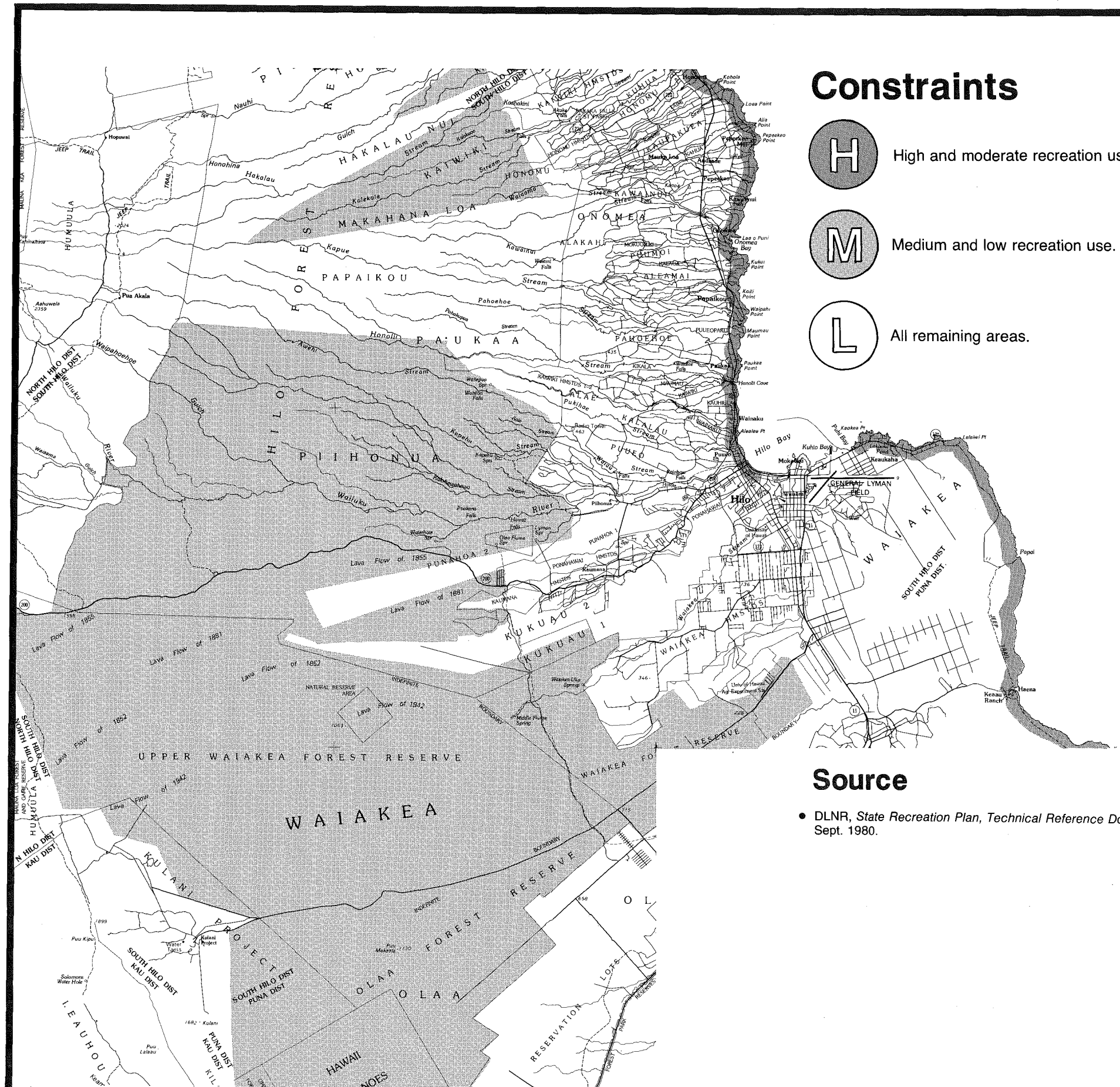


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Constraints

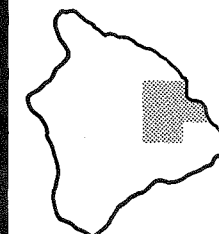
- H** High and moderate recreation use.
- M** Medium and low recreation use.
- L** All remaining areas.



Source

- DLNR, *State Recreation Plan, Technical Reference Document*, Honolulu, Hawaii, Sept. 1980.

Exhibit II-27
**RECREATION:
Hilo Section**



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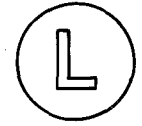
Constraints



High and moderate recreation use.



Medium and low recreation use.



All remaining areas.

Source

- DLNR, *State Recreation Plan, Technical Reference Document*, Honolulu, Hawaii, Sept. 1980.

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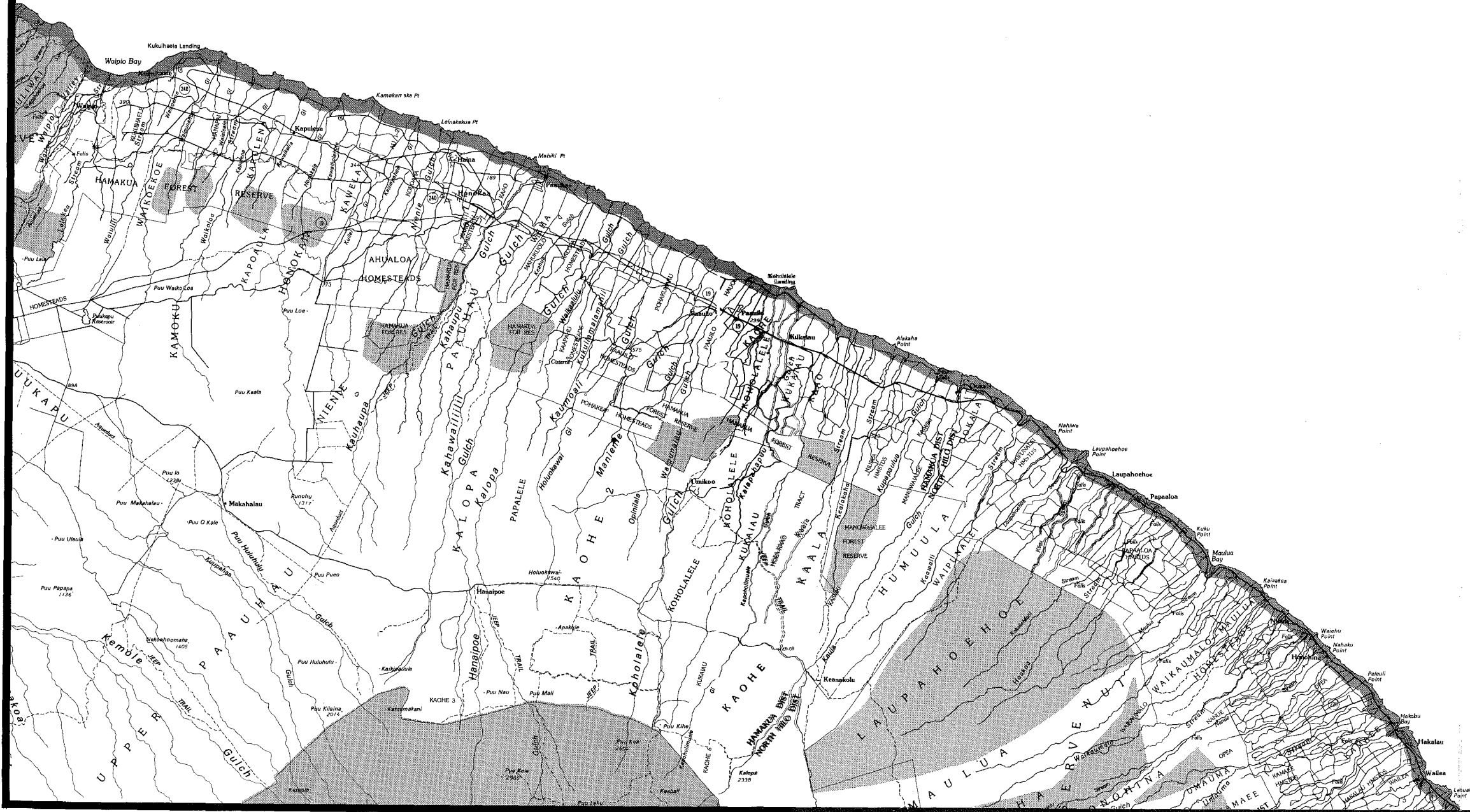


Exhibit II-28

RECREATION: Hamakua Section



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Constraints



High and moderate recreation use.



Medium and low recreation use.



All remaining areas.

Source

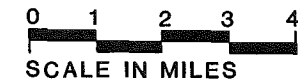
- DLNR, *State Recreation Plan, Technical Reference Document*, Honolulu, Hawaii, Sept. 1980.

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PUNA TO KOHALA OVERLAND TRANSMISSION CORRIDOR STUDY



Exhibit II-29
**RECREATION:
Saddle Section**



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b. Land Use

For the purpose of this report, land use is represented by the districts designated by the State Land Use Commission (LUC); Urban, Rural, Agricultural and Conservation.²² The counties prepare general land use plans for all districts in conformance with the basic intent of the State land use laws, and zone in more detail the urban and rural districts. A review of County Plan and zoning designations should be done during more refined alignment analyses.

Transmission lines can be constructed and maintained to avoid harm to, and minimize interference with, the human use of land. Still, transmission lines are frequently perceived to be unsightly and hazardous intrusions into areas which are intensively used. Experience in Hawaii and elsewhere has shown that there is often strong public opposition to transmission lines through such areas.

In this report, urban and rural areas are classified as a "high" constraint for the location of transmission lines because they receive intense human use. Residential neighborhoods and resort areas are the most sensitive. Industrial areas are of somewhat less concern because in many cases industrial activity may be more compatible with electrical transmission line corridors.

Lands in agricultural use are not as intensively used and are considered to represent a "medium" constraint. Most of the agricultural land in the study area is used for cattle grazing and sugarcane production, and some diversified crop production.

There are small (1 to 5 acre) agricultural lots in the study area, particularly in Puna, which are used primarily for residential purposes. In this "Land Use" section, these lots are evaluated as an agricultural use because they are in the State Agricultural District and because of the low density of housing. However, their residential character is a consideration in the Land Ownership (p. 60) and Land Value (p. 85) sections.

22. Land Use Commission, State of Hawaii, Land Use District maps, Honolulu, Hawaii, 1987.

Conservation is a passive land use and thus lands in the Conservation District have a "low" constraint in this section. These lands are important for the support of human activity, however, the values which make them important for purposes such as groundwater recharge, wildlife habitats, etc., have been considered as constraint factors in themselves.

Land Use

<u>Degree of Constraint</u>	<u>Criteria</u>
High	Urban and Rural State Land Use Districts.
Medium	Agricultural State Land Use District.
Low	Conservation State Land Use District.

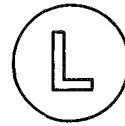
Constraints



Urban and Rural State Land Use Districts.



Agricultural State Land Use District.



Conservation State Land Use District.

Source

- State Land Use Commission, *Land Use District Boundaries*.

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Exhibit II-30

LAND USE: Puna Section



0 1 2 3 4
SCALE IN MILES




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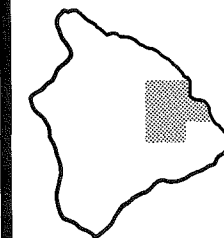
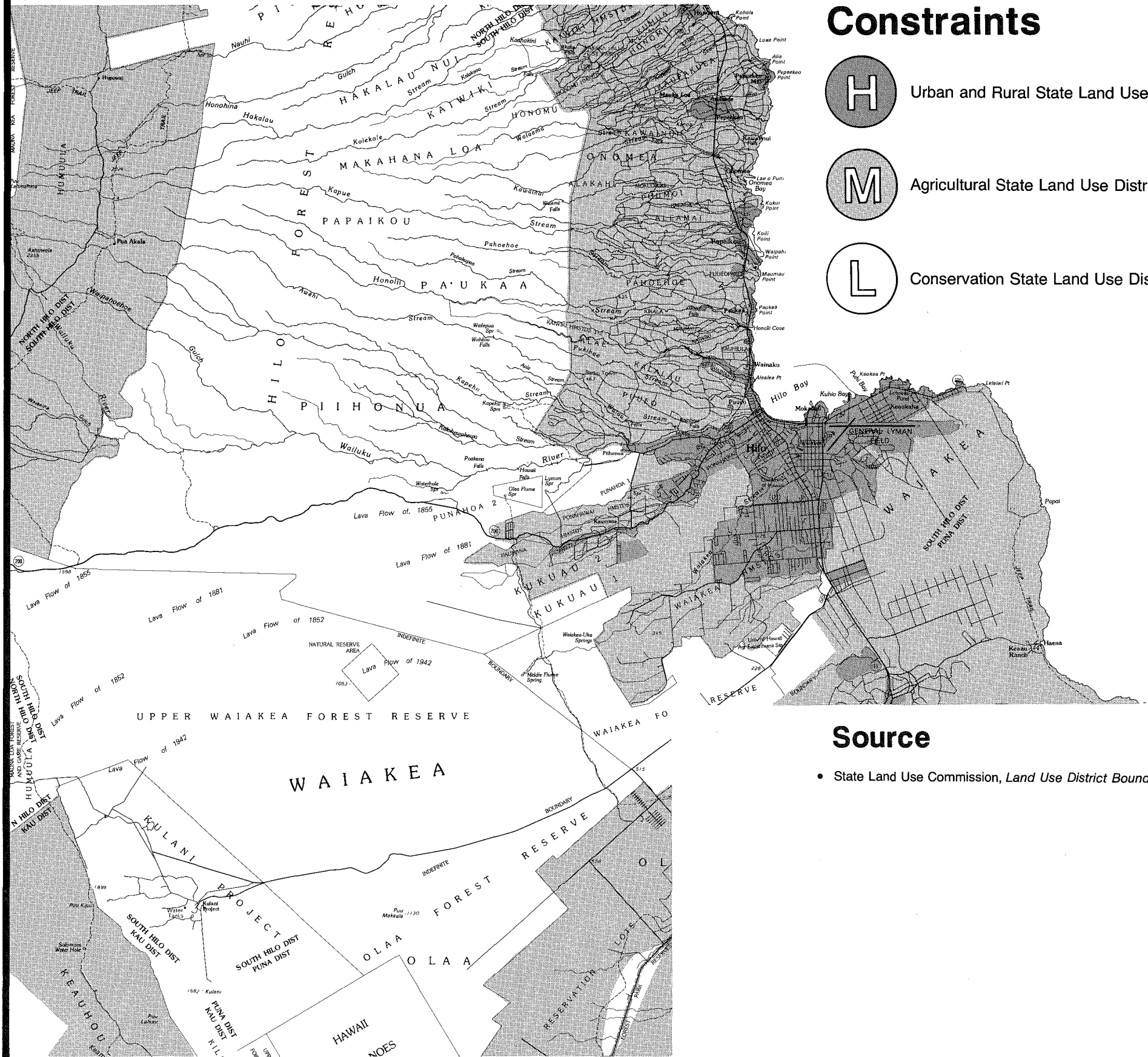
Exhibit II-31
**LAND USE:
Hilo Section**

Constraints

-  Urban and Rural State Land Use Districts.
-  Agricultural State Land Use District.
-  Conservation State Land Use District.

Source

- State Land Use Commission, *Land Use District Boundaries*.



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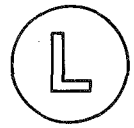
Constraints



Urban and Rural State Land Use Districts.



Agricultural State Land Use District.



Conservation State Land Use District.

Source

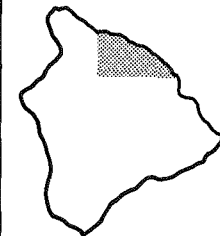
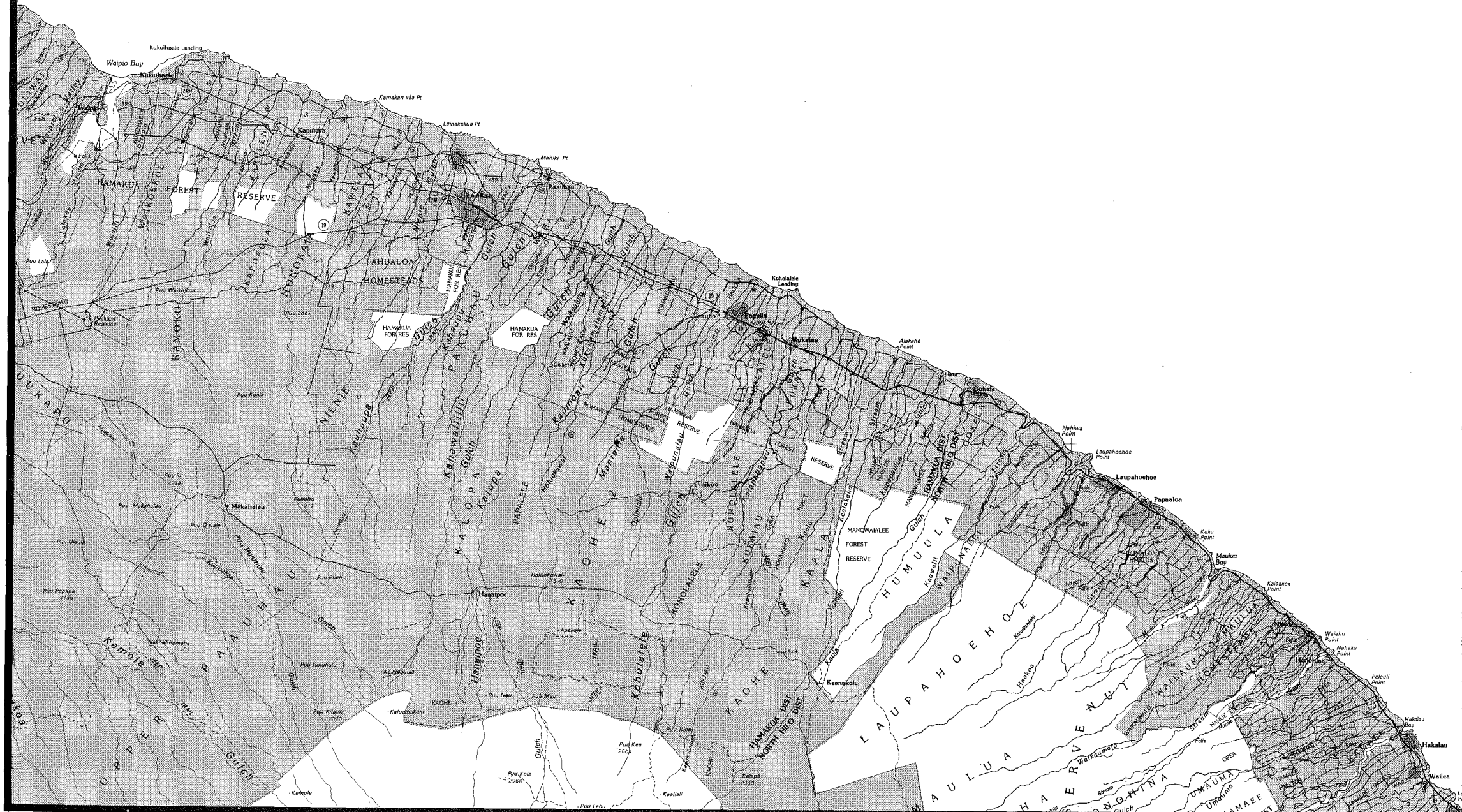
- State Land Use Commission, *Land Use District Boundaries*.

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PUNA TO KOHALA OVERLAND TRANSMISSION CORRIDOR STUDY

Exhibit II-32

LAND USE: Hamakua Section

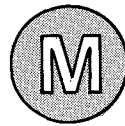


DHM Planners inc.

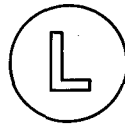
Constraints



Urban and Rural State Land Use Districts.



Agricultural State Land Use District.



Conservation State Land Use District.

Source

• State Land Use Commission, *Land Use District Boundaries*.

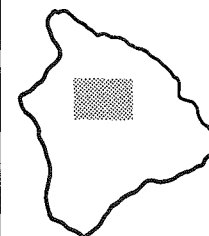


HAWAII DEEP WATER CABLE PROGRAM

PUNA TO KOHALA OVERLAND TRANSMISSION CORRIDOR STUDY

Exhibit II-33

LAND USE: Saddle Section



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c. Transportation and Utilities

In a previous transmission line corridor study,²³ existing transportation and utility rights-of-way were identified because they potentially offered space for 138 kVac lines. During the present analysis, transportation and utility rights-of-way were initially considered. However, these are not presented on maps as data factors because the typical 135-foot wide right-of-way for 300 kVdc lines tends to be wider than existing utility rights-of-way. Therefore, entirely new corridors or significant additions to existing rights-of-way are required. They could be either adjacent to or separate from existing transportation or utility routes.

Because there is no official policy or stated objective encouraging lines to be placed together in a so-called "energy corridor"²⁴ on Hawaii, the locations of existing utility rights-of-way were not considered a factor when identifying a corridor for the potential 300 kVdc line. However, with the number of new transmission lines currently under construction or in the planning stages, the location of existing utility rights-of-way will be an important consideration during alignment selection for the HVDC overhead line. The projected potential for geothermal development in Puna, plus the electrical load growth on the Kona coast, may require additional cross-island transmission lines across lands in the study area of this report.

Major transmission lines in, or proposed for, the study area include the following:

Existing: 69 kVac	Kaumana - Keamuku
Under construction: 138 kVac	Kaumana - Keamuku
Potential: a 2nd 138 kVac	Kaumana - Keamuku
Proposed: Two 69 kVac	Pohoiki - Keaau
Potential: 300 kVdc	Puna - Mahukona

23. EDAW inc., Transmission Line Routing Study: Kaumana to Keamuku, 138 KV Line for Hawaii Electric Light Company, Inc., Honolulu, Hawaii, February, 1983.

24. "Energy corridor" as defined in the glossary of this report. Although Ch. 277 HRS authorizes the establishment of energy corridors, as defined in the law, it does not require their establishment.

d. Land Ownership

Land ownership is an important factor when a utility company must acquire rights-of-way for transmission lines.

Generally, the impacts are greater where small parcels are held by numerous owners as opposed to situations where large parcels are held by few owners. The more property owners which the utility company must deal with in acquiring the easement, the more complicated the procedural requirements. Thus, the number of land owners within a proposed easement exacts a public cost. Also where small parcels are concerned, a 135-foot right-of-way could easily bisect the parcel and create small, irregular remnants which would restrict potential uses. For these reasons, private lands and Hawaiian Home Lands of 10 acres or less in size, and private lands zoned for 10 acres or less are considered to have a "high" constraint. These lands occur primarily in and around the City of Hilo and in the Puna District where there are numerous agricultural subdivisions.

Private lands and Hawaiian Home Lands of more than 10 acres, and public lands of 10 acres or less would pose somewhat fewer problems when obtaining rights-of-way. These lands are considered to have "medium" constraint. There is a considerable number of private and Hawaiian Home Lands parcels greater than 10 acres in the study area particularly on the northern slopes of Mauna Kea. For Hawaiian Home Lands, public utility companies may acquire renewable easement licenses for terms not to exceed 21 years.²⁵ Easements through small (10 acres or less) parcels of public land may be more difficult to acquire than through large public parcels because of existing leases and uses such as agricultural, residential, or other activities.

Public lands in tracts greater than 10 acres generally offer the least constraint to right-of-way acquisition. They are usually not used intensively but may be held as watersheds, forest reserves, grazing lands or military training areas. These lands are "low" in terms of land ownership constraints.

25. Department of Hawaiian Home Lands, State of Hawaii, Hawaiian Homes Commission Act, 1920, (this is the Act of July 9, 1921; 42 STAT.108 as amended through June 1977), Honolulu, Hawaii, no date.

Land Ownership

<u>Degree of Constraint</u>	<u>Criteria</u>
High	Private land and Hawaiian Home Lands parcels of 10 acres or less in size; private land zoned for 10 acres or less.
Medium	Private land and Hawaiian Homes Lands parcels of more than 10 acres; public land of 10 acres or less.
Low	Public lands greater than 10 acres.

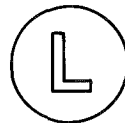
Constraints



Private and Hawaiian Home Lands parcels of 10 acres or less in size; private lands zoned for 10 acres or less.



Private and Hawaiian Home Lands parcels of more than 10 acres; public lands of 10 acres or less.



Public lands greater than 10 acres.

Source

- Real Estate Data, Inc., *Real Estate Atlas of the State of Hawaii*, 1986.
- Hawaii County Planning Department, *Zoning Maps*.



HAWAII DEEP WATER CABLE PROGRAM

PUNA TO KOHALA OVERLAND TRANSMISSION CORRIDOR STUDY

Exhibit II-34

LAND OWNERSHIP: Puna Section



0 1 2 3 4
SCALE IN MILES

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HAWAII
DEEP WATER
CABLE PROGRAM

**PUNA TO
KOHALA
OVERLAND
TRANSMISSION
CORRIDOR
STUDY**

Exhibit II-35

**LAND OWNERSHIP:
Hilo Section**

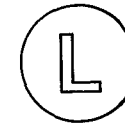
Constraints



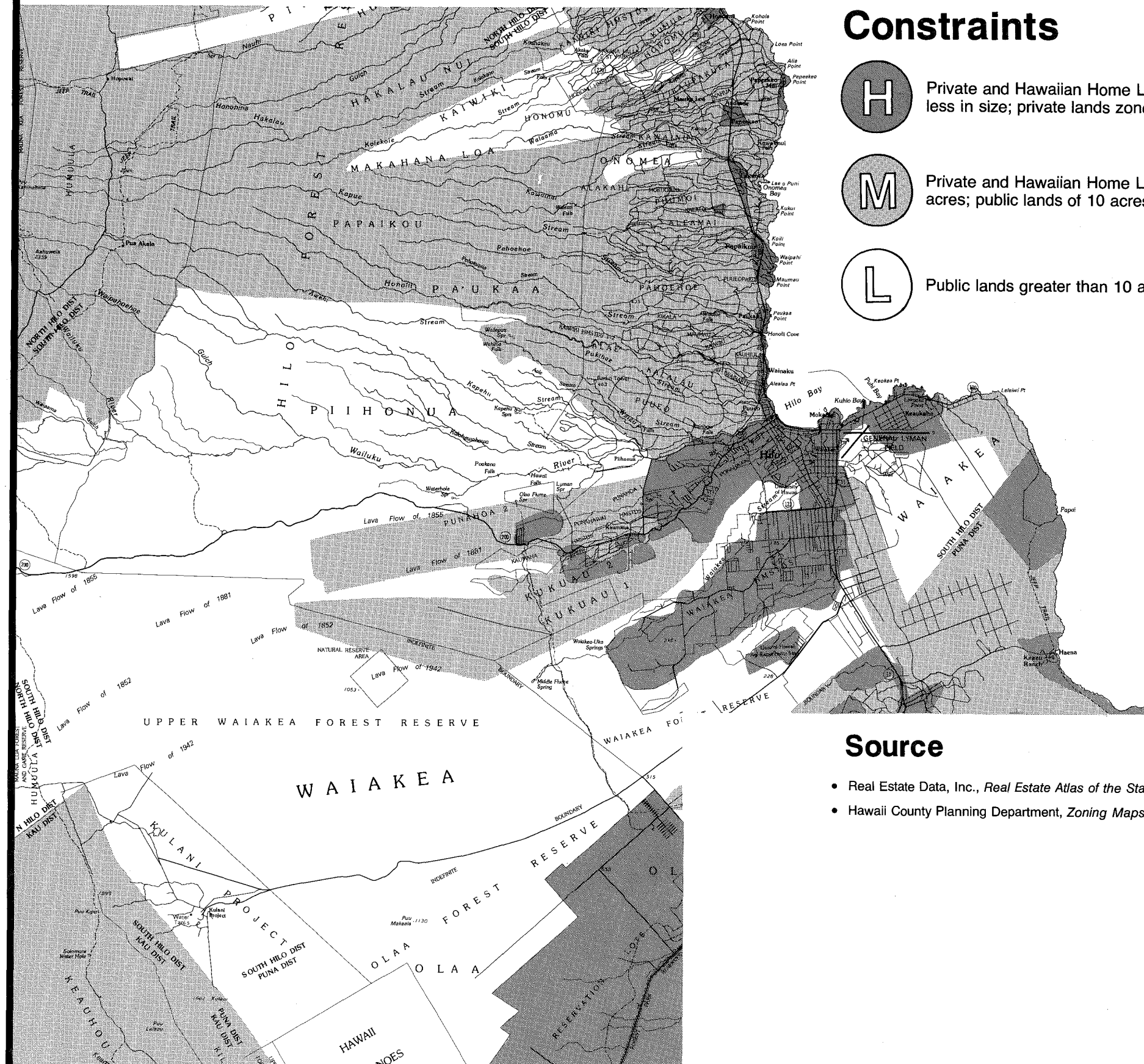
Private and Hawaiian Home Lands parcels of 10 acres or less in size; private lands zoned for 10 acres or less.



Private and Hawaiian Home Lands parcels of more than 10 acres; public lands of 10 acres or less.

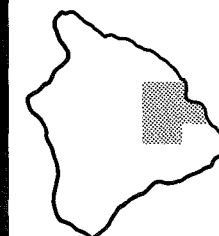


Public lands greater than 10 acres.



Source

- Real Estate Data, Inc., *Real Estate Atlas of the State of Hawaii*, 1986.
- Hawaii County Planning Department, *Zoning Maps*.



DHM Planners inc.

Constraints



Private and Hawaiian Home Lands parcels of 10 acres or less in size; private lands zoned for 10 acres or less.



Private and Hawaiian Home Lands parcels of more than 10 acres; public lands of 10 acres or less.



Public lands greater than 10 acres.

Source

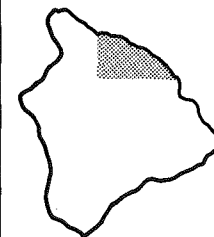
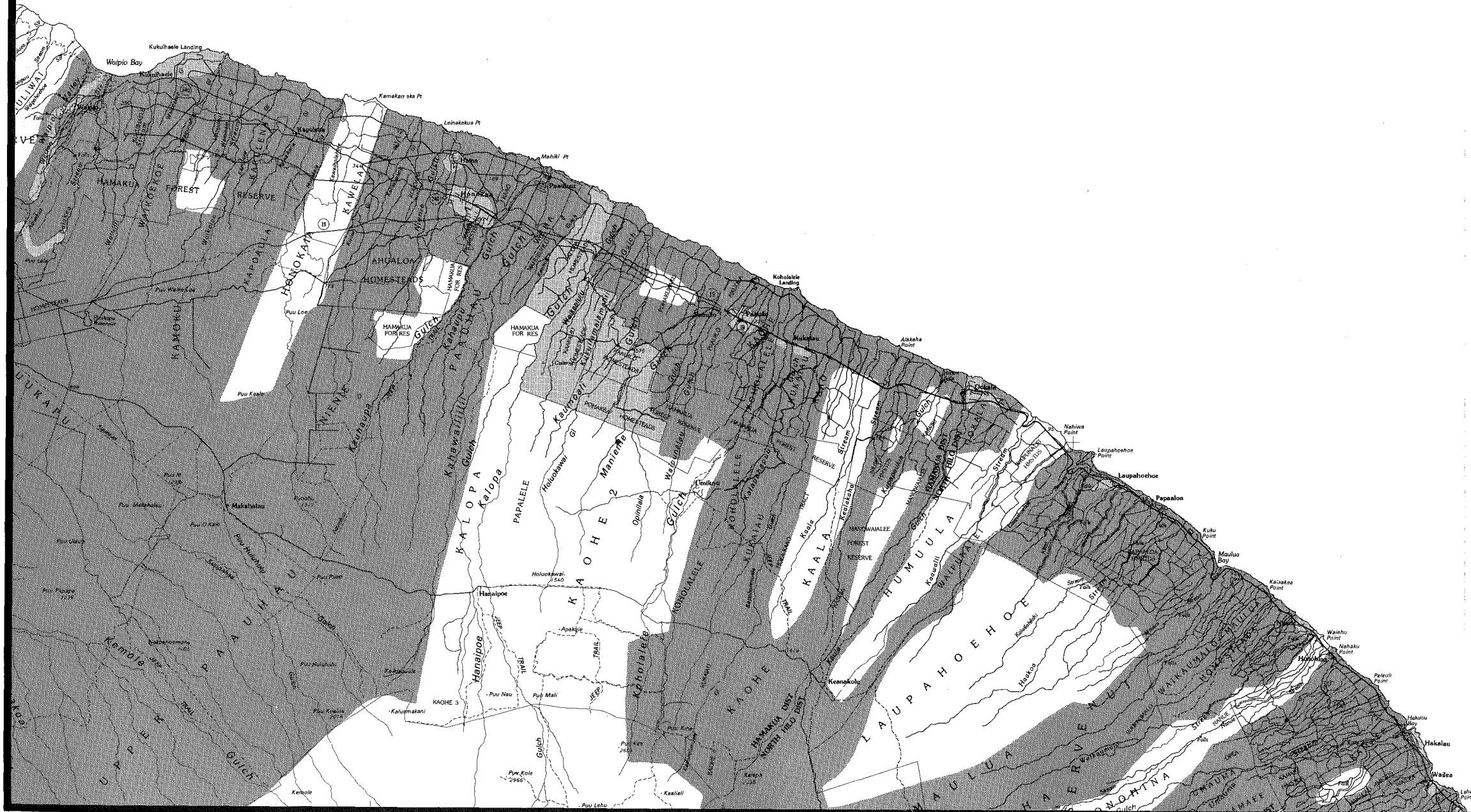
- Real Estate Data, Inc., *Real Estate Atlas of the State of Hawaii*, 1986.
- Hawaii County Planning Department, *Zoning Maps*.

HAWAII DEEP WATER CABLE PROGRAM

PUNA TO KOHALA OVERLAND TRANSMISSION CORRIDOR STUDY

Exhibit II-36

LAND OWNERSHIP: Hamakua Section



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Constraints



Private and Hawaiian Home Lands parcels of 10 acres or less in size; private lands zoned for 10 acres or less.



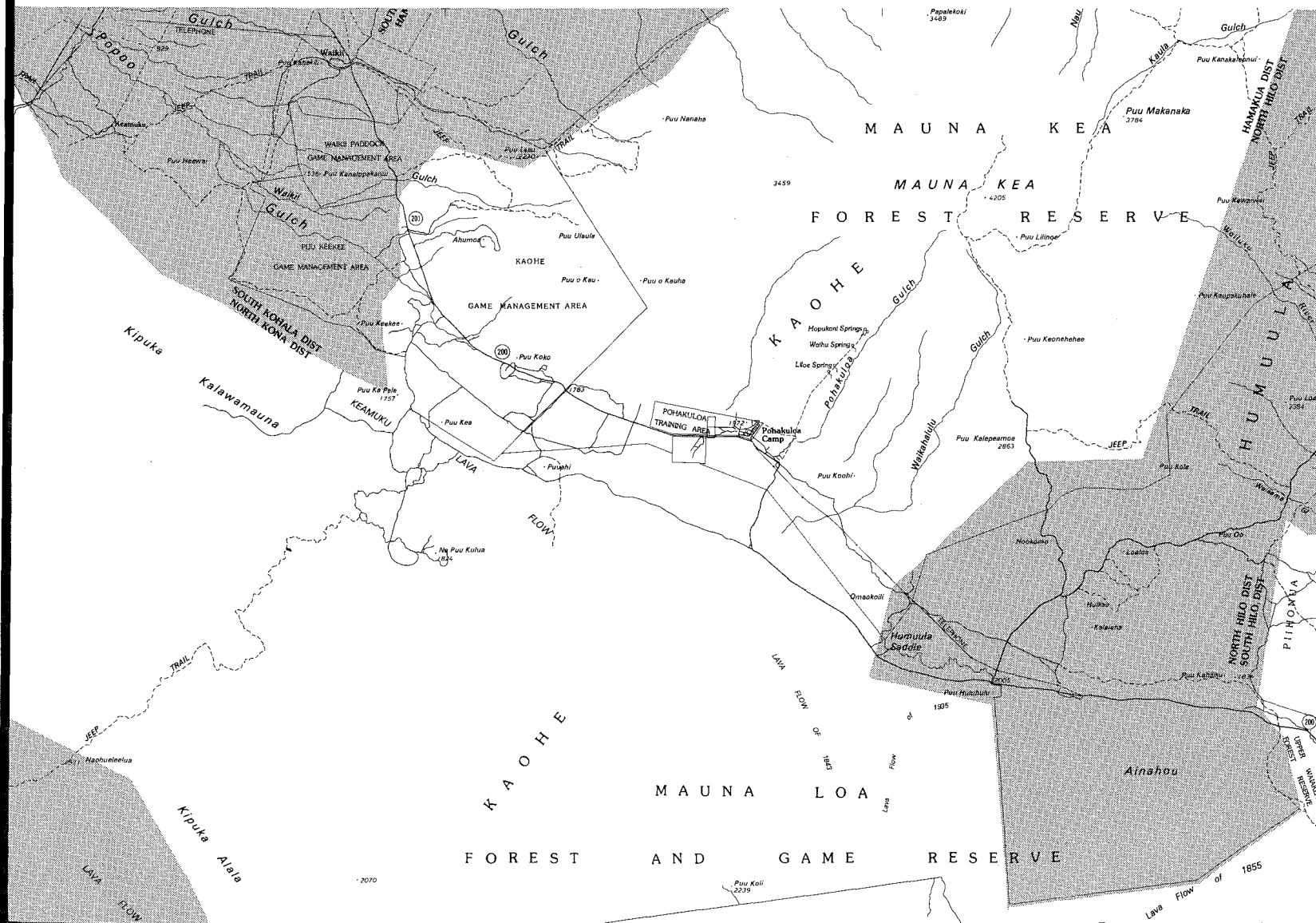
Private and Hawaiian Home Lands parcels of more than 10 acres; public lands of 10 acres or less.



Public lands greater than 10 acres.

Source

- Real Estate Data, Inc., *Real Estate Atlas of the State of Hawaii*, 1986.
- Hawaii County Planning Department, *Zoning Maps*.



HAWAII DEEP WATER CABLE PROGRAM PUNA TO KOHALA OVERLAND TRANSMISSION CORRIDOR STUDY

Exhibit II-37
LAND OWNERSHIP:
Saddle Section



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e. Visual Quality

The proposed 300 kVdc transmission line would be a significant visual intrusion into the environment. The Island of Hawaii does not have transmission lines of the size and scale proposed. In this section, the visual qualities which apply to the study area are described.

Visual quality in the study area is characterized by bright sun and clear skies. The eye tends to be attracted to the coastline, the horizon, ridges mountain tops, and valleys. The relatively smooth and consistent slopes of Mauna Loa and south slopes of Mauna Kea are comprised of open landscapes with little tree cover. These conditions provide excellent visibility with wide, sweeping views from the mountains to the sea. The steeper, north and east slopes of Mauna Kea are more diverse, containing forested and grazing and sugar lands, and many ridges and valleys.

The following criteria for visual constraints are provided as guidelines for use during the broadscale analysis. More specific and sensitive techniques should be applied during alignment selection when specific viewsheds are identified. These criteria are based on the concepts of "distance zones" and "variety classes."²⁶

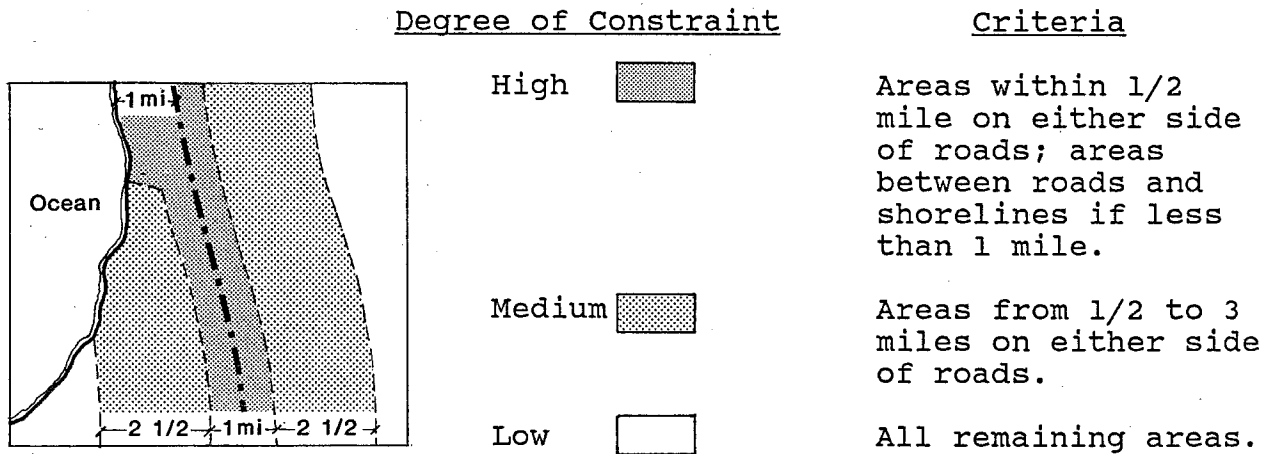
The "foreground" is the visual environment close to the viewer where details of transmission lines and poles can be easily perceived. This "high" constraint area exists within one-half mile on either side of roads and includes all of the area between a road and the shoreline when the distance between the two is less than one mile. The "distinctive" views are those towards the ocean.

The "middleground" is the visual environment where transmission lines and poles would be plainly visible against an open landscape. These "medium" constraint areas exist between one-half and three miles from the viewer. The "common" views are typically those of the rangelands, sugarcane fields, and lava flow areas.

26. Stone, Edward H., II, FASLA, Visual Resource Management, Landscape Architecture Technical Information Series, Vol. 1, No. 2, American Society of Landscape Architects, Washington, D.C., June, 1978, p. 15.

The "background" extends from the "middleground" to infinity, and transmission lines and poles may be seen if the landscape is free of trees and uniform in color or texture. At these distances, visual images such as power poles become small, although the lineal quality of a transmission line may remain distinctive, particularly if the right-of-way is cleared in an otherwise tree-covered area. These are considered areas of "low" constraint where views are "minimal." The vast slopes of Mauna Kea and Mauna Loa fall within this category.

Visual Quality



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CABLE PROGRAM

**PUNA TO
KOHALA
OVERLAND
TRANSMISSION
CORRIDOR
STUDY**

Exhibit II-39

**VISUAL QUALITY:
Hilo Section**

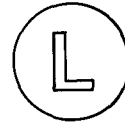
Constraints



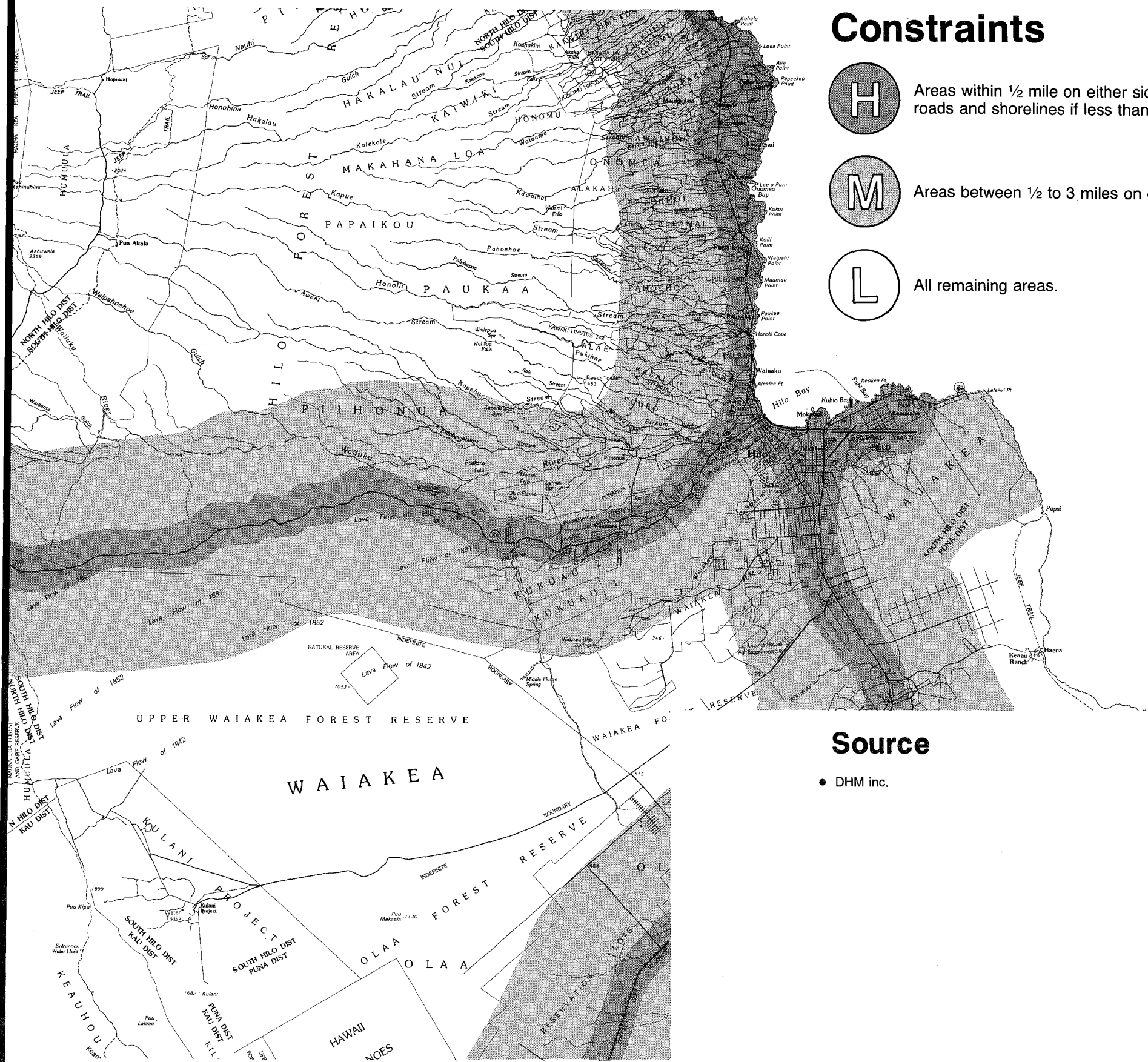
Areas within 1/2 mile on either side of roads; areas between roads and shorelines if less than 1 mile.



Areas between 1/2 to 3 miles on either side of roads.

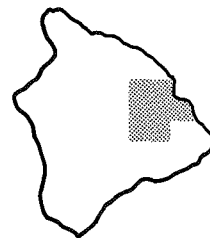


All remaining areas.



Source

- DHM inc.



DHM Planners inc.

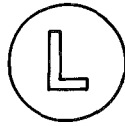
Constraints



Areas within 1/2 mile on either side of roads; areas between roads and shorelines if less than 1 mile.



Areas between 1/2 to 3 miles on either side of roads.



All remaining areas.

Source

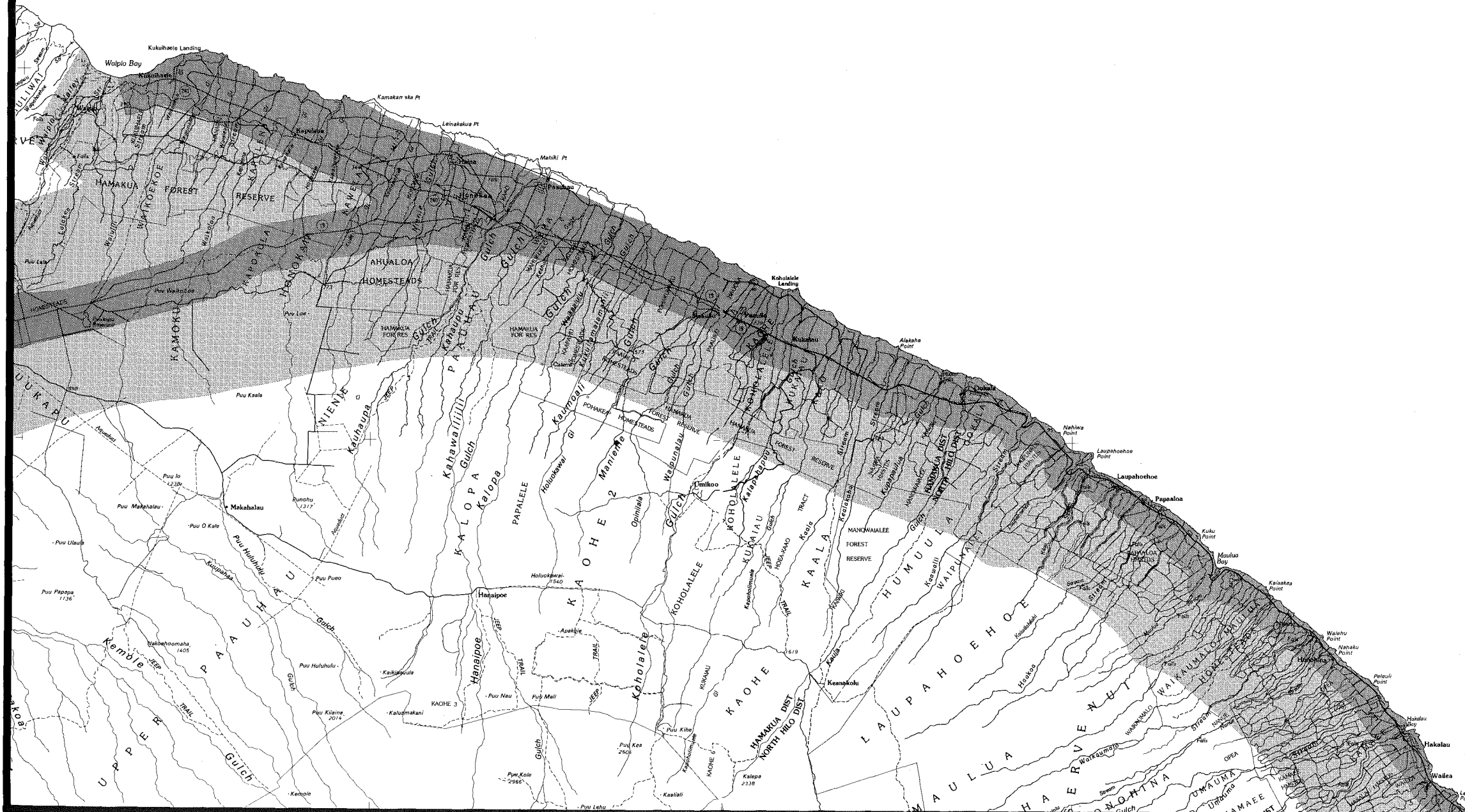
• DHM inc.

HAWAII DEEP WATER CABLE PROGRAM

PUNA TO KOHALA OVERLAND TRANSMISSION CORRIDOR STUDY

Exhibit II-40

VISUAL QUALITY: Hamakua Section



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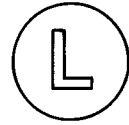
Constraints



Areas within 1/2 mile on either side of roads; areas between roads and shorelines if less than 1 mile.



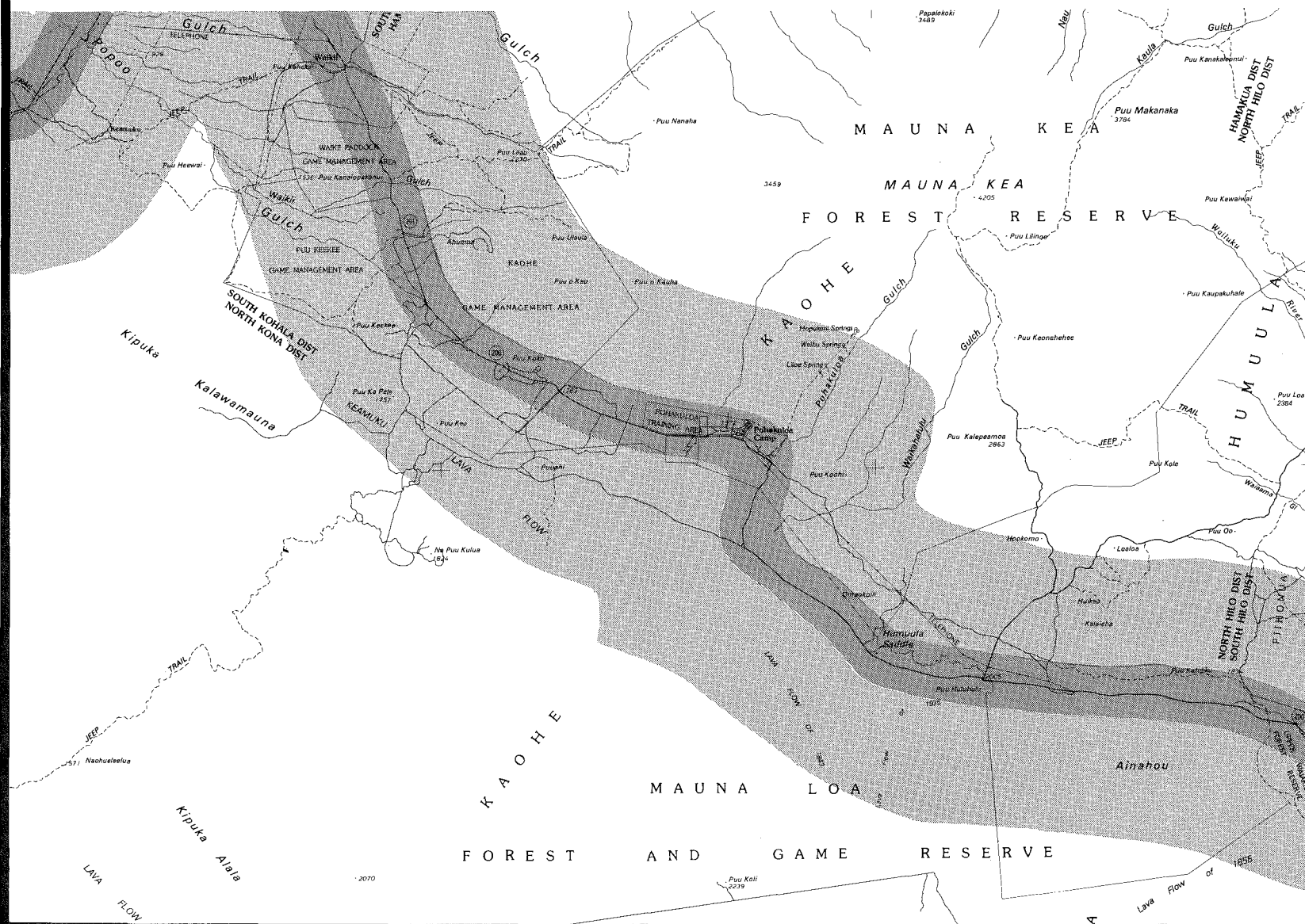
Areas between 1/2 to 3 miles on either side of roads.



All remaining areas.

Source

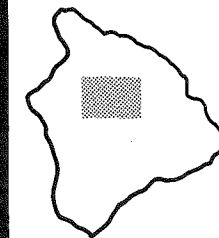
- DHM inc.



HAWAII DEEP WATER CABLE PROGRAM PUNA TO KOHALA OVERLAND TRANSMISSION CORRIDOR STUDY

Exhibit II-41

VISUAL QUALITY: Saddle Section



0 1 2 3 4
SCALE IN MILES

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f. Archaeology and History

The construction of a transmission line can damage or detract from the research, cultural and sometimes sacred value of archaeological and historic property which lies in or very near its path. In Hawaii, cultural resources predating the arrival of Captain James Cook (and Europeans in general) in 1778 are considered prehistoric because there are no written records of their design or function. Prehistoric sites are not all identified nor is their importance to the history of Hawaii always well understood. They consist primarily of archaeological remains of buildings, structures or objects.

Historic properties, those more recent than 1778, are often documented in writing and well-described or even intact. They tend to occur along roads or in settlements such as small towns.

For archaeology and history concerns, areas of high constraint include:

- (1) Sites from both prehistoric and historic periods which have been located, described and assigned a site number by the State Historic Preservation Office (including those on the Register of Historic Places). The major areas of historic interest include the towns of Hilo, Keaau, Pahoia, Honokaa and other former sugar plantation towns and camps whose location and historic characteristics are well-defined.²⁷

Many sites (primarily prehistoric) are very small in size relative to the detail of the broadscale maps. Where sites are highly concentrated, they are mapped as a cluster. Small single sites are not mapped, but would be identified as a constraint during alignment selection.

- (2) Known areas of high concentrations of cultural resources. The Hilo and Puna coastal areas are known to be rich in features, as are wet river valleys where sites usually reflect self-contained settlements. The sites include highly developed irrigated fields, house platforms

27. The entire towns have been described as historic areas and have been assigned site numbers by the SHPO, although none is on the official State or Federal Registers.

and entire community systems. Waipio Valley in the northern end of the study area is a classic example. At the summit of Mauna Kea was a basalt quarry which furnished the raw material for adzes, a basic woodworking tool of the Hawaiians. Surveys in the Pohakuloa area have indicated a high concentration of caves and trails.

Medium constraint areas include areas which are considered to have the potential to contain sites and to be significant cultural properties, but which have not been fully investigated. In the study area, the uplands encircling Mauna Kea may contain historic sites related to travel to the adze quarries, burials, etc.²⁸ All remaining areas, including areas with known or anticipated medium and low site densities, and fields which have been disturbed or obliterated by sugarcane or pineapple cultivation or lava flows, offer "low" constraints.

Archaeology and History

<u>Degree of Constraint</u>	<u>Criteria</u>
High	Known areas of high concentrations of cultural resources including coastal areas, wet river valleys, certain upland areas, and all cultural resources on the State or Federal Register of Historic Places.
Medium	Areas where high concentrations of sites are anticipated but have not been previously investigated in detail.
Low	All remaining areas.

 28. Department of Land and Natural Resources, State of Hawaii, Division of State Parks, Outdoor Recreation, and Historic Sites, Ross Cordy, Personal Interview, Honolulu, Hawaii, May, 1987.

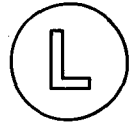
Constraints



Known areas of high concentrations of cultural resources; cultural resources on the Register of Historic Places.



Areas where high concentrations of sites are anticipated.



All remaining areas.

Source

- DLNR, Division of State Parks, Outdoor Recreation & Historic Sites, *The Hawaii National Register of Historic Places*.
- Ross Cordy, Archaeologist with Div. of State Parks, Outdoor Recreation & Historic Sites, Interview, May 1987.

HAWAII DEEP WATER CABLE PROGRAM

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Exhibit II-42

ARCHAEOLOGY AND HISTORY: Puna Section



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Exhibit II-43
**ARCHAEOLOGY
AND HISTORY:
Hilo Section**

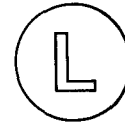
Constraints



Known areas of high concentrations of cultural resources; cultural resources on the Register of Historic Places.



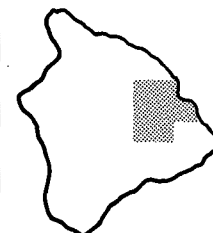
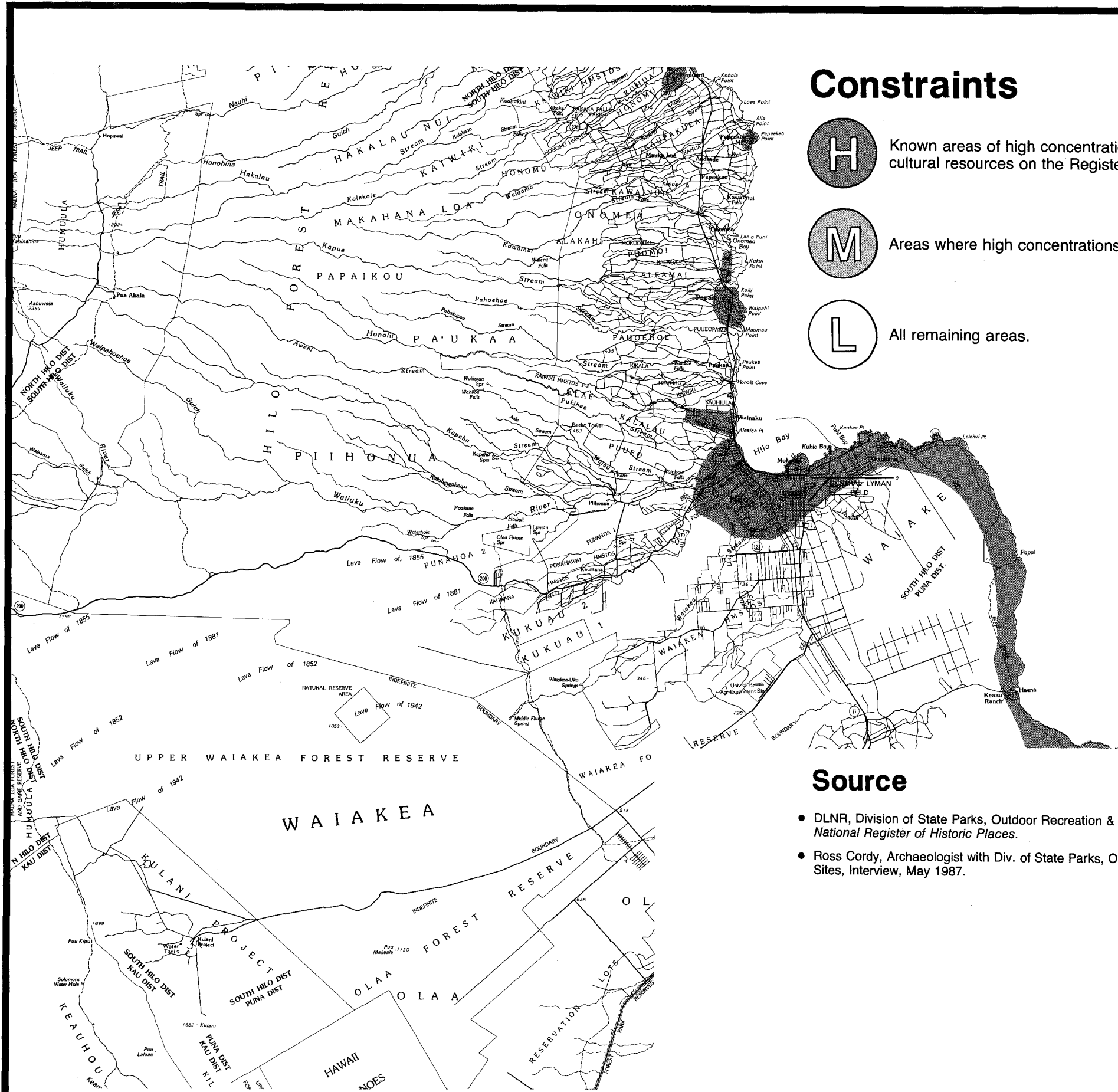
Areas where high concentrations of sites are anticipated.



All remaining areas.

Source

- DLNR, Division of State Parks, Outdoor Recreation & Historic Sites, *The Hawaii/ National Register of Historic Places.*
- Ross Cordy, Archaeologist with Div. of State Parks, Outdoor Recreation & Historic Sites, Interview, May 1987.



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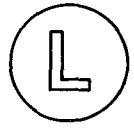
Constraints



Known areas of high concentrations of cultural resources; cultural resources on the Register of Historic Places.



Areas where high concentrations of sites are anticipated.



All remaining areas.

Source

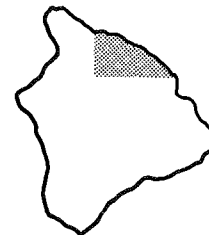
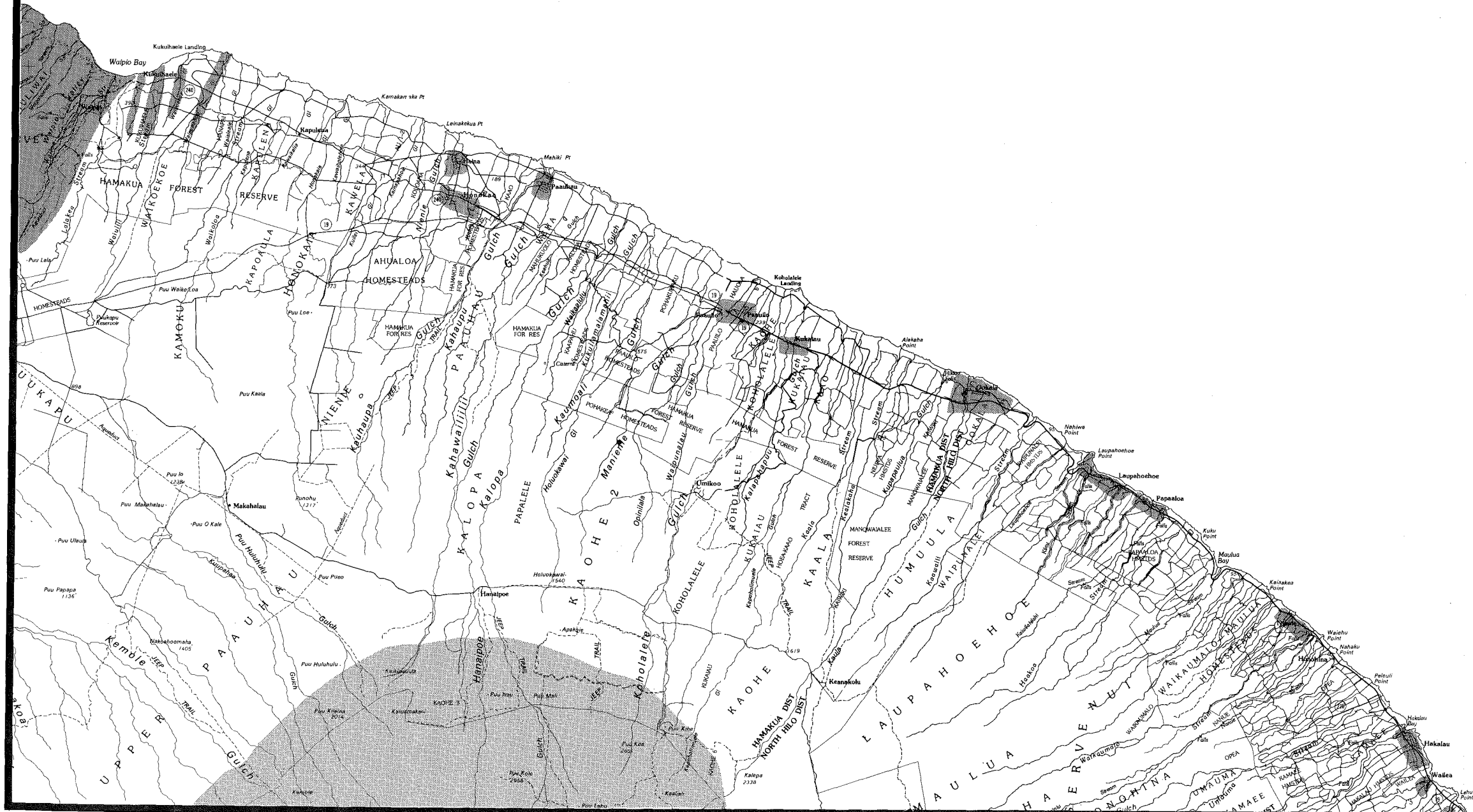
- DLNR, Division of State Parks, Outdoor Recreation & Historic Sites, *The Hawaii National Register of Historic Places*.
- Ross Cordy, Archaeologist with Div. of State Parks, Outdoor Recreation & Historic Sites, Interview, May 1987.

HAWAII DEEP WATER CABLE PROGRAM

PUNA TO KOHALA OVERLAND TRANSMISSION CORRIDOR STUDY

Exhibit II-44

ARCHAEOLOGY AND HISTORY: Hamakua Section



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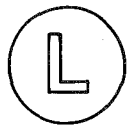
Constraints



Known areas of high concentrations of cultural resources; cultural resources on the Register of Historic Places.



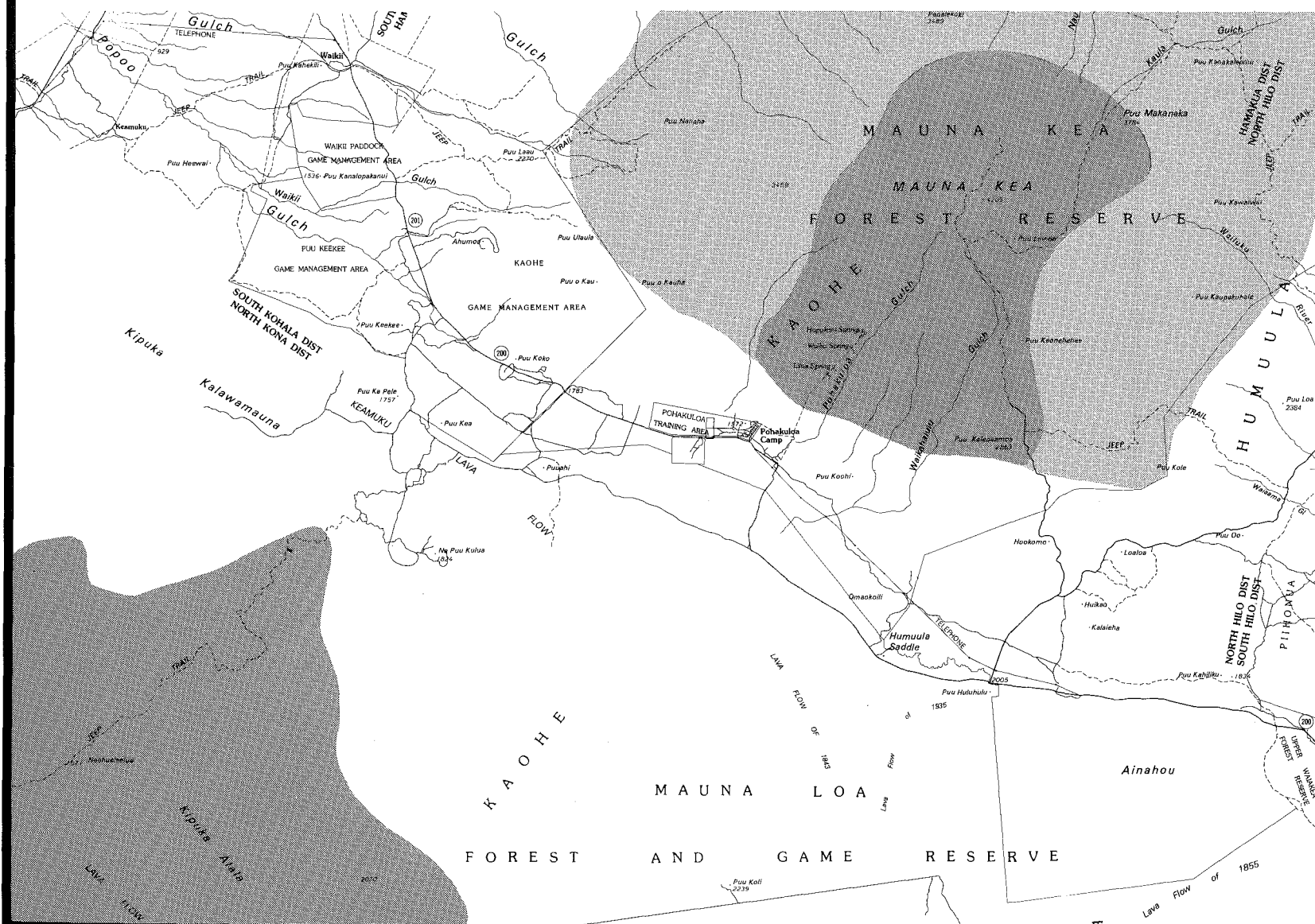
Areas where high concentrations of sites are anticipated.



All remaining areas.

Source

- DLNR, Division of State Parks, Outdoor Recreation & Historic Sites, *The Hawaii National Register of Historic Places*.
- Ross Cordy, Archaeologist with Div. of State Parks, Outdoor Recreation & Historic Sites, Interview, May 1987.

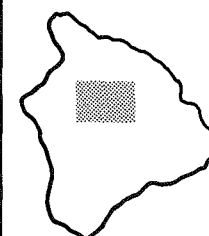


HAWAII DEEP WATER CABLE PROGRAM

PUNA TO KOHALA OVERLAND TRANSMISSION CORRIDOR STUDY

Exhibit II-45

ARCHAEOLOGY AND HISTORY: Saddle Section



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g. Land Regulation

There are areas where the construction of a transmission line would be discouraged by regulatory controls designed to protect special resource values. These regulations are somewhat less restrictive than those which determine the Exclusion Areas. However, extensive reviews by State and County authorities and the public may be anticipated because permits are required for construction in these areas.

The State Conservation District contains several subzones which vary in their degree of restrictiveness. These subzones are briefly described in Exhibit II-46. The Protective Subzone has been previously described as an Exclusion Area; the Limited and Resource Subzones are considered to be "high" constraints; the General Subzone is considered to be a "medium" constraint.

Geothermal Resource Subzones (GRS) are governed under a different statute than Conservation District subzones and they may be designated in any land use district or subzone. The purpose of the GRS is to provide areas for geothermal exploration and development. Because the origin of the 300 kVdc line will be within this subzone, the GRS is considered to be a "low" constraint which overrides the respective constraint of the other Conservation District subzones.

Special Management Areas (SMAs)²⁹ form a band around each island which varies in width (measured inland from the sea) from a minimum distance of 100 yards up to several miles.³⁰ Each County is responsible for administration of the permit system which is used as a vehicle for conformance with Coastal Zone Management policies and guidelines. The purpose of the legislation and permit is "to avoid permanent loss of valuable resources ... and to ensure that adequate public access ... to coastal zone areas is provided."³¹

29. Special Management Areas (SMAs) are derived from the Federal Coastal Zone Management Act of 1972, the State's Shoreline Protection Act of 1975 and Coastal Zone Management (CZM) Act of 1977. (Hawaii Revised Statutes, Chapter 205A, Honolulu, Hawaii).

30. Department of Planning and Economic Development, State of Hawaii, The Hawaii Coastal Zone Management Law, An Assessment, Honolulu, Hawaii, January, 1984, p. 11.

31. Ibid., p. 11.

SMAs are considered a "medium" constraint because major construction is permissible if it provides for public access to the shoreline and if there is no permanent loss of resources.

Land Regulation

<u>Degree of Constraint</u>	<u>Criteria</u>
High	Limited and Resource Subzones of the State Conservation District if not within a Geothermal Resource Subzone.
Medium	General Subzone of the State Conservation District if not within a Geothermal Resource Subzone; Special Management Areas.
Low	All remaining areas.

EXHIBIT II-46

CONSERVATION DISTRICT SUBZONES AND GEOTHERMAL RESOURCE SUBZONES³²

<u>Subzone</u> ^a	<u>Description</u>	<u>Severity of Constraint</u> ^b
Protective ^c	Its purpose is to protect valuable resources (restrictive watersheds, marine, plant, wild-life sanctuaries, significant historic, archaeological, geological and volcanological features and sites).	Exclusion Area
Limited	Its purpose is to limit uses where natural conditions suggest constraints on human activities. Conditions include flood zones; erosion areas; volcanism; 40% or greater slope.	High
Resource	Its purpose is to develop sustained use of the resource such as park lands, timber, outdoor recreation, offshore islands, water bodies.	High
General	Its purpose is to designate open space where urban use would be premature. Includes lands suitable for farming.	Medium
Geothermal Resource	Its purpose is to provide for exploration and use of geothermal energy for the public benefit. Geothermal Resource Subzone may be designated in any Land Use District, and its "low" constraint overrides that of the other subzones.	Low
Special ^d	Its purpose is to provide for areas possessing unique developmental qualities such as Hawaii Loa College; Haka Cemetery; Kapakahi Convalescent Home; Sea Life Park.	n/a

^aFrom top down, ranked in order of most to least restrictive.

^bAs identified in this report with respect to routing a 300 kVdc transmission line.

^cProtective subzones, for the purpose of this report, are considered to be Exclusion Areas and are discussed in that section (p. 11).

^dThere are no Special subzones in the study area.

 32. Department of Land and Natural Resources, State of Hawaii, Title 13, Chapter 2 (Regulation No. 4), Honolulu, Hawaii, June 12, 1981.

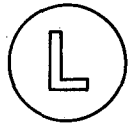
Constraints



Limited and Resource Subzone, excluding Geothermal Resource Subzone.



General Subzone, excluding Geothermal Resource Subzone.



All remaining areas.

Source

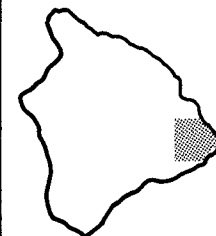
- Dept. of Land & Natural Resources, *Conservation District Subzones*.
- Hawaii County Planning Department, *Special Management Areas*.



HAWAII DEEP WATER CABLE PROGRAM PUNA TO KOHALA OVERLAND TRANSMISSION CORRIDOR STUDY

Exhibit II-47

LAND REGULATION: Puna Section



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CORRIDOR
STUDY**

Exhibit II-48
**LAND REGULATION:
Hilo Section**

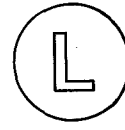
Constraints



Limited and Resource Subzone, excluding Geothermal Resource Subzone.



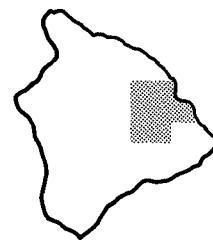
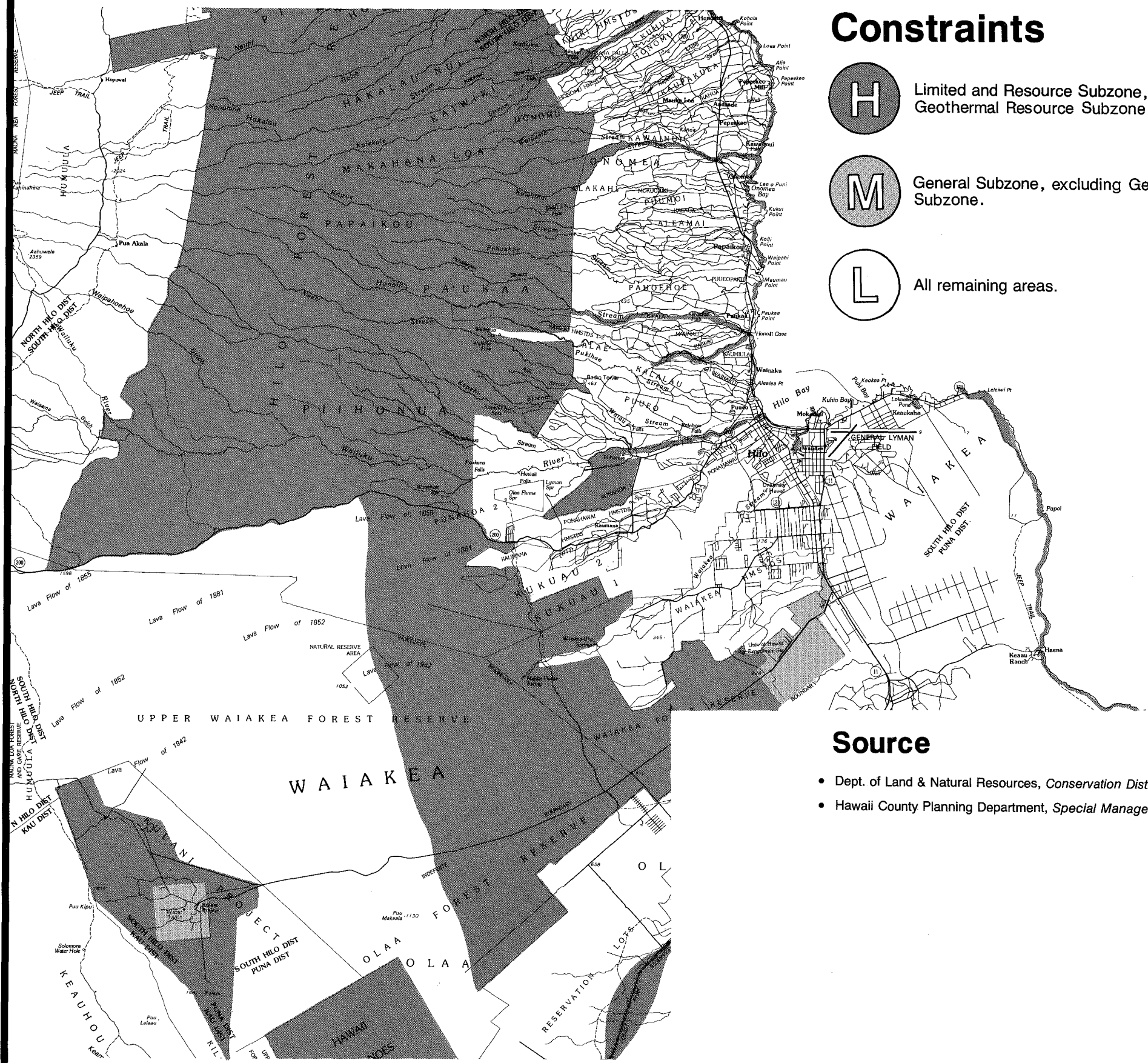
General Subzone, excluding Geothermal Resource Subzone.



All remaining areas.

Source

- Dept. of Land & Natural Resources, *Conservation District Subzones.*
- Hawaii County Planning Department, *Special Management Areas.*



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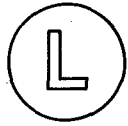
Constraints



Limited and Resource Subzone, excluding Geothermal Resource Subzone.



General Subzone, excluding Geothermal Resource Subzone.



All remaining areas.

Source

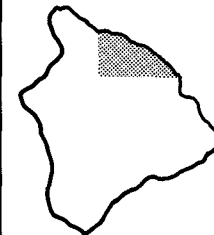
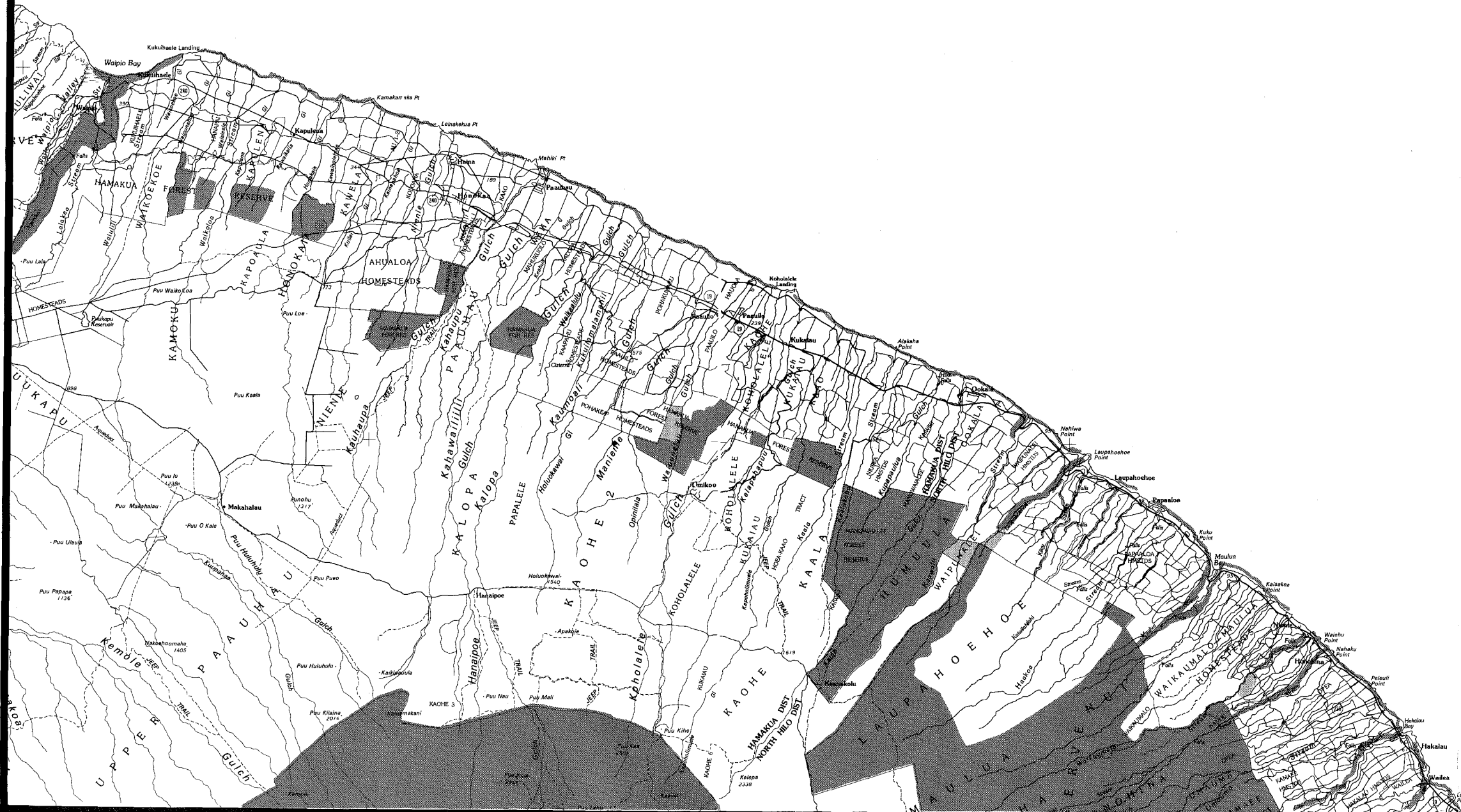
- Dept. of Land & Natural Resources, *Conservation District Subzones.*
- Hawaii County Planning Department, *Special Management Areas.*

HAWAII DEEP WATER CABLE PROGRAM

PUNA TO KOHALA OVERLAND TRANSMISSION CORRIDOR STUDY

Exhibit II-49

LAND REGULATION: Hamakua Section

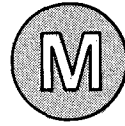


DHM Planners inc.

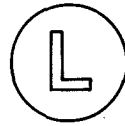
Constraints



Limited and Resource Subzone, excluding Geothermal Resource Subzone.



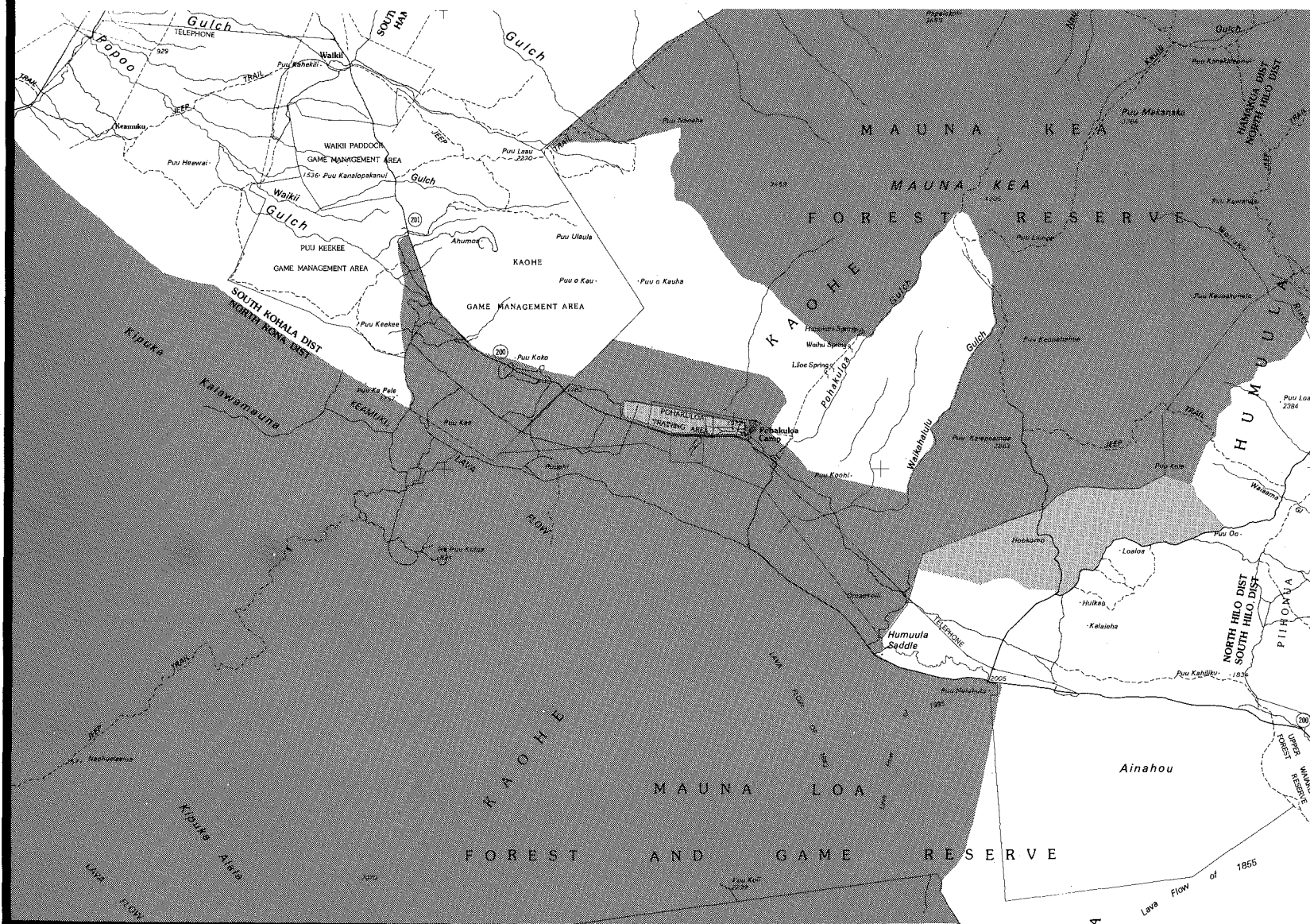
General Subzone, excluding Geothermal Resource Subzone.



All remaining areas.

Source

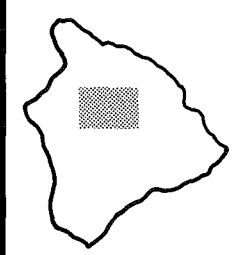
- Dept. of Land & Natural Resources, *Conservation District Subzones*.
- Hawaii County Planning Department, *Special Management Areas*.



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Exhibit II-50 LAND REGULATION: Saddle Section



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4. Cost Factors: In this analysis, the prime elements of cost are identified as land value, maintenance, and access.

a. Land Value

The price of land directly affects transmission line alignments since utility companies must pay for rights-of-way based on an appraised value.

In Hawaii, land values are determined by the land's "highest and best" use which is a function of natural attributes, zoning, and the owner's perceptions. Land values (based on real property assessments) tend to be correlated with the land use district designation made by the State Land Use Commission. Urban District land is the highest value category; Agricultural and Rural land are medium-value; and Conservation land is the lowest value.

Land ownership also influences the cost of a transmission line easement. Large landowners are more likely to provide easements at less cost than small property owners. Private land tends to be more costly than public land, but recently governments have been more exacting in obtaining direct cash returns from public lands. However, since this project supports the State Energy Plan objectives, and the State is financially involved in the HDWCP, costs for easement across public land may be minimal.

Because of these characteristics, all Urban District land, all parcels of 10 acres and less in size, and parcels zoned for lot sizes of 10 acres or less in the Agricultural, Rural, or Conservation Districts, offer "high" constraints. These areas are subdividable and have a greater likelihood of being developed for residential purposes. Such land typically has higher costs. "Medium" constraints are posed by privately held parcels which are more than 10 acres in size and are in Agricultural or Rural Districts. Publicly owned parcels greater than 10 acres and large privately owned parcels in the Conservation District have "low" constraints.

Land Value

Degree of Constraint

Criteria

High

Urban District lands; all parcels of 10 acres or less in size and all lands zoned for 10 acres or less in the Agricultural, Rural or Conservation Districts.

Medium

Private parcels of more than 10 acres in Agriculture or Rural Districts.

Low

All remaining areas.

Constraints



Urban District lands; all parcels of 10 acres or less in size and all lands zoned for 10 acres or less in the Agricultural, Rural or Conservation Districts.



Private parcels of more than 10 acres in Agriculture or Rural Districts.



All remaining areas.

Source

- Real Estate Data, Inc., *Real Estate Atlas of the State of Hawaii*, 1986.
- State Land Use Commission, *Land Use District Boundaries*.
- Hawaii County Planning Department, *Zoning Maps*.

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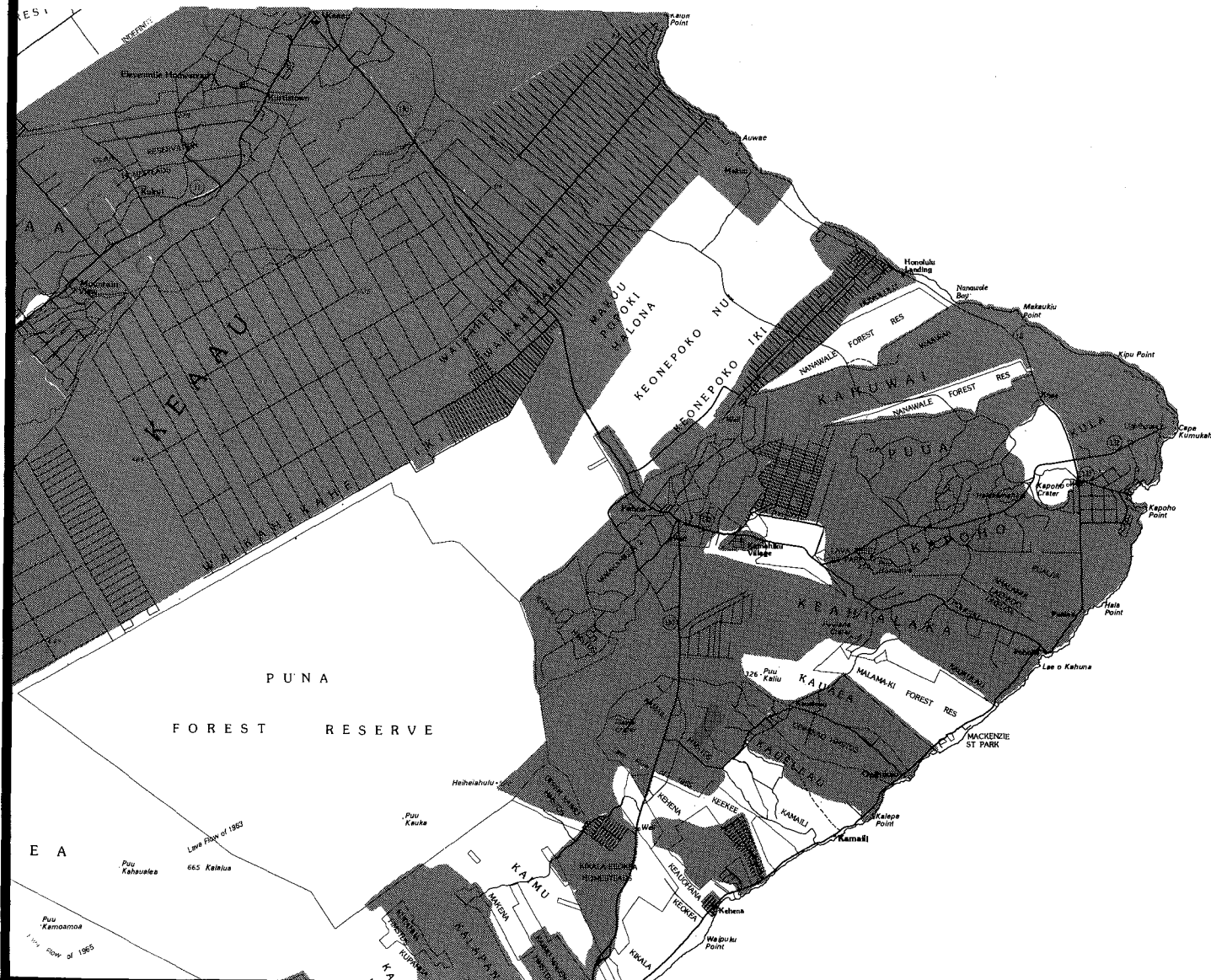
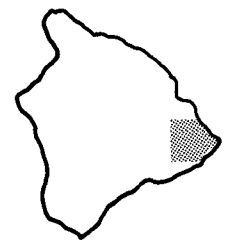


Exhibit II-51
**LAND VALUE:
Puna Section**



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Exhibit II-52
**LAND VALUE:
Hilo Section**

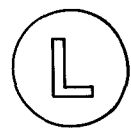
Constraints



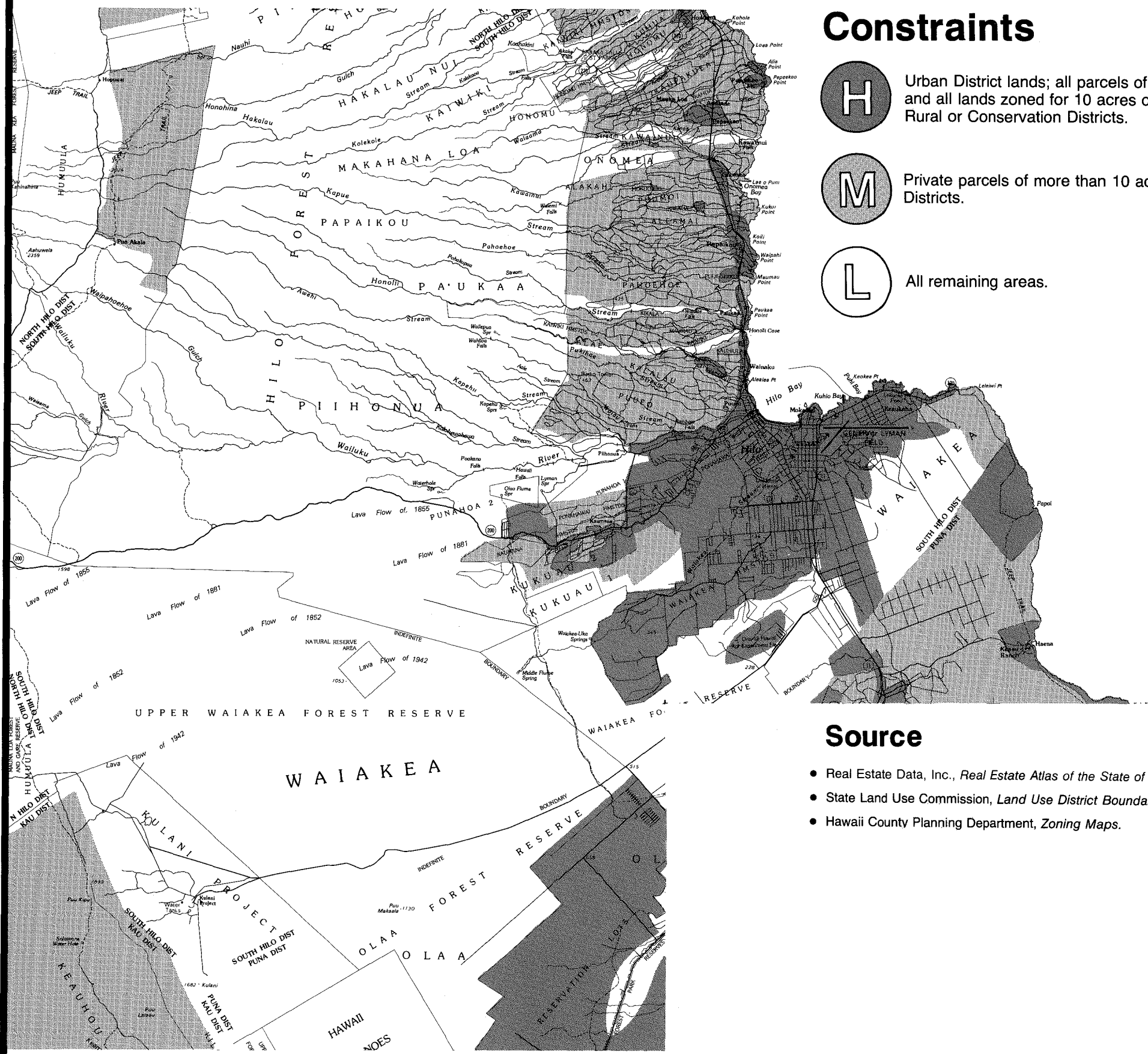
Urban District lands; all parcels of 10 acres or less in size and all lands zoned for 10 acres or less in the Agricultural, Rural or Conservation Districts.



Private parcels of more than 10 acres in Agriculture or Rural Districts.

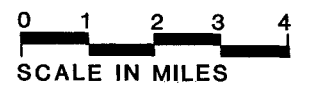
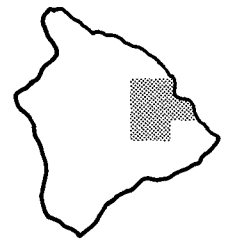


All remaining areas.



Source

- Real Estate Data, Inc., *Real Estate Atlas of the State of Hawaii*, 1986.
- State Land Use Commission, *Land Use District Boundaries*.
- Hawaii County Planning Department, *Zoning Maps*.



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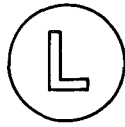
Constraints



Urban District lands; all parcels of 10 acres or less in size and all lands zoned for 10 acres or less in the Agricultural, Rural or Conservation Districts.



Private parcels of more than 10 acres in Agriculture or Rural Districts.



All remaining areas.

Source

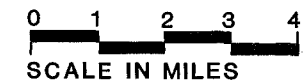
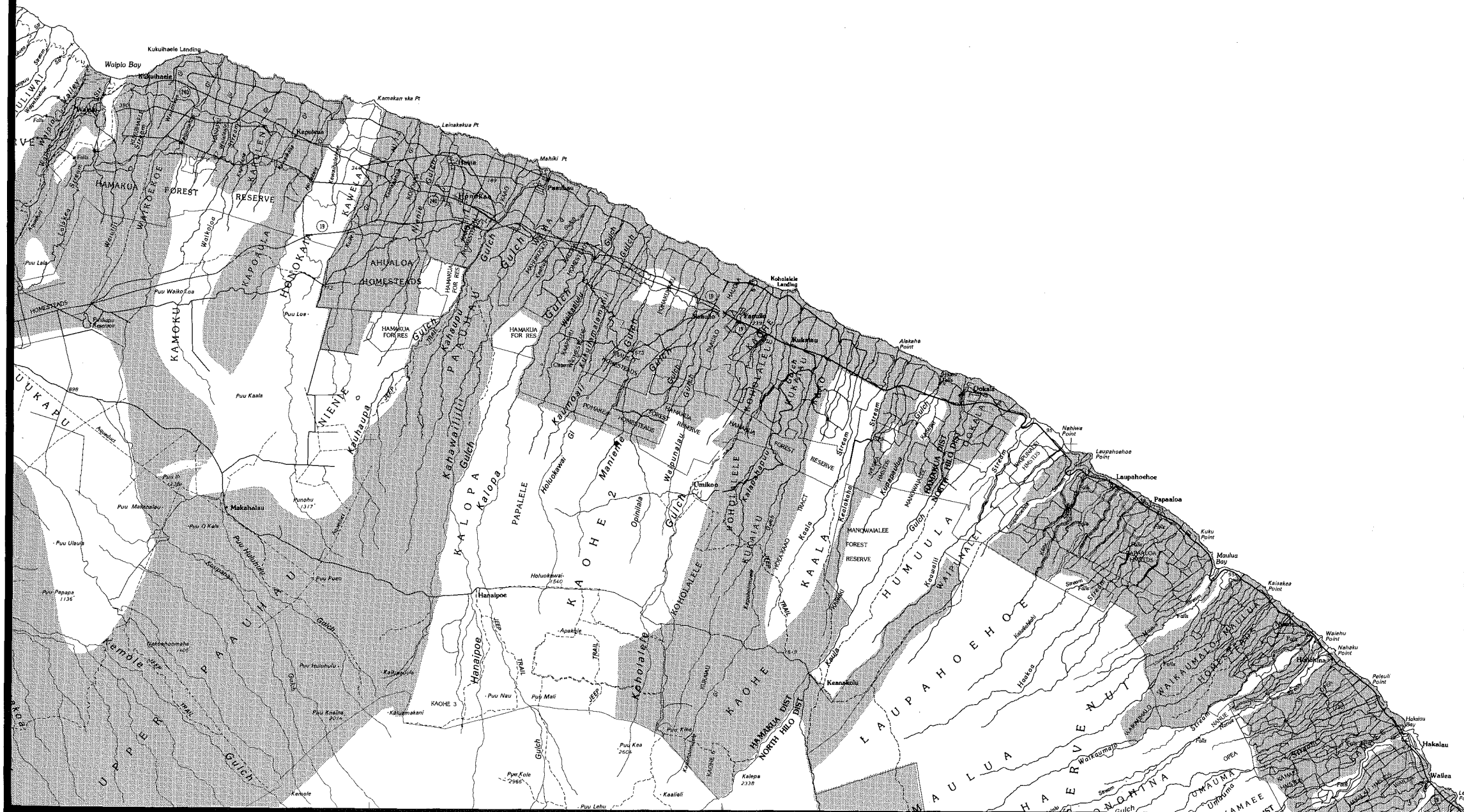
- Real Estate Data, Inc., *Real Estate Atlas of the State of Hawaii*, 1986.
- State Land Use Commission, *Land Use District Boundaries*.
- Hawaii County Planning Department, *Zoning Maps*.

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Exhibit II-53

LAND VALUE: Hamakua Section



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b. Maintenance

Factors which affect the cost, complexity and frequency of maintenance for the proposed transmission line are:

- wind
- salt spray
- forests
- range fires
- dust
- hurricanes
- vandalism

Wind causes vibration of poles, insulators and lines and can loosen or damage fastenings, connections and foundations. The most complete set of wind data (average annual windspeeds) has been collected and mapped by the Hawaii Natural Energy Institute.³³ The calculation of average annual windspeeds is determined by the mean of calm and windy days.

Areas with "high" constraints have an average annual windspeed of 15 MPH or greater. Areas with "medium" constraints have average annual windspeeds of 11.5 to 15 MPH.

Salt spray areas are considered to have "high" constraints because accumulations of salt on insulators can cause flashovers from the transmission line to the pole or tower or to another line. These areas occur approximately within three miles of the ocean, but the actual distance varies depending on the local tradewinds and the average annual rainfall. Delineation of salt spray areas in this report is based on maps provided by HECO.³⁴

Forests present an obstacle to the construction of power lines. The proposed transmission lines require a minimum clearance of 10 feet from surrounding vegetation. Lines may sag to within 42 feet of the ground, therefore maximum tree height should not exceed about 30 feet to provide a 10-foot clearance.

33. Hawaii Natural Energy Institute, HNEI Wind Energy Map: Hawaii, Honolulu, Hawaii, March, 1983.

34. Hawaiian Electric Company, Inc., Insulation Areas, Engineering Data, Drawing 1-4050, Honolulu, Hawaii, August, 1976.

Forests with 25 percent or greater tree-cover and trees 30 feet high or greater are considered to be high constraints. A "medium" constraint occurs where trees are less than 30 feet tall but still provide 25 percent or greater tree-cover.

Fires may be caused by fallen power lines, but this is considered to be much less likely than range or brush fires which occur seasonally in dry areas. These have the capability of severely ionizing air which could cause flashovers and power interruption. Typical fire hazard areas are found in rangeland³⁵ where rainfall is less than 20 inches annually. These areas are considered "medium" constraints.

The same areas which contribute to fire hazards contribute to dust buildup on insulators which can cause arcing, corona discharge and audio, radio or television interference.

Although hurricanes are infrequent in the Hawaiian Islands, the potential effects of catastrophic winds and wind-driven waves can impact line maintenance requirements. Generally, hurricane winds are worse in open and exposed areas, particularly through the saddle areas between mountains, and in coastal lands near ocean channels between Islands. Hurricanes also cause high waves which may have serious effects underwater and on shoreline structures.

The probability of occurrence of hurricanes has not been calculated by the National Weather Service.³⁶ Such calculations are complex because of the different directions from which a hurricane may approach and because data describing hurricane intensities and historic events are not available. Although some high wind analysis and mapping is presently underway, detailed maps of locations sensitive to hurricane winds are not available. Therefore, it is not possible to map hurricane probabilities at this time.

Power lines are susceptible to damage by vandals. The prime concern is gunshot damage to transmission lines and equipment caused by hunters. This problem is considered a "medium"

35. United States Department of the Interior, Geological Survey, Land Use and Land Cover: Hawaii, Open File Reports, Reston, Virginia, 1979.

36. DHM Planners inc., p. 146.

constraint and occurs in areas where hunting takes place. The hunting areas are those designated by the Department of Land and Natural Resources.³⁷

Maintenance

<u>Degree of Constraint</u>	<u>Criteria</u>
High	Average annual windspeed 15 mph or greater; designated salt-spray areas; forests with 25% or greater cover and trees 30 feet or greater in height.
Medium	Average annual windspeed between 11.5 and 15 mph; rangelands with 20 inches or less of rainfall (fire and dust areas); forests with 25% or greater cover and trees less than 30 feet high; hunting areas.
Low	All remaining areas.

37. Department of Land and Natural Resources, State of Hawaii, Division of Forestry and Wildlife, Game Mammal Hunting Rules, Game Bird Hunting Rules, Hawaii, Honolulu, Hawaii, no date.

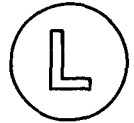
Constraints



Average annual windspeed 15 mph or greater; designated salt-spray areas; forests with trees 30' or taller.



Average annual windspeed between 11.5 and 15 mph; rangelands with 20 inches or less rainfall; forests with trees under 30' high; hunting areas.



All remaining areas.

Source

- Hawaii Natural Energy Institute, *HNEI Wind Energy Maps*, 1984.
- Hawaiian Electric Company, Inc., *Insulation Areas, Engineering Data*.
- USGS, *Land Use & Land Cover*, 1979.
- DLNR, Div. of Forestry & Wildlife, *Game Mammal Hunting Rules, & Game Bird Hunting Rules*.
- U.S. Fish & Wildlife Service, *Jacobi System Vegetation Maps*, Hawaii, Advance Prints.

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Exhibit II-55

MAINTENANCE: Puna Section



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Exhibit II-56
**MAINTENANCE:
Hilo Section**

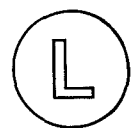
Constraints



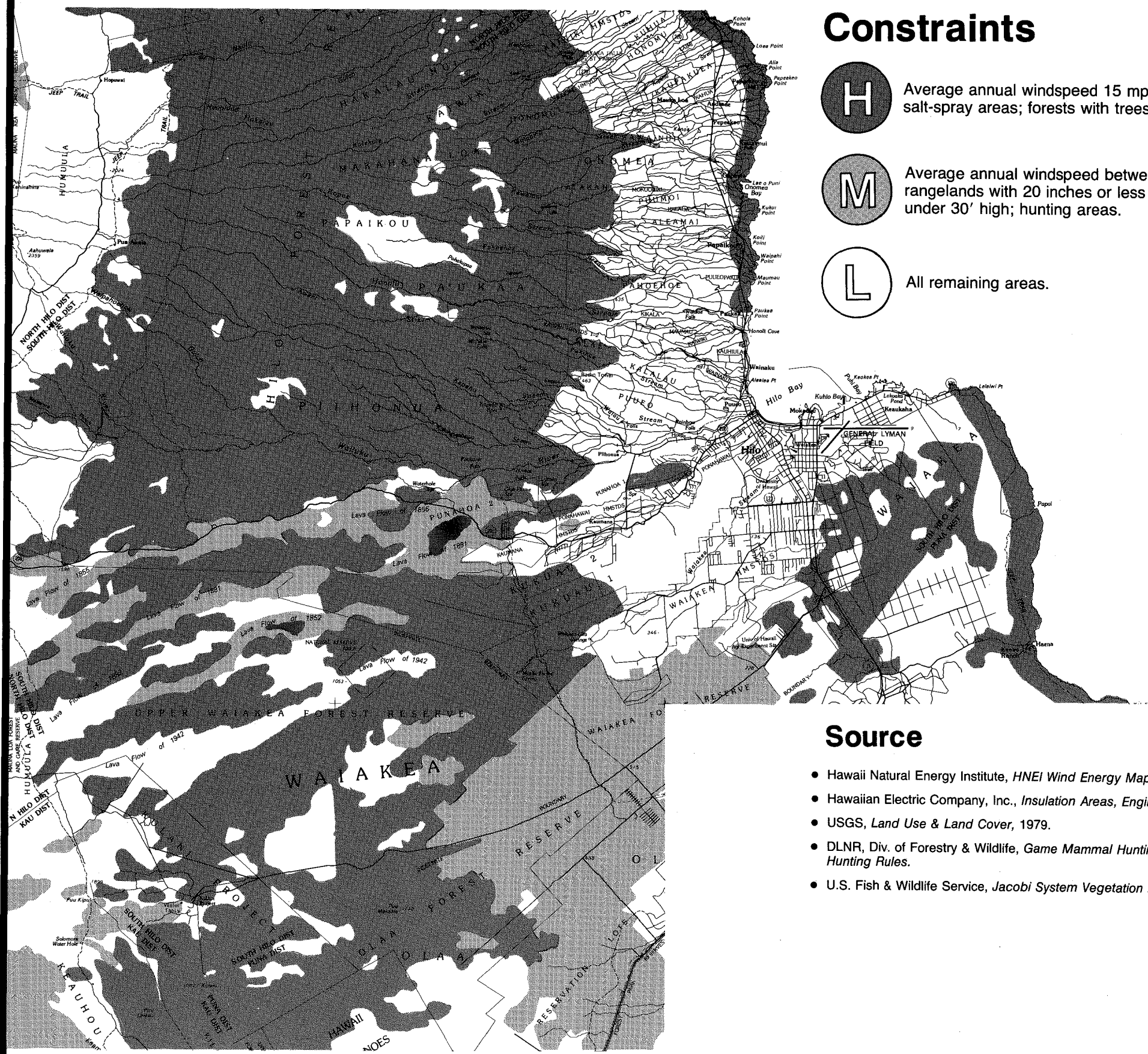
Average annual windspeed 15 mph or greater; designated salt-spray areas; forests with trees 30' or taller.



Average annual windspeed between 11.5 and 15 mph; rangelands with 20 inches or less rainfall; forests with trees under 30' high; hunting areas.

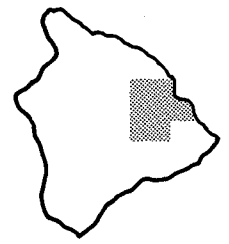


All remaining areas.



Source

- Hawaii Natural Energy Institute, *HNEI Wind Energy Maps*, 1984.
- Hawaiian Electric Company, Inc., *Insulation Areas, Engineering Data*.
- USGS, *Land Use & Land Cover*, 1979.
- DLNR, Div. of Forestry & Wildlife, *Game Mammal Hunting Rules, & Game Bird Hunting Rules*.
- U.S. Fish & Wildlife Service, *Jacobi System Vegetation Maps, Hawaii*, Advance Prints.



DHM Planners inc.

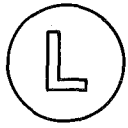
Constraints



Average annual windspeed 15 mph or greater; designated salt-spray areas; forests with trees 30' or taller.



Average annual windspeed between 11.5 and 15 mph; rangelands with 20 inches or less rainfall; forests with trees under 30' high; hunting areas.



All remaining areas.

Source

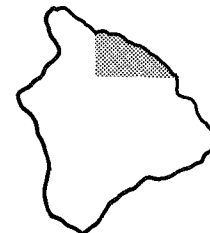
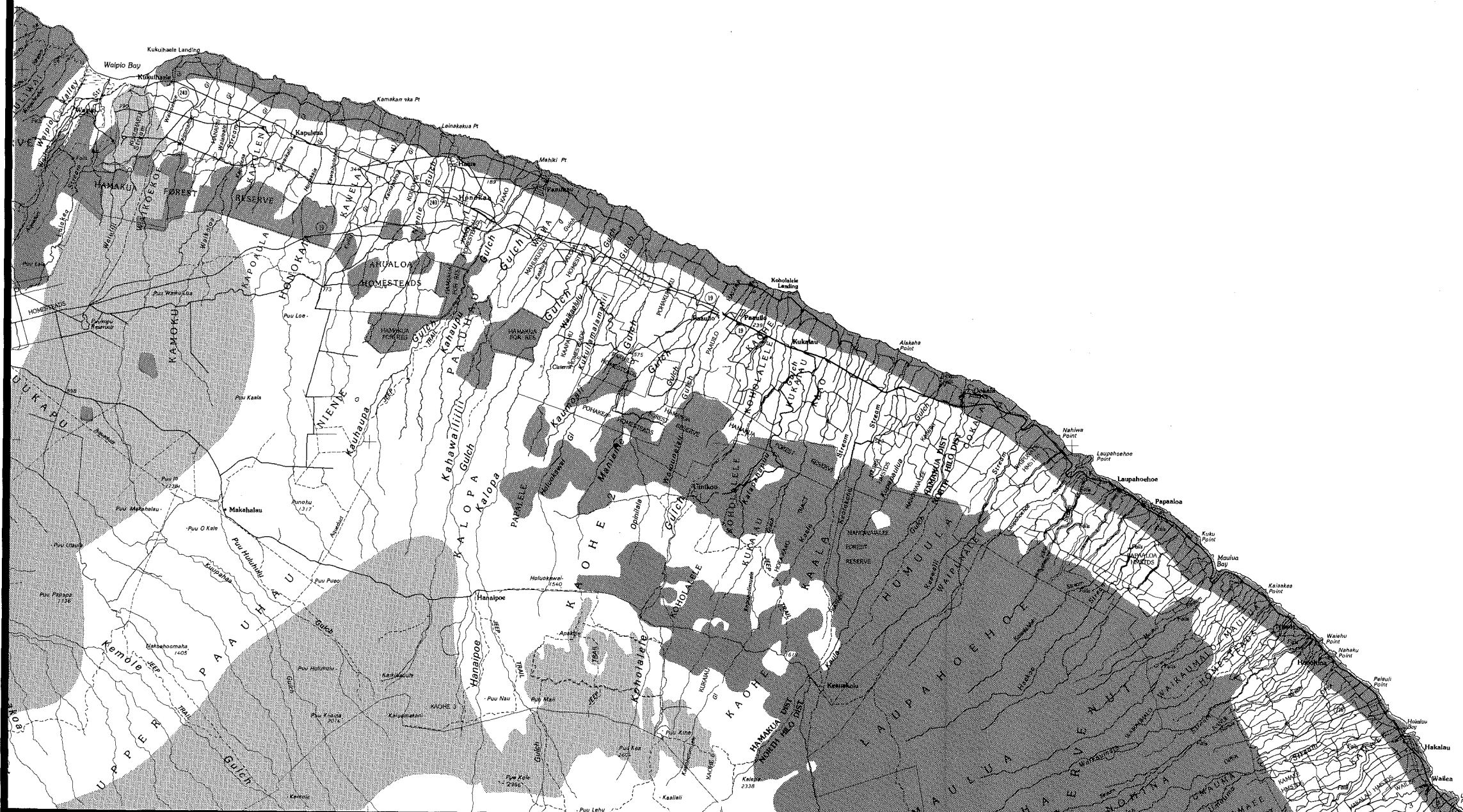
- Hawaii Natural Energy Institute, *HNEI Wind Energy Maps*, 1984.
- Hawaiian Electric Company, Inc., *Insulation Areas, Engineering Data*.
- USGS, *Land Use & Land Cover*, 1979.
- DLNR, Div. of Forestry & Wildlife, *Game Mammal Hunting Rules, & Game Bird Hunting Rules*.
- U.S. Fish & Wildlife Service, *Jacobi System Vegetation Maps*, Hawaii, Advance Prints.

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PUNA TO KOHALA OVERLAND TRANSMISSION CORRIDOR STUDY

Exhibit II-57

MAINTENANCE: Hamakua Section



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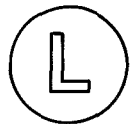
Constraints



Average annual windspeed 15 mph or greater; designated salt-spray areas; forests with trees 30' or taller.



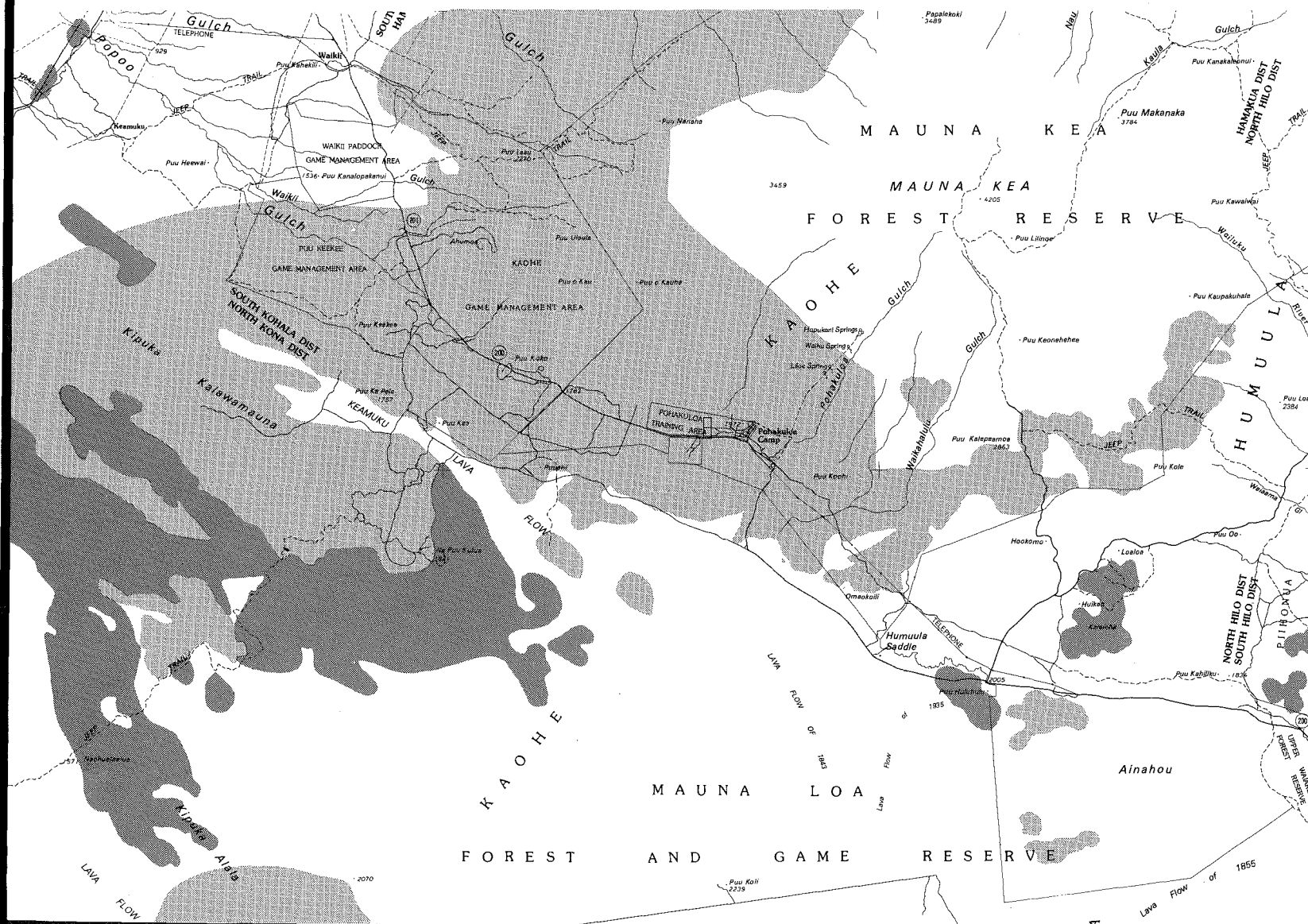
Average annual windspeed between 11.5 and 15 mph; rangelands with 20 inches or less rainfall; forests with trees under 30' high; hunting areas.



All remaining areas.

Source

- Hawaii Natural Energy Institute, *HNEI Wind Energy Maps*, 1984.
- Hawaiian Electric Company, Inc., *Insulation Areas, Engineering Data*.
- USGS, *Land Use & Land Cover*, 1979.
- DLNR, Div. of Forestry & Wildlife, *Game Mammal Hunting Rules, & Game Bird Hunting Rules*.
- U.S. Fish & Wildlife Service, *Jacobi System Vegetation Maps*, Hawaii, Advance Prints.

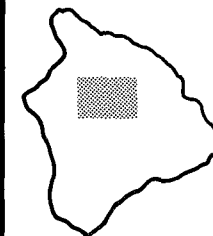


HAWAII DEEP WATER CABLE PROGRAM

PUNA TO KOHALA OVERLAND TRANSMISSION CORRIDOR STUDY

Exhibit II-58

MAINTENANCE: Saddle Section



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c. Access

The degree of difficulty in achieving access to the transmission line right-of-way is determined by varying factors including dense vegetation, steep slopes and high shrink-swell soils as well as the existence of paved and unpaved roads or jeep trails. Other site specific factors such as lava tubes or physical barriers would be addressed during alignment selection. The degree of difficulty of access is directly translated into additional construction and maintenance costs.

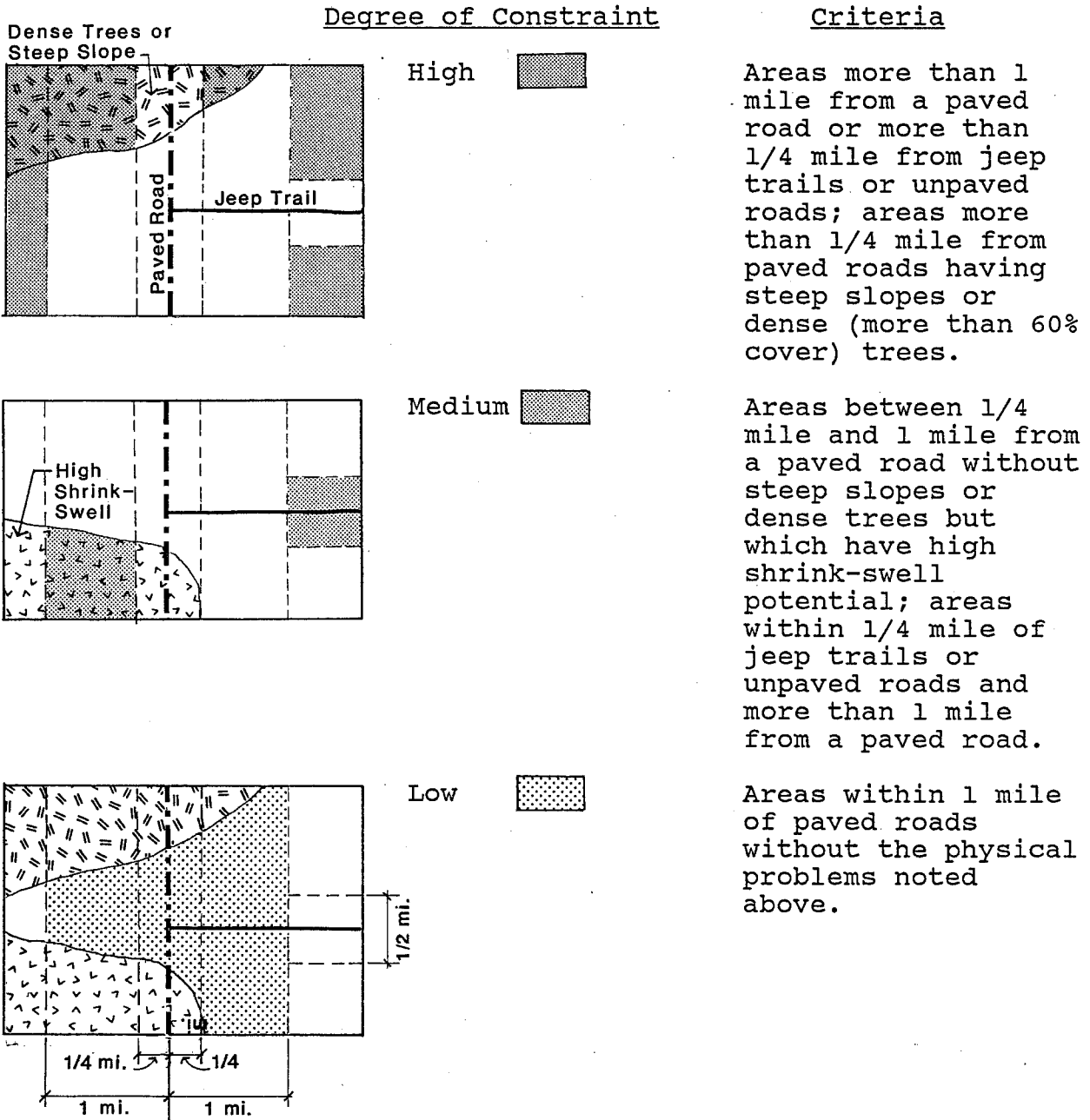
Land is considered to have a "high" constraint if it is more than one mile to either side of a paved road or one-quarter mile to either side of a jeep trail. Land areas more than one-quarter mile from paved roads including steep slopes (20% or greater) or dense trees (more than 60 percent cover) are also considered to have "high" constraints.

"Medium" constraints are imposed on land between one-quarter and one mile from a paved road where there are no steep slopes or dense trees but where there is a high shrink-swell soil classification³⁸ (an indicator of potentially muddy or clay conditions). Land within one-quarter mile of jeep trails is also considered to have a "medium" constraint.

"Low" constraint lands are those within one mile of a paved road where there are none of the problems described above.

38. U.S. Department of Agriculture, Soil Conservation Service, Soil Survey of the Island of Hawaii, State of Hawaii, Washington, D.C., December, 1973.

Access

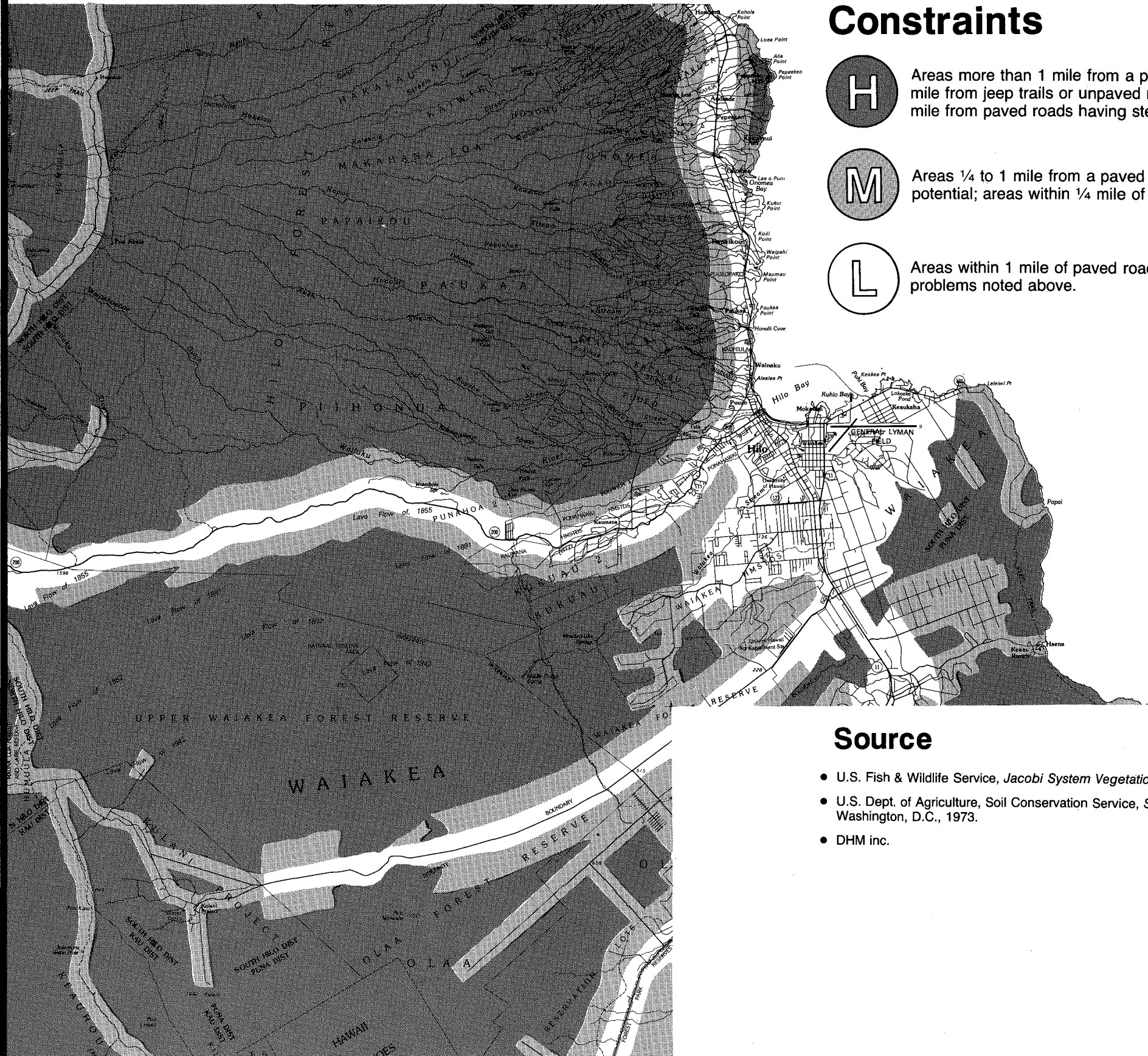


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Exhibit II-60

**ACCESS:
Hilo Section**



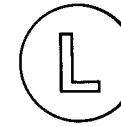
Constraints



Areas more than 1 mile from a paved road or more than 1/4 mile from jeep trails or unpaved roads; areas more than 1/4 mile from paved roads having steep slopes or dense trees.



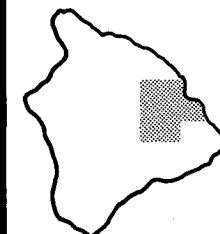
Areas 1/4 to 1 mile from a paved road with high shrink-swell potential; areas within 1/4 mile of jeep trails or unpaved roads.



Areas within 1 mile of paved roads without the physical problems noted above.

Source

- U.S. Fish & Wildlife Service, *Jacobi System Vegetation Maps*, Hawaii, Advance Prints.
- U.S. Dept. of Agriculture, Soil Conservation Service, *Soil Survey of Island of Hawaii*, Washington, D.C., 1973.
- DHM inc.



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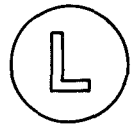
Constraints



Areas more than 1 mile from a paved road or more than 1/4 mile from jeep trails or unpaved roads; areas more than 1/4 mile from paved roads having steep slopes or dense trees.



Areas 1/4 to 1 mile from a paved road with high shrink-swell potential; areas within 1/4 mile of jeep trails or unpaved roads.



Areas within 1 mile of paved roads without the physical problems noted above.

Source

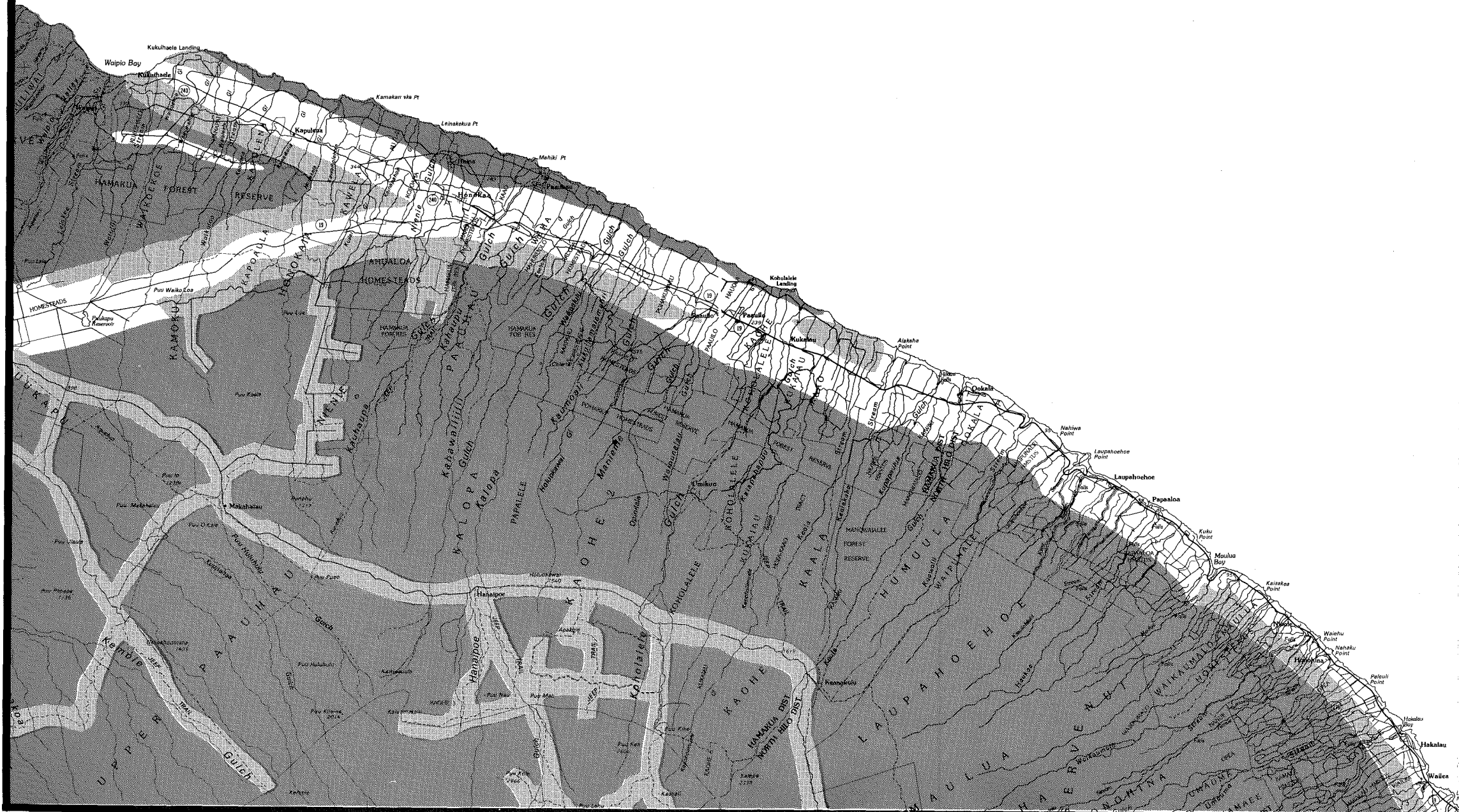
- U.S. Fish & Wildlife Service, *Jacobi System Vegetation Maps*, Hawaii, Advance Prints.
- U.S. Dept. of Agriculture, Soil Conservation Service, *Soil Survey of Island of Hawaii*, Washington, D.C., 1973.
- DHM inc.

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Exhibit II-61

**ACCESS:
Hamakua Section**



0 1 2 3 4
SCALE IN MILES

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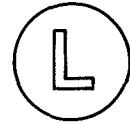
Constraints



Areas more than 1 mile from a paved road or more than 1/4 mile from jeep trails or unpaved roads; areas more than 1/4 mile from paved roads having steep slopes or dense trees.



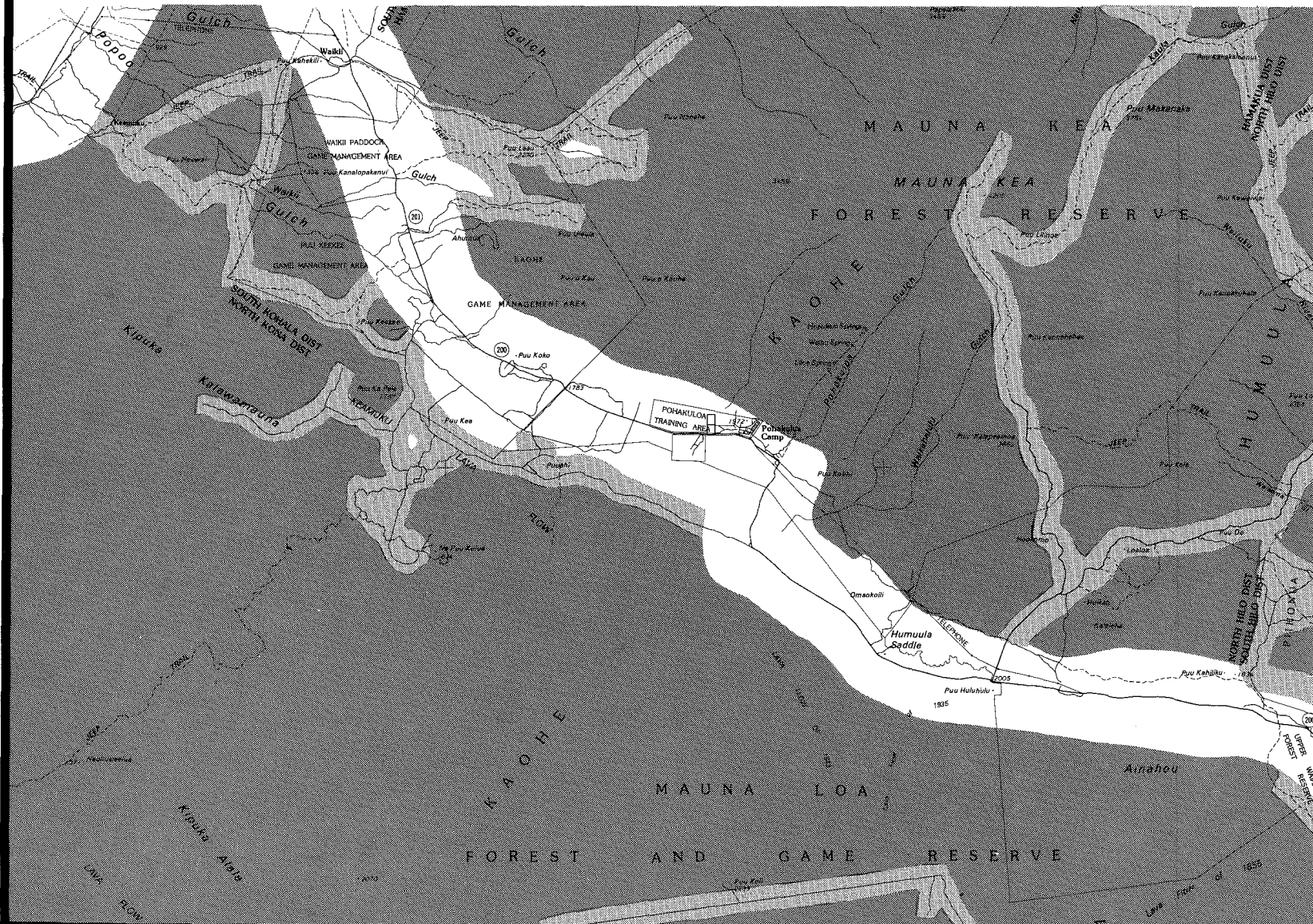
Areas 1/4 to 1 mile from a paved road with high shrink-swell potential; areas within 1/4 mile of jeep trails or unpaved roads.



Areas within 1 mile of paved roads without the physical problems noted above.

Source

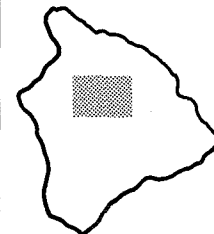
- U.S. Fish & Wildlife Service, *Jacobi System Vegetation Maps*, Hawaii, Advance Prints.
- U.S. Dept. of Agriculture, Soil Conservation Service, *Soil Survey of Island of Hawaii*, Washington, D.C., 1973.
- DHM inc.



HAWAII DEEP WATER CABLE PROGRAM PUNA TO KOHALA OVERLAND TRANSMISSION CORRIDOR STUDY

Exhibit II-62

**ACCESS:
Saddle Section**



0 1 2 3 4
SCALE IN MILES

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Chapter III

CHAPTER III. CORRIDOR IDENTIFICATION

A. COMPOSITE MAPS

In order to present an overall view of the constraints and opportunities for the transmission line route, intermediate composite overlay maps were prepared for the geophysical, biological, socio-economic, and cost data categories for each section of the study area. (Exhibit III-1 through III-16). The intermediate composite maps represent the combined constraints of all the data factors in each data category. The areas of "high" constraint appear dark grey; areas of "medium" constraint are lighter grey; and areas of "low" constraint are the lightest shades of grey. Each factor has been treated as having equal weight.

A final composite map for each section displays the combined constraints of the exclusion areas and all the data categories. (Exhibits III-17 through III-20). These maps are the basis for delineating potential transmission line corridors in the study area. The relatively lighter-toned areas on the maps were outlined to identify those areas having "less constraint" and therefore viewed as opportunities for transmission lines. The lighter areas include those which are considerably lighter than adjacent areas (even though they may be distinctly grey) and which contribute to creating a fairly continuous, linear corridor.

The "areas of less constraint" are shown in white on Exhibits III-21 through III-24. They vary in width from approximately one-half mile to four miles.

B. POTENTIAL CORRIDORS

Potential corridors are identified by linking the areas of less constraint to create continuous and fairly direct routes for a transmission line between the geothermal source and the Mahukona coast. This was done using the areas of less constraint as the main guide, and linking them where they were not contiguous. The linkages were determined by re-evaluating the composite constraint maps to identify the lighter areas in the gaps. If the gaps were relatively equal in degree of constraint (or darkness), straight-line connections were made between discontinuous areas of less constraint. Areas of less constraint that do not contribute to a continuous route were not included in the potential corridors.

The potential corridors for the four sections of the study area are shown on Exhibits III-25 through III-28. Exhibit III-29 displays the potential corridors for the entire study area. Exhibit III-30 combines the potential Hawaii corridors of the previous HDWCP study area with those identified in this report for complete coverage between the source in the Geothermal Resource Subzones and the Big Island terminal point around Mahukona.

C. CONCLUSION

The potential corridors identified in this report indicate that it is feasible to consider an overland route from the geothermal source in Puna to a "jump-off" point near Mahukona as part of the Deep Water Cable Program. However, this study is the initial step towards identifying a specific overland route for the inter-island transmission line. Through a broadscale analysis of geophysical, biological, socio-economic, and cost-related opportunities and constraints for a line, potential corridors were identified by linking the areas of "less constraint."

The route identification process does not end here, however. Once the feasibility of commercial development of the deep water cable is determined, the conditions within the potential corridors must be analyzed in significant detail according to refined selection criteria. This would include first-hand field studies by botanists, wildlife specialists, archaeologists, soils engineers, etc., as well as consultations with resource managers, land agents, and transmission line engineers. Thorough evaluation of this information would lead to the delineation of preliminary potential alignments.

Upon further consultation with various government regulatory agencies, affected landowners, and others, precise alignments can be selected to serve as a basis for engineering investigations, right-of-way acquisition, and applications for appropriate permits before actual construction.

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Range of Constraints

- High Constraint
- Least Constraint

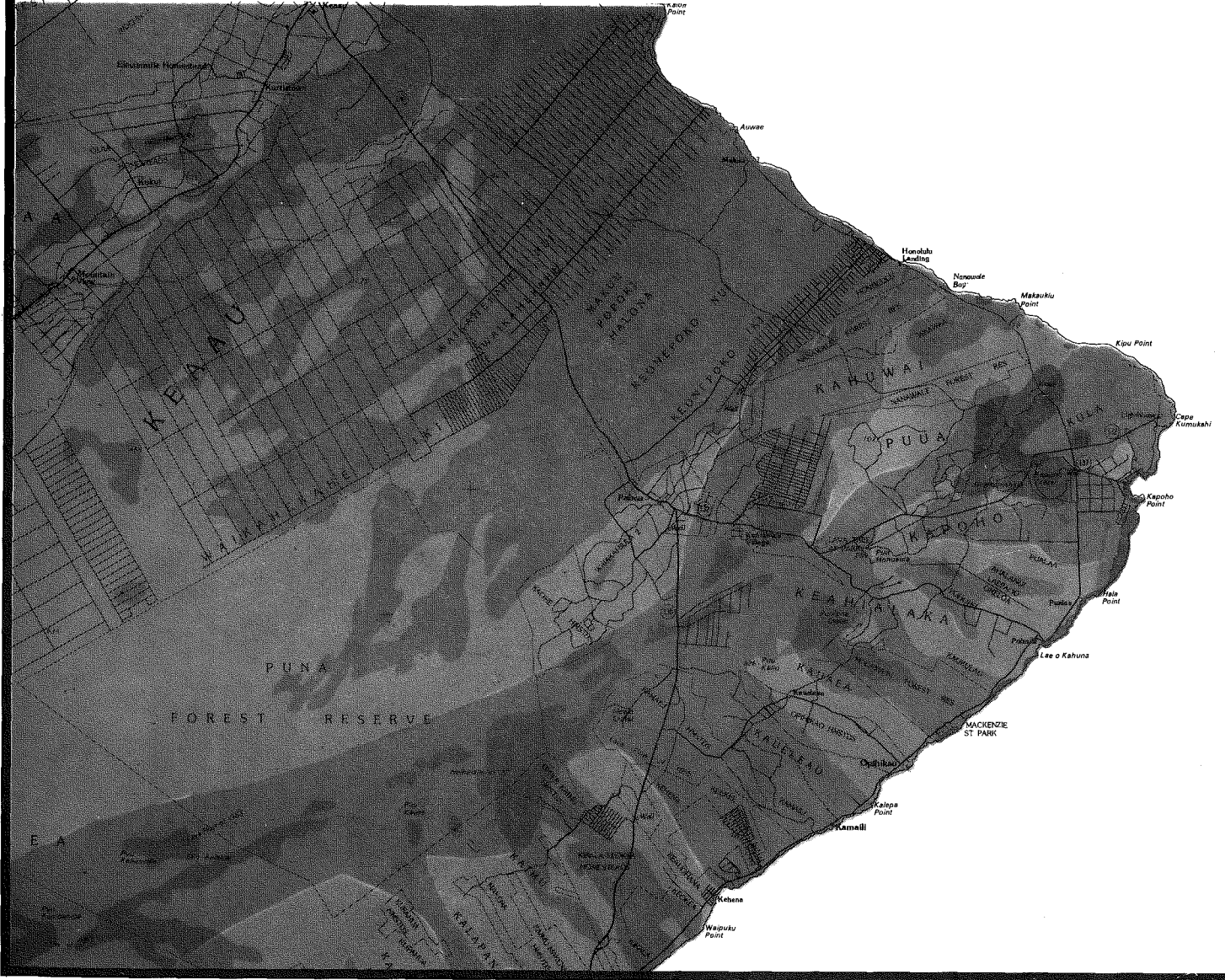
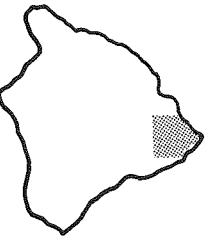


Exhibit III-1
**Composite
Constraints:
Geophysical-
Puna Section**



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Range of Constraints


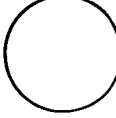
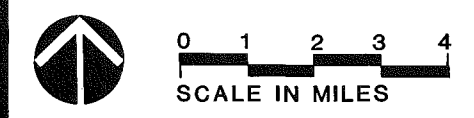
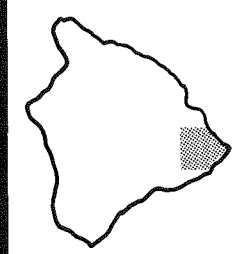
-  High Constraint
-  Least Constraint



Exhibit III-2
**Composite
 Constraints:
 Biological-
 Puna Section**



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Range of Constraints

● High Constraint

○ Least Constraint

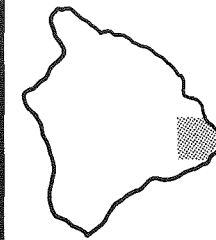


HAWAII DEEP WATER CABLE PROGRAM

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Exhibit III-3

Composite Constraints: Socio-Economic- Puna Section



0 1 2 3 4
SCALE IN MILES

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CORRIDOR
STUDY**

Range of Constraints

- High Constraint
- Least Constraint

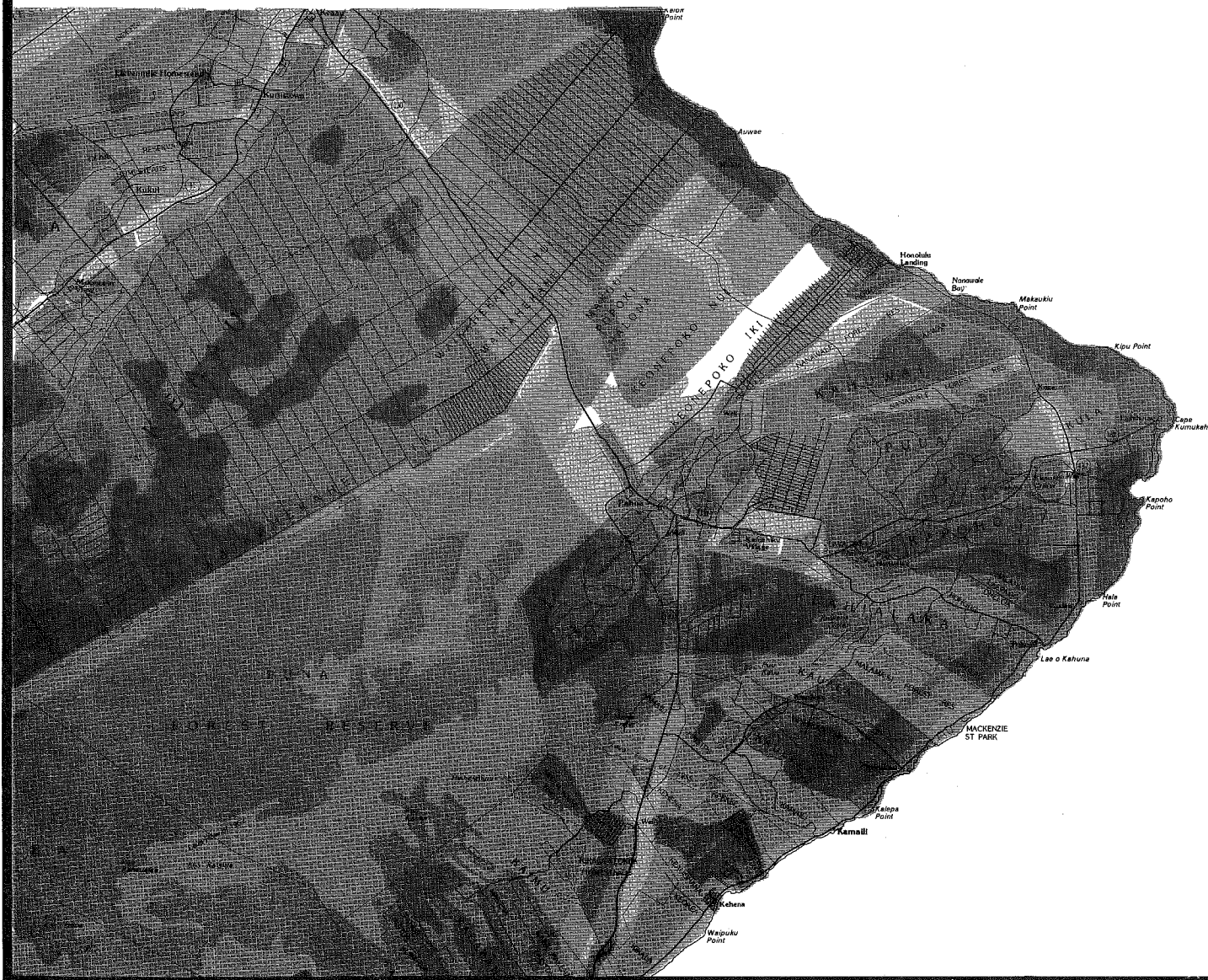
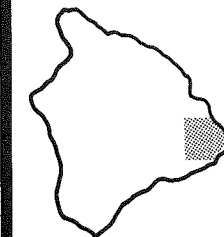


Exhibit III-4

**Composite
Constraints:
Cost-
Puna Section**



0 1 2 3 4
SCALE IN MILES

DHM Planners inc.

HAWAII
DEEP WATER
CABLE PROGRAM

**PUNA TO
KOHALA
OVERLAND
TRANSMISSION
CORRIDOR
STUDY**

Range of Constraints

- High Constraint
- Least Constraint

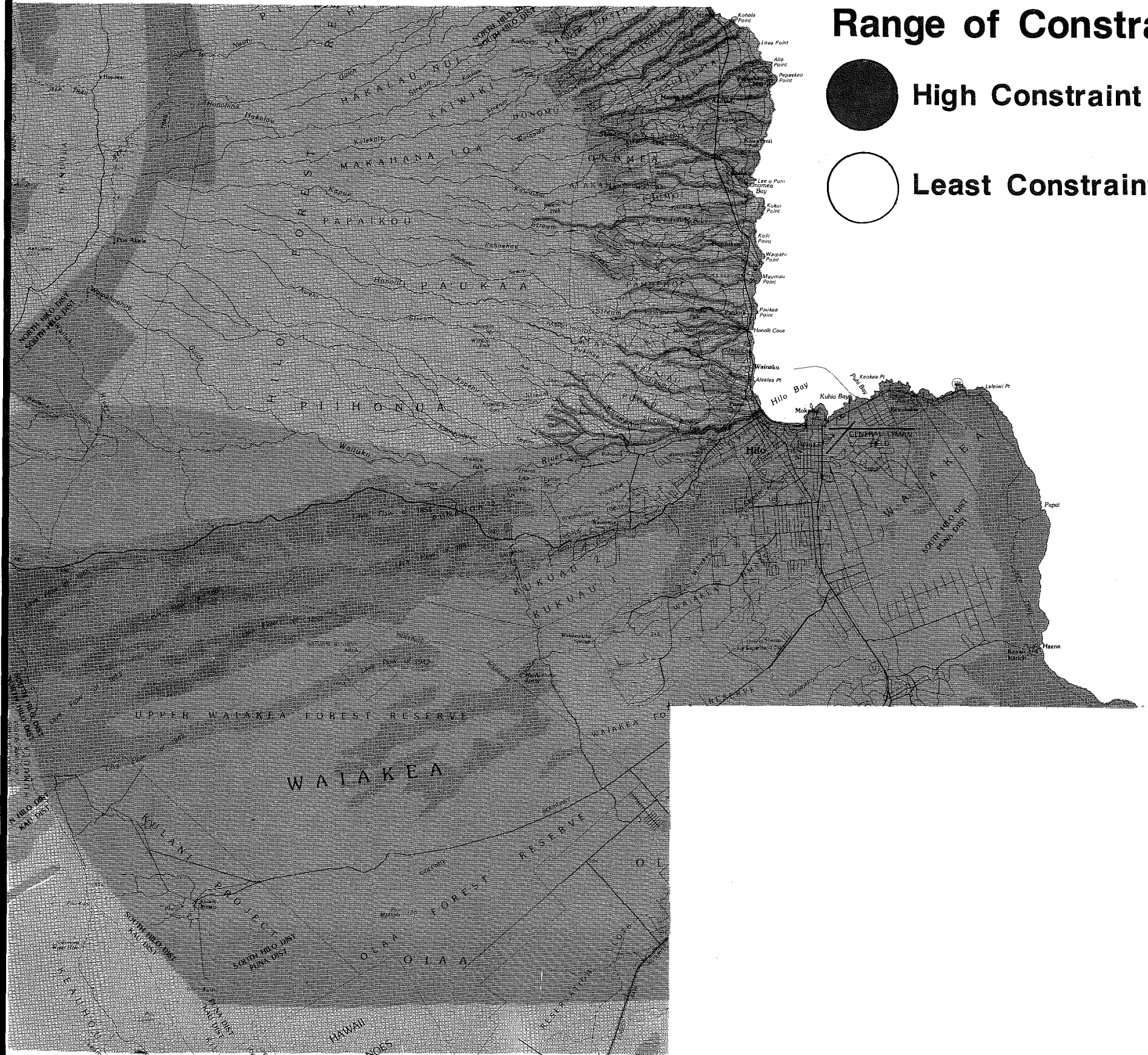


Exhibit III-5

**Composite
Constraints:
Geophysical-
Hilo Section**



0 1 2 3 4
SCALE IN MILES

DHM Planners inc.

HAWAII
DEEP WATER
CABLE PROGRAM

**PUNA TO
KOHALA
OVERLAND
TRANSMISSION
CORRIDOR
STUDY**

Range of Constraints

● High Constraint

○ Least Constraint

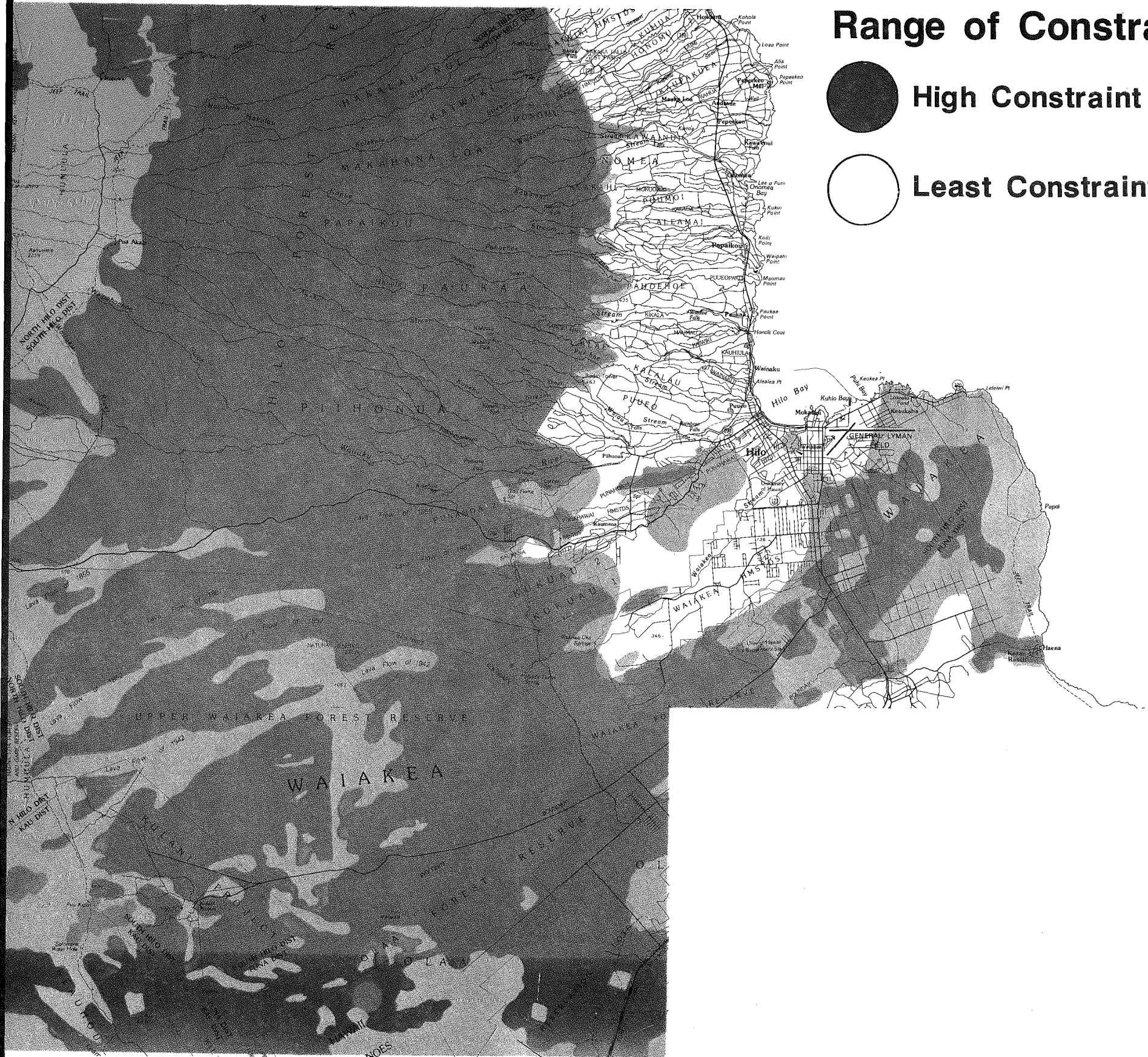
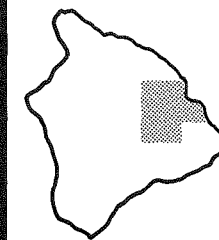


Exhibit III-6

**Composite
Constraints:
Biological-
Hilo Section**



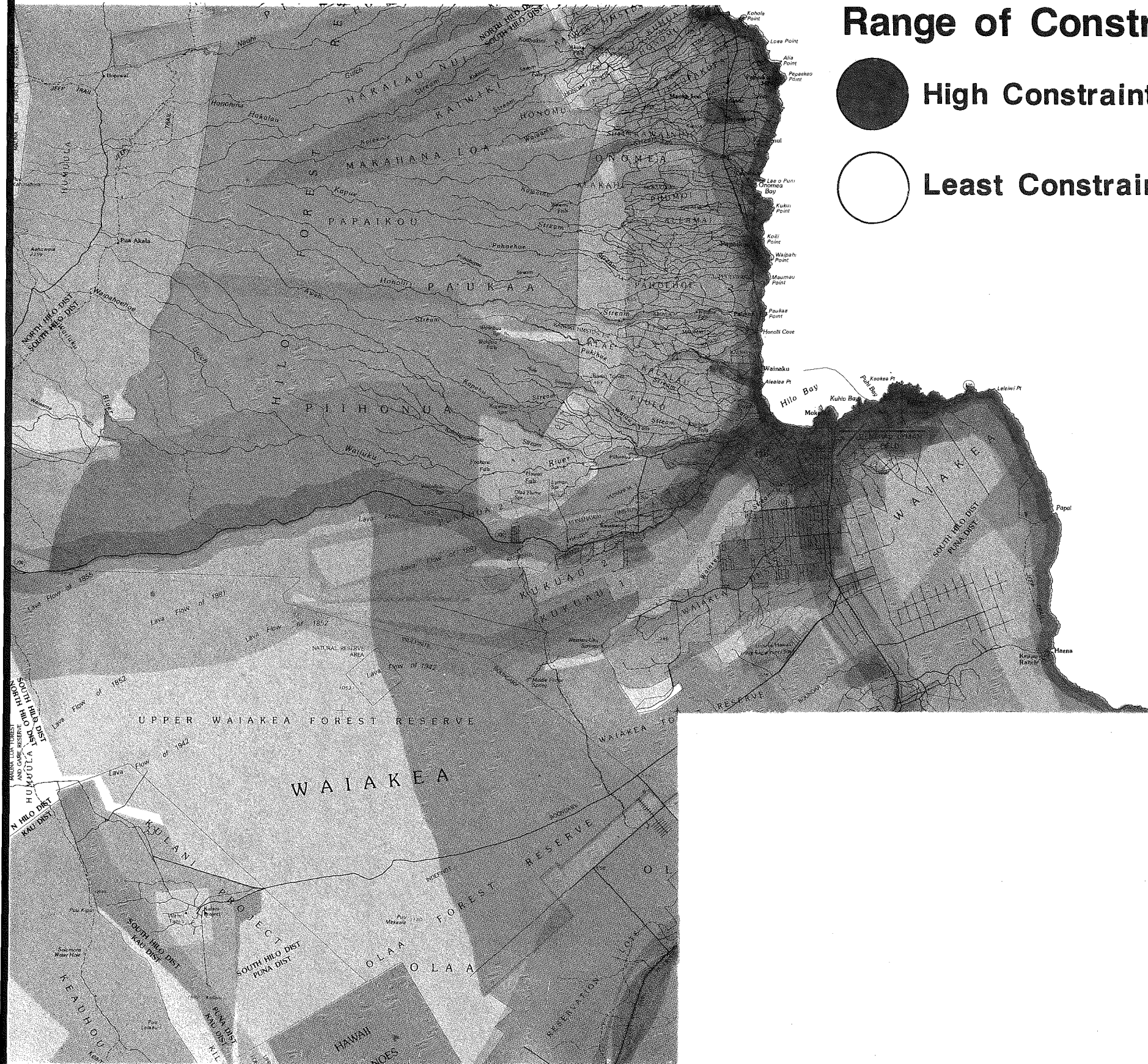
0 1 2 3 4
SCALE IN MILES

DHM Planners inc.

Range of Constraints

● High Constraint

○ Least Constraint

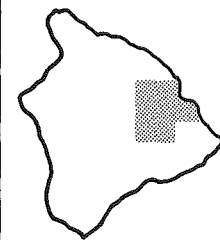


HAWAII DEEP WATER CABLE PROGRAM

PUNA TO KOHALA OVERLAND TRANSMISSION CORRIDOR STUDY

Exhibit III-7

Composite Constraints: Socio-Economic- Hilo Section

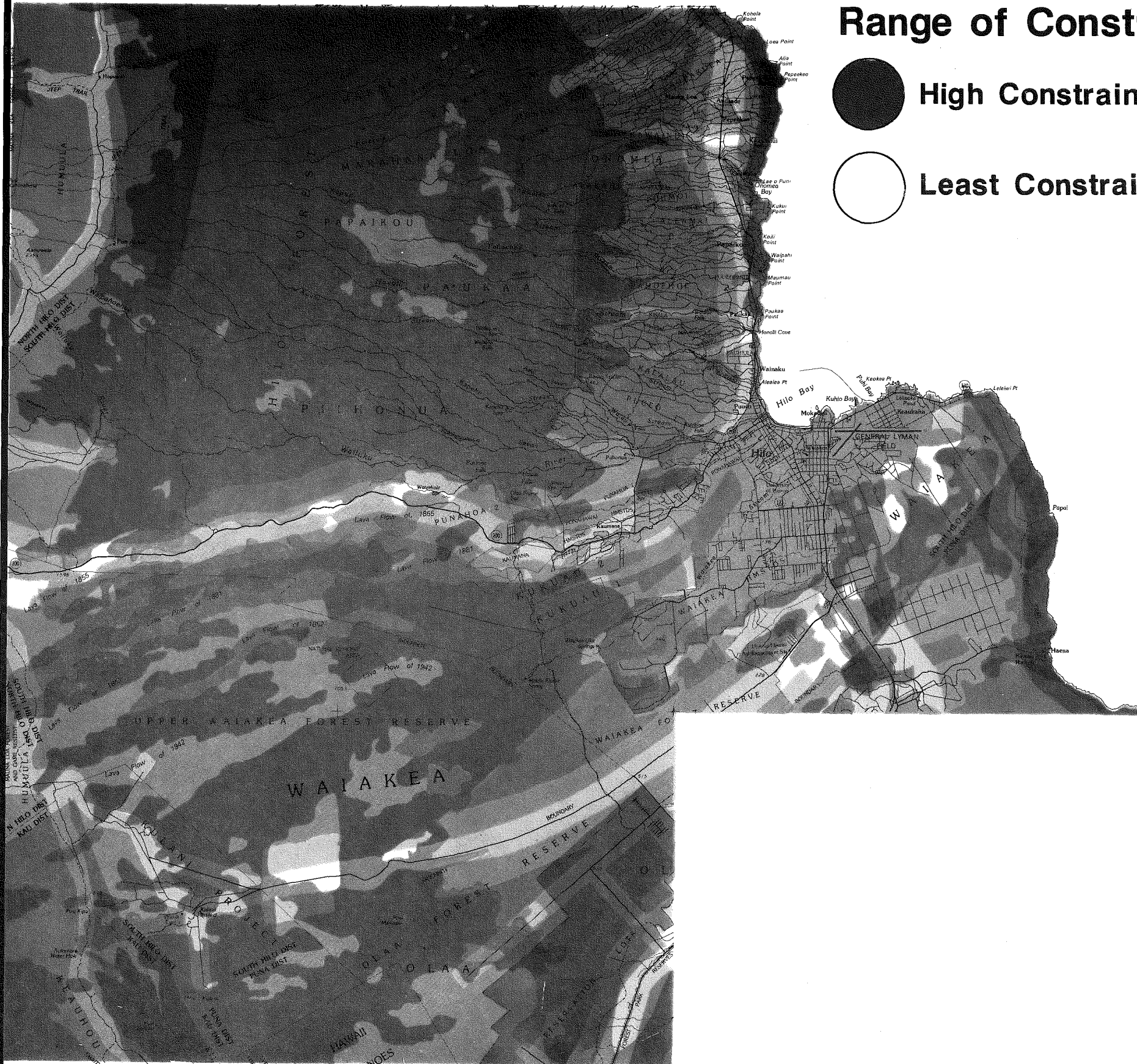


0 1 2 3 4
SCALE IN MILES

DHM Planners inc.

Range of Constraints

- High Constraint
- Least Constraint

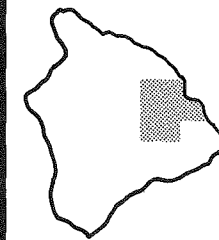


HAWAII DEEP WATER CABLE PROGRAM

PUNA TO KOHALA OVERLAND TRANSMISSION CORRIDOR STUDY

Exhibit III-8

Composite
Constraints:
Cost-
Hilo Section



0 1 2 3 4
SCALE IN MILES

DHM Planners inc.

Range of Constraints

 High Constraint

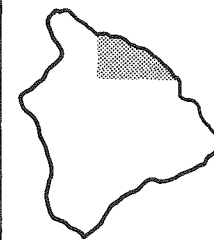
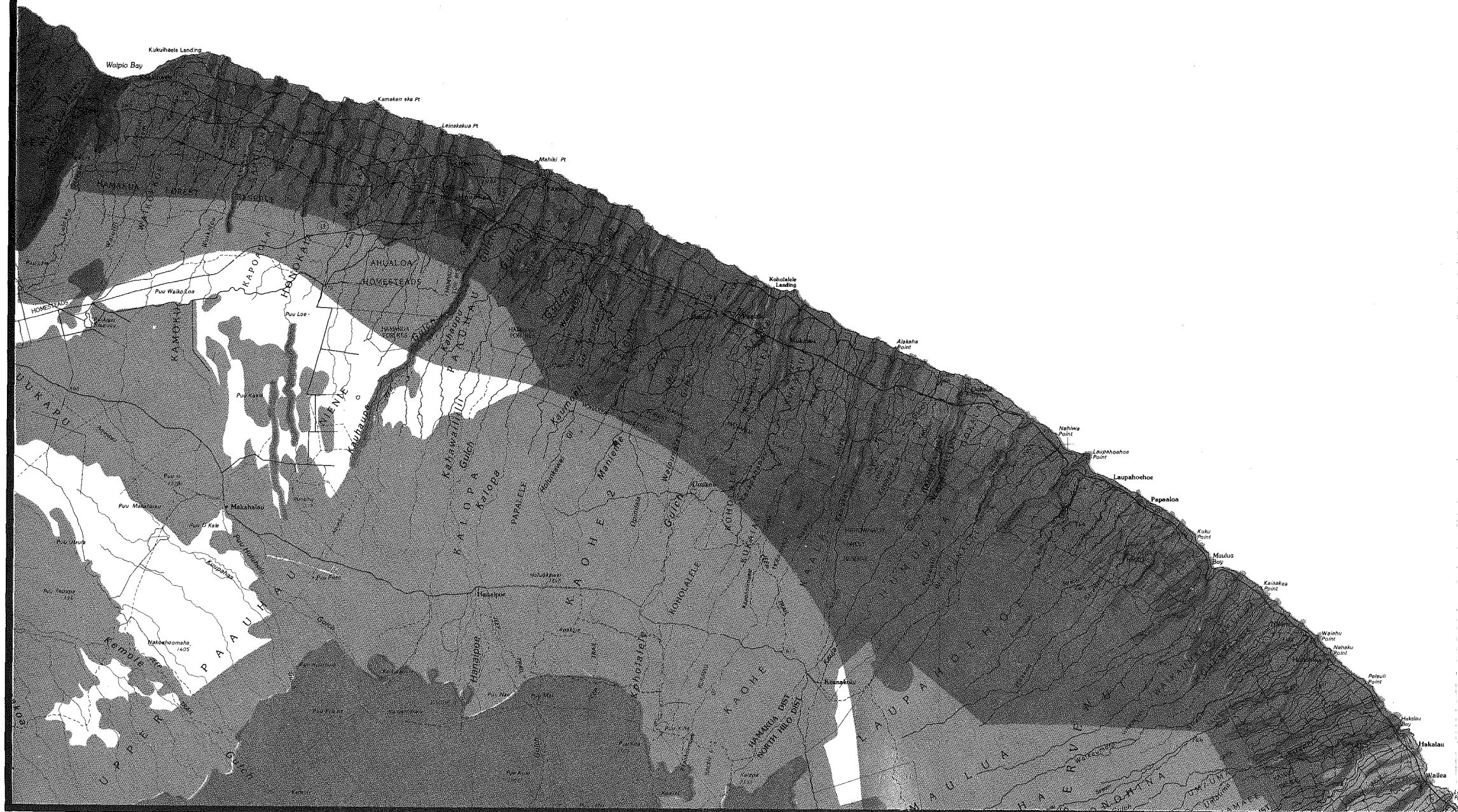
 Least Constraint

HAWAII DEEP WATER CABLE PROGRAM

PUNA TO KOHALA OVERLAND TRANSMISSION CORRIDOR STUDY

Exhibit III-9

Composite Constraints: Geophysical- Hamakua Section



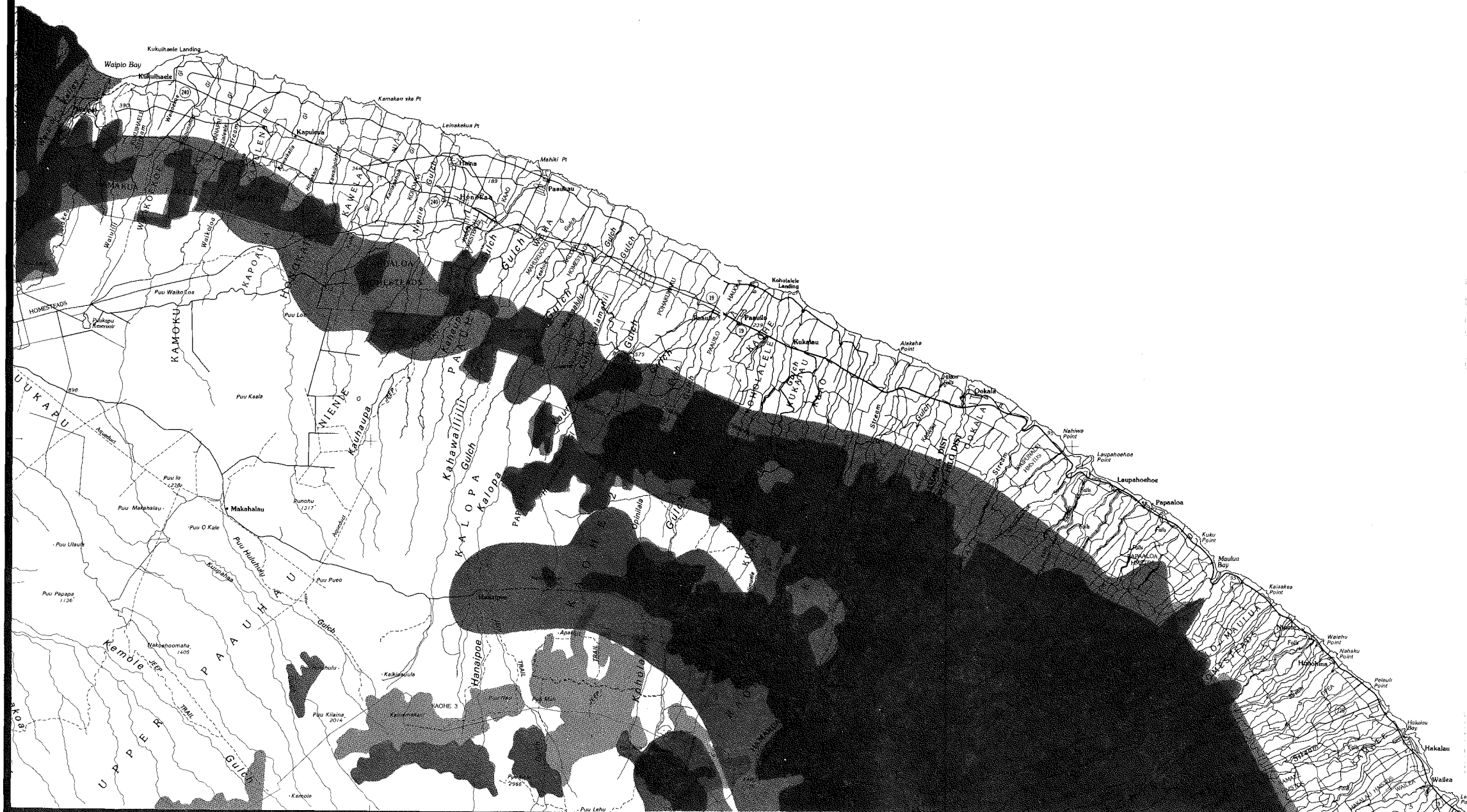
0 1 2 3 4
SCALE IN MILES

DHM Planners inc.

Range of Constraints

● High Constraint

○ Least Constraint



HAWAII DEEP WATER CABLE PROGRAM

PUNA TO KOHALA OVERLAND TRANSMISSION CORRIDOR STUDY

Exhibit III-10

Composite Constraints: Biological- Hamakua Section



DHM Planners inc.

Range of Constraints

● High Constraint

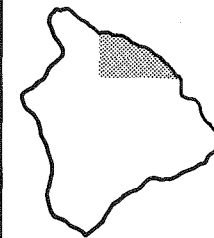
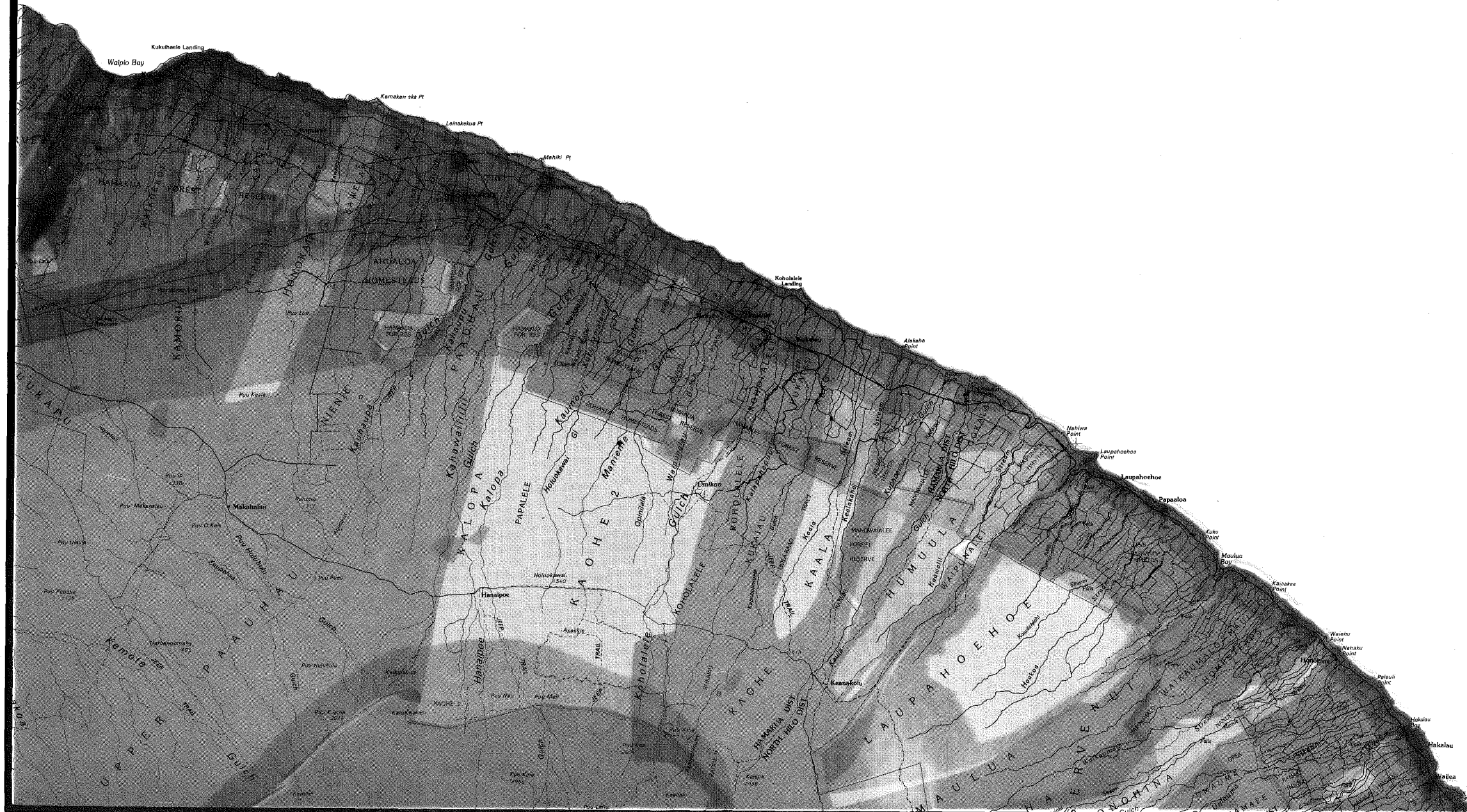
○ Least Constraint

HAWAII
DEEP WATER
CABLE PROGRAM

PUNA TO KOHALA OVERLAND TRANSMISSION CORRIDOR STUDY

Exhibit III-11

Composite
Constraints:
Socio-Economic-
Hamakua Section



0 1 2 3 4
SCALE IN MILES

DHM Planners inc.

HAWAII
 DEEP WATER
 CABLE PROGRAM
**PUNA TO
 KOHALA
 OVERLAND
 TRANSMISSION
 CORRIDOR
 STUDY**

Range of Constraints

- High Constraint
- Least Constraint

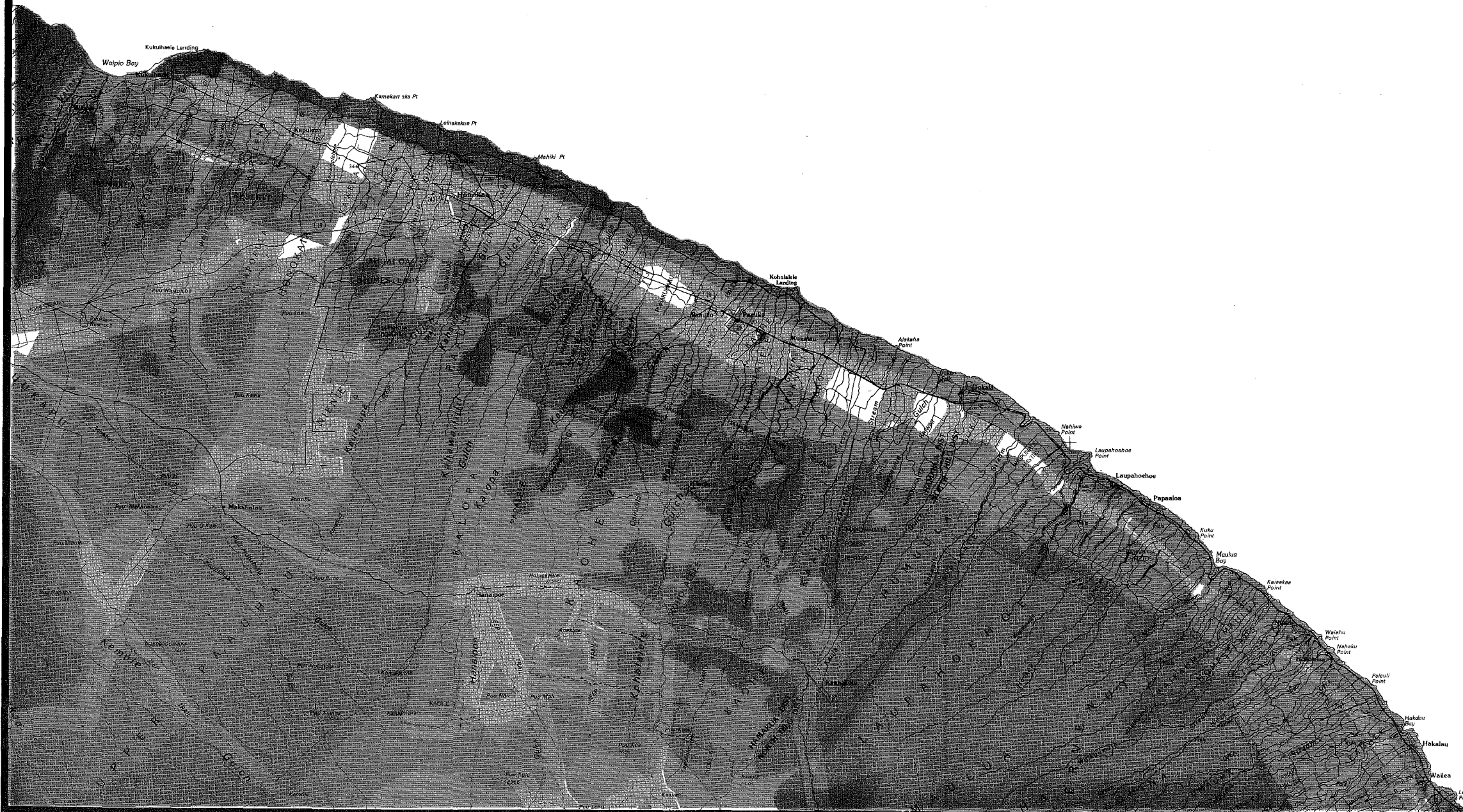


Exhibit III-12
**Composite
 Constraints:
 Cost-
 Hamakua Section**

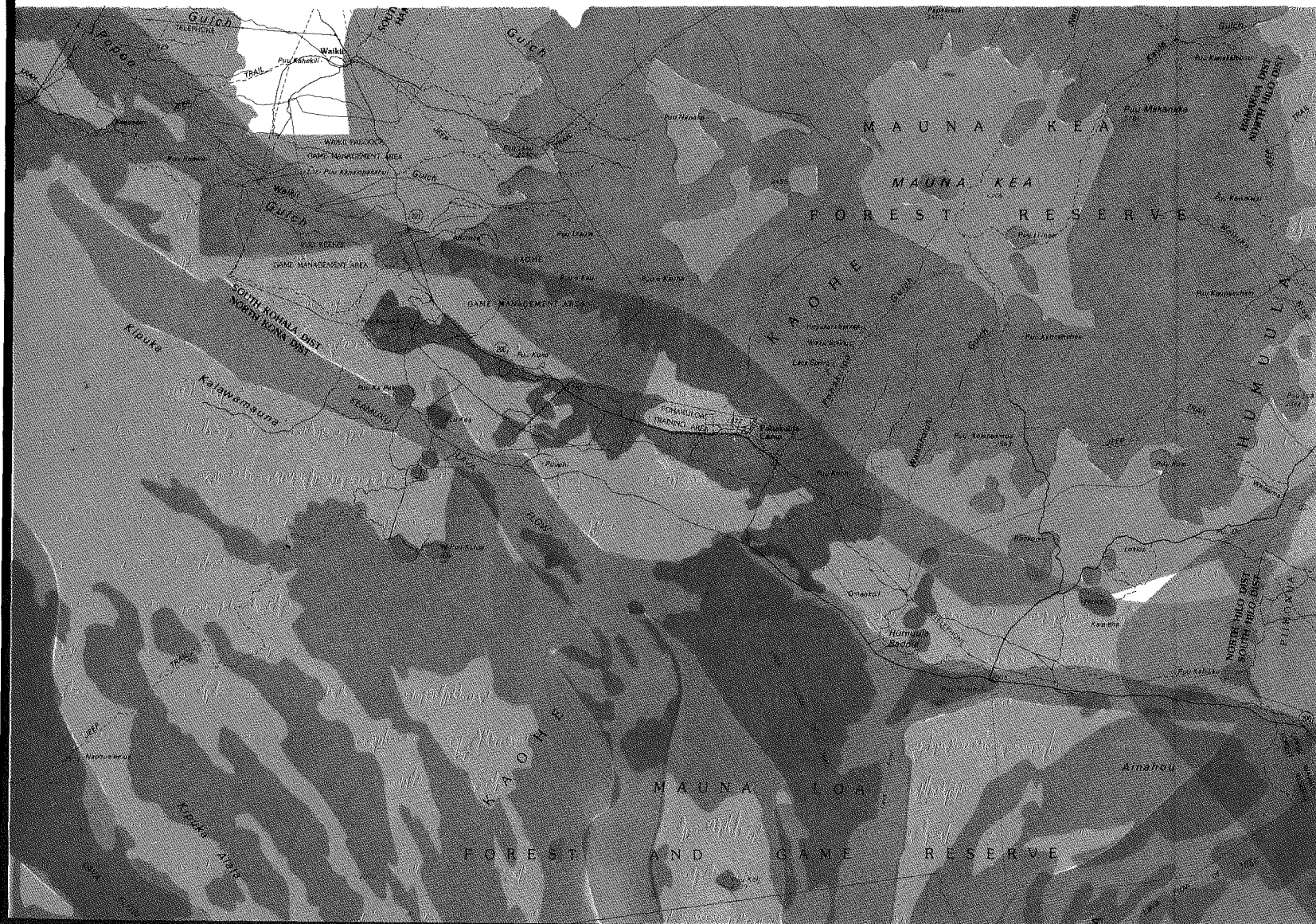


DHM Planners inc.

Range of Constraints

● High Constraint

○ Least Constraint

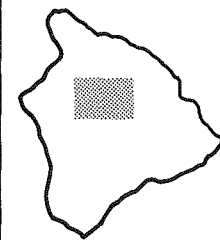


HAWAII DEEP WATER CABLE PROGRAM

PUNA TO KOHALA OVERLAND TRANSMISSION CORRIDOR STUDY

Exhibit III-13

Composite Constraints: Geophysical- Saddle Section



0 1 2 3 4
SCALE IN MILES

DHM Planners inc.

HAWAII
DEEP WATER
CABLE PROGRAM

**PUNA TO
KOHALA
OVERLAND
TRANSMISSION
CORRIDOR
STUDY**

Range of Constraints

● High Constraint

○ Least Constraint

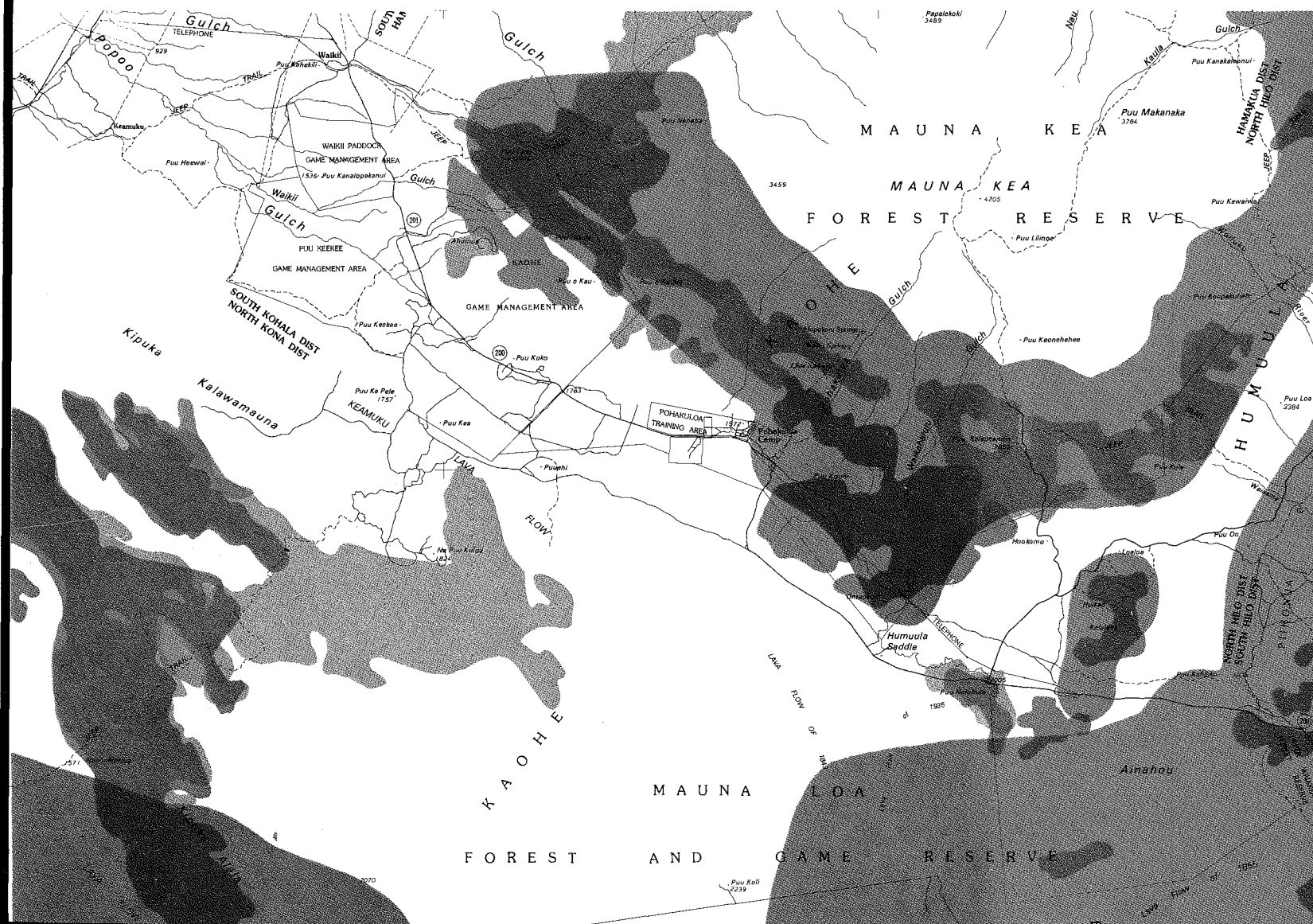
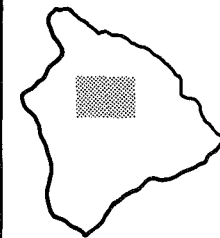


Exhibit III-14

**Composite
Constraints:
Biological-
Saddle Section**



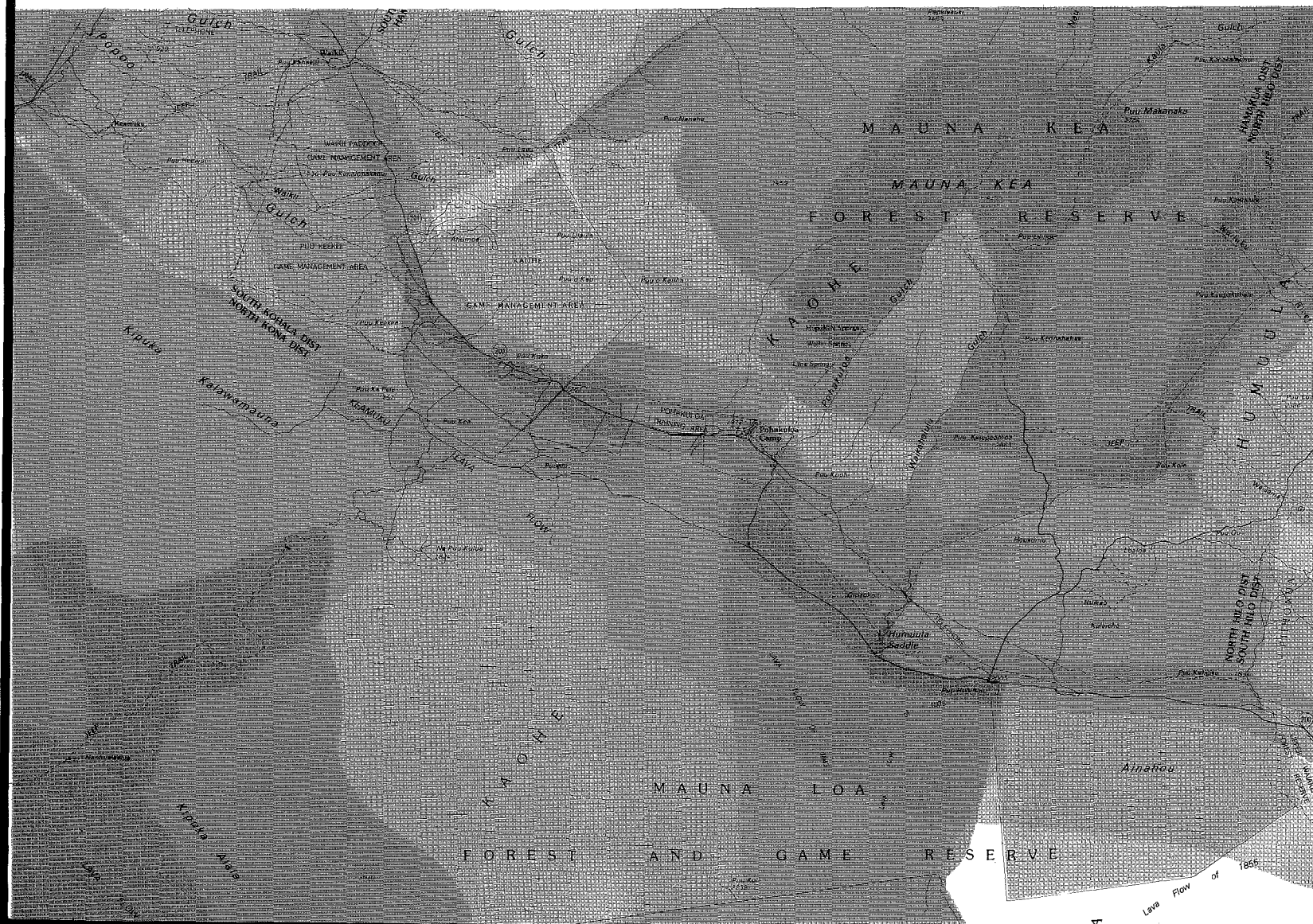
0 1 2 3 4
SCALE IN MILES

DHM Planners inc.

Range of Constraints

● High Constraint

○ Least Constraint

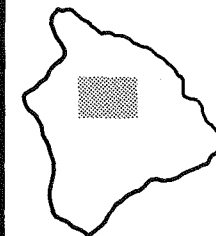


HAWAII
DEEP WATER
CABLE PROGRAM

PUNA TO KOHALA OVERLAND TRANSMISSION CORRIDOR STUDY

Exhibit III-15

Composite
Constraints:
Socio-Economic-
Saddle Section



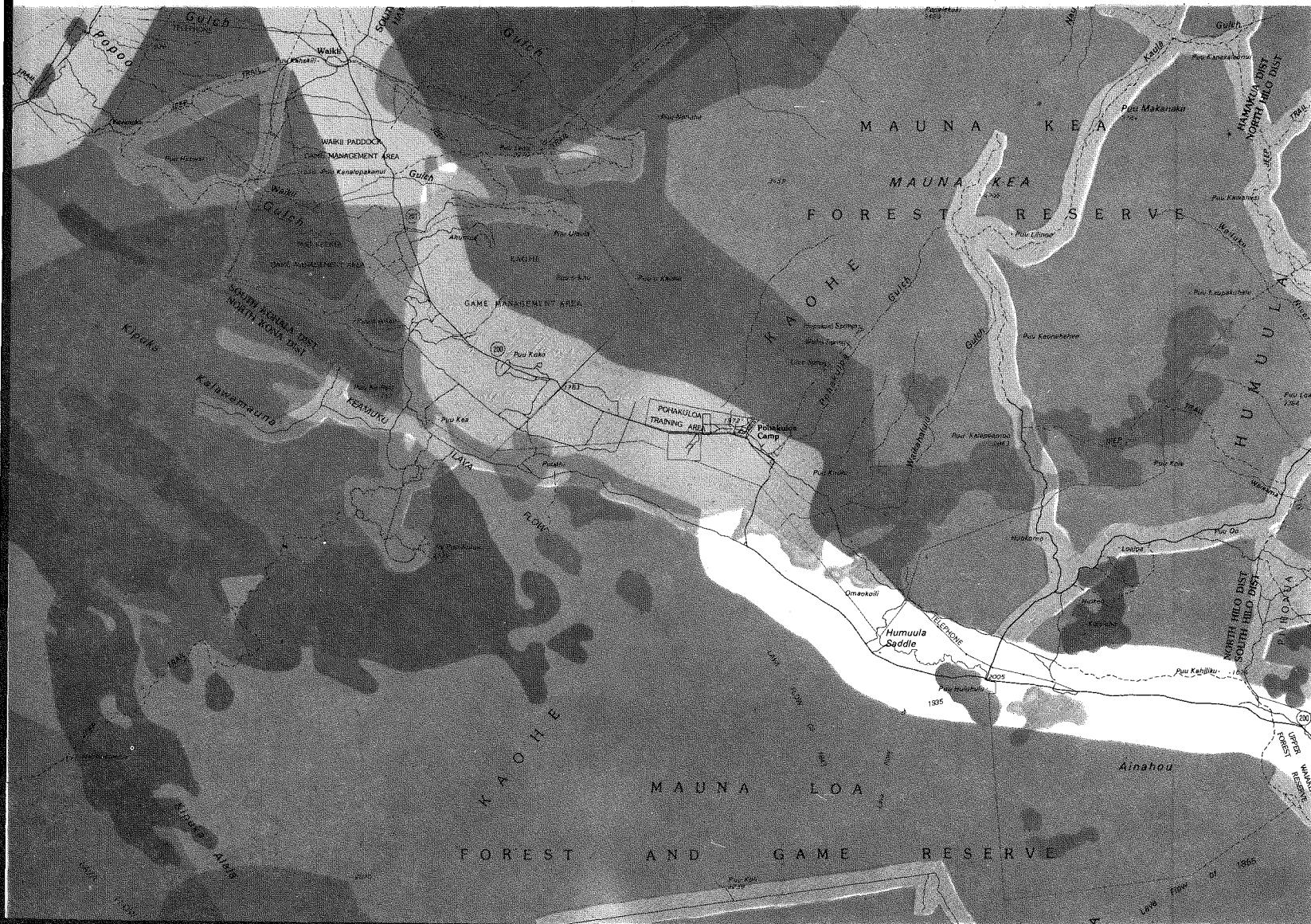
0 1 2 3 4
SCALE IN MILES

DHM Planners inc.

Range of Constraints

● High Constraint

○ Least Constraint

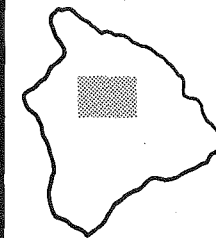


HAWAII
DEEP WATER
CABLE PROGRAM

PUNA TO KOHALA OVERLAND TRANSMISSION CORRIDOR STUDY

Exhibit III-16

Composite
Constraints:
Cost-
Saddle Section



0 1 2 3 4
SCALE IN MILES

DHM Planners inc.

HAWAII
DEEP WATER
CABLE PROGRAM

**PUNA TO
KOHALA
OVERLAND
TRANSMISSION
CORRIDOR
STUDY**

Range of Constraints

- High Constraint
- Least Constraint
- Exclusion Areas

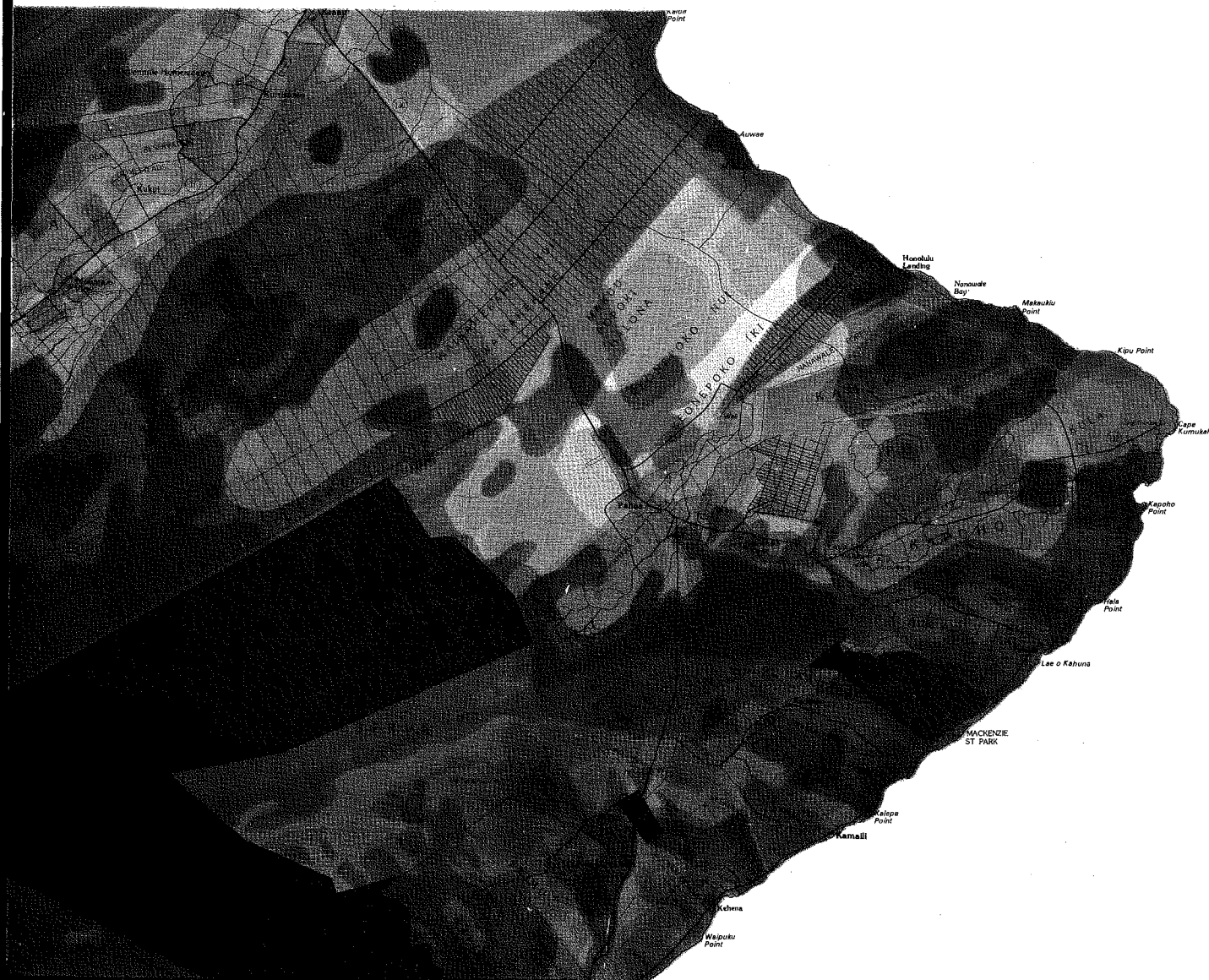
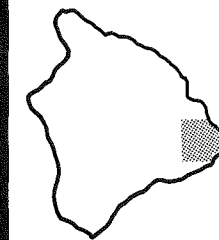


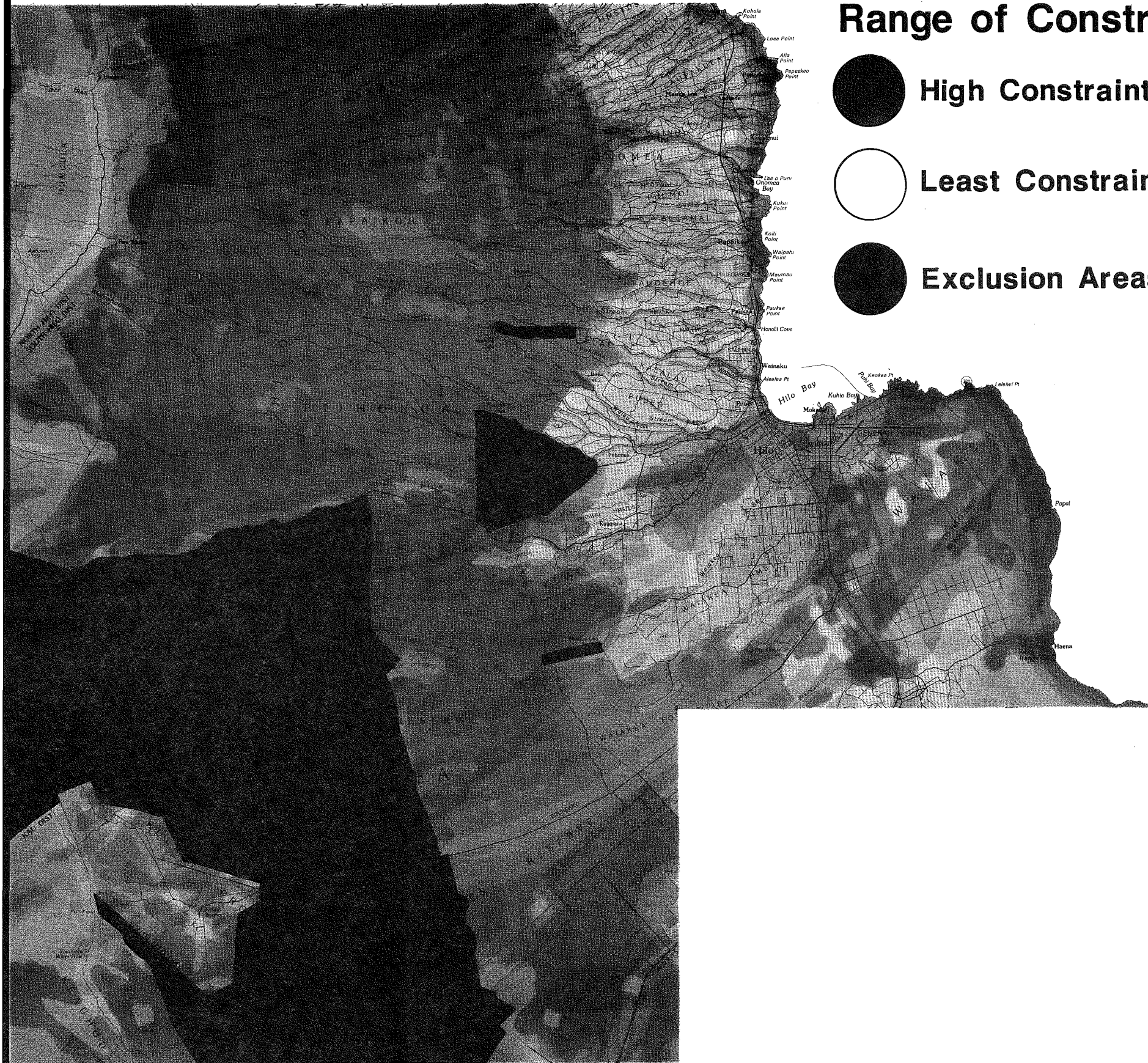
Exhibit III-17

**Composite
Constraints:
All Data Categories—
Puna Section**


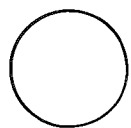



0 1 2 3 4
SCALE IN MILES

DHM Planners inc.



Range of Constraints

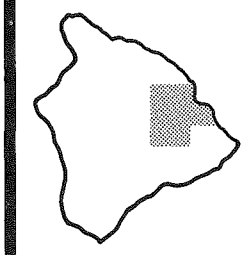
-  High Constraint
-  Least Constraint
-  Exclusion Areas

HAWAII DEEP WATER CABLE PROGRAM

PUNA TO KOHALA OVERLAND TRANSMISSION CORRIDOR STUDY

Exhibit III-18

**Composite
Constraints:
All Data Categories—
Hilo Section**


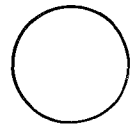



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HAWAII
DEEP WATER
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**PUNA TO
KOHALA
OVERLAND
TRANSMISSION
CORRIDOR
STUDY**

Range of Constraints

-  High Constraint
-  Least Constraint
-  Exclusion Areas

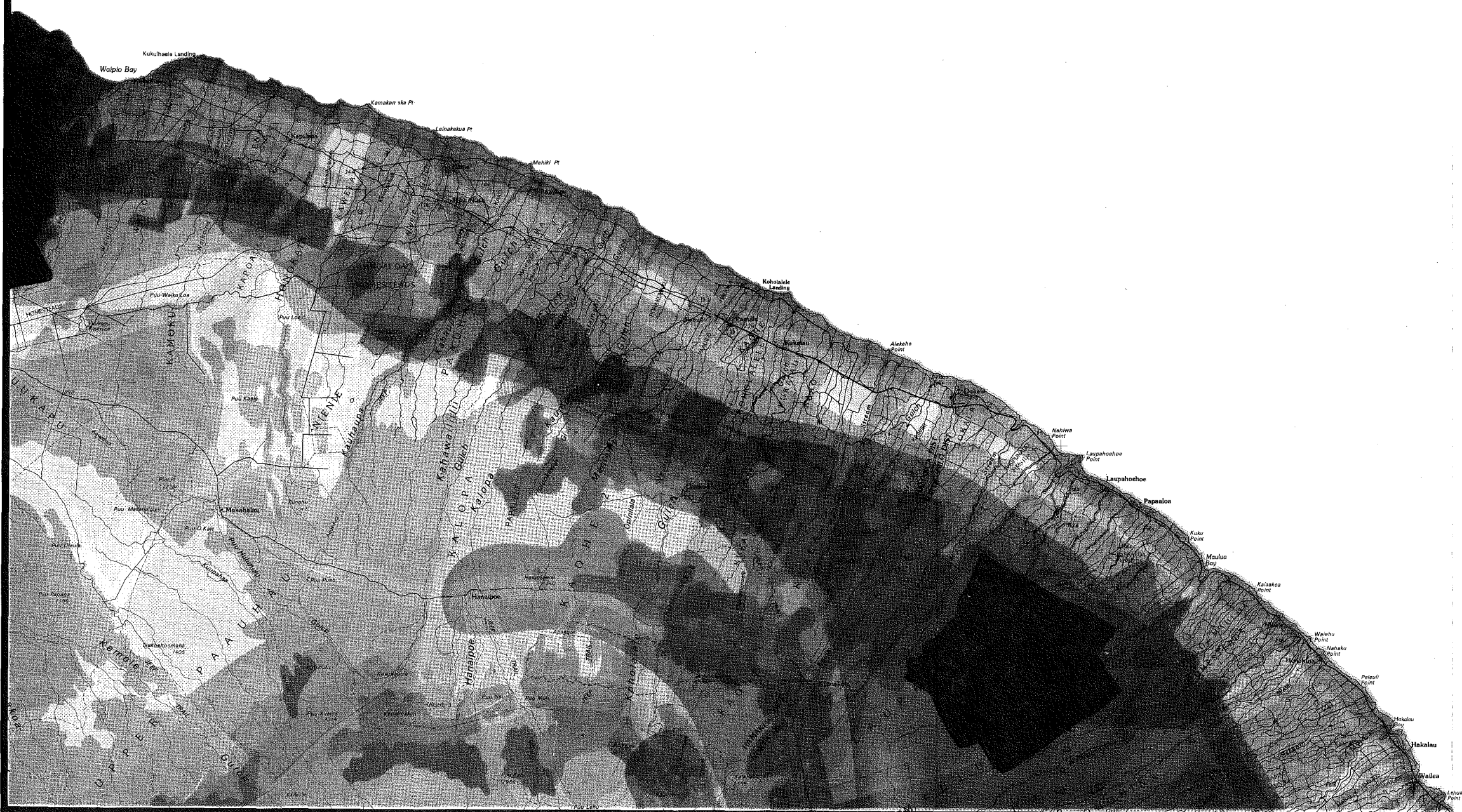
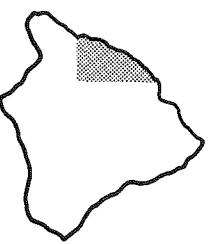

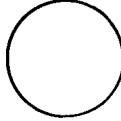



Exhibit III-19
**Composite
Constraints:
All Data Categories-
Hamakua Section**



DHM Planners inc.

Range of Constraints

-  High Constraint
-  Least Constraint
-  Exclusion Areas

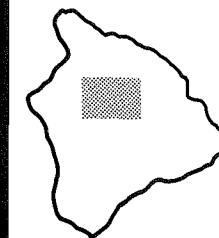


HAWAII
DEEP WATER
CABLE PROGRAM

PUNA TO KOHALA OVERLAND TRANSMISSION CORRIDOR STUDY

Exhibit III-20

**Composite
Constraints:
All Data Categories—
Saddle Section**

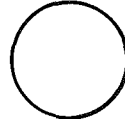
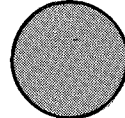
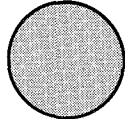


0 1 2 3 4
SCALE IN MILES

DHM Planners inc.

HAWAII
DEEP WATER
CABLE PROGRAM

**PUNA TO
KOHALA
OVERLAND
TRANSMISSION
CORRIDOR
STUDY**

-  Areas of Less Constraint
-  Areas of Greater Constraint
-  Geothermal Resource Subzones

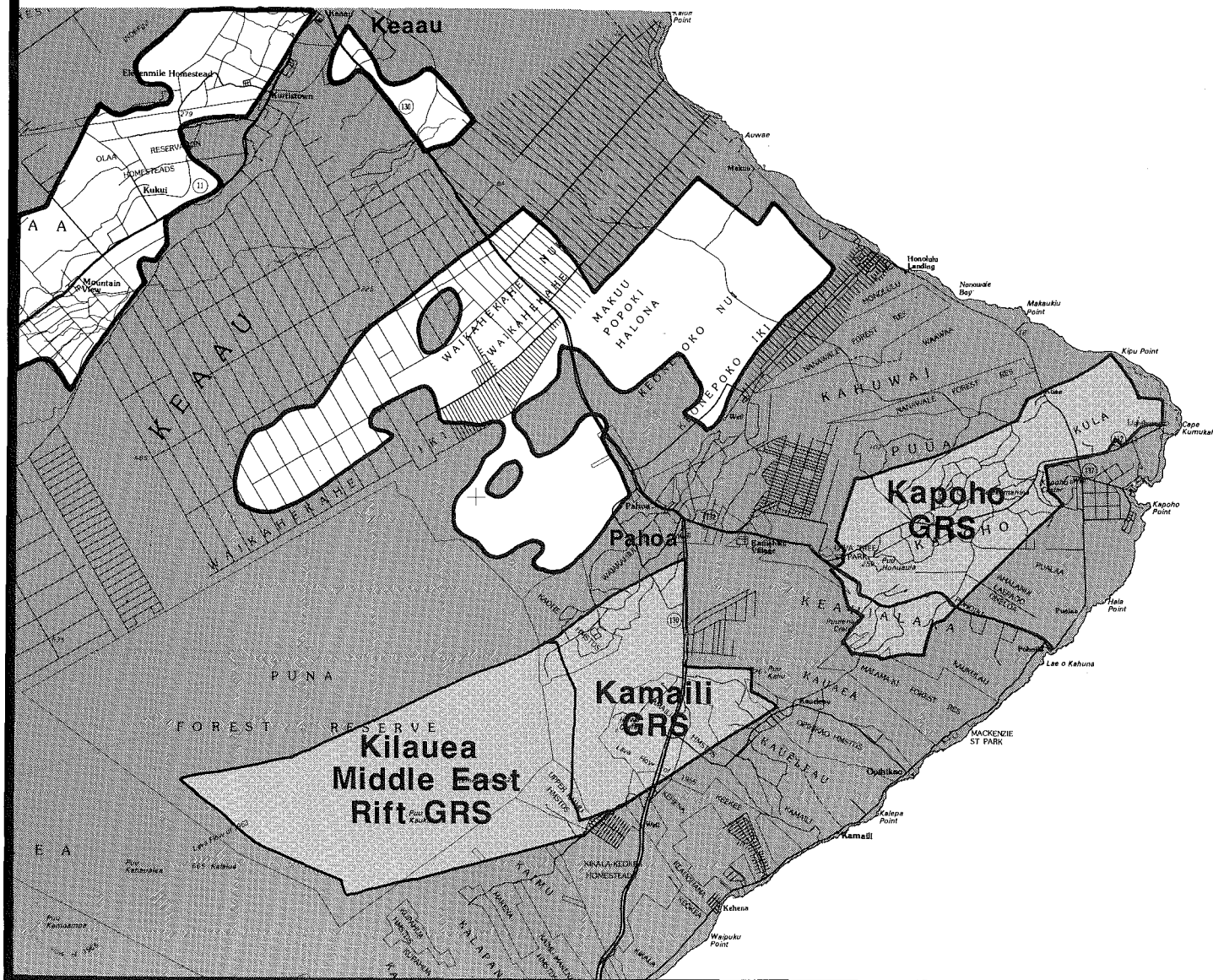
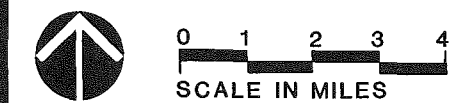
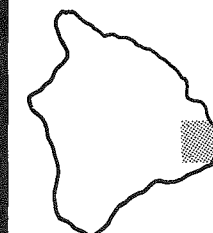
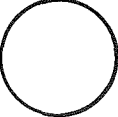
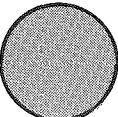


Exhibit III-21
**Areas of
Less Constraint
Puna Section**



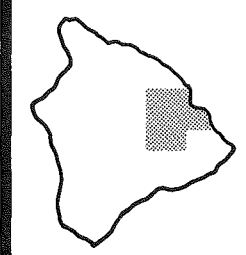
DHM Planners inc.



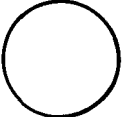

-  Areas of Less Constraint
-  Areas of Greater Constraint

HAWAII
 DEEP WATER
 CABLE PROGRAM
**PUNA TO
 KOHALA
 OVERLAND
 TRANSMISSION
 CORRIDOR
 STUDY**

Exhibit III-22
**Areas of
 Less Constraint
 Hilo Section**



DHM Planners inc.

-  Areas of Less Constraint
-  Areas of Greater Constraint

HAWAII
 DEEP WATER
 CABLE PROGRAM
**PUNA TO
 KOHALA
 OVERLAND
 TRANSMISSION
 CORRIDOR
 STUDY**

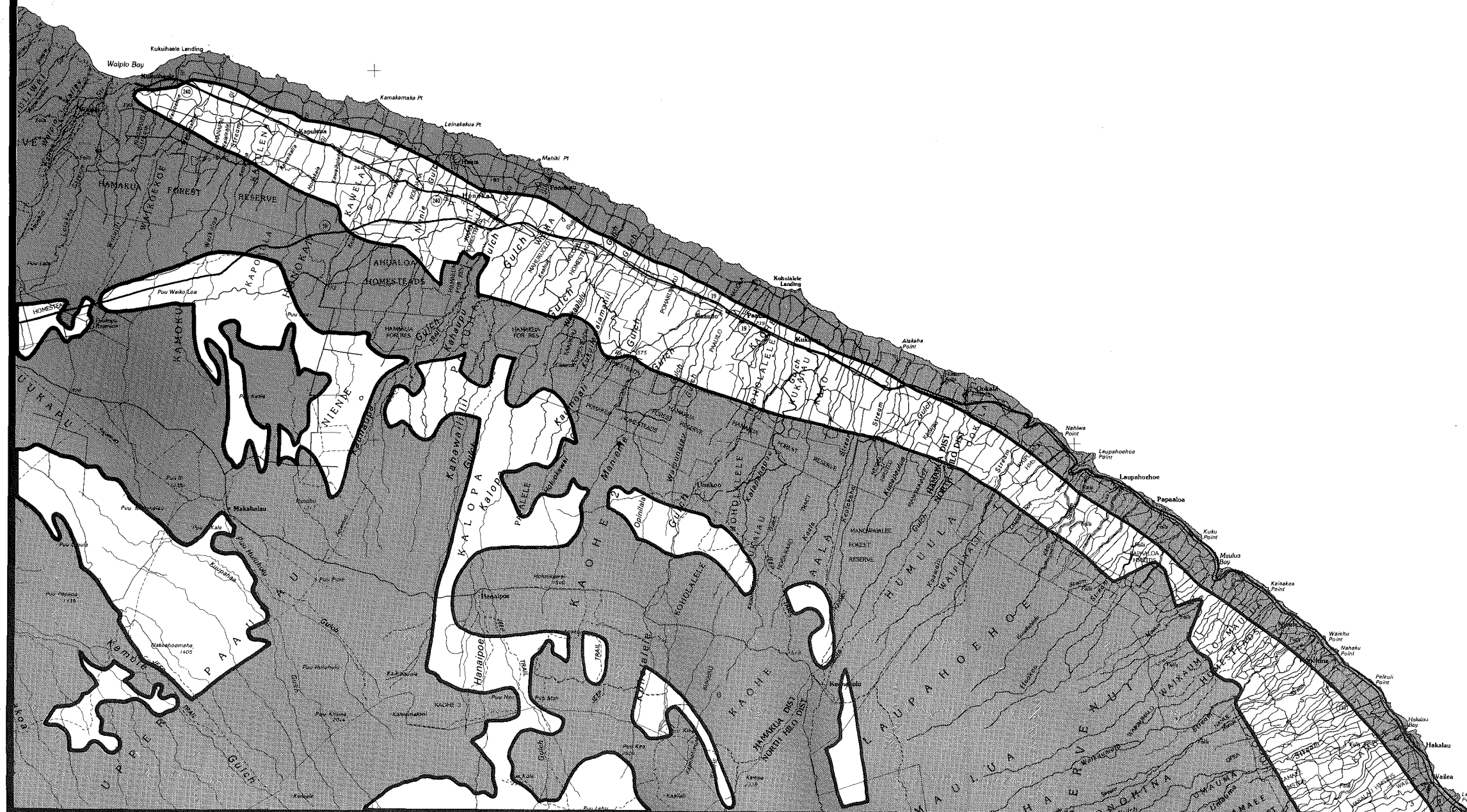
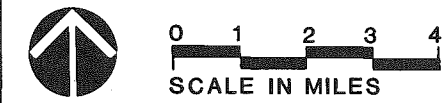
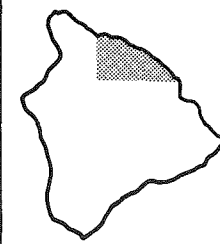
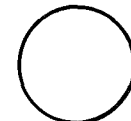
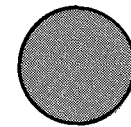


Exhibit III-23
**Areas of
 Less Constraint
 Hamakua Section**



DHM Planners inc.

-  Areas of Less Constraint
-  Areas of Greater Constraint

HAWAII
 DEEP WATER
 CABLE PROGRAM
**PUNA TO
 KOHALA
 OVERLAND
 TRANSMISSION
 CORRIDOR
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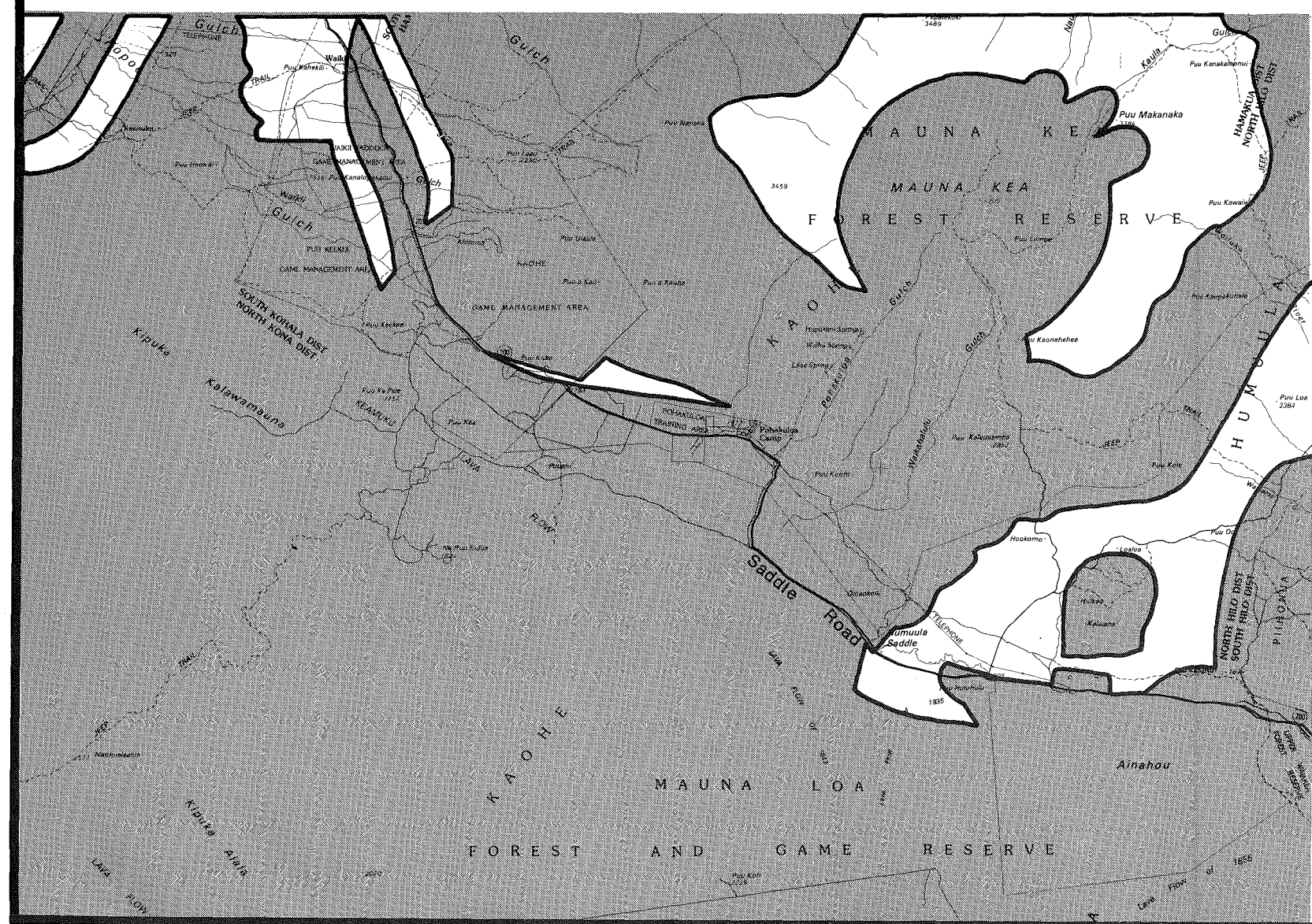
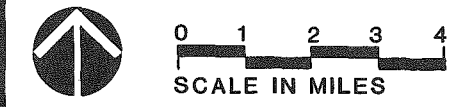
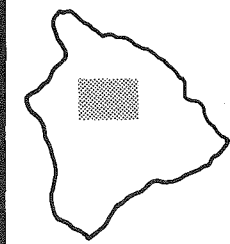


Exhibit III-24
**Areas of
 Less Constraint
 Saddle Section**



DHM Planners inc.

HAWAII
 DEEP WATER
 CABLE PROGRAM
**PUNA TO
 KOHALA
 OVERLAND
 TRANSMISSION
 CORRIDOR
 STUDY**

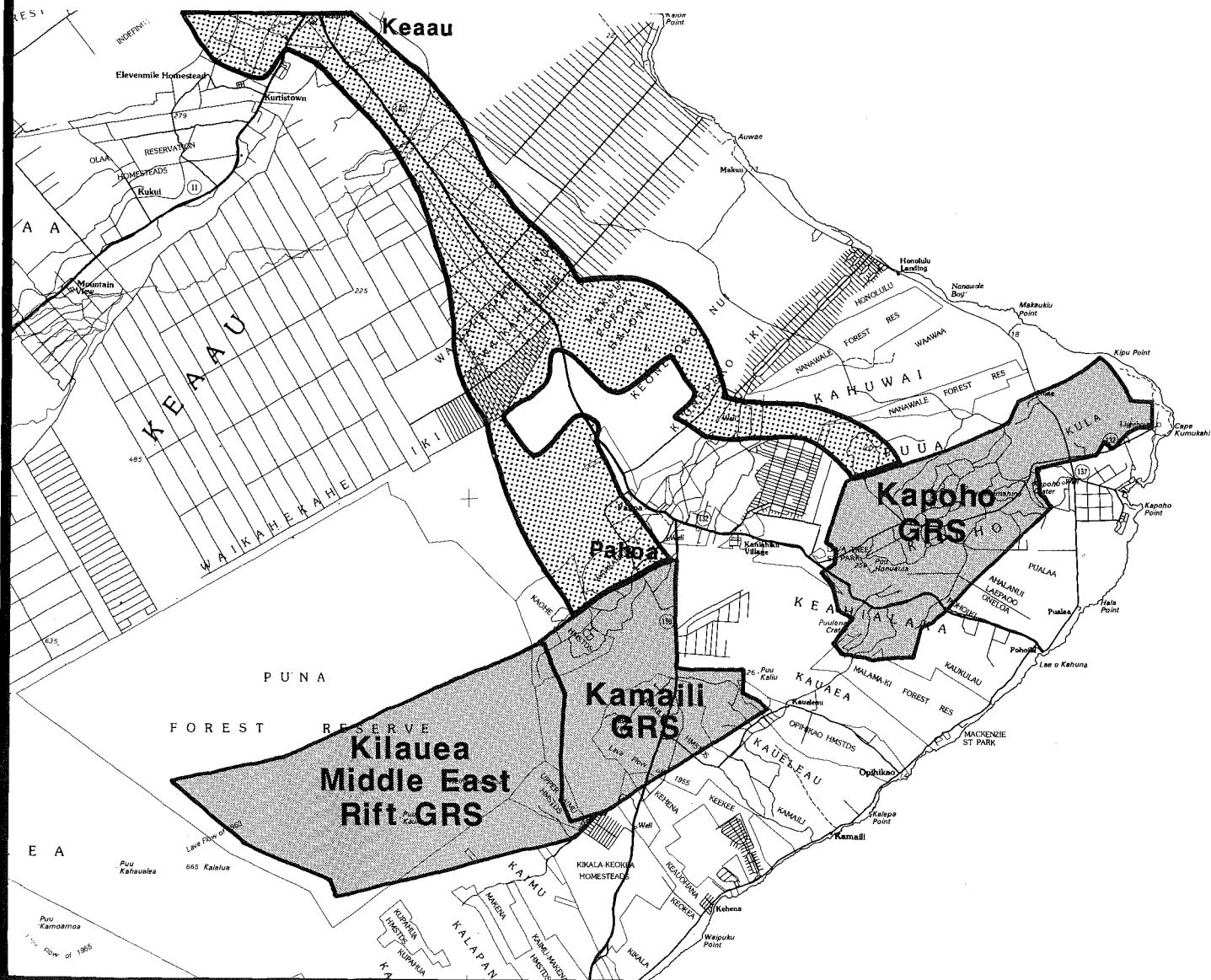
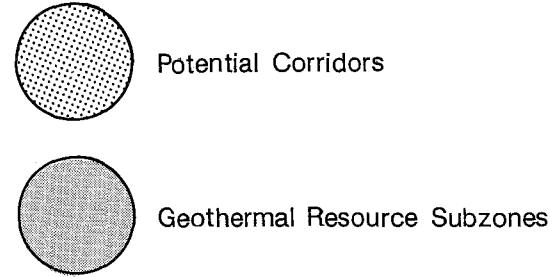


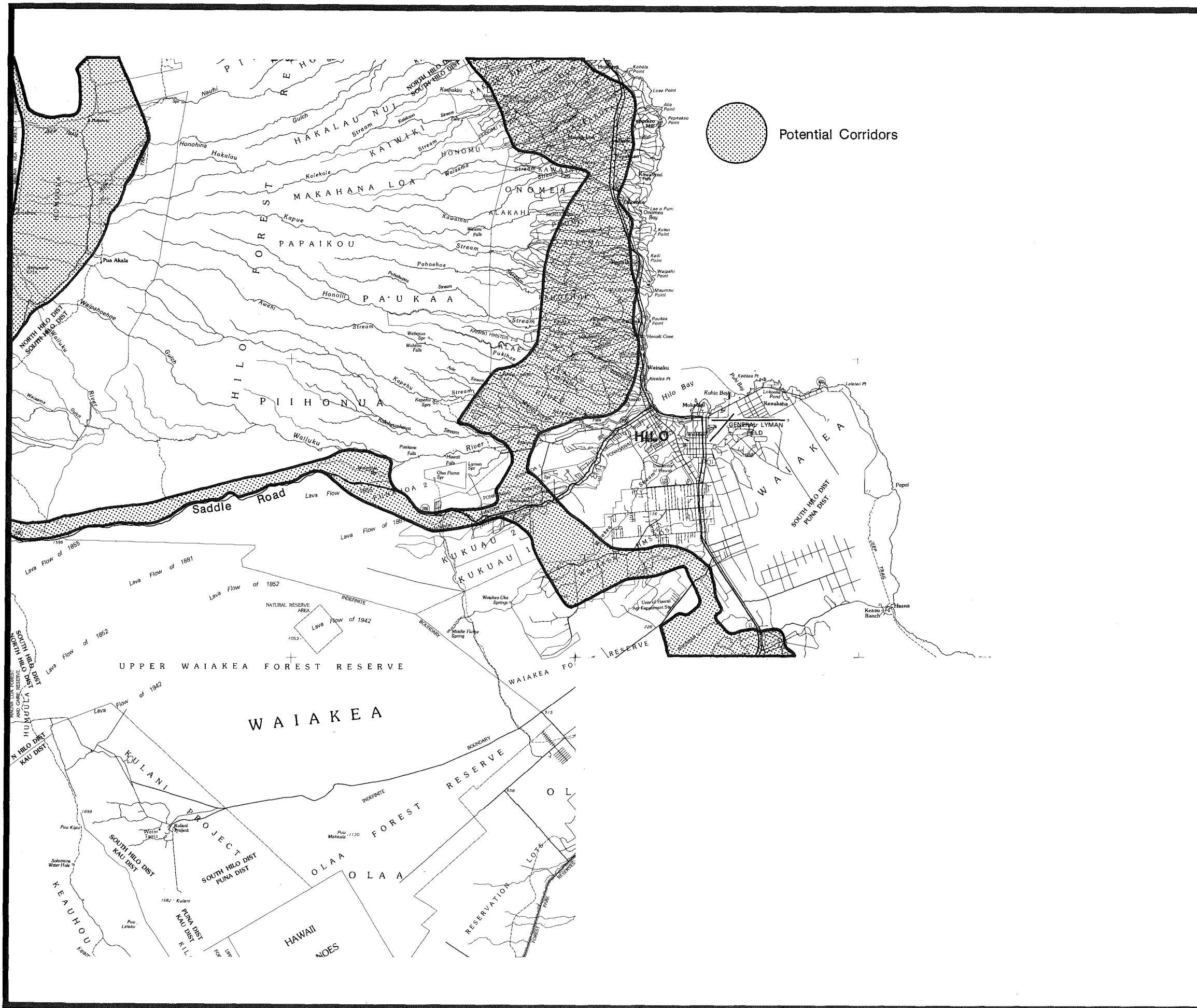
Exhibit III-25
**Potential Corridors:
 Puna Section**



DHM Planners inc.

HAWAII
DEEP WATER
CABLE PROGRAM

**PUNA TO
KOHALA
OVERLAND
TRANSMISSION
CORRIDOR
STUDY**



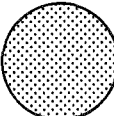
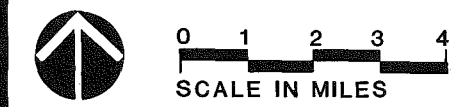
 Potential Corridors

Exhibit III-26
**Potential Corridors:
Hilo Section**



DHM Planners inc.

HAWAII
DEEP WATER
CABLE PROGRAM

**PUNA TO
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OVERLAND
TRANSMISSION
CORRIDOR
STUDY**

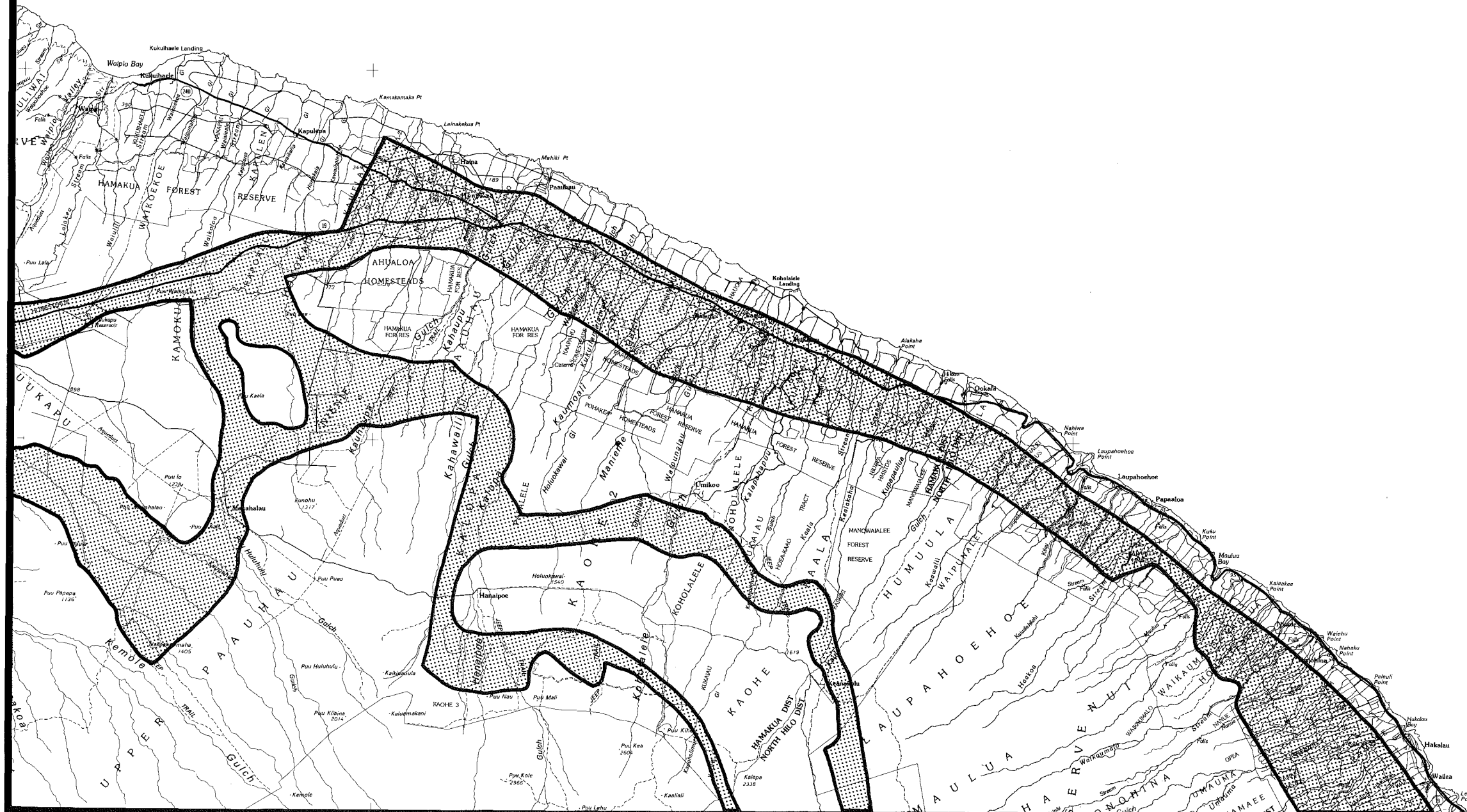
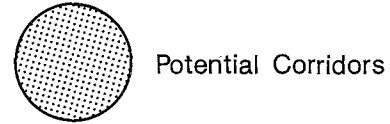
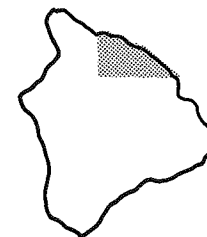


Exhibit III-27
**Potential Corridors:
Hamakua Section**



0 1 2 3 4
SCALE IN MILES

DHM Planners inc.

HAWAII
DEEP WATER
CABLE PROGRAM

**PUNA TO
KOHALA
OVERLAND
TRANSMISSION
CORRIDOR
STUDY**

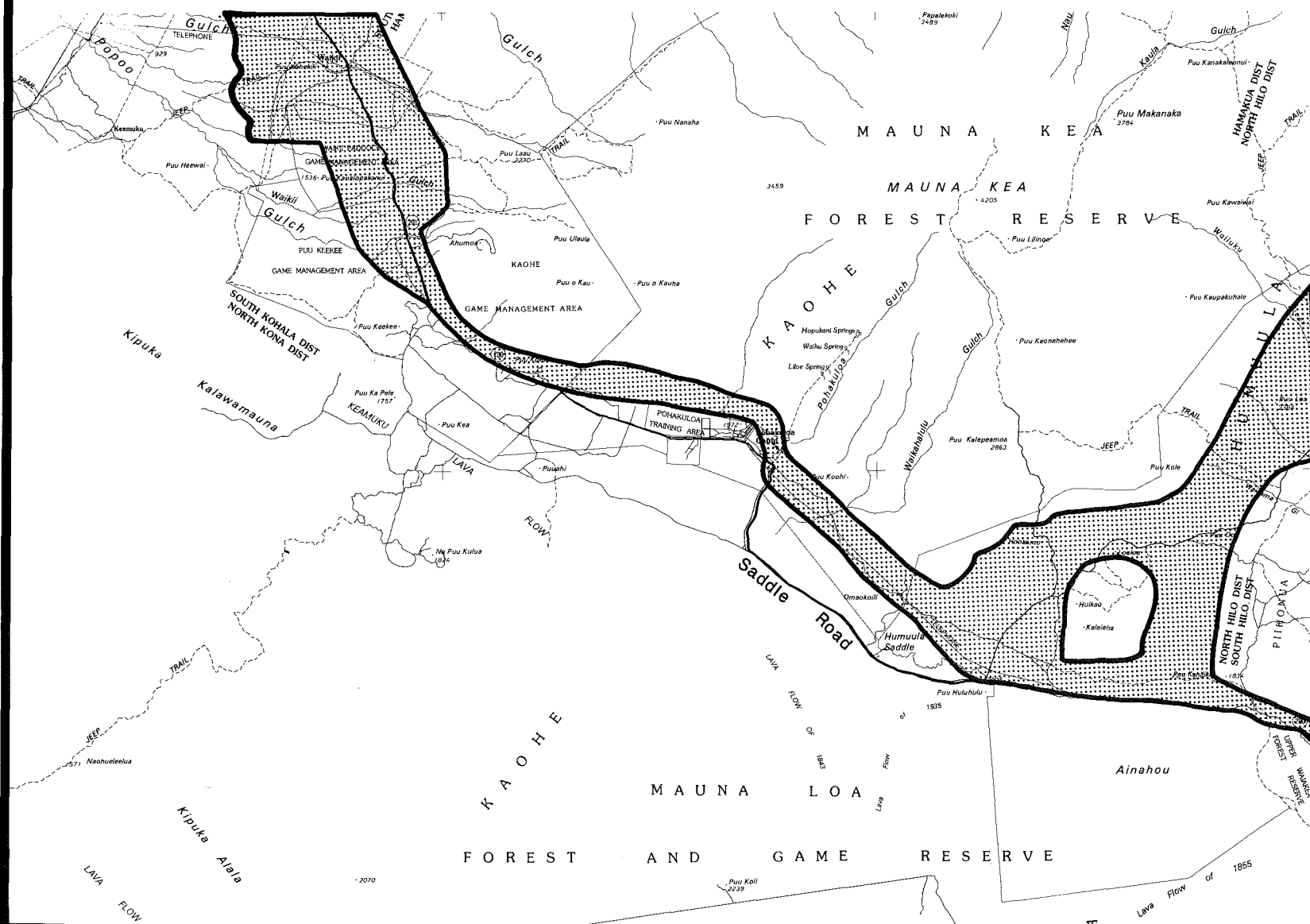
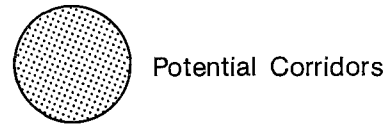
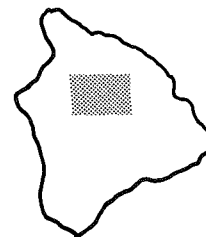


Exhibit III-28

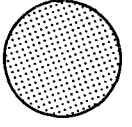
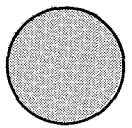
**Potential Corridors:
Saddle Section**



0 1 2 3 4
SCALE IN MILES

DHM Planners inc.

HAWAII
 DEEP WATER
 CABLE PROGRAM
**PUNA TO
 KOHALA
 OVERLAND
 TRANSMISSION
 CORRIDOR
 STUDY**

-  Potential Corridors
-  Geothermal Resource Subzones

(Composite Maps: Puna Area, Hilo Area, Hamakua Area, Saddle Area.)

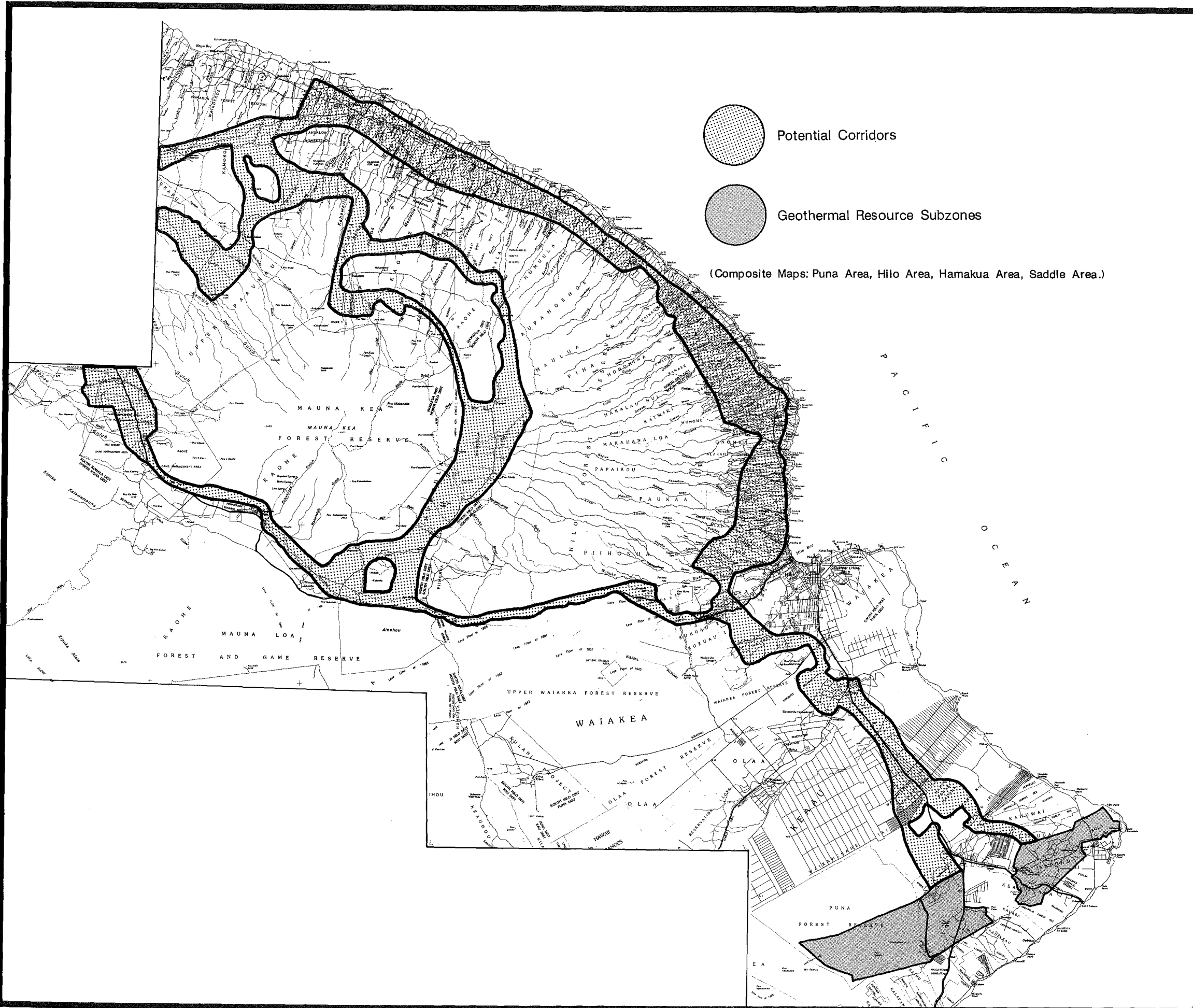
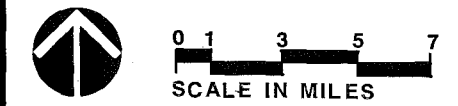
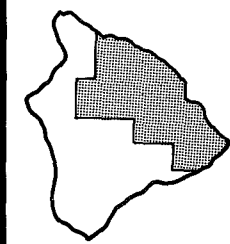


Exhibit III-29
**Potential Corridors:
 Puna Geothermal
 Area to Kohala**



DHM Planners inc.

HAWAII
DEEP WATER
CABLE PROGRAM

**PUNA TO
KOHALA
OVERLAND
TRANSMISSION
CORRIDOR
STUDY**

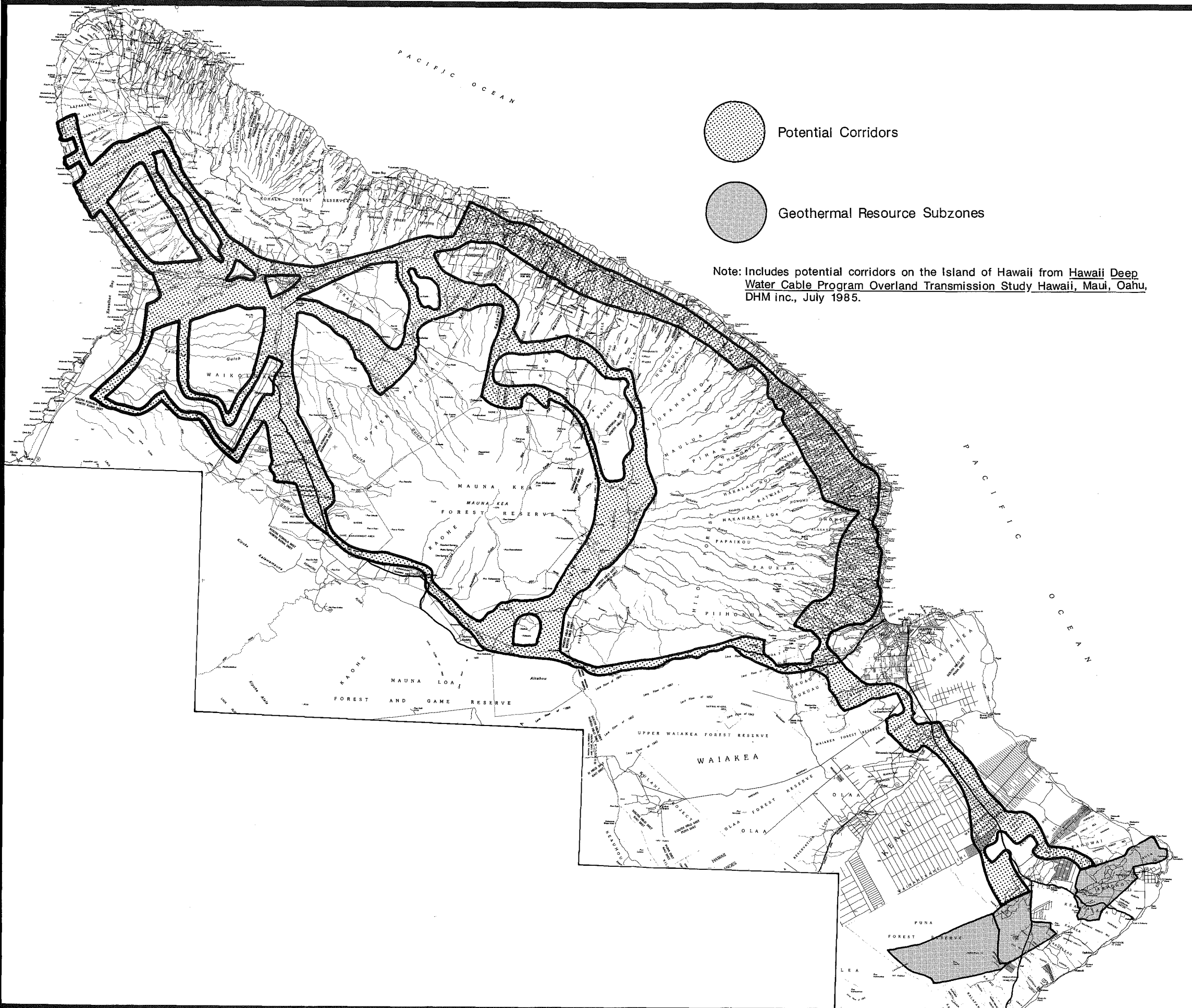
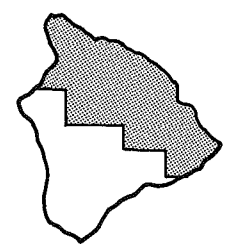


Exhibit III-30

**Potential Corridors:
Puna Geothermal
Area to
Mahukona Coast**



0 1 3 5 7
SCALE IN MILES

DHM Planners inc.

Appendix I

DESIGN CRITERIA

Source: Power Technologies, Inc., Hawaii Deep Water Cable
Program, Phase II-A, Task 2, Electrical Grid System
Investigation, Appendix X, LOP-1 Description, for DPED, 1983.

HVDC LINE COSTING - LINE OPTIMIZATION STUDIES1. INTRODUCTION

This memorandum documents the development of the data for the DC LOP2 study. The output of the LOP2 study was used for an overall transmission system costing study aimed at establishing the optimum DC voltage level.

Presented along with the data development are the results of the LOP2 study which covered three tower types; a guyed lattice mast, a self-supporting lattice and a steel pole tower. Finally, a technical paper, "ECONOMIC AND ENVIRONMENTAL SENSITIVITY ANALYSIS FOR 765 KV LINE DESIGN", describes the LOP2 program and its method of analysis.

Since many of the system variables are ill-defined and also, the transmission line costs are a relatively small part of the system costs, it was assumed that detailed transmission line design and costing studies were not required. Therefore, preliminary studies of structural requirements, insulation requirements, environmental performance, and cost data were performed sufficient to give a design estimate of overall costs. These studies are described below.

2. CONCEPTUAL DESIGNS

Table 1 shows typical phase spacing and crossarm heights based on existing lines. Figure 1 shows the initial configurations chosen for the study.

Table 1. Tower Dimensions

Voltage (kV)	+250	+300	+350	+400
Height to Crossarm (ft)	63	75	88	100
Phase Spacing	25	28	32	35

Caissons were assumed for all foundations and deadman anchors for the guyed towers.

3. STRUCTURAL LOADING CONDITIONS

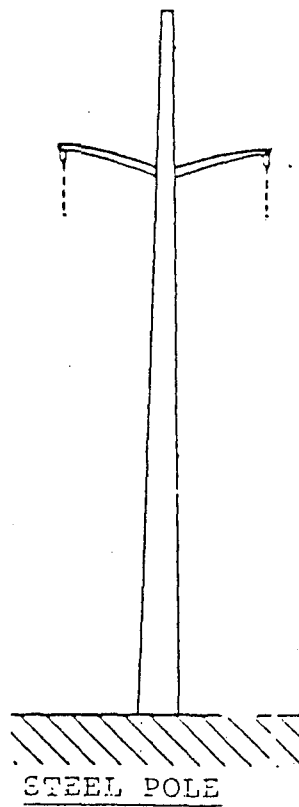
Loading criteria were based upon data received from HECO. Analysis of the Kaumana-Keamuku 138 kV line indicates an average line angle for that terrain of 4.43°. Based on this data and current practice, a wind span of 1.1 and a weight span of 1.3 was assumed. Additionally, the range of spans for this terrain and for all voltage levels was assumed as 600-1300 feet.

The structural loading criteria was defined as shown in Table 2. Analysis of the DC line routing on Big Island indicates that approximately 22 miles of the 80 mile proposed line route will in the heavy loading region (above 6500 feet).

Table 2. Loading Agenda

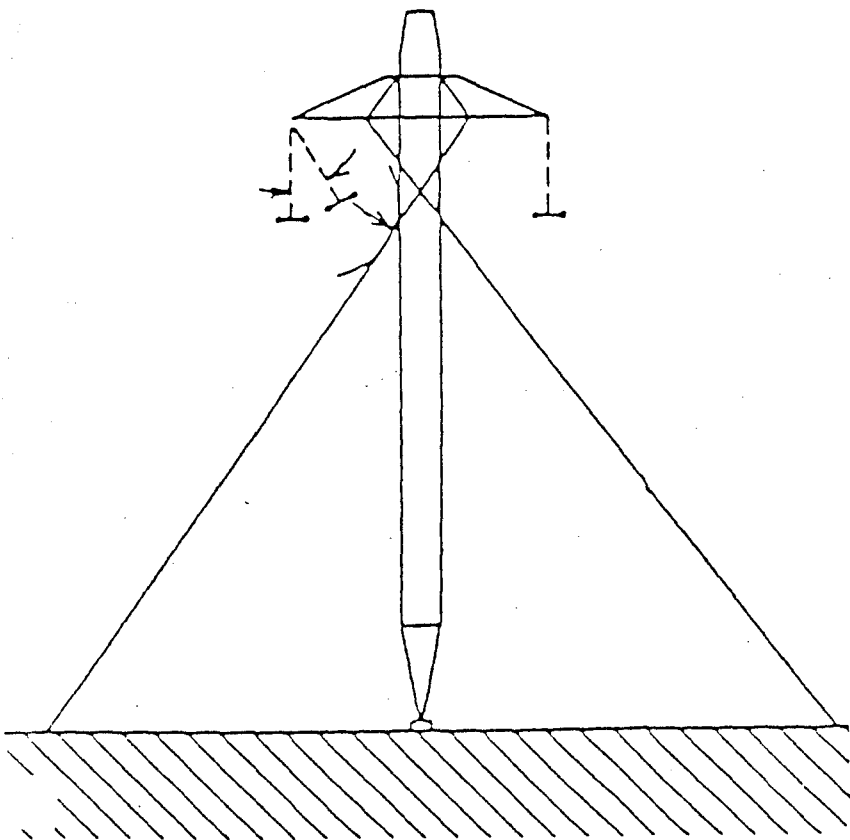
Region	Loading	Wind (PSF)	Ice (Inches)	Temp (°F)	OLF	
					Wind	Angle
Heavy	Transverse	7	.5	0	2.54	1.65
	Vertical	4	.5	0	1.5	-
	Longitudinal*	-	-	-	-	-
Light	Transverse	16	0	50	2.54	1.65
	Vertical	9	0	0	1.5	-
	Longitudinal*	-	-	-	-	-

*Longitudinal loading is defined as a broken phase at EDT with .3pu tension reduction.

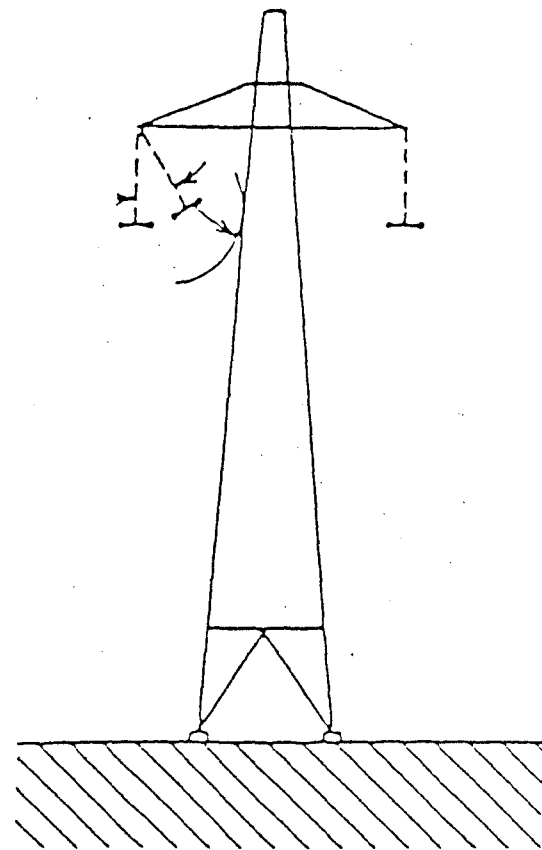


STEEL POLE

FIGURE 1 LOP2 TOWER TYPES



GUYED TOWER



SELF SUPPORTING LATTICE

4. PREDESIGN MATRIX AND WEIGHT FORMULAE

Table 3 shows the predesign loading matrix based on the loading criteria described above and a range of conductors as shown. An effort was made to use HECO standard conductors but based on current practice, loss requirements and environmental constraints, larger conductors will be required for the higher DC voltage levels and MW loadings. However, in accordance with HECO practice, the conductor types were limited to all aluminum conductors (AAC, AAAC, ACAR). The crossarm heights were based on estimates of maximum sag for the candidate conductors and for the assumed midspan clearances as described in the following section. Since the loads resulting from the heavy and light load criteria were similar for the same conductor/span combination, it was decided to specify the same tower for both regions. The governing loads will then be:

transverse - light load

vertical - heavy load

longitudinal - either

Table 3. Predesign Spans, Heights and Loadings

A. <u>Heavy Load</u>		<u>Conductor</u>	<u>Span</u>	<u>Height</u>	<u>T</u>	<u>V</u>	<u>L</u>
<u>Voltage</u>	<u>(+kV)</u>		<u>(ft)</u>	<u>(ft)</u>	<u>(kips)</u>	<u>(kips)</u>	<u>(kips)</u>
250		1x2500 AAC	600	56	15.00	9.88	8.05
		1x3000 ACAR	1300	94	27.47	24.36	11.09
300		1x2750 AAC	600	63	15.70	10.57	8.87
		2x1600 ACAR	1300	101	35.61	29.56	11.71
350		1x3000 AAC	600	70	16.39	11.21	9.08
		2x1700 ACAR	1300	108	36.44	30.78	12.39
400		2x1590 AAC	600	77	20.60	13.59	10.39
		2x1800 ACAR	1300	115	37.30	32.01	13.13
B. <u>Light Load</u>							
250		1x2500 AAC	600	56	16.41	6.15	8.05
		1x3000 ACAR	1300	94	31.98	15.70	11.69
300		1x2750 AAC	600	63	17.32	6.69	8.87
		2x1600 ACAR	1300	101	40.89	16.50	11.71
350		1x3000 AAC	600	70	18.23	6.71	9.68
		2x1700 ACAR	1300	108	42.19	17.46	12.39
400		2x1590 AAC	600	77	22.77	7.57	10.39
		2x1800 ACAR	1300	115	43.53	18.40	13.13

Table 4 shows the tower weight estimating formulae developed by H. B. White based on the conceptual designs and the predesign matrix. It is noteworthy that the steel pole application was initially limited to 600-800 foot spans based on experience where weight limitations become a constraint. If the poles are slip jointed, this may not be a constraint.

Table 4. Tower Weight Formula (+250 to +400 kV)

a. Steel Pole (600-800 foot span)

$$W = 7.0 + .16 (H-56) + .06 (P-25) + .28 (T-15) + .06 (V-10) + .06 (L-11)$$

b. Guyed Mast & Guys (600-1300 foot span)

$$W = 4.5 + .038 (H-78) + .03 (P-32) + .055 (T-23) + .02 (V-14) + .08 (L-14)$$

c. Lattice Mast (600 - 1300 foot span)

$$W = 5.95 + .09 (H-56) + .03 (P-25) + .1 (T-15) + .02 (V-10) + .08 (L-14)$$

d. Lattice Tower (600 - 1300 foot span)

$$W = 4.5 + .065 (H-56) + .03 (P-25) + .08 (T-15) + .02 (V-10)$$

where

W = tower weight (kips)
 H = tower height (feet)
 P = phase spacing (feet)

T = transverse loading (kips)
 V = vertical loading (kips)
 L = longitudinal loading (kips)

5. GROUND CLEARANCE

Ground clearances can be calculated based on the NESC(1) as follows:

$$GC = 22 + \left(\frac{V - 50}{100} \right) + 8.5 = 34.72 \text{ feet}$$

where GC = ground clearance at 50°F final

22 = basic clearance for land accessible to vehicles

= voltage adder for + 250 kV DC

8.5 = sag increase from 50°F to 212°F final for the candidate conductor at 600 foot span

Table 5 was prepared on this basis showing the NESC requirements and those assumed for the study. The margins defined for the study increase with voltage level based on the assumed impact of space charge effects on the electrical field at ground level. (2)

Table 5. Ground Clearances

<u>Voltage</u> (+kV)	<u>Span</u> (feet)	<u>NESC Clearance</u> (feet)	<u>Study Clearance</u> (feet)
250	600	34.72	40
	1300	39.22	40
300	600	35.90	42
	1300	40.40	42
350	600	37.08	45
	1300	41.58	45
400	600	38.26	50
	1300	42.76	50

6. INSULATOR REQUIREMENTS

Lightning and switching surges have less impact on DC system reliability than EHV AC systems because of the automatic ramp-back nature of DC converter control. In addition, switching surges are limited to the relatively low levels of <1.7 p.u. and lightning is unlikely to be a problem as the ceramic level in Hawaii is only 7-10.

The above arguments result in insulator string length normally being the limiting factor for HVDC clearance to crossarm requirements. Therefore, in order to reduce the axial length of the insulator string it is normal to employ insulators with a high ratio of leakage distance to axial length. These are anti-fog insulators and the number/type depend upon local contamination conditions. Assuming a light contamination condition (ESDD of .04 - .05 mg/cm²) and an EPRI Type 1 insulator (2), Figure 8.25 of Reference 2 gives withstand values of .7 - .42 kV/cm of leakage. The Type 1 insulator has dimensions as follows:

axial length = 165 mm
 diameter = 321 mm
 leakage = 508 mm

Converting the withstand values to kV/unit for this insulator results in a withstand strength of 35.56 - 21.34 kV/unit. Taking the weakest strength and converting this to the more common inches of leakage per kV of stress gives .94 inches per kV. Other HVDC lines typically specify a value of 1.0 inch per kV and this was assumed for the present study. Therefore, the withstand strength of the Type 1 insulator is 20 kV/unit and Table 6 gives the resulting string lengths for the various voltage levels.

Table 6. Insulator Requirements

<u>Voltage</u> (+kV)	<u>Number of Units</u>	<u>Axial Length</u> (feet)	<u>Overall Length*</u> (feet)
250	13	7.04	8.04
300	15	8.12	9.12
350	18	9.74	10.74
400	20	10.83	11.83

*Includes 12 inch hanger

Normal practice for HVDC insulator configurations is to assume I-strings. This is because, unlike EHV AC, HVDC V-strings do not show an improvement in contamination performance. In addition, since there is no center phase with DC and the insulator strings are relatively short, there is less advantage to restricting insulator swing. Therefore I-strings were assumed.

7. CLEARANCE REQUIREMENTS

Tower clearances and hence pole spacing are determined by the clearances required to withstand the steady state HVDC, switching surges and lightning. No estimates of lightning requirements were made as the lines will be shielded and the ceramic level is low (7-10). In any case, the impact of lightning on overall costs would be minor.

7.1 HVDC Clearances

Figure 10-3 of Reference 2 gives positive polarity CFO strength as a function of gap length for a simulated tower - conductor gap. For a given HVDC stress, the strength can be calculated as follows:

$$\text{Stress} < \text{CFO} \times (1-3) \times \text{RIS}$$

where Stress = 250 kV etc.

CFO = 50% PFO strength

CFO(1-3) = withstand for 1 gap
= standard deviation

RIS = relative insulation strength

The standard deviation was assumed as .9% (2) and the RIS at a 6500 feet altitude altitude as .75 p.u. This approach allows the CFO to be calculated and hence the required air gap. The air gap is normally applied with the insulator in a displaced position due to some extreme wind. Table 7 shows the results of these calculations for an assumed swing angle of 60°. This is the average swing angle for all the conductors shown in Table 3 with an extreme wind of 80 mph and a weight span to wind span of 1.54.

Table 7. HVDC Clearances

<u>Voltage</u> (+kV)	<u>Air Gap</u> (ft)	<u>Displacement</u> 60° (ft)	<u>Pole Spacing*</u> (ft)
250	2.14	6.96	22.20
300	2.56	7.90	24.92
350	2.99	9.30	28.58
400	3.42	10.25	31.33

*Tower width of 4 feet included.

7.2 Switching Surge Clearances

Figure 10-13 of Reference 2 gives the positive polarity CFO strength for a rod-plane gap which is representative of a tower-conductor gap. The stress can be calculated assuming a 1.7 p.u. overvoltage extant on the whole line. Switching surge performance calculations involve the convolution of distributions of stress, strength, RIS and wind swing. This is a complicated procedure normally done numerically with a computer and requiring detailed data. In the absence of this data, simplifying assumptions were made and a manual calculation performed to estimate switching surge clearance requirements.

Since switching surges are statistically random events with respect to time, the appropriate RIS and wind swing assumptions are every day conditions. This is the reverse of the steady state analysis where the stress was every day and the RIS/wind swing was applied under extreme conditions. One other difference with steady state calculations is that all the towers in the line must be considered since the every day conditions apply to them all.

With these assumptions, the clearances can be estimated from:

$$\text{Stress} < \text{CFO} \times (1-4.7) \times \text{RIS}$$

where

$$\text{Stress} = 250 \text{ kV} \times 1.7 \text{ etc.}$$

$$\text{CFO} = 50\% \text{ PFO strength}$$

$$\text{CFO}(1-4.7) = \text{Withstand for 500 gaps (3)}$$

$$= \text{Standard deviation}$$

$$\text{RIS} = \text{Relative insulation strength}$$

The standard deviation of the stress was assumed as zero and for the strength as 6%. The RIS was assumed as .85 p.u. and the swing angle as 15° . Table 8 shows the results of these calculations and in comparison with Table 7 it can be seen that switching surge clearances are the limiting condition at the higher line voltages but that steady state clearances are limiting at the low end.

Table 8. Switching Surge Clearances

<u>Voltage</u> (+kV)	<u>Stress</u> (kV)	<u>CFO</u> (kV)	<u>Air Gap</u> (ft)	<u>Displacement</u> 15° (ft)	<u>Pole Spacing*</u> (ft)
250	425	696	6.23	2.08	20.62
300	510	835	7.87	2.36	24.46
350	595	974	9.84	2.78	29.24
400	680	1113	13.45	3.06	37.02

*Tower width of 4 feet included.

The analyses shown in Tables 7 and 8 would need considerable refinement for actual tower designs, but are sufficient for preliminary line costing purposes.

8. RI/AN ANALYSIS

Table 9 shows typical ROW widths as a function of voltage level.

Table 9. ROW Widths

<u>Voltage</u> (+kV)	<u>Row</u> (feet)
250	115
300	135
350	155
400	175

Analysis of existing lines indicates typical HVDC RI/AN criteria at the edge of ROW as:

Radio Interference 50 db L₅₀ fair weather

Audible Noise 40 db(A) L₅₀ fair weather

The two conductor bundles were not limited by the RI criterion and in no case was the AN criterion limiting. Table 10 shows the limiting conductor diameters for the single conductor bundles.

Table 10. Limiting Single Conductor Bundle Diameters

<u>Voltage</u> (+kV)	<u>Conductor Diameter</u> (inches)
250	≥ 1.41
300	≥ 1.87
350	≥ 2.32
400	*

*Only two conductor bundles considered.

Appendix II

DHM inc.

land use
and environmental
planning

1188 Bishop Street
Suite 2405
Honolulu, HI 96813
Ph. (808) 521-9855

April 28, 1987

U. S. Army
Support Command Hawaii
Attn. APZZ-FE
Ft. Shafter, Hawaii 96858

Dear sirs,

SUBJECT: 300 kVdc Overland Transmission Corridor Identification
Pohakuloa Military Base

We have been contracted by Parsons Hawaii, an engineering company who is under contract to Hawaiian Electric Company and the State Department of Planning and Economic Development. Our task is to analyze potential physical, biological and socio-economical constraints in identifying potential corridors for the 300 kVdc transmission line.

This 300 kVdc overland transmission corridor identification study is a part of the "Hawaii Deep Water Cable Program (HDWC) Overland Transmission Corridor Study". The purpose of the HDWC Program is to study the feasibility of transmitting the potential electricity generated at geothermal power plants in the Puna region on the Island of Hawaii, to Oahu via overland and undersea transmission lines.

For the purpose of this planning study we would like to learn the constraints which you might place on the alignment of 300 kVdc transmission line through the Pohakuloa military base. We would like to be able to determine the potential areas in which the proposed 300 kVdc transmission poles (approximate height - 90 feet with 135-200 foot right-of-way) can be erected without interfering with military activities. To avoid any possible misunderstanding regarding an appropriate corridor alignment, we would like to obtain maps of the military base with impact zones, firing ranges, flight take-off and landing zones and any other zones which should be completely excluded as a possible corridor for the transmission lines.


Subject: Hawaii Deep Water Cable Program
300 kVdc Overland Transmission Corridor Identification

page 2

In order to meet our project schedule we would appreciate having this information by May 20th. If you have any questions or need further clarification, do not hesitate to call Rachel Sheffield at 521-9855.

Sincerely,

DHM inc.



Duk Hee Murabayashi (Mrs.)
President

RS:rs



DEPARTMENT OF THE ARMY
HEADQUARTERS UNITED STATES ARMY SUPPORT COMMAND, HAWAII
DUNNING HALL
FORT SHAFTER, HAWAII 96858-5000

REPLY TO
ATTENTION OF:

July 20, 1987

Director of Facilities
Engineering

Mrs. Duk Hee Murabayashi
President, DHM inc
1188 Bishop Street
Suite 2405
Honolulu, HI 96813

Dear Mrs. Murabayashi:

Reference is made to your letter dated April 28, 1987, subject: 300 KVdc Overland Transmission Corridor Identification Pohakuloa Military Base, and a meeting held at the U.S. Army's Directorate of Facilities Engineering on July 9, 1987, concerning the same subject, which was attended by you, HECO, Parsons Hawaii and Army representatives (Encl 1).

As indicated in your letter, you have been contracted to analyze potential physical, biological and socio-economical constraints in identifying potential corridors for the 300 KVdc transmission line. It was also stated that for the purpose of this planning study, you would like to know the constraints which the Army might place on the alignment of the 300 KVdc transmission line through the Pohakuloa Training Area (PTA).

To preclude any future misunderstanding as to the Army's position regarding this matter, the referenced July 9, 1987 meeting was held to provide the attendees an opportunity to express their views and concerns. It was explained to you at that time that any proposal to construct additional transmission lines through PTA would adversely impact on military training and aviation activities. The maneuver and deployment of infantry and artillery forces will be substantially restricted. Further, the ability of Army aviators to support these forces by low-level flying and utilizing helicopter sling load operations will be adversely affected.

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NOTE: Many of the references listed are original sources for the 1985 study by DHM Planners inc. entitled Hawaii Deep Water Cable Program, Overland Transmission Corridor Study: Hawaii, Maui, Oahu. These sources are included in the bibliography as references for the reader.

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