

DRAFT

**ECOLOGICALLY SENSITIVE WETLANDS
ON MAUI:**

Groundwater Protection Strategy for Hawai'i

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Identification of Class I: Special Groundwaters
Highly Vulnerable to Contamination, Maui

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ABSTRACT

The EPA Ground-Water Protection Strategy has established differential protection levels based on the beneficial uses of groundwaters. Groundwater resources that are: (1) Irreplaceable sources of drinking water; and/or (2) Ecologically Vital are designated as of unusually high value. To determine those groundwaters that meet the EPA criteria for qualifying as "Ecologically Vital" we have examined 24 groundwater based (wetland) ecological systems on the island of Maui. An inventory of the physical, biological and cultural characteristics of each area including certain "red flag" features has been developed and coded. Using this "habitat code" a rating system that reflects the sensitivity, i.e. "uniqueness" or "nonrenewable" attributes of each system was designed and 18 "ecologically vital" habitats were identified that meet the EPA criteria for Class 1 level of groundwater protection. Insufficient information was available to determine the sensitivity of one of the sites.

INTRODUCTION

This report reflects the results of a study prepared in close accordance with the directives of the U.S. Environmental Protection Agency (EPA) Ground Water Protection Strategy (GPS) (EPA 1984; 1987) to identify special groundwater sources that are characterized as “ecologically vital”. That is to say that the aquifer provides the base flow for a particularly sensitive ecological system that, if polluted, would destroy a unique habitat.

Groundwater Protection Strategy and Guidelines

In response to the recognized importance of the various uses of groundwater and its potential susceptibility to contamination the Environmental Protection Agency promulgated the “Ground-Water Protection Strategy” (EPA 1984). Subsequently, the EPA technical draft document, “Guidelines for Ground-Water Classification under the EPA Ground-Water Protection Strategy”, was issued to provide policy direction for EPA programs with groundwater responsibility (EPA 1986). The “guidelines” document serves two purposes:

1. to further define the classes, concepts, and key terms related to the classification system outlined in the Ground-Water Protection Strategy; and,
2. to describe the procedures and information needs for classifying groundwater.

The Environmental Protection Agency-Groundwater Protection Strategy (EPA-GPS) mandates that each state perform an inventory and analysis of available groundwater resources within their particular state. States are then required to, “set up management strategies, i.e. rules, regulations, laws, ordinances..., to protect these groundwater resources from contamination and misuse”. State agencies responsible for groundwater protection may be required to adopt the classification system for specific state programs that serve to carry out delegated or authorized EPA programs. To assure adequate protection of groundwaters and the compliance with special program requirements of the EPA, the Hawaii State Department of Health (DOH) has initiated a groundwater protection strategy consistent with the program established by the EPA (DOH 1988). Accordingly, the present study serves to address one aspect of this strategy: to identify and evaluate *ecologically sensitive systems* subject to groundwater inflows and to potential pollutants and to determine if those areas are *ecologically vital*. The methodology used for the identification and evaluation of the ecologically sensitive and ecologically vital areas follows that set forth

in the EPA draft guidelines. This report is an adjunct to the Mink and Lau (1987) aquifer classification report.

Groundwater Classification: Definitions and Uses

The EPA Ground-Water Protection Strategy is based on the recognition that “protection should consider the highest beneficial use to which groundwater having significant water resources value can presently or potentially be put” (EPA, 1986). Therefore, EPA has established three classes of groundwaters and has designated differential protection levels consistent with the beneficial uses for each class as follows:

Class I - Special Groundwaters. Class I groundwaters include those “resources of unusually high value” in that they are “highly vulnerable to contamination” and are:

- (1). Irreplaceable sources of drinking water; and/or,
- (2). Ecologically vital.

Groundwater is considered an “irreplaceable source of drinking water” if it serves a substantial population, and, if delivery of comparable quality and quantity of water from alternative sources in the area would be economically infeasible or precluded by institutional constraints. Groundwater is considered “ecologically vital” if it “supplies a sensitive ecological system that supports a unique habitat”. A *sensitive ecological system* is defined “as an aquatic or terrestrial ecosystem located in a ground-water discharge area”, (otherwise known as a wetland), and a *unique habitat* is “primarily defined as a habitat for a listed or proposed endangered or threatened species...”. However, “unique habitats” also include such special areas as National parks, wilderness areas, wildlife refuges, or natural areas (EPA 1986).

In simplified terms, *ecologically vital* groundwater supports a terrestrial or aquatic “wetland type” ecosystem which has exceptional functions including, but not limited to, habitat for endangered or threatened species.

Class II - Current and Potential Sources of Drinking Water and Water Having Other Beneficial Uses. Groundwaters may be classified under the Class II category if they do not meet the Class I criteria and if they include current or potential sources of drinking water and water having other beneficial uses.

Class III - Groundwater Not a Potential Source of Drinking Water and of Limited Beneficial Use. Class III groundwaters are saline or otherwise unsuitable for drinking or other beneficial purposes. Included in this class are groundwaters that are so contaminated by either naturally occurring conditions or by the effects of broad-scale human activity that they can not be cleaned up using reasonably standard or acceptable treatment methods.

Groundwater Protection in Hawai'i: Rationale and Statutory Requirements

In Hawai'i, the ever increasing pressure of urban development has raised the potential for adverse impacts to essential groundwater sources. Urbanization of agricultural and undeveloped land in groundwater recharge areas can affect both the quality and quantity of groundwater through the improper use of chemicals and waste disposal practices, or through alterations in surface conditions that affect groundwater recharge. This avenue for potential contamination has been demonstrated over the past few years with the appearance of residues of volatile organic chemicals in groundwater wells on O'ahu (Lau & Mink, 1987; Oki & Giambelluca, 1985). The need for additional potable water supplies to accommodate increased population and urban development has led to expanded development of groundwater sources and an increased draft on existing wells. Such increased developments if improperly managed can result in contamination of the aquifers. The importance of maintaining and protecting Class I and II groundwaters as sources for potable water is obvious. In this regard, Hawai'i's almost total reliance on groundwater for drinking water puts the State in a particularly sensitive position with respect to the need to wisely locate and balance urban development against maintaining both adequate and safe drinking water supplies. Furthermore, it must also be recognized that Class I groundwaters serve another use, second in importance only to their value for drinking water, and that is their contribution to *ecologically vital* areas. These areas are further define by EPA as *sensitive ecological systems* that support a unique habitat and may include "springs, streams, caves, lakes, wetlands, estuaries, coastlines, embayments, and playas".

Ecologically Sensitive Systems: Wetlands

The commonly accepted terminology for groundwater influenced habitats that are ecologically sensitive is "wetland". However, the term wetland has been specifically defined by various government agencies to suit their respective purposes. For example, the Soil Conservation Service (SCS) defines a wetland as:

“areas that have a predominance of hydric soils and that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and under normal circumstances do support, a prevalence of hydrophytic vegetation typically adapted for life in saturated soil conditions, except lands in Alaska identified as having a high potential for agricultural development and a predominance of permafrost soils”. (National Food Security Act Manual, 1988)

The EPA and United States Army Corps of Engineers (COE) define wetlands as:

“Those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs and similar areas”. (EPA, 40 CFR 230.3, 33 CFR 328.3)

The United States Fish and Wildlife Service (USFWS) definition for wetlands states:

“Wetlands are lands transitional between terrestrial and aquatic systems where the water table is usually at or near the surface or the land is covered by shallow water. For purposes of this classification wetlands must have one or more of the following three attributes: (1) at least periodically, the land supports predominantly hydrophytes, (2) the substrate is predominantly undrained hydric soil, and (3) the substrate is nonsoil and is saturated with water or covered by shallow water at some time during the growing season of each year”.

Each definition includes specific terminology to guide the particular agency in carrying out their mandated programs. For instance the EPA and COE oversee Section 404 of the Clean Water Act, thus their definition reflects their specific interest in regulating the filling and dredging of wetlands. In addition, the Soil Conservation Service is interested in agricultural practices which impact on “wetlands”. Therefore, the SCS definition concentrates on soil types. These agency specific wetland definitions have resulted in confusion and inconsistencies when issuing appropriate permits from two or more agencies. The USFWS may identify a specific area as a wetland when, according to the criteria of the SCS, it is not a wetland. When an agency identifies an area as a wetland, other federal permitting agencies become affected due to the 1977 Federal Executive Order 11990, Protection of Wetlands which makes the protection of wetlands the official policy of all federal agencies. Under this Order wetlands are broadly defined as “those

areas that are inundated by surface or groundwater with a frequency sufficient to support...vegetative or aquatic life that requires saturated or seasonally saturated soil conditions for growth and reproduction". Thus, confusion has reigned over which determination an agency should use when evaluating development proposals. To resolve this dilemma the Army Corps of Engineers, the Soil Conservation Service, the Environmental Protection Agency and the U.S. Fish and Wildlife Service have now developed a unified approach to identifying and delineating wetlands incorporating elements of each agencies specific definitions (1989). The common elements adopted from all definitions include specific criteria with regard to vegetation, soil and hydrology.

The importance of wetlands has been recognized in a wide variety of federal laws, policy statements, executive orders, and planning documents. To mention just the actions that have been initiated since the early 1970's, we might begin with the National Environmental Policy Act (NEPA) and the formation of the Council on Environmental Quality (CEQ) in 1970. Recognition of the need for preservation and protection of the environment, (including some specific citing of wetlands), was one of the primary purposes of NEPA. Subsequently, in 1971, the Federal Water Bank Program was created to prevent "the loss of wetlands and to preserve, restore, and improve wetlands" with special emphasis on conserving specific wetland areas for migratory waterfowl nesting and breeding. In 1973, the EPA issued a statement of "Policy on Protection of The Nations Wetlands" (38 CFR 10834, March 20, 1973). In this policy statement the "unique and major importance" of wetlands was recognized explicitly. It cited critical wetland functions, including provision of habitats for important wildlife including many species of fish and waterfowl, flood control, natural water purification through sediment trapping, nursery habitat for wildlife and plant species, recreational areas, and contributions to the maintenance and recharge of the groundwater resources. One of the most important provisions in this policy statement was the recognition and commitment of EPA to minimize alterations in quantity or quality of the natural flow of waters that nourish wetlands and to protect them against dredging and filling or other forms of potential pollutants. Following the EPA policy statement and to further strengthen the federal commitment to wetland protection, the Federal Executive Order (No. 11990) for the Protection of Wetlands was issued in 1977 by President Carter. The order directed each agency, in the course of carrying out its respective responsibilities, to "take action to minimize the destruction, loss, or degradation of wetlands, and to preserve and enhance the natural and beneficial values of wetlands".

At the State level, Hawai'i statutes and regulations pertinent to the protection of wetlands are under the regulatory responsibilities of the Department of Land and Natural Resources or, in some cases, the Departments of Agriculture and Health. The State Water Commission may have related specific interests and responsibilities. Other documents dealing with wetland management or protection in Hawai'i include the Master Plan for Hawaii Water Resources, developed by the Hawaii Water Resources Regional Study team in 1977 and the current Master Plan for the Hawaiian Wetland National Wildlife Refuge Complex now under review by both state and federal agencies. The rationale for these protective regulations, orders, policy statements, and master plans, has called attention to the importance of wetlands as wildlife sanctuaries for endangered and migratory species, breeding grounds, and nursery habitats for birds, fishes, and invertebrates; their importance to the food chain; their use as recreational areas, storm water retention ponds, silt settling basins, drainage and erosion control, water recharge areas; and their use by electric power generating stations for cooling water supplies or for potential wastewater discharge sites.

OBJECTIVES

Identification and Assessment of Ecologically Sensitive Systems and the Determination of Ecologically Vital Habitats

While all classes of groundwaters may provide base flows to *ecologically sensitive habitats*, the EPA groundwater protection strategy is a differential protection policy and assumes that different types of ground waters require different levels of protection. Hence, in accordance with the priorities established by EPA, the present study had three objectives:

1. to identify ecological systems pursuant to the delineation of Class I groundwaters under the EPA Ground-water Protection Strategy program;
2. to assess the *ecological sensitivity* and "uniqueness" of these systems under the EPA groundwater classification system; and,
3. to determine which of these systems would qualify as *ecologically vital* habitats.

In the outset it must be emphasized that the wetlands listed do not represent an inclusive list of all ecologically sensitive groundwater systems in Hawai'i. Hawai'i's vast groundwater resources preclude an all inclusive inventory of ecologically sensitive groundwater wetland habitats, given the time and budgetary constraints of this study.

However, this report does reflect an inventory and analysis of the primary ecologically sensitive groundwater habitats in Hawai'i and provides a significant introductory baseline inventory from which more comprehensive reports can evolve as their need arises.

PROCEDURE

To identify and assess *ecologically sensitive groundwater systems* and to determine *ecologically vital habitats* the following steps were undertaken:

1. The development of a statewide inventory of ecological systems that receive groundwater discharge and, therefore, are subject to potential groundwater contaminants. This inventory also includes a compilation of descriptive information pertinent to the selected areas in terms of their physical, chemical, biological, and cultural characteristics.
2. The identification of potential sources and generic types of groundwater pollutants to these selected areas.
3. The development of a computer aided search and retrieval system for interactive retrieval of special characteristics of each area.
4. The development of assessment methodologies for determining ecologically vital systems.

Compilation and Processing of Information On Ecological Systems

To compile the inventory and description of *ecologically sensitive systems* that receive groundwater inflows, we first identified a number of documents directed specifically at wetland habitats in the State of Hawai'i. The work on Wetlands and Wetland Vegetation of the Hawaiian Islands (Elliott, 1981), the Hawaii Water Resources Regional Study (1979), the Classification of Wetlands and Deepwater Habitats of the United States prepared by the U.S. Fish and Wildlife Service (1979) and An Ornithological Survey of Hawaiian Wetlands (Shallenberger, 1977) were four of the major sources of information. Individuals knowledgeable in the field of wetland ecology were identified through the Environmental Center review network and with the help of staff of the Department of Health and the University of Hawaii Water Resources Research Center. Through correspondence and meetings, these individuals provided information and identified specific wetland areas on base maps provided by the Department of Health. Matthew Higashida (Environmental Health Specialist, Department of Health), L. Stephen Lau (Director, Water Resources Research Center), and John F. Mink

(Hydrologist/Consultant) were the major contributors to the initial ecologically sensitive habitat site selection/identification procedure.

The identification of potential sources and generic types of groundwater pollutants for each ecological system was synthesized from existing literature sources, verified whenever possible by field checks, and compiled and stored in a computer generated database (DBASE III +) to permit interactive retrieval of the information. Assessment of *ecological sensitivity* and determination of *ecologically vital* areas was developed by the authors based on certain criteria developed in accordance with the EPA-GPS, the "Wetland Function Value Index" of the Water Resources Council (1981), and the "Wetlands Research Program" of the U.S. Army Corps of Engineers (1987).

RESULTS

Ecological Systems in Groundwater Discharge Areas

A list of *ecologically sensitive systems* that receive groundwater flows and their respective habitat codes and sensitivity ratings are given in Table 1. The general location of each ecological system is indicated in Figure 1.

The physical, chemical, biological, and cultural characteristics of each ecological system have been entered into a data base information system designed to provide specialized access (sort) capabilities on individual habitat characteristics including but not limited to, ecological system, aquifer system, map quadrangle numbers (latitude and longitude), map quadrangle name, and endangered terrestrial species. In addition, for any requested area, a complete output of the descriptive characteristics can be retrieved (Appendices). It should be noted that the data base is "open-ended" and can be expanded as the need arises.

Potential sources and generic types of groundwater pollutants to each aquifer system have also been compiled and are included in the data base (Fig. 2 and Appendices).

DISCUSSION

Assessment of Sensitivity of Ecological Systems

As indicated, the objectives of this study were three fold: 1. to identify and describe certain groundwater based ecological systems; 2. to assess the *ecological sensitivity* of these

Table 1. Ecologically Sensitive Wetland Sites, Habitat Code, Sensitivity Rating, and Aquifer Sectors and Systems, Maui, Hawai'i

| Ecological System | Sensitivity Rating | Habitat Code | Aquifer No. and Sector | Aquifer No. and System | App. Ref. | Quadrangle No.-Name |
|--------------------------------|--------------------|--------------|------------------------|------------------------|-----------|---------------------|
| 1. Eke Crater | Ba12wm | 21a352441 | 1-Wailuku | 4-Kahakuloa | A.3.1 | 5-Wailuku |
| 2. Honokohau Stream (Lower) | @Aa12m | 11c31a5421 | 2-Lahaina | 1-Honokohau | B.1.1 | 1-Napili |
| 3. Honomanu Bay | @Aa2m | 11a255444 | 4-Koolau | 3-Waikamoi | D.1.1 | 13-Keanae |
| 4. Iao Stream (Lower) | @Aa12wm3h | 11c333421 | 1-Wailuku | 2-Iao | A.1.1 | 5-Wailuku |
| 5. Kahakuloa Stream (Lower) | @Aa12tm | 11c31a1b421 | 1-Wailuku | 4-Kahakuloa | A.3.2 | 4-Kahakuloa |
| 6. Kahakuloa Stream (Upper) | @Aa12tm | 11a31a1b421 | 1-Wailuku | 4-Kahakuloa | A.3.3 | 4-Kahakuloa |
| 7. Kanaha Pond | @Aa12wtm3h | 11b353411 | 3-Central | 1-Kahului | C.1.1 | 5-Wailuku |
| 8. Kaukauai | * | * | 5-Hana | 4-Kipahulu | E.3.1 | 15-Kaupo |
| 9. Kawaipapa Stream (Lower) | @Aa12m | 11c345411 | 5-Hana | 2-Kawaipapa | E.1.1 | 16-Hana |
| 10. Keahikauo | Ba12wm | 21a352441 | 1-Wailuku | 4-Kahakuloa | A.3.4 | 5-Wailuku |
| 11. Kealia Pond | @Aa12wm3f | 11b322112 | 3-Central | 1-Kahului | C.1.2 | 6-Maalaea |
| 12. Keanae | @Aa12tm | 11c31a1b141 | 4-Koolau | 4-Keanae | D.2.1 | 13-Keanae |
| 13. Makamakaole Stream (Lower) | @Aa12m3h | 11a345421 | 1-Wailuku | 3-Waihee | A.2.1 | 4-Kahakuloa |
| 14. Makamakaole Stream (Upper) | @Aa12m3h | 11a355421 | 1-Wailuku | 3-Waihee | A.2.2 | 4-Kahakuloa |
| 15. Maliko Gulch (Lower) | @Aa2m | 11c21a5421 | 3-Central | 2-Paia | C.2.1 | 7-Paia |
| 16. Manawainui Stream (Lower) | @Aa12m | 11c355421 | 5-Hana | 4-Kipahulu | E.3.2 | 15-Kaupo |
| 17. Muolea | Ba12m | 21b31b5441 | 5-Hana | 3-Waihoi | E.2.1 | 16-Hana |
| 18. Nahiku Springs Area | @Aa12m | 11a355421 | 4-Koolau | 4-Keanae | D.2.2 | 14-Nahiku |
| 19. Olowalu Stream (Lower) | @Aa2m | 11c21a5421 | 2-Lahaina | 5-Olowalu | B.3.1 | 3-Olowalu |
| 20. Paukukalo | @Aa12m3f | 11c31a5144 | 1-Wailuku | 2-Iao | A.1.2 | 5-Wailuku |
| 21. Puu Kukui | Ba12wm | 21a352441 | 1-Wailuku | 2-Iao | A.1.3 | 2-Lahaina |
| 22. Ukumehame Stream (Lower) | @Aa2m3h | 11c21a1b421 | 2-Lahaina | 6-Ukumehame | B.4.1 | 3-Olowalu |
| 23. Violet Lake | Ba12wm | 21a352411 | 2-Lahaina | 3-Honokowai | B.2.1 | 2-Lahaina |
| 24. Waihee Marsh | @Aa12m | 11b21b5441 | 1-Wailuku | 2-Iao | A.1.4 | 5-Wailuku |

* Inadequate Information

@ Ecologically Vital

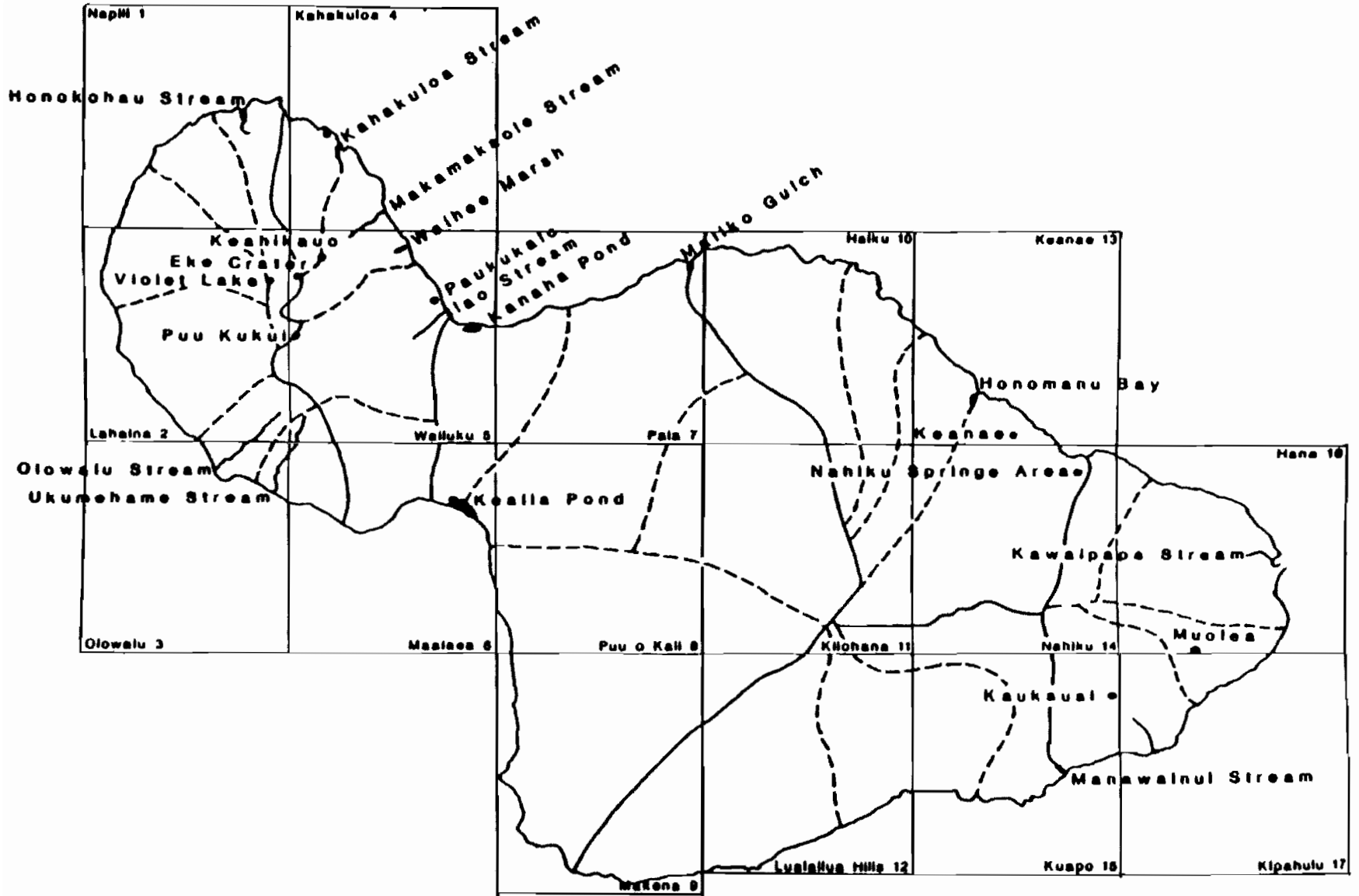


Figure 1. Wetland sites, aquifer systems and sectors, Maui, Hawai'i

| POLLUTANT SOURCE | POTENTIAL POLLUTANTS | | | | | | | | | | | | | | | | REMARKS |
|-------------------------------|-------------------------------|-----------|------------|--------------|----------|---------|----------|-----|--------|-------------|----------|------------|-------|--------|---------------|-------------|---------|
| | DISSOLVED INORGANIC NUTRIENTS | CHLORIDES | PESTICIDES | TOXIC METALS | BACTERIA | VIRUSES | GASOLINE | OIL | SILICA | TEMPERATURE | SOLVENTS | DETERGENTS | BORON | SODIUM | RADIOACTIVITY | ANTIBIOTICS | |
| A. Sewage Effluent | x | x | x | x | x | x | x | x | | | x | x | x | x | | | |
| B. Cesspools | x | x | x | x | x | x | | x | | | x | x | x | x | | | |
| C. Solid Waste (landfill) | x | x | x | x | x | x | x | x | | | x | x | x | | | | |
| D. Animal Waste | x | x | x | | x | x | | | | | | | | | | x | |
| E. Aquaculture Waste | x | x | x | x | x | x | | | | | x | x | | | | x | |
| F. Fuel Facility | | | x | x | | x | x | | | | x | x | x | | | | |
| G. Agriculture (industrial) | x | | x | x | x | x | | | | x | x | x | | x | x | | |
| H. Manufacturing (industrial) | x | | | x | | | | x | | x | x | x | x | x | x | | |
| I. Military (industrial) | x | x | x | x | | | | x | | x | x | x | | x | x | | |
| J. Sugarcane Culture | x | | x | | | | | | | | x | x | | | | | |
| K. Pineapple Culture | x | x | x | | | | | | | | x | x | | | | | |
| L. Urban Runoff | x | x | x | x | x | | | x | | | x | x | | | | | x |
| M. Golf Course | x | x | x | | | | | | | | | | | | | | |
| N. Desalting Plant | x | x | | x | x | | | | x | x | x | x | | x | | | |
| O. Energy Generation | | x | | x | | | | | x | x | x | x | | | | | |
| P. Construction | | | x | | | | | x | | | | | | | | | x |

Figure 2. Potential

systems; and, 3. to determine *ecologically vital* habitats in the context of the EPA Groundwater Protection Strategy program. The ultimate purpose of the study is to provide land use planners/managers with the information necessary to make informed decisions regarding groundwater protection. The inventory and description of ecological, hydrological and geological characteristics of various ecological systems and potential pollutants to those habitats is not sufficient without a mechanism whereby land use managers can readily estimate the significance or relative importance of the information available. Our tasks, therefore, were to compile the descriptive data and to derive a method whereby that descriptive and sometimes subjective ecological data could be objectively evaluated in concert with the hydrological and geological data. Presumably, such a method would allow for “better”, i.e. more objective, decision making as to the relative importance or *ecological sensitivity* of the habitats in accordance with EPA definitions for *ecologically vital* areas as set forth under the Groundwater Protection Strategy.

The U.S. Water Resources Council reviewed and assessed various methods for evaluating inland and coastal wetland functions (1981). In their analysis, critical elements are identified, and an assessment of functional value is determined. These elements include such items as: the function of the habitat with respect to wildlife needs; hydrologic functions; agriculture/silviculture functions; recreation and heritage functions; geographic features; personnel needs or administrative conditions; basic data requirements including monitoring; and so called “red flag” features of the wetlands. Their “sensitivity index” is based on the collective evaluation of each of the functional elements and the index derived varies with the site specific needs of the ecological communities as well as the uses or needs imposed by the evaluator.

We have modified the U.S. Water Resources Council evaluation procedure to suit the needs and environmental issues pertinent to Hawai‘i’s ecological systems. The various wetland function values for each ecological system have been identified and described in terms of the descriptive physical and biological elements. Key environmental attributes and uses of the systems by both the ecological community as well as man, and the potential pollutants to each system are noted.

Activities and Potential Pollutants to Ecological Systems

In the aquifer classification scheme of Mink and Lau (1987), each island is divided into a number of Sectors and Systems based on hydrogeological similarities and groundwater

continuity, respectively. A series of aquifer and status codes is developed to describe the specific types of aquifers in each sector and system and the status of their current use. The “Aquifer” and “Status Codes” for each habitat (see appendices) follow the Aquifer Classification Explanation of Mink and Lau (1987) that is reproduced here as Table 2. Pollutants entering any single aquifer system are assumed to have the potential for contaminating ecological systems receiving groundwater in that aquifer system. Activities occurring within a particular aquifer system that have the potential to contaminate groundwater sources are identified within the System-Wide-Characteristics section of the Appendices. Potential pollutants that may result from these activities are illustrated in Figure 2.

To evaluate *ecological sensitivity*, a two level procedure was developed: First, the characteristics of each ecological system were coded based on descriptive material from the inventory. Second, an ecological sensitivity rating was developed (Fig. 3).

HABITAT CODE. The habitat code (Table 3) is a description of the physical and cultural characteristics compiled for each ecological system and includes both the biological and physical (hydrological) environment of the system. The code reflects a compilation of “red flag” attributes as described by the Wetlands Research Program of the U.S. Army Corps of Engineers (1987), and U.S. Water Resources Council (1981).

SENSITIVE ECOLOGICAL SYSTEMS RATING. According to the EPA Groundwater Protection Strategy document, “*Sensitive Ecological Systems*”, are defined as all terrestrial or aquatic ecosystems that are located in a groundwater discharge area. However, the definition does not “rate” the relative sensitivity of each area to potential groundwater contamination. To determine the specific sensitivity it is necessary to evaluate the unique characteristics of each habitat. These characteristics may include not only the physical and biological attributes of that system, but also the cultural and even aesthetic values placed on the area by the community at large. Concomitantly, sensitivity to contamination varies with the individual system and is based on the magnitude of influence of groundwater, presence or absence of certain key ecological characteristics, and the types and quantity of potential pollutants.

Table 2. Aquifer Classification Explanation *

| AQUIFER AND STATUS CODES** | | | AQUIFER TYPE | HYDROLOGY† |
|----------------------------|--------------|---------------------------------------|---|--|
| Aquifer Code | = | Island + Sector | 1 Basal | Fresh water in contact with seawater |
| | + | Aquifer System | 2 High Level | Fresh water not in contact with seawater |
| | + | Aquifer Type | 1 Unconfined | Where water table is upper surface of the saturated aquifer |
| Thus, 60104214 | = | Aquifer Code | 2 Confined | Aquifer bounded by impermeable or poorly permeable formations, and top of saturated aquifer is below groundwater surface |
| where | 6 | = Maui | 3 Confined or Unconfined | Where actual condition is uncertain |
| | 01 | = Wailuku | | |
| | 04 | = Kahakuloa | | |
| | 2 | = High Level | | |
| | 1 | = Unconfined | | |
| | 4 | = Perched | | |
| and | 12111 | = Status Code | | |
| where | 1 | = Currently Used | | |
| | 2 | = Ecologically Important | | |
| | 1 | = Fresh (< 250 mg/l Cl ⁻) | | |
| | 1 | = Irreplaceable | | |
| | 1 | = High | | |
| ISLAND | SECTOR | AQUIFER SYSTEM | GEOLOGY†† | |
| 6 | 01 Wailuku | 01 Waikapu | 1 Flank | Horizontally extensive lavas |
| | | 02 Iao | 2 Dike | Aquifers in dike compartments |
| | | 03 Waihee | 3 Flank/Dike | Indistinguishable |
| | | 04 Kahakuloa | 4 Perched | Aquifer on an impermeable layer |
| | | | 5 Dike/Perched | Indistinguishable |
| | | | 6 Sedimentary | Non-volcanic lithology |
| | 02 Lahaina | 01 Honokohau | †Hydrologic descriptors (1st two digits from pts. 1,2). | |
| | | 02 Honolulu | ††Geologic descriptor (last digit). | |
| | | 03 Honokowai | STATUS CODE (GROUNDWATER) | |
| | | 04 Launiupoko | Development Stage | |
| | | 05 Olowalu | 1 Currently Used | |
| | | 06 Ukumehame | 2 Potential Use | |
| | 03 Central | 01 Kahului | 3 No Potential Use | |
| | | 02 Paia | Utility | |
| | | 03 Makawao | 1 Drinking | |
| | | 04 Kamaole | 2 Ecologically Important | |
| | 04 Koolau | 01 Haiku | 3 Neither | |
| | | 02 Honopou | Salinity (mg/l Cl ⁻) | |
| | | 03 Waikamoi | 1 Fresh (< 250) | |
| | | 04 Keanae | 2 Low (250-1,000) | |
| | 05 Hana | 01 Kuhiwa | 3 Moderate (1,000-5,000) | |
| | | 02 Kawaiipapa | 4 High (5,000-15,000) | |
| | | 03 Waihoi | 5 Seawater (> 15,000) | |
| | | 04 Kipahulu | Uniqueness | |
| | 06 Kahikinui | 01 Kaupo | 1 Irreplaceable | |
| | | 02 Nakuula | 2 Replaceable | |
| | | 03 Lualailua | Vulnerability to Contamination | |
| | | | 1 High | |
| | | | 2 Moderate | |
| | | | 3 Low | |
| | | | 4 None | |

*Taken from Mink and Lau (1987)

**Where sedimentary caprock aquifers rest on primary basalt aquifers, two Aquifer and Status Codes separated by a slash indicate numerator code is upper aquifer and denominator is lower aquifer.

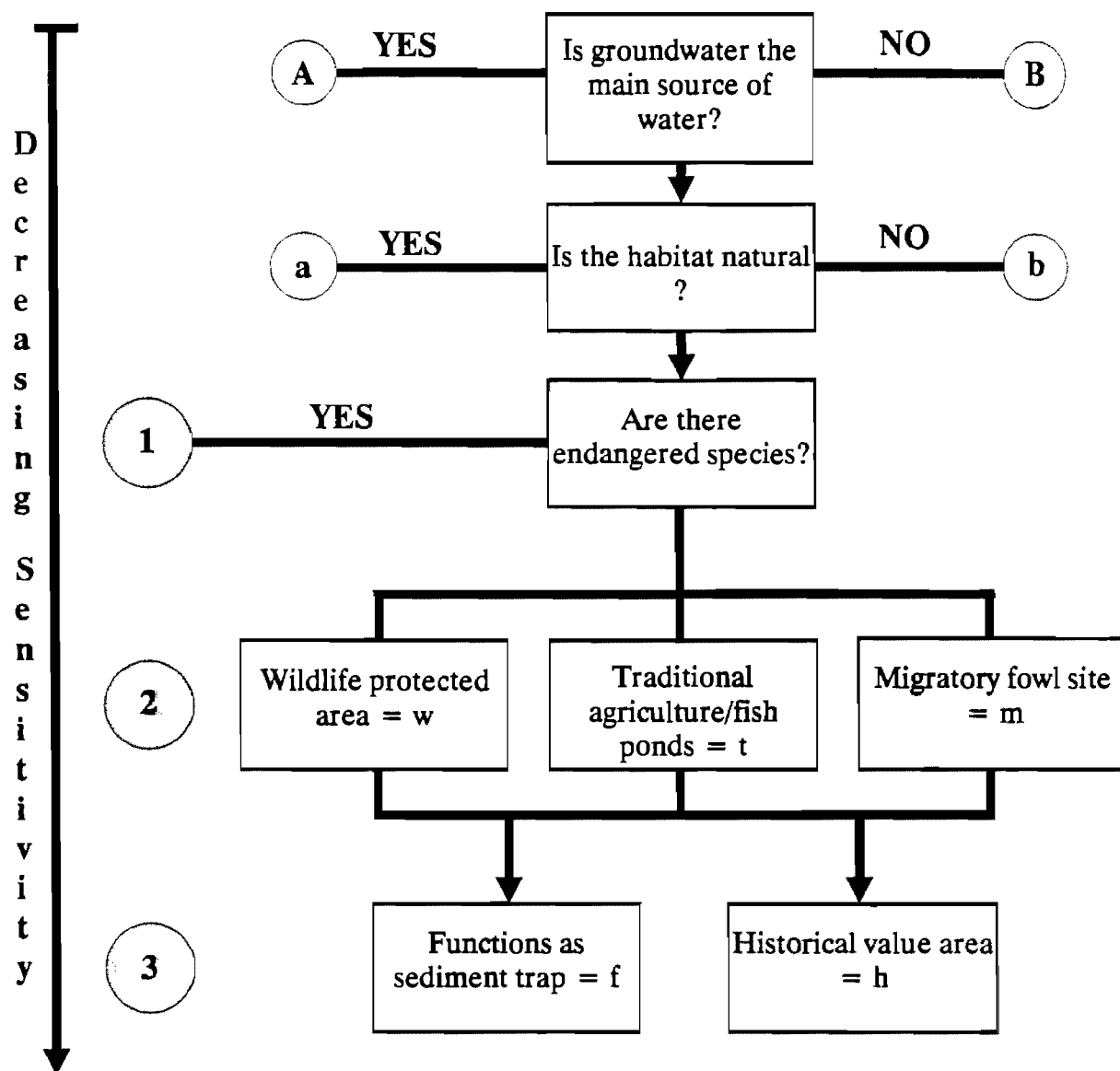


Figure 3. Ecological sensitivity rating. Ecological sensitivity ranked in decreasing level of sensitivity pursuant to EPA-GPS program. The presence of a 'w', 't' or 'm' [②] or 'f' or 'h' [③] reflects equal sensitivity within each respective level.

Table 3. Habitat Code

| Code | Code |
|-----------------------------------|--|
| Water Source | Social Significance |
| 1 Groundwater | 1 Historic |
| 2 Other | a Registered |
| | b Not Registered |
| Habitat Origin/Development | 2 Wildlife Protected |
| 1 Natural | 3 1a + 2 |
| a Pristine | 4 1b + 2 |
| b Altered | 5 Neither |
| c a + b | |
| 2 Artificial | Physical Significance |
| | 1 Sediment Trap |
| Ecological Character | 2 Flood Control |
| 1 Endangered Species | 3 1 + 2 |
| 2 Migratory Birds | 4 Neither |
| 3 1 + 2 | |
| 4 Neither | Wetland Type |
| | 1 Pond |
| Present Activities | 2 Stream |
| 1 Agriculture | 3 Coastal |
| a Crops | 4 Marsh |
| b Livestock | |
| 2 Aquaculture | Water Quality (mg/l Cl⁻) |
| 3 1a + 2 | 1 Fresh (<250) |
| 4 Recreation | 2 Brackish (250-15,000) |
| 5 Neither | 3 Marine (>15,000) |
| | 4 Combination |

In our evaluation of the sensitivity of each of the ecological systems we have chosen to use a modified version of the “Wetland Function Value Index” as promulgated by the U.S. Water Resources Council (1981) as the primary “sensitivity rating” for the systems.

The *sensitive ecological system* rating (Fig. 3) reflects the “uniqueness” or “non-renewable” attributes of the particular system. Some of these evaluation attributes are amenable to measurement and quantification, i.e. presence or absence of endangered species or certain water quality characteristics that either exceed or meet specific values recognized by statute. Other attributes are less tangible, i.e. they may have seasonal periods of importance or varying degrees of value based on circumstances at the time, such as sediment trapping ability, use by migratory fowl, importance of archaeological remains, or the open space visual values subjectively assigned to an area. In general, we have found it to be inappropriate if not impossible to assign absolute numeric values to various attributes of ecological systems as a basis for determining relative ecological sensitivities. In this regard we note the recognition in the EPA Guidelines for Groundwater Protection Strategy of the use of both quantitative as well as qualitative assessments (EPA, 1986). The relative sensitivities of the various systems are coded and assessed in accordance with the criteria indicated in Table 4.

RATING

Each of the *ecologically sensitive systems* identified for this project have been assigned an ecological sensitive system rating based on the criteria shown in Table 4. Sensitivity is determined by following a hierarchial flowchart (Fig. 3) which begins with a determination of the primary water source. For example, an ecological system which has groundwater, is natural, and has endangered species will be assigned a rating of “Aa1”. If the same ecological system also has historical value the rating will be “Aa13h”. The highest sensitivity rating is assigned to ecological systems which are supplied by groundwater (A); a natural ecological system (a); have endangered species (1); or are a designated wildlife protected area (2w), have migratory fowl (2m), or reflect ancient fishponds or other traditional agricultural practices (2t). A minimum rating of Aa1, Aa2, Ab1 or Ab2 represents a system that is *ecologically vital* according to the EPA-GPS guidelines and is entitled to protection as Class I-Special Groundwaters.

Table 4. Codes and Criteria for Sensitivity Ratings

| Code | Criteria |
|------|--|
| A | Groundwater provides the main source of water to the ecological system. |
| B | Groundwater, although present, does not provide the main source of water to the ecological system. |
| a | A natural ecological system, i.e. one capable of sustaining itself without the interjection of “artificial” water sources. Note: Some systems are classified as natural even though they may have been artificially created or significantly altered by human intervention. For example the artificially constructed or enhanced water reservoirs of Nuuanu, island of Oahu, are classified as natural although their dimensions may have been mechanically modified. They now exist without substantive influence or intervention by man. |
| b | Artificial ecological systems. Artificially created systems that receive some groundwater flows but must be maintained by human influences. Examples are the Kuilima Sewage Treatment Pond, the Waialua Sugar Settling Basin on Oahu and most aquacultural facilities. These systems are dependent upon human intervention to supply continual inputs of water rather than natural processes. |
| 1 | The presence of endangered or threatened species described in the Federal register of endangered or threatened species or in the State register of endangered or threatened species. |
| 2w | A wildlife protected area. Wildlife protected includes any Federal, State, County or privately managed wildlife area. Presence of this category implies that some organization has an interest in managing the wildlife resources of the area. |
| 2t | Area is used for traditional agriculture/aquaculture. This ecological system has value as a cultural resource. Traditional crops such as taro or lotus are being cultivated. In addition traditional aquaculture such as mullet raising may be practiced. |
| 2m | Area is used by migratory fowl. |
| 3f | Area serves as a sediment trap or flood control. |
| 3h | Area has historical/cultural value. Historic resources are known to be in the vicinity of the system. Many ancient fishponds are now used for waterbird habitat, but not for traditional agriculture, thus they are historic. |

The Ab rating level reflects groundwater base flow, however these ecosystems are artificially created. Many, if not all, of the Ab ecosystems are also *ecologically vital* by the definition provided in the EPA-GPS program, therefore these artificial systems may be subject to the same statutory protection as a natural wetland ecosystem. However, when an aquaculture facility closes or the sugar industry stops production, the state would have to develop a management program to ensure the perpetuation of these artificial ecosystems. As a matter of fact, many of the National Wildlife Refuges are actually artificially maintained wetlands.

Ecological systems that are assigned a rating of “Ba” have reduced sensitivity to groundwater influx and are not *ecologically vital* by the EPA-GPS definition, however, they do receive some quantity of groundwater. Furthermore, they may exhibit natural qualities which are worthy of protection and therefore, they cannot be ignored in land use decision making for reason of the narrow objectives of this project. Many Hawaiian ecological systems have been recognized as having great historic significance and are listed on the Register of Historic Places. Many more have potential historic value but are not yet on the Register. Similarly, ecological systems which provide sediment trapping and flood control qualities may be essential to protection of coastal ecosystems and cannot and should not be overlooked when making land use decisions.

SUMMARY

In summary, we have identified *ecologically sensitive systems* pursuant to the criteria set forth by the U.S. EPA Groundwater Protection Strategy and have codified certain ecological characteristics for subsequent use in rating the relative sensitivity of each habitat. The results provide the basis, along with certain geohydrological information, for determining if a particular groundwater should be considered *ecologically vital*. It is clear from the information compiled that those ecological systems receiving inflow of groundwater from densely urbanized areas, areas with significant groundwater withdrawal, or agricultural areas are most vulnerable to pollutant impacts. The wetland areas of the Kahuku region on the island of O’ahu for example, are particularly sensitive and are designated a critical habitat due to their use by endangered water fowl and their role in sediment control to reduce pollutants to the nearby coastal waters. This study identifies needs for future studies for ecological characterization of many systems beyond extant available information. Furthermore, the attenuation and dilution of groundwater

contaminants by natural processes...advection, dispersion, sorption, biodegradation, or decay..., before the groundwater is discharged from the aquifer, can significantly affect the relative toxicity of the potential pollutants. However, a discussion of the specific toxicological effects of various potential pollutants on the ecologically sensitive systems is beyond the scope of this study.

REFERENCES CITED

- Department of Health. 1988. The proposed groundwater quality protection strategy for the State of Hawaii (working draft III). State of Hawaii, Department of Health, Honolulu, Hawaii. 15 p. plus app.
- Elliott, M.E. 1981. Wetlands and wetland vegetation of the Hawaiian Islands. Master thesis (Geography), University of Hawaii, Honolulu. 228 p.
- Federal Interagency Committee for Wetland Delineation. 1989. Federal manual for identifying and delineating jurisdictional wetlands. U.S. Army Corps of Engineers, U.S. Environmental Protection Agency, U.S. Fish and Wildlife Service, and U.S.D.A. Soil Conservation Service, Washington, D.C. Cooperative technical publication. 76 p. plus app.
- Lau, L.S., and Mink, J.F. 1987. Organic contamination of groundwater: A learning experience. *J. Am. Water Works Assoc.* 79(8):37-42.
- Mink, J.F., and Sumida, S.T. 1984. Aquifer classification, State of Hawaii. Technical report no. 75, Water Resources Research Center, University of Hawaii, Honolulu. 34 p.
- Mink, J.F., and Lau, L.S. 1987. Aquifer identification and classification for groundwater protection strategy for Hawaii. Technical report no. 179, Water Resources Research Center, University of Hawaii, Honolulu. 28 p. plus 15 maps.
- Oki, D.S., and Giambelluca, T.W. 1985. Subsurface water and soil quality data base for State of Hawaii. Spec. report 7:85, Water Resources Research Center, University of Hawaii, Honolulu. 92 p.

- U.S. Army Corps of Engineers. 1987. Wetland Evaluation Technique (WET) volume II: methodology. Environmental Laboratory, Waterways Experiment Station, Vicksburg, Mississippi. 249 p.
- U.S. Environmental Protection Agency. 1984. A ground-water protection strategy for the Environmental Protection Agency. Office of Ground-Water Protection, Office of Water, U.S. Environmental Protection Agency, Washington D.C. 55 p. plus app.
- U.S. Environmental Protection Agency. 1986. Guidelines for ground-water classification under the EPA ground-water protection strategy. Office of Ground-Water Protection, Office of Water, U.S. Environmental Protection Agency, Washington D.C. 474 p.
- U.S. Fish and Wildlife Service. 1985. Master plan for the Hawaiian Wetlands National Wildlife Refuge Complex. U.S. Fish and Wildlife Service, Honolulu, Hawaii. 77 p.
- U.S. Water Resources Council. 1981. Analysis of methodologies for assessment of wetlands values. Environmental Laboratory, Waterways Experiment Station, Vicksburg, Mississippi. 80 p.

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**Appendix A.1 System-Wide Characteristics of Ecologically Sensitive Habitats,
Aquifers of Wailuku Sector, Iao System**

Aquifer System: Iao (02)

Aquifer Sector: Wailuku (01)

Island: Maui (6)

Water Wells in Aquifer System (Div. of Water and Land Development 1984):

| | | | | | |
|-------------|----|----------|---|------------|---|
| Disposal | - | Domestic | - | Industrial | - |
| Irrigation | 11 | Lost | - | Municipal | 9 |
| Observation | 8 | Other | - | Recharge | - |
| Sealed | 2 | Unused | 2 | Unknown | - |

Water Wells or Sampling Sites Once Contaminated with DBCP, EDB or TCP
(Water Resources Research Center 1985):

None

Potential Pollutant Sources and Pollutants (see Fig. 2):

Source: Iao Valley Lodge (UM 1415)

Pollutants: Secondary treated sewage

Discharge: 3,000 gpd

Source: Gomes Construction (UST)

Pollutants: Fuel

Discharge: Number of Tanks: 1

Source: Japo I. Yokoyama Bdg. Contractors (UST)

Pollutants: Fuel

Discharge: Number of Tanks: 1

Source: Ogawa Service Station (UST)

Pollutants: Fuel

Discharge: Number of Tanks: 3

Source: Maui Farmers Coop. Exchange (UST)

Pollutants: Fuel

Discharge: Number of Tanks: 2

Source: Maui Soda and Ice Works (UST)

Pollutants: Fuel

Discharge: Number of Tanks: 4

Source: Pacific Amusement Co. (UST)

Pollutants: Fuel

Discharge: Number of Tanks: 1

Iao--Continued

Source: Shishido Manju Shop (UST)

Pollutants: Fuel

Discharge: Number of Tanks: 1

Source: State Office Building (UST)

Pollutants: Fuel

Discharge: Number of Tanks: 2

Source: Sida Construction and Mason (UST)

Pollutants: Fuel

Discharge: Number of Tanks: 2

Source: Valley Isle Express, Ltd. (UST)

Pollutants: Fuel

Discharge: Number of Tanks: 2

Source: Hawaiian Telephone Company/Central Office (UST)

Pollutants: Fuel

Discharge: Number of Tanks: 1

Source: Harbor Shell Service (UST)

Pollutants: Fuel

Discharge: Number of Tanks: 4

Source: Maui Shell (UST)

Pollutants: Fuel

Discharge: Number of Tanks: 5

Source: Uptown Service (UST)

Pollutants: Fuel

Discharge: Number of Tanks: 6

Source: Chevron Service Station/1960 Main St. (UST)

Pollutants: Fuel

Discharge: Number of Tanks: 5

Source: Hawaii Metal Forming Corp. (UST)

Pollutants: Fuel

Discharge: Number of Tanks: 1

Source: Hawaiian Homes SPS (Paukukalo) (UST)

Pollutants: Fuel

Discharge: Number of Tanks: 1

Iao--Continued

Source: Wailuku SPS (UST)
Pollutants: Fuel
Discharge: Number of Tanks: 1

Source: Blue and White Bus Line (UST)
Pollutants: Fuel
Discharge: Number of Tanks: 1

Source: Maui County/1827 Kaohu St. (UST)
Pollutants: Fuel
Discharge: Number of Tanks: 2

Source: Maui Memorial Park (UST)
Pollutants: Fuel
Discharge: Number of Tanks: 2

Source: Endo Painting Service (UST)
Pollutants: Fuel
Discharge: Number of Tanks: 2

Source: Maui Memorial Hospital (UST)
Pollutants: Fuel
Discharge: Number of Tanks: 4

Source: Valley Isle Motors (UST)
Pollutants: Fuel
Discharge: Number of Tanks: 2

Source: Nissan of Maui (UST)
Pollutants: Fuel
Discharge: Number of Tanks: 2

Source: Alii Motors (UST)
Pollutants: Fuel
Discharge: Number of Tanks: 1

Source: Maui Army Reserve Center (UST)
Pollutants: Fuel
Discharge: Number of Tanks: 2

Source: Sam's Service (UST)
Pollutants: Fuel
Discharge: Number of Tanks: 4

Iao--Continued

Source: Furomoto Service (UST)
Pollutants: Fuel
Discharge: Number of Tanks: 2

Source: Hale Maka'i (UST)
Pollutants: Fuel
Discharge: Number of Tanks: 2

Source: Maui County (Police Motor Pool) (UST)
Pollutants: Fuel
Discharge: Number of Tanks: 2

Source: American Fence Company (UST)
Pollutants: Fuel
Discharge: Number of Tanks: 1

Source: Maui County (Correction Center) (UST)
Pollutants: Fuel
Discharge: Number of Tanks: 1

Source: National Guard Center (UST)
Pollutants: Fuel
Discharge: Number of Tanks: 1

Source: Agricultural Runoff
Pollutants: Nitrates and phosphates
Discharge: Non-point Source

Source: Urban Runoff
Pollutants: Heavy metals, sediments
Discharge: Non-point Source

Appendix A.1.1 Habitat Description of Iao Stream (Lower)

| | |
|--------------------------|--------------------------------|
| Site: Iao Stream (Lower) | Lat.: 20°54'43" |
| Island: Maui | Long.: 156°29'07" |
| Sector: Wailuku, 01 | El.: 0-1000 ft |
| System: Iao (02) | Approx. Area/Length: 4.4 miles |

Site Description:

Iao Stream is a perennial stream classified as a "Limited Consumptive" which means it has moderate to high water quality or natural value. The stream has nine diversions and is channelized along various segments (Timbol 1978).

Iao Stream originates at the confluence of Poohahoahoa and Nakalaloa Streams. The stream gradient at the headwaters is about 1,800 feet per mile as compared to 120 feet per mile at the ocean. A third major tributary, Kinihapai Stream joins Iao Stream near the base of Iao Needle, the most striking topographic feature in the valley. This feature is 1,200 ft high and is a ridge made of basalt, cut with dikes. It is the central feature of the Iao Needle State Park, developed about 1950 by the State Division of Forestry (U.S. Army Corps of Engineers 1975).

The lower half of the valley is the site of the County of Maui's Kepaniwai Park, about 4 miles upstream from the ocean. The entrance to the valley is located about 3 miles from the sea where the sloping hillsides are used for cattle and hog raising. The existing natural stream channel in this reach is about 80-100 ft wide and heavily shaded by bank side vegetation (U.S. Army Corps of Engineers 1975).

The stream continues to flow east-northeasterly through the broad coastal plain and the town of Wailuku. The sub-drainage area of Happy Valley is located north of the stream about 2 miles upstream from the ocean, and the first major bridge crossing is the Waiehu bridge approximately 300 m from the ocean. The next major bridge is located at Market Street (U.S. Army Corps of Engineers 1975).

From the Wailuku Sugar Company Bridge, the stream continues to flow northeasterly for about one mile before it reaches the Waiehu Beach Road. About midway through this section the north bank becomes higher than the south bank, and at the Waiehu Beach Road, the two banks are at the same elevation. The Pihana and Halekii Heiaus are located on high ground outside the flood plain, where the north streambank rises to ridges above the stream (U.S. Army Corps of Engineers 1975).

Below the Waiehu Beach Road, the stream channel is completely channelized. About 800 ft from the road, the stream forms a sharp bend towards the south, then reverses north to its outlet at Nehe Point (U.S. Army Corps of Engineers 1975).

| | |
|---------------------|-----------------------|
| Sensitivity Rating: | Aa12wm3h |
| Main Water Source: | A Groundwater |
| Habitat: | a Natural |
| Endangered Species: | 1 Observed |
| Wetland Status: | 2w Wildlife Protected |
| Wetland Avifauna: | m Migratory Fowl |
| Other Value: | 3h Historical Value |

Iao Stream (Lower)--Continued

Habitat Code: 1-1c-3-3-3-4-2-1
 Water Source: 1 Groundwater
 Habitat Origin/Development: 1c Natural/Pristine + Altered
 Ecological Character: 3 Endangered Species + Migratory Birds
 Present Activities: 3 Agriculture Crops + Aquaculture
 Social Significance: 3 Historic Registered + Wildlife Protected
 Physical Significance: 4 Neither Sediment Trap nor Flood Control
 Wetland Type: 2 Stream
 Water Quality: 1 Fresh (< 250 mg/l Cl⁻)

Aquifer Code: 60102116
 Island: 6 Maui
 Sector: 01 Wailuku
 Aquifer System: 02 Iao
 Aquifer Type (Hydrology): 1 Basal
 Aquifer Type (Hydrology): 1 Unconfined
 Aquifer Type (Geology): 6 Sedimentary

Status Code: 21221
 Development Stage: 2 Potential Use
 Utility: 1 Drinking
 Salinity: 2 Low (250-1,000 mg/l Cl⁻)
 Uniqueness: 2 Replaceable
 Vulnerability to Contamination: 1 High

Aquifer Code: 60102121
 Island: 6 Maui
 Sector: 01 Wailuku
 Aquifer System: 02 Iao
 Aquifer Type (Hydrology): 1 Basal
 Aquifer Type (Hydrology): 2 Confined
 Aquifer Type (Geology): 1 Flank

Status Code: 21113
 Development Stage: 2 Potential Use
 Utility: 1 Drinking
 Salinity: 1 Fresh (< 250 mg/l Cl⁻)
 Uniqueness: 1 Irreplaceable
 Vulnerability to Contamination: 3 Low

U.S. Fish & Wildlife Service Wetland Code:
 Riverine/Upper perennial/Open water/Permanent/Excavated (R3OWHx)

Riverine/Intermittent/Streambed/Seasonal (R4SBC)

Iao Stream (Lower)--Continued

Geology:

The stream channel lies on loose recent alluvium consisting chiefly of gravel, cobbles and boulders. Underlying the thin layer of recent alluvium is semi-indurated old alluvium several hundred feet thick.

Soil Conservation Service, U.S. Dept. of Agriculture 1975:

IaA (Iao Silty clay)

0-3% slopes

PZUE (Puuone Sand)

7-30% slopes

PtA (Pulehu Cobbly clay loam)

0-3% slopes

IbB (Iao Cobbly silty clay)

3-7% slopes

rSM (Stony alluvial land)

Terrestrial Threatened or Endangered Plant(s):

Cooke kokia (*Kokia cookei* Deg.)

Terrestrial Threatened or Endangered Animal(s):

Maui 'amakihi (*Hemignathus virens wilsoni*)

Hawaiian Stilt (*Himantopus mexicanus knudseni*)

Terrestrial Plant(s):

Candlenut tree (*Aleurites moluccana* (L.) Willd.)

Palai (*Microlepia setosa* (Sm.) Alston)

Hawaiian tree fern (*Cibotium* sp.)

Silver fern (*Pityrogramma calomelanos* (L.) Link)

Ti (*Cordyline terminalis* (L.) Kunth)

Octopus tree (*Brassaia actinophylla* Endl.)

Mountain apple (*Eugenia malaccensis* L.)

Fevervine (*Paederia foetida* L.)

Common guava (*Psidium guajava* L.)

False staghorn fern (*Dicranopteris linearis* (Burm.) Underw.)

Sadleria (*Sadleria cyatheoides* Kaulf.)

'Ohi'alehua (*Metrosideros collina* (Forst.) Gray)

'Olapa (*Cheirodendron* sp.)

Hawaiian olive (*Osmanthus sandwicensis* (A. Gray) B. and H.)

Hawaiian caper (*Capparis sandwichiana* DC.)

Dianella (*Dianella* sp.)

Iao Stream (Lower)--Continued

Kopiko (*Straussia Mariniana* (C. & S.) Gray)
 Lama (*Diospyros ferrea* (Willd.) Bakh.)
 Screw pine (*Pandanus odoratissimus* L. f.)
 Pukiawe (*Styphelia tameiameia* (Cham.) F. Muell.)
 Hairy hopseed bush (*Dodonaea eriocarpa* Sm.)
 False 'ohelo (*Wikstroemia oahuensis* (Gray) Rock)
 Polynesian bony berry (*Osteomeles anthyllidifolia* (Sm.) Lindl.)
 Fragrant canthium (*Canthium odoratum* (Forst.) Seem.)
 Hairy horseweed (*Bidens pilosa* L.)
 Mango (*Mangifera indica* L.)
 Avocado (*Persea americana* Mill.)
 Mesquite (*Prosopis pallida* (Humb. and Bonpl. ex Willd.) HBK.)
 Java plum (*Eugenia cuminii* (L.) Druce)
 Pride of India (*Melia azedarach* L.)
 Monkeypod (*Samanea saman* (Jacq.) Merr.)
 Koa haole (*Leucaena leucocephala* (Lam.) deWit)
 Common ironwood (*Casuarina equisetifolia* L.)

Aquatic Plant(s):

Hau (*Hibiscus tiliaceus* L.)
 Day flower (*Commelina diffusa* Burm. f.)
 Native sawgrass (*Cladium leptostachyum* Nees & Meyen)
 White ginger (*Hedychium coronarium* Koenig)

Terrestrial Animal(s):

Common Myna (*Acridotheres tristis*)
 'Apapane (*Himatione sanguinea*)
 Red-tailed Tropicbird (*Phaethon rubricauda rothschildi*)
 House Sparrow (*Passer domesticus*)
 House Finch (*Carpodacus mexicanus*)
 Northern Mockingbird (*Mimus polyglottos*)
 Red-billed Leiothrix (*Leiothrix lutea*)
 Japanese White-eye (*Zosterops japonicus*)
 Spotted Dove (*Streptopelia chinensis*)
 Zebra Dove (*Geopelia striata*)
 Cattle Egret (*Bubulcus ibis*)
 Black-crowned Night-Heron (*Nycticorax nycticorax hoactli*)

Aquatic Animal(s):

'Opae-kala-'ole (*Atya bisulcata*)
 'O'opu 'alamo'o (*Lentipes concolor*)
 'O'opu naniha (*Awaous genivittatus*)
 'O'opu nopili (*Sicydium stimsonii*)
 'O'opu nakea (*Awaous stamineus*)

Iao Stream (Lower)--Continued

Migratory Animal(s):

Lesser Golden-Plover (*Pluvialis dominica (fulva)*)
Ruddy Turnstone (*Arenaria interpres*)

Freshwater Origin:

The low flows of Iao consist of groundwater spilling from dike compartments and small perched aquifers in upper Iao Valley.

Comments:

Potential contamination via groundwater is likely given the wide array of development adjacent to the stream. In addition, the Iao aquifer contains numerous potential pollutants.

References:

- Timbol, A.S., and Maciolek, J.A. 1978. Stream channel modification in Hawaii. Part A: Statewide inventory of streams, habitat factors and associated biota. Prepared for U.S. Fish and Wildlife Service, U.S. Department of the Interior. 157 p.
- Mogi (H.) - Planning & Research, Inc. 1971. Iao Valley State Park feasibility study. Prepared for the Department of Land and Natural Resources, Honolulu, Hawaii: 70 p.
- U.S. Department of Agriculture, Soil Conservation Service. 1972. Soil survey of islands of Kauai, Oahu, Maui, Molokai, and Lanai, State of Hawaii. In cooperation with the University of Hawaii Agricultural Experiment Station. 232 p. plus illus.
- U.S. Army Corps of Engineers. 1975. Final environmental statement : flood control and allied purposes, Iao Stream, Maui, Hawaii. U.S. Army Engineer District, Honolulu. 48 p. plus app.

Appendix A.1.2 Habitat Description of Paukukalo

| | | | |
|---------|-------------|----------------------|------------|
| Site: | Paukukalo | Lat.: | 20°55'00" |
| Island: | Maui | Long.: | 156°29'35" |
| Sector: | Wailuku, 01 | El.: | 10-20 ft |
| System: | Iao (02) | Approx. Area/Length: | Unknown |

Site Description:

Paukukalo Marshland is a coastal depression approximately 600 yards in length. More than 75% of the site is choked with grasses and scattered patches of bulrush and umbrella sedge, and most of it is wet underfoot. Some of the land is used for grazing, but in its present condition, waterbird use of the area is unlikely. A large area of recently deposited fill bisects the wettest portion of this marsh site. The only open water contains a small amount of taro that appears to have been farmed intermittently. A surface duckweed and patches of water hyacinth keep most of the water surface covered. The pond area contains a variety of small invertebrates (shrimp, snails, aquatic insects). Mosquitofish and bullfrogs are also present. The pond is probably spring fed, as a nearby stream was totally dry at the time of survey. Three black-crowned night-herons flushed from the taro patch when we approached the pond. It is doubtful that the site could sustain many more birds on a continual basis, and human disturbance on neighboring lands probably keeps even the herons away much of the time (Shallenberger 1977).

| | |
|-----------------------------|---|
| Sensitivity Rating: | Aa12m3f |
| Main Water Source: | A Groundwater |
| Habitat: | a Natural |
| Endangered Species: | 1 Observed |
| Wetland Avifauna: | 2m Migratory Fowl |
| Other Value: | 3f Sediment Trap |
| Habitat Code: | 1-1c-3-1a-5-1-4-4 |
| Water Source: | 1 Groundwater |
| Habitat Origin/Development: | 1c Natural/Pristine + Altered |
| Ecological Character: | 3 Endangered Species + Migratory Birds |
| Present Activities: | 1a Agriculture Crops |
| Social Significance: | 5 Neither Historic nor Wildlife Protected |
| Physical Significance: | 1 Sediment Trap |
| Wetland Type: | 4 Marsh |
| Water Quality: | 4 Combination |
| Aquifer Code: | 60102116 |
| Island: | 6 Maui |
| Sector: | 01 Wailuku |
| Aquifer System: | 02 Iao |
| Aquifer Type (Hydrology): | 1 Basal |
| Aquifer Type (Hydrology): | 1 Unconfined |

Paukukalo--Continued

| | | |
|---------------------------------|----|---------------------------------------|
| Aquifer Type (Geology): | 6 | Sedimentary |
| Status Code: | | 22211 |
| Development Stage: | 2 | Potential Use |
| Utility: | 2 | Ecologically Important |
| Salinity: | 2 | Low (250-1,000 mg/l Cl ⁻) |
| Uniqueness: | 1 | Irreplaceable |
| Vulnerability to Contamination: | 1 | High |
| Aquifer Code: | | 60102121 |
| Island: | 6 | Maui |
| Sector: | 01 | Wailuku |
| Aquifer System: | 02 | Iao |
| Aquifer Type (Hydrology): | 1 | Basal |
| Aquifer Type (Hydrology): | 2 | Confined |
| Aquifer Type (Geology): | 1 | Flank |
| Status Code: | | 21113 |
| Development Stage: | 2 | Potential Use |
| Utility: | 1 | Drinking |
| Salinity: | 1 | Fresh (< 250 mg/l Cl ⁻) |
| Uniqueness: | 1 | Irreplaceable |
| Vulnerability to Contamination: | 3 | Low |

U.S. Fish & Wildlife Service Wetland Code:
Palustrine/Emergent/Persistent/Seasonal (PEM1C)

Geology:

The small marsh lies in recent alluvium consisting chiefly of clay. The alluvium overlies calcareous sand dunes, which in turn lie on compacted older alluvium.

Soil Conservation Service, U.S. Dept. of Agriculture 1975:

JcC (Jaucas Sand)
0-15% slopes

Terrestrial Threatened or Endangered Plant(s):

No inventory available

Terrestrial Threatened or Endangered Animal(s):

No inventory available

Terrestrial Plant(s):

Umbrella plant (*Cyperus alternifolius* L.)
Bermuda grass (*Cynodon dactylon* (L.) Pers.)

Paukukalo--Continued

Jungle rice (*Echinochloa colonum* (L.) Link)
 Banana (*Musa paradisiaca* L.)
 Screw pine (*Pandanus odoratissimus* L. f.)
 Wedelia (*Wedelia trilobata* (L.) Hitchc.)
 Swamp cabbage (*Ipomea aquatica* Forsk.)
 Beach morning-glory (*Ipomoea brasiliensis* (L.) Sweet)
 Morning-glory (*Ipomoea congesta* R. Br.)
 Beach naupaka (*Scaevola taccada* (Gaertn.) Roxb.)
 Beach pea (*Vigna marina* (Burm.) Merr.)
 Java plum (*Eugenia cuminii* (L.) Druce)

Aquatic Plant(s):

Water fern (*Azolla filiculoides* Lam.)
 Arrowhead (*Sagittaria sagittaeifolia* L.)
 Taro (*Colocasia esculenta* (L.) Schott)
 Water lettuce (*Pistia stratiotes* L.)
 Day flower (*Commelina diffusa* Burm. f.)
 California bulrush (*Scirpus californicus* (C.A. Meyer) Steud.)
 Great bulrush (*Scirpus validus* Vahl)
 Dense waterweed (*Egeria densa* Planch.)
 California grass (*Brachiaria mutica* (Forsk.) Stapf)
 Job's tears (*Coix lachryma-jobi* L.)
 Seashore paspalum (*Paspalum vaginatum* Sw.)
 Lesser duckweed (*Lemna minor* L.)
 Greater duckweed (*Spirodela polyrrhiza* (L.) Schleid.)
 Water hyacinth (*Eichhornia crassipes* (Mart.) Solms)
 False daisy (*Eclipta alba* (L.) Hassk.)
 Indian pluchea (*Pluchea indica* (L.) Less.)
 Hairy fleabane (*Pluchea odorata* (L.) Cass.)
 Moon flower (*Ipomoea alba* L.)
 Hau (*Hibiscus tiliaceus* L.)
 Primrose willow (*Ludwigia octovalvis* (Jacq.) Raven)

Terrestrial Animal(s):

Black-crowned Night-Heron (*Nycticorax nycticorax hoactli*)
 Common Myna (*Acridotheres tristis*)
 House Sparrow (*Passer domesticus*)
 House Finch (*Carpodacus mexicanus*)
 Northern Cardinal (*Cardinalis cardinalis*)
 Japanese White-eye (*Zosterops japonicus*)
 Nutmeg Mannikin (*Lonchura punctulata*)
 Zebra Dove (*Geopelia striata*)
 Spotted Dove (*Streptopelia chinensis*)
 Rock Dove (*Columba livia*)

Paukukalo--Continued

Wandering Tattler (*Heteroscelus incanus*)
Ruddy Turnstone (*Arenaria interpres*)
Sanderling (*Calidris alba*)
Lesser Golden-Plover (*Pluvialis dominica (fulva)*)

Aquatic Animal(s):
No inventory available

Migratory Animal(s):
Lesser Golden-Plover (*Pluvialis dominica (fulva)*)
Wandering Tattler (*Heteroscelus incanus*)
Ruddy Turnstone (*Arenaria interpres*)
Sanderling (*Calidris alba*)

Freshwater Origin:
The water source is seepage from groundwater perched in the sand dunes by the underlying old alluvium.

Comments:
Potential contamination via groundwater is very likely. There is presently heavy development pressure around the periphery of this sensitive system and the Iao aquifer contains numerous potential pollutants. The sensitive system is located near the coast which makes it susceptible to contamination from groundwater sources lying at higher elevations.

References:
Shallenberger, R.J. 1977. An ornithological survey of Hawaii wetlands. Vol II. Prepared for the U.S. Army Corps of Engineers, Engineer District, Honolulu. 278 p.

U.S. Department of Agriculture, Soil Conservation Service. 1972. Soil survey of islands of Kauai, Oahu, Maui, Molokai, and Lanai, State of Hawaii. In cooperation with the University of Hawaii Agricultural Experiment Station. 232 p. plus illus.

U.S. Army Corps of Engineers. 1979. Detailed project report and environmental statement, Waiehu Beach Park (Withdrawn). 63 p. plus app.

Elliott, M.E., and Hall, E.M. 1977. Wetlands and wetland vegetation of Hawaii. Prepared for the U.S. Army Corps of Engineers, Engineer District, Honolulu. 344 p.

Appendix A.1.3 Habitat Description of Puu Kukui

| | | | |
|---------|---|----------------------|------------|
| Site: | Puu Kukui | Lat.: | 20°53'36" |
| Island: | Maui | Long.: | 156°35'22" |
| Sector: | Lahaina, 02; Lahaina, 02 | El.: | 4800 ft |
| | Lahaina, 02; Wailuku, 01 | Approx. Area/Length: | Unknown |
| System: | Honokowai (03); Launiupoko (04) Honokohau (01); Iao (02) | | |

Site Description:

Puu Kukui is the summit of West Maui. Due to its high elevation the area lies in the high rainfall zone of West Maui. The area has extensive small open ponds and large areas of marshy terrain. Poor permeability of the trachyte lava inhibits percolation of rainfall into the ground, thereby creating this wet habitat. Puu Kukui is protected as part of the Honokowai section of the West Maui Natural Area Reserve System.

Sensitivity Rating:

| | |
|---------------------|-----------------------|
| | Ba12wm |
| Main Water Source: | B Not Groundwater |
| Habitat: | a Natural |
| Endangered Species: | 1 Observed |
| Wetland Status: | 2w Wildlife Protected |
| Wetland Avifauna: | m Migratory Fowl |

Habitat Code:

| | |
|-----------------------------|--|
| | 2-1a-3-5-2-4-4-1 |
| Water Source: | 2 Other |
| Habitat Origin/Development: | 1a Natural/Pristine |
| Ecological Character: | 3 Endangered Species + Migratory Birds |
| Present Activities: | 5 Neither Agriculture, Aquaculture, nor Recreation |
| Social Significance: | 2 Wildlife Protected |
| Physical Significance: | 4 Neither Sediment Trap nor Flood Control |
| Wetland Type: | 4 Marsh |
| Water Quality: | 1 Fresh (< 250 mg/l Cl ⁻) |

Aquifer Code:

| | |
|---------------------------|--------------|
| | 60203212 |
| Island: | 6 Maui |
| Sector: | 02 Lahaina |
| Aquifer System: | 03 Honokowai |
| Aquifer Type (Hydrology): | 2 High Level |
| Aquifer Type (Hydrology): | 1 Unconfined |
| Aquifer Type (Geology): | 2 Dike |

Status Code:

| | |
|--------------------|---------------------------------------|
| | 11111 |
| Development Stage: | 1 Currently Used |
| Utility: | 1 Drinking |
| Salinity: | 1 Fresh (< 250 mg/l Cl ⁻) |

Puu Kukui--Continued

Uniqueness: 1 Irreplaceable
 Vulnerability to Contamination: 1 High

Aquifer Code: 60204212
 Island: 6 Maui
 Sector: 02 Lahaina
 Aquifer System: 04 Launiupoko
 Aquifer Type (Hydrology): 2 High Level
 Aquifer Type (Hydrology): 1 Unconfined
 Aquifer Type (Geology): 2 Dike

Status Code: 11111
 Development Stage: 1 Currently Used
 Utility: 1 Drinking
 Salinity: 1 Fresh (< 250 mg/l Cl⁻)
 Uniqueness: 1 Irreplaceable
 Vulnerability to Contamination: 1 High

Aquifer Code: 60201212
 Island: 6 Maui
 Sector: 02 Lahaina
 Aquifer System: 01 Honokohau
 Aquifer Type (Hydrology): 2 High Level
 Aquifer Type (Hydrology): 1 Unconfined
 Aquifer Type (Geology): 2 Dike

Status Code: 11111
 Development Stage: 1 Currently Used
 Utility: 1 Drinking
 Salinity: 1 Fresh (< 250 mg/l Cl⁻)
 Uniqueness: 1 Irreplaceable
 Vulnerability to Contamination: 1 High

Aquifer Code: 60102212
 Island: 6 Maui
 Sector: 01 Wailuku
 Aquifer System: 02 Iao
 Aquifer Type (Hydrology): 2 High Level
 Aquifer Type (Hydrology): 1 Unconfined
 Aquifer Type (Geology): 2 Dike

Status Code: 21111
 Development Stage: 2 Potential Use
 Utility: 1 Drinking

Puu Kukui--Continued

| | | |
|---------------------------------|---|-------------------------------------|
| Salinity: | 1 | Fresh (< 250 mg/l Cl ⁻) |
| Uniqueness: | 1 | Irreplaceable |
| Vulnerability to Contamination: | 1 | High |

U.S. Fish & Wildlife Service Wetland Code:
Palustrine/Emergent/Persistent/Saturated (PEM1B)

Geology:

The wetland lies on trachyte of the Honolua volcanic series.

Soil Conservation Service, U.S. Dept. of Agriculture 1975:
rRT (Rough mountainous land)

Terrestrial Threatened or Endangered Plant(s):
No inventory available

Terrestrial Threatened or Endangered Animal(s):
'Iwi (*Vestiaria coccinea*)

Terrestrial Plant(s):

'Anali'i (*Asplenium schizophyllum* C. Chr.)
Eke silversword (*Argyroxiphium caliginii* Forbes)
Large Hawaiian reed grass (*Calamagrostis expansa* (Munro in Hbd.) Hitchc.)
Hillebrand's reed grass (*Calamagrostis hillebrandii* (Munro) Hitchc.)
'Oha (*Clermontia oblongifolia* var. *mauiensis* (Rock) Deg.)
'Ohawai (*Cyanea kunthiana* (Gaud.) Hbd.)
'Ohawai (*Cyanea scabra* Hbd.)
(*Diellia erecta* Brack.)
Okupukupu lau'i'i (*Doodia lyoni* Deg.)
Anini (*Eurya sandwicensis* var. *grandifolia* Wawra)
Hinahina (*Geranium humile* Hbd.)
'Ohe (*Joinvillea ascendens* ssp. *ascendens* Brongn. & Gris.)
Howai-a-ulu (*Lagenophora maviensis* Mann)
Kolea (*Myrsine vaccinioides* W.L. Wagner, Herbst & Sohmer)
Alani (*Pelea orbicularis* Hbd.)
Alani (*Pelea parvifolia* var. *apoda* (St. John) Stone)
Alani (*Pelea parvifolia* var. *sessilis* Levl.)
(*Phyllostegia bracteata* Sherff)
Orchid (*Platanthera holochila* (Hbd.) Krzl)
Purple flowered sanicle (*Sanicula purpurea* St. John & Hosaka)

Aquatic Plant(s):
No inventory available

Puu Kukui--Continued

Terrestrial Animal(s):

Northern Cardinal (*Cardinalis cardinalis*)
House Finch (*Carpodacus mexicanus*)
Japanese Quail (*Coturnis japonica*)
Melodious Laughing-thrush (*Garrulax canorus*)
'Apapane (*Himatione sanguinea*)
Red-billed Leiothrix (*Leiothrix lutea*)
Nutmeg Mannikin (*Lonchura punctulata*)
Spotted Dove (*Streptopelia chinensis*)
Japanese White-eye (*Zosterops japonicus*)

Aquatic Animal(s):

No inventory available

Migratory Animal(s):

Maui 'amakihi (*Hemignathus virens wilsoni*)
Lesser Golden-Plover (*Pluvialis dominica (fulva)*)

Freshwater Origin:

The trachyte is poorly permeable, resulting in the perching of groundwater in the weathered zone and in rubble layers. The perched groundwater slowly seeps away but is virtually continuously replenished by high rainfall.

Comments:

Potential contamination via groundwater is very unlikely given that this ecological system is supplied by rainwater and actually recharges the aquifer.

References:

- U.S. Department of Agriculture, Soil Conservation Service. 1972. Soil survey of islands of Kauai, Oahu, Maui, Molokai, and Lanai, State of Hawaii. In cooperation with the University of Hawaii Agricultural Experiment Station. 232 p. plus illus.
- Stearns, H.T., and Macdonald, G.A. 1942. Geology and ground-water resources of the island of Maui, Hawaii. Honolulu Advertiser Publishing Co. 344 p. plus maps and illus.
- Natural Area Reserves System. 1988. West Maui Natural Area Reserve Management Plan. Prepared for the Department of Land and Natural Resources, State of Hawaii, Honolulu. (Unpublished draft) 40 p. plus app.

Appendix A.1.4 Habitat Description of Waihee Marsh

| | | | |
|---------|--------------|----------------------|------------|
| Site: | Waihee Marsh | Lat.: | 20°56'41" |
| Island: | Maui | Long.: | 156°30'45" |
| Sector: | Wailuku, 01 | El.: | 10-20 ft |
| System: | Iao (02) | Approx. Area/Length: | Unknown |

Site Description:

Two separate wetland areas fall under this heading. The portion of the site above Kahekili Highway is now almost totally covered by sugar cane. Residents in the area confirmed that the site was filled and has been cultivated for cane since 1975. Prior to that time, springs and runoff maintained the site in a swampy condition during most of the year. Stilts were observed at the site prior to filling and planting of cane. A small taro patch in the area may still provide some attraction to stilt and other waterbirds, but it is very small and subject to considerable neighboring disturbance (Shallenberger 1977).

Below the highway, an expansive grassland is now used for grazing. The distribution of vegetation indicated that the site may flood temporarily after heavy rains and the presence of water is ephemeral. Neighboring residents confirmed that a small number of ducks may land at the site when water is present. Presumably the presence of cattle would inhibit extensive bird use at any time of year. The site should be revisited during the rainy period of the year to provide further information on bird use (Shallenberger 1977).

In the pasture, a narrow water channel, 5 to 6 ft wide, parallels the farm road for about 1000 ft before it turns northeast, crosses the northern pasture, and empties into the ocean. To the north, the channel broadens slightly and includes a more distinct area of marsh. A large wet area occurs on the eastern side of the pasture just south of the channel. This area appears to be influenced by a high water table in the sandy soil, and is subject to seasonal change (Elliott 1977).

| | |
|-----------------------------|---|
| Sensitivity Rating: | Aa12m |
| Main Water Source: | A Groundwater |
| Habitat: | a Natural |
| Endangered Species: | 1 Observed |
| Wetland Avifauna: | 2m Migratory Fowl |
| Habitat Code: | 1-1b-2-1b-5-4-4-1 |
| Water Source: | 1 Groundwater |
| Habitat Origin/Development: | 1b Natural/Altered |
| Ecological Character: | 2 Migratory Birds |
| Present Activities: | 1b Agriculture Livestock |
| Social Significance: | 5 Neither Historic nor Wildlife Protected |
| Physical Significance: | 4 Neither Sediment Trap nor Flood Control |
| Wetland Type: | 4 Marsh |
| Water Quality: | 1 Fresh (< 250 mg/l Cl ⁻) |

Waihee Marsh--Continued

| | | |
|--|----|---|
| Aquifer Code: | | 60102116 |
| Island: | 6 | Maui |
| Sector: | 01 | Wailuku |
| Aquifer System: | 02 | Iao |
| Aquifer Type (Hydrology): | 1 | Basal |
| Aquifer Type (Hydrology): | 1 | Unconfined |
| Aquifer Type (Geology): | 6 | Sedimentary |
| Status Code: | | 33121 |
| Development Stage: | 3 | No Potential Use |
| Utility: | 3 | Neither Drinking nor Ecologically Important |
| Salinity: | 1 | Fresh (< 250 mg/l Cl ⁻) |
| Uniqueness: | 2 | Replaceable |
| Vulnerability to Contamination: | 1 | High |
| Aquifer Code: | | 60102111 |
| Island: | 6 | Maui |
| Sector: | 01 | Wailuku |
| Aquifer System: | 02 | Iao |
| Aquifer Type (Hydrology): | 1 | Basal |
| Aquifer Type (Hydrology): | 1 | Unconfined |
| Aquifer Type (Geology): | 1 | Flank |
| Status Code: | | 11111 |
| Development Stage: | 1 | Currently Used |
| Utility: | 1 | Drinking |
| Salinity: | 1 | Fresh (< 250 mg/l Cl ⁻) |
| Uniqueness: | 1 | Irreplaceable |
| Vulnerability to Contamination: | 1 | High |
| U.S. Fish & Wildlife Service Wetland Code: | | Palustrine/Emergent/Persistent/Seasonal (PEM1C) |

Geology:

The diffuse wetland consists of recent alluvium and calcareous sand dunes. These formations overlie a thick section of compact old alluvium.

Soil Conservation Service, U.S. Dept. of Agriculture 1975:

JcC (Jaucas Sand, saline)

Terrestrial Threatened or Endangered Plant(s):

No inventory available

Waihee Marsh--Continued

Terrestrial Threatened or Endangered Animal(s):

No inventory available

Terrestrial Plant(s):

Jungle rice (*Echinochloa colonum* (L.) Link)
 Cocklebur (*Xanthium saccharatum* Wallr.)
 Bermuda grass (*Cynodon dactylon* (L.) Pers.)
 Water hyssop (*Bacopa monnieri* (L.) Pennell)

Aquatic Plant(s):

Water fern (*Azolla filiculoides* Lam.)
 California bulrush (*Scirpus californicus* (C.A. Meyer) Steud.)
 Greater duckweed (*Spirodela polyrrhiza* (L.) Schleid.)
 Water hyacinth (*Eichhornia crassipes* (Mart.) Solms)
 Beach dropseed (*Sporobolus virginicus* (L.) Kunth)
 Day flower (*Commelina diffusa* Burm. f.)

Terrestrial Animal(s):

Common Myna (*Acridotheres tristis*)
 House Sparrow (*Passer domesticus*)
 House Finch (*Carpodacus mexicanus*)
 Northern Cardinal (*Cardinalis cardinalis*)
 Japanese White-eye (*Zosterops japonicus*)
 Nutmeg Mannikin (*Lonchura punctulata*)
 Spotted Dove (*Streptopelia chinensis*)
 Zebra Dove (*Geopelia striata*)
 Rock Dove (*Columba livia*)
 Lesser Golden-Plover (*Pluvialis dominica* (fulva))
 Wandering Tattler (*Heteroscelus incanus*)
 Ruddy Turnstone (*Arenaria interpres*)
 Sanderling (*Calidris alba*)
 Cattle Egret (*Bubulcus ibis*)
 Red-crested Cardinal (*Paroaria coronata*)
 Cattle (*Bos tauris*)

Aquatic Animal(s):

Guppy (*Poecilia reticulata* Peters)

Migratory Animal(s):

Lesser Golden-Plover (*Pluvialis dominica* (fulva))
 Wandering Tattler (*Heteroscelus incanus*)
 Ruddy Turnstone (*Arenaria interpres*)
 Sanderling (*Calidris alba*)

Waihee Marsh--Continued

Freshwater Origin:

Groundwater from the old alluvium seeps into the sand and recent alluvium. The Iao basal aquifer is too deep to provide a source of water to the wetland.

Comments:

Potential contamination via groundwater is likely given that the adjacent land is under pressure for development and the Iao aquifer contains numerous potential pollutants. Its coastal location allows for easy contamination by migrating groundwater. Plans for a golf course at this site are in preparation.

References:

Elliott, M.E., and Hall, E.M. 1977. Wetlands and wetland vegetation of Hawaii. Prepared for the U.S. Army Corps of Engineers, Engineer District, Honolulu. 344 p.

U.S. Department of Agriculture, Soil Conservation Service. 1972. Soil survey of islands of Kauai, Oahu, Maui, Molokai, and Lanai, State of Hawaii. In cooperation with the University of Hawaii Agricultural Experiment Station. 232 p. plus illus.

Shallenberger, R.J. 1977. An ornithological survey of Hawaii wetlands. Vol II. Prepared for the U.S. Army Corps of Engineers, Engineer District, Honolulu. 278 p.

**Appendix A.2 System-Wide Characteristics of Ecologically Sensitive Habitats,
Aquifers of Wailuku Sector, Waihee System**

Aquifer System: Waihee (03)

Aquifer Sector: Wailuku (01)

Island: Maui (6)

Water Wells in Aquifer System (Div. of Water and Land Development 1984):

| | | | | | |
|-------------|---|----------|---|------------|---|
| Disposal | - | Domestic | 2 | Industrial | - |
| Irrigation | - | Lost | - | Municipal | - |
| Observation | - | Other | - | Recharge | - |
| Sealed | - | Unused | 1 | Unknown | 5 |

Water Wells or Sampling Sites Once Contaminated with DBCP, EDB or TCP
(Water Resources Research Center 1985):

None

Potential Pollutant Sources and Pollutants (see Fig. 2):

Source: Agricultural Runoff

Pollutants: Nitrates and phosphates

Discharge: Non-point Source

Source: Cattle Pasture

Pollutants: Fecal coliform

Discharge: Non-point Source

Appendix A.2.1 Habitat Description of Makamakaole Stream (Lower)

| | | | |
|---------|----------------------------|----------------------|------------|
| Site: | Makamakaole Stream (Lower) | Lat.: | 20°58'05" |
| Island: | Maui | Long.: | 156°31'41" |
| Sector: | Wailuku, 01 | El.: | 0-800 ft |
| System: | Waihee (03) | Approx. Area/Length: | 1.3 miles |

Site Description:

Makamakaole Stream is an intermittent stream classified as a "Limited Consumptive" which means that it has moderate to high water quality or natural value. The stream is not channelized and has one diversion (Timbol 1978).

The Makamakaole drainage basin lies entirely within the andesites and trachytes of the Honolua volcanic series. The perennial flow recorded in the left branch of the stream issues from springs in andesite clinker beds and from swamps lying on the poorly permeable surface at the head of the drainage (Wilson Okamoto & Associates 1977).

The lower Makamakaole is a swiftly meandering stream with many large boulders and numerous plunge pools. Along the banks of the stream numerous rock terraces have been constructed. Although, presently not in use, terraces of taro in the vicinity indicates previous use for taro cultivation.

| | |
|-----------------------------|---|
| Sensitivity Rating: | Aa12m3h |
| Main Water Source: | A Groundwater |
| Habitat: | a Natural |
| Endangered Species: | 1 Observed |
| Wetland Avifauna: | 2m Migratory Fowl |
| Other Value: | 3h Historical Value |
| Habitat Code: | 1-1a-3-4-5-4-2-1 |
| Water Source: | 1 Groundwater |
| Habitat Origin/Development: | 1a Natural/Pristine |
| Ecological Character: | 3 Endangered Species + Migratory Birds |
| Present Activities: | 4 Recreation |
| Social Significance: | 5 Neither Historic nor Wildlife Protected |
| Physical Significance: | 4 Neither Sediment Trap nor Flood Control |
| Wetland Type: | 2 Stream |
| Water Quality: | 1 Fresh (<250 mg/l Cl ⁻) |
| Aquifer Code: | 60103111 |
| Island: | 6 Maui |
| Sector: | 01 Wailuku |
| Aquifer System: | 03 Waihee |
| Aquifer Type (Hydrology): | 1 Basal |
| Aquifer Type (Hydrology): | 1 Unconfined |
| Aquifer Type (Geology): | 1 Flank |

Makamakaole Stream (Lower)--Continued

Status Code: 21221
 Development Stage: 2 Potential Use
 Utility: 1 Drinking
 Salinity: 2 Low (250-1,000 mg/l Cl⁻)
 Uniqueness: 2 Replaceable
 Vulnerability to Contamination: 1 High

Aquifer Code: 60103121
 Island: 6 Maui
 Sector: 01 Wailuku
 Aquifer System: 03 Waihee
 Aquifer Type (Hydrology): 1 Basal
 Aquifer Type (Hydrology): 2 Confined
 Aquifer Type (Geology): 1 Flank

Status Code: 21223
 Development Stage: 2 Potential Use
 Utility: 1 Drinking
 Salinity: 2 Low (250-1,000 mg/l Cl⁻)
 Uniqueness: 2 Replaceable
 Vulnerability to Contamination: 3 Low

U.S. Fish & Wildlife Service Wetland Code:
 Riverine/Intermittent/Streambed/Seasonal (R4SBC)

Geology:
 All of Makamakaole Stream flows on the Honolua series.

Soil Conservation Service, U.S. Dept. of Agriculture 1975:
 rRK (Rock land)

Terrestrial Threatened or Endangered Plant(s):
 No inventory available

Terrestrial Threatened or Endangered Animal(s):
 'I'iwi (*Vestiaria coccinea*)
 Maui 'amakihi (*Hemignathus virens wilsoni*)
 Maui nuku pu'u (*Hemignathus lucidus affinis*)

Terrestrial Plant(s):
 Candlenut tree (*Aleurites moluccana* (L.) Willd.)
 Ti (*Cordyline terminalis* (L.) Kunth)
 Common guava (*Psidium guajava* L.)
 Sugar cane (*Saccharum officinarum* L.)

Makamakaole Stream (Lower)--Continued

Common morning-glory (*Ipomoea purpurea* (L.) Roth)
Banana (*Musa paradisiaca* L.)

Aquatic Plant(s):

California grass (*Brachiaria mutica* (Forsk.) Stapf)

Terrestrial Animal(s):

Lesser Golden-Plover (*Pluvialis dominica (fulva)*)
Hawaii Storm-Petrel (*Oceanodroma castro*)
Gray-tailed Tattler (*Heteroscelus brevipes*)
Wedget-tailed Shearwater (*Puffinus pacificus chlororhynchus*)
Black Noddy (*Anous minutus melanogenys*)
Great Frigatebird (*Fregata minor palmerstoni*)
Ring-billed Gull (*Larus delawarensis*)
Spotted Dove (*Streptopelia chinensis*)
Zebra Dove (*Geopelia striata*)
Japanese Quail (*Coturnis japonica*)
Japanese White-eye (*Zosterops japonicus*)
Common Myna (*Acridotheres tristis*)
House Sparrow (*Passer domesticus*)
Nutmeg Mannikin (*Lonchura punctulata*)
House Finch (*Carpodacus mexicanus*)

Aquatic Animal(s):

'O'opu 'alamo'o (*Lentipes concolor*)
'O'opu naniha (*Awaous genivittatus*)
'O'opu nakea (*Awaous stamineus*)
'Opae-kala-'ole (*Atya bisulcata*)
'Opae 'oeha'a (*Macrobrachium grandimanus*)

Migratory Animal(s):

Lesser Golden-Plover (*Pluvialis dominica (fulva)*)
Ruddy Turnstone (*Arenaria interpres*)

Freshwater Origin:

The origin of Makamakaole perennial flow is seepage from perched aquifers and drainage from marshes.

Comments:

Potential contamination via groundwater is unlikely. The aquifer contains few potential pollutants and no wells have shown evidence of contamination. However, development pressure from Waihee could eventually change the potential for contamination.

Makamakaole Stream (Lower)--Continued

References:

Wilson Okamoto & Associates. 1977. Kahakuloa water study. Rep. no. R54. Prepared for the Department of Land and Natural Resources, Division of Water and Land Development, State of Hawaii, Honolulu. 84 p. plus app.

U.S. Department of Agriculture, Soil Conservation Service. 1972. Soil survey of islands of Kauai, Oahu, Maui, Molokai, and Lanai, State of Hawaii. In cooperation with the University of Hawaii Agricultural Experiment Station. 232 p. plus illus.

Timbol, A.S., and Maciolek, J.A. 1978. Stream channel modification in Hawaii. Part A: Statewide inventory of streams, habitat factors and associated biota. Prepared for U.S. Fish and Wildlife Service, U.S. Department of the Interior. 157 p.

Appendix A.2.2 Habitat Description of Makamakaole Stream (Upper)

| | | | |
|---------|----------------------------|----------------------|-------------|
| Site: | Makamakaole Stream (Upper) | Lat.: | 20°58'05" |
| Island: | Maui | Long.: | 156°31'41" |
| Sector: | Wailuku, 01 | El.: | 800-2280 ft |
| System: | Waihee (03) | Approx. Area/Length: | 1.2 miles |

Site Description:

Makamakaole Stream is an intermittent stream classified as a "Limited Consumptive" which means that it has moderate to high water quality or natural value. The stream is not channelized and has one diversion (Timbol 1978).

The Makamakaole drainage basin lies entirely within the andesites and trachytes of the Honolua volcanic series. The perennial flow recorded in the left branch of the stream issues from springs in andesite clinker beds and from swamps lying on the poorly permeable surface at the head of the drainage (Wilson Okamoto & Associates 1977).

| | |
|-----------------------------|--|
| Sensitivity Rating: | Aa12m3h |
| Main Water Source: | A Groundwater |
| Habitat: | a Natural |
| Endangered Species: | 1 Observed |
| Wetland Avifauna: | 2m Migratory Fowl |
| Other Value: | 3h Historical Value |
| Habitat Code: | 1-1a-3-5-5-4-2-1 |
| Water Source: | 1 Groundwater |
| Habitat Origin/Development: | 1a Natural/Pristine |
| Ecological Character: | 3 Endangered Species + Migratory Birds |
| Present Activities: | 5 Neither Agriculture, Aquaculture, nor Recreation |
| Social Significance: | 5 Neither Historic nor Wildlife Protected |
| Physical Significance: | 4 Neither Sediment Trap nor Flood Control |
| Wetland Type: | 2 Stream |
| Water Quality: | 1 Fresh (< 250 mg/l Cl ⁻) |
| Aquifer Code: | 60103214 |
| Island: | 6 Maui |
| Sector: | 01 Wailuku |
| Aquifer System: | 03 Waihee |
| Aquifer Type (Hydrology): | 2 High Level |
| Aquifer Type (Hydrology): | 1 Unconfined |
| Aquifer Type (Geology): | 4 Perched |
| Status Code: | 12111 |
| Development Stage: | 1 Currently Used |
| Utility: | 2 Ecologically Important |
| Salinity: | 1 Fresh (< 250 mg/l Cl ⁻) |

Makamakaole Stream (Upper)--Continued

Uniqueness: 1 Irreplaceable
 Vulnerability to Contamination: 1 High

Aquifer Code: 60103212
 Island: 6 Maui
 Sector: 01 Wailuku
 Aquifer System: 03 Waihee
 Aquifer Type (Hydrology): 2 High Level
 Aquifer Type (Hydrology): 1 Unconfined
 Aquifer Type (Geology): 2 Dike

Status Code: 21112
 Development Stage: 2 Potential Use
 Utility: 1 Drinking
 Salinity: 1 Fresh (< 250 mg/l Cl⁻)
 Uniqueness: 1 Irreplaceable
 Vulnerability to Contamination: 2 Moderate

U.S. Fish & Wildlife Service Wetland Code:
 Riverine/Intermittent/Streambed/Seasonal (R4SBC)

Geology:

Makamakaole is unique in that its entire drainage is on andesites and trachytes of the Honolua volcanic series. The stream flows on bedrock through scattered coarse alluvium.

Soil Conservation Service, U.S. Dept. of Agriculture 1975:
 rRT (Rough mountainous land)

Terrestrial Threatened or Endangered Plant(s):
 No inventory available

Terrestrial Threatened or Endangered Animal(s):
 No inventory available

Terrestrial Plant(s):

Candlenut tree (*Aleurites moluccana* (L.) Willd.)
 Ti (*Cordyline terminalis* (L.) Kunth)
 Common guava (*Psidium guajava* L.)
 Sugar cane (*Saccharum officinarum* L.)
 Common morning-glory (*Ipomoea purpurea* (L.) Roth)
 Banana (*Musa paradisiaca* L.)

Makamakaole Stream (Upper)--Continued

Aquatic Plant(s):

California grass (*Brachiaria mutica* (Forsk.) Stapf)

Terrestrial Animal(s):

Lesser Golden-Plover (*Pluvialis dominica (fulva)*)
 Hawaii Storm-Petrel (*Oceanodroma castro*)
 Gray-tailed Tattler (*Heteroscelus brevipes*)
 Wedget-tailed Shearwater (*Puffinus pacificus chlororhynchus*)
 Black Noddy (*Anous minutus melanogenys*)
 Great Frigatebird (*Fregata minor palmerstoni*)
 Ring-billed Gull (*Larus delawarensis*)
 Spotted Dove (*Streptopelia chinensis*)
 Zebra Dove (*Geopelia striata*)
 Japanese Quail (*Coturnis japonica*)
 Japanese White-eye (*Zosterops japonicus*)
 Common Myna (*Acridotheres tristis*)
 House Sparrow (*Passer domesticus*)
 Nutmeg Mannikin (*Lonchura punctulata*)
 House Finch (*Carpodacus mexicanus*)

Aquatic Animal(s):

'O'opu 'alamo'o (*Lentipes concolor*)
 'O'opu nakea (*Awaous stamineus*)
 'O'opu naniha (*Awaous genivittatus*)
 'Opae-kala-'ole (*Atya bisulcata*)
 'Opae 'oeha'a (*Macrobrachium grandimanus*)

Migratory Animal(s):

Lesser Golden-Plover (*Pluvialis dominica (fulva)*)
 Ruddy Turnstone (*Arenaria interpres*)

Freshwater Origin:

The stream is perennial because it is the accumulation of seepages from perched aquifers in the Honolua rocks and surface drainage from marshes.

Comments:

Potential contamination via groundwater is very unlikely. There are few potential pollutants within the aquifer and the elevation of the upper stream prohibits low elevation contamination from migrating upward.

References:

Wilson Okamoto & Associates. 1977. Kahakuloa water study. Rep. no. R54. Prepared for the Department of Land and Natural Resources, Division of Water and Land Development, State of Hawaii, Honolulu. 84 p. plus app.

Makamakaole Stream (Upper)--Continued

Timbol, A.S., and Maciolek, J.A. 1978. Stream channel modification in Hawaii. Part A: Statewide inventory of streams, habitat factors and associated biota. Prepared for U.S. Fish and Wildlife Service, U.S. Department of the Interior. 157 p.

U.S. Department of Agriculture, Soil Conservation Service. 1972. Soil survey of islands of Kauai, Oahu, Maui, Molokai, and Lanai, State of Hawaii. In cooperation with the University of Hawaii Agricultural Experiment Station. 232 p. plus illus.

**Appendix A.3 System-Wide Characteristics of Ecologically Sensitive Habitats,
Aquifers of Wailuku Sector, Kahakuloa System**

Aquifer System: Kahakuloa (04)

Aquifer Sector: Wailuku (01)

Island: Maui (6)

Water Wells in Aquifer System (Div. of Water and Land Development 1984):

| | | | | | |
|-------------|---|----------|---|------------|---|
| Disposal | - | Domestic | - | Industrial | - |
| Irrigation | - | Lost | - | Municipal | - |
| Observation | - | Other | - | Recharge | - |
| Sealed | - | Unused | - | Unknown | - |

Water Wells or Sampling Sites Once Contaminated with DBCP, EDB or TCP
(Water Resources Research Center 1985):

None

Potential Pollutant Sources and Pollutants (see Fig. 2):

Source: Cattle Pasture

Pollutants: Fecal coliform

Discharge: Non-point Source

Appendix A.3.1 Habitat Description of Eke Crater

| | | | |
|---------|----------------|----------------------|------------|
| Site: | Eke Crater | Lat.: | 20°55'14" |
| Island: | Maui | Long.: | 156°34'29" |
| Sector: | Wailuku, 01 | El.: | 4980 ft |
| System: | Kahakuloa (04) | Approx. Area/Length: | Unknown |

Site Description:

Eke Crater is a bulbous dome lying at the head waters of both Kahakuloa and Makamakaole streams. Water in Eke Crater originates as rainfall since the crater is within the high rainfall area of West Maui.

Eke supports the largest population of Eke Silversword in the world. There are also other rare plants living in Eke. The crater is part of the Kahakuloa section of the West Maui Natural Area Reserve System and has been fenced to protect it from ungulate infestation (NARS 1988).

The high rainfall area near Eke supports other swamps and bogs, particularly in the Kahakuloa and Makamakaole watershed where they cover an area of about one square mile. These high level, high rainfall swamps are among the most extensive in the Hawaiian Islands. Slow seepage from the swamps contributes significantly to the dry weather flows of Kahakuloa and Makamakaole streams (Wilson Okamoto & Associates 1977).

| | | |
|-----------------------------|----|--|
| Sensitivity Rating: | | Ba12wm |
| Main Water Source: | B | Not Groundwater |
| Habitat: | a | Natural |
| Endangered Species: | 1 | Observed |
| Wetland Status: | 2w | Wildlife Protected |
| Wetland Avifauna: | m | Migratory Fowl |
| Habitat Code: | | 2-1a-3-5-2-4-4-1 |
| Water Source: | 2 | Other |
| Habitat Origin/Development: | 1a | Natural/Pristine |
| Ecological Character: | 3 | Endangered Species + Migratory Birds |
| Present Activities: | 5 | Neither Agriculture, Aquaculture, nor Recreation |
| Social Significance: | 2 | Wildlife Protected |
| Physical Significance: | 4 | Neither Sediment Trap nor Flood Control |
| Wetland Type: | 4 | Marsh |
| Water Quality: | 1 | Fresh (< 250 mg/l Cl ⁻) |
| Aquifer Code: | | 60104214 |
| Island: | 6 | Maui |
| Sector: | 01 | Wailuku |
| Aquifer System: | 04 | Kahakuloa |
| Aquifer Type (Hydrology): | 2 | High Level |
| Aquifer Type (Hydrology): | 1 | Unconfined |

Eke Crater--Continued

| | | |
|---------------------------------|----|-------------------------------------|
| Aquifer Type (Geology): | 4 | Perched |
| Status Code: | | 12111 |
| Development Stage: | 1 | Currently Used |
| Utility: | 2 | Ecologically Important |
| Salinity: | 1 | Fresh (< 250 mg/l Cl ⁻) |
| Uniqueness: | 1 | Irreplaceable |
| Vulnerability to Contamination: | 1 | High |
| Aquifer Code: | | 60104212 |
| Island: | 6 | Maui |
| Sector: | 01 | Wailuku |
| Aquifer System: | 04 | Kahakuloa |
| Aquifer Type (Hydrology): | 2 | High Level |
| Aquifer Type (Hydrology): | 1 | Unconfined |
| Aquifer Type (Geology): | 2 | Dike |
| Status Code: | | 21112 |
| Development Stage: | 2 | Potential Use |
| Utility: | 1 | Drinking |
| Salinity: | 1 | Fresh (< 250 mg/l Cl ⁻) |
| Uniqueness: | 1 | Irreplaceable |
| Vulnerability to Contamination: | 2 | Moderate |

U.S. Fish & Wildlife Service Wetland Code:
Palustrine/Emergent/Persistent/Saturated (PEM1B)

Geology:

Eke is the remnant of a trachyte "bulbous dome" of the Honolua volcanic series. From it Honolua lavas flowed into Makamakaole Valley.

Soil Conservation Service, U.S. Dept. of Agriculture 1975:
rHT (Hydrandepts - tropaquods)

Terrestrial Threatened or Endangered Plant(s):
No inventory available

Terrestrial Threatened or Endangered Animal(s):
'I'iwi (*Vestiaria coccinea*)

Terrestrial Plant(s):
Purple strawberry guava (*Psidium cattleianum* Sabine)
Eke silversword (*Argyroxiphium caliginii* Forbes)
Ko'oko'olau (*Bidens conjunctata* Sherff)

Eke Crater--Continued

Large Hawaiian reed grass (*Calamagrostis expansa* (Munro in Hbd.) Hitchc.)
 Hillebrand's reed grass (*Calamagrostis hillebrandii* (Munro) Hitchc.)
 'Ohawai (*Cyanea kunthiana* (Gaud.) Hbd.)
 Hinahina (*Geranium humile* Hbd.)
 Koki'o (*Hibiscus kokio* var. *kokio* Hbd.)
 'Ohe (*Joinvillea ascendens* ssp. *ascendens* Brongn. & Gris.)
 Howai-a-ulu (*Lagenophora maviensis* Mann)
 Kolea (*Myrsine vaccinioides* W.L. Wagner, Herbst & Sohmer)
 Alani (*Pelea orbicularis* Hbd.)
 Alani (*Pelea parvifolia* var. *apoda* (St. John) Stone)
 Alani (*Pelea parvifolia* var. *sessilis* Levl.)
 (*Platanthera holochila* Hbd. Krzl)
 Naupaka (*Scaevola hobbayi* W.L. Wagner, sp. Nov. *inedited*)
 'Akia (*Wikstroemia bicornuta* Hbd.)

Aquatic Plant(s):

Quillworts (*Isoetes* sp. Nov. *inedited*)

Terrestrial Animal(s):

Northern Cardinal (*Cardinalis cardinalis*)
 House Finch (*Carpodacus mexicanus*)
 Japanese Quail (*Coturnis japonica*)
 Melodious Laughing-thrush (*Garrulax canorus*)
 Red-billed Leiothrix (*Leiothrix lutea*)
 'Apapane (*Himatione sanguinea*)
 Nutmeg Mannikin (*Lonchura punctulata*)
 Spotted Dove (*Streptopelia chinensis*)
 Japanese White-eye (*Zosterops japonicus*)

Aquatic Animal(s):

No inventory available

Migratory Animal(s):

Maui 'amakihi (*Hemignathus virens wilsoni*)
 Lesser Golden-Plover (*Pluvialis dominica (fulva)*)

Freshwater Origin:

Rainfall accumulates on the trachyte surface and in rubble beds between massive trachyte layers. Seepage off the surface and from the rubble layers drains to streams. Seepage is continuous because rainfall is high.

Eke Crater--Continued

Comments:

Potential contamination via groundwater is very unlikely. Eke Crater is rain fed and actually provides recharge to the groundwater aquifers; thus it is not supplied by groundwater. In addition, its extreme elevation and remoteness effectively eliminate potential groundwater contamination.

References:

- Wilson Okamoto & Associates. 1977. Kahakuloa water study. Rep. no. R54. Prepared for the Department of Land and Natural Resources, Division of Water and Land Development, State of Hawaii, Honolulu. 84 p. plus app.
- U.S. Department of Agriculture, Soil Conservation Service. 1972. Soil survey of islands of Kauai, Oahu, Maui, Molokai, and Lanai, State of Hawaii. In cooperation with the University of Hawaii Agricultural Experiment Station. 232 p. plus illus.
- Stearns, H.T., and Macdonald, G.A. 1942. Geology and ground-water resources of the island of Maui, Hawaii. Honolulu Advertiser Publishing Co. 344 p. plus maps and illus.
- Natural Area Reserves System. 1988. West Maui Natural Area Reserve Management Plan. Prepared for the Department of Land and Natural Resources, State of Hawaii, Honolulu. (Unpublished draft) 40 p. plus app.

Appendix A.3.2 Habitat Description of Kahakuloa Stream (Lower)

| | | | |
|---------|--------------------------|----------------------|------------|
| Site: | Kahakuloa Stream (Lower) | Lat.: | 21°00'05" |
| Island: | Maui | Long.: | 156°40'50" |
| Sector: | Wailuku, 01 | El.: | 0-600 ft |
| System: | Kahakuloa (04) | Approx. Area/Length: | 2.3 miles |

Site Description:

Kahakuloa Stream is a perennial non channelized stream with no diversions classified as a "Limited Consumptive", which means that it has moderate to high water quality or natural values (Timbol 1978).

Kahakuloa Stream is an example of Hawaiian Continuous Perennial Streams, another rare community type. This community is defined by continuous (completely unmodified from head to mouth) and perennial (year-long) flow, characterized by native aquatic biota. Kahakuloa Stream has the best example of native stream animals in the West Maui Natural Area Reserve. The headwaters of Kahakuloa drain from the bog of Eke Crater and nearby swamps resting on Honolua series rocks. The first mile or so of the stream course is on andesite-trachyte, but its final four to five miles cuts a deep canyon in the Wailuku basalt. The lower two mile reach of the valley is covered by a narrow tongue of alluvium (Wilson Okamoto & Associates 1977).

The stream is perennial throughout its observable length and probably all the way to its headwaters in the swamps near Eke. The most voluminous source of perennial flow is a large spring (Kapuna) that overflows a dike compartment in the mid portion of the valley at an elevation of about 500 ft (Wilson Okamoto & Associates 1977). Approximately 50 people live in Kahakuloa and much of the fishing and agrarian lifestyle of the old Hawaiian culture is retained by these people of Kahakuloa Valley. Their lifestyle is center around the stream, which provides the water for growing taro and their domestic needs. The stream and ocean also provide habitats for a major source of food and an environment for recreation (NARS 1988).

Two bulbous domes, Puu Koaie and Puu Olai, dominate the coastal topography between Kahakuloa and Makamakaole, while a third, Eke, lies at the headwaters of both Kahakuloa and Makamakaole streams. Another unique topographic feature of West Maui is high level swamps and bogs, particularly in the Kahakuloa and Makamakaole watersheds where they cover an area of about one square mile. These high level, high rainfall swamps are among the most extensive in the Hawaiian Islands. Slow seepage from the swamps contributes significantly to the dry weather flows of Kahakuloa and Makamakaole streams (Wilson Okamoto & Associates 1977).

| | | |
|----------------------------|----|----------------|
| Sensitivity Rating: | | Aa12tm |
| Main Water Source: | A | Groundwater |
| Habitat: | a | Natural |
| Endangered Species: | 1 | Observed |
| Wetland Use: | 2t | Traditional |
| Wetland Avifauna: | m | Migratory Fowl |

Kahakuloa Stream (Lower)--Continued

Habitat Code: 1-1c-3-1a-1b-4-2-1
 Water Source: 1 Groundwater
 Habitat Origin/Development: 1c Natural/Pristine + Altered
 Ecological Character: 3 Endangered Species + Migratory Birds
 Present Activities: 1a Agriculture Crops
 Social Significance: 1b Historic Not Registered
 Physical Significance: 4 Neither Sediment Trap nor Flood Control
 Wetland Type: 2 Stream
 Water Quality: 1 Fresh (< 250 mg/l Cl⁻)

Aquifer Code: 60104116
 Island: 6 Maui
 Sector: 01 Wailuku
 Aquifer System: 04 Kahakuloa
 Aquifer Type (Hydrology): 1 Basal
 Aquifer Type (Hydrology): 1 Unconfined
 Aquifer Type (Geology): 6 Sedimentary

Status Code: 12211
 Development Stage: 1 Currently Used
 Utility: 2 Ecologically Important
 Salinity: 2 Low (250-1,000 mg/l Cl⁻)
 Uniqueness: 1 Irreplaceable
 Vulnerability to Contamination: 1 High

Aquifer Code: 60104113
 Island: 6 Maui
 Sector: 01 Wailuku
 Aquifer System: 04 Kahakuloa
 Aquifer Type (Hydrology): 1 Basal
 Aquifer Type (Hydrology): 1 Unconfined
 Aquifer Type (Geology): 3 Flank/Dike

Status Code: 21222
 Development Stage: 2 Potential Use
 Utility: 1 Drinking
 Salinity: 2 Low (250-1,000 mg/l Cl⁻)
 Uniqueness: 2 Replaceable
 Vulnerability to Contamination: 2 Moderate

U.S. Fish & Wildlife Service Wetland Code:
 Palustrine/Forested/Broad leaved evergreen/Seasonal (PFO3C)

Kahakuloa Stream (Lower)--Continued

Geology:

The lower reaches of Kahakuloa Stream flows on a thin layer of loose recent alluvium overlying the basalt of the Wailuku volcanic series.

Soil Conservation Service, U.S. Dept. of Agriculture 1975:

rSM (Stony alluvial land)

rRK (Rock land)

Terrestrial Threatened or Endangered Plant(s):

No inventory available

Terrestrial Threatened or Endangered Animal(s):

Hawaiian Owl (*Asio flammeus sandwichensis*)

'I'iwi (*Vestiaria coccinea*)

Maui 'amakihī (*Hemignathus virens wilsoni*)

Maui nuku pu'u (*Hemignathus lucidus affinis*)

Terrestrial Plant(s):

Bermuda grass (*Cynodon dactylon* (L.) Pers.)

Hilo grass (*Paspalum conjugatum* Berg.)

Guinea grass (*Panicum maximum* Jacq.)

Christmas-berry tree (*Schinus terebinthifolius* Raddi)

Lantana (*Lantana camara* L.)

'Ohi'alehua (*Metrosideros collina* (Forst.) Gray)

Formosa koa (*Acacia confusa* Merr.)

Common guava (*Psidium guajava* L.)

Java plum (*Eugenia cumini* (L.) Druce)

Koa haole (*Leucaena leucocephala* (Lam.) deWit)

Polynesian bony berry (*Osteomeles anthyllidifolia* (Sm.) Lindl.)

Fragrant canthium (*Canthium odoratum* (Forst.) Seem.)

Hairy hopseed bush (*Dodonaea eriocarpa* Sm.)

'Akia (*Wikstroemia elongata* Gray)

Styphelia (*Styphelia* sp.)

Hawaiian sandalwood (*Santalum ellipticum* Gaud.)

Lama (*Diospyros ferrea* (Willd.) Bakh.)

Hawaiian olive (*Osmanthus sandwicensis* (A. Gray) B. and H.)

Pittosporum (*Pittosporum insigne* Hbd.)

Shoestring fern (*Vittaria elongata* Sw.)

Maile (*Alyxia olivaeformis* Gaud.)

Rapanea (*Rapanea* sp.)

Kopiko (*Straussia Mariniana* (C. & S.) Gray)

Candlenut tree (*Aleurites moluccana* (L.) Willd.)

False staghorn fern (*Dicranopteris linearis* (Burm.) Underw.)

Kahakuloa Stream (Lower)--Continued

Ti (*Cordyline terminalis* (L.) Kunth)
 Hawaiian tree fern (*Cibotium* sp.)
 Hawaiian caper (*Capparis sandwichiana* DC.)

Aquatic Plant(s):

No inventory available

Terrestrial Animal(s):

Lesser Golden-Plover (*Pluvialis dominica (fulva)*)
 Hawaii Storm-Petrel (*Oceanodroma castro*)
 Gray-tailed Tattler (*Heteroscelus brevipes*)
 Wedget-tailed Shearwater (*Puffinus pacificus chlororhynchus*)
 Black Noddy (*Anous minutus melanogenys*)
 Great Frigatebird (*Fregata minor palmerstoni*)
 Ring-billed Gull (*Larus delawarensis*)
 Spotted Dove (*Streptopelia chinensis*)
 Zebra Dove (*Geopelia striata*)
 Japanese Quail (*Coturnis japonica*)
 Japanese White-eye (*Zosterops japonicus*)
 Common Myna (*Acridotheres tristis*)
 House Sparrow (*Passer domesticus*)
 Nutmeg Mannikin (*Lonchura punctulata*)
 House Finch (*Carpodacus mexicanus*)

Aquatic Animal(s):

Striped Mullet (*Mugil cephalus* L.)
 Silver Perch (*Kuhlia sandvicensis*)
 Mosquitofish (*Gambusia affinis (Baird and Girard)*)
 Electric eel (*Eleotris sandwicensis Vaillant and Sauvage*)
 'Opa-kala-'ole (*Atya hisulcata*)
 'O'opu naniha (*Awaous genivittatus*)
 'O'opu nakea (*Awaous stamineus*)
 'O'opu nopili (*Sicydium stimsonii*)
 Wrinkled Frog (*Rana rugosa*)

Migratory Animal(s):

Lesser Golden-Plover (*Pluvialis dominica (fulva)*)
 Ruddy Turnstone (*Arenaria interpres*)

Freshwater Origin:

Kahakuloa is perennial in its lower reach mainly because of seepage from dike compartments in the Wailuku basalt. Another source of perennial flow is drainage from marshes resting on trachyte of the Honolulu series near Eke.

Kahakuloa Stream (Lower)--Continued

Comments:

Potential contamination via groundwater is unlikely given the current development situation. However, infringing development from Waihee may pose a threat in the future.

References:

- Timbol, A.S., and Maciolek, J.A. 1978. Stream channel modification in Hawaii. Part A: Statewide inventory of streams, habitat factors and associated biota. Prepared for U.S. Fish and Wildlife Service, U.S. Department of the Interior. 157 p.
- Wilson Okamoto & Associates. 1977. Kahakuloa water study. Rep. no. R54. Prepared for the Department of Land and Natural Resources, Division of Water and Land Development, State of Hawaii, Honolulu. 84 p. plus app.
- U.S. Department of Agriculture, Soil Conservation Service. 1972. Soil survey of islands of Kauai, Oahu, Maui, Molokai, and Lanai, State of Hawaii. In cooperation with the University of Hawaii Agricultural Experiment Station. 232 p. plus illus.
- Natural Area Reserves System. 1988. West Maui Natural Area Reserve Management Plan. Prepared for the Department of Land and Natural Resources, State of Hawaii, Honolulu. (Unpublished draft) 40 p. plus app.

Appendix A.3.3 Habitat Description of Kahakuloa Stream (Upper)

| | | | |
|---------|--------------------------|----------------------|-------------|
| Site: | Kahakuloa Stream (Upper) | Lat.: | 21°00'05" |
| Island: | Maui | Long.: | 156°40'50" |
| Sector: | Wailuku, 01 | El.: | 600-3400 ft |
| System: | Kahakuloa (04) | Approx. Area/Length: | 2.7 miles |

Site Description:

Kahakuloa Stream is a perennial, non-channelized stream with no diversions classified as a "Limited Consumptive", which means that it has moderate to high water quality or natural values (Timbol 1978).

Kahakuloa Stream is completely unmodified from head to mouth, exhibits year-long flow, and is characterized by native aquatic biota. Kahakuloa Stream has the best example of native stream animals in the West Maui Natural Area Reserve (NARS 1988). The headwaters of Kahakuloa drain from the bog of Eke Crater and nearby swamps resting on Honolua series rocks. The first mile or so of the stream course is on andesite-trachyte, but its final four to five miles cuts a deep canyon in the Wailuku basalt. The lower two mile reach of the valley is covered by a narrow tongue of alluvium (Wilson Okamoto & Associates 1977).

Beyond an elevation of 900 ft the stream flows through a narrow chasm with unstable walls. An impassable, vertical double waterfall with a total height of 65 ft was observed by Stearns (field notes on file at USGS) at an elevation of about 1100 ft (Wilson Okamoto & Associates 1977).

The stream is perennial throughout its observable length and probably all the way to its headwaters in the swamps near Eke. The most voluminous source of perennial flow is a large spring (Kapuna) that overflows a dike compartment in the mid portion of the valley at an elevation of about 500 ft. Two thousand feet upstream of Kapuna the first right branch of Kahakuloa is perennial, receiving its low flow from the swamp-spring association of Honolua rocks (Wilson Okamoto & Associates 1977).

Two bulbous domes, Puu Koae and Puu Olai, dominate the coastal topography between Kahakuloa and Makamakaole, while a third, Eke, lies at the headwaters of both Kahakuloa and Makamakaole streams. Another unique topographic feature of West Maui is high level swamps and bogs, particularly in the Kahakuloa and Makamakaole watersheds where they cover an area of about one square mile. These high level, high rainfall swamps are among the most extensive in the Hawaiian Islands. Slow seepage from the swamps contributes significantly to the dry weather flows of Kahakuloa and Makamakaole streams (Wilson Okamoto & Associates 1977).

| | | |
|----------------------------|----|----------------|
| Sensitivity Rating: | | Aa12tm |
| Main Water Source: | A | Groundwater |
| Habitat: | a | Natural |
| Endangered Species: | 1 | Observed |
| Wetland Use: | 2t | Traditional |
| Wetland Avifauna: | m | Migratory Fowl |

Kahakuloa Stream (Upper)--Continued

| | |
|-----------------------------|---|
| Habitat Code: | 1-1a-3-1a-1b-4-2-1 |
| Water Source: | 1 Groundwater |
| Habitat Origin/Development: | 1a Natural/Pristine |
| Ecological Character: | 3 Endangered Species + Migratory Birds |
| Present Activities: | 1a Agriculture Crops |
| Social Significance: | 1b Historic Not Registered |
| Physical Significance: | 4 Neither Sediment Trap nor Flood Control |
| Wetland Type: | 2 Stream |
| Water Quality: | 1 Fresh (< 250 mg/l Cl ⁻) |

| | |
|---------------------------|--------------|
| Aquifer Code: | 60104214 |
| Island: | 6 Maui |
| Sector: | 01 Wailuku |
| Aquifer System: | 04 Kahakuloa |
| Aquifer Type (Hydrology): | 2 High Level |
| Aquifer Type (Hydrology): | 1 Unconfined |
| Aquifer Type (Geology): | 4 Perched |

| | |
|---------------------------------|---------------------------------------|
| Status Code: | 12111 |
| Development Stage: | 1 Currently Used |
| Utility: | 2 Ecologically Important |
| Salinity: | 1 Fresh (< 250 mg/l Cl ⁻) |
| Uniqueness: | 1 Irreplaceable |
| Vulnerability to Contamination: | 1 High |

| | |
|---------------------------|--------------|
| Aquifer Code: | 60104212 |
| Island: | 6 Maui |
| Sector: | 01 Wailuku |
| Aquifer System: | 04 Kahakuloa |
| Aquifer Type (Hydrology): | 2 High Level |
| Aquifer Type (Hydrology): | 1 Unconfined |
| Aquifer Type (Geology): | 2 Dike |

| | |
|---------------------------------|---------------------------------------|
| Status Code: | 21112 |
| Development Stage: | 2 Potential Use |
| Utility: | 1 Drinking |
| Salinity: | 1 Fresh (< 250 mg/l Cl ⁻) |
| Uniqueness: | 1 Irreplaceable |
| Vulnerability to Contamination: | 2 Moderate |

U.S. Fish & Wildlife Service Wetland Code:
Riverine/Intermittent/Streambed/Seasonal (R4SBC)

Kahakuloa Stream (Upper)--Continued

Geology:

Inland of the recent alluvium covering the lower reach of Kahakuloa, the stream flows for most of its distance on basement rock of Wailuku basalt. At its extreme headwaters several tributaries drain the trachyte marshes near Eke.

Soil Conservation Service, U.S. Dept. of Agriculture 1975:

rRT (Rough mountainous land)

Terrestrial Threatened or Endangered Plant(s):

No inventory available

Terrestrial Threatened or Endangered Animal(s):

Hawaiian Owl (*Asio flammeus sandwichensis*)

'Iwi (*Vestiaria coccinea*)

Mauī 'amakihi (*Hemignathus virens wilsoni*)

Mauī nuku pu'u (*Hemignathus lucidus affinis*)

Terrestrial Plant(s):

Common guava (*Psidium guajava* L.)

Christmas-berry tree (*Schinus terebinthifolius* Raddi)

Lantana (*Lantana camara* L.)

'Ohi'alehua (*Metrosideros collina* (Forst.) Gray)

Fragrant canthium (*Canthium odoratum* (Forst.) Seem.)

Polynesian bony berry (*Osteomeles anthyllidifolia* (Sm.) Lindl.)

Styphelia (*Styphelia* sp.)

Hairy hopseed bush (*Dodonaea eriocarpa* Sm.)

Hawaiian sandalwood (*Santalum ellipticum* Gaud.)

Lama (*Diospyros ferrea* (Willd.) Bakh.)

Hawaiian olive (*Osmanthus sandwicensis* (A. Gray) B. and H.)

Pittosporum (*Pittosporum insigne* Hbd.)

Shoestring fern (*Vittaria elongata* Sw.)

Maile (*Alyxia olivaeformis* Gaud.)

'Akia (*Wikstroemia elongata* Gray)

Rapanea (*Rapanea* sp.)

Kopiko (*Straussia Mariniana* (C. & S.) Gray)

Candlenut tree (*Aleurites moluccana* (L.) Willd.)

False staghorn fern (*Dicranopteris linearis* (Burm.) Underw.)

Ti (*Cordyline terminalis* (L.) Kunth)

Hawaiian tree fern (*Cibotium* sp.)

Aquatic Plant(s):

No inventory available

Kahakuloa Stream (Upper)--Continued

Terrestrial Animal(s):

Spotted Dove (*Streptopelia chinensis*)
 Zebra Dove (*Geopelia striata*)
 Japanese Quail (*Coturnis japonica*)
 Japanese White-eye (*Zosterops japonicus*)
 Common Myna (*Acridotheres tristis*)
 House Sparrow (*Passer domesticus*)
 Nutmeg Mannikin (*Lonchura punctulata*)
 House Finch (*Carpodacus mexicanus*)
 'Apapane (*Himatione sanguinea*)

Aquatic Animal(s):

'O'opu nakea (*Awaous stamineus*)
 'O'opu nopili (*Sicydium stimsonii*)
 'O'opu 'alamo'o (*Lentipes concolor*)
 Electrid (*Eleotris sandwicensis Vaillant and Sauvage*)
 'Opae-kala-'ole (*Atya bisulcata*)
 'Opae 'oeha'a (*Macrobrachium grandimanus*)

Migratory Animal(s):

Lesser Golden-Plover (*Pluvialis dominica (fulva)*)
 Ruddy Turnstone (*Arenaria interpres*)

Freshwater Origin:

High level dike groundwater in Wailuku basalt provides most of the low flow of the stream. A supplementary source is drainage from the Eke region marshes.

Comments:

Potential contamination via groundwater is very unlikely given the extreme elevation and remoteness of the Upper Kahakuloa. In addition, the Kahakuloa system does not contain a large number of potential pollutants.

References:

- Timbol, A.S., and Maciolek, J.A. 1978. Stream channel modification in Hawaii. Part A: Statewide inventory of streams, habitat factors and associated biota. Prepared for U.S. Fish and Wildlife Service, U.S. Department of the Interior. 157 p.
- Wilson Okamoto & Associates. 1977. Kahakuloa water study. Rep. no. R54. Prepared for the Department of Land and Natural Resources, Division of Water and Land Development, State of Hawaii, Honolulu. 84 p. plus app.
- U.S. Department of Agriculture, Soil Conservation Service. 1972. Soil survey of islands of Kauai, Oahu, Maui, Molokai, and Lanai, State of Hawaii. In cooperation with the University of Hawaii Agricultural Experiment Station. 232 p. plus illus.

Kahakuloa Stream (Upper)--Continued

Natural Area Reserves System. 1988. West Maui Natural Area Reserve Management Plan. Prepared for the Department of Land and Natural Resources, State of Hawaii, Honolulu. (Unpublished draft) 40 p. plus app.

Appendix A.3.4 Habitat Description of Keahikauo

| | | | |
|---------|-----------------------------|----------------------|------------|
| Site: | Keahikauo | Lat.: | 20°56'45" |
| Island: | Maui | Long.: | 156°34'24" |
| Sector: | Wailuku, 01; Wailuku, 01 | El.: | 3003 ft |
| System: | Kahakuloa (04); Waihee (03) | Approx. Area/Length: | Unknown |

Site Description:

Keahikauo marsh is a protected area in the Kahakuloa section of the West Maui Natural Area Reserve System. It is a high rainfall marshy area on the lower slopes near Eke Crater. The Marsh is likely a result of the low permeability of the trachyte lava and is predominately maintained by rainfall.

Keahikauo is one of a few unique high level swamps and bogs of West Maui. They are especially unique in the Kahakuloa and Makamakaole watersheds where they cover an area of about one square mile. These high level, high rainfall swamps are among the most extensive in the Hawaiian Islands. Slow seepage from the swamps contributes significantly to the dry weather flows of Kahakuloa and Makamakaole streams (Wilson Okamoto & Associates 1977).

| | |
|-----------------------------|--|
| Sensitivity Rating: | Ba12wm |
| Main Water Source: | B Not Groundwater |
| Habitat: | a Natural |
| Endangered Species: | 1 Observed |
| Wetland Status: | 2w Wildlife Protected |
| Wetland Avifauna: | m Migratory Fowl |
| Habitat Code: | 2-1a-3-5-2-4-4-1 |
| Water Source: | 2 Other |
| Habitat Origin/Development: | 1a Natural/Pristine |
| Ecological Character: | 3 Endangered Species + Migratory Birds |
| Present Activities: | 5 Neither Agriculture, Aquaculture, nor Recreation |
| Social Significance: | 2 Wildlife Protected |
| Physical Significance: | 4 Neither Sediment Trap nor Flood Control |
| Wetland Type: | 4 Marsh |
| Water Quality: | 1 Fresh (< 250 mg/l Cl ⁻) |
| Aquifer Code: | 60104214 |
| Island: | 6 Maui |
| Sector: | 01 Wailuku |
| Aquifer System: | 04 Kahakuloa |
| Aquifer Type (Hydrology): | 2 High Level |
| Aquifer Type (Hydrology): | 1 Unconfined |
| Aquifer Type (Geology): | 4 Perched |

Keahikauo--Continued

Status Code: 12111
 Development Stage: 1 Currently Used
 Utility: 2 Ecologically Important
 Salinity: 1 Fresh (< 250 mg/l Cl⁻)
 Uniqueness: 1 Irreplaceable
 Vulnerability to Contamination: 1 High

Aquifer Code: 60104212
 Island: 6 Maui
 Sector: 01 Wailuku
 Aquifer System: 04 Kahakuloa
 Aquifer Type (Hydrology): 2 High Level
 Aquifer Type (Hydrology): 1 Unconfined
 Aquifer Type (Geology): 2 Dike

Status Code: 21112
 Development Stage: 2 Potential Use
 Utility: 1 Drinking
 Salinity: 1 Fresh (< 250 mg/l Cl⁻)
 Uniqueness: 1 Irreplaceable
 Vulnerability to Contamination: 2 Moderate

Aquifer Code: 60103212
 Island: 6 Maui
 Sector: 01 Wailuku
 Aquifer System: 03 Waihee
 Aquifer Type (Hydrology): 2 High Level
 Aquifer Type (Hydrology): 1 Unconfined
 Aquifer Type (Geology): 2 Dike

Status Code: 11111
 Development Stage: 1 Currently Used
 Utility: 1 Drinking
 Salinity: 1 Fresh (< 250 mg/l Cl⁻)
 Uniqueness: 1 Irreplaceable
 Vulnerability to Contamination: 1 High

U.S. Fish & Wildlife Service Wetland Code:
 Palustrine/Emergent/Persistent/Saturated (PEM1B)

Palustrine/Scrub-shrub/Broad leaved evergreen/Seasonal (PSS3C1U)

Keahikauo--Continued

Geology:

The marshy region rests on trachyte of the Honolua volcanic series. The trachyte is extensive and originated as a flow from sources at and near Puu Eke.

Soil Conservation Service, U.S. Dept. of Agriculture 1975:

rHT (Hydrandepts - tropaquods)

Terrestrial Threatened or Endangered Plant(s):

No inventory available

Terrestrial Threatened or Endangered Animal(s):

'Iwi (*Vestiaria coccinea*)

Terrestrial Plant(s):

Purple strawberry guava (*Psidium cattleianum* Sabine)

Eke silversword (*Argyroxiphium caliginii* Forbes)

Ko'oko'olau (*Bidens conjunctata* Sherff)

Large Hawaiian reed grass (*Calamagrostis expansa* (Munro in Hbd.) Hitchc.)

Hillebrand's reed grass (*Calamagrostis hillebrandii* (Munro) Hitchc.)

'Ohawai (*Cyanea kunthiana* (Gaud.) Hbd.)

Hinahina (*Geranium humile* Hbd.)

Koki'o (*Hibiscus kokio* var. *kokio* Hbd.)

'Ohe (*Joinvillea ascendens* ssp. *ascendens* Brongn. & Gris.)

Howai-a-ulu (*Lagenophora maviensis* Mann)

Kolea (*Myrsine vaccinioides* W.L. Wagner, Herbst & Sohmer)

Alani (*Pelea orbicularis* Hbd.)

Alani (*Pelea parvifolia* var. *apoda* (St. John) Stone)

Alani (*Pelea parvifolia* var. *sessilis* Levl.)

Orchid (*Platanthera holochila* (Hbd.) Krzl)

Naupaka (*Scaevola hobdyi* W. L. Wagner, sp. Nov. *inedited*)

'Akia (*Wikstroemia bicornuta* Hbd.)

Aquatic Plant(s):

Quillworts (*Isoetes* sp. Nov. *inedited*)

Terrestrial Animal(s):

Northern Cardinal (*Cardinalis cardinalis*)

House Finch (*Carpodacus mexicanus*)

Japanese Quail (*Coturnis japonica*)

Melodious Laughing-thrush (*Garrulax canorus*)

'Apapane (*Himatione sanguinea*)

Red-billed Leiothrix (*Leiothrix lutea*)

Nutmeg Mannikin (*Lonchura punctulata*)

Spotted Dove (*Streptopelia chinensis*)

Keahikauo--Continued

Japanese White-eye (*Zosterops japonicus*)

Aquatic Animal(s):

No inventory available

Migratory Animal(s):

Maui 'amakihi (*Hemignathus virens wilsoni*)

Lesser Golden-Plover (*Pluvialis dominica (fulva)*)

Freshwater Origin:

Rainwater accumulates on and within the trachyte because of its poor permeability. Seepage from perching members in the trachyte sustain the perennial flow of Makamakaole Stream.

Comments:

Potential contamination via groundwater is very unlikely. Keahikauo is rain fed and actually provides recharge to the groundwater aquifers. Its extreme elevation and remoteness effectively eliminate the potential for groundwater contamination.

References:

- Wilson Okamoto & Associates. 1977. Kahakuloa water study. Rep. no. R54. Prepared for the Department of Land and Natural Resources, Division of Water and Land Development, State of Hawaii, Honolulu. 84 p. plus app.
- U.S. Department of Agriculture, Soil Conservation Service. 1972. Soil survey of islands of Kauai, Oahu, Maui, Molokai, and Lanai, State of Hawaii. In cooperation with the University of Hawaii Agricultural Experiment Station. 232 p. plus illus.
- Stearns, H.T., and Macdonald, G.A. 1942. Geology and ground-water resources of the island of Maui, Hawaii. Honolulu Advertiser Publishing Co. 344 p. plus maps and illus.
- Natural Area Reserves System. 1988. West Maui Natural Area Reserve Management Plan. Prepared for the Department of Land and Natural Resources, State of Hawaii, Honolulu. (Unpublished draft) 40 p. plus app.

**Appendix B.1 System-Wide Characteristics of Ecologically Sensitive Habitats,
Aquifers of Lahaina Sector, Honokohau System**

Aquifer System: Honokohau (01)

Aquifer Sector: Lahaina (02)

Island: Maui (6)

Water Wells in Aquifer System (Div. of Water and Land Development 1984):

| | | | | | |
|-------------|---|----------|---|------------|---|
| Disposal | - | Domestic | - | Industrial | - |
| Irrigation | 2 | Lost | - | Municipal | - |
| Observation | - | Other | - | Recharge | - |
| Sealed | - | Unused | - | Unknown | 1 |

Water Wells or Sampling Sites Once Contaminated with DBCP, EDB or TCP
(Water Resources Research Center 1985):

None

Potential Pollutant Sources and Pollutants (see Fig. 2):

Source: Cattle Pasture

Pollutants: Fecal coliform

Discharge: Non-point Source

Appendix B.1.1 Habitat Description of Honokohau Stream (Lower)

| | |
|--------------------------------|--------------------------------|
| Site: Honokohau Stream (Lower) | Lat.: 21°01'29" |
| Island: Maui | Long.: 156°36'43" |
| Sector: Lahaina, 02 | El.: 0-600 ft |
| System: Honokohau (01) | Approx. Area/Length: 3.4 miles |

Site Description:

Honokohau is a perennial non-channelized stream classified as a "Exploitive Consumptive", which means it has moderate to low natural [value] and/or water quality; used for recreational activities. The stream has two diversions (Timbol 1978).

Honokohau, the longest valley in West Maui, follows a nearly straight nine and a half mile northerly course from Puu Kukui to Honokohau Bay. The bottom of the valley is relatively wide and its slope moderate all the way to Honokohau Falls, the focus of the impressive amphitheater valley about 6500 ft downstream of Puu Kukui. The stream has eroded through the marginal dike zone and into the dike complex. Stream direction and dike trend are nearly coincident in the marginal dike zone. All of the base flow of Honokohau is seepage of dike impounded groundwater (Wilson Okamoto & Associates 1977).

In dry weather the approximately one mile interval of the stream between the tunnel intake and elevation 600 ft carries no water even though it lies in the marginal dike zone. Suddenly, at elevation 600 ft, seepage occurs in a narrow band about 100 to 200 ft wide as overflow from a dike compartment. Seepage into the stream is restricted to approximately the 550 to 600 ft level. Flow does not increase downstream. Normally, the lowest flow months are September and October and the highest is April (Wilson Okamoto & Associates 1977).

| | |
|-----------------------------|---|
| Sensitivity Rating: | Aa12m |
| Main Water Source: | A Groundwater |
| Habitat: | a Natural |
| Endangered Species: | 1 Observed |
| Wetland Avifauna: | 2m Migratory Fowl |
| Habitat Code: | 1-1c-3-1a-5-4-2-1 |
| Water Source: | 1 Groundwater |
| Habitat Origin/Development: | 1c Natural/Pristine + Altered |
| Ecological Character: | 3 Endangered Species + Migratory Birds |
| Present Activities: | 1a Agriculture Crops |
| Social Significance: | 5 Neither Historic nor Wildlife Protected |
| Physical Significance: | 4 Neither Sediment Trap nor Flood Control |
| Wetland Type: | 2 Stream |
| Water Quality: | 1 Fresh (<250 mg/l Cl ⁻) |
| Aquifer Code: | 60201116 |
| Island: | 6 Maui |
| Sector: | 02 Lahaina |

Honokohau Stream (Lower)--Continued

| | | |
|---------------------------|----|-------------|
| Aquifer System: | 01 | Honokohau |
| Aquifer Type (Hydrology): | 1 | Basal |
| Aquifer Type (Hydrology): | 1 | Unconfined |
| Aquifer Type (Geology): | 6 | Sedimentary |

| | |
|---------------------------------|--------------------------------------|
| Status Code: | 12111 |
| Development Stage: | 1 Currently Used |
| Utility: | 2 Ecologically Important |
| Salinity: | 1 Fresh (<250 mg/l Cl ⁻) |
| Uniqueness: | 1 Irreplaceable |
| Vulnerability to Contamination: | 1 High |

| | |
|---------------------------|--------------|
| Aquifer Code: | 60201113 |
| Island: | 6 Maui |
| Sector: | 02 Lahaina |
| Aquifer System: | 01 Honokohau |
| Aquifer Type (Hydrology): | 1 Basal |
| Aquifer Type (Hydrology): | 1 Unconfined |
| Aquifer Type (Geology): | 3 Flank/Dike |

| | |
|---------------------------------|--------------------------------------|
| Status Code: | 21122 |
| Development Stage: | 2 Potential Use |
| Utility: | 1 Drinking |
| Salinity: | 1 Fresh (<250 mg/l Cl ⁻) |
| Uniqueness: | 2 Replaceable |
| Vulnerability to Contamination: | 2 Moderate |

U.S. Fish & Wildlife Service Wetland Code:
Palustrine/Forested/Broad-leaved evergreen/Seasonal (PFO3C)

Geology:
The stream channel lies on recent alluvium which overlies basalt of the Wailuku volcanic series.

Soil Conservation Service, U.S. Dept. of Agriculture 1975:
rSM (Stony alluvial land)

Terrestrial Threatened or Endangered Plant(s):
No inventory available

Terrestrial Threatened or Endangered Animal(s):
Hawaiian Owl (*Asio flammeus sandwichensis*)
'I'iwi (*Vestiaria coccinea*)
Maui 'amakihi (*Hemignathus virens wilsoni*)

Honokohau Stream (Lower)--Continued

Maui nuku pu'u (*Hemignathus lucidus affinis*)

Terrestrial Plant(s):

Bermuda grass (*Cynodon dactylon* (L.) Pers.)
 Hilo grass (*Paspalum conjugatum* Berg.)
 Guinea grass (*Panicum maximum* Jacq.)
 Christmas-berry tree (*Schinus terebinthifolius* Raddi)
 Common ironwood (*Casuarina equisetifolia* L.)
 Formosa koa (*Acacia confusa* Merr.)
 Common guava (*Psidium guajava* L.)
 Java plum (*Eugenia cuminii* (L.) Druce)
 Koa haole (*Leucaena leucocephala* (Lam.) deWit)
 Polynesian bony berry (*Osteomeles anthyllidifolia* (Sm.) Lindl.)
 Fragrant canthium (*Canthium odoratum* (Forst.) Seem.)
 Hairy hopseed bush (*Dodonaea eriocarpa* Sm.)
 Lantana (*Lantana camara* L.)
 'Akia (*Wikstroemia elongata* Gray)
 'Ohi'alehua (*Metrosideros collina* (Forst.) Gray)
 Styphelia (*Styphelia* sp.)
 Hawaiian sandalwood (*Santalum ellipticum* Gaud.)
 Lama (*Diospyros ferrea* (Willd.) Bakh.)
 Hawaiian olive (*Osmanthus sandwicensis* (A. Gray) B. and H.)
 Pittosporum (*Pittosporum insigne* Hbd.)
 Shoestring fern (*Vittaria elongata* Sw.)
 Maile (*Alyxia olivaeformis* Gaud.)
 Rapanea (*Rapanea* sp.)
 Kopiko (*Straussia Mariniana* (C. & S.) Gray)
 Candlenut tree (*Aleurites moluccana* (L.) Willd.)
 False staghorn fern (*Dicranopteris linearis* (Burm.) Underw.)
 Ti (*Cordyline terminalis* (L.) Kunth)
 Hawaiian tree fern (*Cibotium* sp.)
 Hawaiian caper (*Capparis sandwichiana* DC.)

Aquatic Plant(s):

No inventory available

Terrestrial Animal(s):

Lesser Golden-Plover (*Pluvialis dominica (fulva)*)
 Ruddy Turnstone (*Arenaria interpres*)
 Gray-tailed Tattler (*Heteroscelus brevipes*)
 Wedget-tailed Shearwater (*Puffinus pacificus chlororhynchus*)
 Black Noddy (*Anous minutus melanogenys*)
 Great Frigatebird (*Fregata minor palmerstoni*)
 Red-tailed Tropicbird (*Phaethon rubricauda rothschildi*)

Honokohau Stream (Lower)--Continued

Spotted Dove (*Streptopelia chinensis*)
 Zebra Dove (*Geopelia striata*)
 Japanese Quail (*Coturnis japonica*)
 Japanese White-eye (*Zosterops japonicus*)
 Common Myna (*Acridotheres tristis*)
 House Sparrow (*Passer domesticus*)
 Nutmeg Mannikin (*Lonchura punctulata*)
 House Finch (*Carpodacus mexicanus*)

Aquatic Animal(s):

Striped Mullet (*Mugil cephalus L.*)
 Silver Perch (*Kuhlia sandvicensis*)
 Mosquitofish (*Gambusia affinis (Baird and Girard)*)
 'O'opu naniha (*Awaous genivittatus*)
 'O'opu nakea (*Awaous stamineus*)
 'O'opu nopili (*Sicydium stimsonii*)
 Electrid (*Eleotris sandwicensis Vaillant and Sauvage*)
 'Opaē-kala-'ole (*Atya bisulcata*)
 Wrinkled Frog (*Rana rugosa*)

Migratory Animal(s):

Lesser Golden-Plover (*Pluvialis dominica (fulva)*)
 Ruddy Turnstone (*Arenaria interpres*)

Freshwater Origin:

Low flows originate as seepage and overflow from dike compartments in the Wailuku series. High flows include direct surface runoff. In the lowermost reach of the valley the alluvium is saturated, forming a wetland.

Comments:

Potential contamination via groundwater is unlikely given the amount of development in the vicinity and the geologic structure which separates the stream from the adjacent agricultural operations.

References:

- Timbol, A.S., and Maciolek, J.A. 1978. Stream channel modification in Hawaii. Part A: Statewide inventory of streams, habitat factors and associated biota. Prepared for U.S. Fish and Wildlife Service, U.S. Department of the Interior. 157 p.
- Wilson Okamoto & Associates. 1977. Kahakuloa water study. Rep. no. R54. Prepared for the Department of Land and Natural Resources, Division of Water and Land Development, State of Hawaii, Honolulu. 84 p. plus app.

Honokohau Stream (Lower)--Continued

U.S. Department of Agriculture, Soil Conservation Service. 1972. Soil survey of islands of Kauai, Oahu, Maui, Molokai, and Lanai, State of Hawaii. In cooperation with the University of Hawaii Agricultural Experiment Station. 232 p. plus illus.

Appendix B.2 System-Wide Characteristics of Ecologically Sensitive Habitats, Aquifers of Lahaina Sector, Honokowai System

Aquifer System: Honokowai (03)

Aquifer Sector: Lahaina (02)

Island: Maui (6)

Water Wells in Aquifer System (Div. of Water and Land Development 1984):

| | | | | | |
|-------------|---|----------|---|------------|---|
| Disposal | - | Domestic | - | Industrial | - |
| Irrigation | 5 | Lost | - | Municipal | 2 |
| Observation | 6 | Other | - | Recharge | - |
| Sealed | - | Unused | 4 | Unknown | 2 |

Water Wells or Sampling Sites Once Contaminated with DBCP, EDB or TCP
(Water Resources Research Center 1985):

None

Potential Pollutant Sources and Pollutants (see Fig. 2):

Source: Polynesian Shores Condominium (UM 1271)

Pollutants: Sewage effluent

Discharge: 20,000 gpd

Source: Lahaina Wastewater Treatment Plant (UM 1357)

Pollutants: Secondary treated sewage

Discharge: 6,700,000 gpd

Source: Hale Kai Condominium (UM 1234)

Pollutants: Secondary treated sewage

Discharge: 6,000 gpd

Source: Maui Kai Condominiums (UM 1221)

Pollutants: Secondary treated sewage

Discharge: 12,000 gpd

Source: Mahinahina Beach Condominium (UM 1231)

Pollutants: Secondary treated sewage

Discharge: 6,000 gpd

Source: Puukolii RD Roundhouse Shop (UST)

Pollutants: Fuel

Discharge: Number of Tanks: 3

Source: Kapalua Waste Treatment, Co. (UST)

Pollutants: Fuel

Discharge: Number of Tanks: 1

Honokowai--Continued

Source: Budget Rent-A-Car (UST)
Pollutants: Fuel
Discharge: Number of Tanks: 3

Source: Cattle Pasture
Pollutants: Fecal coliform
Discharge: Non-point Source

Appendix B.2.1 Habitat Description of Violet Lake

| | |
|------------------------|------------------------------|
| Site: Violet Lake | Lat.: 20°54'56" |
| Island: Maui | Long.: 156°35'41" |
| Sector: Lahaina, 02 | El.: 5200 ft |
| System: Honokowai (03) | Approx. Area/Length: Unknown |

Site Description:

Literature on Violet Lake is very scarce. To date we have found only two sources which describe Violet Lake. The first paragraph is from Maciolek (1982) and the second is from a draft survey of the West Maui Natural Area Reserve System (1989). Note the large difference in surface water reported.

Violet Lake, near the remote summit of West Maui, rests at an elevation of 1530 meters. It has a surface area of 3.0 acres. It is a big pool with a surface area of about 100 square meters lying in an area of high rainfall. The water was clear but deeply stained with humic leachates, much like that of lake Waieleele on East Maui (Maciolek 1982).

Violet Lake represents a little-known ecosystem found only on Maui and Hawaii. This example of a Hawaiian Montane Lake was approximately 10 by 20 ft in size (NARS 1988). To date, constituents of this ecosystem have not been extensively studied.

| | |
|-----------------------------|--|
| Sensitivity Rating: | Ba12wm |
| Main Water Source: | B Not Groundwater |
| Habitat: | a Natural |
| Endangered Species: | 1 Observed |
| Wetland Status: | 2w Wildlife Protected |
| Wetland Avifauna: | m Migratory Fowl |
| Habitat Code: | 2-1a-3-5-2-4-1-1 |
| Water Source: | 2 Other |
| Habitat Origin/Development: | 1a Natural/Pristine |
| Ecological Character: | 3 Endangered Species + Migratory Birds |
| Present Activities: | 5 Neither Agriculture, Aquaculture, nor Recreation |
| Social Significance: | 2 Wildlife Protected |
| Physical Significance: | 4 Neither Sediment Trap nor Flood Control |
| Wetland Type: | 1 Pond |
| Water Quality: | 1 Fresh (< 250 mg/l Cl ⁻) |
| Aquifer Code: | 60203212 |
| Island: | 6 Maui |
| Sector: | 02 Lahaina |
| Aquifer System: | 03 Honokowai |
| Aquifer Type (Hydrology): | 2 High Level |
| Aquifer Type (Hydrology): | 1 Unconfined |
| Aquifer Type (Geology): | 2 Dike |

Violet Lake--Continued

| | |
|---------------------------------|---------------------------------------|
| Status Code: | 11111 |
| Development Stage: | 1 Currently Used |
| Utility: | 1 Drinking |
| Salinity: | 1 Fresh (< 250 mg/l Cl ⁻) |
| Uniqueness: | 1 Irreplaceable |
| Vulnerability to Contamination: | 1 High |

U.S. Fish & Wildlife Service Wetland Code:

Palustrine/Open water/Permanent/Diked or impounded (POWHh)

Geology:

Water accumulates on a patch of Honolua series trachyte. The trachyte is not continuous over a wide area.

Soil Conservation Service, U.S. Dept. of Agriculture 1975:

rRT (Rough mountainous land)

Terrestrial Threatened or Endangered Plant(s):

No inventory available

Terrestrial Threatened or Endangered Animal(s):

'Iwi (*Vestiaria coccinea*)

Terrestrial Plant(s):

'Anali'i (*Asplenium schizophyllum* C. Chr.)
 Eke silversword (*Argyroxiphium caliginii* Forbes)
 Large Hawaiian reed grass (*Calamagrostis expansa* (Munro in Hbd.) Hitchc.)
 Hillebrand's reed grass (*Calamagrostis hillebrandii* (Munro) Hitchc.)
 'Oha (*Clermontia oblongifolia* var. *mauiensis* (Rock) Deg.)
 'Ohawai (*Cyanea kunthiana* (Gaud.) Hbd.)
 'Ohawai (*Cyanea scabra* Hbd.)
 (*Diellia erecta* Brack.)
 Okupukupu lau'i'i (*Doodia lyoni* Deg.)
 Anini (*Eurya sandwicensis* var. *grandifolia* Wawra)
 Hinahina (*Geranium humile* Hbd.)
 'Ohe (*Joinvillea ascendens* ssp. *ascendens* Brongn. & Gris.)
 Howai-a-ulu (*Lagenophora maviensis* Mann)
 Kolea (*Myrsine vaccinioides* W.L. Wagner, Herbst & Sohmer)
 Alani (*Pelea orbicularis* Hbd.)
 Alani (*Pelea parvifolia* var. *apoda* (St. John) Stone)
 Alani (*Pelea parvifolia* var. *sessilis* Levl.)
 (*Phyllostegia bracteata* Sherff)
 Orchid (*Platanthera holochila* (Hbd.) Krzl)
 Purple flowered sanicle (*Sanicula purpurea* St. John & Hosaka)

Violet Lake--Continued

Aquatic Plant(s):

No inventory available

Terrestrial Animal(s):

Northern Cardinal (*Cardinalis cardinalis*)
 House Finch (*Carpodacus mexicanus*)
 Melodious Laughing-thrush (*Garrulax canorus*)
 'Apapane (*Himatione sanguinea*)
 Red-billed Leiothrix (*Leiothrix lutea*)
 Nutmeg Mannikin (*Lonchura punctulata*)
 Spotted Dove (*Streptopelia chinensis*)
 Japanese White-eye (*Zosterops japonicus*)
 Maui 'amakihī (*Hemignathus virens wilsoni*)

Aquatic Animal(s):

No inventory available

Migratory Animal(s):

Lesser Golden-Plover (*Pluvialis dominica (fulva)*)

Freshwater Origin:

Rain is the immediate source of the water. The low permeability of the trachyte prevents the water from infiltrating.

Comments:

Potential contamination via groundwater is very unlikely. The geologic structure indicates that the wetland is fed by rainfall and not groundwater fed.

References:

- Maciolek, J.A. 1982. Lakes and lake-like waters of the Hawaiian Archipelago. Occasional papers of Bernice P. Bishop Museum. Bishop Museum Press, Honolulu. 14 p. plus maps.
- U.S. Department of Agriculture, Soil Conservation Service. 1972. Soil survey of islands of Kauai, Oahu, Maui, Molokai, and Lanai, State of Hawaii. In cooperation with the University of Hawaii Agricultural Experiment Station. 232 p. plus illus.
- Natural Area Reserves System. 1988. West Maui Natural Area Reserve Management Plan. Prepared for the Department of Land and Natural Resources, State of Hawaii, Honolulu. (Unpublished draft) 40 p. plus app.
- Stearns, H.T., and Macdonald, G.A. 1942. Geology and ground-water resources of the island of Maui, Hawaii. Honolulu Advertiser Publishing Co. 344 p. plus maps and illus.

**Appendix B.3 System-Wide Characteristics of Ecologically Sensitive Habitats,
Aquifers of Lahaina Sector, Olowalu System**

Aquifer System: Olowalu (05)

Aquifer Sector: Lahaina (02)

Island: Maui (6)

Water Wells in Aquifer System (Div. of Water and Land Development 1984):

| | | | | | |
|-------------|---|----------|---|------------|---|
| Disposal | - | Domestic | - | Industrial | - |
| Irrigation | 3 | Lost | - | Municipal | - |
| Observation | - | Other | - | Recharge | - |
| Sealed | 1 | Unused | - | Unknown | - |

Water Wells or Sampling Sites Once Contaminated with DBCP, EDB or TCP
(Water Resources Research Center 1985):

None

Potential Pollutant Sources and Pollutants (see Fig. 2):

Source: Agricultural Runoff

Pollutants: Nitrates and phosphates

Discharge: Non-point Source

Appendix B.3.1 Habitat Description of Olowalu Stream (Lower)

| | |
|------------------------------|------------------------------|
| Site: Olowalu Stream (Lower) | Lat.: 20°48'58" |
| Island: Maui | Long.: 156°37'48" |
| Sector: Lahaina, 02 | El.: 0-1200 ft |
| System: Olowalu (05) | Approx. Area/Length: 4 miles |

Site Description:

Olowalu Stream is a perennial stream classified as "Exploited Consumptive" which means it is a stream of moderate to low quality and well exploited. Olowalu Stream has four water diversions (Timbol 1978).

The lower reaches of the Olowalu Stream are completely dry. The stream bed is filled with cobbles measuring about 2 ft in diameter. During times of high rainfall the primary diversion exceeds its capacity and water flows into the lower reaches. However, another diversion collects this water before it reaches the ocean.

The primary diversion for Pioneer Mill runs along eastern slopes of the valley high above the stream bed. During the site visit we were not able to explore the stream above the intake; however, it is believed that the environment is similar to Ukumehame Stream. Pioneer Mill diverts approximately 3 mgd for sugar cane cultivation

Below the intake the stream water runs gently and the environment is much dryer than Ukumehame. The little water which was running never made it to the next diversion due to infiltration and evaporation.

| | |
|---------------------|-------------------|
| Sensitivity Rating: | Aa2m |
| Main Water Source: | A Groundwater |
| Habitat: | a Natural |
| Wetland Avifauna: | 2m Migratory Fowl |

| | |
|-----------------------------|---|
| Habitat Code: | 1-1c-2-1a-5-4-2-1 |
| Water Source: | 1 Groundwater |
| Habitat Origin/Development: | 1c Natural/Pristine + Altered |
| Ecological Character: | 2 Migratory Birds |
| Present Activities: | 1a Agriculture Crops |
| Social Significance: | 5 Neither Historic nor Wildlife Protected |
| Physical Significance: | 4 Neither Sediment Trap nor Flood Control |
| Wetland Type: | 2 Stream |
| Water Quality: | 1 Fresh (< 250 mg/l Cl ⁻) |

| | |
|---------------------------|---------------|
| Aquifer Code: | 60205116 |
| Island: | 6 Maui |
| Sector: | 02 Lahaina |
| Aquifer System: | 05 Olowalu |
| Aquifer Type (Hydrology): | 1 Basal |
| Aquifer Type (Hydrology): | 1 Unconfined |
| Aquifer Type (Geology): | 6 Sedimentary |

Olowalu Stream (Lower)--Continued

| | | |
|---------------------------------|---|---------------------------------------|
| Status Code: | | 21221 |
| Development Stage: | 2 | Potential Use |
| Utility: | 1 | Drinking |
| Salinity: | 2 | Low (250-1,000 mg/l Cl ⁻) |
| Uniqueness: | 2 | Replaceable |
| Vulnerability to Contamination: | 1 | High |

| | | |
|---------------------------|----|----------|
| Aquifer Code: | | 60205121 |
| Island: | 6 | Maui |
| Sector: | 02 | Lahaina |
| Aquifer System: | 05 | Olowalu |
| Aquifer Type (Hydrology): | 1 | Basal |
| Aquifer Type (Hydrology): | 2 | Confined |
| Aquifer Type (Geology): | 1 | Flank |

| | | |
|---------------------------------|---|---------------------------------------|
| Status Code: | | 21212 |
| Development Stage: | 2 | Potential Use |
| Utility: | 1 | Drinking |
| Salinity: | 2 | Low (250-1,000 mg/l Cl ⁻) |
| Uniqueness: | 1 | Irreplaceable |
| Vulnerability to Contamination: | 2 | Moderate |

U.S. Fish & Wildlife Service Wetland Code:

Palustrine/Forested/Broad-leaved evergreen/Temporary (PFO3A)

Geology:

The lower reach of Olowalu Stream is on indurated old alluvium which rests on basalt of the Wailuku series. On the coastal plain the old alluvium is covered by recent sediments into which the stream channel cuts.

Soil Conservation Service, U.S. Dept. of Agriculture 1975:

rRS (Rough broken & stony land)

rSM (Stony alluvial land)

Terrestrial Threatened or Endangered Plant(s):

No inventory available

Terrestrial Threatened or Endangered Animal(s):

No inventory available

Terrestrial Plant(s):

Koa haole (*Leucaena leucocephala* (Lam.) deWit)

Candlenut tree (*Aleurites moluccana* (L.) Willd.)

Olowalu Stream (Lower)--Continued

Cherry tomato (*Lycopersicon esculentum* Mill.)
 Morning-glory (*Ipomoea congesta* R. Br.)

Aquatic Plant(s):

Taro (*Colocasia esculenta* (L.) Schott)
 Hau (*Hibiscus tiliaceus* L.)
 California grass (*Brachiaria mutica* (Forsk.) Stapf)

Terrestrial Animal(s):

Spotted Dove (*Streptopelia chinensis*)
 Zebra Dove (*Geopelia striata*)
 Common Myna (*Acridotheres tristis*)

Aquatic Animal(s):

No inventory available

Migratory Animal(s):

Lesser Golden-Plover (*Pluvialis dominica (fulva)*)

Freshwater Origin:

The perennial flow of Olowalu arises as seepages from high level groundwater in the dike zone. This flow, however, is diverted for irrigation, leaving only direct runoff from heavy showers as flow to the coastal plain. The old alluvium on which the lower Olowalu is emplaced is nearly impermeable.

Comments:

Potential contamination via groundwater is unlikely. The sensitive system is located at an elevation above the agricultural fields, thus prohibiting the movement of contamination to the system.

References:

U.S. Department of Agriculture, Soil Conservation Service. 1972. Soil survey of islands of Kauai, Oahu, Maui, Molokai, and Lanai, State of Hawaii. In cooperation with the University of Hawaii Agricultural Experiment Station. 232 p. plus illus.

Timbol, A.S., and Maciolek, J.A. 1978. Stream channel modification in Hawaii. Part A: Statewide inventory of streams, habitat factors and associated biota. Prepared for U.S. Fish and Wildlife Service, U.S. Department of the Interior. 157 p.

**Appendix B.4 System-Wide Characteristics of Ecologically Sensitive Habitats,
Aquifers of Lahaina Sector, Ukumehame System**

Aquifer System: Ukumehame (06)

Aquifer Sector: Lahaina (02)

Island: Maui (6)

Water Wells in Aquifer System (Div. of Water and Land Development 1984):

| | | | | | |
|-------------|---|----------|---|------------|---|
| Disposal | - | Domestic | - | Industrial | - |
| Irrigation | 1 | Lost | - | Municipal | - |
| Observation | - | Other | - | Recharge | - |
| Sealed | - | Unused | - | Unknown | - |

Water Wells or Sampling Sites Once Contaminated with DBCP, EDB or TCP
(Water Resources Research Center 1985):

None

Potential Pollutant Sources and Pollutants (see Fig. 2):

Source: Agricultural Runoff

Pollutants: Nitrates and phosphates

Discharge: Non-point Source

Appendix B.4.1 Habitat Description of Ukumehame Stream (Lower)

| | | | |
|---------|--------------------------|----------------------|------------|
| Site: | Ukumehame Stream (Lower) | Lat.: | 20°48'09" |
| Island: | Maui | Long.: | 156°33'44" |
| Sector: | Lahaina, 02 | El.: | 0-1600 ft |
| System: | Ukumehame (06) | Approx. Area/Length: | 3 miles |

Site Description:

Ukumehame Stream is a perennial, non-channelized stream listed as a "Limited Consumptive", which means it has moderate to high, water quality or natural value. The stream has two water diversions (Timbol 1978).

The first diversion at approximately 200 ft elevation diverts the stream water along the western side of the valley and into two large reservoirs. The diversion supplies approximately 4 mgd to Pioneer Mill for sugar cane irrigation. During the months of November and December the water is allowed to reach the ocean; thus permitting the survival of diadromous species.

Above the diversion Ukumehame gently meanders through the valley with a varying width from approximately 25 to 50 ft. Boulders of approximately 2 ft in diameter dominate the stream bed to about the 600 ft elevation. However, there are numerous large boulders which act to create large pools of calm water. In these pools native 'opae-kala-'ole and 'opae 'oeha'a were observed along with 'o'opu sp.. Fresh water prawns are also present in the stream.

Numerous ancient terraces line the banks of the Ukumehame stream above the first diversion. There are traces of taro growing in the stream near the terraces which suggests that the terraces were formerly used for taro cultivation.

| | |
|----------------------------|---------------------|
| Sensitivity Rating: | Aa2m3h |
| Main Water Source: | A Groundwater |
| Habitat: | a Natural |
| Wetland Avifauna: | 2m Migratory Fowl |
| Other Value: | 3h Historical Value |

| | |
|-----------------------------|---|
| Habitat Code: | 1-1c-2-1a-1b-4-2-1 |
| Water Source: | 1 Groundwater |
| Habitat Origin/Development: | 1c Natural/Pristine + Altered |
| Ecological Character: | 2 Migratory Birds |
| Present Activities: | 1a Agriculture Crops |
| Social Significance: | 1b Historic Not Registered |
| Physical Significance: | 4 Neither Sediment Trap nor Flood Control |
| Wetland Type: | 2 Stream |
| Water Quality: | 1 Fresh (< 250 mg/l Cl ⁻) |

| | |
|----------------------|--------------|
| Aquifer Code: | 60206116 |
| Island: | 6 Maui |
| Sector: | 02 Lahaina |
| Aquifer System: | 06 Ukumehame |

Ukumehame Stream (Lower)--Continued

| | | |
|---------------------------|---|-------------|
| Aquifer Type (Hydrology): | 1 | Basal |
| Aquifer Type (Hydrology): | 1 | Unconfined |
| Aquifer Type (Geology): | 6 | Sedimentary |

| | | |
|---------------------------------|---|---------------------------------------|
| Status Code: | | 21221 |
| Development Stage: | 2 | Potential Use |
| Utility: | 1 | Drinking |
| Salinity: | 2 | Low (250-1,000 mg/l Cl ⁻) |
| Uniqueness: | 2 | Replaceable |
| Vulnerability to Contamination: | 1 | High |

| | | |
|---------------------------|----|-----------|
| Aquifer Code: | | 60206121 |
| Island: | 6 | Maui |
| Sector: | 02 | Lahaina |
| Aquifer System: | 06 | Ukumehame |
| Aquifer Type (Hydrology): | 1 | Basal |
| Aquifer Type (Hydrology): | 2 | Confined |
| Aquifer Type (Geology): | 1 | Flank |

| | | |
|---------------------------------|---|---------------------------------------|
| Status Code: | | 21212 |
| Development Stage: | 2 | Potential Use |
| Utility: | 1 | Drinking |
| Salinity: | 2 | Low (250-1,000 mg/l Cl ⁻) |
| Uniqueness: | 1 | Irreplaceable |
| Vulnerability to Contamination: | 2 | Moderate |

U.S. Fish & Wildlife Service Wetland Code:

Palustrine/Forested/Broad-leaved evergreen/Temporary (PFO3A)

Geology:

The channel of Ukumehame is in compact, indurated old alluvium over its lower two mile reach. On the coastal plain the stream flows over a thin layer of recent alluvium.

Soil Conservation Service, U.S. Dept. of Agriculture 1975:

rSM (Stony alluvial land)

rRD (Rock outcrop)

Terrestrial Threatened or Endangered Plant(s):

No inventory available

Terrestrial Threatened or Endangered Animal(s):

No inventory available

Ukumehame Stream (Lower)--Continued

Terrestrial Plant(s):

- Mesquite (*Prosopis pallida* (Humb. and Bonpl. ex Willd.) HBK.)
- Koa (*Acacia koa* Gray)
- Prickly narra (*Pterocarpus echinatus* Pers.)
- Cherry tomato (*Lycopersicon esculentum* Mill.)

Aquatic Plant(s):

- Taro (*Colocasia esculenta* (L.) Schott)

Terrestrial Animal(s):

- Zebra Dove (*Geopelia striata*)
- Spotted Dove (*Streptopelia chinensis*)
- Common Myna (*Acridotheres tristis*)

Aquatic Animal(s):

- 'O'opu 'alamo'o (*Lentipes concolor*)
- 'O'opu nakea (*Awaous stamineus*)
- 'Opae-kala-'ole (*Atya bisulcata*)
- 'Opae 'oeha'a (*Macrobrachium grandimanus*)

Migratory Animal(s):

- Lesser Golden-Plover (*Pluvialis dominica (fulva)*)

Freshwater Origin:

The perennial flow of Ukumehame originates in the high level groundwater portion of the valley as drainage from dike aquifers. Except for flood flows and during wet periods, the flow of the stream is diverted for irrigation about a mile inland of the coast.

Comments:

Potential contamination via groundwater is unlikely. The sensitive system is located at an elevation above the agricultural fields, thus prohibiting the movement of contamination to the system.

References:

- Timbol, A.S., and Maciolek, J.A. 1978. Stream channel modification in Hawaii. Part A: Statewide inventory of streams, habitat factors and associated biota. Prepared for U.S. Fish and Wildlife Service, U.S. Department of the Interior. 157 p.
- U.S. Department of Agriculture, Soil Conservation Service. 1972. Soil survey of islands of Kauai, Oahu, Maui, Molokai, and Lanai, State of Hawaii. In cooperation with the University of Hawaii Agricultural Experiment Station. 232 p. plus illus.

Appendix C.1 System-Wide Characteristics of Ecologically Sensitive Habitats, Aquifers of Central Sector, Kahului System

Aquifer System: Kahului (01)

Aquifer Sector: Central (03)

Island: Maui (6)

Water Wells in Aquifer System (Div. of Water and Land Development 1984):

| | | | | | |
|-------------|----|----------|---|------------|---|
| Disposal | 11 | Domestic | - | Industrial | 2 |
| Irrigation | 35 | Lost | 2 | Municipal | - |
| Observation | 4 | Other | 1 | Recharge | - |
| Sealed | 2 | Unused | 3 | Unknown | 4 |

Water Wells or Sampling Sites Once Contaminated with DBCP, EDB or TCP
(Water Resources Research Center 1985):

| | | |
|---------|------|-----|
| 5420 | DBCP | |
| 5420-01 | DBCP | TCP |
| 5521 | DBCP | |

Potential Pollutant Sources and Pollutants (see Fig. 2):

Source: Wailuku-Kahului Waste Treatment Plant (UM 1398)

Pollutants: Secondary treated sewage

Discharge: 6,000,000 gpd

Source: Maui Pineapple Company (UM 1229)

Pollutants: Treated process water

Discharge: 2,160,000 gpd

Source: Maui Pineapple Company (UM 1228)

Pollutants: Cooling water

Discharge: 6,000,000 gpd

Source: Union Oil Company of California/Central 76 (UST)

Pollutants: Fuel

Discharge: Number of Tanks: 6

Source: A-1 Hawaiian Rentals (UST)

Pollutants: Fuel

Discharge: Number of Tanks: 2

Source: Airport Maintenance Baseyard/DOT (UST)

Pollutants: Fuel

Discharge: Number of Tanks: 3

Source: Associated Steel Workers (UST)

Pollutants: Fuel

Discharge: Number of Tanks: 2

Kahului--Continued

Source: Ameron HC & D/Camp 10 (UST)
Pollutants: Fuel
Discharge: Number of Tanks: 2

Source: F & M Contractors, Inc. (UST)
Pollutants: Fuel
Discharge: Number of Tanks: 3

Source: Global Construction Company (UST)
Pollutants: Fuel
Discharge: Number of Tanks: 2

Source: Gray Line Maui (UST)
Pollutants: Fuel
Discharge: Number of Tanks: 1

Source: Kahului Airport/FAA (UST)
Pollutants: Fuel
Discharge: Number of Tanks: 3

Source: Ken's Tire and Supply, Inc. (UST)
Pollutants: Fuel
Discharge: Number of Tanks: 1

Source: Maui Linen and Dry Cleaning (UST)
Pollutants: Fuel
Discharge: Number of Tanks: 2

Source: Maui Meat Company (UST)
Pollutants: Fuel
Discharge: Number of Tanks: 1

Source: Pacific Rent A Car (UST)
Pollutants: Fuel
Discharge: Number of Tanks: 1

Source: Shimizu and Sons Construction (UST)
Pollutants: Fuel
Discharge: Number of Tanks: 2

Source: Texaco Bulk Plant (UST)
Pollutants: Fuel
Discharge: Number of Tanks: 3

Kahului--Continued

Source: J's Texaco Station (UST)

Pollutants: Fuel

Discharge: Number of Tanks: 4

Source: Texaco Station/85 S. Wakea St. (UST)

Pollutants: Fuel

Discharge: Number of Tanks: 5

Source: W and F Washerette, Inc. (UST)

Pollutants: Fuel

Discharge: Number of Tanks: 1

Source: Hawaiian Telephone Company/Baseyard (UST)

Pollutants: Fuel

Discharge: Number of Tanks: 2

Source: Hawaiian Telephone Company/Central Office (UST)

Pollutants: Fuel

Discharge: Number of Tanks: 1

Source: Dollar Rent A Car (UST)

Pollutants: Fuel

Discharge: Number of Tanks: 1

Source: Young Brothers (UST)

Pollutants: Fuel

Discharge: Number of Tanks: 1

Source: Pacific Machinery (UST)

Pollutants: Fuel

Discharge: Number of Tanks: 1

Source: Brewer Chemical Corporation (UST)

Pollutants: Fuel

Discharge: Number of Tanks: 2

Source: Hawaiian Sugar Planters Association (UST)

Pollutants: Fuel

Discharge: Number of Tanks: 1

Source: Island Movers, Inc. (UST)

Pollutants: Fuel

Discharge: Number of Tanks: 3

Kahului--Continued

Source: Maui Electric Company (UST)
Pollutants: Fuel
Discharge: Number of Tanks: 2

Source: Kahului Shell Service (UST)
Pollutants: Fuel
Discharge: Number of Tanks: 6

Source: Shell Service Station/233 Kam Avenue (UST)
Pollutants: Fuel
Discharge: Number of Tanks: 4

Source: Kahului Garage (UST)
Pollutants: Fuel
Discharge: Number of Tanks: 6

Source: Ameron H C & D Ltd. (UST)
Pollutants: Fuel
Discharge: Number of Tanks: 2

Source: Lloyd's Kahului Chevron (UST)
Pollutants: Fuel
Discharge: Number of Tanks: 7

Source: Gra-Pac Warehouse (UST)
Pollutants: Fuel
Discharge: Number of Tanks: 2

Source: Naska SPS/State DOT (UST)
Pollutants: Fuel
Discharge: Number of Tanks: 1

Source: Dairy Road Chevron (UST)
Pollutants: Fuel
Discharge: Number of Tanks: 3

Source: Maui Island Tours (UST)
Pollutants: Fuel
Discharge: Number of Tanks: 3

Source: A & B Commercial Company (UST)
Pollutants: Fuel
Discharge: Number of Tanks: 1

Kahului--Continued

Source: A & B Sewer Pump Station (UST)

Pollutants: Fuel

Discharge: Number of Tanks: 1

Source: Kahului SPS (UST)

Pollutants: Fuel

Discharge: Number of Tanks: 1

Source: Kahului Wastewater Treatment Plant (UST)

Pollutants: Fuel

Discharge: Number of Tanks: 2

Source: Tropical Rent A Car (UST)

Pollutants: Fuel

Discharge: Number of Tanks: 4

Source: Airports District Office/State DOT (UST)

Pollutants: Fuel

Discharge: Number of Tanks: 24

Source: Maui Potato Chip, Inc. (UST)

Pollutants: Fuel

Discharge: Number of Tanks: 1

Source: Haleakala Dairy (UST)

Pollutants: Fuel

Discharge: Number of Tanks: 2

Source: The Wash House (UST)

Pollutants: Fuel

Discharge: Number of Tanks: 1

Source: Highways Division (DOT) (UST)

Pollutants: Fuel

Discharge: Number of Tanks: 3

Source: Charton U-Drive (UST)

Pollutants: Fuel

Discharge: Number of Tanks: 1

Source: Tradewinds Electric Service Contractor (UST)

Pollutants: Fuel

Discharge: Number of Tanks: 1

Kahului--Continued

Source: Trans Hawaiian Maui (UST)
Pollutants: Fuel
Discharge: Number of Tanks: 2

Source: David Pico (UST)
Pollutants: Fuel
Discharge: Number of Tanks: 1

Source: Artie's Maui Foods (UST)
Pollutants: Fuel
Discharge: Number of Tanks: 2

Source: Arisumi Brothers (UST)
Pollutants: Fuel
Discharge: Number of Tanks: 5

Source: Hertz Rent-A-Car (UST)
Pollutants: Fuel
Discharge: Number of Tanks: 2

Source: Hawaii Commercial and Sugar Company (UST)
Pollutants: Fuel
Discharge: Number of Tanks: 13

Source: United Car Rental (UST)
Pollutants: Fuel
Discharge: Number of Tanks: 1

Source: Sugar Mill Auto System (UST)
Pollutants: Fuel
Discharge: Number of Tanks: 5

Source: Maui Car Rental (UST)
Pollutants: Fuel
Discharge: Number of Tanks: 1

Source: Highways Division (DOT) (UST)
Pollutants: Fuel
Discharge: Number of Tanks: 1

Source: National Car Rental Systems (UST)
Pollutants: Fuel
Discharge: Number of Tanks: 2

Kahului--Continued

Source: G.A. Construction (UST)

Pollutants: Fuel

Discharge: Number of Tanks: 1

Source: Kitagawa Motors (UST)

Pollutants: Fuel

Discharge: Number of Tanks: 3

Source: Alamo Rent-A-Car (UST)

Pollutants: Fuel

Discharge: Number of Tanks: 1

Source: Department of Water Supply (UST)

Pollutants: Fuel

Discharge: Number of Tanks: 2

Source: Warehouse (353 Hanamau St) (UST)

Pollutants: Fuel

Discharge: Number of Tanks: 1

Source: Maui Pineapple Company (UST)

Pollutants: Fuel

Discharge: Number of Tanks: 7

Source: Sears Roebuck and Co. (UST)

Pollutants: Fuel

Discharge: Number of Tanks: 1

Source: Marmac, Inc. (UST)

Pollutants: Fuel

Discharge: Number of Tanks: 1

Source: Royal Transportation, Inc. (UST)

Pollutants: Fuel

Discharge: Number of Tanks: 2

Source: Agricultural Runoff

Pollutants: Nitrates and phosphates

Discharge: Non-point Source

Source: Urban Runoff

Pollutants: Heavy metal, sediments

Discharge: Non-point Source

Appendix C.1.1 Habitat Description of Kanaha Pond

| | |
|----------------------|------------------------------|
| Site: Kanaha Pond | Lat.: 20°53'43" |
| Island: Maui | Long.: 156°57'30" |
| Sector: Central, 03 | El.: 10-20 ft |
| System: Kahului (01) | Approx. Area/Length: Unknown |

Site Description:

Kanaha Pond is a shallow, approximately 1 m deep brackish coastal basin with a listed surface area of 16.6 ha. It is classified as a saline marsh which has been perpetuated in a modified state because of its value as a waterbird refuge. The fishpond is of Hawaiian cultural origin that has been strongly modified in recent decades. It was connected to the ocean by a channel and supported a mullet fishery at least until the 1940s. Thereafter, advanced eutrophic conditions developed and aquatic macrofauna became restricted to a few tolerant species (Shallenberger 1977).

Until recently much of the bottom was exposed when rainfall generated runoff into the pond diminished in summer months. The pond is fed by several drainages and presumably a groundwater source as well. Fluctuations of water level in relationship to tidal patterns indicates an underground connection to the ocean also exists (Shallenberger 1977).

The dominant surrounding forest vegetation is kiawe. The wetland supports extensive stands of bulrush and smaller patches of other emergent vegetation. Algal productivity in the pond is very high. After periods of high winds the water in the pond may become quite turbid (Shallenberger 1977).

Kanaha Pond is perennial and provides complete habitat requirements for endemic water birds. Drainage from a dairy farm to the south may introduce some pollutants to Kanaha Pond, but the pond's odor is due to its very high algal productivity and resulting decay of large quantities of organic matter. A surface scum that has been observed in the pond may originate in the area of neighboring industrial storage tanks. A sewage treatment plant near Kanaha Pond uses injection wells to dispose of wastewater beneath the surface. The fate of injected wastes and possible effects on the quality of Kanaha Pond waters are not known. Kanaha Pond exhibits several characteristics that are common to other waterbird habitats affected by botulism. The possibility of a future outbreak of botulism or some other waterfowl disease cannot be ignored (AECOS 1979).

Annual rainfall in the Kanaha Pond area generally is low and occurs primarily during cyclonic storms in the winter months (Johnson 1972).

| | |
|----------------------------|-----------------------|
| Sensitivity Rating: | Aa12wtm3h |
| Main Water Source: | A Groundwater |
| Habitat: | a Natural |
| Endangered Species: | 1 Observed |
| Wetland Status: | 2w Wildlife Protected |
| Wetland Use: | t Traditional |
| Wetland Avifauna: | m Migratory Fowl |
| Other Value: | 3h Historical Value |

Kanaha Pond--Continued

Habitat Code: 1-1b-3-5-3-4-1-1
 Water Source: 1 Groundwater
 Habitat Origin/Development: 1b Natural/Altered
 Ecological Character: 3 Endangered Species + Migratory Birds
 Present Activities: 5 Neither Agriculture, Aquaculture, nor Recreation
 Social Significance: 3 Historic Registered + Wildlife Protected
 Physical Significance: 4 Neither Sediment Trap nor Flood Control
 Wetland Type: 1 Pond
 Water Quality: 1 Fresh (< 250 mg/l Cl⁻)

Aquifer Code: 60301116
 Island: 6 Maui
 Sector: 03 Central
 Aquifer System: 01 Kahului
 Aquifer Type (Hydrology): 1 Basal
 Aquifer Type (Hydrology): 1 Unconfined
 Aquifer Type (Geology): 6 Sedimentary

Status Code: 12211
 Development Stage: 1 Currently Used
 Utility: 2 Ecologically Important
 Salinity: 2 Low (250-1,000 mg/l Cl⁻)
 Uniqueness: 1 Irreplaceable
 Vulnerability to Contamination: 1 High

Aquifer Code: 60301111
 Island: 6 Maui
 Sector: 03 Central
 Aquifer System: 01 Kahului
 Aquifer Type (Hydrology): 1 Basal
 Aquifer Type (Hydrology): 1 Unconfined
 Aquifer Type (Geology): 1 Flank

Status Code: 12212
 Development Stage: 1 Currently Used
 Utility: 2 Ecologically Important
 Salinity: 2 Low (250-1,000 mg/l Cl⁻)
 Uniqueness: 1 Irreplaceable
 Vulnerability to Contamination: 2 Moderate

U.S. Fish & Wildlife Service Wetland Code:
 Lacustrine/Littoral/Open water/Permanent/Diked or impounded (L2OWHh)

Kanaha Pond--Continued

Palustrine/Emergent/Persistent/Semipermanent (PEM1F)

Palustrine/Forested/Broad-leaved evergreen/Seasonal (PFO3C)

Palustrine/Scrub-shrub/Saturated/Seasonal (PSSBC)

Geology:

Kanaha Pond is a shallow indentation into alluvium within the calcareous dune region of the isthmus. The alluvium overlies andesitic rocks of the Kula volcanic series.

Soil Conservation Service, U.S. Dept. of Agriculture 1975:

JcC (Jaucas Sand)

0-15% slopes

Terrestrial Threatened or Endangered Plant(s):

No inventory available

Terrestrial Threatened or Endangered Animal(s):

Hawaiian Stilt (*Himantopus mexicanus knudseni*)

Hawaiian Coot (*Fulica americana alai*)

Hawaiian Gallinule (*Gallinula chloropus sandvicensis*)

Hawaiian Duck (*Anas wyvilliana*)

Hawaiian Owl (*Asio flammeus sandwichensis*)

Terrestrial Plant(s):

Makaloa (*Cyperus laevigatus* L.)

Hilo grass (*Paspalum conjugatum* Berg.)

Bermuda grass (*Cynodon dactylon* (L.) Pers.)

Mesquite (*Prosopis pallida* (Humb. and Bonpl. ex Willd.) HBK.)

Mango (*Mangifera indica* L.)

Bush thunbergia (*Thunbergia erecta* T. Anders.)

Hawaiian goosefoot (*Chenopodium oahuense* (Meyen) Aellen)

Christmas-berry tree (*Schinus terebinthifolius* Raddi)

Australian salt bush (*Atriplex semibaccata* R. Br.)

Beach morning-glory (*Ipomoea brasiliensis* (L.) Sweet)

Water hyssop (*Bacopa monnieri* (L.) Pennell)

Aquatic Plant(s):

Bulrush (*Scirpus juncooides* var. *rockii* (Keuk.) K. and S.)

Beach dropseed (*Sporobolus virginicus* (L.) Kunth)

California bulrush (*Scirpus californicus* (C. A. Meyer) Steud.)

Makai (*Scirpus maritimus* L. var. *paludosus* (A. Nels.) Kuk.)

Kanaha Pond--Continued

Great bulrush (*Scirpus validus* Vahl)
 Sea purslane (*Sesuvium portulacastrum* L.)
 Indian pluchea (*Pluchea indica* (L.) Less.)
 Hairy fleabane (*Pluchea odorata* (L.) Cass.)

Terrestrial Animal(s):

Mongoose (*Herpestes auropunctatus*)
 Spotted Dove (*Streptopelia chinensis*)
 Zebra Dove (*Geopelia striata*)
 Common Myna (*Acridotheres tristis*)
 Japanese White-eye (*Zosterops japonicus*)
 Nutmeg Mannikin (*Lonchura punctulata*)
 House Finch (*Carpodacus mexicanus*)
 Northern Cardinal (*Cardinalis cardinalis*)
 House Sparrow (*Passer domesticus*)
 Gray Francolin (*Francolinus pondicerianus*)
 Black-crowned Night-Heron (*Nycticorax nycticorax hoactli*)
 Cattle Egret (*Bubulcus ibis*)
 Red-crested Cardinal (*Paroaria coronata*)

Aquatic Animal(s):

Tilapia (*Tilapia mossambica*)
 Mosquitofish (*Gambusia affinis* (Baird and Girard))

Migratory Animal(s):

Northern Shoveler (*Anas clypeata*)
 Northern Pintail (*Anas acuta*)
 Lesser Golden-Plover (*Pluvialis dominica (fulva)*)
 Ruddy Turnstone (*Arenaria interpres*)
 Sanderling (*Calidris alba*)
 Wandering Tattler (*Heteroscelus incanus*)
 Canada Goose (*Branta canadensis*)
 Brant (*Branta bernicla*)
 Green-winged Teal (*Anas crecca*)
 Cinnamon Teal (*Anas cyanoptera*)
 American Wigeon (*Anas americana*)
 Ring-necked Duck (*Aythya collaris*)
 Canvasback (*Aythya Valisineria*)
 Lesser Scaup (*Aythya affinis*)
 Bufflehead (*Bucephala albeola*)
 Mallard (*Anas platyrhynchos*)
 Semipalmated Plover (*Charadrius semipalmatus*)
 Sharp-tailed Sandpiper (*Calidris acuminata*)
 Willet (*Catoptrophorus semipalmatus*)

Kanaha Pond--Continued

Blue-winged Teal (*Anas discors*)
 Glaucous Gull (*Larus hyperboreus*)
 Least Sandpiper (*Calidris minutilla*)
 Long-billed Dowitcher (*Limnodromus scolopaceus*)

Freshwater Origin:

Much of the pond water is upward seepage through a thin caprock of groundwater from the deeper Kula aquifer. Groundwater is the source of perennial supply; the surface water component is very small and transient. The groundwater is rich in nutrients because it contains considerable irrigation recharge.

Comments:

Potential contamination via groundwater is very likely. The Kahului aquifer has numerous sources of potential pollutants and various water wells have shown evidence of groundwater contamination. Industrial development is rapidly infringing upon Kanaha Pond. The development of Kahului Airport into an international airport may have significant impacts on the Pond. In addition, the Kahului sewage treatment plant injects treated waste water into the ground. The water quality of Kanaha Pond has been a topic of discussion for many years.

References:

- Maciolek, J.A. 1982. Lakes and lake-like waters of the Hawaiian Archipelago. Occasional papers of Bernice P. Bishop Museum. Bishop Museum Press, Honolulu. 14 p. plus maps.
- Johnson, J.M. 1972. Kanaha Pond baseline data. Environmental Center unpublished report prepared for the Office of Environmental Quality Control and Department of Land and Natural Resources, Division of Fish and Game, Honolulu. 12 p.
- Shallenberger, R.J. 1977. An ornithological survey of Hawaii wetlands. Vol II. Prepared for the U.S. Army Corps of Engineers, Engineer District, Honolulu. 278 p.
- Berger, A.J. 1972. Kanaha Pond bird study; final report. Prepared for Hawaii Division of Fish and Game, Honolulu, Hawaii. (Unpublished) 35 p. plus app.
- Division of Public Works. 1963. A plan for development of a wildlife sanctuary and public park at Kanaha Pond, Kahului, Maui. In consultation with R.I. Bush for Department of Accounting and General Services, State of Hawaii, Honolulu. 38 p.
- AECOS, Inc. 1979. Kanaha Pond, Hawaii coral reef inventory, island of Maui. U.S. Army Corps of Engineers. Pacific Ocean Division. Prepared by AECOS, Inc., Honolulu. (Unpublished) 84-95 p.

Kanaha Pond--Continued

AECOS, Inc. 1977. Field notes from Kanaha Pond. Honolulu, Hawaii. (Unpublished) 6 p.

Department of Land and Natural Resources. 1983-85. Statewide nongame and endangered species program. Project no. W-18-R-9, R-10; Job no. R-III-E(b). 2 p.

U.S. Department of Agriculture, Soil Conservation Service. 1972. Soil survey of islands of Kauai, Oahu, Maui, Molokai, and Lanai, State of Hawaii. In cooperation with the University of Hawaii Agricultural Experiment Station. 232 p. plus illus.

Appendix C.1.2 Habitat Description of Kealia Pond

| | |
|----------------------|------------------------------|
| Site: Kealia Pond | Lat.: 20°47'48" |
| Island: Maui | Long.: 156°28'38" |
| Sector: Central, 03 | El.: 10-20 ft |
| System: Kahului (01) | Approx. Area/Length: Unknown |

Site Description:

Kealia Pond is a developed coastal marsh. The accumulation of silt in runoff filled the original basin so that the pond dried up completely in summer months. Strong tradewinds blew the dried silt off the flatlands into Maalaea Bay. In years of normal rainfall the cycle was repeated; runoff and siltation followed by evaporation and wind erosion. In abnormally wet years, some water remained throughout the summer (Shallenberger 1977).

In recent years, the summer wind erosion has become a major source of complaint in nearby residential and tourist communities. But the cycle has been critical in preventing the heavy runoff of silt-laden waters into the Maalaea Bay and possibly destroying a rich marine ecosystem that has adjusted to the gradual and less severe impact of wind-blown silt (Shallenberger 1977).

After seasonal flooding the shallow water occupies 400-500 acres of flatlands. The development of a small aquaculture facility at the site, and the continued pumping of well water through their system, now maintains at least 150-200 acres of water coverage in the driest months. Drain channels enter the pond from the north, east and west, but none of the streams feeding these channels are perennial.

The shallow, productive waters and mudflats of Kealia Pond provide valuable habitat for resident and migratory waterbirds. In 1970, 25 acres of land on the north edge of the site were leased to Pacific Aquaculture Corporation for the culture of Malaysian Prawns and catfish. Several water impoundments were constructed and a shallow well was dug to feed the operation (Shallenberger 1977).

Permanent water in the pond created by runoff from the aquaculture operation has made it possible for native waterbirds to stay at the pond throughout the summer months. In the past, the evaporation of water in the pond had forced these birds to seek habitat elsewhere. The aquaculture operation has also attracted increasing numbers of birds, particularly herons (Shallenberger 1977).

| | |
|-----------------------------|-----------------------|
| Sensitivity Rating: | Aa12wm3f |
| Water Source | A Groundwater |
| Habitat: | a Natural |
| Endangered Species: | 1 Observed |
| Wetland Status: | 2w Wildlife Protected |
| Wetland Avifauna: | m Migratory Fowl |
| Other Value: | 3f Sediment Trap |
| Habitat Code: | 1-1b-3-2-2-1-1-2 |
| Water Source: | 1 Groundwater |
| Habitat Origin/Development: | 1b Natural/Altered |

Kealia Pond--Continued

| | | |
|------------------------|---|---|
| Ecological Character: | 3 | Endangered Species + Migratory Birds |
| Present Activities: | 2 | Aquaculture |
| Social Significance: | 2 | Wildlife Protected |
| Physical Significance: | 1 | Sediment Trap |
| Wetland Type: | 1 | Pond |
| Water Quality: | 2 | Brackish (250-15,000 mg/l Cl ⁻) |

| | | |
|---------------------------|----|-------------|
| Aquifer Code: | | 60301116 |
| Island: | 6 | Maui |
| Sector: | 03 | Central |
| Aquifer System: | 01 | Kahului |
| Aquifer Type (Hydrology): | 1 | Basal |
| Aquifer Type (Hydrology): | 1 | Unconfined |
| Aquifer Type (Geology): | 6 | Sedimentary |

| | | |
|---------------------------------|---|---------------------------------------|
| Status Code: | | 12211 |
| Development Stage: | 1 | Currently Used |
| Utility: | 2 | Ecologically Important |
| Salinity: | 2 | Low (250-1,000 mg/l Cl ⁻) |
| Uniqueness: | 1 | Irreplaceable |
| Vulnerability to Contamination: | 1 | High |

| | | |
|---------------------------|----|------------|
| Aquifer Code: | | 60301111 |
| Island: | 6 | Maui |
| Sector: | 03 | Central |
| Aquifer System: | 01 | Kahului |
| Aquifer Type (Hydrology): | 1 | Basal |
| Aquifer Type (Hydrology): | 1 | Unconfined |
| Aquifer Type (Geology): | 1 | Flank |

| | | |
|---------------------------------|---|---------------------------------------|
| Status Code: | | 12212 |
| Development Stage: | 1 | Currently Used |
| Utility: | 2 | Ecologically Important |
| Salinity: | 2 | Low (250-1,000 mg/l Cl ⁻) |
| Uniqueness: | 1 | Irreplaceable |
| Vulnerability to Contamination: | 2 | Moderate |

U.S. Fish & Wildlife Service Wetland Code:

Lacustrine/Littoral/Open water/Permanent/Diked or impounded (L2OWHh)

Lacustrine/Littoral/Unconsolidated bottom/Mud/Seasonal (L2UB3C)

Palustrine/Emergent/Persistent/Seasonal (PEM1C)

Kealia Pond--Continued

Geology:

The pond area is in fine grain recent alluvium overlying the Kula volcanic series. The alluvial layer is thin but poorly permeable.

Soil Conservation Service, U.S. Dept. of Agriculture 1975:

KMW (Kealia Silt loam)

Terrestrial Threatened or Endangered Plant(s):

No inventory available

Terrestrial Threatened or Endangered Animal(s):

Hawaiian Stilt (*Himantopus mexicanus knudseni*)

Hawaiian Coot (*Fulica americana alai*)

Terrestrial Plant(s):

Makaloa (*Cyperus laevigatus* L.)

Broad-leaved carpet grass (*Axonopus compressus* (Sw.) Beauv.)

Jungle rice (*Echinochloa colonum* (L.) Link)

Water hyssop (*Bacopa monnieri* (L.) Pennell)

Mesquite (*Prosopis pallida* (Humb. and Bonpl. ex Willd.) HBK.)

Aquatic Plant(s):

Makai (*Scirpus maritimus* L. var. *paludosus* (A. Nels.) Kuk.)

Barnyard grass (*Echinochloa crusgalli* (L.) Beauv.)

Beach dropseed (*Sporobolus virginicus* (L.) Kunth)

Sea purslane (*Sesuvium portulacastrum* L.)

Pickle-weed (*Batis maritima* L.)

Indian pluchea (*Pluchea indica* (L.) Less.)

Red mangrove (*Rhizophora mangle* L.)

Terrestrial Animal(s):

Mongoose (*Herpestes auropunctatus*)

Spotted Dove (*Streptopelia chinensis*)

Zebra Dove (*Geopelia striata*)

Ring-necked Pheasant (*Phasianus colchicus*)

Gray Francolin (*Francolinus pondicerianus*)

Japanese White-eye (*Zosterops japonicus*)

Northern Cardinal (*Cardinalis cardinalis*)

Northern Mockingbird (*Mimus polyglottos*)

House Finch (*Carpodacus mexicanus*)

Common Myna (*Acridotheres tristis*)

House Sparrow (*Passer domesticus*)

Black-crowned Night-Heron (*Nycticorax nycticorax hoactli*)

Kealia Pond--Continued

Aquatic Animal(s):

Milkfish (*Chanos chanos* (Forsk))
 Striped Mullet (*Mugil cephalus* L.)
 Silver Perch (*Kuhlia sandvicensis*)
 'Opae 'oeha'a (*Macrobrachium grandimanus*)
 Wi (*Theodoxus vespertina*)
 Tilapia (*Tilapia mossambica*)
 Catfish (*Ictalurus punctatus*)

Migratory Animal(s):

Northern Pintail (*Anas acuta*)
 Snow Goose (*Chen caerulescens*)
 Mallard (*Anas platyrhynchos*)
 Green-winged Teal (*Anas crecca*)
 American Wigeon (*Anas americana*)
 Canvasback (*Aythya Valisineria*)
 Lesser Scaup (*Aythya affinis*)
 Lesser Golden-Plover (*Pluvialis dominica* (fulva))
 Ruddy Turnstone (*Arenaria interpres*)
 Sanderling (*Calidris alba*)
 Wandering Tattler (*Heteroscelus incanus*)
 Semipalmated Plover (*Charadrius semipalmatus*)
 Greater Yellowlegs (*Tringa melanoleuca*)
 Lesser Yellowlegs (*Tringa flavipes*)
 Sharp-tailed Sandpiper (*Calidris acuminata*)
 Willet (*Catoptrophorus semipalmatus*)
 Bristle-thighed Curlew (*Numenius tahitiensis*)

Freshwater Origin:

Under natural conditions the pond is the accumulation of surface runoff. Now, however, wells driven into the Kula aquifers provide a constant water supply. The groundwater consists in large measure of return irrigation water and therefore is brackish and rich in nitrogen.

Comments:

Potential contamination via groundwater is likely given the ponds location in the Kahului aquifer system and the rapid development occurring at Kihei and Maalaea. Presently, no contaminated wells have been identified in this area.

References:

Elliott, M.E. 1981. Wetlands and wetland vegetation of the Hawaiian Islands. Master thesis (Geography), University of Hawaii, Honolulu. 228 p.

Kealia Pond--Continued

- Shallenberger, R.J. 1977. An ornithological survey of Hawaii wetlands. Vol II. Prepared for the U.S. Army Corps of Engineers, Engineer District, Honolulu. 278 p.
- Maciolek, J.A. 1971. Aquatic ecosystems of Kealia Floodplain and Maalaea Bay, Maui; evaluation for perpetuation and public use. Hawaii Institute of Marine Biology, University of Hawaii, Honolulu. Technical report no. 27. 42 p.
- U.S. Department of Agriculture, Soil Conservation Service. 1972. Soil survey of islands of Kauai, Oahu, Maui, Molokai, and Lanai, State of Hawaii. In cooperation with the University of Hawaii Agricultural Experiment Station. 232 p. plus illus.

**Appendix C.2 System-Wide Characteristics of Ecologically Sensitive Habitats,
Aquifers of Central Sector, Paia System**

Aquifer System: Paia (02)

Aquifer Sector: Central (03)

Island: Maui (6)

Water Wells in Aquifer System (Div. of Water and Land Development 1984):

| | | | | | |
|-------------|----|----------|---|------------|---|
| Disposal | - | Domestic | - | Industrial | - |
| Irrigation | 11 | Lost | - | Municipal | 1 |
| Observation | - | Other | - | Recharge | - |
| Sealed | 1 | Unused | 3 | Unknown | 4 |

Water Wells or Sampling Sites Once Contaminated with DBCP, EDB or TCP
(Water Resources Research Center 1985):

| | | |
|---------|------|-----|
| 5519-01 | DBCP | |
| 5620 | DBCP | EDB |
| 5620-01 | DBCP | |

Potential Pollutant Sources and Pollutants (see Fig. 2):

Source: Union Oil Company of California/East Maui 76 (UST)

Pollutants: Fuel

Discharge: Number of Tanks: 2

Source: Maui Pineapple Company (UST)

Pollutants: Fuel

Discharge: Number of Tanks: 1

Source: Maui Pineapple Company (UST)

Pollutants: Fuel

Discharge: Number of Tanks: 5

Source: Hawaiian Telephone Company/Central Office (UST)

Pollutants: Fuel

Discharge: Number of Tanks: 1

Source: Paia Chevron (UST)

Pollutants: Fuel

Discharge: Number of Tanks: 4

Source: Spreckesville SPS (UST)

Pollutants: Fuel

Discharge: Number of Tanks: 1

Source: Paia SPS #4 (UST)

Pollutants: Fuel

Discharge: Number of Tanks: 1

Paia--Continued

Source: Paia Sewer Pump Station (UST)

Pollutants: Fuel

Discharge: Number of Tanks: 1

Source: Shell Service Station (UST)

Pollutants: Fuel

Discharge: Number of Tanks: 4

Source: Agricultural Runoff

Pollutants: Nitrates and phosphates

Discharge: Non-point Source

Appendix C.2.1 Habitat Description of Maliko Gulch (Lower)

| | |
|----------------------------|------------------------------|
| Site: Maliko Gulch (Lower) | Lat.: 20°56'46" |
| Island: Maui | Long.: 156°20'32" |
| Sector: Central, 03 | El.: Unknown |
| System: Paia (02) | Approx. Area/Length: Unknown |

Site Description:

Maliko is an intermittent stream classified as a "Limited Consumptive" which means it has high to moderate water quality or natural values. The stream is not channelized and has 4 diversions (Timbol 1978).

Maliko Stream, originating at the west edge of the high-rainfall belt on the windward flank of Haleakala and not fed by substantial springs, has only a very small dry-weather flow that is diverted inland for irrigation. Hence, the summer discharge at the coast is negligible. The stream discharges to the Bay through a beach of boulders and mainly terrestrial sand (Cox 1970).

The headwaters of the stream are in forest lands, the middle course in ranch land, and the lower course between cane and pineapple lands. Mauka of the old Maliko bridge is a watercress farm (Cox 1970).

| | |
|-----------------------------|---|
| Sensitivity Rating: | Aa2m |
| Main Water Source: | A Groundwater |
| Habitat: | a Natural |
| Wetland Avifauna: | 2m Migratory Fowl |
| Habitat Code: | 1-1c-2-1a-5-4-2-1 |
| Water Source: | 1 Groundwater |
| Habitat Origin/Development: | 1c Natural/Pristine + Altered |
| Ecological Character: | 2 Migratory Birds |
| Present Activities: | 1a Agriculture Crops |
| Social Significance: | 5 Neither Historic nor Wildlife Protected |
| Physical Significance: | 4 Neither Sediment Trap nor Flood Control |
| Wetland Type: | 2 Stream |
| Water Quality: | 1 Fresh (< 250 mg/l Cl ⁻) |
| Aquifer Code: | 60302214 |
| Island: | 6 Maui |
| Sector: | 03 Central |
| Aquifer System: | 02 Paia |
| Aquifer Type (Hydrology): | 2 High Level |
| Aquifer Type (Hydrology): | 1 Unconfined |
| Aquifer Type (Geology): | 4 Perched |
| Status Code: | 33221 |
| Development Stage: | 3 No Potential Use |
| Utility: | 3 Neither Drinking nor Ecologically Important |

Maliko Gulch (Lower)--Continued

| | | |
|---------------------------------|---|---------------------------------------|
| Salinity: | 2 | Low (250-1,000 mg/l Cl ⁻) |
| Uniqueness: | 2 | Replaceable |
| Vulnerability to Contamination: | 1 | High |

| | | |
|---------------------------|----|------------|
| Aquifer Code: | | 60302111 |
| Island: | 6 | Maui |
| Sector: | 03 | Central |
| Aquifer System: | 02 | Paia |
| Aquifer Type (Hydrology): | 1 | Basal |
| Aquifer Type (Hydrology): | 1 | Unconfined |
| Aquifer Type (Geology): | 1 | Flank |

| | | |
|---------------------------------|---|-------------------------------------|
| Status Code: | | 11112 |
| Development Stage: | 1 | Currently Used |
| Utility: | 1 | Drinking |
| Salinity: | 1 | Fresh (< 250 mg/l Cl ⁻) |
| Uniqueness: | 1 | Irreplaceable |
| Vulnerability to Contamination: | 2 | Moderate |

U.S. Fish & Wildlife Service Wetland Code:
Palustrine/Forested/Broad leaved evergreen/Seasonal (PFO3C)

Geology:

The lower one half mile of the stream cuts through the Kula series to expose the basement of Honomanu basalt. The stream channel is filled with coarse recent alluvium.

Soil Conservation Service, U.S. Dept. of Agriculture 1975:

rRR (Rough broken land)

rRK (Rock land)

rSM (Stony alluvial land)

Terrestrial Threatened or Endangered Plant(s):

No inventory available

Terrestrial Threatened or Endangered Animal(s):

No inventory available

Terrestrial Plant(s):

Prickly narra (*Pterocarpus echinatus* Pers.)

Koa haole (*Leucaena leucocephala* (Lam.) deWit)

Banana (*Musa paradisiaca* L.)

Maliko Gulch (Lower)--Continued

Portia tree (*Thespesia populnea* (L.) Sol.)
 Coconut tree (*Cocos nucifera* L.)
 Morning-glory (*Ipomoea congesta* R. Br.)
 Castor bean (*Ricinus communis* L.)

Aquatic Plant(s):

Hau (*Hibiscus tiliaceus* L.)

Terrestrial Animal(s):

Japanese Quail (*Coturnis japonica*)
 Ring-necked Pheasant (*Phasianus colchicus*)
 Lesser Golden-Plover (*Pluvialis dominica (fulva)*)
 Spotted Dove (*Streptopelia chinensis*)
 Zebra Dove (*Geopelia striata*)
 Northern Mockingbird (*Mimus polyglottos*)
 Common Myna (*Acridotheres tristis*)
 Japanese White-eye (*Zosterops japonicus*)
 Nutmeg Mannikin (*Lonchura punctulata*)
 House Sparrow (*Passer domesticus*)
 House Finch (*Carpodacus mexicanus*)
 Northern Cardinal (*Cardinalis cardinalis*)
 Red-crested Cardinal (*Paroaria coronata*)
 Eurasian skylark (*Alauda arvensis*)

Aquatic Animal(s):

No inventory available

Migratory Animal(s):

Lesser Golden-Plover (*Pluvialis dominica (fulva)*)

Freshwater Origin:

Perennial seepages from small perched aquifers in the Kula series and at the contact of the Kula and Honomanu formations drain to the stream. The flow volume is small, however, and in dry periods is lost to infiltration in the channel alluvium.

Comments:

Potential contamination via groundwater is very likely. Contamination by DBCP and EDB have been identified in various wells in this aquifer. The contaminated wells are actually within Maliko Gulch. The continued existence of EDB and DBCP is very probable.

Maliko Gulch (Lower)--Continued

References:

- Timbol, A.S., and Maciolek, J.A. 1978. Stream channel modification in Hawaii. Part A: Statewide inventory of streams, habitat factors and associated biota. Prepared for U.S. Fish and Wildlife Service, U.S. Department of the Interior. 157 p.
- Cox, D.C., and Gordon, L.C. 1970. Estuarine pollution in the State of Hawaii. Technical report no. 31, Water Resources Research Center, University of Hawaii, Honolulu. 151 p.
- U.S. Department of Agriculture, Soil Conservation Service. 1972. Soil survey of islands of Kauai, Oahu, Maui, Molokai, and Lanai, State of Hawaii. In cooperation with the University of Hawaii Agricultural Experiment Station. 232 p. plus illus.
- Environmental Impact Study Corporation. 1982. Revised environmental impact statement, Makawao and Kula water treatment plants. Prepared for Department of Water Supply. County of Maui, Hawaii. 126 p. plus app.

**Appendix D.1 System-Wide Characteristics of Ecologically Sensitive Habitats,
Aquifers of Koolau Sector, Waikamoi System**

Aquifer System: Waikamoi (03)

Aquifer Sector: Koolau (04)

Island: Maui (6)

Water Wells in Aquifer System (Div. of Water and Land Development 1984):

| | | | | | |
|-------------|---|----------|---|------------|---|
| Disposal | - | Domestic | - | Industrial | - |
| Irrigation | - | Lost | - | Municipal | - |
| Observation | - | Other | - | Recharge | - |
| Sealed | - | Unused | - | Unknown | - |

Water Wells or Sampling Sites Once Contaminated with DBCP, EDB or TCP
(Water Resources Research Center 1985):

None

Potential Pollutant Sources and Pollutants (see Fig. 2):

No known sources

Appendix D.1.1 Habitat Description of Honomanu Bay

| | | | |
|---------|---------------|----------------------|------------|
| Site: | Honomanu Bay | Lat.: | 20°51'56" |
| Island: | Maui | Long.: | 156°10'12" |
| Sector: | Koolau, 04 | El.: | 5-10 ft |
| System: | Waikamoi (03) | Approx. Area/Length: | Unknown |

Site Description:

The wetland at Honomanu Bay is a saturated soil type with no visible open water. It is located on the western side of the bay between the Honomanu stream and the Punalau stream. The wetland is approximately 50-70 m (150 to 200 ft) in length and 25-35 m (75 to 100 ft) in width.

The dominate vegetation is California Grass with a patch of Great Bulrush near the western makai end. Honomanu stream is identified as perennial however no flow was noticed where the Hana Highway crosses the stream bed during our June, 1989 reconnaissance trip. The mouth of the stream was completely inundated with ocean water. The absence of fresh water in the streambed is expected given the extensive irrigation ditch system which exists in East Maui.

| | |
|-----------------------------|--|
| Sensitivity Rating: | Aa2m |
| Main Water Source: | A Groundwater |
| Habitat: | a Natural |
| Wetland Avifauna: | 2m Migratory Fowl |
| Habitat Code: | 1-1a-2-5-5-4-4-4 |
| Water Source: | 1 Groundwater |
| Habitat Origin/Development: | 1a Natural/Pristine |
| Ecological Character: | 2 Migratory Birds |
| Present Activities: | 5 Neither Agriculture, Aquaculture, nor Recreation |
| Social Significance: | 5 Neither Historic nor Wildlife Protected |
| Physical Significance: | 4 Neither Sediment Trap nor Flood Control |
| Wetland Type: | 4 Marsh |
| Water Quality: | 4 Combination |
| Aquifer Code: | 60403214 |
| Island: | 6 Maui |
| Sector: | 04 Koolau |
| Aquifer System: | 03 Waikamoi |
| Aquifer Type (Hydrology): | 2 High Level |
| Aquifer Type (Hydrology): | 1 Unconfined |
| Aquifer Type (Geology): | 4 Perched |
| Status Code: | 11111 |
| Development Stage: | 1 Currently Used |
| Utility: | 1 Drinking |

Honomanu Bay--Continued

| | | |
|---------------------------------|---|-------------------------------------|
| Salinity: | 1 | Fresh (< 250 mg/l Cl ⁻) |
| Uniqueness: | 1 | Irreplaceable |
| Vulnerability to Contamination: | 1 | High |

| | | |
|---------------------------|----|------------|
| Aquifer Code: | | 60403111 |
| Island: | 6 | Maui |
| Sector: | 04 | Koolau |
| Aquifer System: | 03 | Waikamoi |
| Aquifer Type (Hydrology): | 1 | Basal |
| Aquifer Type (Hydrology): | 1 | Unconfined |
| Aquifer Type (Geology): | 1 | Flank |

| | | |
|---------------------------------|---|-------------------------------------|
| Status Code: | | 11112 |
| Development Stage: | 1 | Currently Used |
| Utility: | 1 | Drinking |
| Salinity: | 1 | Fresh (< 250 mg/l Cl ⁻) |
| Uniqueness: | 1 | Irreplaceable |
| Vulnerability to Contamination: | 2 | Moderate |

U.S. Fish & Wildlife Service Wetland Code:
Palustrine/Emergent/Persistent/Seasonal (PEM1C)

Palustrine/Forested/Broad leaved evergreen/Seasonal (PFO3C)

Geology:

The lower reach of Honomanu Stream is incised in the basement rock of the Honomanu volcanic series. This is the type of area used by Stearns to describe the section. The side walls of the valley are cliffs of the later Kula series.

Soil Conservation Service, U.S. Dept. of Agriculture 1975:
rSM (Stony alluvial land)

Terrestrial Threatened or Endangered Plant(s):
No inventory available

Terrestrial Threatened or Endangered Animal(s):
No inventory available

Terrestrial Plant(s):
Candlenut tree (*Aleurites moluccana* (L.) Willd.)
Coconut tree (*Cocos nucifera* L.)
Screw pine (*Pandanus odoratissimus* L. f.)
Bamboo (*Bambusa vulgaris* Schrad. ex Wendl.)
Ti (*Cordyline terminalis* (L.) Kunth)

Honomanu Bay--Continued

Mango (*Mangifera indica* L.)
 African tulip tree (*Spathodea campanulata* Beauv.)
 False staghorn fern (*Dicranopteris linearis* (Burm.) Underw.)

Aquatic Plant(s):

Hau (*Hibiscus tiliaceus* L.)
 White ginger (*Hedychium coronarium* Koenig)
 Taro (*Colocasia esculenta* (L.) Schott)
 Bulrush (*Scirpus juncooides* var. *rockii* (Keuk.) K. and S.)
 California grass (*Brachiaria mutica* (Forsk.) Stapf)

Terrestrial Animal(s):

Spotted Dove (*Streptopelia chinensis*)
 Zebra Dove (*Geopelia striata*)
 Common Myna (*Acridotheres tristis*)

Aquatic Animal(s):

No inventory available

Migratory Animal(s):

Lesser Golden-Plover (*Pluvialis dominica* (fulva))
 Ruddy Turnstone (*Arenaria interpres*)

Freshwater Origin:

The wetland lies in recent alluvium resting on Honomanu basalt. Permanent wetness is caused by drainage from the Honomanu aquifer close to sea level.

Comments:

Potential contamination via groundwater is very unlikely. The bay is very remote and no development occurs on the adjacent land.

References:

U.S. Department of Agriculture, Soil Conservation Service. 1972. Soil survey of islands of Kauai, Oahu, Maui, Molokai, and Lanai, State of Hawaii. In cooperation with the University of Hawaii Agricultural Experiment Station. 232 p. plus illus.

**Appendix D.2 System-Wide Characteristics of Ecologically Sensitive Habitats,
Aquifers of Koolau Sector, Keanae System**

Aquifer System: Keanae (04)

Aquifer Sector: Koolau (04)

Island: Maui (6)

Water Wells in Aquifer System (Div. of Water and Land Development 1984):

| | | | | | |
|-------------|----|----------|---|------------|----|
| Disposal | - | Domestic | 1 | Industrial | - |
| Irrigation | 11 | Lost | - | Municipal | - |
| Observation | - | Other | 7 | Recharge | - |
| Sealed | - | Unused | 3 | Unknown | 70 |

Water Wells or Sampling Sites Once Contaminated with DBCP, EDB or TCP
(Water Resources Research Center 1985):

None

Potential Pollutant Sources and Pollutants (see Fig. 2):

Source: Highways Division (DOT) (UST)

Pollutants: Fuel

Discharge: Number of Tanks: 1

Appendix D.2.1 Habitat Description of Keanae

| | | | |
|---------|-------------|----------------------|------------|
| Site: | Keanae | Lat.: | 20°50'31" |
| Island: | Maui | Long.: | 156°08'44" |
| Sector: | Koolau, 04 | El.: | 300 ft |
| System: | Keanae (04) | Approx. Area/Length: | Unknown |

Site Description:

Keanae Valley is an inland wet meadow marsh resting at an elevation of 500 ft. The northern section is characterized by overgrown grasses, forbs, and saturated soils. Flowing water in places is evident beneath vegetation mats. The southern section resembles a wet plateau of nearly pure swamp cyclosorus ferns (Elliott 1981).

Waiokamilo and Palauhulu streams drain the upper Keanae Valley into an open "marsh" at approximately 500 ft in elevation. This ephemerally wet grassland is surrounded by dense hau forest and other trees. Water permeates the grassland, suggesting the site may be fed in part by underground springs. While it was evident on survey that the condition of the grassland must change with stream flooding and low elevation rainfall, it is doubtful any open water (other than the streams) is ever present at the site. The grassland has been used for limited grazing in the recent past, but now appears to be largely abandoned (Shallenberger 1977).

| | |
|-----------------------------|--|
| Sensitivity Rating: | Aa12tm |
| Main Water Source: | A Groundwater |
| Habitat: | a Natural |
| Endangered Species: | 1 Observed |
| Wetland Use: | 2t Traditional |
| Wetland Avifauna: | m Migratory Fowl |
| Habitat Code: | 1-1c-3-1a-1b-1-4-1 |
| Water Source: | 1 Groundwater |
| Habitat Origin/Development: | 1c Natural/Pristine + Altered |
| Ecological Character: | 3 Endangered Species + Migratory Birds |
| Present Activities: | 1a Agriculture Crops |
| Social Significance: | 1b Historic Not Registered |
| Physical Significance: | 1 Sediment Trap |
| Wetland Type: | 4 Marsh |
| Water Quality: | 1 Fresh (< 250 mg/l Cl ⁻) |
| Aquifer Code: | 60404214 |
| Island: | 6 Maui |
| Sector: | 04 Koolau |
| Aquifer System: | 04 Keanae |
| Aquifer Type (Hydrology): | 2 High Level |
| Aquifer Type (Hydrology): | 1 Unconfined |
| Aquifer Type (Geology): | 4 Perched |

Keanae--Continued

Status Code: 11111
 Development Stage: 1 Currently Used
 Utility: 1 Drinking
 Salinity: 1 Fresh (< 250 mg/l Cl⁻)
 Uniqueness: 1 Irreplaceable
 Vulnerability to Contamination: 1 High

Aquifer Code: 60404111
 Island: 6 Maui
 Sector: 04 Koolau
 Aquifer System: 04 Keanae
 Aquifer Type (Hydrology): 1 Basal
 Aquifer Type (Hydrology): 1 Unconfined
 Aquifer Type (Geology): 1 Flank

Status Code: 11112
 Development Stage: 1 Currently Used
 Utility: 1 Drinking
 Salinity: 1 Fresh (< 250 mg/l Cl⁻)
 Uniqueness: 1 Irreplaceable
 Vulnerability to Contamination: 2 Moderate

U.S. Fish & Wildlife Service Wetland Code:
 Upland (U)

Geology:

Geology in the Keanae area is extremely complicated. The wetlands evidently are in Hana basalt but are affected by nearby alluvium as well as runoff from the Kula volcanic series.

Soil Conservation Service, U.S. Dept. of Agriculture 1975:
 TR (Tropaquepts)

rHT (Hydrandepts - tropaquods)

Terrestrial Threatened or Endangered Plant(s):
 No inventory available

Terrestrial Threatened or Endangered Animal(s):
 'Iwi (*Vestiaria coccinea*)
 Hawaiian Owl (*Asio flammeus sandwichensis*)

Keanae--Continued

Terrestrial Plant(s):

- Swamp cyclosorus (*Cyclosorus gongylodes* (Schkuhr) Link)
- Sword fern (*Nephrolepis exaltata* (L.) Schott)
- Kyllinga (*Cyperus brevifolius* (Rottb.) Hassk.)
(*Cyperus polystachyus* Rottb.)
- Broad-leaved carpet grass (*Axonopus compressus* (Sw.) Beauv.)
- Glenwood grass (*Sacciolepis indica* (L.) Chase)
- Fireweed (*Erechtites valerianaefolia* (Wolf) DC.)
- Ceara rubber (*Manihot glaziovii* Muell.-Arg.)
- Candlenut tree (*Aleurites moluccana* (L.) Willd.)
- Spanish clover (*Desmodium canum* (Gmel.) Schinz & Thellung)
- Shoebuttan ardisia (*Ardisia humilis* Vahl)
- Common guava (*Psidium guajava* L.)
- Yellow liliko'i (*Passiflora edulis* f. *flavicarpa* Deg.)
- Thimbleberry (*Rubus rosaefolius* Sm.)
- Sacramento bur (*Triumfetta rhomboidea* Jacq.)
- Asiatic pennywort (*Centella asiatica* (L.) Urban)
- Jamaica vervain (*Stachytarpheta jamaicensis* (L.) Vahl)
- Hilo grass (*Paspalum conjugatum* Berg.)
- Basket grass (*Oplismenus hirtellus* (L.) Beauv.)
- Screw pine (*Pandanus odoratissimus* L. f.)
- False staghorn fern (*Dicranopteris linearis* (Burm.) Underw.)

Aquatic Plant(s):

- Day flower (*Commelina diffusa* Burm. f.)
- California grass (*Brachiaria mutica* (Forsk.) Stapf)
- Barnyard grass (*Echinochloa crusgalli* (L.) Beauv.)
- Native pink hibiscus (*Hibiscus youngianus* Gaud.)
- Primrose willow (*Ludwigia octovalvis* (Jacq.) Raven)
- Hau (*Hibiscus tiliaceus* L.)

Terrestrial Animal(s):

- Black-crowned Night-Heron (*Nycticorax nycticorax hoactli*)
- Wandering Tattler (*Heteroscelus incanus*)
- Northern Cardinal (*Cardinalis cardinalis*)
- Spotted Dove (*Streptopelia chinensis*)
- Northern Mockingbird (*Mimus polyglottos*)
- Common Myna (*Acridotheres tristis*)
- Nutmeg Mannikin (*Lonchura punctulata*)
- House Sparrow (*Passer domesticus*)
- Japanese White-eye (*Zosterops japonicus*)
- 'Elepaio (*Chasiempis sandwichensis sandwichensis*)

Keanae--Continued

Aquatic Animal(s):

No inventory available

Migratory Animal(s):

Wandering Tattler (*Heteroscelus incanus*)

Lesser Golden-Plover (*Pluvialis dominica (fulva)*)

Freshwater Origin:

Wet conditions are sustained by spring seepage from perched aquifers in the Hana formation in addition to surface runoff.

Comments:

Potential contamination via groundwater is unlikely given the present development situation.

References:

Elliott, M.E. 1981. Wetlands and wetland vegetation of the Hawaiian Islands. Master thesis (Geography), University of Hawaii, Honolulu. 228 p.

Shallenberger, R.J. 1977. An ornithological survey of Hawaii wetlands. Vol II. Prepared for the U.S. Army Corps of Engineers, Engineer District, Honolulu. 278 p.

U.S. Department of Agriculture, Soil Conservation Service. 1972. Soil survey of islands of Kauai, Oahu, Maui, Molokai, and Lanai, State of Hawaii. In cooperation with the University of Hawaii Agricultural Experiment Station. 232 p. plus illus.

Appendix D.2.2 Habitat Description of Nahiku Springs Area

| | |
|---------------------------|-------------------------------------|
| Site: Nahiku Springs Area | Lat.: 20°49'01" |
| Island: Maui | Long.: 156°06'25" |
| Sector: Koolau, 04 | El.: Various |
| System: Keanae (04) | Approx. Area/Length: Not Applicable |

Site Description:

The Nahiku Springs area consists of three major springs and at least eleven minor springs. The largest of the three springs is Big Spring which is sited at an elevation of between 500 and 550 ft. The other two springs are collectively identified on the USGS Nahiku topographic map as the Hanawi Springs, however Cox precisely identifies them as springs one and two.

The Nahiku Springs feed the lower reaches of the Hanawi Stream below the Hana Highway. Hanawi is a perennial stream classified as a "Limited Consumptive" which means it has high to moderate water quality or natural value. Hanawi has three diversions and is not channelized (Timbol 1978). The upper reaches of the stream are within the Hanawi Natural Area Reserve. The reserve extends into the sub-alpine zones of Haleakala and contains ten native communities, including grasslands, streams, shrublands, and forests. The ohi'a forests are valuable watershed, containing rare plants and providing essential habitat for rare Hawaiian birds (Natural Area Reserves System 1988).

During the late 1970s and early 1980s Big Spring was at the center of a major water use controversy. The East Maui Irrigation Company (EMI) petitioned the Maui Planning Commission for the right to divert up to 10 mgd from the plunge pool below Big Spring. Ultimately, EMI withdrew their application after strong protests by environmentalists. During the controversy studies estimated that the flow from Big Spring was between 7.28 and 7.43 mgd. In addition, the flow from spring one was measured between 0.15 and 0.19 mgd. Spring two estimated flow is between 0.31 and 0.40 mgd (Cox 1980). Springs one and two are believed to originate from the same groundwater aquifer as basal groundwater while Big Spring is believed to originate from a separate basal artesian aquifer.

| | |
|-----------------------------|--|
| Sensitivity Rating: | Aa12m |
| Main Water Source: | A Groundwater |
| Habitat: | a Natural |
| Endangered Species: | 1 Observed |
| Wetland Avifauna: | 2m Migratory Fowl |
| Habitat Code: | 1-1a-3-5-5-4-2-1 |
| Water Source: | 1 Groundwater |
| Habitat Origin/Development: | 1a Natural/Pristine |
| Ecological Character: | 3 Endangered Species + Migratory Birds |
| Present Activities: | 5 Neither Agriculture, Aquaculture, nor Recreation |
| Social Significance: | 5 Neither Historic nor Wildlife Protected |

Nahiku Springs Area--Continued

| | | |
|---------------------------------|----|---|
| Physical Significance: | 4 | Neither Sediment Trap nor Flood Control |
| Wetland Type: | 2 | Stream |
| Water Quality: | 1 | Fresh (< 250 mg/l Cl ⁻) |
| Aquifer Code: | | 60404214 |
| Island: | 6 | Maui |
| Sector: | 04 | Koolau |
| Aquifer System: | 04 | Keanae |
| Aquifer Type (Hydrology): | 2 | High Level |
| Aquifer Type (Hydrology): | 1 | Unconfined |
| Aquifer Type (Geology): | 4 | Perched |
| Status Code: | | 11111 |
| Development Stage: | 1 | Currently Used |
| Utility: | 1 | Drinking |
| Salinity: | 1 | Fresh (< 250 mg/l Cl ⁻) |
| Uniqueness: | 1 | Irreplaceable |
| Vulnerability to Contamination: | 1 | High |
| Aquifer Code: | | 60404111 |
| Island: | 6 | Maui |
| Sector: | 04 | Koolau |
| Aquifer System: | 04 | Keanae |
| Aquifer Type (Hydrology): | 1 | Basal |
| Aquifer Type (Hydrology): | 1 | Unconfined |
| Aquifer Type (Geology): | 1 | Flank |
| Status Code: | | 11112 |
| Development Stage: | 1 | Currently Used |
| Utility: | 1 | Drinking |
| Salinity: | 1 | Fresh (< 250 mg/l Cl ⁻) |
| Uniqueness: | 1 | Irreplaceable |
| Vulnerability to Contamination: | 2 | Moderate |

U.S. Fish & Wildlife Service Wetland Code:**Geology:**

The Nahiku area represents the conjunction of the major volcanic formations in East Maui; the basement Honomanu series, the intermediate Kula series, and the later Hana series.

Soil Conservation Service, U.S. Dept. of Agriculture 1975:
rRT (Rough mountainous land)

Nahiku Springs Area--Continued

Terrestrial Threatened or Endangered Plant(s):

No inventory available

Terrestrial Threatened or Endangered Animal(s):

No inventory available

Terrestrial Plant(s):

No inventory available

Aquatic Plant(s):

No inventory available

Terrestrial Animal(s):

Spotted Dove (*Streptopelia chinensis*)

Zebra Dove (*Geopelia striata*)

Common Myna (*Acridotheres tristis*)

Aquatic Animal(s):

'O'opu 'alamo'o (*Lentipes concolor*)

'O'opu nakea (*Awaous stamineus*)

'O'opu nopili (*Sicydium stimsonii*)

'Opae-kala-'ole (*Atya bisulcata*)

Migratory Animal(s):

No inventory available

Freshwater Origin:

The springs are mostly discharges of perched groundwater. Perching members occur within the Hana and Kula series.

Comments:

Potential contamination via groundwater is unlikely given the land use situation which presently exists.

References:

Timbol, A.S., and Maciolek, J.A. 1978. Stream channel modification in Hawaii. Part A: Statewide inventory of streams, habitat factors and associated biota. Prepared for U.S. Fish and Wildlife Service, U.S. Department of the Interior. 157 p.

U.S. Department of Agriculture, Soil Conservation Service. 1972. Soil survey of islands of Kauai, Oahu, Maui, Molokai, and Lanai, State of Hawaii. In cooperation with the University of Hawaii Agricultural Experiment Station. 232 p. plus illus.

Nahiku Springs Area--Continued

Cox, D.C. 1980. Stream-flow effects of proposed diversion from Hanawi Stream, Nahiku, East Maui. SR:0026, Environmental Center, University of Hawaii, Honolulu. 15 p.

Natural Area Reserves System. 1988. Hanawi Natural Area Reserve Management Plan. Prepared for the Department of Land and Natural Resources, State of Hawaii, Honolulu. 33 p. plus app.

Appendix E.1 System-Wide Characteristics of Ecologically Sensitive Habitats, Aquifers of Hana Sector, Kawaipapa System

Aquifer System: Kawaipapa (02)

Aquifer Sector: Hana (05)

Island: Maui (6)

Water Wells in Aquifer System (Div. of Water and Land Development 1984):

| | | | | | |
|-------------|---|----------|---|------------|---|
| Disposal | - | Domestic | - | Industrial | - |
| Irrigation | - | Lost | - | Municipal | 3 |
| Observation | - | Other | 1 | Recharge | - |
| Sealed | - | Unused | 1 | Unknown | 2 |

Water Wells or Sampling Sites Once Contaminated with DBCP, EDB or TCP
(Water Resources Research Center 1985):

None

Potential Pollutant Sources and Pollutants (see Fig. 2):

Source: Hawaiian Telephone Company/Central Office (UST)

Pollutants: Fuel

Discharge: Number of Tanks: 2

Source: Hawaiian Telephone Company/Hana Radio Station (UST)

Pollutants: Fuel

Discharge: Number of Tanks: 1

Source: Cattle Pasture

Pollutants: Fecal coliform

Discharge: Non-point Source

Appendix E.1.1 Habitat Description of Kawaipapa Stream (Lower)

| | |
|--------------------------------|------------------------------|
| Site: Kawaipapa Stream (Lower) | Lat.: 20°45'51" |
| Island: Maui | Long.: 155°59'22" |
| Sector: Hana, 05 | El.: 10-20 ft |
| System: Kawaipapa (02) | Approx. Area/Length: Unknown |

Site Description:

Kawaipapa is an intermittent non-channelized stream classified as a "Limited Consumptive", which means it has moderate or high water quality or natural value. There are two water diversions from the stream (Timbol 1978).

The lower Kawaipapa was dry on the day of our survey although Hana experienced short intense rainfall throughout the night before. Near the mouth of the stream, on the north side of Hana Bay, there exists at least one open pond wetland and various saturated soil areas.

The pond presumably is fed by groundwater sources since the adjacent surface drainage areas were completely dry.

The open pond has an oval shape and measures about 110 ft by 80 ft. It is shown on the USGS topographic map for the Hana area. Three houses sit adjacent to the pond on the north and western sides. The residents must use the pond for recreation since a rubber raft and a small wooden boat were sighted next to the pond. The residents also appear to do some supplemental farming since Geese were seen in pens and various fruit trees were planted around the house. On the southern side of the pond a well kept cemetery exists.

| | |
|---------------------|-------------------|
| Sensitivity Rating: | Aa12m |
| Main Water Source: | A Groundwater |
| Habitat: | a Natural |
| Endangered Species: | 1 Observed |
| Wetland Avifauna: | 2m Migratory Fowl |

| | |
|-----------------------------|---|
| Habitat Code: | 1-1c-3-4-5-4-1-1 |
| Water Source: | 1 Groundwater |
| Habitat Origin/Development: | 1c Natural/Pristine + Altered |
| Ecological Character: | 3 Endangered Species + Migratory Birds |
| Present Activities: | 4 Recreation |
| Social Significance: | 5 Neither Historic nor Wildlife Protected |
| Physical Significance: | 4 Neither Sediment Trap nor Flood Control |
| Wetland Type: | 1 Pond |
| Water Quality: | 1 Fresh (< 250 mg/l Cl ⁻) |

| | |
|---------------------------|--------------|
| Aquifer Code: | 60502111 |
| Island: | 6 Maui |
| Sector: | 05 Hana |
| Aquifer System: | 02 Kawaipapa |
| Aquifer Type (Hydrology): | 1 Basal |

Kawaiipapa Stream (Lower)--Continued

| | | |
|---------------------------------|---|-------------------------------------|
| Aquifer Type (Hydrology): | 1 | Unconfined |
| Aquifer Type (Geology): | 1 | Flank |
| Status Code: | | 11111 |
| Development Stage: | 1 | Currently Used |
| Utility: | 1 | Drinking |
| Salinity: | 1 | Fresh (< 250 mg/l Cl ⁻) |
| Uniqueness: | 1 | Irreplaceable |
| Vulnerability to Contamination: | 1 | High |

U.S. Fish & Wildlife Service Wetland Code:
Riverine/Upper perennial/Open water/ Permanent (R3OWH)

Geology:

Kawaiipapa Stream flows through loose channel alluvium and bedrock of the Hana volcanic series. The Hana formation is the most recent volcanic rock on the island and was emplaced long after the earlier Kula series.

Soil Conservation Service, U.S. Dept. of Agriculture 1975:
HKNC (Hana Silty clay loam)

MYD (Malama Extremely stony muck)

Terrestrial Threatened or Endangered Plant(s):
No inventory available

Terrestrial Threatened or Endangered Animal(s):
'Iwi (*Vestiaria coccinea*)
Hawaiian Owl (*Asio flammeus sandwichensis*)

Terrestrial Plant(s):
Coconut tree (*Cocos nucifera* L.)
Candlenut tree (*Aleurites moluccana* (L.) Willd.)
Banana (*Musa paradisiaca* L.)
Plumeria (*Plumeria* sp.)
Morning-glory (*Ipomoea congesta* R. Br.)
Indian mulberry (*Morinda citrifolia* L.)
Passion flower (*Passiflora* sp.)
Fiddle-leaf fig (*Ficus lyrata* Warb.)

Aquatic Plant(s):
Bulrush (*Scirpus juncooides* var. *rockii* (Keuk.) K. and S.)
California grass (*Brachiaria mutica* (Forsk.) Stapf)

Kawaipapa Stream (Lower)--Continued

Terrestrial Animal(s):

Spotted Dove (*Streptopelia chinensis*)
Zebra Dove (*Geopelia striata*)
Common Myna (*Acridotheres tristis*)
House Finch (*Carpodacus mexicanus*)
House Sparrow (*Passer domesticus*)

Aquatic Animal(s):

Common Carp (*Cyprinus carpio (Linnaeus)*)

Migratory Animal(s):

Lesser Golden-Plover (*Pluvialis dominica (fulva)*)
Ruddy Turnstone (*Arenaria interpres*)

Freshwater Origin:

Where the stream ends at the barrier beach affronting the northern quadrant of Hana Bay, groundwater forms permanent pools. The stream is non-perennial, but at its mouth groundwater of the Hana aquifer surfaces.

Comments:

Potential contamination via groundwater is unlikely. However, future growth of the Hana area may change this situation. Individual household sewage systems may pose the greatest threat to the area's ecologically vital groundwater.

References:

- Timbol, A.S., and Maciolek, J.A. 1978. Stream channel modification in Hawaii. Part A: Statewide inventory of streams, habitat factors and associated biota. Prepared for U.S. Fish and Wildlife Service, U.S. Department of the Interior. 157 p.
- U.S. Department of Agriculture, Soil Conservation Service. 1972. Soil survey of islands of Kauai, Oahu, Maui, Molokai, and Lanai, State of Hawaii. In cooperation with the University of Hawaii Agricultural Experiment Station. 232 p. plus illus.
- Sam O. Hirota, Inc. 1983. Draft environmental impact statement for Wailua - Hana water systems improvements. Prepared for Department of Water Supply, County of Maui, Hawaii. 84 p. plus app.

**Appendix E.2 System-Wide Characteristics of Ecologically Sensitive Habitats,
Aquifers of Hana Sector, Waihoi System**

Aquifer System: Waihoi (03)

Aquifer Sector: Hana (05)

Island: Maui (6)

Water Wells in Aquifer System (Div. of Water and Land Development 1984):

| | | | | | |
|-------------|---|----------|---|------------|---|
| Disposal | - | Domestic | - | Industrial | - |
| Irrigation | - | Lost | - | Municipal | - |
| Observation | - | Other | - | Recharge | - |
| Sealed | - | Unused | - | Unknown | - |

Water Wells or Sampling Sites Once Contaminated with DBCP, EDB or TCP
(Water Resources Research Center 1985):

None

Potential Pollutant Sources and Pollutants (see Fig. 2):

Source: Cattle Pasture

Pollutants: Fecal coliform

Discharge: Non-point Source

Appendix E.2.1 Habitat Description of Muolea

| | | | |
|---------|-------------|----------------------|------------|
| Site: | Muolea | Lat.: | 20°42'30" |
| Island: | Maui | Long.: | 156°02'30" |
| Sector: | Hana, 05 | El.: | 2060 ft |
| System: | Waihoi (03) | Approx. Area/Length: | Unknown |

Site Description:

Muolea is located adjacent to the southern cliffs of Waihoi Valley. No springs or other groundwater sources appear to feed the marsh, thus it is believed to be a result of surface drainage. Probably the trachyte lava flows which filled Waihoi Valley in historic times inhibit the percolation of water into the soil. Stearns identified the surface geology of Muolea as "Unconsolidated Deposits" consisting of poorly sorted stream laid brown silt, sand and gravel (Stearns 1942).

The valley begins at 600 meters elevation to the south and 633 meters elevation to the north. A grass-sedge-guava-scrub ohi'a complex occupies the lower southern boundary of the valley area at 666 meters elevation where the guava-scrub ohi'a members give way to open pasture dominated by a grass-sedge complex also containing scattered patches of taro and dead ohi'a forest with some Cheirodendron, Coprosma, and Gouldia; and adjacent to this complex are the remnants of a once-dominant thicket of uluhe or false staghorn fern. Cattle occupying this pasture area have greatly reduced uluhe often trampling the plants until there is nothing but bare earth. In addition to this damage, continuous trampling about over the marshy open areas has produced a field of hummocks (Kjargaard 1972).

| | |
|-----------------------------|---|
| Sensitivity Rating: | Ba12m |
| Main Water Source: | B Not Groundwater |
| Habitat: | a Natural |
| Endangered Species: | 1 Observed |
| Wetland Avifauna: | 2m Migratory Fowl |
| Habitat Code: | 2-1b-3-1b-5-4-4-1 |
| Water Source: | 2 Other |
| Habitat Origin/Development: | 1b Natural/Altered |
| Ecological Character: | 3 Endangered Species + Migratory Birds |
| Present Activities: | 1b Agriculture Livestock |
| Social Significance: | 5 Neither Historic nor Wildlife Protected |
| Physical Significance: | 4 Neither Sediment Trap nor Flood Control |
| Wetland Type: | 4 Marsh |
| Water Quality: | 1 Fresh (< 250 mg/l Cl ⁻) |
| Aquifer Code: | 60503111 |
| Island: | 6 Maui |
| Sector: | 05 Hana |
| Aquifer System: | 03 Waihoi |
| Aquifer Type (Hydrology): | 1 Basal |

Muolea--Continued

| | | |
|---------------------------------|---|-------------------------------------|
| Aquifer Type (Hydrology): | 1 | Unconfined |
| Aquifer Type (Geology): | 1 | Flank |
| Status Code: | | 11111 |
| Development Stage: | 1 | Currently Used |
| Utility: | 1 | Drinking |
| Salinity: | 1 | Fresh (< 250 mg/l Cl ⁻) |
| Uniqueness: | 1 | Irreplaceable |
| Vulnerability to Contamination: | 1 | High |

U.S. Fish & Wildlife Service Wetland Code:

Geology:

The wetland is on Hana basalt at the base of cliffs of the Kula volcanic series. Covering the Hana basalt are deposits of recent alluvium.

Soil Conservation Service, U.S. Dept. of Agriculture 1975:
rHT (Hydrandepts - tropaquods)

Terrestrial Threatened or Endangered Plant(s):
No inventory available

Terrestrial Threatened or Endangered Animal(s):
'Iwi (*Vestiaria coccinea*)
Hawaiian Owl (*Asio flammeus sandwichensis*)
Dark-rumped Petrel (*Pterodroma phaeopygia sandwichensis*)

Terrestrial Plant(s):
Banana (*Musa paradisiaca* L.)
Olomea (*Perrottetia sandwicensis* Gray)
'Oha (*Clermontia oblongifolia* var. *mauiensis* (Rock) Deg.)
Common guava (*Psidium guajava* L.)
Maui pamakani (*Eupatorium adenophorum* Spreng.)
Jamaica vervain (*Stachytarpheta jamaicensis* (L.) Vahl)
Hawaiian tree fern (*Cibotium* sp.)
Asiatic pennywort (*Centella asiatica* (L.) Urban)
Thimbleberry (*Rubus rosaefolius* Sm.)
Lace fern (*Sphenomeris chusana* (L.) Copel.)
'Ohi'alehua (*Metrosideros collina* (Forst.) Gray)
'Olapa (*Cheirodendron* sp.)
Mountain naupaka (*Scaevola gaudichaudiana* Cham.)

Muolea--Continued

Aquatic Plant(s):

- Marsh pennywort (*Hydrocotyle verticillata* Thunb.)
- Primrose willow (*Ludwigia octovalvis* (Jacq.) Raven)
- Taro (*Colocasia esculenta* (L.) Schott)

Terrestrial Animal(s):

- Northern Cardinal (*Cardinalis cardinalis*)
- Spotted Dove (*Streptopelia chinensis*)
- Melodious Laughing-thrush (*Garrulax canorus*)
- Japanese White-eye (*Zosterops japonicus*)
- Nutmeg Mannikin (*Lonchura punctulata*)
- Red-billed Leiothrix (*Leiothrix lutea*)
- 'Apapane (*Himatione sanguinea*)
- Maui Creeper (*Paroreomyza montana newtoni*)
- White-tailed Tropicbird (*Phaethon lepturus dorotheae*)
- Ring-necked Pheasant (*Phasianus colchicus*)

Aquatic Animal(s):

No inventory available

Migratory Animal(s):

- Maui 'amakihi (*Hemignathus virens wilsoni*)
- Lesser Golden-Plover (*Pluvialis dominica fulva*)
- Wandering Tattler (*Heteroscelus incanus*)

Freshwater Origin:

Some perennial water may seep from small perched aquifers in the Kula series. Surface water accumulates on the recent alluvium.

Comments:

Potential contamination via groundwater is very unlikely. The geologic structure indicates that the wetland is fed by rainfall and not groundwater; however, small quantities of spring fed water may contribute to the wetland.

References:

- Stearns, H.T., and Macdonald, G.A. 1942. Geology and ground-water resources of the island of Maui, Hawaii. Honolulu Advertiser Publishing Co. 344 p. plus maps and illus.
- Kjargaard, J.I. 1972. Scientific report of the Waihoi Valley Project. Prepared for the National Science Foundation. University of Hawaii, Honolulu. 252 p.

Appendix E.3 System-Wide Characteristics of Ecologically Sensitive Habitats, Aquifers of Hana Sector, Kipahulu System

Aquifer System: Kipahulu (04)

Aquifer Sector: Hana (05)

Island: Maui (6)

Water Wells in Aquifer System (Div. of Water and Land Development 1984):

| | | | | | |
|-------------|---|----------|---|------------|---|
| Disposal | - | Domestic | 2 | Industrial | - |
| Irrigation | 2 | Lost | - | Municipal | - |
| Observation | - | Other | - | Recharge | - |
| Sealed | - | Unused | 1 | Unknown | 2 |

Water Wells or Sampling Sites Once Contaminated with DBCP, EDB or TCP
(Water Resources Research Center 1985):

None

Potential Pollutant Sources and Pollutants (see Fig. 2):

Source: Cattle Pasture

Pollutants: Fecal coliform

Discharge: Non-point Source

Appendix E.3.1 Habitat Description of Kaukauai

| | | | |
|---------|---------------|----------------------|------------|
| Site: | Kaukauai | Lat.: | 20°41'18" |
| Island: | Maui | Long.: | 156°05'06" |
| Sector: | Hana, 05 | El.: | 2560 ft |
| System: | Kipahulu (04) | Approx. Area/Length: | Unknown |

Site Description:

Kaukauai is located at approximately 2560 ft elevation near the western ridge of Kipahulu Valley and just above Kaukauai Gulch. The relatively gentle slopes of this area are a result of lava flows filling in the once step valley. The slope at Kaukauai marsh is relatively flat in comparison to adjacent gentle slopes, thus surface water settles in the marsh.

The marsh is within the high rainfall area of East Maui and in addition to rainfall, it appears to receive some of its water from Kaukauai stream which runs partially through and adjacent to the marsh. Stearns identified the surface geology of Kaukauai as "Unconsolidated Deposits" consisting of poorly sorted stream laid brown silt, sand and gravel (Stearns 1942).

Sensitivity Rating: Inadequate Information

Habitat Code: Inadequate Information

| | |
|---------------------------------|---------------------------------------|
| Aquifer Code: | 60504214 |
| Island: | 6 Maui |
| Sector: | 05 Hana |
| Aquifer System: | 04 Kipahulu |
| Aquifer Type (Hydrology): | 2 High Level |
| Aquifer Type (Hydrology): | 1 Unconfined |
| Aquifer Type (Geology): | 4 Perched |
| Status Code: | 11111 |
| Development Stage: | 1 Currently Used |
| Utility: | 1 Drinking |
| Salinity: | 1 Fresh (< 250 mg/l Cl ⁻) |
| Uniqueness: | 1 Irreplaceable |
| Vulnerability to Contamination: | 1 High |

| | |
|---------------------------|--------------|
| Aquifer Code: | 60504111 |
| Island: | 6 Maui |
| Sector: | 05 Hana |
| Aquifer System: | 04 Kipahulu |
| Aquifer Type (Hydrology): | 1 Basal |
| Aquifer Type (Hydrology): | 1 Unconfined |
| Aquifer Type (Geology): | 1 Flank |

Kaukauai--Continued

| | | |
|---------------------------------|---|-------------------------------------|
| Status Code: | | 11112 |
| Development Stage: | 1 | Currently Used |
| Utility: | 1 | Drinking |
| Salinity: | 1 | Fresh (< 250 mg/l Cl ⁻) |
| Uniqueness: | 1 | Irreplaceable |
| Vulnerability to Contamination: | 2 | Moderate |

U.S. Fish & Wildlife Service Wetland Code:

Palustrine/Forested/Broad leaved evergreen/Subtidal/Upland (PFO31U)

Geology:

Kaukauai lies along the contact between the steep pali of Kula andesitic rocks on the west and younger Hana lavas that fill Kipahulu Valley.

Soil Conservation Service, U.S. Dept. of Agriculture 1975:

rHT (Hydrandepts - tropaquods)

Terrestrial Threatened or Endangered Plant(s):

No inventory available

Terrestrial Threatened or Endangered Animal(s):

No inventory available

Terrestrial Plant(s):

No inventory available

Aquatic Plant(s):

No inventory available

Terrestrial Animal(s):

No inventory available

Aquatic Animal(s):

No inventory available

Migratory Animal(s):

No inventory available

Freshwater Origin:

The perennial water in the marsh probably derives from stream flow as well as seepages from perched aquifers in both the Kula and Hana formations.

Kaukauai--Continued

Comments:

Potential contamination via groundwater is very unlikely. The adjacent area is within the Haleakala National Park which inhibits the development of adjacent lands. In addition, the extreme elevation and remoteness of the site prohibits groundwater migration from potentially contaminated areas.

References:

U.S. Department of Agriculture, Soil Conservation Service. 1972. Soil survey of islands of Kauai, Oahu, Maui, Molokai, and Lanai, State of Hawaii. In cooperation with the University of Hawaii Agricultural Experiment Station. 232 p. plus illus.

Stearns, H.T., and Macdonald, G.A. 1942. Geology and ground-water resources of the island of Maui, Hawaii. Honolulu Advertiser Publishing Co. 344 p. plus maps and illus.

Appendix E.3.2 Habitat Description of Manawainui Stream (Lower)

| | |
|---------------------------------|--------------------------------|
| Site: Manawainui Stream (Lower) | Lat.: 20°38'17" |
| Island: Maui | Long.: 156°06'59" |
| Sector: Hana, 05 | El.: 0-5000 ft |
| System: Kipahulu (04) | Approx. Area/Length: 4.7 miles |

Site Description:

Manawainui is an intermittent stream classified as "Limited Consumptive" which means that it has moderate to high water quality or natural values. The stream is non-channelized and has one diversion (Timbol 1978).

Manawainui is a large valley located upon the southern flank of the East Maui shield. From its mouth, opening at the eastern edge of Kaupo Gap, to its head in the middle reaches of the Kipahulu Forest Reserve, Manawainui runs about 8km in length. The stream flow is intermittent in summer months though the springs in the west wall appear to drain continuously (Gon 1976).

Within 200 m from the ocean, the first still pools were noted, stagnate and populated by mosquito larvae; *Aedes* sp., (forest day mosquito); the dragonflies, Odonata, *Anax* sp., and a predaceous diving beetle in the family Dytiscidae.

At nearly 800 m from the ocean, actual stream flow occurred. USGS maps also show permanent stream flow at this elevation. In these slow-moving sections, perhaps a meter in width and roughly 10 cm in-depth, were found the Dytiscid beetle and Odonata in the genus *Megalagrion* (Gon 1976).

| | |
|-----------------------------|--|
| Sensitivity Rating: | Aa12m |
| Main Water Source: | A Groundwater |
| Habitat: | a Natural |
| Endangered Species: | 1 Observed |
| Wetland Avifauna: | 2m Migratory Fowl |
| Habitat Code: | 1-1c-3-5-5-4-2-1 |
| Water Source: | 1 Groundwater |
| Habitat Origin/Development: | 1c Natural/Pristine + Altered |
| Ecological Character: | 3 Endangered Species + Migratory Birds |
| Present Activities: | 5 Neither Agriculture, Aquaculture, nor Recreation |
| Social Significance: | 5 Neither Historic nor Wildlife Protected |
| Physical Significance: | 4 Neither Sediment Trap nor Flood Control |
| Wetland Type: | 2 Stream |
| Water Quality: | 1 Fresh (< 250 mg/l Cl ⁻) |
| Aquifer Code: | 60504214 |
| Island: | 6 Maui |
| Sector: | 05 Hana |
| Aquifer System: | 04 Kipahulu |
| Aquifer Type (Hydrology): | 2 High Level |

Manawainui Stream (Lower)--Continued

Aquifer Type (Hydrology): 1 Unconfined
 Aquifer Type (Geology): 4 Perched

Status Code: 11111
 Development Stage: 1 Currently Used
 Utility: 1 Drinking
 Salinity: 1 Fresh (< 250 mg/l Cl⁻)
 Uniqueness: 1 Irreplaceable
 Vulnerability to Contamination: 1 High

Aquifer Code: 60504111
 Island: 6 Maui
 Sector: 05 Hana
 Aquifer System: 04 Kipahulu
 Aquifer Type (Hydrology): 1 Basal
 Aquifer Type (Hydrology): 1 Unconfined
 Aquifer Type (Geology): 1 Flank

Status Code: 11112
 Development Stage: 1 Currently Used
 Utility: 1 Drinking
 Salinity: 1 Fresh (< 250 mg/l Cl⁻)
 Uniqueness: 1 Irreplaceable
 Vulnerability to Contamination: 2 Moderate

U.S. Fish & Wildlife Service Wetland Code:
 Riverine/Intermittent/Streambed/Seasonal (R4SBC)

Geology:

Manawainui cuts through hundreds of feet of andesitic lavas of the Kula series to expose basement rock of the Honomanu series in its upper reaches. Downstream it flows on the Kula series, then the younger Hana series before reaching the coast.

Soil Conservation Service, U.S. Dept. of Agriculture 1975:
 rRT (Rough mountainous land)

Terrestrial Threatened or Endangered Plant(s):
 No inventory available

Terrestrial Threatened or Endangered Animal(s):
 American Wigeon (*Anas americana*)

Manawainui Stream (Lower)--Continued

Terrestrial Plant(s):

- Hawaiian maiden hair (*Adiantum capillus-veneris* L.)
- Fern (*Gonocormus minutus* (Blume) V.D. Bosch.)
- East Indian polypody (*Microsorium scolopendria* (Burm.) Copel.)
- Thunberg pleopeltis (*Pleopeltis thunbergiana* Kaulf.)
- Psilotum (*Psilotum* sp.)
- Lepelepe-a-moa (*Selaginella arbuscula* (Kaulf.) Spring)
- Gaudichaud tectaria (*Tectaria gaudichaudii* (Mett.) Maxon)
- Sisal (*Agave sisalana* (Engelm.) Perrine)
- Kyllinga (*Cyperus brevifolius* (Rottb.) Hassk.)
- Molasses grass (*Melinis minutiflora* Beauv.)
- Hilo grass (*Paspalum conjugatum* Berg.)
- Glenwood grass (*Sacciolepis indica* (L.) Chase)
- Candlenut tree (*Aleurites moluccana* (L.) Willd.)
- Maui wormwood (*Artemisia mauiensis* (Gray) Skottsb.)
- Hairy horseweed (*Bidens pilosa* L.)
- Fragrant canthium (*Canthium odoratum* (Forst.) Seem.)
- Java plum (*Eugenia cuminii* (L.) Druce)
- Lantana (*Lantana camara* L.)
- Mango (*Mangifera indica* L.)
- Pride of India (*Melia azedarach* L.)
- 'Ohi'alehua (*Metrosideros collina* (Forst.) Gray)
- Artillery plant (*Pilea peploides* H. and A.)
- Glue fruit tree (*Pisonia brunoniana* Endl.)
- Purple strawberry guave (*Psidium cattleianum* Sabine)
- Common guava (*Psidium guajava* L.)

Aquatic Plant(s):

- Job's tears (*Coix lachryma-jobi* L.)

Terrestrial Animal(s):

- White-tailed Tropicbird (*Phaethon lepturus dorotheae*)
- Zebra Dove (*Geopelia striata*)
- Spotted Dove (*Streptopelia chinensis*)
- Japanese White-eye (*Zosterops japonicus*)
- Nutmeg Mannikin (*Lonchura punctulata*)
- House Finch (*Carpodacus mexicanus*)
- Northern Cardinal (*Cardinalis cardinalis*)
- Northern Mockingbird (*Mimus polyglottos*)

Aquatic Animal(s):

- Freshwater Snail (*Erinna*)
- 'Opae-kala-'ole (*Atya bisulcata*)
- 'O'opu nakea (*Awaous stamineus*)

Manawainui Stream (Lower)--Continued

‘O‘opu ‘alamo‘o (*Lentipes concolor*)

Migratory Animal(s):

Lesser Golden-Plover (*Pluvialis dominica (fulva)*)

Freshwater Origin:

The headwater tributaries cascade over the deeply incised Kula series. Perched groundwater in the Kula formation contributes small but continuous drainage. In the short distance where the stream lies on Honomanu basalt high level dike water seepage may occur. Downstream any perennial flow is lost to infiltration in the Kula and Hana series.

Comments:

Potential contamination via groundwater is very unlikely. This remote area has very little development and access to the area is limited by undeveloped roads.

References:

- Timbol, A.S., and Maciolek, J.A. 1978. Stream channel modification in Hawaii. Part A: Statewide inventory of streams, habitat factors and associated biota. Prepared for U.S. Fish and Wildlife Service, U.S. Department of the Interior. 157 p.
- Stemmerman, M.A. 1976. Ornithology report, Manawainui research project, National Science Foundation. 209-233 p.
- Gon, S.M., III. 1976. A preliminary report: The freshwater fauna of the Manawainui region. Manawainui research project, National Science Foundation. 289-298 p.
- U.S. Department of Agriculture, Soil Conservation Service. 1972. Soil survey of islands of Kauai, Oahu, Maui, Molokai, and Lanai, State of Hawaii. In cooperation with the University of Hawaii Agricultural Experiment Station. 232 p. plus illus.
- Sam O. Hirota, Inc. 1983. Draft environmental impact statement for Kaupo water system improvements. Prepared for Department of Water Supply, County of Maui, Hawaii. 89 p. plus app.