

APPENDIX E

LITERATURE ABSTRACTS FOR SELECTED STUDIES AND DATA REPORTS

A selection of reports and studies with a direct bearing on watershed issues within the Central O'ahu Watershed Study area are briefly described in this section. References abstracted are not the only documents used for the report. Items below are also found within the Central O'ahu Watershed bibliography.

- (1) Associations Among Land Use, Habitat Characteristics, and Invertebrate Community Structure in Nine Streams on the Island of O'ahu, Hawai'i, 1999–2001
- (2) Central O'ahu Sustainable Communities Plan
- (3) Central O'ahu Sustainable Communities Plan (Drainage Section)
- (4) East Kapolei Master Plan Final Environmental Impact Statement (Drainage Section)
- (5) Ecologically Sensitive Wetlands on O'ahu: Groundwater Protection Strategy for Hawai'i
- (6) 'Ewa Development Plan (Drainage Section)
- (7) Flood Control and Flood Water Conservation in Hawai'i, Volume II (Revised): General Flood Control Plan for Hawai'i (Circular C93)
- (8) Ground-Water Quality and its Relation to Land Use on O'ahu, 2000–01
- (9) Hawaii's Coastal Nonpoint Pollution Control Program
- (10) Hawai'i Wetland Management Policy
- (11) Kapolei Village Drainage Master Plan
- (12) Kapolei Village Environmental Impact Statement
- (13) Koa Ridge Draft Environmental Impact Statement (Drainage Section)
- (14) M.A.P.S Multi-Attribute Prioritization of Streams Project
- (15) Naval Air Station Barbers Point, O'ahu, Hawai'i, Community Redevelopment Plan
- (16) O'ahu National Wildlife Refuge Complex
- (17) Primary Urban Center Development Plan
- (18) Riparian Plant Restoration. A Management Tool for Habitat Restoration in Hawai'i
- (19) State of Hawai'i Aquatic Invasive Species (AIS) Management Plan
- (20) Statewide Capital Improvement Program, Flood Control Projects, Report R98

- (21) Stream Channel Modifications in Hawai'i
- (22) Trends in Streamflow Characteristics at Long-Term Gauging Stations, Hawai'i Scientific Investigations Report 2004–5080
- (23) U.S. Army Garrison Hawai'i, O'ahu Training Areas, Natural Resource Management
- (24) Waipahu Town Plan, A Special Area Plan of the Central O'ahu Development Plan

Title: Associations Among Land Use, Habitat Characteristics, and Invertebrate Community Structure in Nine Streams on the Island of O'ahu, Hawai'i, 1999–2001

Report No.: 01

Prepared By: Brasher, Anne M.D., Reuben H. Wolff, and Corene D. Luton

Prepared For: U.S. Department of the Interior, U.S. Geological Survey

Date of Publication: 2004

Report Objective(s): To examine associations among land use, habitat characteristics (physical and chemical), and benthic invertebrate community structure on the island of O'ahu.

Relevance to Central O'ahu: The report summarizes intensive data accumulation and surveys undertaken in O'ahu streams during a two-year period. Two of the streams studied, Waikele and Waikakalaua, are within the Central O'ahu watershed.

Findings: Of particular interest is the effect of urbanization on habitat characteristics and how this relates to invertebrate communities. Any association information can be a useful part of a comprehensive assessment of stream quality.

General data collected included general land physiography, land use, stream flow characteristics and rainfall. Individual surveys collected data on water quality, aquatic community structure (vertebrates and invertebrates with heavy emphasis on insects), and habitat characteristics. Waikele and Waikakalaua Streams were determined to have mixed (urban/forest) riparian characteristics. Waikele was found to have a high degree of embeddedness more in common with urban and low elevation streams. Waikakalaua Stream was found to have more in common with forested streams with higher oxygen levels and greater substrate diversity.

Both streams are challenged by a high percentage of non-indigenous species. Invertebrate abundance in both streams was lower than the more forested streams with the exception of the large crustacean. The total number of insect taxa was higher than in comparable forested streams.

Recommendations: None provided.

Title: Central O’ahu Sustainable Communities Plan
Report Number: 02
Prepared By: Department of Planning and Permitting
Prepared For: City and County of Honolulu
Date of Publication: December 2002

Report Objective(s): Help guide public policy, investment, and decision-making over the next 25 years toward sustaining Central Oahu’s unique character, lifestyle, and economic opportunities.

Relevance to Central O’ahu: Central O’ahu plays a key role in implementing the directed growth policies of the General Plan of the City and County of Honolulu. Additionally, development patterns of Central O’ahu will affect future water demands and have impacts on the environment.

Findings: The towns of Waipahu and Wahiawā serve as gateways to ‘Ewa and the North Shore and historically, have been headquarters for sugar and pineapple plantations and support centers for the military. In 1968, Central O’ahu began to play a role as a major area for housing development, e.g., Mililani Town, Village Park, Gentry Waipi’o, Waikele, Royal Kunia. 1989 changes to the General Plan designated the urban fringe areas in Central O’ahu as one of Oahu’s principal residential development areas. Since then, Central O’ahu, with the Primary and Secondary Urban Centers and urban fringe areas in ‘Ewa, provided the bulk of new housing developed on the island. The General Plan also called for maintaining viability of agriculture on O’ahu and specifically stated that “sufficient agricultural land” should be provided “in ‘Ewa, Central O’ahu, and the North Shore to encourage the continuation of...pineapple as [a] viable industry.”

As to growth, the Plan anticipates:

- Population of the Central O’ahu area to grow from 149,000 in 2000 to over 173,000 in 2025
- The addition of 11,000 new housing units to the existing 45,000 homes in Central O’ahu in 2000

Recommendations: In general, the Central O’ahu Sustainable Communities Plan recommends focusing future residential development on master planned suburban communities within an Urban Community Boundary and on redevelopment around two transit centers in Waipahu. Specific recommendations to support the concept include:

- Promote diversified agriculture and pineapple on 10,500 acres of prime and unique agricultural lands along Kunia Road, surrounding Mililani, and on the Waipi’o Peninsula in accordance with the *General Plan* to support agricultural diversification in all agricultural areas and to encourage continuation of a viable pineapple industry;
- Provide for a variety of housing types;
- Provide for redevelopment around two transit centers (bus transfer points) planned at a site on Hikimoe Street near the Civic Center and at a site now used for agriculture, located below the H-1 Highway and on the Wai’anae side of Kunia Road.
- Provide new employment in existing commercial and industrial areas (including Mililani Technology Park), in new commercial areas designed to serve their surrounding residential communities, and at a new medical park at Koa Ridge;
- Identify the infrastructure needed to meet the likely residential, commercial, and industrial development through 2025; and
- Help relieve urban development pressures on rural and urban fringe Sustainable Communities Plan Areas to preserve the “country” lifestyle of the rural areas and sustain the stable, low-density residential character of the urban fringe areas

Title: Central O'ahu Sustainable Communities Plan (Drainage Section)
Report No.: 03
Prepared By: Department of Planning and Permitting
Prepared For: City and County of Honolulu
Date of Publication: December 2002

Report Objective(s): To provide a policy context for City land use and budgetary actions. The Sustainable Community Plan replaces the previous Development Plan.

Relevance to Central O'ahu: This community plan directs growth and sets policies for the vast majority of the land area of our Central O'ahu watershed study.

Findings: Central O'ahu can be divided into two areas for assessing drainage needs—the uplands mauka of the H-1 Freeway and the lowlands makai of the freeway. The urban developments sited on high plateaus in the Central O'ahu uplands benefit from the natural flood protection provided by the deep gulches that drain storm water and filter some pollutants. Historically, upland flooding problems have only occurred in the portion of Waikakalaua Gulch, which has been developed with houses and apartments.

Flooding has been more prevalent in the Central O'ahu lowlands, particularly in Waipahu around Waikele Stream and in Waiawa around the lower reaches of Waiawa Stream where flood plain and wetland areas have been developed. The discharge of drainage to Pearl Harbor has caused siltation problems and has aggravated water pollution. Siltation causes navigation problems in the harbor and forces the Navy to dredge at frequent intervals.

As to growth, the Plan anticipates:

- Population of the Central O'ahu area to grow from 149,000 in 2000 to over 173,000 in 2025
- Addition of 11,000 new housing units to the existing 45,000 homes in Central O'ahu in 2000

Recommendations:

General Policies

- Planned improvements to Central O'ahu drainage systems should be integrated into the regional open space network by emphasizing use of retention basins and recreational access.
- Drainage system design should emphasize control and minimization of nonpoint source pollution and the retention and/or detention of storm water on-site and in appropriate open space and wetland areas.
- Storm water should be viewed as a potential source for aquifer recharge and should be retained for absorption rather than funneled to the coast.
- Natural and man-made vegetated drainages and retention basins should be the preferred drainage solution wherever they could promote water recharge, control nonpoint-point source pollutants, and provide passive recreation benefits.

Planning Principles

Central O'ahu natural resources, including endangered species habitats, ravines, potable water supply, and Pearl Harbor waters, will be conserved by:

- Identifying and protecting endangered species habitats and other important ecological zones from threats such as fire, weeds, feral animals, and human activity;
- Retaining the major Central O'ahu ravines as flood plains and open space resources by restricting further development and minimizing grading or other disturbance of the gulch walls;
- Designing the regional drainage and wastewater treatment system to minimize nonpoint source pollution of the ocean and Pearl Harbor;
- Protecting prime watershed recharge areas and the Pearl Harbor potable aquifer underlying Central O'ahu;
- Protecting valuable habitats for endangered water birds located on the shoreline of Pearl Harbor at Pouhala Marsh and Pearl Harbor Ponds

Title: East Kapolei Master Plan Final Environmental Impact Statement (Drainage Section)
Report Number: 04
Prepared By: PBR Hawai'i
Prepared For: Housing and Community Development Corporation of Hawai'i
Date of Publication: July 1998

Report Objective(s): To provide an assessment of the impact upon the environment surrounding the project area. This project is a 1,300-acre master planned residential, commercial, public facility and open space community at 'Ewa, O'ahu. The project also involves land owned and/or controlled by the Department of Hawaiian Homelands.

Relevance to Central O'ahu: The East Kapolei development encompasses a large area of the Central O'ahu study area and its build-out could have significant impacts on the watershed.

Findings: This report describes the improvements proposed to accommodate the public facility needs of the project. It also describes the existing natural environment of the project site and surrounding area, the potential impacts that might result from the proposed project, and mitigation measures to minimize potential adverse impacts.

The report includes the complete East Kapolei Drainage Master Plan (Appendix B) prepared by R.M. Towill Corporation. The master plan includes an assessment of existing drainage conditions, a proposed drainage plan, and calculations for sizing of regional and backbone drainage facilities. The intent of the drainage plan is to control flooding and provide adequate storm water disposal for on-site and off-site generated runoff. Generated runoff is proposed to be mitigated through the use of inlets, channels, culverts, detention basins, and a bridge. A large portion of the site lies in the Kalo'i Stream flood plain. Existing drainage conditions are poor due to the flat topography of the land and inadequate drainage swales. Runoff from two primary drainage basins flow through the area. These basins are the Kalo'i Gulch and the Hunehune Gulch.

Recommendations: To mitigate the increase in runoff and facilitate groundwater recharge:

- A drainage control system was planned within the 300-foot wide utility, drainage and access corridor along the proposed North-South Road.
- On-site retention basins with outlet structures designed to control quantities and siltation.
- At the time of the EIS, U.S. Army Corps of Engineers approval was needed to realign Kalo'i Gulch.
- Irrigation for common areas use brackish water and treated effluent.

Title: Ecologically Sensitive Wetlands on O'ahu: Groundwater Protection Strategy for Hawai'i
Report Number: 05
Prepared By: Environmental Center Water Resources Research Center, University of Hawai'i at Mānoa
Prepared For: State of Hawai'i, Department of Health
Date of Publication: 1989

Report Objective(s): To identify ecological systems pursuant to the delineation of Class I groundwaters under the EPA; to assess the ecological sensitivity and uniqueness of these systems; to determine which of these systems qualified as ecologically-vital habitats.

Relevance to Central O'ahu: Wetlands and ecological systems can be greatly affected by changes to the surface and groundwater of central O'ahu.

Findings: In the Pearl Harbor aquifer system the following ecologically-vital habitats were identified. 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.

- Fort Kamehameha
- Pearl Harbor East Loch
- Pouhala
- Waiawa National Wildlife Refuge
- Waikele
- Waipahu Landfill
- Waipi'o Basins
- Walker's Bay

Each of the ecologically sensitive systems identified for this project have been assigned an ecological sensitive rating based on numerous criteria of the U.S. EPA Groundwater Protection Strategy. The results provide the basis, along with certain geohydrological information, for determining if a particular groundwater should be considered ecologically vital. The attenuation and dilution of groundwater contaminants by natural processes can significantly affect the relative toxicity of the potential pollutants.

Recommendations: None provided.

Title: 'Ewa Development Plan (Drainage Section)
Report No.: 06
Prepared By: Department of Planning and Permitting
Prepared For: City and County of Honolulu
Date of Publication: May 2000 (currently being revised)

Report Objective(s): To provide a policy context for the land use and budgetary actions of the City.

Relevance to Central O'ahu: The study area encompasses the 'Ewa Development Plan area. 'Ewa suffers drainage problems and is expecting more growth in the coming years.

Findings: The report assesses the 'Ewa district's drainage needs. Low-lying parts of the 'Ewa plain are subject to flooding during intense rainstorms. Typical urban flood control has been provided through concrete-lined channels that convey storm water to the ocean. However, floodwater discharge is a major source of nonpoint source pollution of nearshore waters, negatively affecting coral growth, fish populations and ocean recreation. The federal government has initiated a major program to reduce nonpoint source pollution, mandating response by the State and the Counties.

Currently, lined channels deliver storm water to the ocean at several points along the 'Ewa shoreline—at Barbers Point, on the western edge of the Barbers Point Naval Air Station (BPNAS), and in 'Ewa Beach. Ko Olina Resort drainage joins Waimanalo gulch watershed drainage and is conveyed underground to an ocean discharge at the northern end of the resort.

Recommendations:

Drainage improvements are planned for:

- A major new system to drain Makaiwa Hills, Kapolei Business Park, and the industrial areas closest to the Barbers Point Deep Draft Harbor;
- Expansion of the channel at the western edge of BPNAS to provide additional capacity for the City of Kapolei;
- A system to drain the West Loch Drainage Basin, serving 'Ewa by Gentry and development in East Kapolei; and
- A system to drain the Kalo'i Gulch Drainage Basin.

General Policies and Planning Principles

- Drainage system design should emphasize control and minimization of nonpoint source pollution and the retention and/or detention of storm water on-site and in appropriate open space and wetland areas. To the extent possible, developers should integrate planned improvements to the drainage system into the regional open space network by emphasizing the use of retention basins and creating passive, pedestrian, and bicycle recreational areas.
- Storm water should be viewed as a potential irregular source of water for recharge of the aquifer, which should be retained for absorption rather than quickly moved to coastal waters.
- Natural and man-made vegetated drainage ways and retention basins should be the preferred solution to drainage problems wherever they could promote water recharge, help control nonpoint source pollutants, and provide passive recreation benefits.

The following principles apply specifically to development within the Kalo'i Gulch drainage basin.

- The City supports timely development of the 'Ewa Marina as a key element needed to mitigate drainage impacts in the Kalo'i Gulch watershed during major storms.
- Relation to the 'Ewa Village Master Plan and other previously approved developments in the basin. Solutions to handling drainage problems on lands above 'Ewa Villages must be compatible with the drainage design of the 'Ewa Village Master Plan and other previously approved developments in the Kalo'i Gulch drainage basin.

Title: Flood Control and Flood Water Conservation in Hawai'i, Volume II (Revised): General Flood Control Plan for Hawai'i (Circular C93)
Report No.: 07
Prepared By: State of Hawai'i, Department of Land and Natural Resources, Division of Water and Land Development
Prepared For: State of Hawai'i, Department of Land and Natural Resources, Division of Water and Land Development
Date of Publication: September 1983

Report Objective(s): To update the original Vol. II published in 1963; to provide delineations of watersheds and specific flood control projects for many of them; to develop a watershed identification code for Hawai'i.

Relevance to Central O'ahu: The report covers various flood control measures that may be implemented throughout the study area and that could affect the watershed and drainage.

Findings: For Central O'ahu, the existing programs were comprised of the Kalauao Stream Flood Control Project, Waimano Stream Flood Control Project, Waikele Stream Flood Control Project and Honouliuli Lands Flood Control Project. For Central O'ahu, the proposed programs were comprised of the Hālawā Stream Project, Waiawa Stream and Tributaries Program and Honouliuli Stream and Tributaries Program.

This report includes background details on the general flood control plan, including discussion of existing and planned flood control programs, completed control works for each island, and flood problem areas. The report also includes analysis of available data on flood problem areas, recommendations to improve existing active and inactive flood control programs, and new programs.

Recommendations:

For the Kalauao Project

- flood plain zoning
- improving existing channels
- implementing a tsunami warning and evacuation program.

For the Waimano Project

- constructing channel improvements

For the Waikele Project

- flood plain zoning
- stream improvement
- implementing soil conservation measures.

For the Honouliuli Project

- flood plain zoning
- implementing a tsunami warning and evacuation program

For the Hālawā Project

- dredging and stream bank protection
- implementing a tsunami warning and evacuation system
- implementing a stream maintenance program.

For the Waiawa Project

- flood plain zoning
- dam and stream improvements
- implementing a tsunami warning and evacuation program
- organizing a flood fighting unit
- practicing soil conservation in crop areas and forest reserve lands.

Title: Ground-Water Quality and its Relation to Land Use on O'ahu, 2000–01
Report No.: 08
Prepared By: U.S. Department of the Interior, U.S. Geological Survey
Prepared For: National Water Quality Assessment Program
Date of Publication: 2004

Report Objective(s): To assess the quality of drinking water resources; to describe the occurrence and distribution of inorganic elements and organic compounds in O'ahu groundwater; to evaluate relationships between groundwater quality and use; to determine whether land use changes have caused changes in groundwater quality; to describe how the chemical composition of groundwater is influenced by flow system factors such as depth below the water table, proximity to recharge areas, and presence or absence of confining units.

Relevance to Central O'ahu: The Central O'ahu study area is the most urbanized area of the state. These same urbanized areas were once predominantly used for agriculture. These two land uses could have a great impact on water resources.

Findings: Water quality in the main drinking water source aquifers of O'ahu was assessed by a one-time sampling of untreated groundwater from 30 public supply wells and 15 monitoring wells. Characteristic suites of chemicals were associated with particular land uses and geographic locales. Solvents were associated with central O'ahu urban-military lands whereas fumigants, herbicides, and fertilizer nutrients were associated with agricultural lands. Although large tracts of land in central O'ahu have been converted from agriculture to residential urban use since the 1950s, water quality in the converted areas still more closely reflects the former agricultural land use.

Most organic and nutrient contamination appears to reflect decades-old releases and former land use. Emerging local issues in groundwater quality include ongoing organic and nutrient leaching, proposed land application of treated wastewater effluent and the movement to diversified agriculture and its attendant decentralization of oversight in pesticide application and handling.

Recommendations: Shallow penetration monitoring wells could be a valuable component in ongoing water quality monitoring efforts.

Title: Hawaii's Coastal Nonpoint Pollution Control Program
Report No.: 09
Prepared By: State of Hawai'i, Office of State Planning, Hawai'i Coastal Zone Management Program
Prepared For: State of Hawai'i, Office of State Planning, Hawai'i Coastal Zone Management Program
Date of Publication: June 1996

Report Objective(s): To describe government programs and management measures to control nonpoint source pollution; to formulate government rationale for various control measures.

Relevance to Central O'ahu: The report discusses various government programs and management measures that may be undertaken in the Central O'ahu area to control nonpoint source pollution. This document formulates the governmental rationale for various control measures, and defines the administrative context and coordination required to meet the anti-degradation goals in Central O'ahu.

Findings: The Hawai'i Coastal Zone Management (CZM) Program completed this report as part of a federal mandate for states with CZM programs requiring the implementation of EPA guided management measures based on. Management measures reflect the most effective approach to prevent or minimize pollution that might result from a particular activity. The consequences of nonpoint source pollution include increased risk of disease, algae blooms, fish kills, destroyed aquatic habitats and turbid waters. The document recommends that 56 measures be implemented and then monitored.

Nonpoint source pollution in Hawai'i includes sediments, nutrients, toxic chemicals, pathogens, acidity, and freshwater inflows. Researchers estimate that O'ahu generates 102,000 tons per year, primarily from land-based activities. Agricultural, forestry, urban, hydromodification and marina activities cause most of these problems. Storms and heavy rains carry the pollution downstream. In addition, when wetlands and riparian areas are degraded, they damage important natural areas that would otherwise absorb and filter polluted runoff before it reaches coastal areas.

Recommendations: Recommendations for management measures are categorized as:

Agriculture

- Erosion/grazing control
- Alternate farming practices
- Soil/pesticide management

Forestry

- Revised harvesting /forest regeneration
- Streamside/wetland management
- Revised road construction practices
- Revised timber harvesting practices
- Fire/chemical management

Urban areas

- Urban design changes
- Site development of roads, highways and bridges
- Construction site erosion and chemical control
- On-site disposal systems and pollution prevention
- Golf course management

Marinas and Recreational Boating

- Marina flushing
- Siting and design of marinas
- Shoreline stabilization
- Fueling station and sewage facility design

Hydromodifications

- In-stream and riparian habitat restoration
- Dams management
- Stream bank and shoreline erosion management

Wetland and Riparian Areas

- Vegetated treatment systems
- Restoration of wetland and riparian areas

Title: Hawai'i Wetland Management Policy
Report No.: 10
Prepared By: Hawai'i Wetland Management Policy Workgroup
Prepared For: State of Hawai'i, Department of Health, Environmental Planning Office
Date of Publication: April 1999

Report Objective(s): To address issues of public participation, agency roles and responsibilities, mitigation, watershed management, cultural issues, and dispute resolution pertaining to wetlands in Hawai'i.

Relevance to Central O'ahu: There are some wetland areas in the Central O'ahu study area, especially around Pearl Harbor. This document provides definitions, descriptions, functions, and wetland interconnectedness with other natural resources and processes. The document goes on to set goals and management policies that should be applied to areas of the Central O'ahu watershed.

Findings: Wetland functions include:

- storage of surface water
- storage of subsurface water
- dissipation of energy
- maintenance of biodiversity
- cycling of nutrients
- removal of elements and compounds
- retention of particulates
- exportation of organic carbon

Economically, wetlands can provide recreation, education, and a place for wetland crops. Culturally, wetlands are important to the State for both residents and visitors. Finally, wetlands provide aesthetic and open space value. Seasonal wetlands can meet both flood control and habitat achievement objectives.

Recommendations: The document encourages public participation and cooperation among agencies (including Hawaiian groups) to the maximum extent practical in wetland management decisions. The document also encourages mitigation banking to allow proponents of unavoidable wetland fills to improve high priority wetlands or to buy credits in pre-established mitigation sites or banks. Other recommendations are long-term maintenance and technical assistance for wetlands and establishment of a GIS-based database for identification and management of wetlands.

Title: Kapolei Village Drainage Master Plan
Report No.: 11
Prepared By: R.M. Towill Corporation
Prepared For: State of Hawai'i, Housing Finance and Development Corporation
Date of Publication: December 1991

Report Objective(s): To provide on-site drainage and to allow no increase in runoff volume and peak rates downstream as a result of the development.

Relevance to Central O'ahu: The Kapolei Village development encompasses a large area of the Central O'ahu study area and its build-out could have significant impacts on the watershed. The Kapolei Village project is a development proposed by the Housing Finance and Development Corporation of the Department of Budget and Finance, State of Hawai'i. Kapolei Village is an 890-acre, mixed residential project located on the southern side of the Wai'anae Mountain range on the 'Ewa Plain in Honouliuli.

Findings: The study includes an assessment of existing and future drainage conditions, an evaluation of subdivision facilities for on-site drainage requirements and an evaluation of regional facilities for watershed drainage requirements. The project site is separated from the ocean by the Barbers Point Naval Air Station (BPNAS). Because there are no defined ocean outlets for drainage of the site, on-site disposal of some runoff is proposed.

The increase in runoff due to the development of Kapolei Village will be approximately 126 acre-feet for a 100-year, 24-hour storm. Urbanization of the entire watershed above the BPNAS will produce an increase of 247 acre-feet. The minimum amount for on-site disposal was set at 247 acre-feet so as not to increase runoff into the BPNAS for the design 100-year, 24-hour storm. This area receives little rainfall from the prevailing northeasterly trade winds. Most of the rainfall occurs during the southerly Kona storms. The median annual rainfall ranges between 31 inches in the lower mountain areas to 20 inches near the coastline.

Recommendations: The proposed drainage plan consists of stormwater detention basins and culverts.

Title: Kapolei Village Environmental Impact Statement
Report Number: 12
Prepared By: R. M. Towill Corporation
Prepared For: State Housing Finance and Development Corporation
Date of Publication: February 1988

Report Objective(s): To provide information to public officials and members of the community on the proposed Kapolei Village; to assess existing environmental conditions of the property and surrounding areas; to evaluate potential impacts that may result from development of the project and to propose mitigating measures for those impacts; and to consider alternatives to the proposed action.

Relevance to Central O’ahu: Kapolei Village is located in the ‘Ewa area, which is included within the boundaries of the area Central O’ahu Watershed Study. This Statement included review of the area’s water infrastructure and surrounding land uses and provided information on environmental and socio-economic impacts.

Findings: The ‘Ewa area was designated as the Secondary Urban Center (SUC) in 1977 by the City and County of Honolulu to attract future population growth and employment opportunities and to relieve urban pressures within the Honolulu area, which was designated as the Primary Urban Center (PUC). The ‘Ewa Development Plan area was amended in 1986 for the establishment of the SUC. The Plan’s goal was to develop a self-contained community with a full range of support facilities and services, including a mix of housing unit types, commercial/retail centers, businesses, and community support facilities.

The proposed development area was 22 miles west of the PUC, near the center of the ‘Ewa plain, north of the Barbers Point Naval Air Station, south of the Makakilo community, and directly east of the proposed Kapolei Town Center. The State was the lead in the proposed project and they were to work with the City and private sector in the actual development. The overall development concept for a planned residential community with a full range of community support facilities was designed to help alleviate Oahu’s severe affordable housing shortage.

Probable impacts and related mitigation measures included the following items:

- Agricultural Impacts
- Air Quality
- Traffic
- Socio-Economic Conditions
- Noise
- Topography and Soils
- Flora and Fauna
- Water
- Sewer
- Drainage
- Solid Waste
- Power and Communications
- Unresolved Issues, i.e., purchase of the site; requirement of a Land Use District Boundary Amendment (agriculture to urban); and operations and management of the golf course.

There were five alternative concept plans, each providing approximately 5,000 housing units (60 percent affordable and 40 percent market), varied design elements, infrastructure systems, and recreational facilities. The best features were combined into a preferred alternative plan, which was then refined to become the recommended “master site plan” for the proposed project.

Recommendations: None required nor provided. The environmental impact statement and the master plan were to be used as basic documents to justify the proposed State land use redesignations and amendments to the City’s Development Plan.

Title: Koa Ridge Draft Environmental Impact Statement (Drainage Section)
Report No.: 13
Prepared By: Helber, Hastert and Fee, Planners
Prepared For: Castle and Cooke Homes Hawai'i, Inc.
Date of Publication: February 2003

Report Objective(s): To provide an assessment of the impact upon the environment surrounding the project area. This project is a 1,248-acre master planned community with a residential component and a medical park. It is located in the 'Ewa District to the west of Mililani.

Relevance to Central O'ahu: This large project is within the study area and any drainage changes or development could affect the watershed.

Findings: This study describes the existing natural environment of the project area, the potential impacts that might result from the proposed project and mitigation measures to minimize potential adverse impacts.

Rainfall in the project vicinity ranges from about 50 inches per year to 100 inches per year, depending on elevation. The prevailing wind direction for this area is east northeast. Elevations within the project area range from 440 feet above mean sea level to over 1,000 feet above mean sea level. Storm runoff from the project area flows overland and discharges into streams and gulches that are tributaries of Waikele Stream and Waiawa Stream. Waikele Stream discharges into West Loch while Waiawa Stream discharges into Middle Loch.

Recommendations: In order to comply with the City and County's policy of no net increase in storm water runoff volume, detention/retention systems within each development area would need to be established. Prior to discharge into existing streams and gulches, storm water would be conveyed by on-site drainage systems within the internal roads to on-site detention/retention basins to satisfy flood control and water quality requirements.

Title: M.A.P.S Multi-Attribute Prioritization of Streams Project
Report No.: 14
Prepared By: Uyeno, Dean D.
Prepared For: State of Hawai'i, Department of Land and Natural Resources,
Commission on Water Resource Management
Date of Publication: March 1998

Report Objective(s): To expand on the efforts of the 1990 Hawai'i Stream Assessment (HSA); to update and prepare a GIS database of stream quality attributes and descriptions in Hawai'i.

Relevance to Central O'ahu: This document prioritized streams and classified them as to certain values so that resources could be directed where most appropriate.

Findings: The primary goal of the HSA was to identify high quality streams suitable for protection. The HSA was prepared to help policy-makers, resource managers, developers, scientists, and the interested public to:

- locate published information for a particular stream
- identify and prioritize areas where information is needed
- understand stream resources within a statewide context
- make management decisions based on data
- develop general stream resource protection guidelines
- identify specific stream appropriate for protection and enhancement

The MAPS project ranked streams according to various attributes and established a stream protection and management system to protect surface water resources, watersheds, and natural stream environments. No streams within the central O'ahu watershed were ranked as potential heritage, potential non-diverted valuable streams, or potential diverted valuable streams.

Recommendations: The report recommends a minimum number of gauging stations be established on all streams to provide accurate and consistent baseline estimate of stream flow and size. A systematic series of gages on all the watershed streams at each stream crossing would provide valuable data for hydrologic modeling. These gauging stations could also be used to monitor water quality. The report goes on to recommend establishment of a GIS-based system as a stream management tool. This data should be a composite of data from various agencies.

Title: Naval Air Station Barbers Point, O'ahu, Hawai'i, Community Redevelopment Plan
Report Number: 15
Prepared By: Helber, Hastert & Fee, Planners
Prepared For: NAS Barbers Point Redevelopment Commission, State of Hawai'i Office of Planning
Date of Publication: March 1997

Report Objective(s): To satisfy the requirements of the reuse planning process, and to provide an overall reuse strategy for the conversion of the base to civilian use after its closure in 1999.

Relevance to Central O'ahu: The entire NAS Barbers Point is situated within the boundaries of the Central O'ahu Watershed Study. Any future actions and plans are anticipated to impact this watershed.

Findings: Closure of Naval Air Station (NAS) Barbers Point was recommended in June 1993 to President Clinton. This was confirmed by the U.S. Senate three months later with closure to be completed in July 1999. The State of Hawai'i was identified as the "lead government" for the planning and implementation of the transition of uses and the Barbers Point Reuse Committee was formed to assist in this process. The Committee was formalized as the Barbers Point Redevelopment Commission by Executive Order 94-08 on December 2, 1994. On October 8, 1996, the Redevelopment Commission adopted a final land use plan.

Full build-out and occupancy is not expected until after 2020 due to anticipated slow growth of industrial and residential areas. Employment is expected to increase by about 300 jobs annually during this period due to construction. An additional 2,000 jobs are forecasted for creation by 2020 to service the operations of the recreation and commercial facilities.

The Navy is retaining a significant portion of the Barbers Point complex and will continue to maintain and operate its own infrastructure in these areas. Almost all of the roads will be transferred to the Local Redevelopment Authority (LRA) as well as many of the utility systems. Many of the existing roads do not have curbs, gutters, sidewalks, and paved on-street parking as required by City standards for urban roadways; these roads will not be transferred to the City until they are upgraded. Other utilities will either be transferred directly to the City or negotiated for the privatization or outsourcing of the utility.

Recommendations: Homeless Programs: 13 acres in the urban core and 65 acres of vacant land, including 15 acres for self-help housing and 50 acres for multi-family residential units. Airport: 725 acres for general aviation reliever airport, aviation training, and an aviation component of the City's Life Safety Academy. Parks and Recreation: 420 acres for regional shoreline parks and recreation and 227 acres in the northeast for active sports and recreation. Commercial/Recreation: Three large areas totaling 280 acres. Housing: 150 acres, 78 previously committed for the homeless, and the remainder for redevelopment by the Department of Hawaiian Home Lands. Light Industrial and Commercial: Four parcels totaling 113 acres. Public Facility: 7 acres for a Pacific Life Safety Academy; 9 potential linkages between on-base roadways and off-base regional system; expand and upgrade existing infrastructure systems. New LRA: Include State, City, and community representation for implementation of the Plan.

Title: O’ahu National Wildlife Refuge Complex
Report No: 17
Prepared By: U.S. Fish & Wildlife Service
Prepared For: <http://www.fws.gov/pacific/pacificislands/wnwr/O’ahunwrindex.html>
Date of Publication: January 13, 2005

Report Objective(s): To provide general information on the O’ahu National Wildlife Refuge (NWR) Complex, made up of the Pearl Harbor NWR, O’ahu Forest NWR, and James Campbell NWR. The O’ahu NWR Complex provides important habitat for Hawaii’s endangered water birds: the Hawaiian stilt (ae’o), the Hawaiian moorhen (‘alae ‘ula), the Hawaiian coot (‘alae ke’oke’o), and the Hawaiian duck (koloa).

Relevance to Central O’ahu: The Pearl Harbor NWR is located in the Central O’ahu watershed study area. Four species of endangered water bird species find refuge within the wetland units and are impacted by upstream water quality and from habitat encroachment by alien mangrove species.

Findings: The Pearl Harbor NWR is composed of two units. The 37-acre Honouliuli Unit borders West Loch, and the 25-acre Waiawa Unit borders Middle Loch. Managed under a cooperative agreement with the U.S. Navy, Pearl Harbor NWR was established in 1976 as mitigation for construction of the Honolulu International Airport Reef Runway. Through cooperative efforts, the Federal Aviation Administration, the State of Hawai’i, the U.S. Navy, and the U.S. Fish and Wildlife Service made the refuge a reality.

The Honouliuli Unit, also a freshwater wetland, is extensively managed for a variety of water birds, including Hawaii’s endangered water birds and migrant waterfowl. It serves as the site of the Hawai’i Nature Center’s Third Grade Wetlands Education Program. During the fall semester, thousands of students learn about the recovery of Hawaii’s water birds and the value of wetlands.

The Waiawa Unit is composed of two ponds, one of which is primarily managed for the endangered Hawaiian stilt (ae’o). However, its estuarine environment is ideal for establishing a host of food resources for all four endangered waterbird species (Hawaiian coot [‘alae ke’oke’o], moorhen [‘alae ‘ula], and duck [koloa maoli]). Fresh water is pumped into the refuge from a nearby stream and empties into Pearl Harbor.

Recommendations: These refuges are to remain as “set asides” primarily to benefit Hawaii’s four species of endangered water birds, while also providing habitat and a protected coastal home for migratory seabirds. Amidst a changing Hawai’i, these refuges indeed provide a “refuge” where the state’s native species exist without man-made intrusions.

Title: Primary Urban Center Development Plan
Report Number: 17
Prepared By: Department of Planning and Permitting
Prepared For: City and County of Honolulu
Date of Publication: May 2002

Report Objective(s): Provide guidelines for shaping the future of O'ahu to enhance the Primary Urban Center's (PUC) livability while accommodating a moderate amount of growth over the next 20 years; establish broad regional policy and provide a foundation for more specific planning at the neighborhood level.

Relevance to Central O'ahu: Together with the Central O'ahu Sustainable Communities Plan, the Primary Urban Center Development Plan is one of eight regional plans mandated by the City's Charter. The neighborhoods of Pearl City, Waimalu, 'Aiea, Hālawā Heights, and Foster Village are within the PUC. The development patterns of Central O'ahu will affect future water demands and have impacts on the environment.

Findings: The PUC, capital of the State of Hawai'i, home to almost half of Oahu's population and three-quarters of all jobs, is a mature urban center with no remaining "greenfields."

The key elements of the PUC's Vision are:

- Honolulu's natural, cultural, and scenic resources are protected and enhanced;
- Livable neighborhoods have business districts, parks and plazas, and walkable streets;
- In-town housing choices for people of all ages and incomes;
- Honolulu is the Pacific's leading city and travel destination; and
- A balanced transportation system provides excellent mobility for residents and visitors.

Recommendations: These are specific to Central O'ahu:

- Protect and enhance natural, cultural, and scenic resources, e.g., the few remaining wetlands near Pearl Harbor; provide continuous lateral, physical, and visual access along and around the Pearl Harbor waterfront; develop streamside pathways to include the 'Aiea Stream segment through the former 'Aiea Sugar Mill site.
- Better integrate military and civilian land uses and circulation routes; relocate the Navy Public Works Center to Pearl Harbor Naval Base closer to the shipyard; redevelop the PWC site for housing, linking the adjacent Moanalua Terrace and Āliamanu residential neighborhoods.
- Pearl City-'Aiea Town Centers--create a "community center" development pattern that mixes residential, commercial, and institutional uses within relatively short distances and expose building entrances and activity areas to invite passersby.
- Provide for development of village inns in existing commercial centers, e.g., Pearl Ridge and Pearl City, to serve resident and business needs as well as resort alternatives for visitors.
- Implement a pedestrian network for the Pearl Harbor area with priority for pedestrians between the Town Centers and linking shoreline parks.
- Expand the Pearl Harbor Bike Path to link into the 100 miles of new bikeways as planned in the "Lei of Parks."
- Implement wastewater collection system improvements in Māmala Bay Sewerage District to serve projected demand increases; the West Māmala Bay service area is from Hālawā through Pearl City and outflows are processed through the Honouliuli Wastewater Treatment Plant.
- Support retention and upgrade of the Waiau Power Plant to improve reliability of the electrical power system.
- Manage stormwater--control and manage urban watersheds and protect coastal water quality; urban runoff from Māmala Bay's subembayments, i.e., Pearl Harbor via Waiawa, Waimalu, and Hālawā Streams, contributes to nearshore water pollution.

Title: Riparian Plant Restoration. A Management Tool for Habitat Restoration in Hawai’i
Report No.: 18
Prepared By: Crago, L.M., C.F. Puttock, and S.A. James
Prepared For: Bishop Museum
Date of Publication: 2005

Report Objective(s): To develop an interactive plant key model, designed as a tool to assist managers of riparian restoration projects in selecting native plants.

Relevance to Central O’ahu: This program may be of use when planning for the restoration of various stream corridors within the Central O’ahu watershed especially along Waikele Stream and around Pearl Harbor.

Findings: The interactive computer design program uses LucID Professional software and a plant database from the Bishop Museum to select appropriate plants for any given island, altitude, soil type, and riparian zone in Hawai’i. Development of this project was based on the needs identified by the “Riparian Vegetation for Soil Bioengineering in Hawai’i (April 29, 2003)” working group.

Recommendations:

Wildlife Habitat

Restoration with native plants will enhance the habitat of our unique wildlife and help in their survival. Specifically, plants that grow into and over the streams will help in keeping water temperature low and enhance other water quality functions, such as sediment and nutrient load reduction.

Removal of Nutrients

Nutrients that create problems for Hawai’i streams are nitrates, phosphates, and sulfates. Humans and ungulates are the main sources of these pollutants, in the form of organic materials, fertilizers, wastewater, and polluted runoff from our streets, construction sites, and altered landscapes.

Removal of Sediment

Plants within the riparian zone play a crucial part in limiting the amount of sediment that reaches the stream. Key plant attributes such as rhizomatous root structures, shrubs with many low branches, and thick clumping grasses and sedges all work together in slowing the water velocity, binding the soil and trapping sediment, protecting the stream from high sediment loads.

Flood Buffer

It is important to have plants within the riparian zone that serve as a flood buffer. These plants trap sediment and slow the water as it comes down the stream, decreasing flood peaks, and lessening the effect of soil erosion and high sediment loads in the stream, flood plain, and wetlands. These plants are generally sturdy shrubs and trees with deep or stabilizing root structures that will tolerate high water volume.

Bank Stabilization

Root systems and plant structure play an important part in preventing soil erosion. Flexibility of the stems and rhizomatous root structures are two important structural plant attributes that prevent soil erosion on stream banks. These types of plants hold the soil and bend as the water washes over them, shielding the soil from being washed away with the flood.

Title: State of Hawai'i Aquatic Invasive Species (AIS) Management Plan
Report No.: 19
Prepared By: The Nature Conservancy of Hawai'i
Prepared For: State of Hawai'i, Department of Land and Natural Resources,
Division of Aquatic Resources
Date of Publication: September 2003

Report Objective(s): To minimize the harmful ecological, economic, and human health impacts of aquatic invasive species through the prevention and management of their introduction, expansion, and dispersal into, within, and from Hawai'i.

Relevance to Central O'ahu: Invasive aquatic plants can alter the productivity of water systems, reduce fishery yields, and change surface water chemistry. All of these could have impacts on the watershed as a whole.

Findings: Both marine and freshwater invasive species impact the ecology of waters within the Central O'ahu watershed. Invasive species include marine fish, invertebrates, and algae, but also include many freshwater species such as insects, floating or rooted aquatic plants, fish, birds, and invertebrates. These species both compete with native Hawaiian species and may spread disease to plant, animal, or human populations. The management plan discusses the impacts of invasive species to our native Hawaiian flora and fauna and to water quality and discusses mechanisms to control or eradicate these threats. These plans and strategies impact the management of Pearl Harbor and of the nine stream systems feeding into this estuary. The report discusses the extent of the problem, the existing federal and state authorities and programs, and develops a rational set of objectives, strategies, and tasks to address the problem.

Recommendations:

Marine Specific Strategies

- Implement and fund the existing Ballast Water and Hull Fouling Prevention Program
- Research to better understand the cause of algal blooms
- Develop a range of control options that are appropriate for the coral reef environment
- Research to better understand and quantify the impacts of ta'ape and roi
- Assess the distribution and threat of the many non-native marine invertebrate species that are in our waters
- Examine the ability for control of key invertebrate species like *Carijoa riisea*

Inland Water Management Priorities

- Increase coordination among inland water researchers, resource managers, and representatives from relevant industries
- Continue and increase education effort, especially those focusing on unauthorized release of organisms into inland water aquatic systems

Title: Statewide Capital Improvement Program, Flood Control Projects, Report R98
Report No.: 20
Prepared By: Fukunaga & Associates, Inc.
Prepared For: State of Hawai'i, Department of Land and Natural Resources, Division of Water and Land Development
Date of Publication: April 1994

Report Objective(s): To conduct a literature search to identify and assess flood prone areas appropriate for flood damage mitigation; to formulate criteria for a State Capital Improvement Program (CIP) for flood control improvements and engineering studies; to identify State funding opportunities to supplement County an/or Federal flood control projects. This report may be considered an extension of the State General Flood Control Plan updated by the DLNR in 1983.

Relevance to Central O'ahu: The report identifies flood-prone areas and proposed flood control measures. The subareas for the Central O'ahu watershed that are listed in the report include 'Aiea, Kalauao, Waimalu, Waiawa, Waikele, Kapakahi, Honouliuli, and Kalo'i Gulch.

Findings: This report includes the identification of flood-prone areas in the State, an assessment of their hazard potential, flood damage mitigation measures, an inventory of flood control projects, development of general criteria for the selection of flood control projects appropriate for placement of projects on the CIP, development of specific technical criteria for establishing priorities for placement of projects on the CIP, and identification of areas requiring further investigation. Evaluation criteria in determining prioritization includes loss of life, historical and potential damages, land use, extent of flooding, existence and effectiveness of remedial measures, environmental and social concerns, ownership of stream right-of-way, and ownership of lands being flooded.

Recommendations: Eighty-six ongoing projects were listed for five islands, with 10 of them being high priority, 15 being median priority, and 61 being low priority. Within the Central O'ahu study area, the Waikele Berm Enhancement is a priority project.

'Aiea

Improvements upstream of Moanalua Road

Kalauao

3,650 feet of channel improvements

Waimalu

6,300 feet of channel improvements

Waimano

n/a

Waiawa

Earth dam upstream, unlined channelization and realignment

Waikele

Enhancement of existing berm to 100-year level protection

Honouliuli

Flood plain zoning and land treatment

Kalo'i

Flood Plain Zoning

Title: Stream Channel Modifications in Hawai'i
Report No.: 21
Prepared By: U.S. Department of the Interior, U.S. Fish and Wildlife Service
Prepared For: U.S. Department of the Interior, U.S. Fish and Wildlife Service
Date of Publication: 1978

Report Objective(s): To document the extent of stream channelization on all of the islands (including that of Central O'ahu streams) and the negative impact of these structures on native stream biota.

Relevance to Central O'ahu: The report discusses Waikele Stream, the largest channelized stream on O'ahu. The Waikele Stream watershed covers a large portion of the Central O'ahu project area.

Findings: **With increased urban growth from 1945–1978 Hawaii's streams underwent increasing amounts of channelization to protect against flood damage. The report contains a statewide inventory of streams,** a discussion of native species, and a summary report.

Of 366 perennial streams surveyed in Hawai'i, 15% of those have been channelized. Six types of channel modifications were identified:

- lined 40%
- channel realignment and/or vegetation removal 28%
- revetment 24%
- blocked or filled-in channel 5%
- elevated culvert 3%
- extended culvert 1%

Both in numbers and biomass, native species are dominant in most unaltered streams, while exotic species are dominant in altered streams. No native species were collected from lined channels. O'ahu streams carry the highest total of dissolved solids. It can be said that the warming effect of a lined channel is about twice that of a revetment and about four times that of a clearing/realignment. Elevated temperature seems to be related to shallowness, loss of vegetative cover, channel substrate, and strong insolation. Because this report was done in 1978, changes to all of the above information may have occurred.

Most of the Waikele Stream is in its natural flow state. When Waikele Stream reaches the urbanized area near Pearl Harbor, it goes into a cleared, realigned channel, and the main portion flows through an extended culvert then a revetment and terminates in a cleared, realigned portion prior to flowing into the West Loch of Pearl Harbor. The stream contains "common" to "abundant" exotic species and no native species downstream of the first cleared, realigned channel.

Recommendations: None provided.

Title: Trends in Streamflow Characteristics at Long-Term Gauging Stations, Hawai’i Scientific Investigations Report 2004–5080
Report No.: 22
Prepared By: Oki, Delwyn S.
Prepared For: State of Hawai’i, Department of Land and Natural Resources, Commission on Water Resource Management; County of Maui, Department of Water Supply; and U.S. Department of the Interior, U.S. Geological Survey
Date of Publication: 2004

Report Objective(s): To obtain a better understanding of long-term trends and variations in stream flow on the Hawaiian islands.

Relevance to Central O’ahu: This report shows how large-scale atmospheric influences and climate changes can significantly affect surface water and groundwater quality and quantity in the Central O’ahu area.

Findings: This report included an analysis of long-term trends in flows, a description of patterns within the State, and discussion of possible regional factors that are related to the observed trends and variations. This report reviews stream flow quantity from records as far back as 1913. The introduction gives an excellent summary of Oahu’s general climate, rainfall patterns, and surface water characteristics. The report specifically discusses how atmospheric processes such as El Niño and the Pacific Decadal Oscillation, can produce cyclical changes in water resources on O’ahu. There is a strong correlation among streamflow, the Southern Oscillation Index, and the Pacific Decadal Index. The study found that streamflows generally reflect statewide trends in rainfall. Both long -and short-term trends for streamflow were downward. The report notes that long-term downward trends in flows of streams may indicate a reduction in groundwater discharge to streams caused by a long-term decrease in groundwater storage and recharge. This possible reduction could have serious implications for drinking water, habitat, and irrigation availability.

While the study can be used for analysis of O’ahu in general, no flow records from streams within the central O’ahu watershed were analyzed specifically.

Recommendations: None provided.

Title: U.S. Army Garrison Hawai'i, O'ahu Training Areas, Natural Resource Management
Report Number: 23
Prepared By: The Pacific Cooperative Studies Unit, Army Natural Resource Center
Prepared For: U.S. Army Garrison, Hawai'i, Directorate of Public Works, Env. Div.
Date of Publication: August 2004

Report Objective(s): To provide an overview of the actions accomplished under the Scopes of Work between the Pacific Cooperative Studies Unit (PCSU) and the Army. To provide a tool for Natural Resources Staff (NRS) to critically analyze management approaches and efforts and to make recommendations for the next year's work.

Relevance to Central O'ahu: Training areas studied were Mākua, Schofield, Kawaihoa, Kahuku, and Dillingham. A portion of the Schofield Barracks Military Reservation (SBMR) and its off-site area of the Honouliuli Preserve are within the Central O'ahu Watershed. There are three management units (MU) within the SBMR, Ka'ala (one-half of the wet forest atop the summit of Mt. Ka'ala and downslope to the east to 3,200 feet elevation), Pu'u Hāpapa (the top of Pu'u Hāpapa, the first peak south of Kolekole Pass), and Schofield-Waikāne (northern Ko'olau Mountains). Pu'u Hāpapa MU is completely within the Central O'ahu Watershed.

Findings: There are 38 endangered species in the SBMR, six of which are animal species, including the 'elepaio, four tree snail species, and the 'ōpe'ape'a (Hawaiian hoary bat). Pu'u Hāpapa contains the only native forest patch deemed worthy of intensive ecosystem management in Schofield Barracks South (SBS). The habitat in the lower mesic portion is very degraded; single species management is the focus. Pu'u Hāpapa is home to a large population of the endangered *Achatinella mustelina*, and populations of the rare terrestrial snails, *Laminella sanguinea* and *Amastra micans*. There are also three endangered plants. A small fence was constructed in 2003 to protect a population of *Laminella* and *Amastra*. Feral Ungulate Management: There is no monitoring of any ungulate transects within SBS nor is any ungulate control conducted. Weed Management: SBS is a patchwork of weeds and native areas and does not merit weed control. Rare Plant Management: The Hawai'i Natural Heritage Program has been contracted for annual surveys and NRS regularly monitors critical populations as well as conducts threat control, propagation, and reintroduction. Rare Vertebrate Management: Six 'elepaio were believed to be in SBS, all male. Due to the lack of females, predator control methods have never been initiated and monitoring has been inconsistent; however, NRS will assist The Nature Conservancy with monitoring 'elepaio pairs in the Honouliuli Preserve. Rare Invertebrate Management: Rare snail management involves: Surveying to identify new populations, monitoring known populations, and prioritizing and managing known sites.

Recommendations: None.

Title: Waipahu Town Plan, A Special Area Plan of the Central O'ahu Development Plan
Report Number: 24
Prepared By: Wilson Okamoto & Associates, Inc.
Prepared For: City and County of Honolulu Planning Department
Date of Publication: December 1995

Report Objective(s): To document the planning analysis, plan elements, and rationale involved in the formulation of the Special Area Plan.

Relevance to Central O'ahu: Waipahu is within the Central O'ahu region and the Central O'ahu Watershed. Central Oahu's role in Oahu's future growth is to provide lands for diversified agriculture, residential development with a variety of housing types, new employment in existing commercial and industrial area, and to help limit urban development pressures on other rural and urban fringe areas. Any future actions and plans are anticipated to have impact on its watershed.

Findings: In January 1995, Honolulu City Council Resolution No. 94-309. C.D. 1, endorsed the City Planning Department's preparation of a community-based special area plan for Waipahu. The Waipahu Town Plan is to provide comprehensive, long-range objectives to guide land use and public improvements, as well as specific plans for certain improvements, including transportation improvements, which address the needs and concerns of the community and enhance the long-term livability and economic vitality of Waipahu.

Revitalization plans include new investment and increased levels of activity in the traditional commercial and civic center areas; mid-rise development along the transit corridor; and a Transit Corridor to link the Primary Urban Center with the University of Hawai'i West O'ahu Campus and the City of Kapolei. Land use and socio-economic analysis was conducted on land use (ownership, existing uses, current plans), environment (Blast Zone and flood hazards), and economy (economic setting, existing economic and social conditions, and economic trends). Preferred plan: Planning area analysis was based on four categories: high transition zone, medium transition zone, stable areas, and circulation system; land uses and economic activities assessments were undertaken; and a circulation plan with alternative concepts were presented. Urban design plan focused on landscape and open space concepts for Waipahu Town and on design guidelines for the Old Town Commercial Area in the historic town core. Plan implementation would be through a combination of public and private initiatives; the Plan should be the guiding document in development reviews.

Recommendations: Planning objectives: (1)provide opportunities for economic revitalization which generate jobs and attract people to Waipahu while minimizing adverse impacts to existing businesses; (2)provide land uses which are compatible with existing uses and which provide for community needs; (3)promote and preserve Waipahu's plantation and cultural heritage; (4)improve the overall visual appearance and character of Waipahu Town; (5)provide increased opportunities for recreation and near-shore recreation; and (6)improve vehicular access into and within Waipahu. Revisions or amendments may need periodic consideration; the overall Plan should be reviewed at least every five years to coincide with the Development Plan review. The Waipahu Town Plan Task Force should be reconvened to oversee the five-year review.