Draft Environmental Assessment

‘Iao Stream Flood Control Project

Wailuku, Maui, Hawai‘i

US Army Corps of Engineers, Honolulu Engineering District

County of Maui, Department of Public Works

March 2009

TABLE OF CONTENTS

TABLES

FIGURES

APPENDICES

ACRONYMS AND ABBREVIATIONS

°F	degrees Fahrenheit
AAQS	Ambient Air Quality Standards
ALISH	agricultural lands of importance to the State of Hawaiʻi
APC	Air Pollution Control
APE	Area of Potential Effects
AR	Army Regulation
BMPs	Best Management Practices
CAA	Clean Air Act
CDUA	Conservation District Use Application
CDUP	Conservation District Use Permit
CEQ	Council on Environmental Quality
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
cfs	cubic feet per second
CIA	Cultural Impact Assessment
COM	County of Maui
CRM	concrete rubble masonry
CWA	Clean Water Act
CWRM	Commission on Water Resource Management
CZM	Coastal Zone Management
dBA	decibels
DAR	Department of Aquatic Resources
DLNR	Department of Land and Natural Resources
DNL	day-night sound levels
EA	Environmental Assessment
EDR	Engineering Documentation Report
EO	Executive Order
EPA	United States Environmental Protection Agency
ER	Engineer Report
ERDC	Army Engineer Research and Development Center
FEMA	Federal Emergency Management Agency
FIRM	Flood Insurance Rate Map
fps	feet per second
ft	feet
FWCA	Fish and Wildlife Coordination Act
FWPCA	Federal Water Pollution Control Act
GEC	Gulf Engineers and Consultants
GIS	geographical information system
HAR	Hawaiʻi Administrative Rules
HDOA	State of Hawaiʻi Department of Agriculture
HDOH	State of Hawaiʻi Department of Health
HEC-FDA	Hydrologic Engineering Center Flood Damage Analysis
HEC-RAS	Hydrologic Engineering Center River Analysis System
HRS	Hawaiʻi Revised Statutes
HSOP	State of Hawaiʻi Office of Planning
HTRW	hazardous, toxic, and radioactive waste
HUD	Department of Housing and Urban Development
H:V	height to volume

IaA	ʻĪao silty clay, 0 to 3 percent slopes
IbB	ʻĪao cobbly silty clay, 3 to 7 percent slopes
IWR	Institute for Water Resources
JcC	Jaucas sand, saline, 0 to 12 percent slopes
LER	land, easements and/or rights-of-way
MGD	million gallons per day
msl	mean sea level
MVN	New Orleans District of the Corps of Engineers
N	nitrogen
NAAQS	National Ambient Air Quality Standards
NED	National Economic Development
NEPA	National Environmental Policy Act
NHPA	National Historic Preservation Act
NMFS	National Marine Fisheries Service
NPDES	National Pollutant Discharge Elimination System
ns	not specified
O&M	operation and maintenance
OHA	Office of Hawaiian Affairs
OSHA	Occupational Safety and Health Administration
pH	potential of hydrogen
PL	Public Law
PtA	cobbly clay loam, 0 to 3 percent slopes
PW	Department of Public Works
PZUE	Puuone sand, 7 to 30 percent slopes
P&G	Principles and Guidelines (for the WRPA)
P&S	Principles and Standards (for the WRPA)
rSM	stony alluvial land
RCC	roller compacted concrete
SCAP	Stream Channel Alteration Permit
SCS/CRMS, Inc.	Scientific Consultant Services/Cultural Resource Management Services, Inc.
SFRs	single family residential structures
SHPO	State of Hawaiʻi Historic Preservation Officer
SMP	Special Management Area Use Permit
SPF	Standard Project Flood
sq. mi.	square miles
SRP, Inc.	Social Research Pacific, Inc.
TCPs	Traditional Cultural Properties
TMDL	total maximum daily load
TMK	tax map key
USACE	United States Army Corps of Engineers
USC	United States Code
USFWS	United States Fish and Wildlife Service
USGS	United States Geologic Survey
WSEL	Water Surface Elevation
WQC	Water Quality Certification
WRPA	Water Resources Planning Act
%	percent

EXECUTIVE SUMMARY

The United States Army Corps of Engineers (USACE) is conducting an Environmental Assessment (EA) for the modification of the existing 1981 ʻĪao Stream Flood Control Project in Wailuku, Maui, Hawaiʻi. Under the legislative authority of the Flood Control Act of 1948, Section 205, Public Law (PL) 80-858, as amended, 33 United States Code (USC) 701s; PL 93-251, as amended; PL 97-140 and PL 99-662, the USACE is authorized to implement flood damage reduction improvements to the ʻĪao Stream that meet or exceed Standard Project Flood (SPF) requirements to protect the existing Wailuku community.

Proposed Action. Under the "Modification to Completed Projects" Program, a total of five alternatives and a no action alternative are presented. One of the alternatives is recommended based on environmental feasibility and project ability to meet or exceed SPF requirements. The project was designed for SPF protection with a peak design discharge of 27,500 cubic feet per second (cfs) downstream of Station 84+42 (near the ʻImi Kālā Street Bridge, see Figure 3-8) and 26,000 cfs downstream of Station 92+02 (near Spreckles Ditch, see Figure 3-8).

Purpose and Need.

Purpose: The ʻĪao Stream channel was originally modified by the USACE from 1968 through 1981. This original Flood Control Project, completed in October of 1981 has since experienced repeated erosion events that have damaged existing levees, causing undermining and a gradual collapse (Figures 4-4 and 4-5). High stream flows resulted in downcutting of the natural streambed and erosion of the base of the east bank levee structure at the approximate mid-point of the straightened stream channel segment, 1,700 m upstream of the stream mouth (See Section 2.0 for more details). Several residential and commercial structures along the right bank are in danger of being undercut if streambank erosion continues, as is the heiau along the lower reach of the left bank. Erosion caused by high flow events has been partially repaired with concrete rubble masonry (CRM), however these repairs have subsequently suffered from additional erosion. The purpose of the proposed ʻĪao Stream Flood Control Project is to correct deficiencies associated with the existing Flood Control Project constructed in 1981. Frequent repairs have proved to be costly and do not adequately address the problem.

Need: Modifications to the 1981 Flood Control Project are needed to prevent further property damage resulting from undermining of stream bank and levee locations, and to protect Wailuku town from flood damage. In addition, levee certification that the completed project can withstand a 100-year frequency flood is required by the Federal Emergency Management Agency (FEMA) by February 2009; otherwise, the area protected by the project will revert to a flood hazard area in the Fall of 2009. A government agency responsible for levee construction or a Registered Professional Engineer must provide this certification. In its present condition, the project cannot be certified as providing 100-year flood protection because the project is deficient as outlined in this report. Therefore, the USACE has analyzed five alternatives and a no action alternative to modify the existing ʻĪao Stream Flood Control Project and prevent further high levels of streambed erosion, loss of life, and property damage during flood seasons.

Alternatives. The proposed alternatives are: I) Trapezoidal Concrete-Lined Channel, II) Rectangular and Compound Channel, III) Roller Compacted Concrete (RCC) and Boulder Invert Channel Following Existing Alignment, IV) Levee Reconstruction, V) Removal of Flood Control Improvements, and VI) No Action. Alternatives II and IV do not meet the project objectives and were not carried on for further analysis. Although Alternative VI is not a possible solution, it will be discussed throughout the document to provide a view of the "without project" scenario.

In response to public comment during the scoping phase of the Draft EA, the USACE will be working with the local sponsor of the project, the County of Maui (COM) Department of Public Works (PW), to look into recreational possibilities to be incorporated with the chosen alternative, such as jogging and walking paths along the levees.

Recommended Alternative. Alternative III is the recommended plan, as it would best resolve the project's design deficiency with the least amount of negative fiscal and environmental impacts and greatest net benefits. It includes RCC lining of 7,200 ft of stream and raising the existing levee using CRM (See Section 3.0). A recharge basin and diversion levee were considered for incorporation into the project approximately 1,100 ft upstream of Market Street to address the public comments concerning existing drought conditions on Maui, but were dropped from consideration following the recommendation of United States Fish and Wildlife Services (USFWS) and Department of Land and Natural Resources (DLNR) Department of Aquatic Resources (DAR) personnel that these features' presence would have negative impacts on aquatic organisms. Alternative III also includes a low-flow channel that is also designed to facilitate upstream and downstream migration of native organisms during periods of low water flow. Mitigation measures agreed upon by the USACE, USFWS, and the COM include alignment of the low-flow channel along vegetated stream banks to allow existing overhanging vegetation to shade the channel and reduce water temperatures, and a retrofit of improved portions of the channel that are currently lacking low-flow design elements or that pose a challenge to migrating aquatic organisms.

Affected Environment and Potential Impacts. Potential negative impacts include short-term, long-term, and cumulative impacts of Alternatives I, III and V, although the negative impacts for Alternative III have been minimized by the incorporation of several mitigation measures. The majority of the concerns regarding potential negative environmental impacts were raised by the USFWS in its 2(b) report. During subsequent discussions between the USFWS and the USACE, these concerns were addressed by collectively devising mitigation measures which have been agreed to by the USFWS in a revised mitigation recommendation letter (Appendix J). Alternative VI represents the current scenario, and thus would result in no new significant environmental impacts due to no action being taken. The current levels of erosion and sedimentation would continue, however, along with the risk of flooding to the community.

Geology and Soils. While some degree of sedimentation is natural for any stream system, the 'Īao Stream in its current state is experiencing extreme streambank erosion (i.e., 6 to 8 ft below the 1983 repairs) that leads to excessive sedimentation during high water flow storm events. Alternatives I and III would effectively eliminate the excessive erosion and associated sedimentation, while Alternative V would exacerbate the current situation. All three alternatives would have short-term sedimentation impacts during construction, although these can be mitigated through the incorporation of best management practices (BMPs) by the construction contractor. Alternative VI would allow the continued streambank erosion and sedimentation of 'Īao Stream because no action would be taken.

Oceanography, Hydrology, and Flooding. Alternatives I and III would effectively eliminate potential flood damage to the Wailuku community and surrounding areas. Implementation of either alternative is not expected to adversely affect oceanographic characteristics of the area, adjacent beaches, or the inshore water circulation patterns. Alternative I could negatively impact groundwater recharge due to its elimination of the existing flood plain and hardening of an additional 7,200 ft of channel. Alternative III also hardens the 7,200 ft of channel, but mitigates this by incorporating weepholes in the RCC and keeping the existing flood plain. As a direct result of water diversion features upstream from the project area, the stream basin is currently characterized by an absence of water 80 to 90 % of the time. Alternative III's invert channel is designed to collect and facilitate groundwater movement during periods of low water flow.

Alternative V would return the stream to its natural condition prior to 1981, facilitating groundwater recharge but allowing further streambank erosion as well as the possibility of major flooding to occur. Alternative VI would take no corrective action on the current state of the stream and streambank erosion would continue to occur. While some degree of streambank flooding is natural for any stream system, in the case of the 'Īao Stream this flooding can lead to a loss of life and property.

Water Quality. A short-term increase in turbidity is inevitable if water is flowing in the stream during construction for all proposed alternatives. The general contractor is required to use silt containment devices and other effective methods to control turbidity to the maximum extent practicable. The USACE will monitor the marine water quality at the mouth of the stream before, during, and after construction to assure water quality standards are not exceeded.

Sampling and analysis was performed at four locations in the near shore ocean off of the mouth of the ‘Īao Stream. Turbidity and potential of hydrogen (pH) were similar at all stations. Near shore waters in the sampling area were turbid with very limited visibility due to strong winds and large waves caused by consistent northeasterly trade winds and currents. While some level of sedimentation is natural for any stream system, current levels of sedimentation in the stream are likely elevated following storm events due to the excessive level of streambank erosion experienced during storm events, which may lead to an increase in sedimentation of Kahului Bay if sufficient water is flowing continuously to the ocean. Alternatives I and III would reduce the increased sedimentation that results from stream bank erosion during high water flow or flood events. Alternatives V and VI would not only continue the current amount of sedimentation in the stream during storm events, but would exacerbate the erosion of streambanks and in turn increase the sedimentation of Kahului Bay if sufficient water were flowing continuously through the stream to the ocean.

<u>Terrestrial and Aquatic Biological Resources.</u> The proposed alternatives will subject terrestrial and riparian species to minimal adverse impacts. The stream is currently used by aquatic organisms that undergo upstream and downstream migration for breeding and metamorphosis. Under current conditions (Alternative VI), a limited number of upstream migrating fish and invertebrates successfully ascend thorough the channel to middle and upper reaches of the stream. The number of successfully migrating organisms is limited due to the lack of water in the stream 80 to 90% of the time. Aquatic species are susceptible to changes in stream flow due to their amphidromous life cycle. Alternative I would negatively impact the aquatic fauna with the proposed smooth concrete channel. Alternative III would have some negative impacts to aquatic species habitat, although these have been mitigated to the maximum extent practicable by incorporating a low flow boulder channel to replicate a more natural stream and design elements to facilitate the movement of aquatic organisms through the modified channel area. Alternative III mitigation measures currently under discussion between the USACE, USFWS, and the COM include alignment of the low-flow channel along vegetated stream banks to allow overhanging vegetation to shade the channel and reduce water temperatures, and a retrofit of improved portions of the channel that are currently lacking low-flow design elements or that pose a challenge to migrating aquatic organisms.

Alternative V would revert the stream back to its natural state and might enhance the aquatic fauna, however it would also lead to flooding of the community. Contaminants could be introduced into the stream during storm and flooding events.

The draft FWCA report noted the presence of coral reef ecosystems within Kahului Bay, near the mouth of the ʻĪao Stream. Coral ecosystems are sensitive to excessive sedimentation. Short-term construction for all alternatives could result in an increase in turbidity in ʻĪao Stream as well as a potential increase in sedimentation of Kahului Bay, although this would be mitigated with engineering controls and BMPs. Alternatives I and III would provide a long-term reduction in sedimentation by eliminating the current excessive streambank erosion occurring within the ʻĪao Stream during high rainfall and flood events, while Alternative V would most likely not eliminate the excessive erosion problem.

Wetland maps maintained by the USFWS indicate the potential presence of wetlands in the vicinity of the proposed project, particularly on the flood plain, which is currently used for agricultural and residential use. These potential wetlands have not been field verified or jurisdictionally delineated. Alternative I would open the flood plain up for development, while Alternatives III and V retain the flood plain in a natural state. Any development of the floodplain would first require an investigation of whether any wetlands do indeed exist. Alternative III's project modifications are designed to take place within the existing flood control project limits, thus no wetlands issues have been identified with this alternative.

Threatened and Endangered Species. The USFWS and National Marine Fisheries Service (NMFS) have concurred with the USACE's determination that no known federally listed endangered or threatened biota or their critical habitats occur within the study area. Formal consultation under Section 7 of the Endangered Species Act is therefore not required. The USFWS stated that there is a potential existence of two candidate species of insects in the project area, although this has not been confirmed by field studies.

Historic and Cultural Resources. Studies indicate that there are no significant archaeological sites or traditional cultural properties within the Area of Potential Effects (APE). No further archaeological investigation is necessary. As a mitigation measure, the USACE will include monitoring by a qualified archaeologist during construction associated with the widening of the stream to accommodate the proposed improvement of the ʻImi Kālā Street Bridge.

Implementation of any available alternatives will not impact known historic or cultural resources. Interviews conducted during a cultural impacts assessment in 2003 found that any proposed flood control related projects create concern for residents regarding possible water diversion, erosion, and adverse impacts to the natural environment. Possible cultural impacts include potentially negative reactions from the Wailuku community to Alternatives I and III, and a positive reaction to Alternative V. A public scoping meeting was held on August 12, 2003 to address these public concerns. Consultation with resource agencies has been pursued throughout the course of this project, and will continue throughout the design and construction phases of the project to ensure all environmental concerns are being addressed and mitigated to the maximum extent practicable. This will be conveyed to the Wailuku community.

Section 106 consultation has been initiated with the State of Hawai‘i Historic Preservation Office (SHPO), the Office of Hawaiian Affairs (OHA), the County of Maui Cultural Resources Commission, the Central Maui Hawaiian Civic Club, and the President of the Association of Hawaiian Civic Clubs. The USACE sent a letter to these parties indicating that a “no adverse effect” determination had been made. Consultation is ongoing. Any further developments will be addressed and included in the final EA.

Land Use and Visual Resources. Short term land use impacts may be generated from construction activities limiting access to and from public areas. USACE will work closely with local police and fire authorities and provide early planning for alternate routes, as well as traffic control. With the exception of Alternative V, no adverse land use impacts are expected, as Alternatives I and III do not encroach into developed areas of the Wailuku community. Alternatives V and VI will result in long-term erosion and private property damage to key parcels of land along the stream.

Aesthetic impacts differ depending on the alternative chosen. Alternatives I and III would remove 70% of the remaining natural alluvial channel of the stream, adversely impacting the aesthetic quality of the stream. Alternative III mitigates this to the maximum extent practicable by providing a more visually appealing low-flow channel and maintaining stream-side vegetation, though the RCC channel walls and levee raises will impact the existing aesthetic natural quality of the stream. Alternative V would effectively remove all man-made flood control improvements since 1981. With time, the stream would be restored to a completely natural condition which could potentially become more aesthetically pleasing than its current state. With no flood control protection however, local residents and businesses would be subject to flood damage to properties and potential loss of life. Alternative VI would make no changes to the current conditions of ‘Īao Stream.

The flood plain is designated agricultural lands by the State of Hawaii, and current uses of this area are a mix of residential and agricultural use. Alternatives III and V retain the flood plain, while Alternative I would allow the flood plain to be used for development.

Land use in the area has transitioned from primarily sugarcane agriculture to alternative crops as well as commercial and residential development. As a result, there may not be a need to divert the same amount of water from the ‘Īao Stream as was necessary to support sugarcane growth.

Hazardous, Toxic, and Radioactive Waste (HTRW). The HTRW initial assessment was conducted under the USACE regulations (Engineer Report (ER) 1165-2-132) in 1997. The results of the report have indicated that there are no existing or previous HTRW activities located in the project area. The ʻĪao Stream basin has not been designated as a Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) action site, and no spills or other HTRW activity has been known to have affected the project area in the past. All available alternatives, with the exception of Alternative VI, will consist of excavation of materials from the stream channel and its margins. As the project area does not contain HTRW materials, the excavated material is not deemed hazardous. Excess quantities of the excavated materials will be subject to testing and evaluation for suitability of disposal in accordance with the United States Environmental Protection Agency (EPA) before disposal in the COM landfill. Therefore, no potentially damaging impacts will befall the surrounding environment.

Noise. Noise levels will be temporarily increased during construction for all proposed alternatives due to the operation of heavy construction equipment. Implementation of BMPs and compliance with applicable Federal, state, and local laws as indicated in Section 5.8 will mitigate construction noise levels to acceptable levels. Prior to construction activities, a permit will be obtained from the State of Hawaiʻi Department of Health (HDOH) for operation of construction equipment, power tools, and vehicles which will emit noise levels in excess of the allowable limits. Alternative VI would result in continued short-term construction noise during continuous repair activities. There are no foreseeable long-term noise issues with any of the proposed alternatives and noise studies were not conducted for this project.

Air Quality. For all available alternatives, short-term dust and vehicle exhaust emissions will be present in the project area due to construction activities. These effects are temporary, however, and only affect the area within the vicinity of the project so long as the contractor is required to strictly adhere to implementing all necessary measures to ensure containment of dust on the construction site. Mitigation measures include the use of BMPs as well as strict adherence to Hawaiʻi Administrative Rules (HAR) Title 11, Chapter 59 and 60.1 for Ambient Air Quality Standards (AAQS) and Air Pollution Control (APC) respectively. On-site emissions generated from construction equipment emit nitrogen oxides and carbon monoxide. Standards for nitrogen dioxide set by the National Ambient Air Quality Standards (NAAQS) are on an annual basis, and short-term construction is not likely to violate set annual standards. Carbon monoxide emissions will be very low and should be insignificant compared to normal vehicular emissions.

Traffic. The proposed alternative designs, with the exception of Alternative VI, consist of modifications to the existing flood channel and do not consist of new land uses, structures, or developments that would require additional infrastructure needs. Therefore the available alternatives will not affect existing traffic conditions. COM, in cooperation with a private developer, is planning to replace the ʻImi Kālā Street bridge and extend ʻImi Kālā Street to connect to Kahekili Highway. This will likely change the traffic patterns in the vicinity of the ʻImi Kālā Street Bridge. As there are no foreseeable impacts to existing traffic conditions from the alternatives however, a study was not conducted for this purpose. Alternative VI would have no impact of the current traffic conditions.

Recreation and Resource Use. Alternative I would create adverse impacts on the natural quality of the ʻĪao stream, impacting existing recreational resources along the stream in the long term. Alternative III also would create some impacts to the natural quality of the stream, although these impacts have been mitigated somewhat by the incorporation of RCC and stream-side vegetation. In response to public comments during the public scoping period, the USACE is currently working with the PW to look into recreational possibilities to be incorporated with the chosen alternative, such as jogging and walking paths along the levees, similar to the Kawainui Marsh in Kailua, Oahu. Alternative V would remove all man-made improvements and allow ʻĪao Stream to return to a completely natural state and might enhance the recreational quality of the stream area. However, the lack of flood control devices could limit recreational activities for safety reasons. Alternative VI would not change any of the current conditions. Over the long-term, the accessibility to ʻĪao Stream would be impacted due to inadequate flood control.

Economic and Social Resources, and Environmental Justice. All available alternatives will generate short-term economic vitality for the island by providing temporary construction jobs. Alternative I would provide long term positive economic prosperity to the growing community of Wailuku by mitigating flood events and eliminating ongoing stream bank erosion. As part of this alternative, the existing left flood plain area may be utilized for future development opportunities by COM.

Alternative III is designed to provide a SPF level of protection by constructing a new low-flow channel, hardening the existing banks with RCC, raising levees, and incorporating the existing flood plain as is. In the long term, these measures will prevent damages to life and property, allow for development and growth of the community with minimal modifications, and will remain less intrusive to the existing environment. The proposed concrete channel lining for Alternatives I and III may negatively impact the visual quality of ʻĪao Stream. This may detract potential visitors, although this is unlikely considering the well-known ʻĪao Valley tourist attraction is located approximately 2 miles from the top of the project area.

Alternative V would effectively remove all man-made flood control improvements since 1981, and the Wailuku community would be provided a flood-warning system in place of flood control improvements.

This alternative does not provide tangible flood control for the community and may hinder future development in the area. Loss of life would be possible and damage to property would be inevitable.

Alternative VI would not change any of the current conditions, and the area would return to a Flood Hazard Area in the fall of 2009. Alternative VI would be a fiscal strain on the government to provide flood related assistance. This alternative does not provide tangible flood control for the community and may hinder future development in the area. Loss of life would be possible and damage to property would be inevitable.

An assessment of possible adverse impacts resulting from implementation of any of the available alternatives indicates there are no disproportionate negative impacts toward minority and low-income populations (Executive Order (EO) 12898).

Accessibility for Maintenance. In its current state, the 'Īao Stream requires regular channel repair by bulldozers, particularly after every storm event. Eroded material is also removed from the concrete channel located under the Waiehu Beach Road Bridge. Alternative VI would leave 'Īao Stream in this current condition. The need for maintenance would be lessened if Alternative I or III were implemented.

Alternative I would be the easiest to maintain, while Alternative III would be more difficult due to the grouted boulder invert channel and potential vegetative growth. Alternative V would return the stream to a natural state, and thus would not require maintenance. However, this alternative does not meet the project objectives of flood and erosion control.

Cumulative Impacts. Alternative I would modify the existing flood channel system to prevent inevitable project failure, the loss of life, and extensive property damage. Positive cumulative impacts created by these modifications including social/economic growth without hindrance from seasonal flooding. Government fiscal resources would not be strained to provide repairs and emergency support for flood damage to persons and properties. Alternative I, however, would adversely impact the aquatic fauna of the 'Īao Stream by removal of the natural streambed, leading to long-term deterioration of the existing aquatic fauna as well as adverse impacts to the scenic quality of the 'Īao Stream. This may in turn affect tourism and the economy.

Alternative III has the least adverse impacts as the proposed grouted boulder invert channel will follow the existing stream alignment, use RCC side slopes, and retain streambank vegetation. This will provide a more habitable area for existing aquatic fauna, but will still cause some degree of visual impact. Mitigation measures proposed by the USACE include alignment of the low-flow channel along vegetated stream banks to allow overhanging vegetation to shade the channel and reduce water temperatures, and a retrofit of improved portions of the channel that are currently lacking low-flow design elements (refer to Section 3, Appendix I, and Appendix J for a more detailed description of retrofit mitigation measures proposed). In the long-term, this alternative provides a means of enabling upstream migration of aquatic organisms, preserving streambank vegetation, and using grouted boulders to replicate a more natural looking stream. Although this alternative represents an alteration of a natural stream system to a concrete-lined channel, the design elements mitigate the impacts to the maximum extent practicable. The USFWS has indicated their concurrence with these mitigation measures in a revised mitigation recommendation letter (Appendix J). Potential cumulative impacts from the ʻImi Kālā Street Bridge replacement and ʻImi Kālā Street extension, as well as the Hale Mua affordable housing subdivision planned by COM may include increased traffic in the vicinity of the project, although the project itself would not generate additional long-term traffic.

Alternative V would allow the ʻĪao Stream to return to its natural state; with the use of a state-of-the-art flood warning system, lives may be saved but property damage will be inevitable. The inconvenience and cost of repairs are serious public health and safety issues in the long term. If this alternative was pursued, the project would incur heavy costs to relocate residents living within the flood-prone areas. These additional costs contribute to the many factors that make Alternative V an unacceptable option.

Alternative VI would leave ʻĪao Stream in its current condition. Severe erosion would continue, contributing to levee failure in multiple locations, which would eventually lead to flooding of the ʻĪao Stream drainage basin. Alternative VI would be a long-term inconvenience and fiscal strain on the government to provide flood related assistance. This alternative does not provide tangible flood control for the community and may hinder future development in the area. Loss of life would be possible and damage to property would be inevitable..

<u>Irreversible and Irretrievable Commitment of Resources.</u> The USACE believes that project modification cannot be avoided due to the need to provide flood control for the Wailuku community. Implementation of the recommended alternative will prevent otherwise inevitable project failure and thus prevent the potential loss of life and property.

Alternative I – Long term negative impacts include visual and environmental degradation of the ʻĪao Stream which may affect the tourist economy. Natural resources impacted are limited to existing aquatic species, which will not be able to adapt to the increased flow speed of water in the channel brought upon by the concrete lining.

Alternative III – Long term negative impacts of visual and environmental degradation of the stream are minimized by mitigation measures. The natural portion of the stream is currently characterized by boulders and weeds, but a lack of water flow up to 90% of the time (Figures 4-4 and 4-5). With Alternative III, this middle reach of the ‘Īao Stream would be converted to an RCC-lined section similar to the downstream and upstream portions of the stream (Figures 4-4 and 4-5). The low-flow channel incorporated into this alternative is designed to minimize habitat loss for existing aquatic species in the stream as well as provide an opportunity for migration of aquatic organisms during low water flow events. Incorporating stones into the concrete lined channel will provide a less negative visual impact to the natural character of the stream, although it will not be as aesthetically pleasing as a natural stream. Retaining the existing managed flood plain would facilitate groundwater recharge. Success of this alternative will also rest upon mitigation measures including alignment of the low-flow channel along vegetated stream banks to allow overhanging vegetation to shade the channel and reduce water temperatures, and a retrofit of improved portions of the channel that are currently lacking low-flow design elements (Appendix I and Appendix J).

Alternative V – Resources invested in the removal of all man-made flood control structures and relocation of residents in flood-prone areas would be irreversible. Replaced by a state-of-the-art flood warning system, the natural environment of the ‘Īao Stream would be returned, at the cost of loss of property, and possibly life, in future flood events.

Alternative VI – Since no action would be taken, over the long-term there would be inconvenience and fiscal strain on the government to provide repairs relating to flood related issues. This alternative does not provide tangible flood control for the community and may hinder future development in the area. Loss of life would be possible and damage to property would be inevitable.

Probable Adverse Environmental Effects Which Cannot Be Avoided. Alternatives I and III will impact the existing stream environment with flood control improvements, although the impacts of Alternative III will be minimized or compensator for by mitigation measures. Alternatives V and VI would impact the existing community with floods. For Alternatives I and III, changes in the visual appearance of the stream may be viewed as adverse by some individuals. Alternative III will minimize visual impacts by incorporating boulders in the low-flow channel that mimic the natural character of the stream . For all alternatives, temporary noise and sedimentation impacts during construction or repairs are unavoidable. Possible sedimentation can be mitigated through the use of BMPs during construction. The probable impacts of Alternative III are unavoidable but can be mitigated. The proposed compensatory mitigation measures have been agreed to in a revised mitigation recommendation letter by the USFWS (Appendix J).

Risk and Uncertainty. The USACE believes that the project modification cannot be avoided due to the need to provide flood control for the Wailuku community. Implementation of the recommended alternative (Alternative III) will prevent otherwise inevitable project failure and thereby prevent the loss of life and property. Both Alternatives I and III will achieve the project objective and prevent substantial damages to life and property in the long term. Alternative I however, may negatively impact the existing natural environment of ʻĪao Stream, leading to degradation of aquatic fauna and eventually the aesthetic quality of the stream as a whole. The proposed concrete lining of 70% of the remaining natural alluvial channel may adversely affect tourism and the economic viability of ʻĪao Valley, as it is a well-known attraction on Maui, although this is unlikely considering the 2-mile separation between the project area and the tourist attraction area. Alternative III will provide a more environmentally friendly design with integration of boulders to mimic the natural habitat of the ʻĪao Stream and the inclusion of a low-flow channel with design elements to enable migration of aquatic organisms. Not only will the aquatic fauna have an environment in which to survive, but the stream itself will appear more natural and aesthetically pleasing. Survival of aquatic organisms will depend on proposed mitigation measures. Alternative VI leaves the stream in its current state, and the area would return to a Flood Hazard Area in the fall of 2009. Alternative V eliminates all flood control, and is a high risk option.

Economic Analysis. The SPF floodplain is estimated to contain 362 single family residencies, 45 multi-unit residential structures containing 464 condominium units, and 105 tax map parcels with one or more commercial structures. The estimated replacement cost less depreciation value for commercial and residential structures is $194 million, and the estimated value of damageable contents is $164 million (Appendix K), using 2007 property tax assessed values. The benefits of the project, in terms of damages or costs prevented, are calculated by comparing the without-project damages and/or costs to the with-project damages and/or costs. The benefits summary conducted as part of the economic analysis shows an annual total of approximately $2,572,000 in damages and/or costs prevented, as compared to the without-project condition. The greatest benefits are estimated from residential and commercial structures and contents (ibid).

It is a comparison of an alternative's total average annual benefits and total average annual costs that determines its economic viability from a federal standpoint. The federal government will consider participating in the construction of the alternatives with benefit-cost ratios greater than one. The alternative with the highest net benefits is chosen as the recommended alternative from among the viable plans with benefit-cost ratios greater than one.

Alternative III has the highest net benefits of the alternatives analyzed, as well as a benefit-cost ratio greater than one, is considered the National Economic Development (NED) Alternative Recommended Plan.

Comments and Coordination. Public participation is organized in the form of public posting and agency consultations. Public posting as well as individual notices were mailed to Federal, state, and county resource agencies in 1996 through 1997. A public scoping meeting was held on August 12, 2003. Notification of the meeting was circulated via posting of the meeting notice in the daily paper, the *Maui News*. Meeting notices were also mailed to potential stakeholders and community associations. The scoping meeting was held at the Wailuku Community Center. A public informational meeting is planned for the review of the draft Environmental Assessment report.

Permits and Approvals. The following are required permits and approvals for the proposed project. Section 401 State Water Quality Certification (WQC); Section 401(b)1 Analysis, National Pollutant Discharge Elimination System (NPDES) permit; Coastal Zone Management Consistency Determination; Stream Channel Alteration Permit (SCAP); State Conservation District Use Application (CDUA); and Special Management Area Use Permit (SMP).

Table ES-1 provides a summary of the potential impacts and mitigation measures associated with each alternative.

This page is intentionally left blank.

Table ES-1. SUMMARY OF ENVIRONMENTAL IMPACTS AND PROPOSED MITIGATION			
Geology and Soils			
Alternative	Impact	Section	Proposed Mitigation
I	Short-term construction sedimentation Long-term reduce shoreline erosion	4.1	BMPs and appropriate permits and regulations to minimize turbidity.
III	Short-term construction sedimentation Long-term reduce shoreline erosion and reduce sediment load		BMPs and appropriate permits and regulations to minimize turbidity.
V	Short-term construction sedimentation Long-term erosion and sedimentation		BMPs and appropriate permits and regulations to minimize turbidity. None
VI	Long-term erosion and sedimentation		N/A
Oceanography, Hydrology and Flooding			
Alternative	Impact	Section	Proposed Mitigation
I	Eliminate Flooding. Potentially impact groundwater recharge.	4.4	N/A None
III	Eliminate Flooding.		N/A
V	Erosion and sedimentation impact ocean		None
VI	Erosion and sedimentation impact ocean		None
Water Quality			
Alternative	Impact	Section	Proposed Mitigation
I	Short-term construction sedimentation Long-term reduce shoreline erosion	4.5	BMPs and appropriate permits and regulations to minimize turbidity.
III	Short-term construction sedimentation Long-term reduce shoreline erosion and reduce sediment load		BMPs and appropriate permits and regulations to minimize turbidity.
V	Short-term construction sedimentation Long-term erosion and sedimentation		BMPs and appropriate permits and regulations to minimize turbidity. None
VI	Long-term erosion and sedimentation		N/A
Terrestrial and Aquatic Biological Resources			
Alternative	Impact	Section	Proposed Mitigation
I	Adverse impact to aquatic species	4.6	Baffle Blocks & Drop Structures
III	Minimal adverse impact to aquatic species		Baffle Blocks & Drop Structures; low-flow channel; align low-flow channel close to bank and maintain adequate vegetation to shade; retrofit measures.
V	No impact		N/A
VI	No impact		N/A

Table ES-1. SUMMARY OF ENVIRONMENTAL IMPACTS AND PROPOSED MITIGATION			
Threatened and Endangered Species			
Alternative	Impact	Section	Proposed Mitigation
I	No impact	4.7	N/A
III	No impact		N/A
V	No impact		N/A
VI	No impact		N/A
Historic, Cultural Resources			
Alternative	Impact	Section	Proposed Mitigation
I	No impact on historic resources, adverse cultural impact from current residents	5.1	Cultural resources construction monitoring by a qualified archaeologist, additional public informational meeting. Ongoing consultation with resource agencies, transparency with community.
III	No historic impact, adverse cultural impact from current residents		Cultural resources construction monitoring by a qualified archaeologist, additional public informational meeting. Ongoing consultation with resource agencies, transparency with community.
V	No impact		N/A
VI	No impact		N/A
Land Use and Visual Resources			
Alternative	Impact	Section	Proposed Mitigation
I	Adverse visual impact from concrete channel	5.2	Proposed recreational features along 'Īao Stream.
III	Minimal adverse visual impact		Low-flow channel with grouted boulders to mimic natural stream habitat; Proposed recreational features along 'Īao Stream.
V	Positive visual impact		N/A
VI	Minimal adverse impact		None
Hazardous, Toxic and Radioactive Waste (HTRW)			
Alternative	Impact	Section	Proposed Mitigation
III	No impact	5.3	N/A
V	No impact		N/A
VI	No impact		N/A
Noise			
Alternative	Impact	Section	Proposed Mitigation
I	Short-term construction noise	5.4	BMPs, contractor to strictly adhere to construction monitoring plan, proper maintenance of heavy equipment, appropriate permits and regulations.
III	Short-term construction noise		BMPs, contractor to strictly adhere to construction monitoring plan, proper

Table ES-1. SUMMARY OF ENVIRONMENTAL IMPACTS AND PROPOSED MITIGATION			
			maintenance of heavy equipment, appropriate permits and regulations.
V	Short-term construction noise		BMPs, contractor to strictly adhere to construction monitoring plan, proper maintenance of heavy equipment, appropriate permits and regulations.
VI	Short-term noise during continuous repairs		None
Air Quality			
Alternative	Impact	Section	Proposed Mitigation
I	Short-term construction fugitive dust	5.5	BMPs, contractor to strictly adhere to agreed upon dust control measures, (also add measure to control odor) and appropriate permits and regulations.
III	Short-term construction fugitive dust		BMPs, contractor to strictly adhere to agreed upon dust control measures, (also add measure to control odor) and appropriate permits and regulations.
V	Short-term construction fugitive dust		BMPs, contractor to strictly adhere to agreed upon dust control measures, (also add measure to control odor) and appropriate permits and regulations.
VI	No impact		N/A
Traffic			
Alternative	Impact	Section	Proposed Mitigation
I	No Impacts	5.6	N/A
III	No Impacts		N/A
V	No Impacts		N/A
VI	No impact		N/A
Recreation and Resource Use			
Alternative	Impact	Section	Proposed Mitigation
I	♦ Short-term construction impacts related to accessibility of public areas. ♦ Long-term aesthetic impacts to existing recreational areas.	5.7	♦ Preplanning of alternate routes and police officers to direct traffic during construction periods. ♦ Added recreational features are being proposed to be incorporated into alternative.
III	♦ Short-term construction impacts related to accessibility of public areas. ♦ Minimal long-term aesthetic impacts to existing recreational areas.		♦ Preplanning of alternate routes and police officers to direct traffic during construction periods. ♦ Added recreational features are being proposed to be incorporated into alternative.
V	♦ Short-term construction impacts related to accessibility of public areas. ♦ Long-term impacts to accessibility of areas due to lack of flood control devices.		♦ Preplanning of alternate routes and police officers to direct traffic during construction periods. ♦ Proposed recreational features may be limited due to lack of flood control devices.
VI	Long-term impacts to accessibility of areas		Recreational use may be limited due to inadequate flood control.

Table ES-1. SUMMARY OF ENVIRONMENTAL IMPACTS AND PROPOSED MITIGATION			
	due to inadequate flood control.		
Economic and Social Resources and E.O. 12898			
Alternative	Impact	Section	Proposed Mitigation
I	♦ Short term economic vitality from construction. ♦ Long term protection from floods brings economic and social prosperity. Aesthetics of the stream is detracted and may adversely affect tourism.	5.8	Added recreational features are being proposed to be incorporated into alternative for long-term recreational value.
III	♦ Short term economic vitality from construction. ♦ Long term protection from floods brings economic and social prosperity. Minimal adverse aesthetic features may affect tourism.		Added recreational features are being proposed to be incorporated into alternative for long-term recreational value.
V	♦ Hinder future development in addition to possible loss of life and damage to property. ♦ Fiscal strain on government to provide flood related assistance.		State of the art flood warning system.
VI	♦ Hinder future development in addition to possible loss of life and damage to property. ♦ Fiscal strain on government to provide flood related assistance.		None
Cumulative Impacts			
Alternative	Impact	Section	Proposed Mitigation
I	♦ Long term protection from floods brings economic and social prosperity. ♦ Adverse impact to aquatic fauna leading to long-term deterioration of scenic quality, may in turn affect tourism and the economy. ♦ Potential impacts on traffic from ʻImi Kālā Bridge replacement, road extension and Hale Mua affordable housing subdivision.	5.10	Added recreational features are being proposed to be incorporated into alternative for long-term recreational value. None No traffic impacts attributable to the proposed projects are anticipated.
III	♦ Long term protection from floods brings		Added recreational features are being proposed to be incorporated into

Table ES-1. SUMMARY OF ENVIRONMENTAL IMPACTS AND PROPOSED MITIGATION			
	economic and social prosperity. ♦ Minimal adverse impact to aquatic fauna and scenic quality. ♦ Potential impacts on traffic from ʻImi Kālā Bridge replacement, road extension and Hale Mua affordable housing subdivision.		alternative for long-term recreational value. Low-flow invert channel; maintenance of vegetation to reduce water temperatures, retrofit measures. No traffic impacts attributable to the proposed projects are anticipated. Alternative III incorporates design elements to support the proposed bridge replacement.
V	♦ High possibility of loss of life and property damage. Long-term inconvenience and fiscal stress on government and the community for flood related issues. ♦ Positive impact to aquatic fauna and scenic quality as all man-made structures are removed and stream is returned to natural state.		State of the art flood warning system.
VI	♦ Possibility of loss of life and property damage. Long-term inconvenience and fiscal stress on government and the community for flood related issues.		None
Irreversible and Irretrievable Commitment of Resources			
Alternative	Impact	Section	Proposed Mitigation
I	♦ Labor and fiscal resources ♦ Adverse impact to aquatic fauna leading to long-term deterioration of natural resources.	5.11	N/A
III	♦ Labor and fiscal resources ♦ Minimal adverse impact to aquatic fauna lessens impact of deterioration to natural resources.		N/A Low-flow invert channel; maintenance of vegetation to reduce water temperatures, retrofit measures.
V	♦ Labor and fiscal resources ♦ Possible loss of life/property damage ♦ Fiscal strain on government to provide flood related assistance.		N/A
VI	♦ Labor and fiscal resources ♦ Possible loss of life/property damage		N/A

Table ES-1. SUMMARY OF ENVIRONMENTAL IMPACTS AND PROPOSED MITIGATION			
	♦ Fiscal strain on government to provide flood related assistance.		
Probable Adverse Environmental Effects Which Cannot Be Avoided			
Alternative	Impact	Section	Proposed Mitigation
I	♦ Short-term adverse impacts from construction: noise, air, and water. ♦ Visual changes to stream by increase in area covered by concrete lining resulting in harsher, less natural environment.	5.12	BMPs, contractor will be required to strictly adhere to state and county construction noise and air quality standards, and appropriate permits and regulations. Construction equipment will need to be maintained in good working order at all times.
III	♦ Short-term adverse impacts from construction: noise, air, and water. ♦ Minimal visual changes to stream from impact to natural environment.		BMPs, contractor will be required to strictly adhere to state and county construction noise and air quality standards, and appropriate permits and regulations. Visual changes mitigated by using stones to approximate natural appearance of the stream. Facilitates groundwater recharge by retaining the floodplain and incorporating weepholes. Maintain adequate vegetation to provide shade and reduce water temperatures. Retrofit measures.
V	♦ Short-term adverse impacts from construction: noise, air, and water. ♦ Positive environmental effects to enhance visual quality of stream.		BMPs, contractor will be required to strictly adhere to state and county construction noise and air quality standards, and appropriate permits and regulations.
VI	♦ Long term adverse impacts from erosion and sedimentation		None

1.0 INTRODUCTION

The United States Army Corps of Engineers (USACE) is conducting an Environmental Assessment (EA) for the modification of the ʻĪao Stream Flood Control Project, Wailuku, Maui, Hawaiʻi, completed in 1981. During the years 1981-1989, severe flood damage caused erosion that compromised channel stability and weakened portions of the existing levees. As a result of this damage, the ʻĪao Stream Flood Control Project of 1981 requires upgrades and modifications, as future flood events may cause damage to life and property in areas of Wailuku town. Levee certification that the completed project can withstand a 100-year frequency flood is required by the Federal Emergency Management Agency (FEMA) by February 2009; otherwise, the area protected by the project will revert to a flood hazard area in the fall of 2009.

The USACE has determined that the damages incurred to the 1981 Flood Control Project during the years immediately following the completion of the project are due to design deficiencies to the original project. Under the legislative authority of the Flood Control Act of 1948, Section 205, Public Law (PL) 80-858, as amended, 33 United States Code (USC) 701s; PL 93-251, as amended; PL 97-140 and PL 99-662, the USACE is authorized to implement flood damage reduction improvements to the ʻĪao Stream that meet or exceed Standard Project Flood (SPF)[1] requirements to protect the existing Wailuku community. The project was designed for SPF protection with a peak discharge of 27,500 cubic feet per second (cfs) at the downstream limit of the project (250 feet (ft) upstream from the mouth of the stream) and 26,000 cfs at the upstream limit of the project (2.5 miles upstream from the mouth of the stream).

Environet, Inc. has been retained, under Contract No. DACA83-01-D-0014 to prepare an EA in accordance with the National Environmental Policy Act (NEPA) of 1969, as amended, Council on Environmental Quality (CEQ) regulations (40 Code of Federal Regulations (CFR) 1500-1508); Engineer Report (ER) 200-2-2, Environmental Quality Procedures for Implementing NEPA; and Chapter 343, Hawaiʻi Revised Statutes (HRS) and Act 50, as amended.

[1] The SPF is the flood that may be expected from the most severe combination of meteorologic and hydrologic conditions that are considered to be reasonably characteristic of the geographical region involved, excluding extremely rare combinations. The SPF represents a "standard" against which the degree of protection selected for a project may be judged and compared with protection provided at similar projects in other localities. The SPF for the ʻĪao Stream is estimated as approximately 27,500 cfs.

1.1 LOCATION

The ʻĪao Stream drainage basin is a 10 square mile area that begins at the boundary between the Lahaina and Wailuku Judicial districts and extends along the crests of the Kahoolewa and Kapilau Ridges to the Pacific Ocean (Figure 1-1). The basin is eight miles long and averages 1.25 miles in width. It is characterized by two major topographic features: a coastal plain that extends about three miles inland, and ʻĪao Valley, the largest valley in West Maui, which extends from the coastal plain to the summit of Puʻu Kukui at an elevation of 5,800 ft above sea level.

The ʻĪao Stream Flood Control Project was initiated in 1977 and completed in 1981. The stream drains into a steep valley with stream flows at the upstream project limit conveyed into a debris basin. The 1981 ʻĪao Stream Flood Control Project consists of a debris basin located 2.5 miles upstream from the stream mouth, a 3,500-foot long channel downstream from the debris basin: levees along the left and right bank, flood plain management along 6,950 ft of the left bank, and stream realignment for a 1,730-foot reach to the shoreline. In the flood plain management reach, levees are located on the right stream bank and are offset up to 80 ft beyond the existing stream bank. The proposed improvements to the 1981 Flood Control Project extend from above Waiehu Beach Road (Sta 22+00) to the debris basin at the upstream limits of the project, a distance of approximately 2.5 miles (Figure 1-2).

The lower portion of the ʻĪao Stream in its current state (i.e., the area downstream from the water diversion structure (See Figure 1-3)) is not conducive to aquatic life. Due to the diversion of water from the stream, and also due to the intermittent nature of the stream itself, the stream below the diversion structure is absent of water approximately 90 % of the time (Appendix A). Were it not for the efforts of a local aquatic biologist to capture organisms from ponded areas near the ocean outlet and physically transport them to the upper reaches of the stream, there would likely be no instream migration of aquatic organisms from the ocean to upstream areas. In some concrete-lined portions of the stream, a low-flow channel has been constructed. This low-flow element has been identified as a positive feature for aquatic organisms, particularly where shade is present. Other barriers to instream migration of aquatic organisms include the 22-foot drop structure at Station 97+23, concrete-lined portions without a low-flow channel, and a few smooth elevation drops that lack sufficient rugosity for migrating organisms to grasp or rest (See Figure 1-3).

The preferred alternative (Alternative III) involves converting 7,200 ft of natural stream bed to a roller compacted concrete (RCC)-lined channel. The channel has been designed to include low-flow elements that will enhance passage of aquatic organisms during periods of stream flow. While United States Fish and Wildlife Service (USFWS) originally viewed the proposed alternative as a significant environmental impact, subsequent discussions between the USACE and USFWS identified ways to mitigate these impacts to an acceptable level. As a result of these discussions, the proposed alternative includes several additional design features and retrofitting of existing concrete-lined portions of the stream that are outside the project area. These measures are discussed in greater detail in Section 3.0 of this report, and are also included in a revised mitigation recommendation letter by the USFWS (Appendix J).

1.2 PROPOSED ACTION

The proposed ‘Īao Stream Flood Control Project is intended to correct deficiencies associated with the existing Flood Control Project completed in 1981. Modifications to the 1981 Flood Control Project are needed to prevent further streambed erosion and protect Wailuku town from flood damage. In addition, construction of an alternative to restore ‘Īao Stream to its original design capacity of 27,500 cfs will certify the project to FEMA standards.

NEPA, in conjunction with applicable regulations listed in the previous section, requires alternative solutions to the proposed action be developed and presented collectively in this report. The proposed action and alternatives are then evaluated in order to determine the most feasible and environmentally acceptable plan for implementing flood damage reduction improvements that meet or exceed SPF requirements.

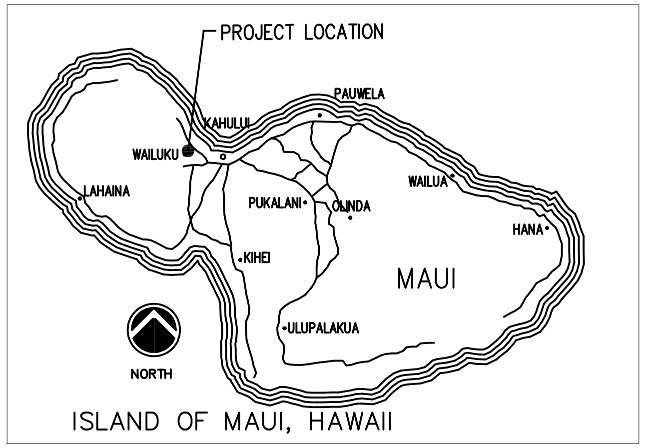
During the public scoping meeting for the project on August 12, 2003, consideration of an additional alternative was requested. The result was inclusion of a fifth alternative, which includes removal of existing flood control improvements from the area and the return of ‘Īao Stream to its original state, pre-flood control construction conditions.

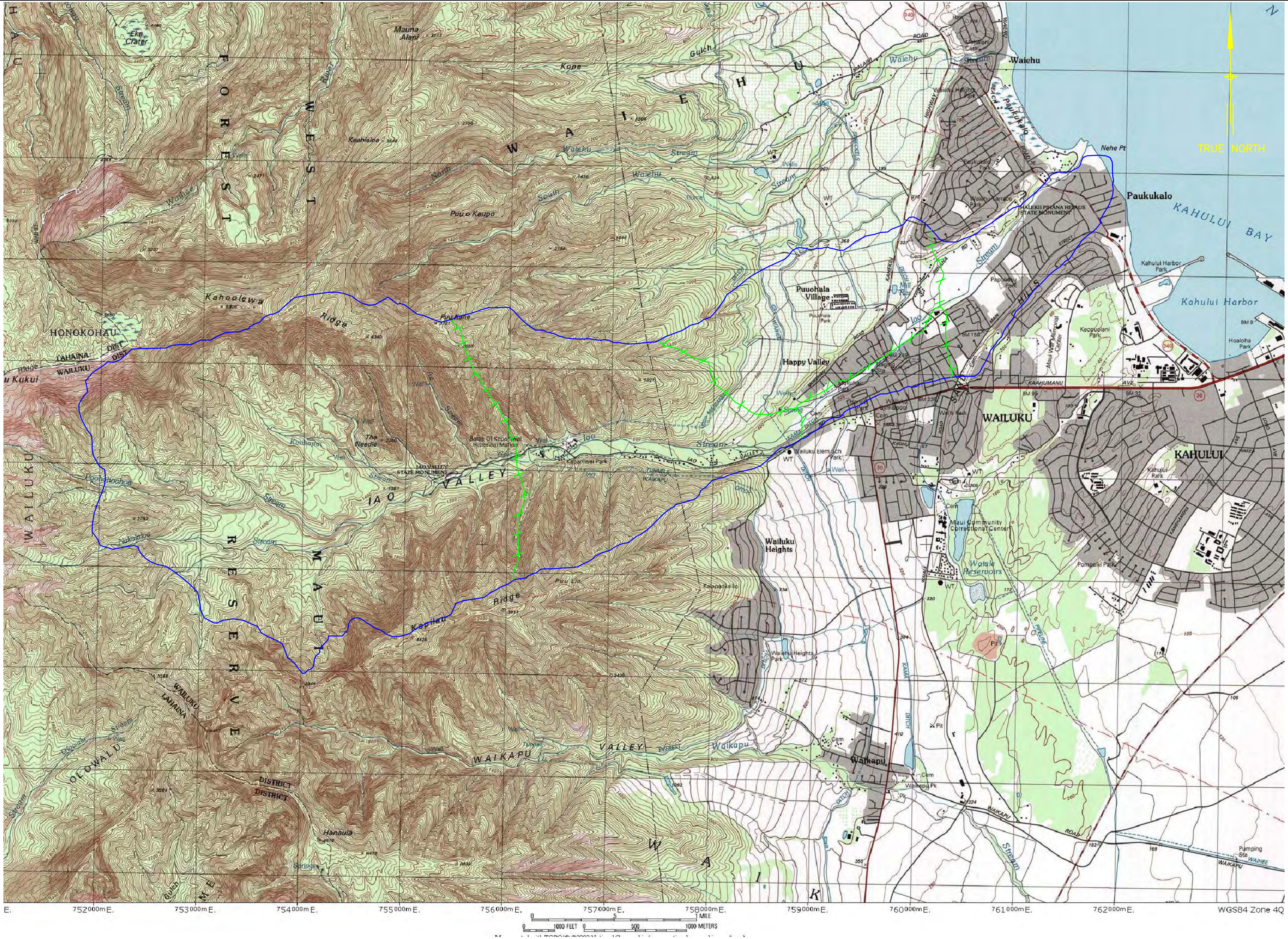
A total of five alternatives and a no action alternative are discussed in this EA. Alternatives are presented in Table 1-1 and described further in detail in Section 3.0.

Table 1-1: Alternatives

Alternative	Description
I	Trapezoidal Concrete-Lined Channel
II	Rectangular and Compound Channel
III	RCC and Boulder Invert Channel Following Existing Alignment
IV	Levee Reconstruction
V	Removal of Flood Control Improvements
VI	No Action

This page is intentionally left blank.





LEGEND:

DRAINAGE BOUNDARY

DRAINAGE SUB-BOUNDARY

ENVIRONET, INC.
PRESERVING EARTH'S RESOURCES FOR THE FUTURE

DRAWN BY:	IAO STREAM FLOOD CONTROL EA	
I.K.N.		
CHECKED BY:	DRAINAGE AREA MAP IAO STREAM WAILUKU, MAUI, HAWAII	FIGURE 1-1
R.C.A.		
REF:		
USGS		

ENVIRONET, INC.
PRESERVING EARTH'S RESOURCES FOR THE FUTURE

DRAWN BY: I.K.N.	IAO STREAM FLOOD CONTROL EA	
CHECKED BY: R.C.A.	PROJECT LOCATION IAO STREAM WAILUKU, MAUI, HAWAII	FIGURE 1–2
REF: USACE		

Looking upstream at drop structure from Spreckles Ditch overpass.

Drop structure; note lack of water and sheer drop that prevents migration.

Smaller drop structure, with water diversion feature in the background.

Concrete-lined low-flow stream channel upstream from water diversion structure.

Looking down towards debris basin. Spring in foreground is supplying water to the channel.

Waiehu Beach Road crossing, facing southeast.

Low-flow channel beneath Waiehu Beach Road, identified as ideal by DAR.

Looking dowstream from Imi Kala Bridge. Note lack of water in stream.

Looking upstream from Imi Kala Bridge.

Legend

Project Area

ENVIRONET, INC.
PRESERVING EARTH'S RESOURCES FOR THE FUTURE

DRAWN BY: B.I.	'IAO STREAM FLOOD CONTROL EA	
CHECKED BY: S.G.	SITE PHOTOGRAPHS 'IAO STREAM WAILUKU, MAUI, HAWAI'I	FIGURE 1-3
REF: USGS & COM		

1.3 OVERVIEW OF ALTERNATIVES CONSIDERED

In response to public comment regarding the possibility to add recreational features to the modification to the 1981 Flood Control Project, the USACE is currently working with the local project sponsor, the County of Maui (COM) Department of Public Works (PW), to look into jogging and walking paths along the levees as added recreational features to be incorporated with the chosen alternative.

The proposed alternatives are as follows:

Alternative I Trapezoidal Concrete-Lined Channel – This alternative would contain up to the SPF within the improved channel. Alternative I consists of a trapezoidal, concrete-lined channel with a 40-foot bottom width, 90-foot top width and interior splitter walls at channel curves (Figure 1-4). The new channel would mainly follow the existing stream alignment Station 22+00 (0.5 miles upstream from the stream mouth) to 92+02 (1.8 miles upstream from the stream mouth), for a distance of 7,200 ft. The channel would also be realigned to the north between Stations 76+40 to 86+60 (an approximate 950-foot length extending east and west of the ʻImi Kālā Street Bridge) to avoid affecting structures that have been constructed on the right bank. All design flows up to the standard project flood would be contained within the channel, thereby eliminating the need for the existing floodplain on the left bank and making the land available for development. Negative environmental impacts include potential objections by public and resource agencies with regard to the conversion of a natural stream bottom to a concrete-lined invert (70% conversion). Total project cost is estimated at $38.8 million. This alternative would achieve project objectives and is considered to be feasible from an engineering and economic perspective. Therefore, this alternative was further analyzed.

Alternative II Rectangular and Compound Channel – This alternative would contain up to the SPF. Alternative II consists of a rectangular and compound, concrete-lined channel with a 20-foot bottom width and 145-foot top width between Stations 22+00 and 92+02 for a distance of approximately 7,200 ft (Figure 1-5). Improvements would include a straightened alignment and a shallow 55-foot wide grass-lined channel adjacent on the left bank (to contain up to the SPF). Total project cost is estimated at $52.8 million. Although effective in addressing flood control concerns, negative environmental impacts include destruction of the existing stream habitat due to straightening of the natural channel alignment and concrete lining of the stream, which will likely generate strong objections from the public and resource agencies. This alternative was eliminated from further consideration due to environmental concerns and economic viability.

Alternative III Roller Compacted Concrete and Boulder Invert Channel – This alternative was designed for SPF protection with a peak design discharge of 27,500 cfs downstream of Station 84+42 (0.5 miles upstream from the stream mouth) and 26,000 cfs downstream of Station 92+02. Typical stream stabilization improvements would consist of boulders in the main channel low flow section with RCC stream bank protection, in order to replicate a more natural stream invert. Design elements would be included into existing and planned channel segments to facilitate the movement of native fish and other aquatic organisms (Figure 1-6). Total project length extends from Station 22+00 to the debris basin (2.5 miles upstream from the shore). Modifications are described in more detail below:

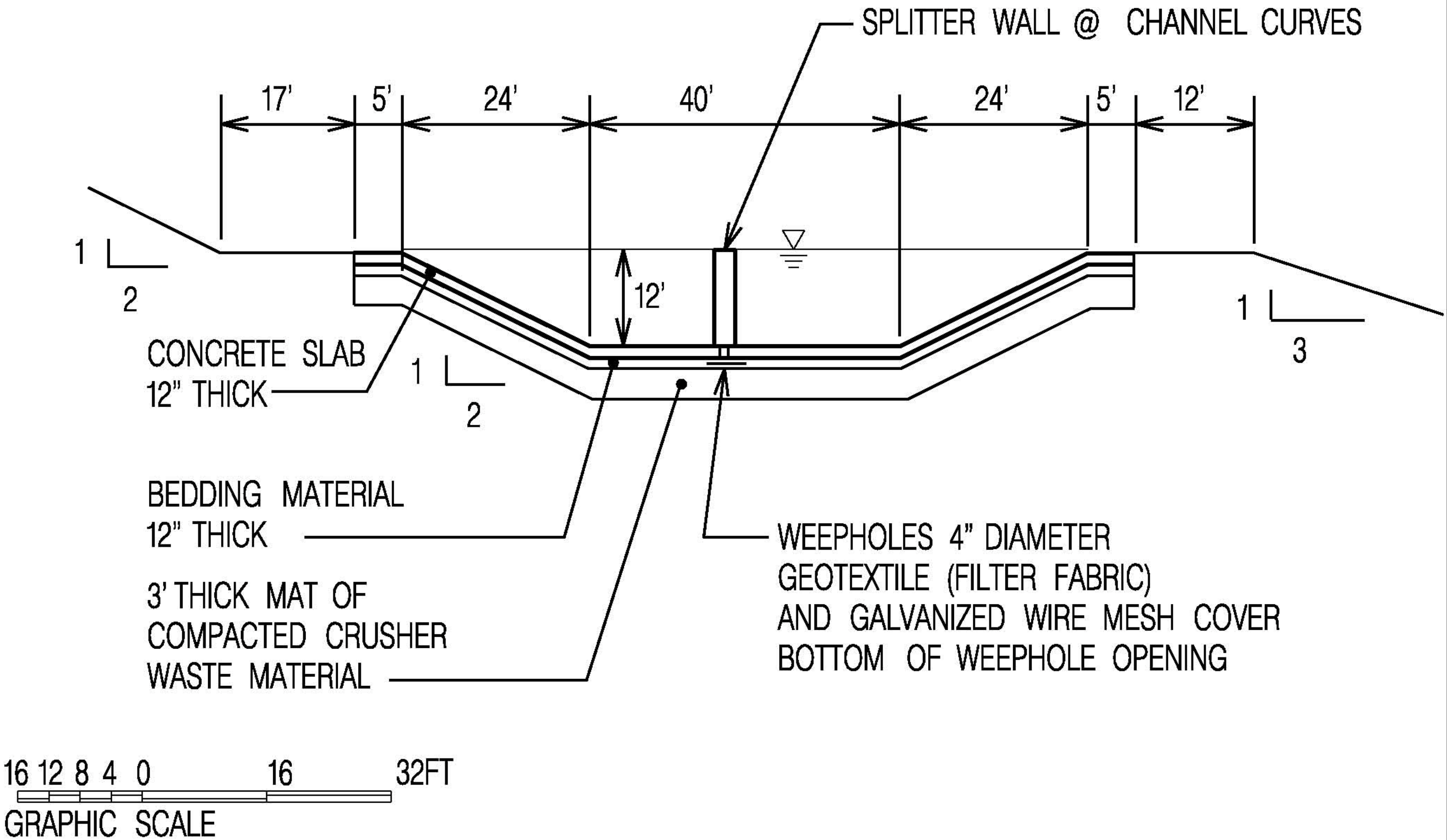
A new ground water recharge basin and diversion levee were considered for inclusion by partially blocking the low flow outlets at the existing debris basin located approximately 1,100 ft upstream of Market Street at Station 127+00 and adding a levee on the left bank upstream of the existing debris basin. Water would pond in the debris basin and help facilitate percolation into the ʻĪao aquifer during rainy season. This mitigation was dropped from consideration following the recommendation of USFWS and Department of Land and Natural Resources (DLNR) Department of Aquatic Resources (DAR) personnel citing the presence of the recharge basin would have negative impacts on aquatic organisms.

Modify the drop structure between Stations 96+74.21 and 97+23.21. A new stepped drop structure would eliminate the dangerous 22-foot vertical drop and improve passage of in-stream fish (*ʻoʻopu*) and other aquatic organisms.

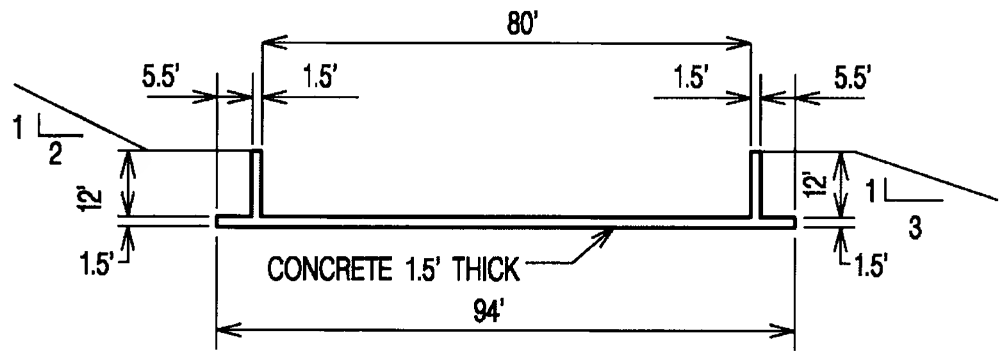
Modify existing low flow concrete channels with small blocks to break up high velocity flows and facilitate fish passage.

Add hydraulic improvements to the concrete channel between Stations 92+02 and 95+41. These improvements include baffle blocks and a weir within the existing concrete channel to more evenly distribute flow.

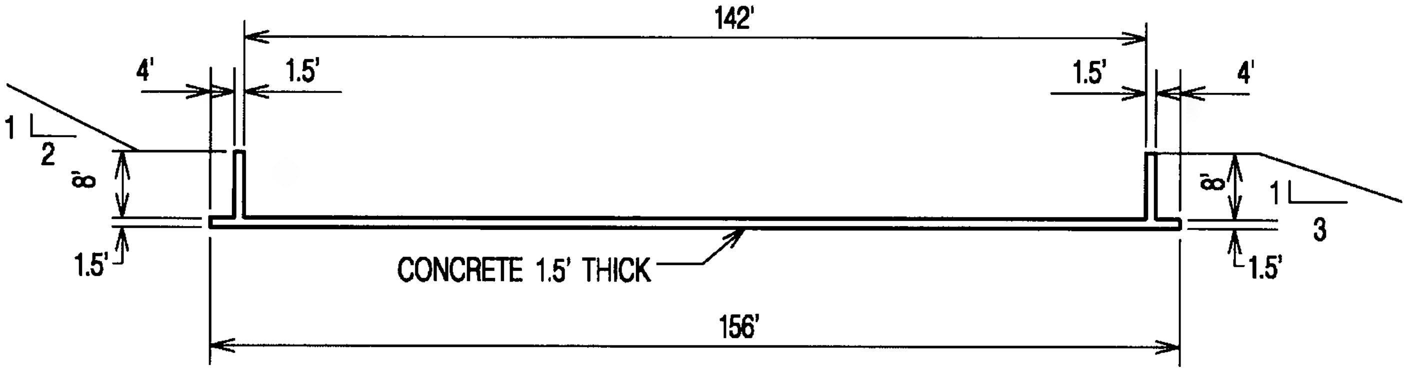
Incorporate RCC side slopes and an approximately 15-foot wide and 20-inch deep grouted boulder invert channel that would mainly follow the alignment of the existing stream between Stations 22+00 and 92+02 (approximately 7,200 ft long). The median base width range would vary between 40 to 60 ft.



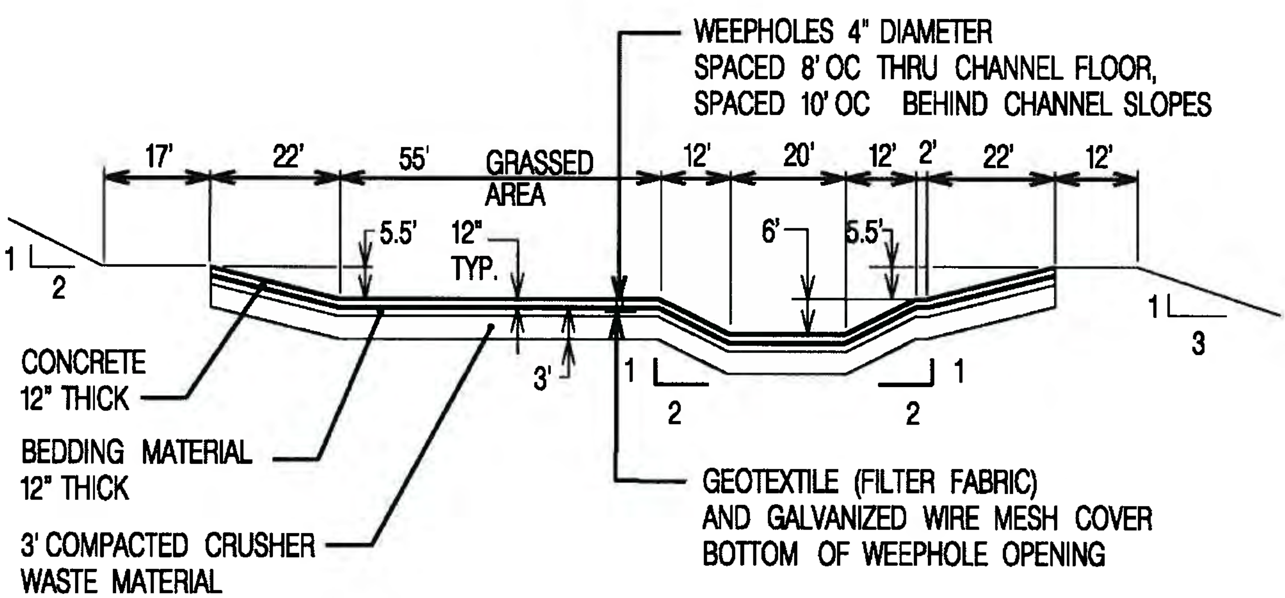
ENVIRONET, INC. PRESERVING EARTH'S RESOURCES FOR THE FUTURE	DRAWN BY: B.I.	IAO STREAM FLOOD CONTROL EA	FIGURE 1-4
	CHECKED BY: S.G.	ALTERNATIVE I TRAPEZOIDAL CONCRETE CHANNEL	
	REF: USACE		



UPSTREAM RECTANGULAR CHANNEL SECTION



DOWNSTREAM RECTANGULAR CHANNEL SECTION



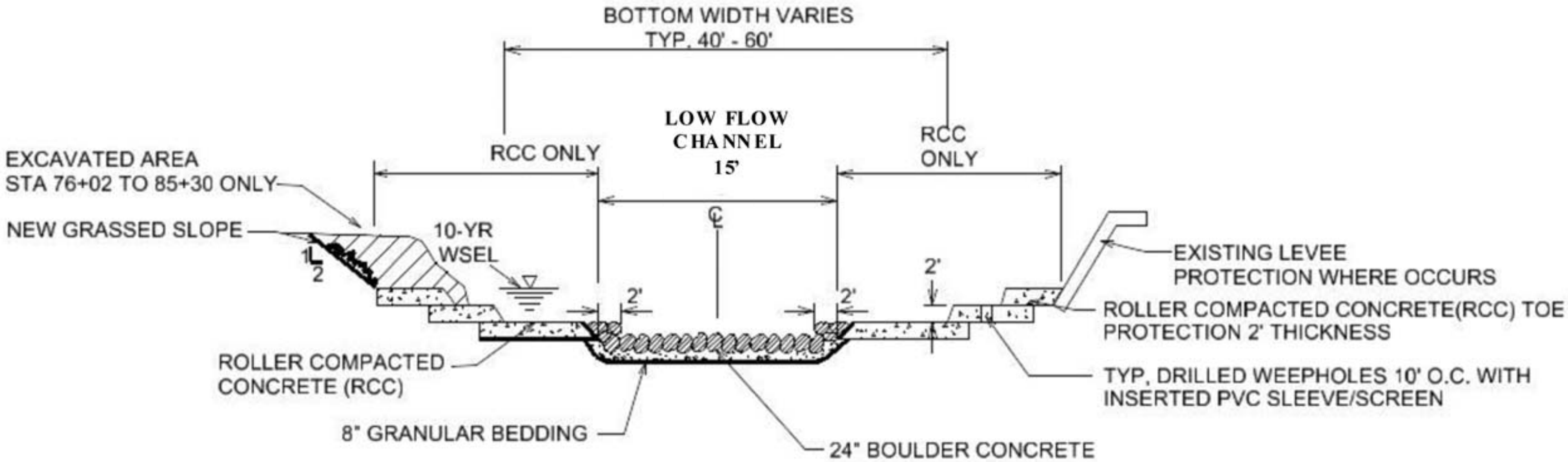
TRAPEZOIDAL CHANNEL SECTION

16 12 8 4 0 16 32FT

GRAPHIC SCALE

ENVIRONET, INC.
PRESERVING EARTH'S RESOURCES FOR THE FUTURE

DRAWN BY: B.I.	IAO STREAM FLOOD CONTROL EA	
CHECKED BY: S.G.	ALTERNATIVE II RECTANGULAR AND COMPOUND CHANNEL	FIGURE 1-5
REF: USACE		



TYPICAL CHANNEL CROSS SECTION

NOT TO SCALE

NOTES:

1. ROLLER COMPACTED CONCRETE (RCC) WILL LINE THE CHANNEL INVERT (EXCEPT LOW FLOW CHANNEL), UP TO 10 YEAR WATER SURFACE ELEVATION.
2. RCC WILL BE PLACED IN 6" - 12" LIFTS ON CLEARED AND GRUBBED GROUND SURFACE.
3. RCC TOE PROTECTION WILL BE PLACED 1 FOOT ABOVE TOE OF LEVEE.
4. RCC "STEPS" ARE UNFORMED AND WILL NOT EXCEED 1H:1V SLOPE.
5. 10-YR WSEL VARIES FROM 6'-10' DEEP, AVE = 8'.
6. BOULDERS 1' - 2' DIAMETER WILL BE GROUTED IN PLACE IN THE LOW FLOW CHANNEL. (1/3 PROJECTING)
7. CONCRETE CUTOFF WALLS 3' DEEP AND 1' THICK WILL BE ADDED PERPENDICULAR TO THE CHANNEL AT 300 FOOT INTERVALS.
8. STA 76+02 - 85+30 ONLY: DISTANCE BETWEEN TOP OF LEFT BANK TO CENTERLINE VARIES, 125' MAX .

ENVIRONET, INC. PRESERVING EARTH'S RESOURCES FOR THE FUTURE	DRAWN BY: I.K.N.	IAO STREAM FLOOD CONTROL EA	FIGURE 1–6
	CHECKED BY: R.C.A.	ALTERNATIVE III GROUTED BOULDER INVERT CHANNEL	
	REF: USACE		

Include stream realignment and widening between Stations 76+02 and 85+30. The channel would be realigned to the north on the left bank to avoid existing structures to the right bank and be widened to reduce water surface profile at the ʻImi Kālā Street Bridge. As a result of the channel widening, the 10-year flood (i.e., the low flow condition of 7,200 cfs) will be contained within the channel but floods greater than 7,200 cfs and up to the SPF of 27,500 cfs will spread out on the existing left bank flood plain area.

Construct a low flow boulder channel within the RCC portion. The approximately 15-foot wide low flow channel would use boulders embedded in concrete to replicate a more natural streambed substrate. Retrofit design elements have also been included to facilitate the movement of native organisms through the modified channel area. These elements include a step structure at the 22-foot vertical drop (Station 97+23), widening existing low-flow channel areas, installing low-flow channel segments in existing flat-bottomed cement channel segments and in the center of the existing debris basin, blocks along the sloped portions of the existing channel to provide a resting place for climbing organisms, and an alignment along the vegetated portions of the left bank to provide shade and reduce water temperatures. These mitigation measures have been proposed as compensation for unavoidable impacts, and have been agreed to in a revised mitigation recommendation letter by the USFWS (Appendix J).

Incorporate right bank levee raises. The existing right bank levee would be raised at Stations 45+37 to 48+85 by 4.5 ft using a concrete rubble masonry (CRM) wall on top of the existing earth levee and up to 0.7 ft at Stations 25+62 to 26+46. The 0.7-foot raise can be accomplished using earth levee fill material. Adjacent land uses that may have an impact to their viewscape by the levee raises include warehouses in the vicinity of the 0.7 foot levee raise and residential townhomes in the vicinity of the 4.5 foot levee raise. The impact to the viewscape of the warehouses would be minimal, but the impact to the townhomes would be noticeable. The modified levee would look similar to the levee built for the Kawainui marsh restoration on Oahu (Figure 3-4).

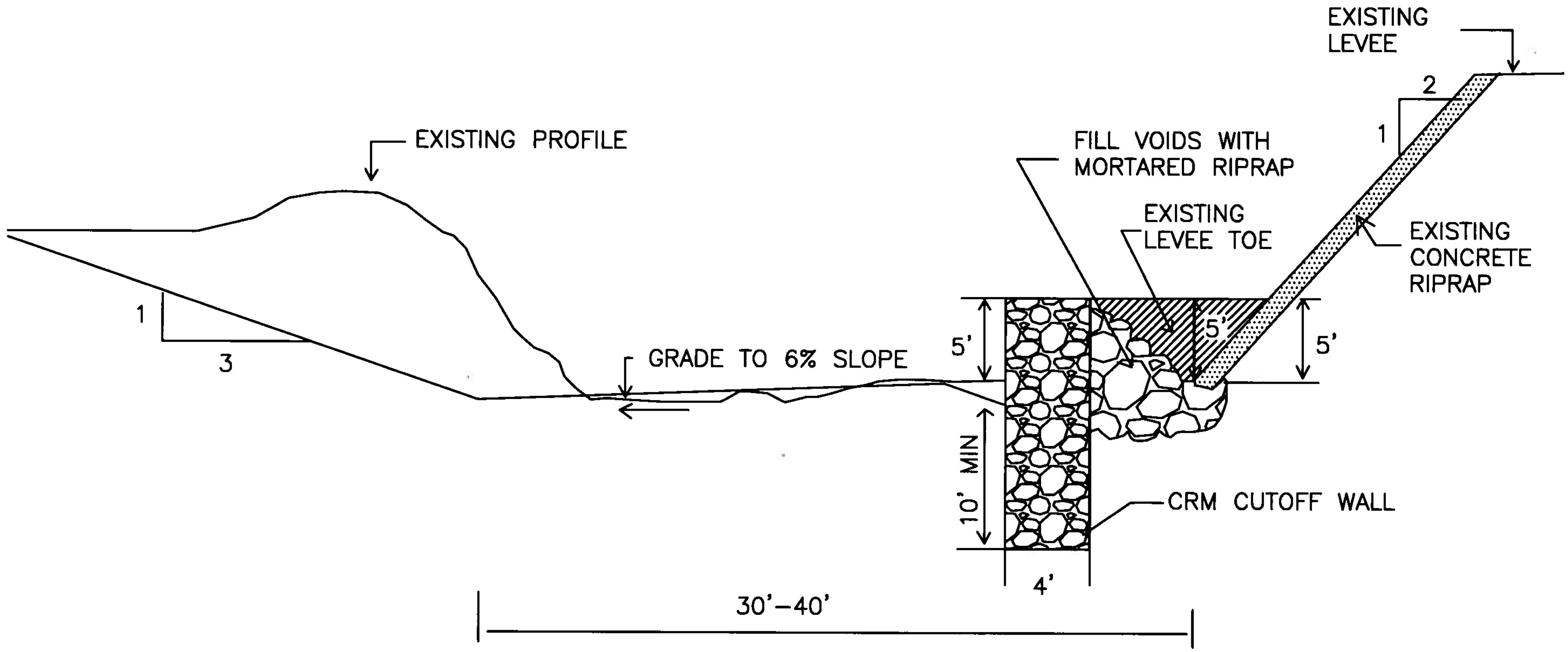
Channel lining, retaining walls, and raising the levee walls would be necessary due to the excessive flow velocities and higher flood levels. This alternative would achieve project objectives and is considered to be feasible from an engineering and cost perspective. Total project cost is estimated at $30.1 million. Alternative III is considered the "environmental alternative" because it would minimize or otherwise mitigate for negative environmental impacts to the project area. Therefore, Alternative III is the recommended alternative (reformulated plan) as it would best reduce the flooding problems and minimize or mitigate for environmental impacts.

Alternative IV Levee Reconstruction – This alternative would widen the basal stream area, flattening the slope of the left bank, and reconstructing the levee toe with concrete riprap filling the void under the levee toe. A CRM cutoff wall would be constructed fronting the existing levees (Figure 1-7). This alternative would retain the floodplain on the left bank and contain up to the SPF. Potential impacts would be minimal. Total project cost is estimated at $12.5 million.

The risk of failure also remained because rebuilding and extending toe protection was tried at ʻĪao Stream after storms in January 1980 and after a storm in 1981, as documented in a Memorandum for Commander (March 28, 1995), U.S. Army Engineer Division, Pacific Ocean. ʻĪao Stream has continued to erode adjacent to the toe protection works and is now 8 to 10 ft below the last toe protection repair, completed in November 1983. The toe continues to erode due because the cutoff wall at the levee toe is a fixed hard point in a moveable boulder and gravel bed stream. The unlined left bank of the stream erodes and the bottom of the stream erodes, but the cutoff wall does not. As the stream erodes, the fixed hard point is gradually uncovered and undermined. The COM PW fills areas adjacent to the toe cutoff wall after flood events by placing large boulders against the eroding levee toe (Figures 4-4 and 4-5).

Although this work is effective for low frequency events, no flood events larger than a 4% flood have occurred in ʻĪao Stream since project construction. Floods larger than the 4% flood will likely have enough force and duration to erode the stream near the toe of the cutoff wall causing undermining and consequential levee slope failure. Levee toe protection with a cutoff wall is not considered a viable solution for ʻĪao Stream flood control. Therefore, Alternative IV was not carried forward for further evaluation.

Alternative V Removal of Flood Control Improvements – This would include removal of all existing man-made improvements to the existing channel and returning the stream to its original natural state. The community of Wailuku would be placed back into the flood plain, with no flood protection levees. A state-of-the-art flooding warning system would replace man-made flood control devices. The estimated project cost for this alternative is $34.5 million. This estimate does not include the costs of relocating residents in flood-prone areas, which would be required for this alternative and would be expected to be quite substantial given the costs of real estate in Maui. Although this alternative does not meet project objectives from an engineering perspective, there is an expressed public support for this alternative due to its environmental benefits, and the alternative was carried forward for further evaluation. Despite its public support, this alternative was not selected due to potential for loss of life and protection to urbanized areas.



ENVIRONET, INC.
PRESERVING EARTH'S RESOURCES FOR THE FUTURE

DRAWN BY: I.K.N.	IAO STREAM FLOOD CONTROL EA		FIGURE 1–7
CHECKED BY: R.C.A.	ALTERNATIVE IV LEVEE RECONSTRUCTION		
REF: USACE			

Alternative VI No Action - Alternative VI is not to perform modifications to the existing Flood Control Project. Continuing severe erosion may be a result of the no action alternative, contributing to levee failure in multiple locations, which would eventually lead to flooding of the ʻĪao Stream drainage basin. A project failure would cause possible loss of life and extensive property damage would be inevitable. Although this alternative would not meet project objectives, it is discussed throughout the document to provide the reader with a perspective of the without-project scenario.

This page is intentionally left blank.

2.0 PURPOSE AND NEED FOR ACTION

2.1 PURPOSE OF THE PROPOSED ACTION

The 1981 ʻĪao Stream Flood Control project was authorized by the Flood Control Act of 1968 and completed in October of 1981. The original project consisted of a debris basin, channel improvements, diversion levees, and flood plain management.

During the construction phase in January 1980 a flood occurred that caused extensive erosion of the sacrificial berm and undermined portions of the completed levees. As a result, the streamside slope of the levees was extended with a concrete riprap slope lining into the streambed. Considered to be a state of the art design at that time, the toe of the cutoff walls was imbedded five ft in depth as provided in the project design document.

Shortly after project completion, stream flows occurred that caused erosion of the stream bottom along an approximately 7,000 foot reach between the concrete channel and the Waiehu Beach Road. The erosion undermined the project levee with scour depths extending to a maximum of six ft below the existing boulder concrete slope lining. In July 1982, the Honolulu District Corps of Engineers requested that corrective work be approved to extend the boulder concrete slope protection from the damaged portion to a minimum of five ft below the eroded stream bottom. The Office of the Chief of Engineers granted approval for this work in January 1983. The corrective work was completed in November 1983 under the Productive Employment Appropriation Act of 1983 and authorized under Section 205 of the Flood Control Act of 1948, PL 80-858, as amended. The stream channel has since eroded as much as six to eight feet below the 1983 repair. The USACE subsequently decided to conduct a reconnaissance study to investigate solutions to the recurring problems that are slowly undermining areas of the levee. In March 1995, a report was submitted by USACE recommending modification to ʻĪao Stream to replace the existing levee system with a trapezoidal concrete-lined channel (7,200 ft long).

A slope stability analysis was performed in 1997 to determine the stability of two areas identified as possible locations of levee failure. Stability analysis indicates instability may occur after flood waters have receded at Station 40+00. This assumes the 1996 slope geometry is further eroded to steepen the slope and deepen the stream bottom. Should a standard project flood occur prior to any repairs, flood waters would be able to pass through this portion of the levee and enter into adjacent housing areas. Water passing will further erode the levee.

The existing stream channel has a relatively narrow width of 40 to 60 ft, is boulder lined, and dry about 90% of the time. Levees with a surface of grouted riprap are interspersed along the right bank. The channel has an average slope of 2.6%. This steep stream channel results in critical and supercritical flows in the stream. The average channel velocity through the unlined portion of the stream varies between 8 and 32 feet per second (fps) with an average velocity in excess of 20 fps during annual floods. These high velocities have eroded the channel bed and caused severe undermining of the existing levees. To date, no flow larger than a 4% event has occurred in ʻĪao Stream since construction was completed in 1981.

Levee certification that the completed project can withstand a 100-year frequency flood is required by the Federal Emergency Management Agency (FEMA) by February 2009; otherwise, the area protected by the project will revert to a flood hazard area in the fall of 2009. A government agency responsible for levee construction or a Registered Professional Engineer must provide this certification. In its present condition, the project cannot be certified as providing 100-year flood protection.

Repeated floods in this area have caused high stream flows, undermining the existing flood plain levees in key locations (Figures 4-4 and 4-5). High stream flows resulted in downcutting of the natural streambed and erosion of the base of the east bank levee structure (See Section 2.0, and Figures 4-4 and 4-5 for more details). Several residential and commercial structures along the right bank are in danger of being undercut if streambank erosion continues, as is the heiau along the lower reach of the left bank. The USACE has determined that the damages incurred by the 1981 Flood Control Project during the years immediately following the completion of the project are due to design deficiencies of the original project.

The purpose of the proposed action is to find a solution to stop levee and streambed erosion and to protect adjoining property from flooding during major storm events. A secondary objective is to maintain habitat for aquatic species passage by keeping a low-flow channel as recommended by the USACE Committee on Channel Stabilization. The estimated lifespan of the Flood Control Project is anticipated to be between 50 and 100 years. Five alternatives and a no action alternative have been formulated for consideration. Of these alternatives, three are considered for further evaluation in this EA (see Section 1.3).

2.2 NEED FOR THE PROPOSED ACTION

The ʻĪao Stream Flood Control project has prevented an estimated $24.2 million in damages to date. It has instilled a sense of security in the growing community of Wailuku. A failure in the existing levees would cause flood waters to inundate the ʻĪao Stream drainage basin as if there were no levees present at all. Loss of life and extensive property damage due to floods and erosion would be inevitable.

Modifications to the existing ʻĪao Stream Flood Control Project are needed to preserve the reliability of the existing project and to protect the health and well-being of the Wailuku Community. Implementation of the modifications would resolve the project's design deficiency and prevent further high levels of streambed erosion, thereby eliminating the risk of levee failure and the associated loss of life and property damage that could result.

This page is intentionally left blank.

3.0 ALTERNATIVES

3.1 GENERAL DESCRIPTION OF THE ACTION'S TECHNICAL, ECONOMIC, SOCIAL, AND ENVIRONMENTAL CHARACTERISTICS

3.1.1 Technical

Baffle Blocks and Weir. The recommended baffle block structures consist of nine concrete blocks that would be constructed at the downstream end of the existing concrete channel (Station 92+02). These blocks are required to slow high velocity flows before they enter the middle reach of the project within the levee system. A weir structure is also required upstream of the baffle blocks in the concrete channel section to more evenly distribute water flows (Figure 3-1). The weir is placed at an angle across the channel to more evenly distribute flows. The weir is 45 ft long and 3 ft high and begins at Station 95+41 and ends at Station 95+10. A modified drop structure would eliminate the 22-foot vertical drop that exists at the end of the rectangular channel. The structure is not required for hydraulic reasons or a criterion required by any of the resource agencies, but is desirable for safety and in-stream fish passage. The estimated construction cost of the blocks is $188,400.

Drop Structure. A drop structure (Stations 96+74.21 to 97+23.21) would eliminate the existing 22-foot vertical drop at the end of the existing rectangular channel. This structure, although not required for hydraulic reasons, is desirable for safety of residents utilizing the area because it would increase safety in the stream as well as improve the ability of aquatic animals to migrate upstream (Figure 3-2). The present 22-foot drop prevents instream migration. Proposed mitigation measures for Alternative III include a stepped fish passage structure at the drop structure to facilitate upstream fish and invertebrate migration. This portion of the channel would also be designed to connect the low-flow channel upstream from the drop structure to the low-flow channel downstream from the drop structure. The profile and plan views for the proposed drop structure are shown on Figure 3-2.

The drop structure, weir, and baffle blocks improve flow conditions in the concrete channel no matter what is constructed downstream. An existing danger is that high velocity flows leaving the concrete channel would erode the outlet area and cause undermining of the channel. The weir and baffle blocks would typically even out the flow and reduce exit velocities from the concrete channel, thereby improving flow conditions downstream. This was verified by the hydraulic model study conducted by the Army Engineer Research and Development Center (ERDC).

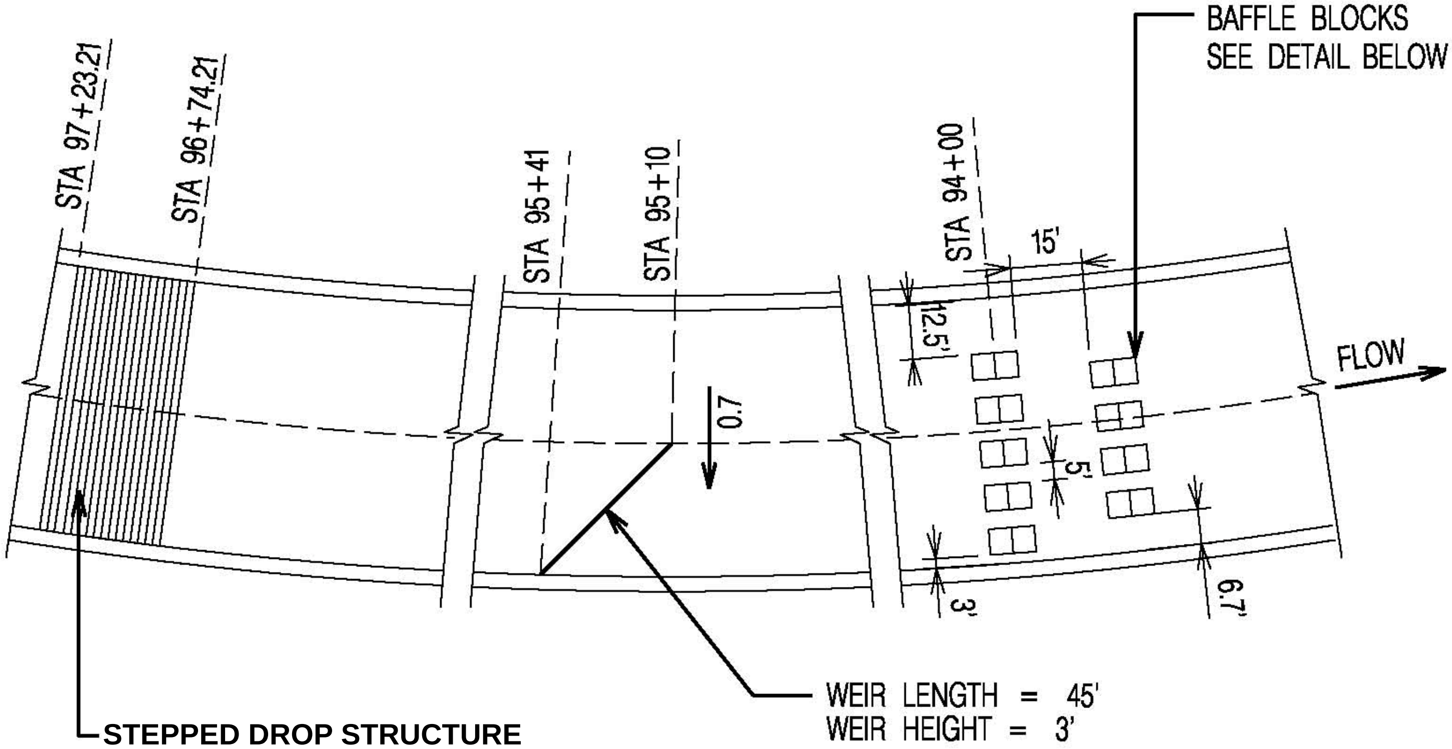
The model study showed that hydraulic conditions in this portion of the channel are unbalanced below the drop structure with the inside of the bend at channel Station 94+20 dewatered and velocities exiting the channel approaching 40 fps. This is much different than the original design report which assumed a hydraulic jump would form downstream of the drop structure and velocities would not exceed 11.8 fps in this section of the concrete channel. This unbalanced flow as detailed in the model study may result in undermining and failure of the concrete channel at its downstream end. Recommendations from ERDC to improve existing conditions included adding baffle blocks and a weir to more evenly distribute flows. ERDC also recommended construction of a stilling basin at the outlet.

The drop structure, weir, and baffle blocks should be considered part of each alternative, except the alternative of removing all structures from the channel (Alternative V) and the No Action alternative (Alternative VI). The decision to include this structure will be determined by the PW who is the local project sponsor. The PW will review such factors as feasibility, maintenance requirements, and community interest. The estimated construction cost of the drop structure is $266,000.

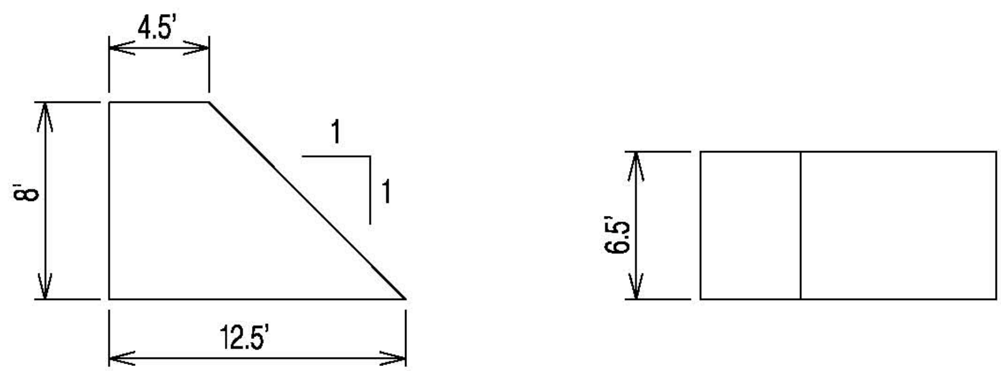
Low-Flow Channel. The proposed typical section in Alternative III includes an approximately 15-foot wide low flow channel installed approximately 20 inches lower than the proposed RCC channel invert. Due to high velocities, the boulders, which will range in size from 15 to 18 inches in diameter with six inches protruding above the channel, will be grouted. Minimal non-woody vegetation would be allowed to grow in the low flow channel in order to simulate a more natural channel and reduce water temperatures. Where practical, the low flow channel would be placed closer to the left bank because trees on the overbank would provide some shade over the channel and reduce water temperatures.

As part of an agreement between USFWS, USACE, DAR, and PW, Alternative III includes a retrofit of some portions of the currently existing concrete lined low-flow channel elements. The retrofit, which would mainly include widening the low-flow channel in specified areas, would allow for enhanced passage of aquatic organisms during periods of stream flow.

Channel Realignment and Widening. The channel will be realigned away from the right bank between Stations 76+02 and 85+30. The right bank in this area is very steep and buildings located at the top of bank are in danger of collapse into the stream. Additional hydraulic analysis of this reach indicates that if the reach captures the entire design flow of 27,500 cfs then existing levees on the right bank will be overtopped. In order to reduce the probability of this overtopping, a channel widening is recommended in this area.

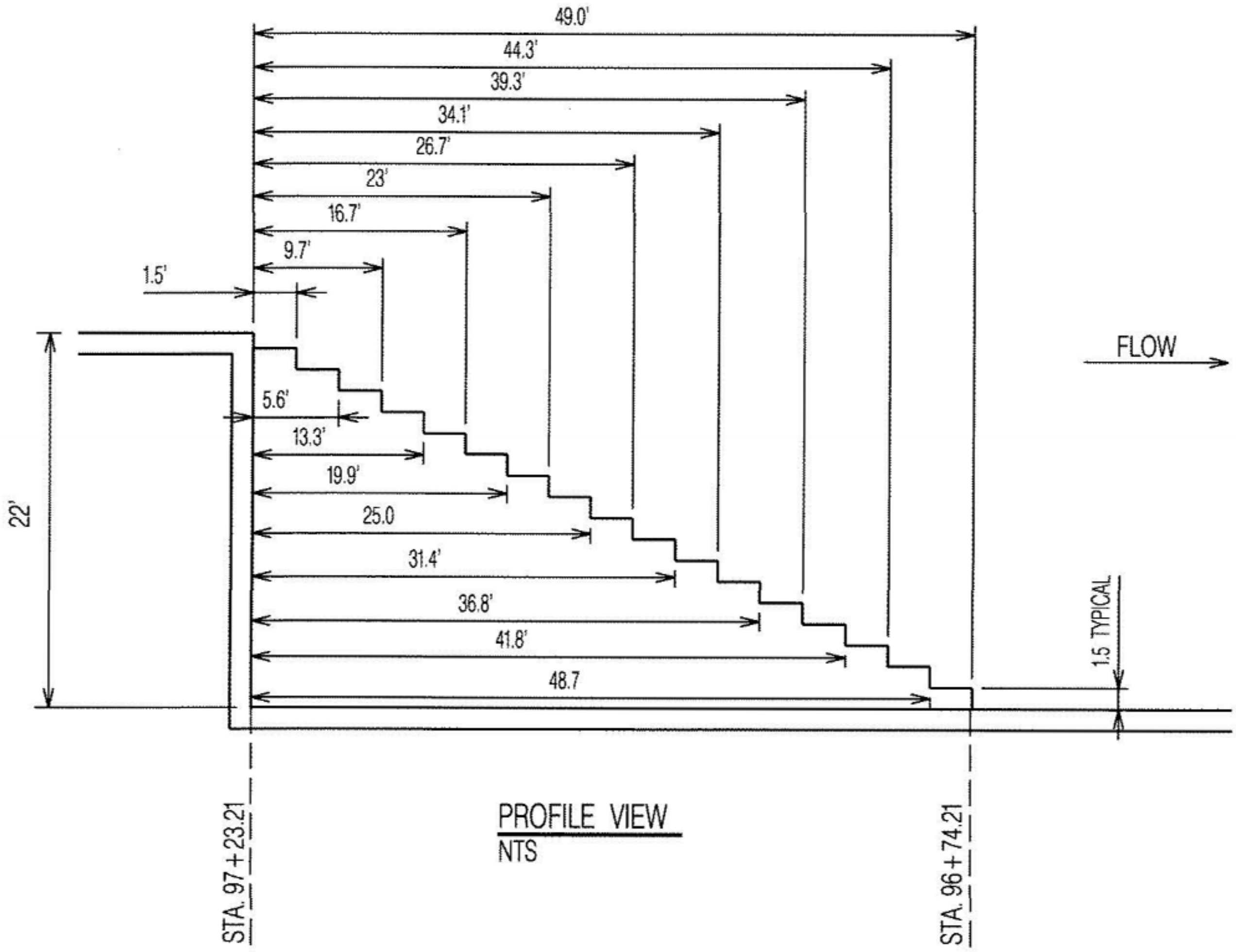


NEW DROP STRUCTURE, BAFFLE BLOCKS, AND WEIR PLAN VIEW
NTS

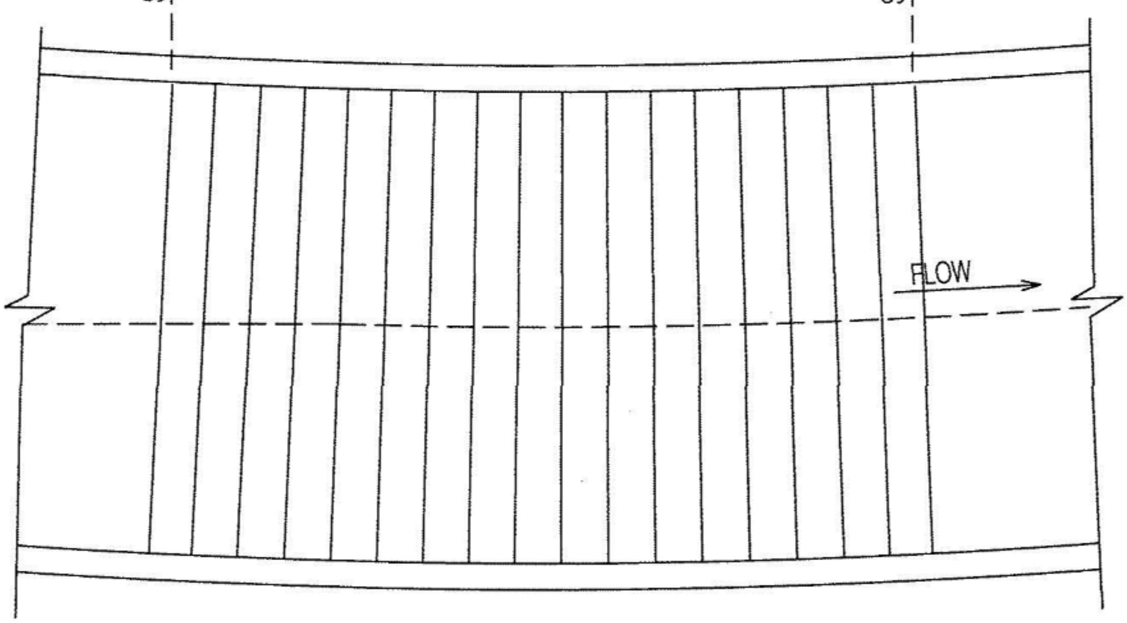


BAFFLE BLOCK DETAIL
NTS

ENVIRONET, INC. PRESERVING EARTH'S RESOURCES FOR THE FUTURE	DRAWN BY: B.I.	IAO STREAM FLOOD CONTROL EA	FIGURE 3-1
	CHECKED BY: S.G.	NEW DROP STRUCTURE, BAFFLE BLOCKS, AND WEIR PLANE VIEW	
	REF: USACE		



PROFILE VIEW
NTS



PLAN
NTS

NEW STEPPED DROP STRUCTURE

ENVIRONET, INC. PRESERVING EARTH'S RESOURCES FOR THE FUTURE	DRAWN BY: I.K.N.	IAO STREAM FLOOD CONTROL EA	
	CHECKED BY: R.C.A.	NEW STEPPED DROP STRUCTURE	FIGURE 3-2
	REF: USACE		

The channel realignment between Stations 76+02 and 85+30 includes a wider main channel which will significantly reduce water surface profile at the ʻImi Kālā Street Bridge. To widen the channel, the left bank would be excavated up to 90 ft starting at a bank elevation just above the 10% flood elevation. Low flows and flood flows of less than 10% frequency will remain in the existing channel. When flows exceed the 10% flood, they would overtop the left overbank and flow through the excavated area, reducing the design water surface profile from existing conditions. The widened cut surface would be paved with roller compacted concrete to withstand the high design velocities of approximately 25 fps. The new left bank in the excavated area would be cut to a 3 horizontal to 1 vertical side slope and would be revegetated. The widened channel Water Surface Elevation (WSEL) is significantly below the right bank elevation but was designed like that in order to accommodate the low chord elevation of the new ʻImi Kālā Street Bridge. The ʻImi Kālā Street Bridge would require two separate spans to cross the excavated section at Station 78+61 (Table 3-1).

Table 3-1: Channel Widening

River Cross Section	Existing WSEL* (ft msl)	Right Bank Elevation (ft msl)	Left Overbank Widening From Channel Centerline(ft)	Left Overbank Elevation (ft msl)	Widened Channel WSEL* (ft msl)
85+30	198.19	215.52	0	190.73	197.71
84+81	202.65	214.20	52	190.48	201.74
84+57	202.83	212.34	55	188.7	201.99
84+42	202.81	212.29	53	188.3	202.05
84+13	199.61	212.38	60	188.26	199.37
83+12	195.37	208.14	89	185.34	191.44
82+12	190.96	199.93	122	184.02	188.36
81+07	186.22	197.10	125	180.86	184.81
80+12	192.18	194.14	96	179.05	183.24
79+01	189.01	189.00	76	174.81	179.57
78+61	186.64	186.31	60	173.33	178.63

Table 3-1: Channel Widening

River Cross Section	Existing WSEL* (ft msl)	Right Bank Elevation (ft msl)	Left Overbank Widening From Channel Centerline(ft)	Left Overbank Elevation (ft msl)	Widened Channel WSEL* (ft msl)
77+95	187.14	183.01	58	171.56	177.05
77+18	180.53	180.01	60	170.28	177.15
76+02	175.24	180.01	0	166.66	179.33
75+03	171.40	179.96	0	165.13	172.19

*27,500 cfs – Downstream of Station 84+42

'Imi Kālā Street Bridge. The existing bridge near Station 78+61 has a computed capacity of about 9,600 cfs based on the original design report. The water surface at this bridge was computed at the approximate elevation of the underside of the bridge in the original design analysis with significant flows bypassing the bridge on the left bank. The County of Maui, in cooperation with a private developer, has plans to replace this bridge. The design discharge for the new bridge will be 27,500 cfs.

Grouted riprap. Grouted riprap consists of stone bed and slope protection having voids filled with grout or concrete to form a veneer of cementitious-bonded aggregate armor. Components of the grouted riprap system include stable and properly prepared slope; free draining sub-base or bedding layer; and protection layer consisting sound, durable stone bonded by a mixture of cementitious materials, water, aggregates, and admixtures. Granular filter and sub-base materials, geotextiles, sub-drains, weep holes, cutoffs, and other special features are also included as needed. Grouted riprap is widely used as an economical alternative to conventional riprap treatment where required stone size cannot be economically produced; and when repairing conventional riprap that has been damaged as a consequence of being subjected to water velocities exceeding design values. However, extreme caution is advised to insure that the stone displacement was indeed related to high velocities and not the result of slope or foundation failure. Grouted riprap must only be used on properly designed slopes. Grouted riprap requires special attention to the design of stable slopes, edge and toe protections, sub-base, pressure relief and drainage, stone size and gradation, stone quality, and grout design. Stability of the materials to be protected by grouted riprap controls the design of slope geometry in the same manner as it would for conventional riprap protection. Grouted riprap is generally considered to be a rigid structure but does not possess significant strength to bridge sizeable voids or withstand uplift pressures. Therefore, foundation support is critical. Riprapped levee side slopes have performed well in this project except where the toe has been undermined.

Roller-Compacted Concrete. RCC may be considered for application where no-slump concrete can be transported, placed, and compacted using earth and rock-fill construction equipment. Ideal RCC projects will involve large placement areas with little or no reinforcement. RCC may be used to repair undermined sections of the boulder concrete and for repair of the failed levee slopes. The properties of hardened RCC are similar to those of conventionally placed mass concrete. For well-compacted RCC mixtures, the influences of type of cementitious materials and aggregate quality to the compressive strength are similar to those for conventionally placed mass concrete. RCC with high-quality aggregates will produce compressive strength equal to that of conventional concrete.

A primary design consideration for RCC for this project is abrasion-erosion resistance. For both RCC and conventional concrete, resistance to degradation by abrasion-erosion increases with compressive strength. Since hard durable basalt concrete aggregates are readily available, a design compressive strength ($f'c_{90}$) of 5000 to 6000 pounds per square inch should be considered. Based on historical data, an estimated cement content of 500 pounds per cubic yard will be required to achieve this strength level for the RCC.

The foundation and slopes on which RCC is to be placed should be properly prepared to fully support the RCC. The RCC system should be designed similar to a conventional concrete channel liner including a free-draining granular sub-base, weep holes, drains and other special features as needed (Figure 3-3). A significant amount of excavation will be required to remove large boulders and vegetation, level the stream channel invert and trim and excavate the side slopes.

Minor flooding is possible at any time of the year and so construction sequencing and staging is an important consideration. Channel and side slope excavation, foundation preparation and placement of RCC should be accomplished in a staged fashion exposing a minimal amount of the prepared channel that is not protected by RCC. RCC that is in place five to seven days should perform well if exposed to flowing water.

Existing Floodplain Hydraulic Modeling. This analysis assumes that existing right bank levees will fail or become non-effective if a flood event of greater than 25-year return period occurs. The project floodplain thus reverts to the original floodplain that existed before the right bank levees downstream of Station 92+02 were constructed. The areas and depths of flooding were modeled to match the floodplains shown in 'Īao Stream Design Memorandum No. 1, Hydrology, dated March 1974.

Manning Roughness Coefficients. Manning Roughness Coefficients (Table 3-2) are 0.07 for the left bank based on pasture and light brush and 0.015 for the RCC lined main channel. Values of 0.03 are used for the low flow boulder channel located within the RCC lined area. The "n" value shown is taken from the 1976 Design Memorandum.

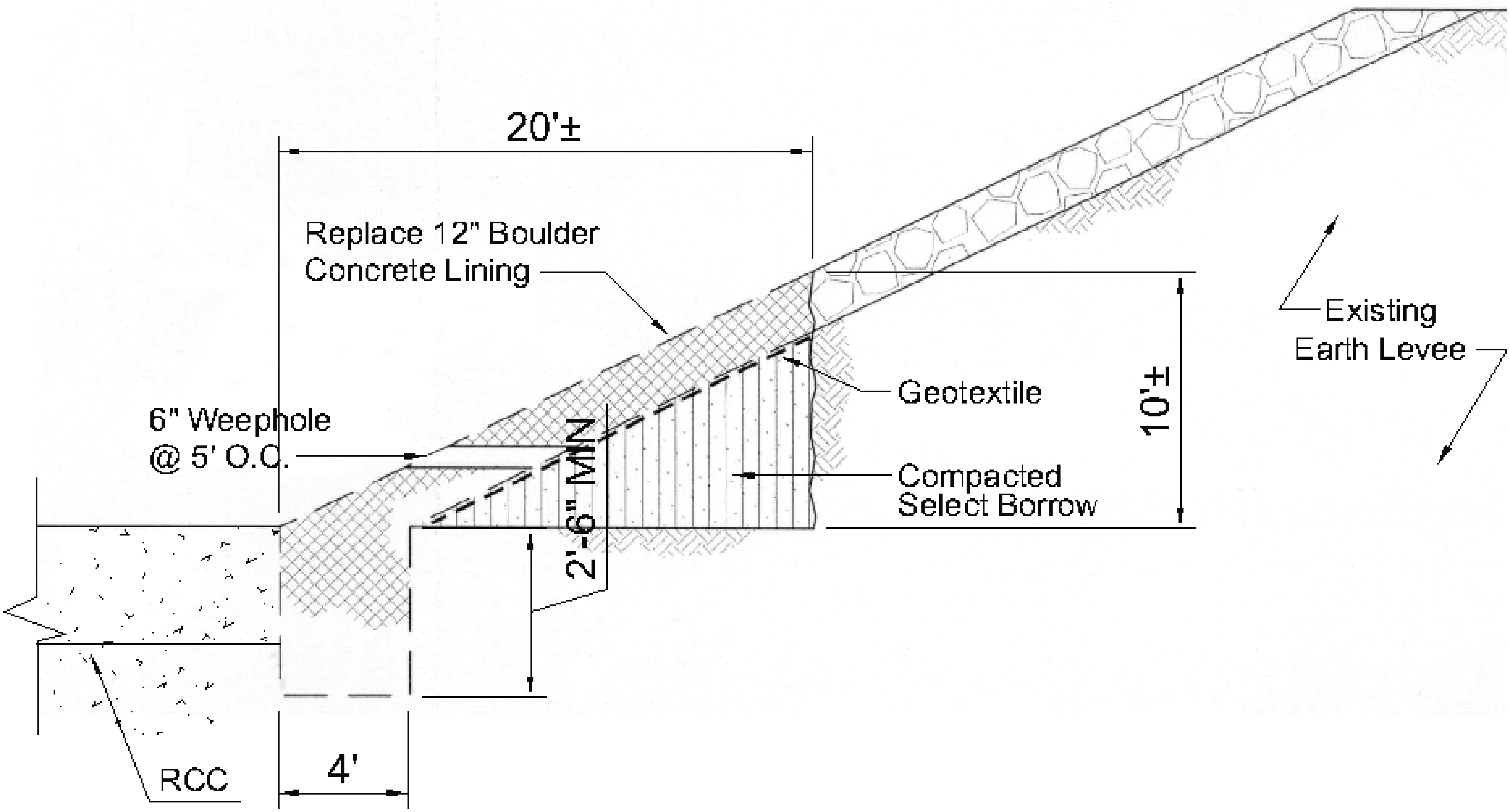
Table 3-2: Roughness Factors Manning's "n"

Item	"n"*
Concrete - RCC Lining	0.015
Boulder Concrete *	0.030
Right Overbank Primary Flow Area	0.032
Grouted Riprap *	0.035
Existing Stream *	0.040
Residential Areas or Pasture/Light Brush *	0.070
Dense Brush *	0.090

Source: *1976 Design Memorandum

Levee Raise Risk and Uncertainty Analyses. The top of levee has been set based on a risk and uncertainty analyses using the guidance provided in EM 1110-2-1619 dated 1 August 1996. The standard deviation used for stage is estimated at 0.6 ft based on Table 5-2 (EM 1110-2-1619); ʻĪao Stream cross sections are based on a topographic map with 4-foot contours and Manning's n reliability is considered good. Assuming that 95 % of the error range would be encompassed by stages two standard deviations above the mean, then 1.2 ft is added to the mean WSEL to determine the upper WSEL. Because ʻĪao Stream experiences rapid flow with significant wave action during floods that is not accounted for in Hydrologic Engineering Center River Analysis System (HEC-RAS), an additional 2.0 ft was added to the upper bound of stage to set the top of levee height. For example, at Station 47+93 the mean WSEL based on HEC-RAS was found to be 104.67 ft above msl (Figure 3-4). Adding 1.2 feet for the upper bound of state plus 2.0 feet for wave uncertainty, the levee height is determined to be 107.87 feet above msl which is 3.37 feet above the existing right bank elevation.

The levees in damage Reaches 2 and 4 between river stations 25+62 and 49+03 have shown in multiple studies that the existing levee heights are not high enough to meet the criteria of the Risk and Uncertainty analysis. The levees may need to be raised as much as four feet in certain areas, however, the existing levee elevations are based on old survey information that has not been updated or tested for accuracy. It is recommended that a survey of the top of the right bank levee be completed during Plans and Specifications to determine the actual height the levee would need to be raised in order to meet the risk and uncertainty requirements stated above.



NOT TO SCALE

ENVIRONET, INC. PRESERVING EARTH'S RESOURCES FOR THE FUTURE	DRAWN BY: B.I.	IAO STREAM FLOOD CONTROL EA	FIGURE 3-3
	CHECKED BY: S.D.	ERODED SLOPE REPAIR WITH ROLLER-COMPACTED CONCRETE	
	REF: USACE		

Construction. Normal construction equipment for this project would most likely include bulldozers, backhoes, front-end loaders, and dump trucks. Alternative III would also include a batch plant with rotating drum mixer, rolling compactors (probably rubber tires), and bottom dump trucks for placing the RCC before it is compacted by the rollers. For Alternatives I and III, concrete trucks with pumping equipment would likely be used to line the channel (Alternative I) or embed the boulders in the bottom of the low-flow channel (Alternative III).

Alternative I. Alternative I consists of a trapezoidal, concrete-lined channel with a 40-foot bottom width and 90-foot top width. The new channel alignment would mostly follow the existing stream alignment from Stations 22+00 (0.5 miles upstream from the stream mouth) and Station 94+00 (2.5 miles upstream from the stream mouth), for a distance of approximately 7,200 ft. However, between Stations 76+40 and 86+60, the channel would be realigned to the north to avoid affecting existing structures on the right of the bank. The channel includes interior splitter walls at all channel curves. All design flows up to the SPF would be contained within the channel, thereby eliminating the need for a floodplain on the left bank of the project and making the land available for development (See Figure 3-5). All the levees could possibly be de-authorized through separate action. The channel would be widened in the vicinity of the 'Imi Kālā Street Bridge to reduce WSELs, reduce erosion potential on the right bank, and accommodate the proposed road and bridge crossing the 'Īao Stream at Station 78+61. Total project cost is estimated at $38.8 million. This alternative would achieve project objectives and is considered to be feasible from an engineering and economic perspective. Negative environmental impacts include potential objections by public and resource agencies with regard to the conversion of a natural stream bottom to a concrete-lined invert.

Alternative II. Alternative II would contain up to the SPF. Alternative II consists of a rectangular and compound, concrete-lined channel with a 20-foot bottom width and 145-foot top width. Improvements would include a straightened alignment and a shallow 55-foot wide grass-lined channel adjacent on the left bank (to contain up to the SPF). Total project cost is estimated at $52.8 million. Although effective in addressing flood control concerns, negative environmental impacts include destruction of the existing stream habitat due to straightening of the natural channel alignment and concrete lining of the stream, which will likely generate strong objections from the public and resource agencies. Due to potentially severe environmental impacts and the likelihood of strenuous objections from the public and resource agencies, this alternative was not carried forward for detailed evaluation.

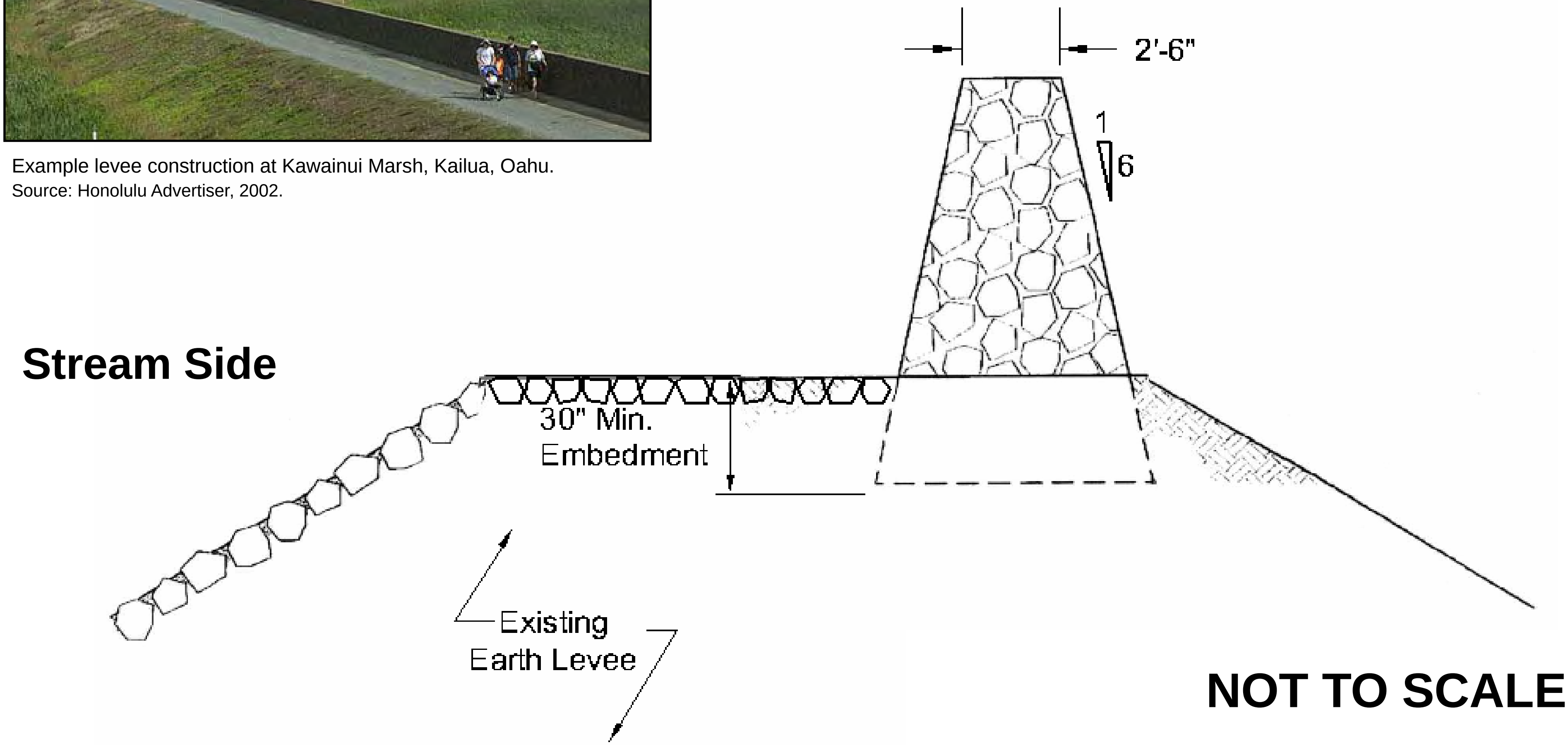
Alternative III. Alternative III would contain 10-year flood events, also known as low-flow events (7,200 cfs) within the structural improvements and overflows up to the SPF within the existing floodplain on the left bank. This alternative would include an RCC-lined main channel with a grouted boulder invert channel, which would mainly follow the existing stream alignment between Stations 22+00 and 94+00 (approximately 7,200 ft long). However, between Stations 76+40 and 86+60, the channel would be realigned to the north to avoid existing structures to the right bank. This alternative involves excavating approximately 8,000 cubic yards of material along the 7,200 foot channel. The channel invert would also be graded in order to place the RCC. The median base width would vary between 40 to 60 ft. Typical stream stabilization improvements would consist of boulders in the main channel low-flow section with RCC stream bank protection on a 1.5:1 (height to volume (H:V)) to 5:1 bank slope. These boulders would replicate a more natural stream invert and facilitate the movement of native fish and other aquatic organisms through the modified low-flow channel area. Channel lining, retaining walls, and raising the levee walls would be necessary due to the excessive flow velocities and higher flood levels. The channel would be widened in the vicinity of the ʻImi Kālā Street Bridge to reduce WSELs, reduce erosion potential on the right bank, and accommodate the proposed road and bridge crossing the ʻĪao Stream at river Station 78+61 (Figures 3-6 through 3-8).

A new ground water recharge basin and diversion levee were considered for inclusion in this alternative. The basin would be constructed by partially blocking the low-flow outlets at the existing debris basin, located approximately 1,100 ft upstream of Market Street at the top of the project. Water would pond in the debris basin and help facilitate percolation into the ʻĪao aquifer during rainy season. The recharge basin was dropped from consideration following the recommendation of USFWS and DLNR-DAR personnel citing negative impacts on aquatic organisms.

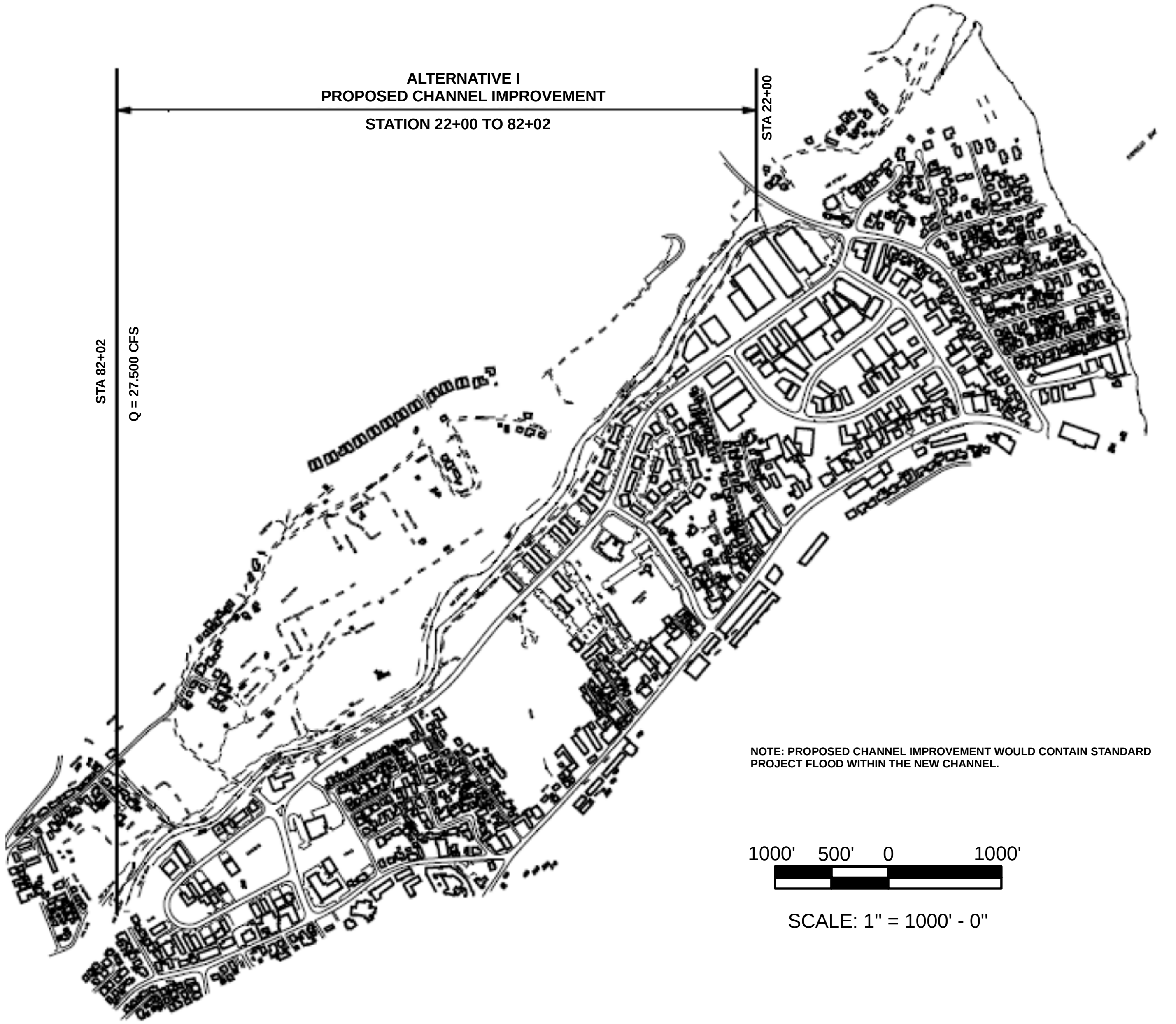
Alternative III would achieve project objectives and is considered to be feasible from an engineering and cost perspective. Total project cost is estimated at $30.1 million.

Alternative III is considered the "environmental alternative", because it would minimize negative environmental impacts to the project area by: 1) utilizing the original floodplain along the left bank of the project for flood flows greater than 7,200 cfs and as a result keeping this area in open space; and 2) incorporating a boulder lined low-flow channel that would simulate a natural stream thereby creating a less severe stream environment than one that is strictly concrete lined. The low-flow channel is also designed to facilitate upstream and downstream migration of aquatic organisms. During discussions between the USFWS and the USACE, additional mitigation measures were discussed. The first is to align the low-flow channel close to stream banks with overhanging vegetation where possible, so that the vegetation will provide shade for the channel, thereby reducing water temperatures.

Example levee construction at Kawainui Marsh, Kailua, Oahu.
Source: Honolulu Advertiser, 2002.



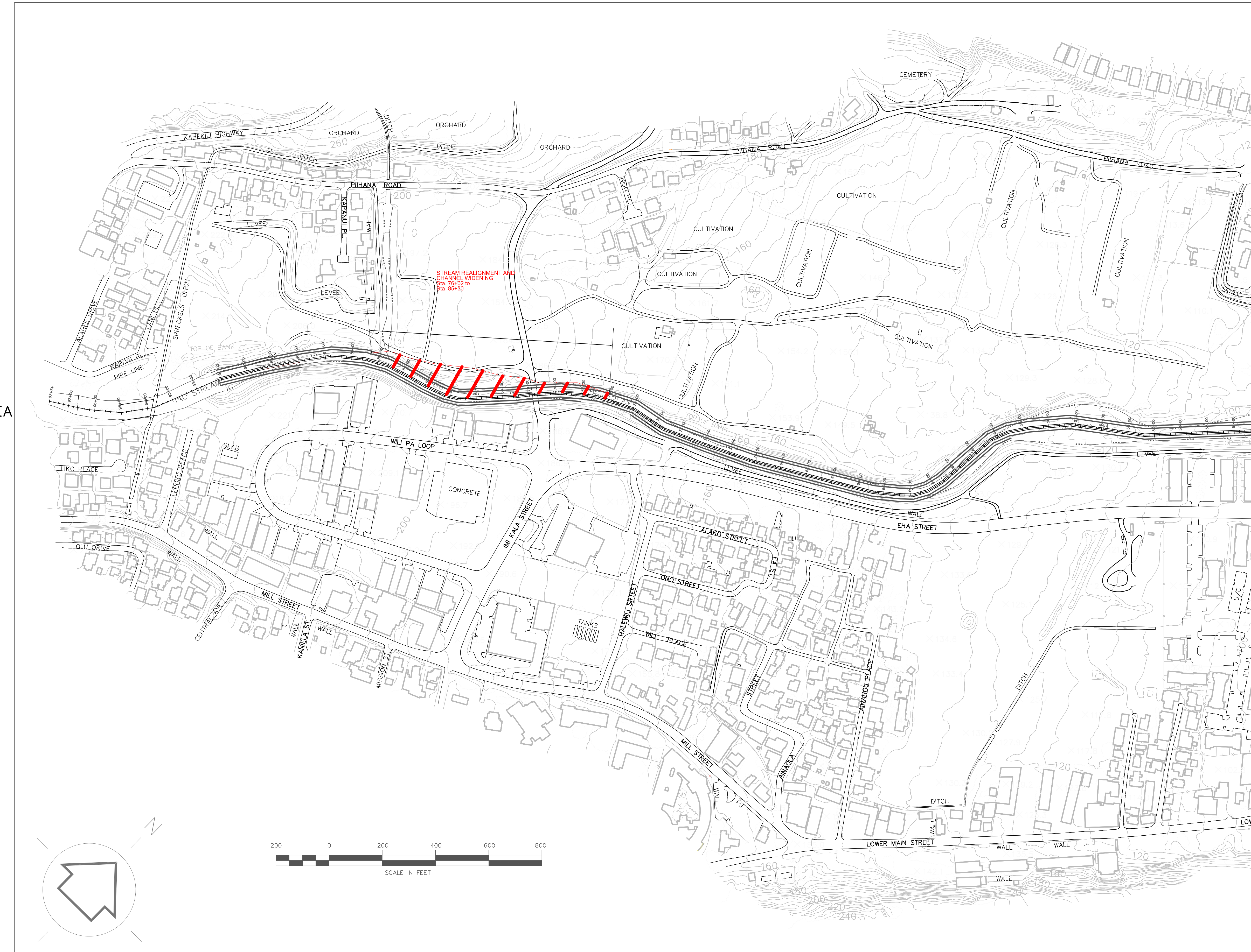
ENVIRONET, INC. PRESERVING EARTH'S RESOURCES FOR THE FUTURE	DRAWN BY: B.I.	IAO STREAM FLOOD CONTROL EA	FIGURE 3-4
	CHECKED BY: S.D.	CONCRETE RUBBLE MASONRY LEVEE WALL RAISE	
	REF: USACE		



ENVIRONET, INC. PRESERVING EARTH'S RESOURCES FOR THE FUTURE	DRAWN BY: B.I.	IAO STREAM FLOOD CONTROL EA	FIGURE 3-5
	CHECKED BY: S.D.	ALTERNATIVE 1: OVERVIEW TRAPEZOIDAL CONCRETE CHANNEL	
	REF: USACE		

LEGEND

- BUILDING
- PAVEMENT
- TRAIL OR EARTH ROAD
- FENCE
- STREAM OR SHORELINE
- 460 INDEX CONTOUR
- INTERMEDIATE CONTOUR
- 416.2 SPOT ELEVATION
- TREES
- TREELINE
- POLE
- STREAM REALIGNMENT AREA



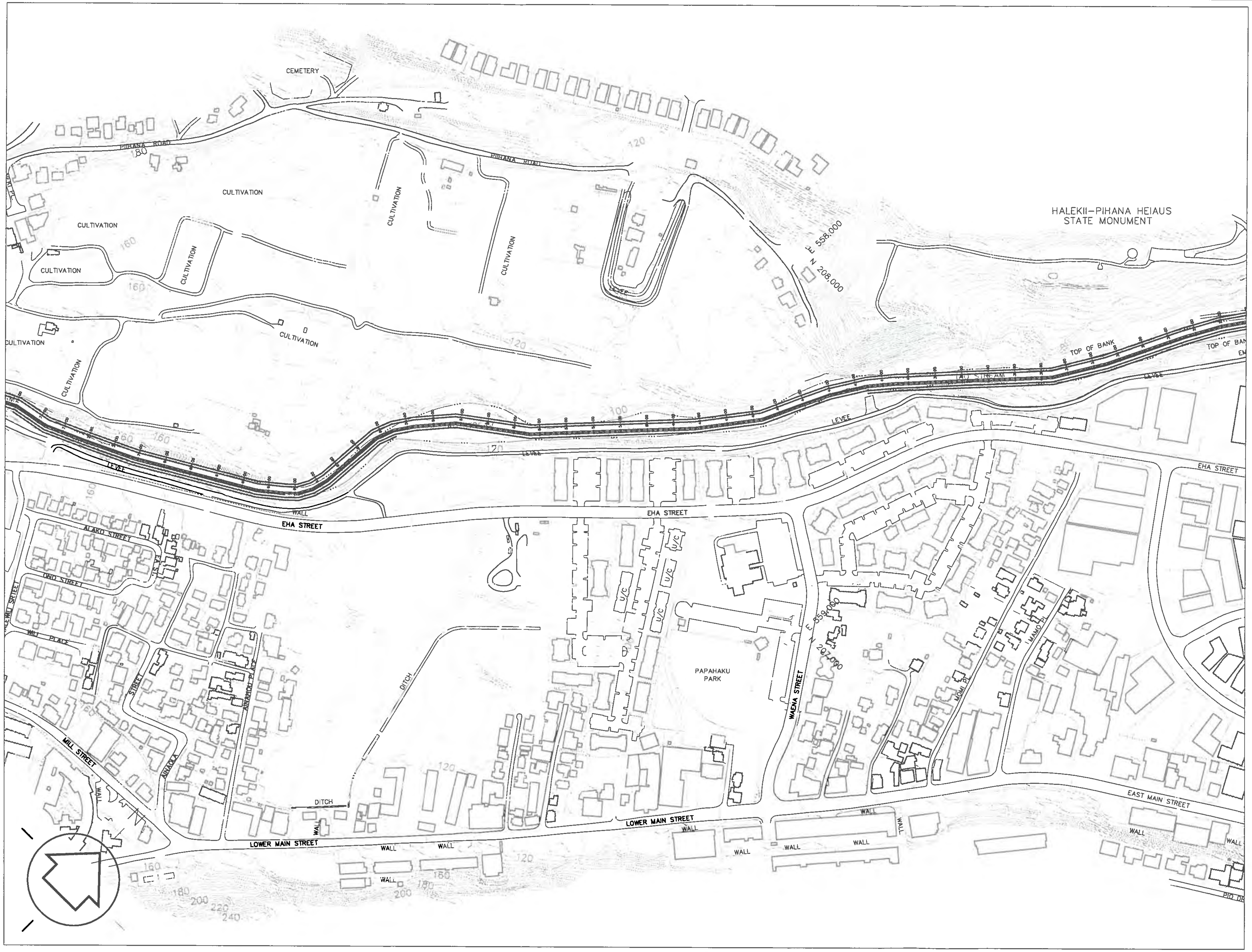
NOTES

1. CONTOUR INTERVAL; 4'.
2. VERTICAL DATUM: MEAN SEA LEVEL.
3. ORIGIN OF COORDINATES: HAWAIIAN PLANE COORDINATE SYSTEM, ZONE 2.
4. COMPILED BY PHOTOGRAMMETRIC METHODS FROM PHOTOGRAPHY TAKEN 8-21-96 AT AN ALTITUDE OF 4400' ABOVE MEAN TERRAIN.
5. ALL CONTOURS IN AREAS WHERE THE HEIGHT OF THE VEGETATION EXCEEDS FIVE FEET ARE TO BE INTERPRETED AS FORM LINES ONLY AND AS SUCH MAY BE SUBSTANDARD.

ENVIRONET, INC. PRESERVING EARTH'S RESOURCES FOR THE FUTURE	DRAWN BY: AEH	IAO STREAM FLOOD CONTROL EA	
	CHECKED BY: SG	ALTERNATIVE III: WESTERN PORTION OVERVIEW IAO STREAM WAILUKU, MAUI, HAWAII	FIGURE 3-6
	REF: USACE		

LEGEND

- BUILDING
- PAVEMENT
- TRAIL OR EARTH ROAD
- FENCE
- STREAM OR SHORELINE
- INDEX CONTOUR
- INTERMEDIATE CONTOUR
- SPOT ELEVATION
- TREES
- TREELINE
- POLE



NOTES

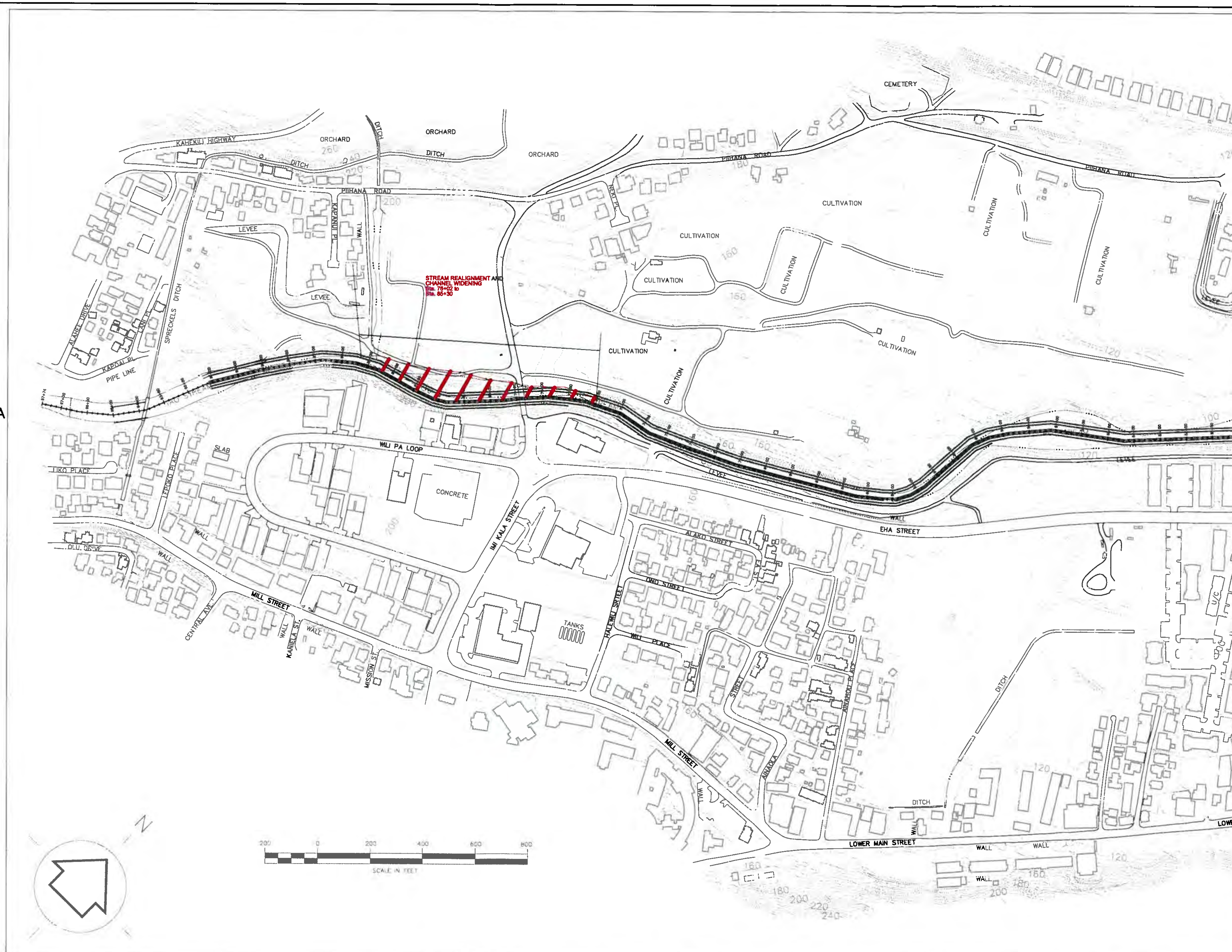
1. CONTOUR INTERVAL; 4'.
2. VERTICAL DATUM: MEAN SEA LEVEL.
3. ORIGIN OF COORDINATES: HAWAIIAN PLANE COORDINATE SYSTEM, ZONE 2.
4. COMPILED BY PHOTOGRAMMETRIC METHODS FROM PHOTOGRAPHY TAKEN 8-21-96 AT AN ALTITUDE OF 4400' ABOVE MEAN TERRAIN.
5. ALL CONTOURS IN AREAS WHERE THE HEIGHT OF THE VEGETATION EXCEEDS FIVE FEET ARE TO BE INTERPRETED AS FORM LINES ONLY AND AS SUCH MAY BE SUBSTANDARD.

ENVIRONET, INC.
PRESERVING EARTH'S RESOURCES FOR THE FUTURE

DRAWN BY: AEH	IAO STREAM FLOOD CONTROL EA	
CHECKED BY: SG	ALTERNATIVE III: CENTRAL PORTION OVERVIEW IAO STREAM WAILUKU, MAUI, HAWAII	FIGURE 3-7
REF: USACE		

LEGEND

BUILDING
PAVEMENT
TRAIL OR EARTH ROAD
FENCE
STREAM OR SHORELINE
460 INDEX CONTOUR
INTERMEDIATE CONTOUR
SPOT ELEVATION
TREES
TREELINE
POLE
STREAM REALIGNMENT AREA



NOTES

1. CONTOUR INTERVAL; 4'.
2. VERTICAL DATUM: MEAN SEA LEVEL.
3. ORIGIN OF COORDINATES: HAWAIIAN PLANE COORDINATE SYSTEM, ZONE 2.
4. COMPILED BY PHOTOGRAMMETRIC METHODS FROM PHOTOGRAPHY TAKEN 8-21-96 AT AN ALTITUDE OF 4400' ABOVE MEAN TERRAIN.
5. ALL CONTOURS IN AREAS WHERE THE HEIGHT OF THE VEGETATION EXCEEDS FIVE FEET ARE TO BE INTERPRETED AS FORM LINES ONLY AND AS SUCH MAY BE SUBSTANDARD.

ENVIRONET, INC.
PRESERVING EARTH'S RESOURCES FOR THE FUTURE

DRAWN BY: AEH	IAO STREAM FLOOD CONTROL EA
CHECKED BY: SG	ALTERNATIVE III: WESTERN PORTION OVERVIEW IAO STREAM WAILUKU, MAUI, HAWAII
REF: USACE	FIGURE 3-8

The second mitigation measure is a retrofit of improved portions of the stream that are currently not conducive to fish and other aquatic organism migration. Retrofit design elements have also been included to facilitate the movement of native organisms through the modified channel area. These elements include a step structure at the 22-foot vertical drop (Station 97+23), widening existing low-flow channel areas, installing low-flow channel segments in existing flat-bottomed cement channel segments and in the center of the existing debris basin, blocks along the sloped portions of the existing channel to provide a resting place for climbing organisms, and an alignment along the vegetated portions of the left bank to provide shade and reduce water temperatures. These mitigation measures have been proposed as compensation for unavoidable impacts, and have been agreed to in a revised mitigation recommendation letter by the USFWS (Appendix J). Therefore, Alternative III is preferred as it would best reduce the flooding problems and minimize or mitigate for unavoidable environmental impacts.

Alternative IV. Rebuilding and extending toe protection was tried at ʻĪao Stream after a storm in January 1980 and after a storm in 1981, as documented by the U.S. Army Engineer Division, Pacific Ocean (USACE, March 1995). ʻĪao Stream has continued to erode adjacent to the toe protection works and is now 8 to 10 ft below the last toe protection repair, completed in November 1983. The toe continues to erode because the cutoff wall at the levee toe is a fixed hard point in a moveable boulder and gravel bed stream. Although COM continues to fill areas adjacent to the toe cutoff wall after flood events by placing boulders against the eroding levee toe, the fixes are temporary because the work is effective for low frequency events (USACE, 2008). No flood events larger than a four % flood have occurred in the ʻĪao Stream since project construction. Floods larger than the four % flood will likely have enough force and duration to erode the stream near the toe of the cutoff wall causing undermining and consequential levee slope failure. Therefore, levee toe protection with a cutoff wall is not considered a viable solution for ʻĪao Stream flood control.

This option would not meet the project objective and erosion would continue to occur. This alternative was therefore not carried forward for detailed evaluation.

Alternative V. Alternative V includes the removal of all concrete and man-made structures constructed since 1981 for the existing Flood Control Project, thereby returning the stream to its original natural condition. This alternative would result in removal of 2,500 linear feet of existing cement-lined stream channel. Urbanized areas adjacent to the stream would become part of the natural stream overbank and would be placed back into the flood plain, subject to flooding.

A flooding warning system would be installed to replace the protection provided by the Flood Control Project levees. The estimated project cost is $34.5 million. Although this alternative does not meet project objectives from an engineering perspective, there is an expressed public support for this alternative due to its environmental benefits, and the alternative was carried forward for further analysis.

Alternative VI. Alternative VI is to not perform the modifications to the existing Flood Control Project. Continued severe erosion may be a result of Alternative VI, contributing to levee failure in multiple locations. This would eventually lead to flooding of the ʻĪao Stream drainage basin as if there were no Flood Control Project. The existing Flood Control Project has instilled a sense of security in the Wailuku community which has grown in size since 1981. A project failure would cause possible loss of life and extensive property damage would be inevitable. Although this alternative is not feasible, it has been carried forward throughout this document to illustrate the "without-project" scenario.

3.1.2 Socioeconomic

Estimated project costs range from approximately $12.5 million to $52.8 million depending on the alternative chosen. Short-term, negative impacts during construction are expected for residences/businesses near the construction areas. With the exception of Alternative V and VI, long-term positive impacts include the protection from erosion and flood damages to life and property from future flooding in the Wailuku area. Long-term positive impacts from Alternative V include restoration of the ʻĪao Stream to a state near its natural condition, although negative impacts such as flood and erosion damages to property would be unavoidable. Alternative VI would leave ʻĪao Stream in its current condition, which would allow the continual erosion of the streambanks and a high risk of flooding. Property damage would occur, and the reversion of the area to a Flood Hazard Area would have a negative impact on businesses in the area.

A Real Estate Planning Report was prepared by the USACE to determine the cost of completing this project according to the recommended alternative, Alternative III, an RCC and boulder invert channel with a 40 to 60-foot bottom. The report found that there is no necessity for relocation of public utilities, and no relocations under PL 91-646 are anticipated. There are no known surface or subsurface minerals that would affect the construction, operation or maintenance of this modification project. The non-Federal sponsor, COM, has been assessed as to its capabilities to acquire the necessary land, easements and/or rights of way (LER) for this modification project. Zoning is agricultural, residential, and industrial (Figure 3-7) and no zoning adjustments or land use change is required for this project (Appendix L)

The modification project will require 4.78 acres of permanent channel improvement easements, 0.32 acres of perpetual joint use road easements, and 2.06 acres of temporary work area easements. The non-Federal sponsor, COM, has approved the Government's standard easement estates for the 3 types of easements necessary for this modification project. There are multiple owners. Baseline cost estimate for real estate includes $118,400 for the easements, a 30 % contingency in the amount of $35,000 and $240,000 for administrative costs, totaling $394,000. A schedule of proposed land acquisition milestones, approved by the Government Project Manager and COM, is included in the Real Estate Planning report, which is included as part of the Engineering Documentation Report (EDR) prepared by USACE (USACE, 2008).

3.1.3 Environmental

Available alternatives include I, III, V, and VI. Of these options, Alternative I would result in the most changes to the existing habitat of the native stream fauna. Proposed changes in stream alignment and smooth concrete channelization would adversely affect existing natural habitat as well as alter stream flow, so that native amphidromous species may not survive. Alternative V presents the least long term alteration to the native environment, as all previous man-made flood control improvements would be removed, thus resulting in a completely natural stream, and a community susceptible to flooding. Alternative VI would have long term adverse impacts from erosion and sedimentation and would not meet the goals of this project. Alternative VI also represents the current condition of the stream, which lacks stream flow approximately 90% of the time and is not conducive to migration of instream aquatic organisms. Alternative III will be able to achieve both flood control and environmental project objectives, as flood control improvements are designed to include a habitat for native species as well as maintaining a flood plain, and low-flow stream channel. Mitigation measures currently under discussion between the USACE, USFWS, and the COM include alignment of the low-flow channel along vegetated stream banks to allow overhanging vegetation to shade the channel and reduce water temperatures, and a potential retrofit of improved portions of the channel that are currently lacking low-flow design elements or that pose a hindrance to migration of aquatic organisms. These mitigation measures have been agreed to by USFWS in a recent revised mitigation recommendation letter (Appendix J) as sufficient compensation for unavoidable impacts to the natural environment.

Alternative III is designed to facilitate upstream and downstream migration of aquatic organisms, given sufficient water flow. Stream flow restoration is a topic that is currently under discussion by state and federal resource agencies, community groups, and private entities that hold licenses for diversion and out-of-stream consumptive use of ʻĪao Stream water. This decision is outside the function and authority of the USACE, however. If and when stream flow is partially restored, the low-flow design elements of Alternative III will function to enhance passage of native stream fauna.

Baffle blocks and a low weir are required to slow down and more evenly distribute high velocity flows before entry to the middle reach of the project within the levee system. This system will be considered for all the alternatives, and consist of nine concrete blocks that would be constructed at Station 94+00, near the downstream end of the existing rectangular concrete channel, and a low weir structure upstream of the baffle blocks in the concrete channel section.

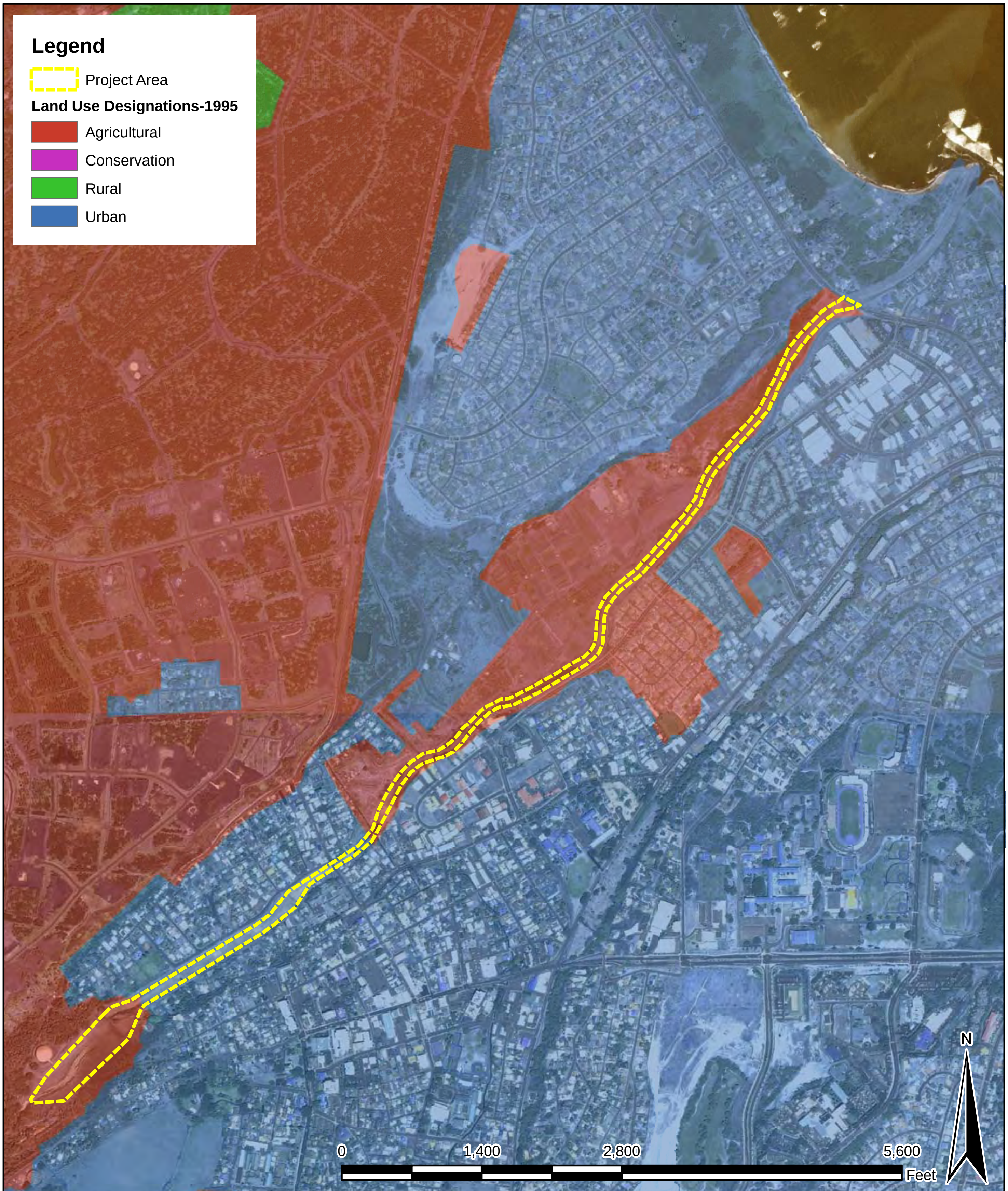
A drop structure would eliminate the existing 22-foot vertical drop at the end of the existing rectangular channel located at Station 97+23. This structure is not required for hydraulic reasons, but is desirable for safety for people utilizing the area and could provide a pathway for the migration of native fish and other aquatic organisms. The decision for the construction of this structure will be determined consistent with COM plans and public interest.

3.2 COMPARISON OF ALTERNATIVES

The alternatives evaluated in this EA are summarized in Table 3-1. Alternatives that are suitable upon evaluation of environmental and social impacts are further discussed in subsequent sections.

3.2.1 Recommended Alternative

Alternative III is the recommended alternative as it addresses both flood control and environmental issues. The selection process for choosing this alternative from the available options presented is three-fold. First, the type of management measures, both structural and nonstructural, are considered in regards to problem resolution and meeting the purpose and constraints for the project. Second, the best management measures are combined with consideration for environmental impacts and mitigation of the affected areas. Third, local community desires and needs are evaluated in detail when considering the selected alternative. Alternative III addresses all concerns as implementation of this design will meet the project purpose of flood control and stream bank stabilization, while minimizing or mitigating for the impact to the existing environment. Recommended mitigation measures include alignment of the low-flow channel along vegetated stream banks to allow overhanging vegetation to shade the channel and reduce water temperatures, and a retrofit of improved portions of the channel that are currently lacking low-flow design elements and a pathway for migration of aquatic organisms.



ENVIRONET, INC.
PRESERVING EARTH'S RESOURCES FOR THE FUTURE

DRAWN BY:	ʻIAO STREAM FLOOD CONTROL EA	
A.E.H.		
CHECKED BY: S.G.	STATE OF HAWAIʻI LAND USE DESIGNATIONS ʻIAO STREAM WAILUKU, MAUI, HAWAIʻI	FIGURE 3-9
REF: HSOP		

Table 3-3: Summary Comparison of Alternatives

	Alternative I	Alternative II	Alternative III	Alternative IV	Alternative V	Alternative VI
Description of Alternative	Trapezoidal Concrete-Lined Channel	Rectangular and Compound Channel	RCC and Grouted Boulder Invert Channel Following Existing Alignment	Levee Reconstruction	Removal of Flood Control Improvements	No Action
Level of Flood Protection	SPF Protection	SPF Protection	SPF Protection	SPF Protection, but risk of structural failure	None. Flood warning system only	SPF Protection, but risk of structural failure
Utilization of Flood Plain	Flood plain may be utilized for other purpose	Flood plain may be utilized for other purpose	Left bank remains a restricted flood plain	Left bank remains a restricted flood plain	Left bank remains a restricted flood plain	Left bank remains a restricted flood plain
Visual Aesthetics	Concrete channel replaces natural stream	Concrete channel replaces natural stream bottom	RCC channel replaces natural bottom; include low-flow channel.	Retains natural stream invert	Natural stream	Retains natural stream invert
Ease of Maintenance	Easiest to maintain	Somewhat easy to maintain	Difficult to maintain	Difficult to maintain. Requires continual repairs of levees	No maintenance required	Future reconstruction is required
Environmental Acceptability	May not be easily acceptable	Not likely to be accepted	2nd most favorable	May be accepted	Most favorable	May be accepted
Technical Adequacy	Meets project objective	Meets engineering project objective but does not meet environmental preservation objective	Meets project objective	Does not meet project objective. Risk of failure remains	Does not meet project objective	Does not meet project objective. Risk of failure remains
Cost	3rd highest cost	Most expensive	4th highest cost	5th highest cost	2nd highest cost	Least expensive

This page is intentionally left blank.

4.0 AFFECTED NATURAL ENVIRONMENT

4.1 GEOLOGY AND SOILS

The Hawaiian Archipelago is a chain of seamounts and islands in the North Pacific extending 1,616 miles west by northwest from the largest island of Hawaiʻi. Volcanic rocks are the dominant rock type and consist of basaltic flows, caldera and dike complexes, and pyroclastics. Sediments include limestone reefs and dunes, beach and dune sands, and alluvium deposited near present day and ancient shorelines, typical of tropical to subtropical atoll cycles. Some ancient limestone reefs and dunes are found inland due to climatic and sea level fluctuations.

The island of Maui, the second largest of the Hawaiian chain, was formed by two volcanoes, East Maui (Haleakalā) and West Maui, linked by the narrow Isthmus of Maui. The older, smaller, and more eroded volcanic center constitutes West Maui, while East Maui is the product of Haleakalā, a younger, much larger, and less dissected volcanic shield (Hazlett and Hyndman, 1996; Stearns, 1985). West Maui rises 5,788 ft above sea level and is 18 miles long and 15 miles wide. Thin flows of pāhoehoe lava formed the young shield of West Maui, completed around 1.3 million years ago. The lavas that erupted during this main stage of growth are known as the Wailuku basalts. Rift zones were developed that trend north and south of the caldera at the summit of West Maui.

As volcanic activity declined, the chemical composition of West Maui's lavas changed from the early frequent and mild eruptions of tholeiitic basalt to more explosive eruptions of alkalic basalt and trachyte during late-stage volcanism. The new cinder cones and domes made the originally smooth profile of West Maui's shield rough. The youngest Honolua lavas probably erupted about a half million years ago (Hazlett and Hyndman, 1996). The younger volcano forming East Maui, Haleakalā, is 33 miles long, 20 miles wide and 10,023 ft high. The volcano first rose above sea level around 900,000 years ago. In its prime, Haleakalā was a vast shield of olivine tholeiite basalts.

About 700,000 years ago, shield growth slowed and explosive eruptions began to produce more alkalic rocks. These eruptions are known as the Kula volcanic formation and continued until about 350,000 years ago. About 100,000 years ago, the rejuvenated stage of volcanism began on Haleakalā, resulting in hundreds of cinder cones and flows of alkalic basalt with ʻaʻā surfaces. Rocks from the rejuvenated stage are the Hāna volcanic formation (Hazlett and Hyndman, 1996). The most recent eruption from East Maui in the early 1790's flowed from the southwest rift zone near Mākena.

Soils in the area of Wailuku retain a high organic matter, and are composed of clay, silt, and sand, mixed with varying degrees of gravel, cobble, and boulders. Major soil types in the vicinity of the stream include 'Īao silty clay, 0 to 3 percent slopes (IaA), Puuone sand, 7 to 30 percent slopes (PZUE), Pulehu cobbly clay loam, 0 to 3 percent slopes (PtA), 'Īao cobbly silty clay, 3 to 7 percent slopes (IbB), Jaucas sand, saline, 0 to 12 percent slopes (JcC), and stony alluvial land (rSM) (Figure 4-1). In its current state, the 'Īao Stream bed is experiencing extreme erosion of the right bank in the vicinity of Station 82+12. The channel has dropped up to nine feet in some locations, and is being actively graded on a regular basis by COM to prevent accelerated erosion. This erosion is likely contributing to sedimentation of the near shore marine environment at the mouth of the 'Īao Stream. While some degree of erosion and sedimentation is natural for any stream system, the erosion experienced during flood events is excessive. Of the proposed alternatives, I and III would eliminate this excessive erosion and resulting sedimentation, but Alternative V would potentially exacerbate it. In turn this would increase the turbidity of 'Īao Stream and siltation of Kahului Bay especially during storm and flood events (see Section 4.5.2 for a more detailed discussion of sedimentation).

4.2 CLIMATE

Maui has a subtropical climate with uniform temperatures year-round. Much like the rest of the Hawaiian Islands, it is dominated by mild temperatures, humid conditions with a variety of rainfall, and a constant trade wind flow from the northeast. The seasons are characterized by two stages consisting of a five-month summer and a seven-month winter. Ocean temperatures range from 77-81 degrees Fahrenheit (°F) in the summer; and 72-77 °F in the winter. From May through September, trade winds prevail 80 to 95% of the time, providing heat relief during the summer months. From October through April, the prevalence of the trade winds decreases to 50 to 80%.

Maui's strikingly different geographic differences of mountains and valleys create numerous microclimates with dramatically different rainfall averages. The project area is generally tropical with cooler and wetter areas at higher elevations.

4.3 PRECIPITATION

Trade winds produce most of the annual rainfall over the Hawaiian Islands; however it is during their absence that most of the flood producing rainfall occurs. Southerly winds bring moist warm air which creates "Kona" storms that produce the damaging floods in Hawai'i. These storms usually occur during the winter months. Rainfall in and around the project area varies greatly due to geographic locations. The mean annual precipitation along the project area varies from about 20 inches along the coastal plain to about 400 inches at the summit of Pu'u Kukui. Precipitation increases with elevation from the coastline, which follows normal orographic patterns for windward areas of Maui. Table 4-1 shows rain gage stations and corresponding data.

Table 4-1: ʻĪao Aquifer System Rainfall Station Data

Station	Station Number	Elevation (ft)	Mean Annual Rain (in)	Median Annual Rain (in)	Period of Record
Puʻu Kukui	380	5788	391.6 380.9	381 NA	1928-02
ʻĪao Valley Cave	380.1	1720	162	NA	1911-14
ʻĪao Needle	387.2	1250	70	70	1949-77
ʻĪao Valley	387.1	720	67.3	66.8	1949-02

Source: DLNR, 2002
ft = feet
in = inches

4.4 OCEANOGRAPHY, HYDROLOGY AND FLOODING

Executive Order (EO) 11988 on Floodplain Management requires the responsible Federal agency to evaluate the proposed action with respect to flood plain management and related controls. Development within the regulatory flood plain is not allowed unless proper provisions to minimize or eliminate flood damages are implemented.

COM is authorized to implement their flood plain management regulations once a flood plain has been delineated on the Flood Insurance Rate Map (FIRM) that is prepared by the FEMA (Figure 4-2). Development within the regulatory flood plain is not allowed unless proper provisions to minimize or eliminate flood damages are implemented.

Existing Conditions

The ʻĪao Stream begins in the upper elevations of the ʻĪao Valley and flows eastward towards the Pacific Ocean, discharging into Kahului Bay. The stream has a drainage basin of approximately 10 square miles (sq. mi.), and is located above the ʻĪao Aquifer (Figure 4-3). The ʻĪao Aquifer is approximately 17.81 sq. mi. (11,400 acres) and is subject to intermittent, high intensity rainfall causing runoff from drainage basins for North and South Waiehu Streams as well as the ʻĪao Stream within the ʻĪao Aquifer boundaries.

The State Commission on Water Resource Management (CWRM) estimates that the ʻĪao Aquifer has a total annual runoff of 54.4 million gallons per day (MGD). Table 4-2 below summarizes stream discharge data for the ʻĪao Aquifer area from DLNR (2002).

Table 4-2: 'Īao Aquifer System Stream Gage Discharge Data

Gage	Drainage Area (sq. mi.)	Period of Record	Average Flow (MGD)	Median Flow (MGD)	Base Flow (MGD)
'Īao Stream	NA	1910-15	51.2 38.7	35.0	13.6
'Īao Stream	5.98	1983-00	42.1	26.5	12.9

Source: DLNR, 2002

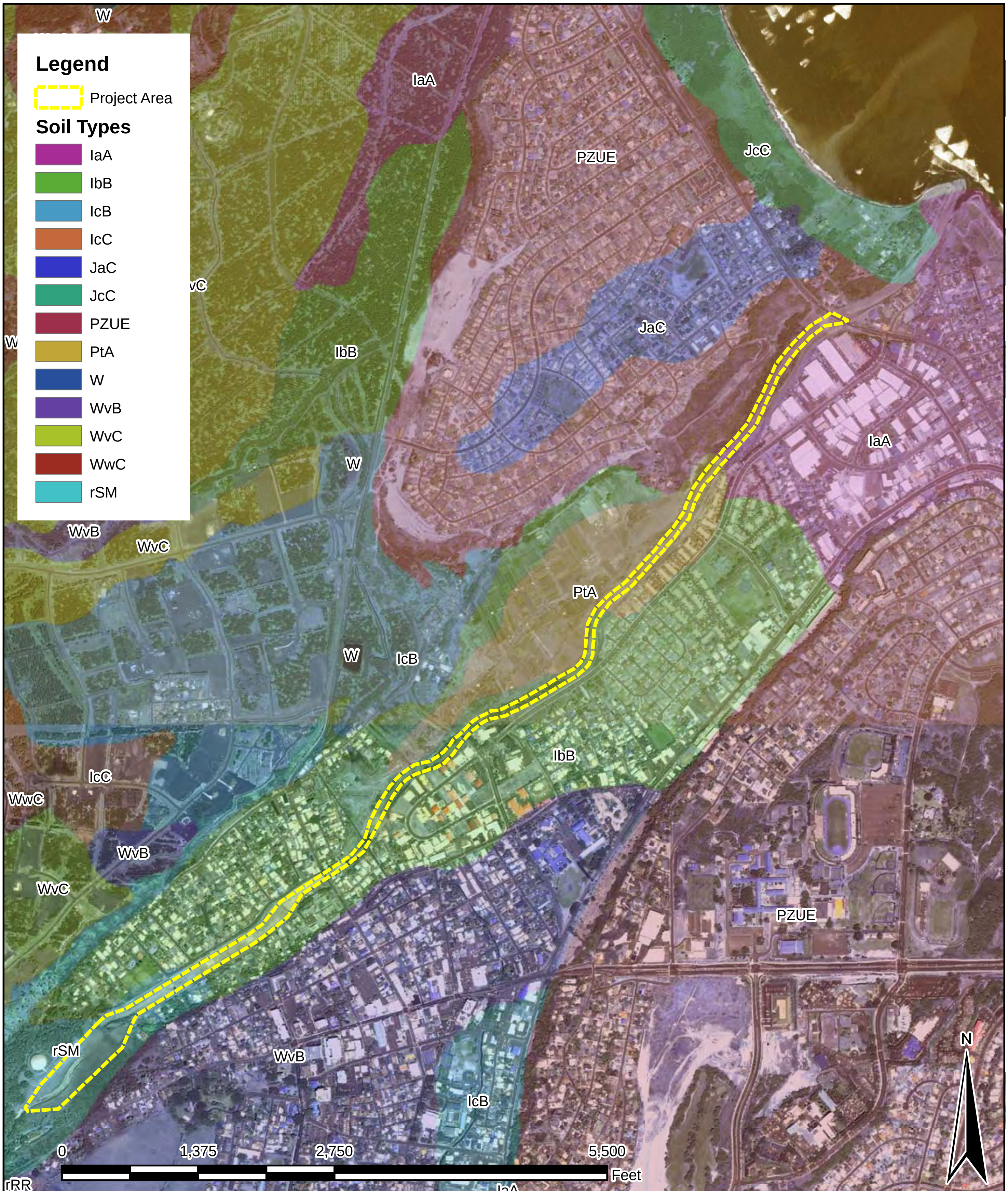
Groundwater occurs in the upper regional high-level dike confined water, lower regional basal water, and caprock water. The basal aquifer's initial volume is computed to be 220 billion gallons. Potable ground water in the 'Īao Aquifer system is found in high-level and basal portions of the system while non-potable ground water is found in the caprock. CWRM records indicate there are a total of 48 listed wells, test holes, and tunnels within the 'Īao Aquifer system.

Stream Description and Flow Records

'Īao Stream is one of three major waterways on the island of Maui. Located on the windward side of the West Maui Mountains, the stream has a drainage basin of approximately 10 sq. mi. The headwaters of 'Īao Stream begin in the upper elevations of the 'Īao Valley near Pu'u Kukui, originating from the confluence of the Po'o hahoahoa and Nakalaloa Streams. Flowing eastward towards the Pacific Ocean, the stream is joined by a third major tributary, the Kinihapai Stream about 3,100 ft from the Po'o hahoahoa-Nakalaloa confluence.

Except for its flood plain along the west bank, 'Īao Stream has a width of about 2.5 miles at the debris basin to about a half a mile near the stream outlet. The stream is about 10,000 ft in length, and about 30% is lined with existing concrete channels. The remaining 7,200 ft of the stream is an alluvial channel where the stabilization problems occur. Levees are situated on the right bank to protect the town of Wailuku.

The stream is perennial and is subject to short duration, high intensity rainfall typical of the windward geomorphic region. Stream flow is intermittent below the 'Īao Intake due to three diversion structures which redirect the water to agricultural interests in the drainage basin. Downstream of the diversions, 'Īao Stream can be characterized by the absence of water about 80 to 90% of the time, punctuated by infrequent high flows when stream discharge volume is sufficient to overtop the water diversion structures (USFWS, 2006). Water flows into the channelized portion of 'Īao Stream only during periods of prolonged intense rainfall.



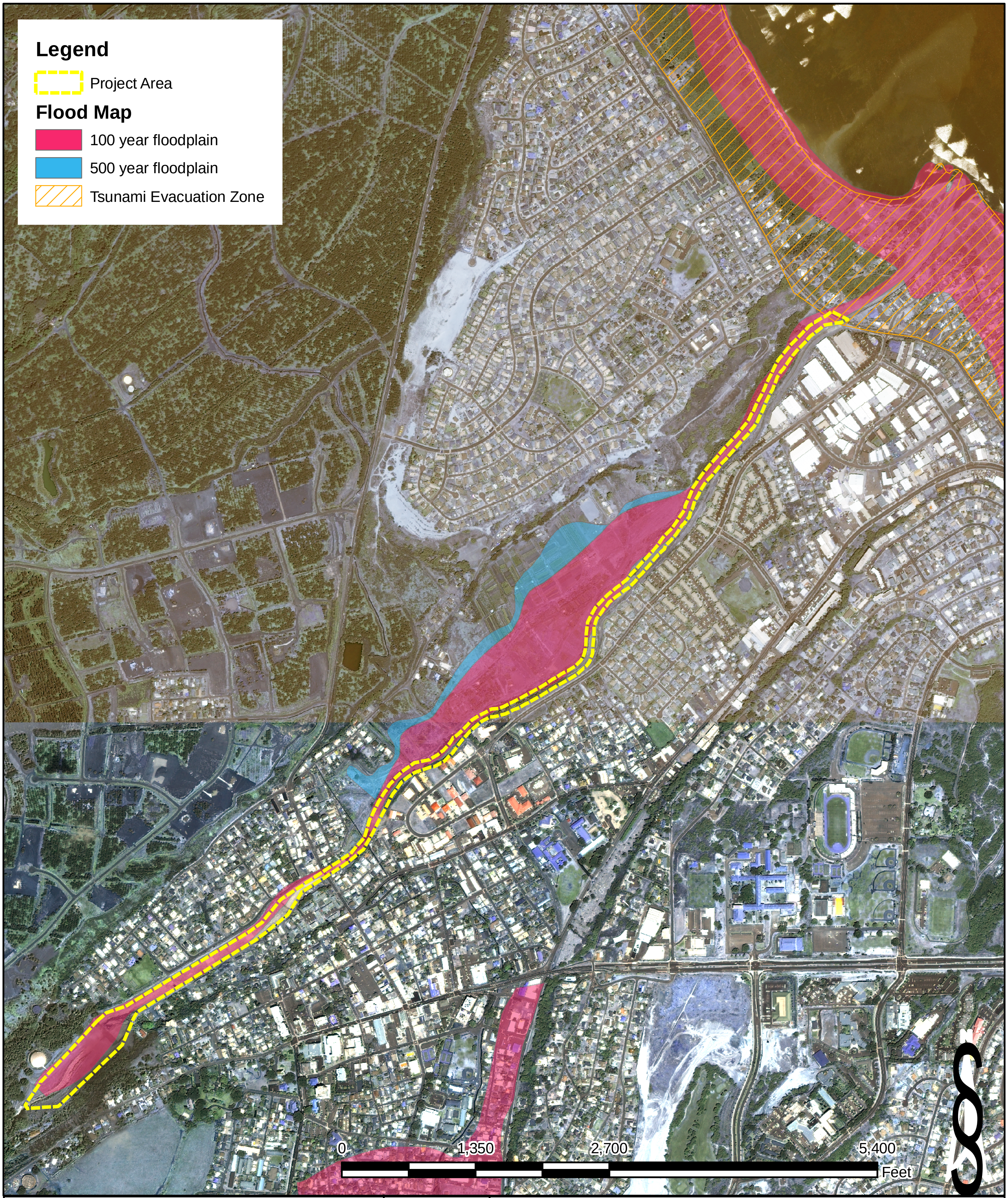
ENVIRONET, INC.
PRESERVING EARTH'S RESOURCES FOR THE FUTURE

DRAWN BY: A.E.H.
CHECKED BY: S.G.
REF: USGS

ʻIAO STREAM FLOOD CONTROL EA

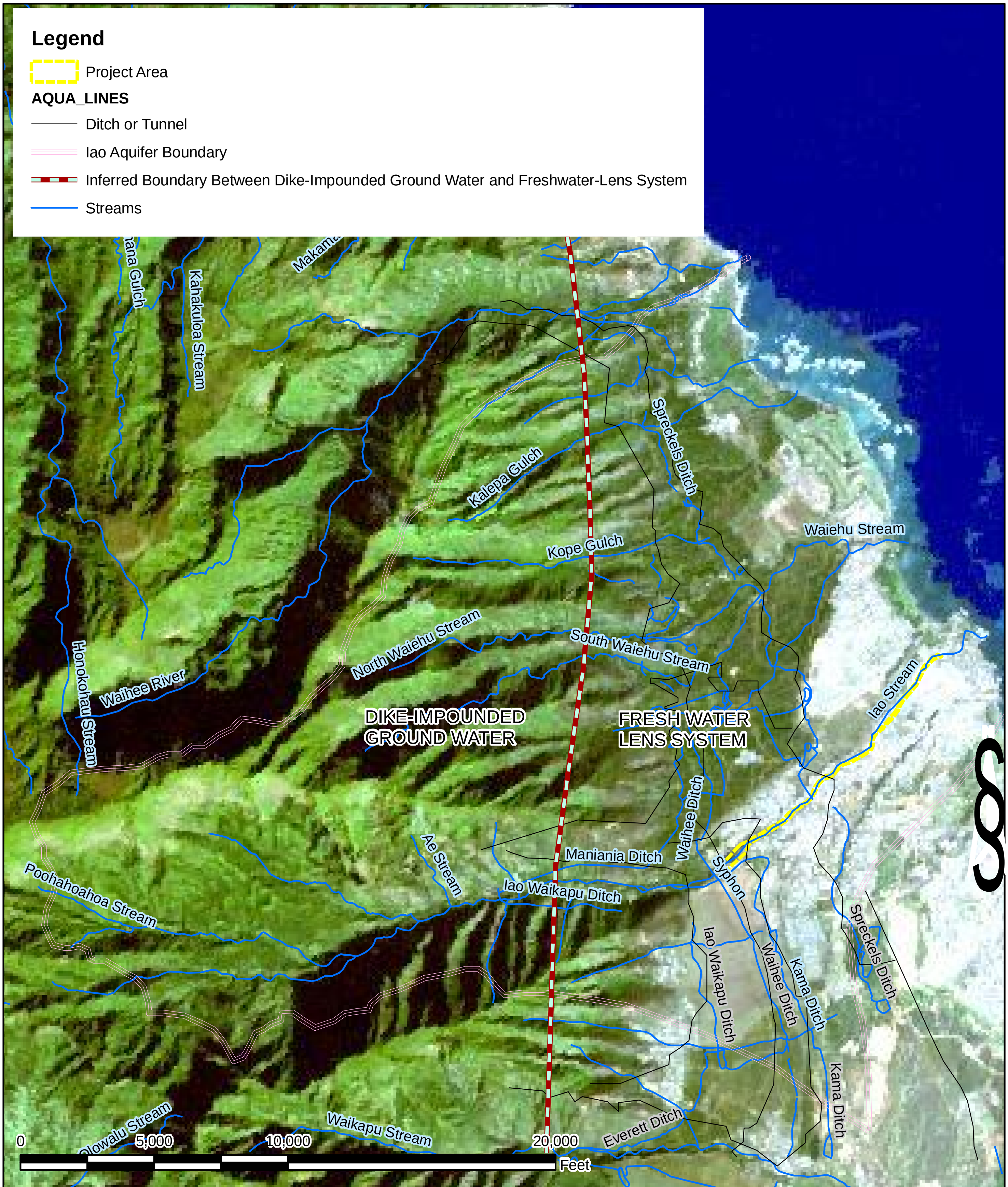
SOIL TYPES
ʻIAO STREAM
WAILUKU, MAUI, HAWAIʻI

FIGURE 4–1



ENVIRONET, INC.
PRESERVING EARTH'S RESOURCES FOR THE FUTURE

DRAWN BY:	`IAO STREAM FLOOD CONTROL EA	
A.E.H.		
CHECKED BY: S.G.	FLOOD ZONES `IAO STREAM WAILUKU, MAUI, HAWAI`I	FIGURE 4 - 2
REF: FIRM		

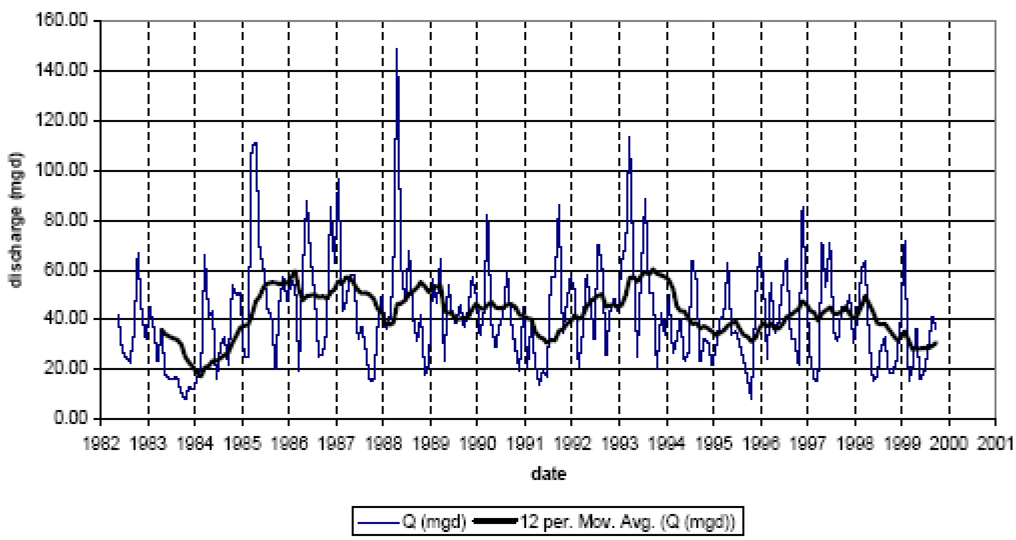


ENVIRONET, INC.
PRESERVING EARTH'S RESOURCES FOR THE FUTURE

DRAWN BY: A.E.H.	`IAO STREAM FLOOD CONTROL EA	
CHECKED BY: S.G.	`IAO AQUIFER `IAO STREAM WAILUKU, MAUI, HAWAI`I	FIGURE 4 - 3
REF: USACE		

Since completion of the original federal project in 1981, the maximum discharge experienced in the 'Īao Stream is approximately 4,100 cfs, and the average channel velocities throughout the natural portion of the channel range between about 8 and 32 fps during a project design discharge event with average velocities in excess of 20 fps at most places in the natural reach. Table 4-3 below summarizes stream flow data for 'Īao Stream at Kepaniwai Park (Stream Gage No. 16604500) from 1982 to 2001.

Table 4-3: 'Īao Stream Average Monthly Flow



Source: DLNR, 2002

The lack of consistent stream flow has been reported as detrimental to aquatic resources in the stream (USFWS, 2006). Observations by DLNR-DAR staff made at the lower channel and mouth of 'Īao Stream provide an estimate of the number of days per year that the stream flows through the extent of the channel and reaches the sea. These estimates are shown in Table 4-4.

Because of these long periods in which the stream is not flowing to the ocean, there has been an impact on native organisms that are migrating both upstream and downstream, and get stranded during the dry times. These impacts are discussed in further detail in Section 4.5.

Flooding

A history of flooding during and after the completion of the 'Īao Stream Flood Control Project in 1981 has caused extensive streambed erosion (Figure 4-4 and 4-5). This is of great concern due to the high probability of future flood damage in the community. During the original project construction, a January 1980 flood caused extensive erosion which undermined portions of the completed levees. Shortly thereafter, in 1981, high stream flows eroded a 980 foot reach of the stream bottom above Waiehu Beach

Road. Then again in 1989, more flood damage occurred along the streambed. Overall, damage in the form of erosion is slowly compromising channel stability and undermining portions of the existing levees.

Table 4-4: ‘Īao Stream Estimated Days of Continuous Flow to the Ocean

YEAR	Days of flow to ocean (approx.)	Percent of days per year of stream flow to ocean
1993-94	72	20
1994-95	33	9
1995-96	35	10
1996-97	39	11
1997-98	48	13
1998-99	34	9
1999-00	18	5

Source: USFWS, 2006

Potential Effects and Mitigation

Alternatives I and III are designed to improve the existing Flood Control Project and Alternative V is designed to restore the ‘Īao Stream to its natural condition prior to man made improvements made before 1981. Flooding would be mitigated with Alternatives I and III, but significant adverse affects of flooding would be expected under Alternatives V and VI which lack sufficient improvements to prevent water from overflowing the streambanks and entering the surrounding communities during high intensity rainfall events.

Alternatives I and III address the current stabilization problems by converting an additional 7,200 ft of natural stream bottom to a concrete-lined channel; smooth concrete for Alternative I and a RCC and boulder-grouted invert channel with the potential for vegetative growth for Alternative III. Alternative V would likely exacerbate the stabilization problems by removing all improvements from the stream. Alternative VI would likewise allow for further stabilization problems, although to a lesser degree than Alternative V.

View from right bank looking west from top of levee at approximate Station 24+00

Channel invert eroded 6' to 8' below original channel cutoff walls

Slope failure of levee on right bank at approximate Station 39+00

Maintenance performed by Maui County includes placing stone along the toe of the levee as an interim repair measure

Erosion of channel invert causing undermining of 'boulder concrete' along right bank

View looking west from the right bank

ENVIRONET, INC. PRESERVING EARTH'S RESOURCES FOR THE FUTURE	DRAWN BY: B.I.	`IAO STREAM FLOOD CONTROL EA	
	CHECKED BY: S.G.	STREAMBED EROSION PHOTOGRAPHS `IAO STREAM WAILUKU, MAUI, HAWAI`I	FIGURE 4 - 4
	REF: USACE		

View looking at the area of "boulder concrete"
that is being undermined by erosion

Imi Kala Street Bridge (To be replaced by others)

View looking east from the right bank
Note the proximity of homes to the levee

View looking downstream from the Imi Kala Street Bridge

View looking upstream at the left bank
Note vegetation and erosion

View looking upstream from the Imi Kala Street Bridge

ENVIRONET, INC. PRESERVING EARTH'S RESOURCES FOR THE FUTURE	DRAWN BY: B.I. CHECKED BY: S.G. REF: USACE	`IAO STREAM FLOOD CONTROL EA STREAMBED EROSION PHOTOGRAPHS `IAO STREAM WAILUKU, MAUI, HAWAI`I	FIGURE 4 - 5

The current stream is characterized by intermittent stream flow in the downstream reaches of the project. An increase in the rate and volume of water flow through the channel during heavy rainfall events would be anticipated with Alternative I due to the smooth, concrete lined channel bottom and increased flows contained within the channel, due to the removal of a flood plain. Alternative I would not provide a means to maintain a low-flow stream in the absence of high volume events. Alternative III addresses this by altering the 7,200 ft to a RCC channel with a low-flow grouted-boulder invert channel that would facilitate the migration of native organisms. Alternatives V and VI retain 7,200 ft of natural alluvial stream bed which is currently unstable.

Due to the infrequent nature of water flow in the lower portions of the ʻĪao Stream and the high wave energy system of the near shore environment (Appendix E), none of the proposed alternatives would be expected to cause a long-term adverse effect on oceanographic characteristics of the area, adjacent beaches, or the inshore water circulation patterns (although see Section 4.5 for a discussion of sedimentation).

Alternative I would be expected to adversely affect groundwater recharge due to the elimination of the flood plain and hardening of the stream channel along the entire length of the project. This would be mitigated under Alternative III, which includes weepholes in the RCC lining and retains the existing floodplain. The proposed recharge basin was dropped from consideration following the recommendation of USFWS and DLNR-DAR personnel. The retention of the flood plain will facilitate percolation into the ʻĪao Aquifer during rainy season. Groundwater recharge would also be enhanced under Alternative V, which removes all concrete lining of the channel along the entire length of the project area and retains the flood plain. Alternative VI would provide the same level of groundwater recharge currently experienced in the area.

Implementation of Alternative I would close off the existing floodplain on the left bank and make it available to be utilized for future developments in the Wailuku area, whereas Alternatives III, V, and VI are designed to allow the floodplain to remain as is.

4.5 WATER QUALITY

4.5.1 The Federal Water Pollution Control Act (FWPCA)

Section 402 of the 1972 amendments established the National Pollutant Discharge Elimination System (NPDES) to authorize the EPA issuance of discharge permits (33 USC 1342). Section 403 stipulated guidelines for EPA to issue permits for discharges into the territorial sea, the contiguous zone, and ocean waters further offshore (33 USC 1393).

The Clean Water Act (CWA) of 1977 (PL 95-217) expanded provisions related to pollutant discharges and applies regulatory and non-regulatory tools to reduce point source and non-point source pollution, in addition to setting standards for water quality.

Impacts to the water quality are based on: 1) whether the alternatives will create an imbalance of chemical, physical, and biological integrity to the stream waters; 2) possible negative effects on existing aquatic species and recreation in and on the water; and 3) duration of imbalance. Applicable Army regulations include Army Regulation (AR) 200-1 and ER-200-2-3, as the policy of the Army is to ensure the availability, conservation, and protection of water resources of civil works activities that are under the jurisdiction of the USACE.

Existing Conditions

Water sampling was conducted from October of 1996 to September of 1997. Sampling and analysis were performed at four locations in the near shore ocean off of the mouth of the ‘Īao Stream. To obtain representative sampling, a set time and date was chosen for the monthly sampling. Sampling reports are included in Appendix E.

Results of the analysis showed no distinct patterns. Turbidity and potential hydrogen (pH) were similar at all stations. Near shore waters in the sampling area were turbid with very limited visibility due to strong winds and large waves caused by consistent northeasterly trade winds and currents.

Potential Effects and Mitigation

The presented alternatives would involve a discharge into waters of the United States and would require preparation of a Section 404(b) (1) evaluation by the Corps which has been conducted and is included in Appendix G. A Section 401 State Water Quality Certification (WQC) from the State of Hawai‘i Department of Health (HDOH) would also be required. In addition, the HDOH may require a NPDES permit.

Some degree of erosion and sedimentation is expected for any natural stream system. The ‘Īao Stream system is experiencing accelerated erosion during high water flow events, which likely contributes to short-term increases in turbidity of Kahului Bay. An increase in turbidity is likewise inevitable if water is flowing in the stream during construction. This is the case for all available alternatives. The general contractor is required to use silt containment devices and other known methods to control turbidity to the maximum extent practicable. Construction will be timed to coincide with the dry season, as much as is practicable. Low water flows will be diverted away from the work area, particularly during grading. Any flows greater than the 1 to 2 year storm event would most likely flow through the work area. The

USACE will monitor the marine water quality at the mouth of the stream before, during, and after construction to assure water quality standards are not exceeded. Best management practices (BMPs) will be strictly adhered to during construction.

4.5.2 Section 303(d)

Section 303(d) of the CWA requires states to maintain a list of water bodies that do not meet, or are not expected to meet state water quality standards. States must obtain and review all readily available surface water quality data to compare against state standards, and then make a decision on the level of impairment for each waterbody. The listing applies to both point and non-point sources of pollution, and must include a listing of pollutants for which applicable standards are exceeded.

Existing Conditions

The segment of the 'Īao Stream discussed in this EA is classified as "Class 2 inland waters" by the State of Hawai'i. The objective of Class 2 waters is "to protect their use for recreational purposes, the support and propagation of aquatic life, agricultural and industrial water supplies, shipping, and navigation" (Hawai'i Administrative Rules (HAR) §11-54-3(b)(2)). Kahului Bay is classified as "Class A marine waters" by the State of Hawai'i. It is the objective of Class A waters "that their use for recreational purposes and aesthetic enjoyment be protected" (HAR §11-54-3(c)(2). This section includes a discussion of the anticipated effects of the proposed alternatives on the water quality of 'Īao Stream and Kahului Bay.

The State of Hawai'i's most recent list is the 2004 303(d) list (HDOH, 2004), which includes a listing of impaired waterbodies and a low, medium, or high prioritization for total maximum daily load (TMDL) development. 'Īao Stream and Kahului Bay, into which 'Īao Stream flows, are included on the state list.

The 'Īao Stream is included in the 2004 303(d) list as a high priority impaired waterbody for turbidity and trash. This listing was based on a visual, rather than a numerical assessment. The source of trash in the 'Īao Stream was not identified as originating from a specific source or point, and is thus assumed to fall into the category of non-point source discharge. The amount of trash discharged into the stream is a function of residents of the surrounding area and their actions. None of the proposed alternatives are expected to have any significant influence on the amount of trash deposited in or near the stream by residents of the area.

The second parameter, turbidity, is a measurement of the degree of cloudiness, or murkiness of the water. Turbidity is largely determined by the amount of suspended particulates found in the water. Particulates are typically sediment particles, although they can also be phytoplankton or zooplankton, or small fragments of organic detritus, such as dead plant or animal material. The amount of suspended particulates in the ʻĪao Stream can be affected by the degree of stream bank erosion and methods for trapping or reducing sediment load within the stream. A reduction in erosion would result in lowered turbidity, or increased water clarity.

Potential Effects and Mitigation

Alternative I would provide a reduction in streambank erosion, but would not provide vegetation to trap or reduce particulate load in the water. Alternative III would provide a reduction in streambank erosion, and would also provide a vegetative buffer on the floodplain and habitat for natural aquatic plant life on the channel bottom, which would help trap and anchor particulates in place. Alternatives V and VI would not provide substantial reduction of erosion and sedimentation, and thus turbidity would not be decreased. Of the alternatives discussed, Alternative III would provide the maximum potential for reducing sediment load by stabilizing the streambank, maintaining a flood plain as a buffer for high volume water events, and by providing a habitat for natural aquatic organisms, which help trap and anchor particulates in place along the stream bed.

Kahului Bay is included in the 2004 303(d) list as a low priority impaired waterbody for turbidity, chlorophyll a, total nitrogen (N), nitrite/nitrates, and ammonium. This listing was based on numerical assessments in both wet and dry conditions for all standards, with the exception of total N, which only exceeded the standard under wet conditions. These pollutants likely originate from a number of non-point sources both along the shoreline as well as throughout the watershed. The ʻĪao Stream, as one of the major sources of freshwater discharging to the bay, has the potential to affect the water quality of the bay. Improvements to the water quality of the stream will result in improvements to the water quality of Kahului Bay. As discussed in the paragraph above, Alternative III is expected to provide the greatest reduction in suspended particulates and sediment in the ʻĪao Stream, and will also provide some uptake of nutrients via the plants allowed to grow in the channel.

A decrease in turbidity of the ʻĪao Stream would be expected to also prevent an increase in turbidity of Kahului Bay over the long term. The other pollutants listed for Kahului Bay can also be reduced by improving the water quality of the ʻĪao Stream. These pollutants are not limited to stream bank erosion, however, and are more difficult to identify and reduce. Typical targets for excess nutrient load include fertilizer use, animal wastes, and urban runoff. While none of these targets can be directly addressed through the ʻĪao Stream Flood Control Project, Alternative III would allow for uptake of nutrients by vegetation in the channel and the flood plain on the left bank.

Alternative I would not provide habitat for natural vegetation in the channel or flood plain. Alternative V would provide maximum habitat for natural vegetation, but would most likely result in increased erosion and sedimentation. Alternative VI would also retain a large area of natural vegetation, but would not stop the erosion and resulting sedimentation experienced during high water flow events. Of the alternatives considered, Alternative III would provide the maximum potential for reducing both sediment and nutrient loading of Kahului Bay.

Both the ʻĪao Stream and Kahului Bay are assigned into EPA Category 5, where "water is impaired or threatened and a TMDL is needed." Factors for determining the priority level included the severity of pollution (both number of pollutants listed and degree to which standards were exceeded); the uses of the waters; type and location of the waterbody; degree of public interest; and vulnerability of the waters. As mentioned above, the ʻĪao Stream was assigned a high priority for the development of a TMDL, while Kahului Bay was assigned a low priority for TMDL development.

4.6 TERRESTRIAL AND AQUATIC BIOLOGICAL RESOURCES

Pursuant to the Fish and Wildlife Coordination Act (FWCA) of 1946, projects by any agency under Federal permit or license that involve the "waters of any stream or other body of water (which) are proposed or authorized, permitted or licensed to be impounded, diverted . . . or otherwise controlled or modified" must consult with the USFWS and the fish and wildlife agencies of the state where the project is to take place. In conjunction with USACE, ER 1130-2-540, consultation and environmental maintenance is to be undertaken for the purpose of preventing loss and/or damage to wildlife/environmental resources.

The FWCA requires that proposed USACE actions be coordinated with the USFWS, the National Marine Fisheries Service (NMFS), and the appropriate head of the state agency (DLNR) exercising administration over fish and wildlife resources. A FWCA Revised Draft Report was prepared by the USFWS to describe existing conditions and assess potential resource impacts associated with the ʻĪao Stream Flood Control Project (USFWS, 2006). The report in its entirety is included as Appendix A. Key elements of the report are included in the discussion below.

Existing Conditions

Sufficient documentation and information is available to characterize the existing biological resources conditions, thus a survey was not conducted for terrestrial and riparian biological resources within the project area. The proposed alternatives will subject terrestrial and riparian species to minimal adverse impacts. A review of Scientific Consultant Services/Cultural Resource Management Services (2003) prepared for the ʻĪao Stream area indicates the presence of the following terrestrial vegetation and wildlife species in the project area and the general vicinity:

Table 4-5: Vegetation and Wildlife Observed in the Project Vicinity in Previous Reports

	Vegetation	
Sub-Region	Scientific name	Common Name
Coastal Lowlands	ns	sugarcane
	Prosopsis pallida	*kiawe*
ʻĪao Valley entrance	*Persea americana*	avocado
	Aleurites moluccana	*kukui*
	Eugenia cuminii	java plum
	Samanea saman	monkeypod
	Melia azedarach	pride of India
	Mangifera indica	mango
	Psidium guajava	guava
Higher valley slopes	*Casuarina equisetifolia*	ironwood
	Leucaena sp.	*koa haole*
	Wildlife	
Sub-Region	Scientific name	Common Name
Drainage basin	ns	*amakihi*
	ns	*apapane*
	ns	Kentucky cardinal
	ns	house finch
	ns	house sparrow
	ns	mockingbird
	ns	mynah
	ns	red-billed leiothrix
	ns	white eye
	ns	pacific golden plover
	ns	ruddy turnstone
Upland	ns	barr doves
	ns	lace necked doves
	ns	pheasants
	ns	Franklin partridge
Lowland area and seashore marsh south of the project area	ns	black-crowned night herons
	ns	egrets
	ns	Hawaiian stilt

ns = not specified

Source: SCS/CRMS, Inc., 2003

Other terrestrial fauna observed in the vicinity of the project include introduced species such as cats, mice, rates, and mongoose. Game animals such as wild goats, pigs, and deer have been reported to occur in the forest reserve area.

Additional riparian and terrestrial vegetation in and around project site can be characterized as coastal dry forest and consists of at least nine plants species: Bermuda grass (*Cynodon*), bristly foxtail (*Setaria* *verticillata* L.), finger grass (*Chloris* L.), *kiawe* (*Prosopis pallida*), klu (*Acacia farnesiana* L.), lantana or *lakana* (*Lantana camara* L.), *koa haole* (*Leucaena leucocephala*), sand bur (*Cenchrus* L.; endemic), and natal red top (*Rhynchely trum repens* Wild.) (SCS/CRMS, Inc., 2003).

According to wetland maps created by the USFWS, several freshwater emergent wetlands may be located adjacent to the project limits (Figure 4-6), although some of the depicted wetlands occur in areas currently developed for residential or commercial purposes. The mapped wetlands may or may not be present, and would require field verification to definitively prove their presence. The other potential wetland area occurs in the managed flood plain on the north side of the ʻĪao Stream. No wetlands are depicted within the boundaries of the actual project. These downstream portions of the project were heavily modified between 1968 and 1981 (USFWS, 2006), and this project does not constitute new development of an emergent wetland, but rather maintenance of an existing structure.

UWFWS personnel conducted a habitat characterization assessment of the ʻĪao Stream in the vicinity of the ʻImi Kālā Street Bridge (USFWS, 2006). Based on an assessment of nine factors, the stream was assessed to have a total score of 83 out of 135 points, or a score of 61.5%. According to the grading matrix, this score puts ʻĪao Stream in the category having habitat that is partially supportive of aquatic life.

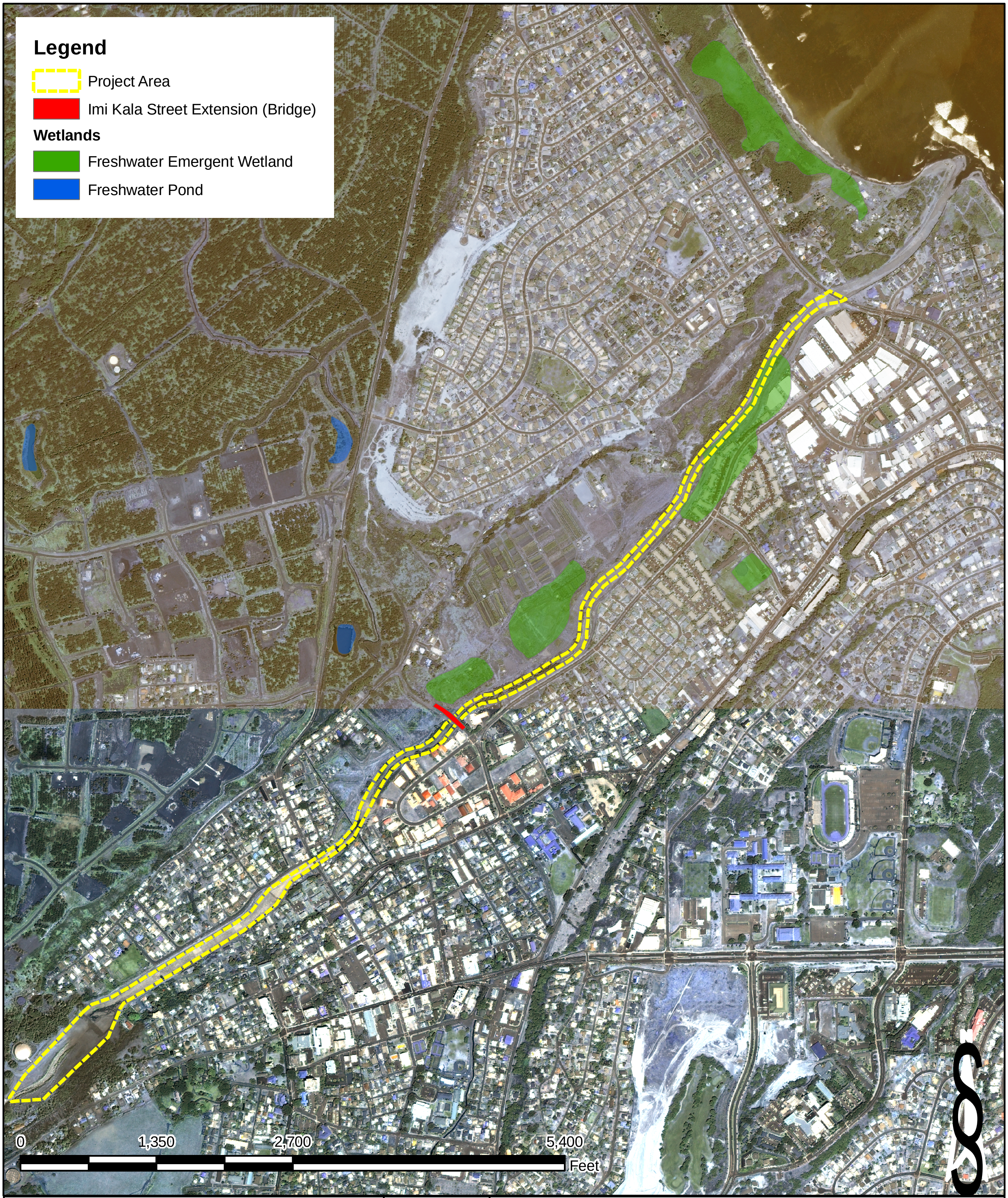
Aquatic species are sensitive to any modifications of the stream as they have an amphidromous life cycle. Native and indigenous freshwater gobies such as *Lentipes concolor*, *Sicyopterus stimpsoni*, and *Awaous guamensis* were observed in ʻĪao Stream (Way, 1996). Along with the atyid shrimp and neritid snail, these stream-dwelling fauna require streams which flow continuously as eggs and larvae are washed into the ocean. Juveniles subsequently migrate back into ʻĪao Stream and ʻĪao Valley to mature, reproduce and spawn, although the project area itself is used for migration only, not breeding. Three significant water diversion features, located upstream from or within the channelized portion of the stream, carry a significant amount of water away from the stream for consumptive use, primarily sugarcane and other agricultural crops. The current lack of continuous stream flow has been detrimental to populations of native organisms, due to stranding and desiccation of organisms during upstream and downstream migration (USFWS, 2006). Recent changes to land use patterns in the vicinity of the stream have included the conversion of former sugarcane lands to other crops, as well as to commercial and residential real estate. The replacement crops require only a small fraction of the water required by sugarcane, yet the existing diversion infrastructure is being maintained with no change to the amount of water diverted from the stream.

Field surveys of marine ecosystems and species were not included in the USFWS draft report due to limited funds, logistics, and time constraints. The report did note the presence of coral reefs in the coastal ecosystem adjacent to the mouth of the ʻĪao Stream. Coral reef ecosystems, comprising corals, reef fish, and associated invertebrates and plants are considered sensitive ecosystems. Corals and reef-associated fish in particular are of fundamental importance to species diversity and abundance of this valued resource. Corals are sensitive to sediment and nutrient runoff, and require clean, relatively nutrient free waters to thrive. Because corals form the framework of the coral reef ecosystem, any decline in coral health can result in an eventual decline or shift of the entire reef ecosystem. The near shore coastal environment in Kahului Bay is also noted to support sport fisheries for jacks (Carangidae) including *Caranx melampygus* and *C. ignobilis* (called omilu or ulua as adults and papio as juveniles); *Selar crumenopthalmus* (called akule as adults and halalu as juveniles); and goatfish (Mullidae) such as *Mullodichthys vanicolensis* (called weke as adults and oama as juveniles).

The USFWS report identified the lower ʻĪao Stream as belonging to Resource Category 2 habitat (Habitat to be impacted is of high value for selected evaluation species and is relatively scarce or becoming scarce on a national basis or in the ecoregion section) due to the severe degradation of stream habitat across the north shore Maui landscape and statewide. The marine waters adjacent to the mouth of ʻĪao Stream at Waiehu are also considered to be Resource Category 2 due to the presence of coral reef habitat throughout the area. The USFWS resource goal for Category 2 habitat is no net loss of in-kind habitat values. If losses are unavoidable, mitigation measures will be recommended to immediately rectify, reduce, or eliminate those losses (USFWS, 2006).

Potential Effects and Mitigation

Alternative I would allow for residential and commercial development of the existing floodplain. As noted earlier, there may be wetlands in the floodplain, and thus Alternative I would require a field investigation to determine whether any wetlands are present. With Alternatives III, V, and VI the floodplain would remain undeveloped, thus there would be no wetlands concerns. There are no wetlands concerns for work to be conducted within the project area. These downstream portions of the project were heavily modified between 1968 and 1981 (USFWS, 2006), and this project does not constitute new development of an emergent wetland, but rather maintenance of an existing structure.



ENVIRONET, INC.
PRESERVING EARTH'S RESOURCES FOR THE FUTURE

DRAWN BY: A.E.H.	`IAO STREAM FLOOD CONTROL EA		
CHECKED BY: S.G.	WETLANDS `IAO STREAM WAILUKU, MAUI, HAWAI`I	FIGURE 4 - 6	
REF: HDA			

All project alternatives, with the exception of Alternative VI, share the potential for temporary construction-related impacts. Alternative VI includes continued short-term construction activities during regular repairs. During the period of construction, earthmoving and related activities would create a risk for the entry of terrigenous sediments into the stream channel and adjacent near shore marine waters. This is especially the case during periods of wet weather. A variety of voluntary and regulatory controls function to minimize this risk. Runoff is inevitable, however, during torrential rains which occur regularly but unpredictably in Hawaiʻi. Development of site-specific BMPs are integral elements in the planning and application process for the CWA section 404 permits and the concurrent CWA section 401 WQC administered by the HDOH Clean Water Branch. Both Alternatives I and III provide for a long-term reduction in sedimentation, however, as either would eliminate the current large-scale streambank erosion occurring within the channel during flood events.

Alternative I would have the greatest negative impact due to loss of habitat currently used by native aquatic species during periods of flowing water. Converting the current natural boulder and cobble stream bottom substrate to a flat concrete lined channel would also effectively eliminate the riparian vegetation that is currently found along the unlined section of the stream. This vegetation, although consisting of introduced "weedy" species such as java plum (*Syzygium cumini)* and haole koa (*Leucaena leucocephala)* provide shade to much of this section of the stream. Native fauna are very sensitive to elevated temperatures and associated changes in dissolved oxygen and pH. Because shade results in lower water temperatures, removing vegetation would most likely prove detrimental to native aquatic species currently present in the stream (USFWS, 2006).

Alternative III reduces the impacts to the natural stream bottom and riparian vegetation anticipated under Alternative I by incorporating several mitigation measures agreed to by the USFWS (Appendix J). During periods of moderate to low stream discharge, water would be entrained in a low-flow channel that is envisioned to be of sufficient rugosity to create microhabitat conditions that are more suitable than flat unshaded concrete for upstream migrating organisms. Where possible, the low-flow channel would be aligned close to the stream bank so that existing vegetation could provide shade to the channel. In addition, non-woody vegetation could grow among the grouted boulders that form the low-flow channel. This streambank and channel vegetation, if appropriately managed, would function to provide critical shade and maintain lower water temperatures.

In their draft FWCA report, USFWS expressed concerns that converting 7,200 ft of natural alluvial stream bed to a RCC and boulder invert channel would have a negative impact on the ʻĪao Stream and cumulatively to the hydrologic landscape of north-shore Maui (USFWS, 2006; Appendix A). USFWS also noted that although they would recommend Alternative V or IV as the preferred alternative, they do not meet the project requirements and thus would likely be removed from consideration. In that case, USFWS recommended selection of Alternative III as the preferred alternative, emphasizing that “the goal of the mitigation flow would be to re-establish continuous flow of ‘Īao Stream to the sea no less than 80% of the time and to enhance flow duration to maximize survival of migratory aquatic organisms.” In a follow-up discussion between USFWS, USACE, and the COM, stream flow restoration was discussed and was recognized as being outside the authority or purpose of the USACE. Retrofit design elements have also been included to facilitate the movement of native organisms through the modified channel area. A site visit was conducted on 3/4/2008 to identify these areas and measures (Appendix I). These elements include a step structure at the 22-foot vertical drop (Station 97+23), widening existing low-flow channel areas, installing low-flow channel segments in existing flat-bottomed cement channel segments and in the center of the existing debris basin, blocks along the sloped portions of the existing channel to provide a resting place for climbing organisms, and an alignment along the vegetated portions of the left bank to provide shade and reduce water temperatures. These mitigation measures have been proposed as compensation for unavoidable impacts, and have been agreed to in a revised mitigation recommendation letter by the USFWS (Appendix J).

Alternative III is designed to facilitate upstream and downstream migration of aquatic organisms, given sufficient water flow. Stream flow restoration is a topic that is currently under discussion by the CWRM, state and federal resource agencies, community groups, and private entities that hold licenses for diversion and out-of-stream consumptive use of ‘Īao Stream Water. This decision is outside the function and authority of the USACE, however. If and when stream flow is partially restored, the low-flow design elements of Alternative III will function to enhance passage of stream fauna.

Alternative V would result in increased usable stream habitat that could support native fish and invertebrates, particularly if there was an effort to appropriately reconstruct the natural channel specifically for habitat value. This would only be possible if stream flow was restored, however. This alternative would result in removal of 2,500 ft of existing cement-lined stream channel. Removal of the existing ‘Īao Stream Flood Control Project would result in one of the largest stream channel restoration projects ever undertaken in the State and would result in a precedent-setting benefit to the entire stream ecosystem. Over the long-term, however, neighborhoods with homes and businesses located within the newly unprotected flood plain would be subject to major flood events. Although infrequent, major floods are expected to occur with regularity. Recurring floods will result in deposition of large amounts of debris (flood-demolished homes and other structures, vehicles, etc.) either into the stream channel itself or into the near shore marine environment. This debris would contain contaminants such as sewage, petrochemicals, lead paint, and other materials. Flood-related input of contaminants and debris could be minimized with sufficient acquisition of land along the ʻĪao Stream corridor and within the floodplain, and relocation of residential and business structures (USFWS, 2006). Opinions of support for Alternative V were presented by members of the community during the August 12, 2003 public scoping meeting. Comments included concerns about groundwater recharge, restoration of area, and cultural/recreational practices and values associated with ʻĪao Stream (See Table 8-1).

Alternative VI would retain 7,200 feet of natural stream bottom which would be a continued benefit to aquatic organsisms, but similar to Alternative V this is of little benefit in the absence of stream flow. Alternative VI would also allow continued high levels of streambank erosion and resulting excessive sedimentation during high water flow events.

4.7 THREATENED AND ENDANGERED SPECIES

The Endangered Species Act of 1973, (50 CFR 402), Section 7, requires Federal agencies to consult with other agencies to insure that any action authorized, funded, or carried out by such agency is not likely to jeopardize the continued existence of any endangered species or threatened species or result in the destruction or adverse modification of habitat of such species. Correspondence with USFWS and NMFS is included in Appendix H.

Existing Conditions

There are no known federally listed endangered or threatened biota and their critical habitats within the study area, therefore formal consultation under Section 7 of the Endangered Species Act is not required. The USFWS and NMFS concurred in this determination by letters dated July 1, 1996 and March 19, 1996. The USFWS stated that there is a potential existence of two candidate species of insects (*Megalagrion pacificum and M. xanthomelas*) in the project area, although this has not been confirmed by field studies. These letters of concurrence are attached in Appendix H.

Potential Impacts and Mitigation

Because no known federally listed endangered or threatened biota are present within the proposed project area, no effects to listed species are expected.

Table 4-6: Proposed Mitigation measure for natural resource impacts of Alternative III.

Potential Impacts	Potential Mitigation Measures
Aquatic Organism Passage	
• No stream flow	• Low flow element built into proposed channel structures. • Existing channel to be retrofitted with low flow elements. • Low flow element to be approximately 15 ft wide and 20 inches deep.
• Vertical Drop at Station 92+20	• Step type structure to eliminate existing 22-foot vertical drop structure. • Low-flow channel continuation along the new drop structure on the right bank side, and then connect to existing low-flow channel on the left bank side.
• High water temperatures	• Aligned to bank that provides shaded areas.
• High water velocity	• Installation of small concrete blocks to slow stream flow in smooth, sloped areas of current concrete-lined channel. • Provides resting area for migrating species.
Vegetation Removal and Paving	
• Aquatic Vegetation	• Cobble structures in channel would promote deposition of sediment and reestablishment of aquatic and riparian vegetation species.
Hydrology	
• Negative Impact to Groundwater Recharge	• Weepholes in RCC. • Retention of the natural floodplain.

5.0 AFFECTED HUMAN ENVIRONMENT

The following subsections contain detailed descriptions of possible impacts as well as proposed mitigation measures. As stated in earlier sections, Alternatives II and IV were not carried forward for detailed evaluation regarding impacts and mitigation.

5.1 HISTORIC AND CULTURAL RESOURCES

Pursuant to Section 106 of the National Historic Preservation Act (NHPA) of 1966 and its implementing regulations (36 CFR Part 800), alternatives which may affect properties listed or eligible for listing on the National Register of Historic Places are subject to the provisions of this Act.

An archaeological reconnaissance study, including subsurface testing, was conducted in November and December of 1998 by Scientific Consultant Services/Cultural Resource Management Services, (SCS/CRMS) Inc. 2003. At the time of the study, the proposed alternatives included realignment to the north of the current ʻĪao Stream, and thus the study included an investigation of this corridor. Subsequent to the completion of the archeological reconnaissance study, the alternatives were revised such that improvements have been limited to the existing ʻĪao Stream alignment. The single site discovered during the archaeological reconnaissance study, although presented in Appendix B as being within the project corridor, is actually now outside the boundaries of any of the alternatives.

The purpose of the archaeological reconnaissance study was to identify any archaeological sites or features occurring within the project boundaries. Information collected for this report includes previous archaeological research, pedestrian (reconnaissance) survey, limited excavations, and laboratory analysis. The extent of the project was altered after the archaeological reconnaissance study was completed, thus the study only covers the area from the downstream limit of the project to the Spreckels Ditch area, approximately 4,700 ft upstream. The extent of the archaeological survey thus does not cover the area from Spreckels Ditch to the debris basin, a distance of approximately 1.5 miles. The original Flood Control Project, covering the entire 2.5 project length, included additional archaeological study of the upstream area. These previous studies are discussed in the SCS/CRMS, Inc. report, key elements of which are discussed in the sections below.

Articles IX and XII of the State Constitution of Hawaiʻi (Chapter 343, HRS) require government agencies to promote and preserve cultural beliefs, practices, and resources of native Hawaiian and other ethnic groups. The "Guidelines for Assessing Cultural Impacts", adopted by the Environmental Council of the State of Hawaiʻi (1997), identifies the protocol for conducting cultural assessments.

An oral history survey and a cultural impact assessment (CIA) were conducted between August and November of 2003 by Social Research Pacific, (SRP) Inc. to identify properties of historic and cultural significance (SRP, Inc., 2003).

5.1.1 Archaeological Resources

A complete archaeological reconnaissance survey found the area between Spreckles Ditch and the downstream limit of the project to be relatively void of visible architectural and/or surface remains with the exception of one site, as described below. The full report, "Archaeological Reconnaissance Survey and Limited Subsurface Testing for the Alternative Channel Alignment, ʻĪao Stream Flood Control, ʻĪao Valley, Island of Maui, Hawai'i", (2003) by SCS/CRMS, Inc. is provided in Appendix B.

One site was originally identified during the reconnaissance survey as being within the project boundaries, but due to revisions of the alternatives is now located outside the boundaries of any of the alternatives. The site in question is known as State Site Number 50-50-04-4755 (Tax Map Key (TMK) 3-4-32:1). The site is composed of three features. The three features consist of a concrete foundation with concrete troughs, a soil filled terrace and retaining wall, and a wall remnant. These features form a small, presumably historic (post 1776) habitation complex activity area. A majority of these features, particularly the basalt cobble and boulder-formed walls, exist in the state of poor-to-fair preservation condition. Structurally and materially, the site is most probably a post-Contact, late 19th or early 20th century, agricultural site (SCS/CRMS Inc., 2003). According to local residents, the site was associated with a former piggery in operation several decades ago. This site was initially assessed as significant under Criterion D, due to its potential to yield information important to research on the history in the area, but considering information collected during the current reconnaissance survey, the site is now deemed to be no longer significant. No further work is considered necessary or recommended for the site (SCS/CRMS Inc., 2003).

Additional archaeological sites identified in the vicinity of the ʻĪao Stream project include State Site No. 50-50-04-2978 (Wallace System Complex) and State Site No. 50-50-04-2979 (North Terrace System Complex). These sites were identified by Connolly (1974, as cited in SCS/CRMS Inc., 2003) during the initial ʻĪao Valley Flood Control Project, and were reported as two historic complexes composed of a substantial amount of terraces, free-standing walls, ditches, historic house foundations, and several stone mounds (Figure 5-1). Further discussion of previous archaeological studies is provided in Appendix B.

ENVIRONET, INC.
PRESERVING EARTH'S RESOURCES FOR THE FUTURE

DRAWN BY: A.E.H.
CHECKED BY: S.G.
REF: USACE

`IAO STREAM FLOOD CONTROL EA

CULTURAL RESOURCES
`IAO STREAM
WAILUKU, MAUI, HAWAI`I

FIGURE 5 - 1

5.1.2 Cultural Resources

An oral history survey was conducted in November of 2003 by SRP, Inc., to obtain information regarding properties of cultural and historical significance from Hawaiian *kūpuna,* Hawaiian elders, that live on Maui. Along with interviews, information about traditional cultural properties (TCPs) was gathered from written and archival sources and incorporated in a CIA in accordance with National Park Service guidance (Parker and King, 1995). The full report is provided in Appendix C.

The ‘Īao Valley, as with the remainder of the Wailuku ahupua‘a has unique significance to native Hawaiian culture. Changes in land ownership, military presence, sugar cane farming, and general urbanization have over time, however, dramatically altered the land uses within ‘Īao Valley. Remnants of old buildings and traditional land uses are being phased out by the influx of urban growth in the valley. Traditional practices had been discontinued even before the rise of sugar cane farming in the project location (SRP, Inc., 2003).

Even with the substantial change to this cultural landscape, vestiges of its highly significant past do remain and the traditional significance of Wailuku as a region needs to be preserved. Oral history from Hawaiian *küpuna* indicates there are three known TCPs in the vicinity of the project area but not within the boundaries of the proposed location. TCPs in the vicinity of the project area are noted below:

- Haleki‘i-Pi‘ihana *heiau* complex (Figure 5-1).
- Fresh water spring (listed as *Waiola* by the CWRM), located on the Sevilla property.
- Burials along the sand dunes and at Mahalani Cemetery (Pi‘ihana side). The burials within the sand dunes are well known and recorded.

Possible cultural impacts were assessed using a questionnaire-based survey for existing residents within the project area. Thirty-two residents of the project area were surveyed, and results of the report are summarized as follows.

The majority of individuals interviewed have not witnessed severe floods, and expressed more concern over erosion than flood control. Although most of the interviewees rarely use the stream for recreational and/or social purposes, the community’s concern is concentrated around social and recreational values of the ‘Īao Stream, including a concern that the proposed flood control measures will only lead to more inefficient water flow to further promote degradation of the natural stream (SRP, Inc., 2003).

The cultural impacts report also noted that the Haleki‘i-Pi‘ihana Heiau State Monument lies along the bank of the ‘Īao Stream, near the downstream limits of the project. Specifically, the report noted that continued erosion of the stream bank could lead to the land beneath the heiau being compromised (SRP, Inc., 2003).

Potential Impacts and Mitigation Measures

Although one archaeological site was initially assessed as significant under Criterion D, this based upon archaeological work conducted at the site, sufficient information has now been obtained from recording and excavations at the site so it may be considered no longer significant. No further work is necessary (SCS/CRMS Inc., 2003).

Cultural resources coordination and consultation with the State of Hawaiʻi Historic Preservation Officer (SHPO) was based on the assumption that construction efforts will be confined to the existing stream channel, and thus any construction work will have no effect on historic properties or significant cultural resources. In the area of ʻImi Kālā Street, however, the channel will be widened to accommodate the proposed improvement of the ʻImi Kālā Street bridge. In this area, there is the potential that buried cultural resources may be adversely impacted. To counter such potential adverse effects, the USACE will include monitoring by a qualified archaeologist during construction associated with the widening of the stream to accommodate the proposed improvement of the ʻImi Kālā Street Bridge.

Based on written history, oral information from Hawaiian *kūpuna*, and a questionnaire-based survey, no immediate/direct changes are foreseen to known TCPs within the vicinity of the project area as a result of the implementation of any of the considered alternatives for the proposed project. It is recommended that the Halekiʻi-Piʻihana *Heiau* State Monument be monitored on a continuous basis, as the *heiau* lies immediately along the banks of the ʻĪao Stream. The location of this *heiau* has been identified as a potentially high erosion area, and inadequate flood control measures may compromise the land on which the *heiau* is situated.

The USACE sent a copy of the CIA to Office of Hawaiian Affairs (OHA) summarizing the cultural study conducted for the project and including a "no adverse effect" determination. The OHA responded in a letter dated October 30, 2007 (Appendix H), that included an appreciation for the number of sources consulted in preparation of the CIS, but noted their concerns about the presence of numerous culturally significant sites and native Hawaiian practices in the vicinity of the project. These concerns are addressed in the Section 106 consultation letter sent to OHA in November 2007 (See Appendix H and the following section) as well as in this draft EA, a copy of which will be forwarded to OHA for their review.

5.1.3 Section 106 Compliance and Coordination

The USACE assessed the potential cultural affects of proposed modifications to the project area, and summarized their finding of "no effect" in letters to the SHPO and OHA, as well as the County of Maui Cultural Resources Commission, the Central Maui Hawaiian Civic Club, and the President of the Association of Hawaiian Civic Clubs. The SHPO was contacted initially in 1996 and responded with concurrence in a letter to the USACE (Appendix H). A second set of letters was sent to both SHPO and OHA in 2005, and a response was received from OHA requesting that archeological level survey work be conducted in the project area. The third round of letters was sent to SHPO, OHA, the County of Maui Cultural Resources Commission, the Central Maui Hawaiian Civic Club, and the President of the Association of Hawaiian Civic Clubs in 2007, requesting Section 106 consultation. OHA responded that they did not receive a Section 106 consultation letter, so the USACE resent the letter on November 5, 2007. As of the time of report preparation, no responses have been received from OHA, but both USACE and OHA are committed to the ongoing consultation process. Any updates or revisions reached during the consultation will be incorporated into the final EA.

5.2 LAND USE AND VISUAL RESOURCES

Development and analysis of the EA alternatives also took into consideration the possible visual and aesthetic impacts the modification to the existing Flood Control Project might have on existing visual resources. The ʻĪao Stream is situated in the ʻĪao Valley, a 6.2 acre landmark seeped in Hawaiian history and beauty. The valley is a steep, eroded caldera of the West Maui Mountains occupied by lush green vegetation. With the exception of the existing concrete lined channels and water diversions that occupy 30% of the stream, it remains mostly undeveloped. The ʻĪao Stream remains a natural beauty and tourist attraction of Maui.

Existing Conditions

Present day land uses generally fall into residential, commercial, recreational, and farming categories (Figures 5-2 and 5-3). Just along ʻĪao Stream, residential uses extend from Kahului Bay to the far western (mauka) sections of the valley, with the densest residential concentration along the lower (makai) portions of the stream. From Millyard to Waiehu Beach Road along the northern corridor of the project area, there is additional residential housing along with farms located in the flood plain bordering Piʻihana. The farms grow mostly banana and papayas and are restricted to the northern corridor of the stream. The southern corridor of the project area consists of residential and commercial properties.

With the exception of a few older businesses, commercial development is restricted to the southern corridor of the project area. The types of businesses vary significantly, from a supermarket at the westernmost end, to the Maui Waste Disposal and several legal, accounting and real estate firms on the easternmost end. A levee along the southern corridor is utilized as a maintenance road for County of Maui vehicles, and also serves as a recreational area for local residents, as well as a buffer for many of the homes from the stream.

Land in and surrounding the affected area is owned by multiple private landowners, COM, and the State of Hawaiʻi. Zoning is agricultural, residential and industrial and no land use change is required for this project. The local, non-Federal sponsor, COM, will be responsible for acquiring the necessary LER for this project.

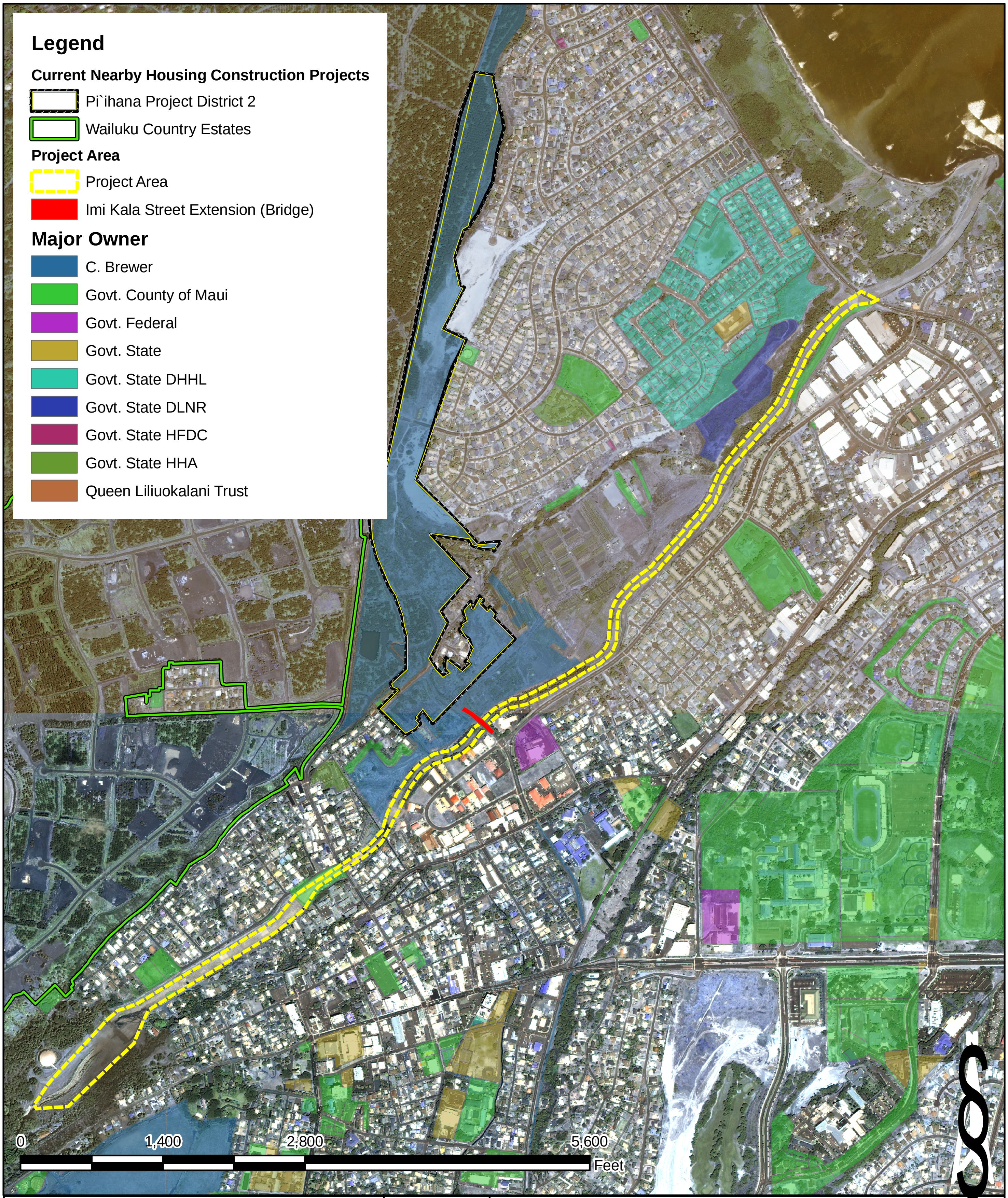
The existing flood plain occurs in an area designated as prime agricultural lands by the State of Hawaiʻi, Department of Agriculture (HDOA). This designation also applies to several stretches of land occurring on both the east and west sides of the ʻĪao Stream, however they have subsequently been developed for commercial and residential use (Figure 5-4).

Three significant water diversion features, located in or upstream from the channelized portion of the stream, carry a significant amount of water away from the stream for consumptive use, which formerly consisted primarily of sugarcane and other agricultural crops. Recent changes to land use patterns in the vicinity of the stream have included the conversion of former sugarcane lands to other crops, as well as to commercial and residential real estate. The replacement crops require only a small fraction of the water required by sugarcane, yet the existing diversion infrastructure is being maintained with no change to the amount of water diverted from the stream.

Potential Effects and Mitigation

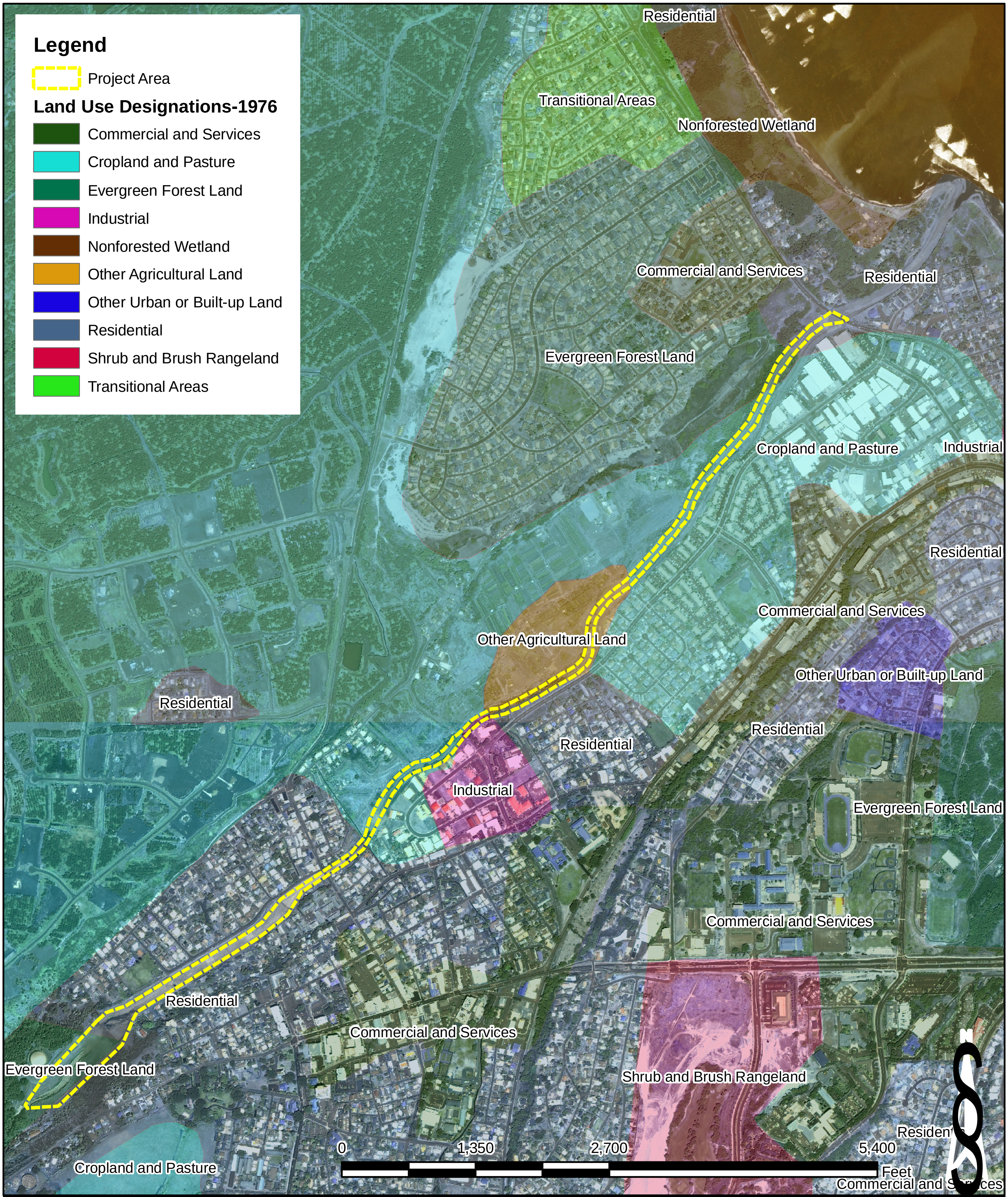
Alternative I would allow development of an area designated as prime agricultural lands (existing floodplain), while Alternatives III, V, and VI would leave the floodplain as is. Approximately three acres of vegetated streambank would be cleared during construction for Alternative III, but it would be allowed to regrow as much as possible following the completion of construction activities.

Short term land use impacts may be generated from construction activities which may limit access to and from public and/or recreational areas for use by the community. USACE will require its contractor to work closely with local police and fire authorities and provide early planning for alternate routes, as well as a traffic control plan.



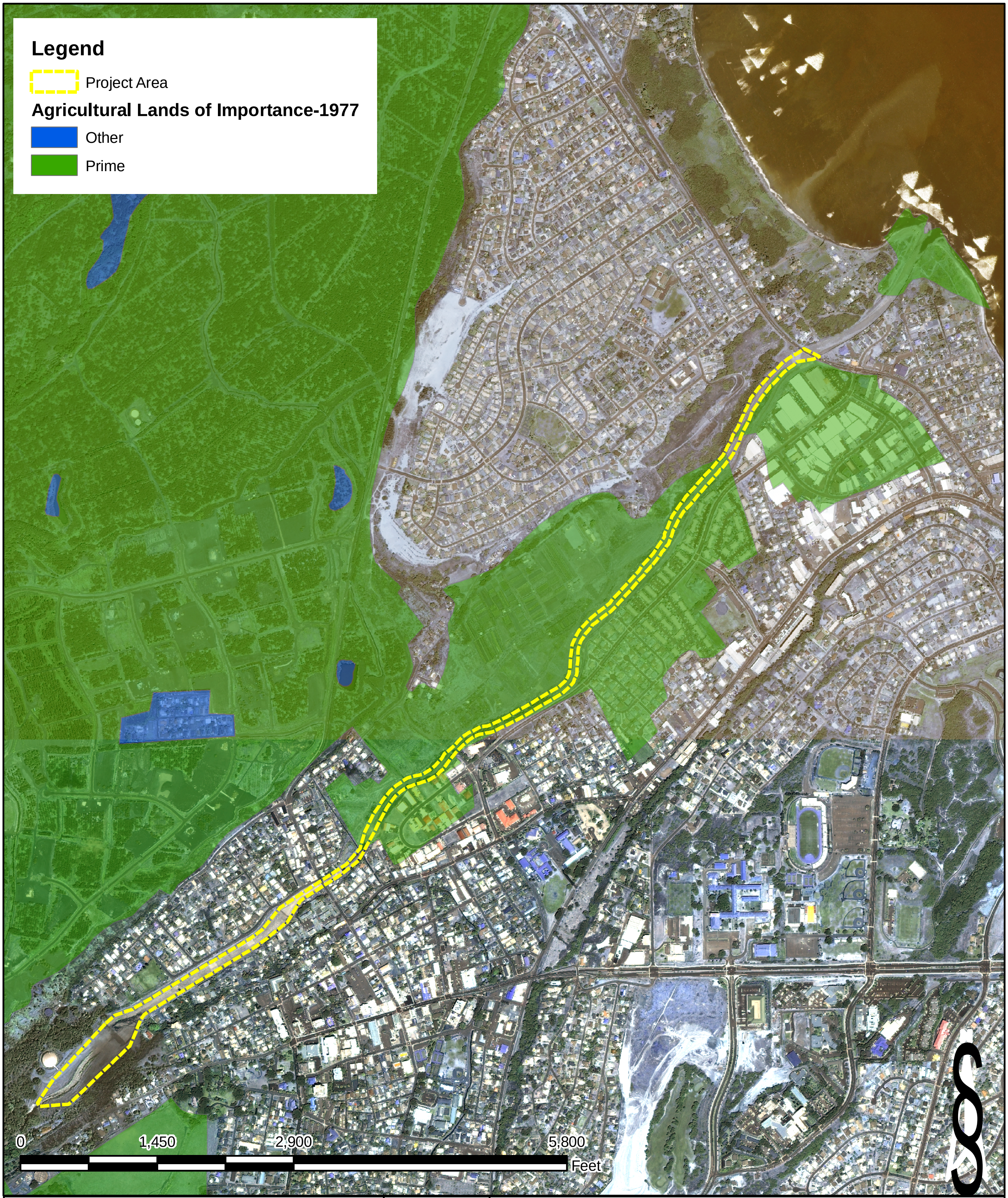
ENVIRONET, INC.
PRESERVING EARTH'S RESOURCES FOR THE FUTURE

DRAWN BY: A.E.H.	`IAO STREAM FLOOD CONTROL EA		
CHECKED BY: S.G.	SURROUNDING PROPERTY CHARACTERISTICS: `IAO STREAM WAILUKU, MAUI, HAWAI`I		FIGURE 5 - 2
REF: COM			



ENVIRONET, INC.
PRESERVING EARTH'S RESOURCES FOR THE FUTURE

DRAWN BY: A.E.H.	`IAO STREAM FLOOD CONTROL EA		
CHECKED BY: S.G.	EXISTING LAND USES `IAO STREAM WAILUKU, MAUI, HAWAI`I	FIGURE 5 - 3	
REF: USGS & COM			



ENVIRONET, INC.
PRESERVING EARTH'S RESOURCES FOR THE FUTURE

DRAWN BY: A.E.H.
CHECKED BY: S.G.
REF: HDA

`IAO STREAM FLOOD CONTROL EA

AGRICULTURAL LANDS OF IMPORTANCE TO STATE OF HAWAI`I (ALISH): `IAO STREAM WAILUKU, MAUI, HAWAI`I

FIGURE 5 - 4

With the exception of Alternatives V and VI, there are no foreseeable long-term adverse land use impacts, as Alternatives I and III do not encroach into developed areas of the Wailuku community. Alternatives V and VI will result in long-term erosion and private property damage to key parcels of land along the stream.

Aesthetic impacts differ depending on the alternative chosen. Alternative I includes a fully lined concrete channel, which will take away the remaining natural alluvial channel of the ʻĪao Stream without providing a means for instream migration. This would take away the aesthetic beauty of the stream, and affect aquatic biological resources that depend on the alluvial channel habitat for survival.

Alternative III offers a more natural alternative, following most of the existing stream alignment, with stream stabilization improvements consisting of boulders in the main channel low-flow section with RCC stream bank protection. The boulder-embedded low flow channel is more natural in appearance than a standard concrete stream bottom, and will minimize but not eliminate the visual impact to the existing natural quality of the ʻĪao Stream (refer to the photos in Figures 4-4 and 4-5 for photos of RCC lining compared to natural stream bottom).

Alternative V would effectively remove all man-made flood control improvements since 1981. With time, the stream would be restored to a completely natural condition which may or may not become more aesthetically pleasing than its current state. Alternative VI would leave 7,200 feet of natural stream bottom, although erosion of side-slopes and levee undermining would continue.

COM will be responsible for the acquisition of land and easements in order to implement the proposed project improvements. The project will require three types of easements: 1) 4.78 acres of permanent channel improvement easements; 2) 0.32 acre of permanent joint use road easements; and 3) 2.06 acres of temporary work area easements. The total cost of real estate acquisition for easements is estimated at $394,000.00 according to USACE (Real Estate Planning Report, November 2007). The project is not expected to result in the need to relocate public utilities. No relocations under the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, as amended (PL 91-646, 42 USC 4601, 7 CFR 21) are anticipated. Table 5-1 provides a detailed breakout of the land areas involved.

Impacts to existing land uses are expected to be minimal because the affected land is vacant, no surface or subsurface minerals or cultural resources are known to exist, and no change in zoning is necessary for the proposed creation of the easements (Appendix L). COM has been notified of the acquisition actions needed to proceed, and coordination between the Federal sponsor and COM is ongoing.

Table 5-1: Proposed Project Easements

Expected Use of Easement	Size of Area	Permanent or Temporary
Channel improvement easements	4.78 acres	permanent
Joint-use road easements	0.32 acres	permanent
Work-area easements	2.06 acres	temporary

Source: Appendix L

5.3 HAZARDOUS, TOXIC AND RADIOACTIVE WASTE

Hazardous, Toxic and Radioactive Waste (HTRW) occurrences within the project area must be treated in compliance with AR 200-1 Environmental Protection and Enhancement, ER 200-2-3 on hazardous waste management procedures, and ER 1130-2-540 Environmental Stewardship Operations and Maintenance Policies as well as applicable Federal, state, and local environmental laws and regulations.

Under ER 1165-2-132, HTRW Guidance for Civil Works Projects, HTRW is defined as any material listed as a hazardous substance in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). Dredged materials and sediments beneath navigable waters are exceptions to the list of identified HTRW.

HTRW initial assessment was conducted under USACE regulations (ER 1165-2-132) by the USACE, U.S. Army Engineer District, Honolulu. The report was completed in 1997 and revised in 2002, and is attached in Appendix D.

Existing Conditions

The results of the report have indicated that there are no existing or previous HTRW activities located in the project area. The ʻĪao Stream basin has not been designated as a CERCLA action site, and no spills or other HTRW activities are known to have affected the project area in the past. There are no known Formerly Used Defense Sites in the project vicinity, according to USACE (2005).

Potential Effects and Mitigation

Under ER 1165-2-132, HTRW is defined as any material listed as a hazardous substance in accordance with CERCLA, with the exception of dredged material and sediments beneath navigable waters proposed for dredging. All available alternatives will consist of excavation of materials from the stream channel and its margins. As the project area does not contain HTRW materials, the excavated material is not deemed hazardous. Excess quantities of excavated materials from Alternatives I and III will most likely be recycled and used on other sections of the project. Any excess materials not recycled will be subject to testing and evaluation for suitability of disposal in accordance with the EPA before disposal in the COM landfill. Therefore, no potentially damaging impacts will befall the surrounding environment.

5.4 NOISE

Sound travels through the air as waves of minute air pressure fluctuations caused by some type of vibration. Determination of noise levels are based on: 1) sound pressure level generated (decibels (dBA) scale); 2) distance of listener from source of noise; 3) attenuating and propagating effects of the medium between the source and the listener; and 4) period of exposure.

The average exterior noise level generally considered acceptable for projects receiving Federal assistance is 65 day-night sound level (DNL). The DNL represents the 24-hour average sound level for day, with nighttime noise levels increased by 10 dBA.

The Noise Control Act of 1972 requires Federal agencies to adhere to all applicable Federal, state, and local regulations when engaging in any activity which may result in the emission of noise. Supplemented by AR 200-1 Environmental Protection and Enhancement, any and all noise impacts will be properly mitigated to protect the health and welfare of the community.

The U.S. Department of Housing and Urban Development (HUD) is the lead Federal agency setting standards for interior and exterior noise for housing. These standards, outlined in 24 CFR 51, establish site acceptability standards based on day-night equivalent sound levels. The standards are used to designate noise levels as acceptable, normally unacceptable, or unacceptable. The acceptable exterior noise level for residential housing is 65 dBA or less, the normally unacceptable noise level is 65 dBA to 75 dBA, and the unacceptable noise level is above 75 dBA.

The Occupational Safety and Health Administration (OSHA), Occupational Noise Exposure guidelines, codified in 29 CFR 1910.95, set an action level of 85 dBA as the maximum acceptable noise level for the workplace.

Existing Conditions

Sensitive noise receptors are land uses, such as residences, schools, libraries, and hospitals that are considered to be sensitive to noise. There are no sensitive receptors within the project area, but residences are present adjacent and to the east of the project area, in Wailuku town. There are normally no noise sources within the project area.

Construction of the flood control improvement within the project area will involve varying degrees of excavation, grading and other typical construction activities depending on the alternative chosen. The construction may generate significant amounts of noise. The surrounding residences may be impacted by the construction noise due to their proximity to the project. The actual noise levels produced during construction will be a function of the methods employed during the construction process. Typical ranges of construction equipment noise are shown in Figure 5-5.

Potential Effects and Mitigation

Noise levels will be temporarily increased during construction for all available alternatives due to the operation of heavy construction equipment. Residential areas will be affected more than commercial and undeveloped areas near the stream bank.

Implementation of BMPs and compliance with applicable Federal, state, and local laws as described above will mitigate construction noise levels to acceptable levels. Prior to the commencement of construction activities, a permit will be obtained from the HDOH for operation of construction equipment, power tools, and vehicles which will emit noise levels in excess of the allowable limits. There are no foreseeable long-term noise issues with any of the proposed alternatives.

5.5 AIR QUALITY

The Clean Air Act (CAA, 42 USC 7401, et seq.), as amended, authorizes the EPA to establish National Ambient Air Quality Standards (NAAQS) to protect public health and the environment

Section 176 (c) of the CAA, requires Federal agencies to ensure that their actions are consistent with the CAA and with applicable air quality management plans (state implementation plans). Agencies are required to evaluate their proposed actions to make sure they will not violate or contribute to new violations of any Federal ambient air quality standards, will not increase the frequency or severity of any existing violations of Federal Ambient Air Quality Standards (AAQS), and will not delay the timely attainment of Federal AAQS.

Projects funded by the USACE are required to follow guidance from AR 200-1 and ER 200-2-3, to manage air emissions to protect human health and the environment as well as pollution prevention management, and to comply with all legally applicable and appropriate Federal, state, and local air quality control regulations.

Existing Conditions

The regional and local climate together with the amount and type of human activity generally dictate the air quality of a given location. There are no sources of criteria air pollutants associated with the project site.

Potential Effects and Mitigation

The major potential short term air quality impact of the project will occur from the emission of fugitive dust during construction. An effective dust control plan will need to be implemented in order to eliminate emissions of fugitive dust during project construction in order to comply with State of Hawai'i air pollution control regulations; HAR Title 11, Chapter 59 and 60.1 for AAQS and Air Pollution Control (APC) respectively. HAR 11-60.1-33 'Fugitive dust' lists the following as appropriate measures to take in order to prevent fugitive dust: "use of water or suitable chemicals for the control of dust generated from grading and moving of dirt; installation of hoods, fans, and other fabric filters to minimize dust when applicable; covering of open and moving-bodied trucks transporting materials which may result in fugitive dust; prompt removal of earth or other materials from paved roads that may result in fugitive dust".

During construction, emissions from engine exhausts (primarily consisting of carbon monoxide and nitrogen oxides) will also occur both from on-site construction equipment and from vehicles used by construction workers and from trucks traveling to and from the project site. Standards for nitrogen dioxide set by the NAAQS are on an annual basis, and short-term construction is not likely to contribute to the violation of set annual standards. Carbon monoxide emissions will be very low and should be insignificant compared to normal vehicular emissions.

5.6 TRAFFIC

The proposed alternative designs consist of modifications to the existing flood channel and do not consist of new land uses, structures, or developments that would require additional infrastructure needs. Therefore, the available alternatives will not affect existing traffic conditions.

As there are no foreseeable impacts to existing traffic conditions from the alternatives, a study was not conducted for this project.

5.7 RECREATION AND RESOURCE USE

Federal regulation 36 CFR 327, supplemented by ER 1130-2-405, contains guidelines for rules and regulations regarding USACE public use of water resource development projects. The policy of the USACE is to "…manage the natural, cultural and developed resources of each project in the public interest, providing the public with safe and healthful recreational opportunities while protecting and enhancing these resources." Determination of whether recreational and resource uses are substantially affected is based on the following: 1) degree to which uses of recreational resources are eliminated or displaced; 2) duration of time that recreation and resources are inhibited; and 3) the cumulative effects of temporary disruptions of recreational use.

Existing Conditions

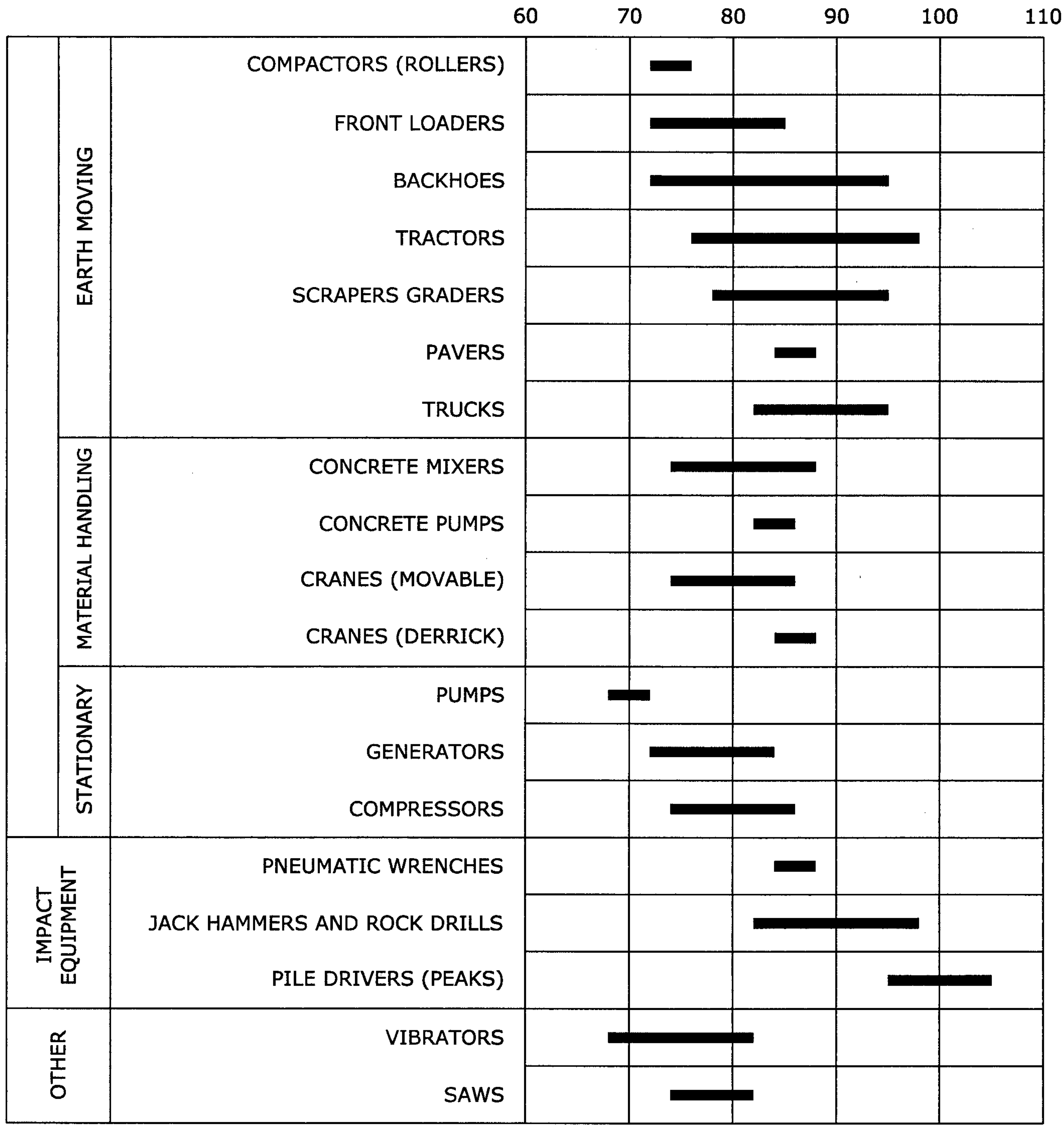
The ʻĪao Valley is a pristine area on Maui with important historical significance and visited by numerous people each year. It is a major tourist attraction featuring the ʻĪao Needle, a natural rock pinnacle, and the ʻĪao Stream. Surrounded by the walls of the Puʻu Kukui Crater, ʻĪao Stream offers a natural hiking environment with pristine views.

Potential Effects and Mitigation

Recreational areas surrounding the ʻĪao Stream will not be accessible to the public until construction to implement modifications to the stream is completed. This short-term access impact is inevitable for all available alternatives due to construction activities.

In response to public comment regarding added recreational features of the project, the USACE is currently working with PW to look into recreational possibilities to be incorporated with the chosen alternative, such as jogging and walking paths along the levees. This will provide additional recreational uses to the ʻĪao Stream area in the long-term.

Other long term impacts differ with respect to each of the available alternatives. Alternative I would replace 70% of the existing natural alluvial channel with concrete, which would create adverse impacts on the natural appearance of the ʻĪao Stream, as well as negative impacts on the aquatic biological habitat within the alluvial channel. This would impact recreational resources along the ʻĪao Stream in the long term. Alternative III provides a grouted boulder invert channel following the existing stream alignment, allowing for a more natural alternative to stream stabilization. In the long term, this low-flow channel will minimize (but not eliminate) the visual impact to the existing natural quality of the stream. More importantly, the proposed mitigation measures of Alternative III would enable survival of aquatic organisms. Alternative V would remove all man-made improvements and allow the ʻĪao Stream to return to its natural state, thereby enhancing the recreational quality of the stream area. With no flood control devices however, recreational activities may be restricted for safety reasons. Alternative VI would keep 7,200 feet of natural stream bottom, but would not protect against continued erosion and levee undermining.



NOTE: BASED ON LIMITED AVAILABLE DATA SAMPLES

ENVIRONET, INC.
PRESERVING EARTH'S RESOURCES FOR THE FUTURE

DRAWN BY: I.K.N.
CHECKED BY: R.C.A.
REF: D.L. ADAMS & ASSOC.

IAO STREAM FLOOD CONTROL EA

TYPICAL CONSTRUCTION NOISE LEVELS

FIGURE 5–5

5.8 ECONOMIC AND SOCIAL RESOURCES

5.8.1 EO 12898 Environmental Justice

EO 12898 on Environmental Justice directs all Federal agencies to achieve environmental justice, by identifying and addressing disproportionately high adverse human health or environmental effects of its actions on minority and low-income populations within the US and its territories. Assessment of possible adverse impacts resulting from implementation of any of the available alternatives indicates there are no disproportionate negative impacts toward minority and low-income populations.

All available alternatives, with the exception of Alternative VI, will generate short-term economic vitality for the island by providing temporary construction opportunities for the duration of the project.

Alternative I would provide long term positive economic prosperity to the growing community of Wailuku by flood-proofing and eliminating ongoing stream bank erosion. As part of this alternative, the existing flood plain area is proposed to be utilized for future development opportunities. The proposed concrete channel lining, however, may negatively impact the visual quality of the ‘Īao Stream by creating a harsher, less natural environment.

Alternative III is designed to incorporate the existing flood plain as is, and channel lining proposed for this design will provide adequate flood-proofing and stream bank stabilization while incorporating design elements and mitigation measures to minimize or mitigate for impacts to the natural environment. In the long term, these measures will prevent damage to life and property, allowing for development and growth of the community with minimal modifications and will be less intrusive to the existing environment.

Alternative V would effectively remove all man-made flood control improvements installed since 1981. The Wailuku community would be provided with a state-of-the-art, flood-warning system in place of flood control improvements. Alternative VI would leave ‘Īao Stream in its current state, allowing for further streambank erosion, and the area would revert to a Flood Hazard Area. These alternatives do not provide tangible protection from flood and erosion related damages, and would hinder future development in the area. In the long term there is the possibility of loss of life and damage to property. Loss of life will affect all citizens, regardless of income status. Damage to property resulting from flood and erosion may have an adverse impact on minority and lower income populations that cannot afford flood insurance and will not be able to rebuild.

Potential Impacts and Mitigation Measures

Cultural impacts include potential negative reactions from the community to Alternatives I and III, a positive reaction to Alternative V, and no change in current reactions with Alternative VI. There is a cyclical history of water shortage on Maui, and water allocation between residential and agricultural use has always been a sensitive subject. In addition to the community's concern regarding social and recreational values of the ʻĪao Stream, any proposed flood control related project creates concern for residents regarding possible water diversion, erosion, and adverse impacts to the natural environment. Alternatives I and III, though the most beneficial to prevent continual erosion and flooding, would have a negative impact on tourism by detracting from the natural beauty that is associated with ʻĪao Stream and ʻĪao Valley. Alternative III mitigates this somewhat by incorporating an RCC lined channel with a low-flow channel using irregular boulder- and cobble-sized rock to form microhabitat and refuge for fish and invertebreates and to facilitate upstream migration of aquatic organisms. Alternative V appears to generate the most positive reactions from the community, as most residents in the high flood area have moved in after the initial completion of the ʻĪao Stream Flood Control Project and have not witnessed any severe floods in their lifetime. Alternative VI would likewise be more acceptable to the community as it retains 7,200 feet of natural stream bottom. Erosion, however, is a very real problem for many of the residents and they welcome erosion prevention improvements. A public scoping meeting was held on August 12, 2003 to address these public concerns. Consultation with resource agencies has been pursued throughout the course of this project, and will continue throughout the design and construction phases of the project to ensure all environmental concerns are being addressed and mitigated to the maximum extent practicable. This will be conveyed to the Wailuku community.

5.9 ACCESSIBILITY FOR MAINTENANCE

Ease and accessibility for maintenance can be important to COM as the local sponsor of the project. In its current state, the ʻĪao Stream requires regular channel repair by bulldozers, particularly after every storm event. Eroded material is also removed from the concrete channel located under the Waiehu Beach Road Bridge. The need for maintenance would be lessened if Alternative I or III were implemented. The resulting stream improvement in Alternative I trapezoidal concrete channel with a 40-foot bottom width would be the easiest to maintain by COM because the stream channel would be concrete lined and accessible to maintenance vehicles. Alternative III with its boulder invert channel would be somewhat difficult to maintain because the low-flow channel portion would not be accessible by maintenance vehicles, although the RCC areas would. This more naturally appearing stream improvement may necessitate some manual maintenance by COM personnel. Alternative V which requires removal of flood control improvements would not require any maintenance because the stream would be returned to its natural state. Alternative VI would require continued placement of boulders at eroding levee toes in an attempt to temporarily slow or halt erosion.

While Alternatives I and V appear to offer the greatest ease of maintenance, both represent the extremes because Alternative I would not be environmentally acceptable, and Alternative V, while environmentally sensitive, would not meet the project objective of flood and erosion control. Alternative VI likewise does not meet project objective. Alternative III would be environmentally sensitive and would meet the project objective of flood and erosion control.

5.10 CUMULATIVE IMPACTS

Cumulative impacts are two or more individual effects which, when considered together, compound or increase the overall impact. Cumulative impacts can arise from the individual effects of a single action or from the combined effects of past, present, or future actions. Thus, cumulative impacts can result from individually minor but collectively significant actions taken over a period of time. The cumulative impacts of implementing the proposed action along with past and reasonably foreseeable future projects proposed were assessed based upon available information.

Two of the available alternatives, I and III, attempt to modify the existing flood channel system to prevent inevitable project failure, the loss of life, and extensive property damage. Positive cumulative impacts created by these modifications will allow for long term social and economic growth without hindrance from seasonal flooding. Government and local fiscal resources will not be strained to provide emergency and repair support for flood damage to properties and rescue teams responding to flood-related emergencies.

Alternative I would negatively impact the aquatic fauna of the ʻĪao Stream by replacing 70% of the remaining natural alluvial channel with a concrete lined channel. This would lead to long-term deterioration of the scenic quality of the downstream portion of the ʻĪao Stream, which may in turn affect tourism and the economy. It is important to note that the main tourist attraction is the ʻĪao Valley, which is upstream of and separate from the project area.

There are few foreseeable negative cumulative impacts related to Alternative III. The proposed grouted boulder invert channel will follow the existing stream alignment, allowing for a more natural alternative to stream stabilization. With the incorporation of boulders, the low-flow channel is more environmentally acceptable, providing a habitable area for existing aquatic fauna, and will somewhat mitigate the visual impact to the existing natural quality of the stream caused by the RCC channel walls. In the long-term, this would help preserve the existing natural resources and promote growth of terrestrial and riparian vegetation.

Alternative V would allow the ‘Īao Stream to return to its natural state. With the use of a state-of-the-art flood warning system, lives can be saved, but continual erosion will cause property. The inconvenience and cost of repairs is a serious concern.

Alternative VI would retain 7,200 feet of natural stream bottom, but would not prevent against continued erosion and levee undermining. Structures along the left bank would continue to be endangered under this alternative.

COM is planning an upgrade to the existing ‘Imi Kālā Street Bridge. This project has necessitated the inclusion of several revisions to the original Corps' constructed ‘Īao Stream Flood Control Project. Notable revisions include the stream bank excavation and channel widening in the area directly upstream from the bridge to reduce WSELs and erosion potential on the right bank. There is the potential that buried cultural resources may be adversely impacted during construction associated with the widening of ‘Īao Stream. The USACE will include monitoring by a qualified archaeologist to counter such potential adverse effects. Although the bridge upgrade project has slightly changed the scope of the proposed Flood Control Project, this is not considered a cumulative impact to the natural or social environment, other than the benefit to the community of having an improved bridge.

The County is also planning to extend ‘Imi Kālā Street to connect to Kahekili Highway, as part of the development of the Hale Mua affordable housing subdivision. This may cause changes to traffic in the vicinity of the proposed project, but not as a result of any of the project design elements.

No other projects are planned for the channel or in the vicinity of the channel that would compound or increase the impact of the proposed project. Areas surrounding the channel are being developed into residential and commercial communities; however these developments are not anticipated to have a significant cumulative impact on the proposed project.

5.11 IRREVERSIBLE AND IRRETRIEVABLE COMMITMENT OF RESOURCES

The USACE believes that the project modification cannot be avoided due to the need to provide flood control for the Wailuku community. Implementation of the recommended alternative will prevent inevitable project failure, loss of life, and extensive property damage.

Alternative I – Long term negative impacts include and environmental degradation of the ‘Īao Stream by creating a harsher, sterile environment thereby making it a less desirable visitor experience to the area. This overall effect could slow local economic growth in the long term. Natural resources are impacted as existing aquatic species will not be able to adapt to the increased flow speed of water in the channel brought upon by the concrete lining.

Alternative III – Long term negative impacts of visual and environmental degradation of the stream is minimized by or compensated for by mitigation measures. A special low-flow channel is designed to minimize habitat loss for existing aquatic species in the stream. The grouted boulders in the low-flow channel will minimize, but not eliminate the negative visual impact to the natural character of the stream caused by the RCC channel lining. Proposed mitigation measures would enable native organisms to migrate up and down the stream via the low-flow grouted-boulder invert channel and several supplemental mitigation measures (Section 3.0).

Alternative V – Resources invested in the removal of all man-made flood control structures would be irreversible. Replaced by a state-of-the-art flood warning system, the natural environment of the ʻĪao Stream would be returned, but at the cost of loss of property and possibly life in future flood events.

Alternative VI – Stream banks would continue to erode, and levees would be further undermined. This would lead to an eventual detrimental impact to structures along the stream banks, and potential loss of property and life in future flood events.

5.12 PROBABLE ADVERSE ENVIRONMENTAL EFFECTS WHICH CANNOT BE AVOIDED

Alternatives I and III would impact the existing stream environment with flood control improvements, although the impacts of Alternative III would be mitigated to an acceptable level. Alternatives V and VI would impact the existing community with floods and related erosion. As stated in previous sections, temporary noise and sedimentation impacts during construction (e.g., a temporary increase in stream turbidity if water is flowing at the time of construction) are unavoidable. Noise and sedimentation problems will be mitigated to the extent possible through the use of BMPs during construction. For Alternatives I and III, there will be changes in the visual appearance of the stream, although the impact of Alternative III would be mitigated to the maximum extent practicable. Adverse environmental effects from noise and construction-related sedimentation will be temporary and mitigated through BMPs, and are thus not considered significant.

5.13 SUMMARY OF ENVIRONMENTAL CONSEQUENCES

5.13.1 Direct, Indirect and Cumulative Impacts

Direct Impacts. Direct impacts are environmental effects that are caused by the action and occur at the same time and place. A typical example of direct impacts are effects of construction activities on the immediate surrounding environment during the period such operations are taking place. During construction activities the proposed project would result in unavoidable, short-term, insignificant direct impacts.

Indirect Impacts. Indirect impacts are effects that may occur removed in distance or time from the proposed project. Indirect impacts may include growth inducing impacts and other effects related to changes in land use patterns, population density or growth rate, and related effects on air, water, and other natural systems.

The proposed project is intended to correct deficiencies associated with the existing Flood Control Project constructed in 1981, and to prevent further streambed erosion, loss of life, and property damage during flood seasons. By incorporating recommended mitigation measures, it is not expected to result in adverse secondary impacts on the area’s resident population, land use patterns, facilities infrastructure, and natural environment.

Table 5-2 on the following page provides a summary of the environmental impacts associated with the three available alternatives proposed for the project. Alternative VI is not included in the table because it does not meet the project objectives.

Table 5-2: Summary of Project-Related Impacts

Environmental Attribute	Alternative	Direct Impact	Indirect Impact	Cumulative Impact
Oceanography, Hydrology, and Flooding	I	○	+	+
	III	○	+	+
	V	-	-	-
Terrestrial and Aquatic Biological Resources	I	-	○	-
	III	-	○	-
	V	+	+	+
Geology and Soils	I	○	+	+
	III	○	+	+
	V	-	-	-
Threatened and Endangered Species	I	○	○	○
	III	○	○	○
	V	○	○	○
Historic and Cultural Resources	I	○	○	○
	III	○	○	○
	V	○	○	○
Land Use and Aesthetics	I	-	-	-
	III	-	○	○
	V	+	○	○
Hazardous, Toxic and Radioactive Waste (HTRW)	I	○	○	○
	III	○	○	○
	V	○	○	○
Noise Quality	I	-	○	○
	III	-	○	○
	V	-	○	○
Air Quality	I	-	○	○
	III	-	○	○
	V	-	○	○
Water Quality	I	-	○	○
	III	-	○	○
	V	-	-	-
Traffic	I	○	○	○
	III	○	○	○
	V	○	○	○
Recreational and Resource Use	I	-	-	-
	III	○	○	○
	V	-	-	-
Economic and Social Resources	I	+	+	+
	III	○	+	+
	V	-	-	-
Environmental Justice	I	○	○	○
	III	○	○	○
	V	○	○	○

○ No significant impact anticipated

\+ Beneficial impact

\- Adverse (insignificant or significant) impact; mitigation required

This page is intentionally left blank.

6.0 RISK AND UNCERTAINTY

Risk addresses differences between planned and actual outcomes and includes methods for quantifying risk in economic terms. Federal Flood Control Projects generally follow guidelines from the Flood Control Act of 1948, Section 205, PL 80-858, as amended, and USACE supplemental risk assessment, EM 1110-2-1619 on Flood Control Projects. The USACE believes that the project modification cannot be avoided due to the need to provide flood control for the Wailuku community. Implementation of the recommended alternative will prevent inevitable project failure and reduce the loss of life, and extensive property damage.

Alternative I may negatively impact the existing natural environment of the ‘Īao Stream, leading to degradation of aquatic fauna and eventually the aesthetic quality of the stream as a whole. The proposed concrete lining of 70% of the remaining natural alluvial channel may affect tourism and economic viability of the ‘Īao Valley, as it is a well-known location and major revenue-generating location on Maui. This is unlikely however, given the two mile distance between the project area and the valley itself, which is the tourist destination.

Alternative III will provide a more environmentally acceptable design with the integration of a low-flow grouted-boulder invert channel to mimic the natural habitat of the ‘Īao Stream and to facilitate upstream and downstream migration of native organisms. The grouted boulders in the low-flow channel will minimize, but not eliminate the negative visual impact to the natural character of the stream caused by the RCC channel lining. Proposed mitigation measures include alignment of the low-flow channel along vegetated stream banks to allow overhanging vegetation to shade the channel and reduce water temperatures, and a retrofit of improved portions of the channel that are currently lacking low-flow design elements.

Alternative III is designed to facilitate upstream and downstream migration of aquatic organisms, given sufficient water flow. Stream flow restoration is a topic that is currently under discussion by the CWRM, state and federal resource agencies, community groups, and private entities that hold licenses for diversion and out-of-stream consumptive use of ‘Īao Stream Water. This decision is outside the function and authority of the USACE, however. If and when stream flow is partially restored, the low-flow design elements of Alternative III will function to enhance passage of native stream fauna. To mitigate for unavoidable impacts to the affected natural environment, retrofit design elements have been included to facilitate the movement of native organisms through the modified channel area. These elements include a step structure at the 22-foot vertical drop (Station 97+23), widening existing low-flow channel areas, installing low-flow channel segments in existing flat-bottomed cement channel segments and in the center of the existing debris basin, blocks along the sloped portions of the existing channel to provide a resting place for climbing organisms, and an alignment along the vegetated portions of the left bank to provide shade and reduce water temperatures. These mitigation measures have been proposed as compensation for unavoidable impacts, and have been agreed to in a revised mitigation recommendation letter by the USFWS (Appendix J).

Alternatives V and VI do not provide an acceptable level flood or erosion control, and are considered high risk options in the long term.

7.0 ECONOMIC ANALYSIS

The Water Resource Planning Act (WRPA) of 1965, supplemented by Principles and Standards (the P&S, 1973) and Principles and Guidelines (the P&G, 1983) provides guidelines for Federal water related resource projects.

> "The Federal objective of water and related land resources project planning is to contribute to national economic development consistent with protecting the Nation's environment, pursuant to national environmental statutes, applicable executive orders, and other Federal planning requirements” (P&G, 1983).

Economic evaluations for this project were conducted in accordance with the P&G as well as USACE policy. The complete report entitled “Economic Update, ‘Īao Stream Flood Control Project, Wailuku, Island of Maui, State of Hawai‘i” (Appendix K) is included. The objective of the economic analysis is to determine the alternative that will reasonably maximize net National Economic Development (NED) benefits. This is accomplished by comparing the average annual benefits and costs of the alternatives being considered. The alternative that meets project objectives and has a benefit-cost ratio greater than one and the highest net benefits will be designated the NED alternative. Costs and benefits occurring at different points in time are converted to an average annual equivalent basis over the 50-year period of analysis using the federal discount rate prescribed for water resource projects.

This economic analysis compares the benefits and costs related to three of the five alternative plans proposed for ‘Īao Stream Flood Control Project. Cost Estimates and detailed discussions are provided in the Economic Update (Appendix K). Flood plain management, including flood control and prevention, contributes to the NED objective by improving the net productivity of flood-prone land resources, either by increasing the output of goods and services and/or by reducing the cost incurred in using those resources. These improvements in economic efficiency, or project benefits, are estimated by comparing the most likely future conditions without the project (the “without-project” condition) with the most likely future conditions resulting from the implementation of flood damage reduction measures (the “with-project” condition).

7.1 GENERAL

In this economic analysis, both costs and benefits are expressed at an estimated October 2007 price level. Costs and benefits occurring at different points in time are converted to an average annual equivalent basis over a 50-year period of analysis using the federal discount rate prescribed for water resources projects. This rate is currently set at 4.875 %. The project base-year, or first year of project operation, is FY2013. The 50-year period of analysis is from FY2013 through FY2062, inclusive.

The objective of this economic analysis is to determine the alternative that will reasonably maximize net NED benefits. This is accomplished by comparing the average annual benefits and costs of the alternatives being considered. The alternative with a benefit-cost ratio greater than one and the highest net benefits will be designated as the NED alternative.

7.2 ALTERNATIVES.

The six alternatives initially considered in this study are summarized in Table 7-1. Of these, only the performance of Alternative III was evaluated in detail using the Hydrologic Engineering Center Flood Damage Analysis (HEC-FDA) computer program. Alternatives I and II are assumed to provide the same benefits as Alternative III when designed for the same degree of protection. Alternative IV, levee reconstruction, is not considered a viable solution since it does not address erosion and undermining of levees. It is therefore not included in the NED analysis. Alternative V, removal of the existing flood control improvements and the restoration of the stream to its original natural condition, will remove all existing project flood control features for flooding events of all frequencies. Although for the purposes of this comparison it is assumed to have zero benefits, it is likely to have negative benefits to the extent that flooding events with a return period of less than 25-years are likely to cause damage in excess of the without project condition. Consequently it was not analyzed in this NED analysis. Alternative VI is represented as the "without project" scenario in the Economic Analysis (Section 7).

Table 7-1: ʻĪao Stream Alternative Plans

	Description
Alternative I	Trapezoidal Concrete-Lined Channel
Alternative II	Rectangular and Compound Channel
Alternative III	Roller Compacted Concrete and Boulder Invert Channel along Existing Alignment
Alternative IV	Levee Reconstruction
Alternative V	Removal of Flood Control Improvements
Alternative VI	No Action

7.3 METHODOLOGY.

Inundation damages are computed by combining an inventory of structures in the floodplain with the anticipated extent and effects of the flooding from various storms in the without-project and with-project alternatives. Flooding associated with 1-year, 10-year, 25-year, 20-year, 50-year, 100-year, the verify 222-year SPF, and 500-year events were estimated using the USACE' HEC-RAS computer software. The areas of flooding and the flooding depths associated with the different events were computed as discussed in the hydrology section of this report.

The analysis assumes that in the without-project condition the existing levees along the right bank of ʻĪao Stream will fail in a rainfall event of 25-year of greater return period but not in the case of smaller events. This is expected to cause flooding along the entire length of the over-bank as a result of levee and bank failure in one or two places. In order to represent this condition, levees were specified in the HEC-FDA model to represent both levees and river banks, with levee heights artificially set halfway between the 20-year and 25-year flood stages. For the with-project condition, levee heights were set to reflect the levee and river bank elevations of Alternative III, which are the same as those now existing along ʻĪao Stream. A list of the levee heights specified in the HEC-FDA model for the without-project and with-project conditions is provided in Table 7-2.

Table 7-2: Levee Heights in HEC-FDA Model

	Without-Project Levee Height (ft)	With-Project Levee Height (ft)
Reach 1	14.39	20.15
Reach 2	41.03	52.80
Reach 3	61.22	72.80
Reach 4	88.43	95.80
Reach 5	111.83	118.63
Reach 6	139.50	144.70
Reach 7	147.63	154.80
Reach 8	179.60	186.20

In order to determine the economic effects of flooding on structures in the floodplain, structure values, content values, first floor elevations, depth-damage curves, and the estimated water surface profiles for different frequency events were entered into the HEC-FDA computer program. HEC-FDA compares the flood heights for different events with the first floor elevations for each structure in the flood plain. This determines the expected height of flood waters at each structure for any given flood event. HEC-FDA analyzes the percent of damages to each structure and its contents associated with each level of flooding.

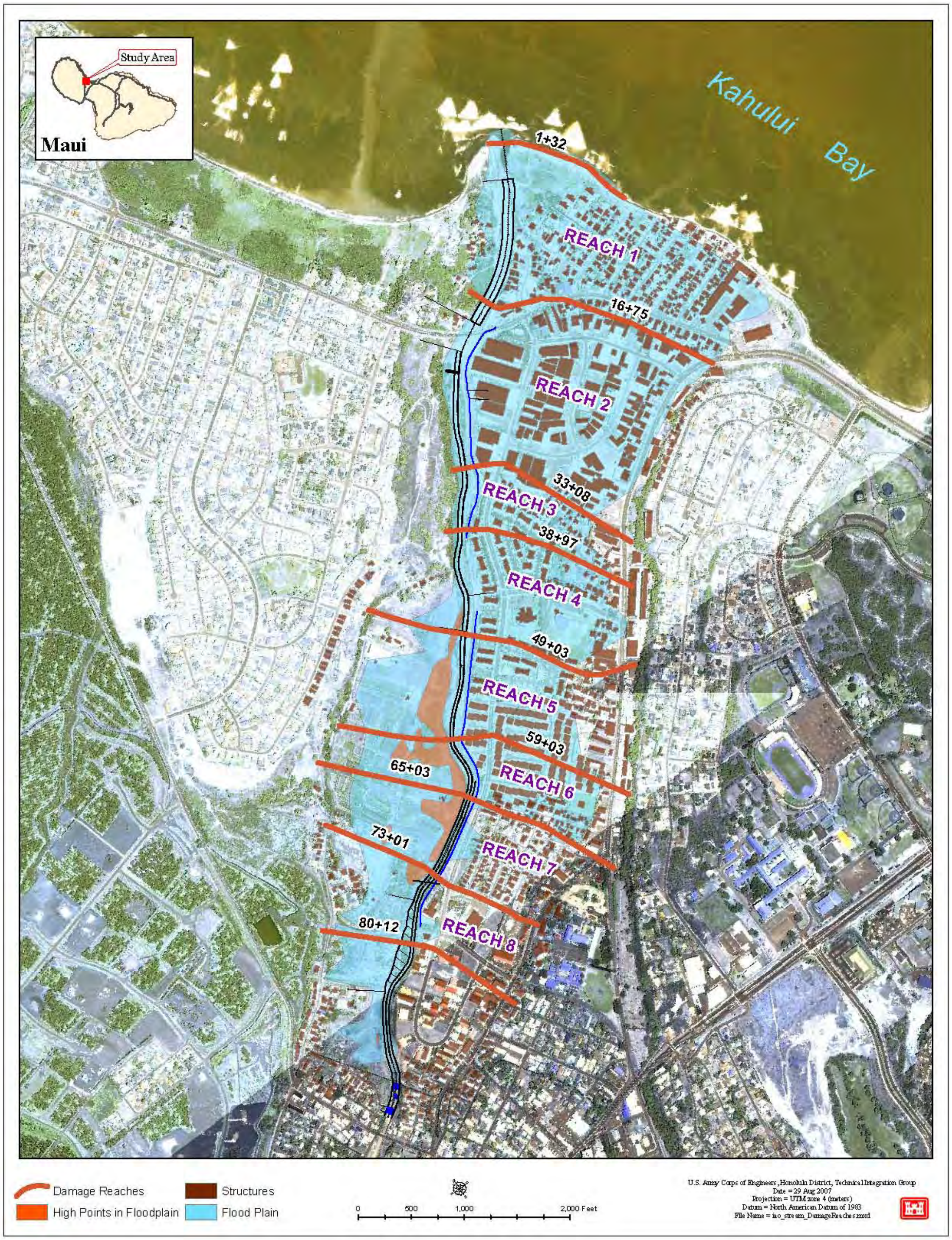
The percent damages are multiplied by the structure or content value to arrive at dollar damages. This procedure is performed for every structure in the flood plain with results consolidated by reach and then integrated over the range of probabilities that flooding of different intensities will occur. The HEC-FDA program also explicitly takes into consideration the uncertainty of the engineering and economic variables involved in calculating flood damages.

7.4 STRUCTURE INVENTORY.

The structure inventory for this economic analysis is composed of all residential and commercial buildings in the SPF (222-year) floodplain. Structures were identified by the use of a geographical information system (GIS) map with layers for TMK parcels, the SPF floodplain, an aerial survey topographic map with 5-foot contour lines, and aerial photographs of the project area. In this analysis, the residential category includes single-family residences, and also multi-unit low-rise condominium and apartment buildings. The commercial structures category includes buildings serving commercial, industrial, and public purposes.

The study area is located in Wailuku along ‘Īao Stream on the north coast of the island of Maui. Structures in the SPF-floodplain are located within an area approximately bounded by ‘Īao Stream to the Northwest, Lower Main Street and Mill Street to the Southeast, ‘Imi Kālā Street to the Southwest, and Kahului Bay to the Northeast. The ground elevations range from about 186 feet above msl at the upstream end of the study area to about eight feet above msl near Kahului Bay. There are about 362 single family residential structures (SFRs) in the 222-year floodplain. The average age of SFRs is about 31 years, and about a third were built after 2000. In addition to the SFRs, 45 multi-unit residential structures containing 464 condominium units were built between 1993 and 2002. The total replacement cost less depreciation value of residential structures in the SPF floodplain is about $111 million and total contents value is about $43 million. The total replacement costs less depreciation of commercial structures in the 222-year floodplain is about $83 million and the total commercial contents value is about $121 million. The residential and commercial structures together have a replacement cost less depreciation value of about $194 million and damageable contents worth about $164 million. For the purposes of this analysis, the flood plain was divided into eight reaches, all on the right bank of ‘Īao Stream (refer to Figure 7-1).

Figure 7-1: Damage Reaches



This page is intentionally left blank.

7.5 DEPTH-DAMAGE FUNCTIONS.

The depth-damage functions or "curves" used in this study for SFRs are from the Economic Guidance Memorandum 04-01, "Generic Depth-Damage Relationships for Residential Structures with Basements (Institute for Water Resources (IWR), 2004)".

Because the multi-unit residential structures in the ʻĪao Stream floodplain are similar in structure to large two story residential homes (although significantly larger), the IWR depth damage curves for SFR structures with two or more stories without basements were used to estimate structure and content damages.

Depth damage functions for commercial structures and contents developed for the New Orleans District of the Corps of Engineers (MVN) were used to evaluate damages to commercial structures and contents (Gulf Engineers and Consultants (GEC), "Depth-Damage Relationships for Structures, Contents, and Vehicles and Content-to-Structure Value Ratios (CSVRs) in Support of the Jefferson and Orleans Flood Control Feasibility Studies," Baton Rouge, Louisiana, June 1996). Depth-damage functions developed for MVN were also used to assess damages to parked vehicles.

7.6 EVALUATION OF OTHER DAMAGE CATEGORIES.

In addition to inundation damages to structures and vehicles, three other damage categories were evaluated. Damages to yards and outside property were evaluated using data from previous Corps of Engineers studies of flood damages in Niu Valley on the Island of Oahu in 1988. These data were also used to evaluate the costs of emergency services. Reduction in the operating cost of the National Flood Insurance Program was evaluated using average operating costs per policy of $192 as specified in Economic Guidance Memorandum 06-04.

7.7 BENEFITS SUMMARY.

Table 7-3 summaries the without-project and with-project damage and the resulting benefits. Total without-project damages are about $2,579,000. With-project damages are about $7,000. The total benefits for these damage categories are about $2,572,000. As noted earlier, Alternatives I and II, although not evaluated, are assumed to have the same benefits as Alternative III. Alternative VI is represented as the "without project" scenario in the economic analysis.

Table 7-3: Damage Summary

	Without Project Damages and Costs ($)	With Project Damages and Costs ($)	Benefits (Damages or Costs Prevented) ($)
Residential structures and contents	923,000	4,000	919,000
Commercial structures and contents	1,438,000	2,000	1,436,000
Vehicles	88,000	1,000	87,000
Yard and Outside Property Damage	73,000	0	73,000
Emergency Assistance Costs	38,000	0	38,000
Flood Insurance Operating Costs	19,000	0	19,000
Total	2,579,000	7,000	2,572,000

7.8 PROJECT COSTS.

Table 7-4 lists the various costs involved in constructing and maintaining the improvements to the ʻĪao Flood Control Project and changes in annual operating and maintenance costs associated with each alternative.

Table 7-4: Project Costs

	Alternatives			
	I	II	III	IV
Project First Cost[1]	$40,641,882	$55,187,961	$30,809,128	$40,641,882
Months of Construction	30	30	22	30
Interest During Construction (months, 4.875%, EOY)	$1,607,371	$2,208,762	$691,982	$1,607,371
Investment Cost	$42,249,253	$57,396,723	$31,501,110	$42,249,253
Amortized Investment Cost	$2,269,726	$3,083,483	$1,692,312	$2,269,726
Difference in Annual O&M[2]	-$61,175	$0	$122,352	-$61,175
Total Average Annual Cost	$2,208,551	$3,083,483	$1,814,664	$2,208,551
Total Average Annual Cost (Rounded)	$2,209,000	$3,083,000	$1,815,000	$2,209,000

[1]Includes PED, S&A, EDC, and LERRD.
[2]The difference between without-project operation and maintenance (O&M) of $147,307 per year and O&M for with-project alternatives.

7.9 BENEFIT-COST RATIOS AND NET BENEFITS.

Two criteria are applied in order to choose the plan that reasonably maximizes NED benefits: the plan must have a benefit-to-cost ration greater than one, and must also have the greatest net benefits. Table 7-5 shows the average annual benefits, the average annual costs, the benefit-cost ratios and the net benefits of the four alternatives considered in the analysis. Alternatives IV and VI were eliminated from consideration because they do not meet project objectives. Alternative V was not analyzed because it is assumed to have a benefit/cost ratio of zero or less.

Table 7-5: Benefit Summary

	Alternatives		
	I	II	III
Average Annual Benefits	**$2,572,000**	**$2,572,000**	**$2,572,000**
Average Annual Costs	$2,209,000	$3,083,000	$1,815,000
Benefit/Cost Ratio	1.2	0.8	1.4
Net Benefits	$363,000	($511,000)	$757,000

7.10 NATIONAL ECONOMIC DEVELOPMENT PLAN.

According to the information in Table 7-5, Alternative III has a benefit-cost ratio greater than 1 and the highest net benefits. Therefore, the recommended plan is Alternative III, with a benefit-cost ratio of 1.4 and net benefits of $757,000.

7.11 RISK AND UNCERTAINTY.

As noted above, the HEC-FDA software program explicitly takes into consideration the uncertainties related to the variables involved in calculating flood damages. The uncertainties of elevations, depth-damage functions, project performance of Alternative III, and frequency/discharge and stage/discharge functions are described in the economic appendix.

This page is intentionally left blank.

8.0 COMMENTS AND COORDINATION

NEPA of 1969, as amended, CEQ regulations (40 CFR 1500-1508); ER 200-2-2, Environmental Quality Procedures for Implementing NEPA; and Chapter 343, HRS and Act 50, as amended, require public involvement and agency consultation at various stages of the development of the EA process.

8.1 PUBLIC INVOLVEMENT

Public participation is organized in the form of public posting and agency consultations.

8.1.1 Agency Coordination

Public posting as well as individual notices were mailed to Federal, State, and county resource agencies in 1996 through 1997. Comments and feedback from various agencies are included in Appendix H. Throughout the development of the EA document, resource agencies have been consulted for concurrence with the preferred alternative and all proposed mitigation measures. A site visit to the project area was conducted in March of 2008 with representatives from COM, USACE, USFWS, and DLNR-DAR to discuss potential mitigation measures for Alternative III impacts. A copy of the trip report has been included as Appendix I. A revised mitigation recommendation letter from the USFWS, in which they confirm their concurrence with proposed mitigation, has been included as Appendix J.

8.1.2 Public Scoping Meetings

A public scoping meeting was held on August 12, 2003. Notification of the meeting was circulated via posting of the meeting notice in the daily paper, the *Maui News*. Meeting notices were mailed to potential stakeholders and community associations. The scoping meeting was held at the Wailuku Community Center, 395 Waena Place, Wailuku, Maui, Hawaiʻi.

A summary of questions and comments made during the public scoping meeting is provided in Table 8-1. A second, informational public meeting is planned for the review of this draft environmental assessment report.

This page is intentionally left blank.

Table 8-1: Summary of Comments, Public Scoping Meeting

Name	Affiliation	Comment	Response
Charmain Tavares	Maui County Council	Will stream restoration be evaluated in the EA? Need to contact Water Dept. Recreational components should be considered. Economic evaluation needed before proceeding w/engineering improvements	Stream restoration is currently a topic being pursued by several community organizations and the County. Any decisions about stream flow restoration must be made by the CWRM. The preferred alternative is designed to facilitate up-stream migration of aquatic organisms and maintenance of habitat supportive of aquatic life, should restoration of stream flow be achieved.
Joe Bertram III	Greenways Maui	Will Cultural Assessment involve considering stream restoration as far as what kind of flow is desirable in ʻĪao Stream area? And what will protection of left bank entail? Planning Commission recommended natural stream - does it matter? Property owners have been unable to develop areas within the floodplain because of the flood designation. Also suggested that recreational components/opportunities be included as another alternative to restore the stream as a cultural resource. Need to contact Water Department because this agency draws from this resource and can capture some of the volumes when the flow is large. Mr. Bertram cited reference: "History of the Wailuku River"	Stream restoration is currently a topic being pursued by several community organizations and the County. Any decisions about stream flow restoration must be made by the CWRM. A natural stream was evaluated as Alternative V, but was found to not meet the project objectives. The floodplain may remain as is if Alternative III is pursued. The left bank will be designed for flood protection of existing structures. Recreational components have been evaluated for inclusion with Alternative III.
Glenn Shepard	none provided	Use this project to augment the water that can get into the aquifer; build percolation basins to allow water to percolate down into the aquifer—"cheap" to construct and maintain. He said he talked to United States Geologic Survey (USGS) on Maui; Mr. Shepard quoted USGS as saying the, '56 million gpd flowing (quoted USGS) downstream into the ocean. ' Suggested an Option 5; i.e., do the least amount to the stream to allow water to "cycle back down."	Alternative III has been revised to include a groundwater recharge basin that would facilitate percolation of surface water down into the aquifer.
Lucienne deNaie	Maui Sierra Club	Alternative V: Look at this as a resource rather than a "destructive force" This is "sacred" in that the stream	Alternative V was considered, but it does not meet the objectives of protecting

Name	Affiliation	Comment	Response
		supported streamside agriculture as well as stream life. Need to look at other examples from elsewhere (she said she's aware of one example) that reversed concrete channelized streams. The project should offer open recreation areas on the banks as a community benefit.	human life and property, and it also had one of the highest costs of all the alternatives. This alternative was thus eliminated from consideration.
Nik Hilananda	none provided	Glenn's (Shepard) suggestion should be labeled "Alternative VI." Should get rid of all 4 alternatives (that were presented tonight) and look at (a new) Alternative V and Alternative VI. Existing stream sides should remain a floodplain. Utilize the water and put back the stream to how it was. Maintain a natural state and show how community can use it as recreational area and access it; + Cultural and historical significance of the area—return to Wailuku Stream (i.e., pre-improvements).	The preferred alternative (III) retains the flood plain along the left bank, and also includes a groundwater recharge basin to help facilitate percolation of surface water down into the aquifer. Community use is planned in the form of running/jogging paths. Removal of all flood control improvements was evaluated as an alternative, but would found to not meet the project objectives of protecting human life and property.
Claire Cappelle	National Marine Sanctuary	EA to look at fast flowing stream's impact on the receiving waters vs. slow-flowing Now that she knows a heiau is located in the project area; this may need to become an EIS.	The EA evaluated potential impacts to surface water, hydrology, and oceanographic patterns in the vicinity of the project. The heiau is located adjacent to the project, but is not in the actual project corridor. The proposed project will prevent the erosion that is currently undermining the banks and might eventually impact the heiau.
Duke Sevilla	Project area resident for 47 years.	Stressed the stream's Cultural values; kūpuna believed that the waters of the stream gave longevity-- longer life.	Thank you for the additional insight. The proposed alternative is designed to be protective of human life in the vicinity of the stream.
Ed Lindsey	none provided	Cultural values: self-sustaining. ʻĪao Valley =believes this was designated for burials for ali'is. Upper part of stream channelization (valley) = taro farming. Need to look at recharge above the area to optimize resources.	A qualified archaeologist will be on-site to monitor excavation of the stream banks in the vicinity of the ʻImi Kālā Street bridge. Groundwater recharge has been incorporated into Alternative III with a proposed groundwater recharge basin.
Elaine Wender	none provided	Please detail developed areas on the right side that are at	Please refer to the appropriate portions of

Name	Affiliation	Comment	Response
		risk of no action is taken. How big an area? Cost of purchasing? Why was development allowed in this area? Estimated cost of alternatives I to IV. Who owns land in left bank flood plain?	the EA, the EDR, and supplemental appendices for detailed answers to these questions.
Ann (no last name provided)	none provided	Does the county pay for part of the project besides maintenance?	
Glenn Shepard	none provided	Break up concrete channel bottom or drill holes to recharge the aquifer.	The preferred alternative (III) will include weepholes in the concrete that will facilitate recharge. The RCC material will also have irregular cracks for expansion that will facilitate recharge.
No name		Remove all ‘improvements’ installed by the Corps and come up with a plan that restores a vibrant river as major economic recreational cultural and environmental resource. Start community partnerships to build and maintain. Recognize cultural gathering practices. Use a cultural agricultural attraction for economic development. No recreational Hawaiian streambed when can we start a new way? Since original improvements created this erosion would removing these improvements improve flows?	Removal of flood control improvements was an alternative evaluated as part of this EA. The alternative did not project objectives. Removing the improvements would not improve flows. Only changing the current water diversion patterns will change stream flow.

Source: Environet, Inc.

This page is intentionally left blank.

9.0 PERMITS AND APPROVALS

The USACE must comply with the provisions of various Federal, state, and local regulations. Executive Order 12372, Intergovernmental Review of Federal Programs, provides that Federal agencies shall rely upon the coordination and review processes established by each state. Federal and local regulations pertaining to the proposed project are as follows:

9.1 SECTION 401 STATE WATER QUALITY CERTIFICATION

Under the Federal CWA, Section 401, WQC is required. Pursuant to HAR 11-54, a State WQC is required for activities when proposed construction or operation may result in discharge into state waters. This certification is in place to regulate water quality during and after the construction phase of the project to assure discharge will meet State Water Quality Standards. The WQC application will be submitted to the HDOH Clean Water Branch after completion of the EA process.

9.2 SECTION 404(B)1 FEDERAL CLEAN WATER ACT

Under the Federal CWA, Section 404(b)1 requires that "except as provided under section 404(b)2, no discharge of dredged or fill material shall be permitted if there is a practicable alternative to the proposed discharge which would have less adverse impact on the aquatic ecosystem, so long as the alternative does not have other significant adverse environmental consequences." A Section 404(b)1 writeup has been completed, and is included as Appendix G.

9.3 NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM PERMIT

Under the CWA, Section 402, a NPDES permit is required. Administered under HAR 11-55, a permit is required for the regulation of point source discharges into surface waters of the U.S. Separate Notices of Intent are required for NPDES permit coverage for discharges to surface waters of construction related storm water runoff or dewatering on sites sized five acres or greater.

9.4 COASTAL ZONE MANAGEMENT

Hawaiʻi Coastal Zone Management (CZM) Program, Chapter 205A, HRS, was promulgated in response to the Federal Coastal Zone Management Act of 1972. The objective of the program is to protect, preserve, and restore scenic, historic, and recreational resources as well as implementing the state's ocean resources management plan and protecting coastal ecosystems. The CZM designated area consists of the entire state of Hawaiʻi, as well as all marine waters to the extent of the state's police power and management authority boundaries.

The original ʻĪao Stream Flood Control Project did not require CZM evaluation, as the original project commenced before the CZM program was implemented in the State of Hawaiʻi. The State Office of Planning references this fact in a letter dated June 18, 1996 (Appendix H), and recommended a full evaluation of the ʻĪao Stream Flood Control Modification Project for consistency with HRS Chapter 205A to ensure that proper procedures are taken in regards to possible impacts to the state's resources.

A full evaluation of the proposed project under the Coastal Zone Management Act Chapter 205A, HRS is available in Appendix F

9.5 STREAM ALTERATION PERMIT

A Stream Channel Alteration Permit (SCAP) is required for the proposed project from the State of Hawaiʻi, DLNR, CWRM. Pursuant to HAR 13-169-50, "Stream channels shall be protected from alteration whenever practicable to provide for fishery, wildlife, recreational, aesthetic, scenic, and other beneficial in stream uses."

9.6 STATE CONSERVATION DISTRICT USE APPLICATION (CDUA)

A Conservation District Use Permit (CDUP) application will be prepared upon the selection of a preferred alternative for construction.

9.7 SPECIAL MANAGEMENT AREA USE PERMIT (SMP)

The COM Department of Planning will determine the need for a SMP when a preferred alternative is selected.

10.0 REFERENCES

Burgett, Bee and Michael F. Dega, 1999. *Archaeological Reconnaissance Survey and Limited Subsurface Testing for the Alternative Channel Alignment, ʻĪao Stream Flood Control, ʻĪao Valley, Island of Maui, HI.* April 1999. USACE, Fort Shafter, HI.

Conners, Tim, 1997. *Geology Fieldnotes - Haleakalā National Park Hawaiʻi* [online]. National Park Service, Geologic Resources Division, Hawai'i. Available from: http://www.aqd.nps.gov/grd/parks/hale/ [Accessed 17 July 2003]

Connolly, Robert D. III, 1974. *Phase I Archaeological Survey of ʻĪao Valley Flood-Control-Project Area.* October 11, 1974. Bernice P. Bishop Museum, Honolulu, HI.

DLNR, 2002. ʻĪao and Waihee Aquifer Systems State Aquifer Codes 60102 and 60103 Ground-Water Management Area Designation Findings of Fact. Commission on Water Resource Management. DLNR. November 14, 2002.

Environmental Council of State of Hawai'i, 2007. Guidelines for Assessing Cultural Impacts. State of Hawai'i. November 19, 1997.

GEC, 1996. "Depth-Damage Relationships for Structures, Contents, and Vehicles and Content-to-Structure Value Ratios in Support of the Jefferson and Orleans Flood Control Feasibility Studies," Baton Rouge, Louisiana, June 1996.

Hazlett, R.W., and D.W. Hyndman, 1996. *Roadside Geology of Hawai'i.* Mountain Press Publishing Company, Missoula, Montana.

HDOH, 2004. Final 2004 List of Impaired Waters in Hawai'i Prepared Under Clean Water Act §303(d). Hawai'i State Department of Health, Environmental Planning Office. June 16, 2004

IWR, 2004. Economic Guidance Memorandum 04-01, "Generic Depth-Damage Relationships for Residential Structures with Basements." USACE-IWR, 2004

Mink and Lau, 1990. *Aquifer Identification and Classification for Maui: Groundwater Protection Strategy for Hawai'i.* Water Resources Research Center, University of Hawai'i at Mānoa. Technical Report No. 185.

Nilsen, R. and J.D. Bisignani, 2001. M*oon Handbooks: Maui: Including Molokai and Lanai.* 6th Edition. Emeryville: Avalon Publishing.

Parker, P.L. and T.E. King, 1995. *Guidelines for Evaluating and Documenting Traditional Cultural Properties*. National Register Bulletin #38: Prepared for the National Park Services.

Principles and Standards, 1973. Policies, Standards and Procedures in the Formulation, Evaluation and Review of Plans for Use and Development of Water and Related Land Resources, S.Doc. 97 (87th Congress, Second Session), reissued in 1986.

Principles and Guidelines, 1983. U.S. Water Resources Council, Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies, approved by President Regan on February 3, 1983.

Scientific Consultant Services/Cultural Resource Management Services, (SCS/CRMS) Inc., 2003. *Archaeological Reconnaissance Survey and Limited Subsurface Testing for the Alternative Channel alignment, ʻĪao Stream Flood Control, ʻĪao Valley, Island of Maui, Hawai'i.* Prepared for U.S. Army Engineer District Corps of Engineers, Building 252, Fort Shafter, Hawai'i 96858. Final Report, Delivery Order No. 041

Social Research Pacific, (SRP) Inc, 2003. *Oral History Studies for the Determination of Traditional Cultural Properties and Cultural Impact Assessment for the ʻĪao Flood Control Project, Maui Island, Hawai'i.* Prepared for the U.S. Army Corps of Engineers, Honolulu Engineer District.

Stearns, HT, 1985. Geology of the State of Hawaii. Pacific Books, Publishers, Palo Alto. 335 pp.

The Marine Research Consultants, 1996-1997. Several studies for USACE under the Water Quality Baseline Monitoring Program from October of 1996 to September of 1997.

U.S. Army Corps of Engineers, (USACE), 2003. Information Paper, ʻĪao Stream Flood Control, Maui. Prepared by the Honolulu Engineering District. March, 2003.

USACE, 2008. ʻĪao Stream Flood Control Project, Wailuku, Maui, Hawaii, Engineering Documentation Report. October, 2008.

U.S. Fish and Wildlife Service (USFWS), 2006. *Revised Draft Fish and Wildlife Coordination Act Report for the ʻĪao Stream Flood Control Project, Maui, Hawai'i*. U.S. Department of the Interior. November. Prepared for U.S. Army Corps of Engineers, Pacific Ocean Division, Honolulu Engineering District.

Way, Carl M., 1996. *Migration patterns of native and indigenous freshwater goby postlarve and the use of artificial corridors for stream mitigation/restoration projects. July, 1996. Environmental Laboratory – Aquatic Ecology Branch, Vicksburg, MS.*

This page is intentionally left blank.

11.0 LIST OF PREPARERS

Margaret Chang, Environmental Planner, Environet, Inc.

B.S. Environmental Science, University of California at Irvine

Ida K. Namur, Environmental Scientist, Environet, Inc.

B.S. Environmental Science, Hawaii Pacific University

Andy Hall, Environmental Scientist, Environet, Inc.

B.A. Environmental Science and Policy, Duke University

Branden Ibara, Environmental Scientist, Environet, Inc.

B.S. Global Environmental Science, University of Hawaii: Manoa

Sonia Garcia, Project Manager, Environet, Inc.

B.S. Biology; Environmental Science and Policy, Duke University

M.S. Biology, University of Guam

Colette M. Sakoda, Senior Environmental Planner, Environet, Inc.

M.C.P. City and Regional Planning, University of California at Berkeley

Roger C. Aoki, P.E., Senior Project Manager, Environet, Inc.

M.S. Environmental Engineering, Purdue University

Lianne Mitsui, Executive Administrator, word processing, Environet, Inc.

A.A. Business Management, Honolulu Community College

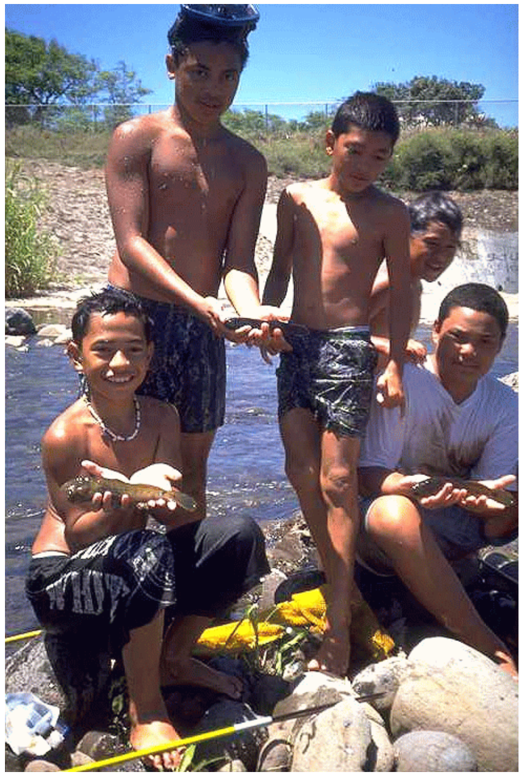
SCS/CRMS, Inc., Historic and Cultural Resources.

This page is intentionally left blank.

Appendix A:

Fish and Wildlife Coordination Act Report

REVISED DRAFT
FISH AND WILDLIFE COORDINATION ACT REPORT
for the
IAO STREAM FLOOD CONTROL PROJECT,
MAUI, HAWAII



Prepared by

U.S. Department of the Interior
Fish and Wildlife Service
Pacific Islands Fish and Wildlife Office
Honolulu, Hawaii

Prepared for

U.S. Army Corps of Engineers
Pacific Ocean Division
Honolulu Engineer District
Fort Shafter, Hawaii

January 2006

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

INTRODUCTION

Authority, Purpose and Scope

This is the U.S. Fish and Wildlife Service's (Service's) draft report on the proposed Iao Stream Flood Control Project, Island of Maui, State of Hawaii. This project is being developed by the U.S. Army Corps of Engineers, Honolulu Engineer District, on behalf of the County of Maui, Department of Public Works and Environmental Management.

This report has been prepared under the authority of the Fish and Wildlife Coordination Act of 1934 [16 U.S.C. 661 et seq.; 48 Stat. 401], as amended (FWCA), and other authorities mandating Department of the Interior concern for environmental values. This report is also consistent with the National Environmental Policy Act of 1969 [42 U.S.C. 4321 et seq.; 83 Stat. 852], as amended (NEPA). The purpose of this report is to document the significant fish and wildlife resources existing throughout the proposed project site and to ensure that fish and wildlife conservation receives equal consideration with other project objectives, as required under the FWCA. The report includes a description of the significant biological resources at the proposed project site, an assessment of potential resource impacts associated with the proposed project, and recommendations for avoiding and minimizing impacts to the fish and wildlife resources in the project area.

Between 1968 and 1981, the lower reaches of the Iao Stream channel were subjected to extensive physical alterations due to a major flood control project authorized by the Flood Control Act. The uppermost component of this previous project is located approximately 4 kilometers (km) (2.5 miles [mi]) upstream of the Iao Stream mouth. Modifications to the natural stream channel associated with the previous project consisted of the following (listed from upstream to downstream): a debris basin; a concrete channel segment that is 335 meters (m)(1,100 feet [ft]) long; a straightened stream channel segment with a natural stream bottom that is 2,195 m (7,200 ft) long and bounded by a levee on the east bank and a managed floodplain on the west bank; and a concrete channel segment that is 427 m (1,400 ft) long and ends near the stream's confluence with the sea (Figure 1).

The proposed Iao Stream Flood Control Project is intended to correct apparent deficiencies associated with existing Corps-designed and County-operated flood control infrastructure. In 1981, and again in 1989, high stream flows resulted in downcutting of the natural stream bed and erosion of the base of the east bank levee structure at the approximate mid-point of the straightened stream channel segment. This area of erosion is 1,700 m [5,550 ft] upstream of the stream mouth. Erosion has occurred at the toe of the levee structure, which consists mostly of earthen embankment, across an area approximately 100 yards in length. Project planning to date has identified five alternatives in addition to the "no-action alternative." Three of the five alternatives under consideration envision placement of concrete lining over the 2,195 m (7,200 ft) of stream channel that is currently natural substrate. A fourth alternative retains the existing substrate but includes significant reconstruction of eroded levies and additional channel alteration. A fifth alternative considers removal of the original existing flood control infrastructure and the installation of a flood warning system.

The downcutting and erosion are the result of several factors, principally the combined effects of increased water velocity due to channel straightening and a rigorous maintenance regime that calls for operation of heavy equipment in the stream to perform “channel clearing” by removing obstacles and smoothing the cobble and boulder substrate that make up the natural stream bed (USCOE 2002). The results of this maintenance include a significant loss of channel complexity and the creation of conditions that accelerate water flow, which increases flood capacity but also increases the erosion potential of the flowing water during periods of high flow. In addition, and perhaps as an added result of the artificially smooth channel and high flow velocities, lateral forces have increased and a noticable meander has been reestablished by the stream in this location. The meander is not of concern on the floodplain (west) bank, however, as the stream rebounds toward the east bank, bed material is being removed from the base of the levee. The erosion caused by high flow events has been partially repaired with concrete rubble masonry (CRM), however, these repairs have subsequently suffered from additional erosion.

Coordination with Federal and State Resource Agencies

Service biologists have exchanged correspondence on the proposed project with staff from the Hawaii Department of Land and Natural Resources’ Division Aquatic Resources (DLNR–DAR) and the Commission on Water Resource Management (DLNR–CWRM). Personnel from the DLNR–DAR Maui District office contributed significantly to this report by assisting with site visits and providing quantitative information on aquatic resources currently found in Iao Stream. Additional information was obtained from the U.S. Geological Survey’s Water Resources Division (USGS–WRD), which currently is performing in-depth studies of surface and ground water resources on Maui.

Other important natural resource information was obtained from researchers familiar with Iao Stream and affiliated with the University of Hawaii Center for Conservation Research and Training, and Michigan State University. Concerns expressed by biologists and other natural resource technical staff with regard to the project have been considered in this draft FWCA report. Copies of this draft report will be provided to the U.S. Environmental Protection Agency; the Hawaii Department of Health’s (HIDOH) Clean Water Branch and Environmental Planning Office; the DLNR–DAR and DLNR Division of Forestry and Wildlife; and the Hawaii Department of Business, Economic Development and Tourism’s Coastal Zone Management Program.

Prior Fish and Wildlife Service Correspondence, Site Visits, and Reports

The environmental review process for the original Iao Stream Flood Control and Related Improvements Project began in 1966 and continued until a Final Environmental Impact Statement was completed in 1975. The studies and reports associated with the review of the original project pre-date much of the currently accepted policy, guidance and standards under which NEPA and Clean Water Act (CWA) project review is undertaken today. A review of Service files indicates that serious concern was repeatedly expressed regarding resource impacts anticipated to result from the original project, and that these concerns were transmitted in writing to the Corps by the Service, other Department of the Interior bureaus, and other Federal and State resource agencies. These concerns included: 1) threats to populations of fish and invertebrates due to reduction or elimination of instream and riparian habitat and substrate; 2) recreational fishery impacts; and 3) visual and aesthetic impacts. With regard to native aquatic resources, there was early recognition that a minimum flow recommendation was a critical component in appropriately mitigating anticipated impacts to aquatic resources in Iao Stream. The following list of prior correspondence describes Service letters, site visits and reports associated with the current proposal to correct perceived deficiencies in the existing Iao Stream flood control project and does not include correspondence, site visits and reports for the original project:

March 3, 1996 The Service provided a FWCA Scope of Work (SOW) letter to the Corps concerning the proposed project.

March 8, 1996 The Corps provided a letter to the Service initiating the FCWA investigation and consultation under section 7 of the Endangered Species Act (ESA).

May 13, 1996 A site visit and initial aquatic resource survey was made to the project area by Service biologists accompanied by a DLNR-DAR representative.

July 1, 1996 The Service provided a Planning Aid Letter (PAL) to the Corps along with a revised SOW and transfer fund cost estimate for additional aquatic resource surveys. The letter expressed concerns for aquatic life due to anticipated effects of lining the channel with cement and concurred that no endangered species were known to be found in the project area. The letter noted that impact avoidance and mitigation features recommended in 1975 appeared not to have been implemented in the existing project.

September 9, 1996 An additional aquatic resource survey was conducted by Service biologists accompanied by DLNR-DAR representatives.

October 31, 1996 The Service provided a Supplemental PAL to the Corps with additional specific information on potential project-related effects. The PAL highlighted the existence of significant gaps in quantitative data regarding stream flow conditions.

November 14, 1996 The Corps provided a letter to the Service regarding hydrologic and engineering considerations for the proposed project. The lack of information regarding stream flow duration characteristics and flow diversion was noted, however, no additional research was initiated to address these gaps in available data.

March 7, 1997	Public Notice CW97-0003 was issued by the Corps pursuant to section 404 of the CWA regarding the intent to discharge fill into Iao Stream channel as a result of implementation of the Iao Stream Flood Control Modifications Project.
April 2, 1997	The Service Provided the Corp with a response letter to Public Notice CW97-0003 and indicated that insufficient data was available to provide adequate comments on the potential effects of the proposed project.
August 8, 2000	A site visit to resurvey habitat conditions was made to the project area by Service biologists. At the time, Iao Stream was flowing in the channel in the vicinity of Imikala Street bridge but flowing water did not extend to the sea on this date.
July 28, 2003	A site visit to survey upstream migrating native organisms in the lower project area and observe water diversion structures throughout the watershed was made by Service biologists accompanied by the DLNR-DAR District Aquatic Biologist.
November 30, 2005	A site visit with Environmental Protection Agency personnel was conducted to discuss environmental review of the proposed project. The stream was flowing in the channel in the vicinity of Imikala Street bridge but flow did not extend to the sea on this date.

DESCRIPTION OF THE PROJECT AREA

The Iao Stream watershed is located on the northeastern side of the West Maui mountains (Figure 1). The watershed encompasses approximately 26.4 km^2 (6,500 acres [ac]) and is 12.4 km (7.7 mi) in length. The upper reaches of Iao Stream originate in the wet, windward interior of West Maui, which receives a mean annual rainfall of approximately 303 centimeters (cm) (120 inches [in]). The stream flows generally northward to its confluence with the sea at Waiehu, an area that receives substantially less precipitation, approximately 76 cm (30 in) per year (Giambelluca et al. 1986; Shade 1997). Due to the steep slopes, porous basalt geology, and soil characteristics of the valley, Iao Stream can experience flash floods during relatively brief rain events (Shade 1997; Benbow et al. 1997; Benbow 1999). As is typical for a Hawaiian stream, Iao Stream is characterized by having great variability in its daily, monthly, and yearly natural flow regime, making stream flow conditions highly unpredictable and “flashy” (Kinzie et al. 1986; Benbow 1999).

Iao Stream is the largest of Maui's altered streams on the basis of stream length and watershed area. Seven percent of all Maui streams are reported as being either straightened, realigned or modified with concrete lining (Timbol and Maciolek 1978). Diversions are reported on 59 percent and road crossings on 96 percent of Maui's streams. A total of five km (3.1 mi) of modified stream channels occur among the seven "channelized" perennial streams identified on Maui. Only one percent (one stream) of Maui streams were reported to be physically pristine in the Timbol and Maciolek study.

Iao Stream is the largest Maui stream to be extensively altered with regard to both its physical structure and its flow regime (Norton et al. 1978, Parrish et al. 1978). Three significant water diversion structures entrain approximately 189,270 cubic meters per day (m^3/day) (50 million gallons per day [mgd]) of Iao Stream water into three large ditch systems (the Maniania Ditch, the Iao-Waikapu Ditch, and the Kama Ditch) that carry water away from the stream for consumptive use, primarily for sugarcane and other agricultural crops. These diversions are located upstream of the channelized portion of the stream. A smaller diversion for a fourth ditch, the Waihee Ditch, originates a short distance downstream of the debris basin, within the cement-lined channel constructed under the previous project (Figure 4). A USGS gauging station (gauge number 16604500) is located approximately 0.5 km (0.3 mi) upstream of Kepaniwai Park, above the first diversion. The catchment area above this gauge is 15.5 km^2 (3,830 ac).

Upstream of the diversions and at typical flow levels, Iao Stream can be characterized as having ample stream flow, with numerous riffle, pool and cascade habitats (Benbow et al. 1997; Benbow 1999). Downstream of the diversions, Iao Stream can be characterized by the absence of water about 80 to 90 percent of the time, punctuated by infrequent high flows when stream discharge volume is sufficient to overtop the four water diversion structures. Occasionally, conditions are such that moderate flows exist in the lower stream, which create riffle and pool habitat in areas of natural substrate, but these episodes are relatively short-lived. The natural substrate of Iao Stream can be characterized as a heterogeneous mixture of boulder and cobble. Other substrate types such as exposed bedrock, gravel, and sand are rare in the lower stream.

In addition to agricultural use of surface waters, groundwater resources in the Iao Stream area are an increasingly important municipal water source for central Maui. This area is subject to increasing demand for domestic water due to a growing population and associated urbanization (Shade 1997).

FISH AND WILDLIFE RESOURCE CONCERNS AND PLANNING OBJECTIVES

The primary project-related concern of the Service is the potential for adverse impacts to fish and wildlife resources resulting from: 1) elimination of natural substrate from the stream channel; 2) degradation of quality and quantity of water that forms the in-stream pathway required by native migratory aquatic organisms; and 3) the elimination of stream-side riparian vegetation, which provides temperature-moderating shade to the stream for aquatic organisms and habitat for terrestrial wildlife. Secondary concerns include potential adverse water quality impacts to the nearshore coastal marine environment that may result in detrimental changes to marine fish and invertebrate communities.

Specific Service planning objectives are to maintain and enhance the native migratory fish and aquatic invertebrate populations and the habitat conditions that support them in the Iao Stream watershed by: 1) evaluating and analyzing the impacts of proposed-project alternatives on fish and wildlife resources and their habitats; 2) identifying the proposed-project alternative least damaging to fish and wildlife resources; and 3) recommending compensatory mitigation for unavoidable project-related habitat losses consistent with the FWCA and other applicable policy.

The Iao Stream Flood Control Project area consists of an interupted perrenial stream that exhibits a series of riffles and pools formed on boulder and cobble substrate. From a regulatory standpoint, the CWA specifically places a high relative value on riffle-pool complexes. This status is conferred in the CWA section 404(b)(1) guidelines and implementing regulations (40 CFR Part §230.44). This authority identifies riffle-pool complexes as one of several types of "special aquatic sites" which are defined as:

> "*...geographic areas, large or small, possessing special ecological characteristics of productivity, habitat, wildlife protection, or other important and easily disrupted ecological values. These areas are generally recognized as significantly influencing or positively contributing to the general overall environmental health or vitality of the entire ecosystem of a region.*"

These guidelines identify a number of well-recognized impacts that can result from elimination of riffle-pool complexes such as: reduction of the aeration and filtration capabilities at the project site and downstream; reduction of stream habitat diversity; reduction of fish and wildlife populations at the project site and in downstream waters through sedimentation and the creation of unsuitable habitat; scouring or sedimentation of riffles and pools; and reduction of water-holding capacity of streams resulting in rapid runoff from a watershed. In addition, these hydrologic alterations usually result in increasing the volume and timing of surface runoff, which can cause the delivery of large quantities of flood water in a short time to downstream areas and result in the destruction of natural habitats, property loss, and the need for subsequent further hydraulic modification (40 CFR Part §230.45(b)[b]). We note that the proposed project is, in fact, largely a hydrologic modification response to the inadequacy of and problems caused by the original flood control project. The cumulative extent of riffle-pool habitat loss due to both the original and the proposed actions has increased significantly. The original project eliminated 762 m (2,500 ft) of stream channel, and the proposed subsequent modification is envisioned to alter or outright eliminate an additional 2,195 m (7,200 ft) of channel. The combined result, if the project is implemented, will be 2957 m (9,700 ft) of riffle-pool habitat permanently altered or lost.

The terminus of Iao Stream is located near the western end of Kahului Bay and discharges into marine waters that are colonized by a variety of corals and other reef-building marine organisms. The institutional significance of coral reefs is also established through their designation as special aquatic sites under the CWA (40 CFR Part §230.44, 45 FR 249). In addition, Executive Order on Coral Reef Protection (EO 13089) further specifies that all Federal agencies whose actions may affect U.S. coral reef ecosystems shall: 1) identify their actions that may affect U.S. coral reef ecosystems; 2) utilize their programs and authorities to protect and enhance the conditions of such ecosystems; and 3) to the extent permitted by law, ensure that any actions they authorize, fund, or carry out will not degrade the conditions of such ecosystems.

In 2002, the Corps reaffirmed its national commitment to maintaining the reach and extent of aquatic habitats that fall under its jurisdiction. The most recent technical guidance on this topic is Regulatory Guidance Letter (RGL) 02-2. This guidance outlines conceptual criteria for development of mitigation to replace aquatic resource functions unavoidably lost or adversely affected by Corps permits and activities. The RGL clarifies and supports the national policy for no overall net loss of wetlands, streams, and other aquatic habitats and reinforces the Corps' commitment to protect waters of the United States. The guidance further clarifies the requirement that project proponents must provide, as a integral project component, and concurrent with project implementation, appropriate and practicable mitigation for authorized impacts to aquatic resources in accordance with applicable laws and regulations. Further, this guidance recommends early planning to regularly review mitigation projects and flexibility to adapt mitigation efforts to ensure their success.

Recently, the Corps Honolulu District Regulatory Branch issued proposed Compensatory Mitigation and Monitoring Guidelines (PN # 200400448). The guidelines acknowledge the regional applicability of CWA regulations for aquatic resource preservation throughout the Honolulu District and reaffirm the District's commitment to require adequate compensation for authorized impacts to aquatic habitats. The proposed guidelines highlight the importance of mitigation planning based upon watershed-scale evaluations of lost environmental functions and values, and describe required components of mitigation planning such as site identification, monitoring, performance evaluation, adaptive management and reporting.

Both RGL 02-2 and the proposed regional guidelines require the use of watershed and ecosystem approaches when determining mitigation requirements, including consideration of the resource needs of the entire watershed as a whole within which the impacts are anticipated to occur. In the case of Iao Stream, a planning process that is based first upon avoidance and minimization of impacts, and secondly upon compensatory mitigation to replace unavoidable functional losses to aquatic resources is required. This approach is assumed to be appropriate and practicable for most cases. A watershed-based approach to aquatic resource protection considers entire systems and their constituent parts. In the case of Iao Stream, the guidance set forth in RGL 02-2 requires that mitigation planning incorporate avoidance, minimization, and compensation for potential impacts of the project in the context of the entire watershed. This implies factoring in the condition of the stream due to cumulative effects of the previous Corp project, and requires simultaneously considering hydrologic effects that result from off-stream diversions of water.

A multiparty effort is required to implement this approach to aquatic resource conservation, and project proponents must recognize and rely on the expertise of State, local, and various Federal resource management programs to achieve this level of resource protection. During the project evaluation process, the Corps must coordinate with these entities to take into account State and local land use regulations, County initiatives, special area management rules and regulations, and other factors of local public interest. The RGL and proposed mitigation guidelines reinforce policies mandating the use of performance standards, post-project monitoring, and enforcement to ensure mitigation requirements are met in perpetuity to maintain adequate ecosystem function.

The Service's Mitigation Policy (Service 1981) also outlines guidance for evaluating project impacts affecting fish and wildlife resources. The Mitigation Policy complements and supports the Service's responsibilities under NEPA, CWA section 404, and FWCA. The Service's Mitigation Policy was formulated with the intent of protecting and conserving the most important fish and wildlife resources through encouraging equitable multiple use of the nation's natural resources. The policy focuses primarily on habitat values by identifying four resource categories and providing mitigation guidelines that include avoidance and minimization of unnecessary impacts, and compensation for impacts anticipated to be unavoidable. The four resource categories are:

a. Resource Category 1: Habitat to be impacted is of high value for selected evaluation species and is unique and irreplaceable on a national basis or in the ecoregion section;

b. Resource Category 2: Habitat to be impacted is of high value for selected evaluation species and is relatively scarce or becoming scarce on a national basis or in the ecoregion section;

c. Resource Category 3: Habitat to be impacted is of high to medium value for selected evaluation species and is relatively abundant on a national basis; and

d. Resource Category 4: Habitat to be impacted is of medium to low value for selected evaluation species.

The Service considers the potentially affected stream and nearshore coastal environments to be habitats of high value. Using the criteria above, lower Iao Stream is considered to be Resource Category 2 habitat due to the severe degradation of stream habitat across the north shore Maui landscape and statewide. The marine waters adjacent to the Iao Stream terminus at Waiehu are also considered to be Resource Category 2 due to the presence of coral reef habitat throughout the area. The Service's resource goal for Category 2 habitat is no net loss of in-kind habitat values. Under this designation, the Service will recommend ways to avoid or minimize losses. If losses are unavoidable, mitigation measures to immediately rectify, reduce, or eliminate these losses over time will be recommended. As necessary, compensation by replacement of the in-kind habitat values may be incorporated as integral project features.

For the purposes of categorization of the freshwater aquatic habitats in Iao Stream, eight species of migratory native Hawaiian stream organisms, which are known to occur in the stream, are considered to be evaluation species (Table 1). These organisms are particularly well-suited to serve as biological indicators because they require cold, clean, high-quality stream water that is relatively free of excessive land-derived nutrients and suspended particulates. This group of animals includes five species of fish and three aquatic invertebrates. All of these species require passage through the stream at two significant and vulnerable time periods in the course of their life histories.

All eight species are reported from the Iao Stream watershed (DLNR-DAR 1999, DLNR-DAR 2001). All of these species are migratory and are dependent upon a free-flowing connection to the sea, via the stream channel, to complete their development and reproduction. These species exhibit a diadromous life cycle known as amphidromy in which adults live and spawn in the stream environment. Newly-hatched larvae are dispersed by stream flow to the ocean where the planktonic larvae feed and grow in the marine environment until they re-enter a stream and undertake a remarkable upstream migration (McDowall 1988, Kinzie 1990). Because the pelvic fins of the fishes are modified to form a suction cup, several of these species, such as the gobies *Lentipes concolor* and *Sicyopterus stimpsoni*, are capable of ascending vertical or overhanging waterfalls and can be found at higher elevations in the streams as adults. Occasionally, these species may be found in high-elevation perennial sections of intermittent or interrupted (diverted) streams, above reaches that do not contain perennially flowing water. This is the case in Iao Stream where upstream migration to these intermittently isolated upper reaches appears opportunistic and is successfully accomplished by a few individuals as flowing water conditions allow. All of these stream-dwelling species are rarely found as adults in man-made waterbodies such as ditches, flumes, or impoundments. If juveniles are entrained into these types of structures and survive to adulthood, they are effectively removed from the breeding population because their reproductive success is zero without a connection to the sea for downstream dispersal of larvae.

In addition to the larger stream-dwelling fish and invertebrates, a number of other less conspicuous native invertebrate species are found in these systems. Many of these are endemic to the Hawaiian Islands or limited in distribution to Maui itself, such as the unusual freshwater sponge (*Hetermyenia baileyi*), a genus of moths that exhibit an aquatic larval stage (*Hyposmocoma sp.*), and the torrent midges (*Telmatogeton sp.*, Benbow et al. 2003; Yamamoto and Tagawa 2000, pers obs).

Table 1. Native migratory freshwater organisms of Hawaiian streams.

Scientific name	Hawaiian name	Biogeographic status	Type of organism
Awaous guamensis	O'opu nakea	indigenous	Freshwater fish (family Gobiidae)
Lentipes concolor	O'opu alamo'o	endemic	Freshwater fish (family Gobiidae)
Stenogobius hawaiiensis	O'opu naniha	endemic	Freshwater fish (family Gobiidae)
Sicyopterus stimpsoni	O'opu nopili	endemic	Freshwater fish (family Gobiidae)
Eleotris sandwicensis	O'opu akupa	endemic	Freshwater fish (family Eleotridae)
Atyoida bisulcata	Opae kala'ole	endemic	Freshwater shrimp Crustacean
Macrobrachium grandimanus	Opae 'oeha'a	endemic	Freshwater prawn Crustacean
Neritina granosa	Hihiwai	endemic	Freshwater snail Mollusc

The embayment and open coastal marine environment downstream and adjacent to the Iao Stream watershed is the ultimate discharge point of Iao Stream. Although not specifically selected as evaluation species for this report, the biological communities found in the nearby marine environment may be affected by stream channel alteration in the Iao Stream watershed. In marine waters of the Hawaiian Islands, corals and reef-associated fish are of fundamental importance to biological community diversity and abundance. Although corals are small and sensitive organisms, healthy coral colonies are important for providing the basic foundation for habitat that supports diverse communities of other highly specialized aquatic organisms. Corals contribute the bulk of the calcareous raw material that forms and maintains the basic structural framework of the reef. Reef fishes are of importance in the ecological function of nearshore environments (e.g., grazing of algal biomass and higher order predator/prey relationships) and as sources of food and recreational opportunities for people. Marine waters adjacent to the mouth of Iao Stream support sport fisheries for a variety of nearshore species, notably jacks (Carangidae) including *Caranx melampygus* and *C. ignobilis* (called omilu or ulua as adults and papio as juveniles) *Selar crumenopthalmus* (called akule as adults and halalu as juveniles); and goatfish (Mullidae) such as *Mullodichthys vanicolensis* (called weke as adults and oama as juveniles).

EVALUATION METHODOLOGY

Current and historical information on aquatic species and habitats that may be affected by the proposed action were gathered through literature searches and a review of our files. In addition to Service records, information was solicited from several agencies and a non-governmental organization that have undertaken field investigations of aquatic resources in the area, including the USGS–WRD, DLNR–DAR, and The Nature Conservancy.

Field surveys of fish and wildlife resources by the Service were primarily qualitative in nature. The goals of the surveys were to develop a reasonably complete list of the significant larger taxa that inhabit the stream within the project area and to better understand the needs of these organisms for upstream and downstream migration through areas that will be directly or indirectly impacted the project. A variety of survey and analysis methods were used for this report, including straightforward enumeration of organisms observed at selected locations in the field to the application of a habitat evaluation methodology based upon a weighted scoring regime. These are described in the sections below. Although the marine environment is directly downstream and adjacent to the project area and receives surface and ground water input from Iao Stream on a constant basis, field surveys did not include a marine component. Potential impacts to the marine environment were evaluated based upon a literature review and through contact with State, academic, and non-governmental organization subject matter experts.

The DLNR–DAR Maui District Office contributed substantial quantitative data for inclusion in this report. These data were collected at several locations in lower Iao Stream during flowing and non-flowing conditions. The results of these quantitative observations are presented in the tables below. Also included in this evaluation are results of recent academic research on occurrence and distribution of organisms as a result of flow characteristics (Benbow et al. 2003; McIntosh et al. 2003).

DESCRIPTION OF FISH AND WILDLIFE RESOURCES

Existing Conditions

Channel and Substrate Features

Habitat conditions are the result of the complex interplay between natural land and water processes, biological influences, and human landscape alteration. Analysis of habitat is important because support of viable habitat is a key element of the protection of biological integrity. Habitat can be evaluated on a relative scale based upon the concept of "reference conditions," which are assumed to represent minimally impaired natural conditions. Biological assessments using scored habitat characteristics are supported by a growing body of literature both nationally and in Hawaii (Barbour et al. 1996; Karr and Chu 1999; Kido et al. 2001). These relative comparisons can illustrate whether waterbody impairment is a result of biological effects (such as shifts in community composition due to non-native species introductions) or physical effects (streambank alteration, water diversion), or a combination of both. Hawaiian streams are not greatly impacted by point-source discharges or resource extraction activities such as heavy industry or mining. Habitat degradation is, therefore, often a significant factor contributing to overall stream degradation. The larger Hawaiian stream fauna require suitable habitat conditions throughout their migratory pathways (moving downstream as just-hatched larvae and then upstream as postlarval juveniles). Channel straightening, channel lining, and other stream bank and riparian modification have incrementally combined to reduce or eliminate the occurrence of native species in many Hawaiian watersheds.

A semi-quantitative scoring method was used to evaluate habitat characteristics in Iao Stream near Imikala Street bridge. The habitat characterization was based on scoring a number of individual elements, each of which represents an important habitat feature of the aquatic environment (Table 2). The scores are weighted to reflect the effects different habitat characteristics impart to fish or macroinvertebrate living space. Nine habitat characteristics were chosen specifically because of their importance to the biological integrity of Hawaiian streams and especially to the native Hawaiian aquatic fauna (Kido et al. 2001; HIDOH 1998). Two characteristics are quantitative in that they are directly measured (pool-riffle ratio and width-to-depth ratio) and two are semi-quantitative in nature (substrate composition and substrate embeddedness). The remaining five habitat characteristics are evaluated qualitatively. The scoring for these characteristics was developed from other bioassessment protocols; however, each characteristic was analyzed separately to produce scoring ranges applicable to Hawaiian streams.

"Reference conditions" are defined as the set of highest habitat characterization scores computed in a region, as determined from a representative sample of least impaired streams. Subsequent comparisons of stream reaches under assessment are then made on a relative basis. For example, a habitat characterization score that is 90 percent of the reference condition score would be considered nonimpaired, and a habitat characterization score that is only 10 percent of reference would be considered severely impaired. The development of habitat characterization scores, and the basis for comparison of characterization values, is done on an ecoregional scale using a data set that includes sites that range in condition from least-impaired to highly degraded.

For the scoring method used in Iao Stream, the reference condition score (highest expected value) for the sum of all scored characteristic is 135. Sites scoring above 75 percent of the reference score are considered to have habitat that is supportive of aquatic life, sites with scores between 50 percent and 75 percent have habitat that is partially supportive, and sites that score below 50 percent do not have habitat considered to be adequate to sustainably support aquatic life. A habitat evaluation data sheet is included in Appendix I.

Habitat characterization of Iao stream was performed at a representative location below Imikala Street bridge. Because water diversions upstream of the site, this section of the stream is considered to be an “interrupted” perennial stream. Approximately 0.2 cubic meters per second (m^3/s)(4.5 mgd) of water was flowing in the stream on the date of the survey.

Table 2. Habitat characterization scores, Iao Stream Flood Control Project area.

Character	Max Score	Iao Stream Score
Substrate	20	18
Embeddedness	20	18
Velocity-depth	20	7
Channel shape	15	9
Width to depth ratio	15	2
Pool to riffle ratio	15	12
Soil stability	10	4
Vegetation	10	9
Riparian zone	10	4
TOTAL SCORE	135	83 (61.5%)

The substrate at the survey location was clean and largely free of fine sediment. The cobble/boulder substrate was loose and unconsolidated. This generated high scores for substrate composition and substrate embeddedness. The channel configuration was broadly u-shaped which did not allow for deep flowing water or deep pools, and this habitat limitation is reflected by moderate to low scores for the characteristics of velocity-depth, channel shape, width-to-depth ratio and pool-to-riffle ratio. Soil stability and riparian zone scores were low, but the score reflecting riparian plant biomass was high (Figure 1) due to favorable growing conditions (principally the absence of grazing or vegetation clearing activities such as herbicide use) for weedy species such as Job's tears *(Ciox lachryma-jobi)*.

While we recognize that the habitat survey is limited because it was performed at a single location in the project area, the results indicate that physical habitat conditions in the currently-unlined channel areas of Iao Stream exhibit values that fall in between a highly impaired, straightened but unlined stream on Oahu (Waimanalo Stream) and scores from sites in the Waiahole-Waianu watershed, also on Oahu. The latter is considered to represent one of the least impaired large watersheds on Oahu, and is considered a regional reference stream (HIDOH 1998).

The human-made substrate built into the original Iao Stream Flood Control Project is a combination of concrete and CRM. This accounts for a total channel length of 762 m (2,500 ft), of which 335 m (1,400 ft) is in the upper section of lined channel and 427 m (1,100 ft) is in the lower section. There is a "low-flow channel" present in some of the concrete-lined areas, although this feature does not extend throughout the entire lined channel. The low-flow channel appears most functional in the upper section adjacent to Happy Valley.

Throughout much of the concrete-lined channel, exposed basaltic cobble and small boulders are found (Figure 3). Apparently, these features were installed to provide areas with "more natural" microhabitat conditions to assist upstream migrating organisms. The total surface area with cemented-in exposed cobble and boulder substrate material ranges from zero to 90 percent of the total channel surface area.

Flow Characteristics

The streams of West Maui have been significantly altered for over a century by diversion of water out of natural stream channels for agricultural use. These extensive modifications to surface water environments have profoundly altered natural hydrologic regimes. Plantation diversion and ditch systems, built to support the cultivation of sugarcane, transfer large volumes of water out of natural watercourses and into extensive irrigation systems composed of ditches, tunnels, flumes, and reservoirs (Wilcox 1991). The extent of stream alteration in the Hawaiian islands is remarkable, with at least 58 percent of the estimated 366 perennial streams in Hawaii exhibiting some type of stream flow alteration due to diversion or source water withdrawal (DLNR 1991). On the more populated and urbanized islands of Maui and Oahu, the compounding effect of channel alteration is also significant because the majority of these streams are straightened or cement-lined in their lower reaches for flood control purposes (Parrish et al. 1978).

At the time of their construction, agricultural diversion structures were built to be highly efficient in their ability to entrain water. These dams divert all flowing stream water out of the stream channel during moderate to low flow periods, often leaving the stream channel below the dam completely dry. Historically, no structural modifications were incorporated into the design of these dams and weirs to facilitate passage of aquatic organisms within natural stream channels, nor have more recent environmental considerations led to maintenance of stream flows in the reaches below the dams. To the contrary, these diversion structures are expressly designed and maintained to be highly efficient in capturing and diverting as much of the stream flow as possible, particularly during periods of moderate and low flow. This time period usually corresponds to when agricultural demand for water is high, and coincidentally, when the need for water to support aquatic life is most acute.

After more than a century of plantation-style agricultural operations by Wailuku Agribusiness (a subsidiary of C. Brewer & Co.) and its predecessors, the largest licencee of diverted stream water on West Maui is undergoing a transformation of corporate assets. This includes liquidation of its landholdings, ventures into commercial and residential real estate, and various forms of alternative “diversified” agriculture such as seed corn and macadamia nuts grown on former sugarcane lands. However, the acreage devoted to new agricultural ventures is relatively small, and replacement crops require only a small fraction of the amount of irrigation water that sugarcane required. Existing water diversion infrastructure is being maintained, however, and it continues to remove very large volumes of stream water from natural stream channels for agriculture, domestic use, and unspecified future uses.

Despite the reduction in agricultural need, an extensive system of surface water diversions, ditches, tunnels, and impoundments continue to exist in and around the Iao watershed. The 1989 water use declaration with the DLNR–CWRM submitted by Wailuku Agribusiness is 3.7 m^3/s (84.8 mgd) from Iao Stream alone (this volume was submitted and recorded pursuant to requirements of Hawaii Revised Statutes 174C, also known as the State Water Code). Although current water use has diminished somewhat due to minor ditches being taken out of service, the present diversion capacity of the Wailuku Agribusiness water system is at least 2.2–2.6 m^3/s (50–60 mgd). This total capacity (reported in 1978 and based on a 23-year period of record) includes some well water and water derived from horizontal shafts. Therefore, the long term average for total surface water diversion alone is closer to 2.1 m^3/s (48 mgd). This value would include flow volumes entrained by the Iao-Waikapu Ditch (0.34–0.50 m^3/s, 7.76–11.52 mgd); and the Maniania Ditch (0.37–0.53 m^3/s, 8.40–12.13 mgd), which are the largest diversions currently removing water out of Iao Stream. (Because of local convention and historical factors, ditch names are notoriously difficult to standardize, for instance there are two “Spreckels Ditches” on Maui, including one that traverses the Iao Stream watershed; see Wilcox 1991 for discussion. In this report, ditch names illustrated on USGS 1:24,000 topographic maps are used.)

Iao stream is the largest and most significant freshwater aquatic feature of the west Maui landscape. Mean annual discharge in the stream above the diversions is 1.9 m^3/s (43.2 mgd) (USGS data, 14-year period of record). The detrimental effects to aquatic resources in the stream due to water withdrawal is profound (DLNR-DAR 1999; DLNR-DAR 2001; McIntosh 2003). Although no stream gauge is present in the lower stream, monthly observations by DLNR-DAR staff of conditions in the lower channel and mouth of Iao Stream over a period of nearly 10 years provide reasonably accurate estimates of the number of days that the stream flows throughout the extent of the channel and reaches the sea. These estimates are shown in Table 3.

Other factors function to limit aquatic life in the proposed project area. Flow duration characteristics are also a critically important factor of the Iao Stream hydrograph for the support of aquatic life. This is because upstream migrating individuals require continuous flow to be of sufficient duration to traverse the 4.5 mile section of stream that is regularly dewatered. If flow terminates when post-larvae are midway up this section, of stream they will desicate and die. In fact, this is assumed to occur with each successive episode of flow, and as a result, large numbers of upstream migrants may begin their migration only to become stranded and lost from the population when flow terminates. No quantitative data is available to estimate flow duration characteristics or numbers of organisms killed due to flow cessation. At the opposite extreme is the number of days of excessively high flows. For the duration of each high flow event, conditions are not suitable for passage of aquatic fauna because of high water velocity, turbidity, and violent motion of the substrate (rolling cobbles and boulders). The extent of time during which these periods exist further limit the actual number of hours during which successful upstream migration occurs. The estimate of total days of flow and other stream characteristics indicate that conditions for the migration of native stream fauna are severely impaired by reduction in flow, which is further compounded by elimination of supporting habitat as a result of the flood control project as it currently exists.

Table 3. Iao Stream discharge and estimated days of continuous flow to ocean.

YEAR	Mean Discharge (mgd)	Days of flow to ocean (approx.)	Percent of days per year of stream flow to ocean
1993-94	89	72	20
1994-95	63	33	9
1995-96	61	35	10
1996-97	59	39	11
1997-98	70	48	13
1998-99	60	34	9
1999-00	43	18	5

Biological Resources

As described above, the larger migratory native stream fauna undergo a period of development in the open ocean where they are planktonic. The process by which these larvae recruit to the mouths of streams, undergo metamorphosis to their post-larval form, and begin their upstream migration is poorly understood. A 1988 study (Radtke et al. 1998) found that the period of time these organisms spend as larvae appears rather long (3–6 months) in comparison to larval reef fish and invertebrates (typically days to weeks, although sometimes several months). The chemosensory signals that the larvae use as directional cues for finding a stream mouth is only now becoming a topic of serious research (DLNR–DAR 2001). Anecdotal evidence seems to indicate that groundwater entering the sea in the vicinity of the stream terminus also provides a sufficient chemosensory signal to attract larvae to the Iao Stream mouth (DLNR pers. comm.). These recruits then aggregate at the stream mouth and begin moving upstream almost immediately when suitable flowing water conditions begin. Table 4 presents results of monitoring by DLNR–DAR staff of upstream migration attempts over a period of five years.

Because the Iao Stream channel is dry for long periods of time in the project area, the lower stream channel currently functions as only a temporary conduit through which upstream migrating post-larvae attempt to reach perennially flowing water when conditions allow. A limited number of these upstream migrants are able to successfully complete the journey, but large numbers are lost in their attempt to ascend the lower reaches of the stream.

Table 4. Number of most abundant upstream migrating post-larval native fish and invertebrates trapped at Iao Stream mouth 1996 – 2001 (DLNR-DAR data).

YEAR	*Lentipes concolor*	*Awaous guamensis*	*Sicyopterus stimpsoni*	TOTAL FISH	*Atyoida bisulcata*	Stream flow to ocean (days)
1996-97	1,050	77	176	1,303	13,589	39
1997-98	775	29	51	855	11,883	48
1998-99	316	16	22	354	2,121	34
1999-00	214	0	71	285	3,364	18
2000-01	61	3	10	74	2,162	(no data)

The large numbers of post-larvae entering the lower stream channel during the relatively brief periods when there is sufficient flow represent a potentially huge pool of recruits that are capable of restoring native aquatic life to the stream, provided adequate instream flows exist.

Another recurring impact resulting from the current regime of hydrologic and habitat conditions in Iao Stream stems from the unusual and poorly-understood spawning behaviors of *Awous guamensis*. During flood-level flows, especially at the onset of winter season rains, at least some of these fish appear to move down stream to spawn *en mass* (Ego 1956; Kinzie 1990; Ha and Kinzie 1996). Whether all or only some mature adults do this, or if spawning is followed by an attempt to return to upstream habitat, are not known with certainty. In any event, there appears to be periodic downstream movement of adult *A. guamensis* in Iao Stream (DLNR–DAR pers. comm.). These larger, mature *A. guamensis* support a small recreational and subsistence fishery that includes spearing and trapping of fish that are left stranded in temporary pools as flows rapidly recede (Figures 4 and 5). Individual fish that are left stranded as flows terminate due to water withdrawals dessicate and perish. This results in an ongoing elimination of large and sexually mature individuals from the stream-wide population.

Future Without the Project

In the absence of the proposed project, substrate conditions, flow characteristics and biological resources are not expected to change in the near future. The erosion that has occurred due to down-cutting of the channel bed could continue if stream discharges of sufficient volume reoccur. Limited-scale erosion control efforts using CRM repairs to the levy would be perfomed when future erosion damage occurs. Iao Stream would continue to act as a “population sink” resulting in the loss of many hundreds of native organisms due to stranding and dessication during upstream and downstream migration. Over the long term, there is some potential for minimum instream flows to be established in Iao Stream under administrative direction of the DLNR–CWRM. Recent policy development and judicial decisions at the State level support establishment of conservation flows, despite the continued regional demand for water for agriculture and domestic consumption.

DESCRIPTION OF ALTERNATIVES EVALUATED

Four project alternatives have been developed for review. They include Alternative 1: a trapezoidal concrete channel following existing alignment that would eliminate the use of the managed floodplain on the west bank; Alternative 2: a rectangular and compound channel along a straight alignment which also discontinues use of the managed floodplain on the west bank; Alternative 3: a roller-compacted concrete and boulder invert channel following the existing alignment; Alternative 4: which proposes levee reconstruction to rebuild the base of damaged levees and to raise levee height at key locations, the managed floodplain would be retained under this alternative; and Alternative 5: which proposes removal of all existing flood control infrastructure and installation of a flood warning system. A “no action” alternative (Alternative 6) will be an element of project planning and NEPA review; this status quo condition, described above, is considered one of the viable alternatives for project planning and for baseline comparative purposes in this report.

Alternative 1 consists of a trapezoidal, concrete-lined channel with a bottom width of 12.2 m (40 ft). The channel would follow the existing stream alignment over a distance of about

2,195 m (7,200 ft). The top width is approximately 27.4 m (90 ft) and includes interior splitter walls at all channel curves. All design flows would be contained within the channel, eliminating the managed floodplain on the west bank of the project. This alternative would achieve the project objectives and is feasible from an engineering and construction standpoint. The primary disadvantage of this alternative is that the long reach of existing natural substrate which functions as intermittent habitat for aquatic life would be lost. Secondary impacts include the continued alteration of the hydrologic water quality characteristics of the system, which will result in impacts to nearshore marine waters.

Alternative 2 consists of a rectangular and compound, concrete-lined channel with a bottom width of 6.1 m (20 ft). It would include a straightened alignment and a shallower grass-lined channel (16.8 m [55 ft] wide) adjacent to it to handle larger storms. Total top width of this channel is approximately 44.2 m (145 ft). Design flows would be contained within this channel. This alternative also would achieve the project objectives and has the added benefit of being easy and inexpensive to maintain. However, it is the most expensive alternative because of the extensive channel straightening required for this design. This alternative would also result in the loss of natural substrate due to the need to line the straightened channel with concrete, and may cause impacts to nearshore marine environments due to altered hydrology and water quality.

Alternative 3 follows the alignment of the existing stream and contains up to the 10-year flood event within the structural improvements. Higher flows would be directed into the adjacent managed floodplain on the west bank. This alternative incorporates existing levees as part of the project. The median base width of the channel would be 6.1 to 15.2 m (20 to 50 ft). The typical stream stabilization improvements would consist of large stones in the main channel low-flow section with roller compacted concrete stream bank protection on the bank slope. Channel lining, retaining walls, and raised levee walls would be necessary due to excessive flow velocities and to contain high flood levels. Although feasible and not more expensive than the other alternatives, this design would be the most expensive to maintain due to the irregular shape of the embedded boulder design of the low-flow channel. Growth of vegetation in the vicinity of the low-flow channel would be an integral part of the design. This mid-channel vegetation would function to reduce potential project impacts by creating shade and keeping stream water cool but would add to maintenance costs.

Alternative 4 undertakes repair and reconstruction of damaged levee toes and increases levee heights in key flood-prone areas. The alternative consists of widening the basal stream area, flattening the slope of the west bank, and reconstructing the levee toe with concrete riprap to fill the void under the levee toe. A cutoff wall would be constructed adjacent to the existing levees. This alternative would retain existing natural stream bottom throughout the project area and would retain the managed floodplain extending from the west bank. Management of the natural stream bottom would continue in its present form, with minimally managed vegetation allowed to grow in the channel between levees. Alternative 4 would require less than half the total cost of the Alternatives 1, 2, 3 or 5 ($6 million vs. $20-35 million), however, this channel configuration is anticipated to be difficult and costly to maintain due to continued exposure of earthen levee structures to high-velocity water. According to Corps technical documents, this design may not be capable of containing design flows, therefore, this alternative is limited to addressing channel stabilization requirements but not flood containment objectives.

Alternative 5 consists of complete removal of existing flood control infrastructure and includes installation of a flood warning system. This alternative was put forward in response to public support for restoration of natural ecosystem function in the Iao Stream watershed. However, "natural function" of the channel implies that erosion and deposition is allowed to occur to the extent that natural stream meanders can be re-established throughout the stream corridor and into the flood plain. In order for this to occur, Alternative 5 would need to include a land acquisition component whereby, in addition to flood containment, certain lands are identified and aquired to accomodate the requirement for the stream to meander within its floodplain. Natural resource features associated with Alternative 5 could be maximized with active vegetation management in the riparian zone. In the last twenty years or so, housing and business development has occurred adjacent to the lower Iao Stream channel (in part due to the original flood control project, which is now deemed deficient). A restored, vegetation-lined channel that is allowed to meander could be re-established throughout lower the Iao Stream channel with sufficient funds for real estate acquisition. However, land costs in Hawaii are extraordinarily high and the associated project costs could make the project cost-prohibitive. Furthermore, degradation of ecosystem function in lower Iao Stream is a result of several factors including severe water withdrawal, as described above. Elimination of all existing flood control features and channel restoration would not address the extensive loss of water that results in a lower stream channel that may be dry for 80 to 90 percent of the time.

POTENTIAL PROJECT IMPACTS

All project alternatives share the potential for temporary construction-related impacts. During the period of construction, earthmoving and related activities would create a risk for the entry of terriginous sediments into the stream channel and adjacent nearshore marine waters. This is especially the case during periods of wet weather. A variety of voluntary and regulatory controls function to minimize this risk. However, even the best construction site management practices are inadequate to control runoff during torrential rains, which occur regularly but unpredictably in Hawaii. Development of site-specific Best Management Practices (BMPs) are integral elements in the planning and application process for CWA section 404 permits and the concurrent CWA section 401 Water Quality Certification administered by the HIDOH Clean Water Branch.

Alternatives 1 and 2 would have the greatest impact due to outright loss of habitat that is currently used by native aquatic species during periods of flowing water. Under these alternatives, the existing natural boulder and cobble stream bottom substrate would be permanently converted to a flat concrete channel. The stream flow throughout this reach would form a thin flowing sheet of water. This would severely limit or eliminate the existing intermittent pool/riffle flow characteristics that function to provide refugia from high flows, shelter from predators, and suitable substrate for invertebrate and algal food resources for upstream migrating post-larval amphidromous species.

Both alternatives 1 and 2 also would eliminate the riparian vegetation that is currently found along the unlined section of the stream. This vegetation, although consisting of introduced "weedy" species such as java plum (*Syzygium cumini*) and haole koa (*Leucaena leucocephala*) provide shade to much of this section of stream. The shade results in lower water temperatures during periods of water flow. Native fauna are quite sensitive to elevated temperatures and associated changes in dissolved oxygen and pH (Parrish et al. 1978). If constructed, the entire lower 2, 957 m (9,700 ft) of Iao Stream would flow entirely over unshaded cement. In this condition, the increase in water temperatures alone could make the channelized lower stream an impassable barrier to native species, at least during periods when sun exposure is high.

Alternative 3 represents an attempt to reduce the impacts anticipated under Alternatives 1 and 2. During periods of moderate to low stream discharge, water would be entrained in a low-flow channel that is envisioned to be of sufficient rugosity to create microhabitat conditions that are more suitable than flat unshaded concrete for upstream migrating organisms. Schematic drawings submitted for Service analysis indicate that vegetation would be allowed to grow among the grouted boulders that form the low-flow channel. This vegetation, if appropriately managed, would function to provide critical shade and maintain lower water temperatures. Even with the implementation of design features intended to reduce impacts to the aquatic environment, cementing an additional 2,195 m (7,200 ft) to eliminate a total of 2,957 m (9,700 ft) of natural stream will result in a highly significant impact to Iao Stream itself and cumulatively to the hydrologic landscape of north-shore Maui.

Potential project impacts due to Alternative 4 are anticipated to result from reconfiguration the stream bottom, alteration of the channel slopes and in-channel reconstruction of levee toes with rip-rap. These alterations will increase water velocities during periods of moderate flows due to confinement of the lower channel due to the levee repairs. Existing stream channel substrate and vegetation would be left as is. The rebuilding and repairing of eroded levee structures would not extensively alter existing aquatic habitat features, however some maintenance activities, such as vegetation management, would necessarily undergo minor changes in response to a slightly different shape and layout of the levee walls.

Alternative 5 would result in a significant increase in usable stream habitat that could support native fish and invertebrates, particularly if there was an effort to appropriately reconstruct the natural channel specifically for habitat value. This alternative would result in removal of 762m (2,500ft) of existing cement-lined stream channel. A secondary benefit could be the re-establishment of a riparian plant community in currently cemented areas that would function to shade the stream channel and moderate temperatures for migratory fish and invertebrates. Removal of the existing Iao Stream Flood Control Project would result in one the largest stream channel restoration projects ever undertaken in the State and would result in a precedent-setting benefit to the entire stream ecosystem. Over the long-term, neighborhoods with homes and businesses located within the newly unprotected flood plain would be subject to major flood events. Although infrequent, major floods are expected to occur with regularity. Recurring floods will result in deposition of large amounts of debris (flood-demolished homes and other structures, vehicles, etc.) either into the stream channel itself or into the nearshore marine environment. This debris will contain contaminants such as sewage, petrochemicals, lead paint, and other materials. Flood-related input of contaminants and debris could be minimized with sufficient acquisition of land along the Iao Stream corridor and within the floodplain, and relocation of residential and business structures.

SERVICE RECOMMENDATIONS

The alternatives under consideration vary widely: from removal of the entire project, to limited repairs of the damaged portion of the levy, to a 2 mile-long, 145 foot-wide concrete channel. As a result, our recommendations are presented in order of acceptability for fish and wildlife resources commensurate with realistic cost and implementation considerations.

The most important resource considerations include the following: 1) unavoidable loss of natural stream bottom habitat due to Alternatives 1, 2 and 3; 2) the excellent quality and quantity of stream habitat in mid and upper Iao Stream; 3) the large numbers of potential upstream migrating organisms ready to immediately begin colonizing the mid-elevation reaches of the stream with the onset of sufficient flow; and 4) the designation of Iao Stream as Category 2 habitat under the Service mitigation policy.

Based on these considerations we recommend the following:

> <u>Recommendation A.</u> If sufficient lands are acquired throughout the stream corridor for both floodplain function and for restoration of natural channel processes (meandering, erosion, and deposition), we recommend that Alternative 5 be chosen for implementation. Because there would be a net gain of natural stream bottom under this scenario, no mitigation requirement would be recommended for this project alternative.
>
> <u>Recommendation B.</u> We recognize that Alternative 5 may not be chosen because of the high costs of real estate acquisition. If that is the case, we recommend that Alternative 4 be selected for implementation and that unavoidable natural resource impacts resulting from the proposed project be mitigated through restoration of stream flow. We recommend that mitigation flows be re-established to provide continuous flow throughout lower Iao Stream to the sea no less than 50 percent of the time. We recommend that flow restoration be actively managed to enhance episodic flow duration in order to maximize survival of migratory aquatic organisms. Because we lack hydrologic data for the Iao Stream system we cannot estimate the specific volume of water that would be required to achieve this 50 percent goal at the present time.

> Recommendation C. Because Alternative 4 does not fully meet project requirements for flood control, we recognize that it may be removed from consideration upon further analysis. In the event that neither Alternative 5 nor Alternative 4 are viable, we recommend that Alternative 3 be selected, and as above, that unavoidable natural resource impacts resulting from the proposed project be mitigated through: 1) restoration of stream flow, and 2) restoration of riparian vegetation throughout the project corridor. The goal of the mitigation flow would be to re-establish continuous flow of Iao Stream to the sea no less than 80 percent of the time and to enhance flow duration to maximize survival of migratory aquatic organisms; the goal of the riparian vegetation management would be to provide shade to the stream water to minimize the effect of temperature increases that inhibit survivorship of upstream migrating fish and invertebrates.

Mitigation planning to achieve flow restoration adds three additional elements to the flood control project: 1) creation and implementation of a flow restoration agreement between a number of partners including the Corps, DLNR–CWRM, the County of Maui, and private entities that hold licences for diversion and out-of-stream consumptive use of Iao Stream water; 2) engineering and reconstruction of at least four existing diversion structures to allow managed minimum stream flows to remain in the stream and allow for passage of aquatic organisms; and 3) management in perpetuity of the flow restoration conditions to enhance support of aquatic organisms, including instream water volumes and in-channel riparian vegetation by the County as an integral element of the flood control project.

Just as the current project proposes to correct engineering and design deficiencies in the original Iao Stream Flood Control Project, this mitigation scenario will address what we believe to be parallel mitigation deficiencies in the original project. A variety of correspondence in our files indicate that flow restoration was repeatedly suggested by resource agencies to compensate for unavoidable habitat loss due to channelization during environmental review of the previous project. These suggestions were not adequately pursued at that time by the Corps. Because the Corps is reaffirming its commitment to compensate for impacts to aquatic habitats regionally and nationally, and because of regional changes in priorities for water resource allocation, we again recommend that project mitigation be achieved through a program of flow restoration.

Finally, we recommend stringent application of effective best management practices (BMPs) throughout project construction. A comprehensive set of BMPs should be tailored to specifically recognize the challenges posed by the location of and climatic conditions found within the Iao Stream watershed in the vicinity of Wailuku. A variety of sources should be consulted regarding BMP development and standard operating procedures for the construction phase of the project, particularly the Corps Regulatory Branch and the HIDOH Clean Water Branch. At a minimum, the Iao Stream Flood Control Project BMPs should incorporate the standard Service BMPs listed in Appendix II.

SUMMARY AND SERVICE POSITION

The results of our assessment show that there would be a clear natural resource benefit from removing the existing 762m (2,500ft) of cement-lined channel under Alternative 5. These benefits would be maximized if the project incorporates sufficient land acquisition to re-establish natural channel function (erosion and deposition). Our analysis also provides a strong indication that substantial detrimental impacts to aquatic resources are anticipated under Alternatives 1, 2 and 3, although we recognize that project features under consideration as part of Alternative 3 are intended to reduce these impacts. Alternative 4 essentially retains the status quo condition of the existing Iao Stream channel, with a moderate effort expended to repair and rebuild damaged levee toes and raise levee heights in areas likely to overtop under design flow conditions.

Under Alternative 4, unavoidable direct impacts to the aquatic environment would include reconfiguration (straightening and widening) the stream bottom, reducing the steepness of the west channel slope and in-channel reconstruction of levee toes with rip-rap. These alterations will increase water velocities during periods of moderate flows, and will allow for water to encroach onto the neighboring floodplain at lower flows than at the present time. During design flow conditions (the highest flows anticipated) water may overtop the rebuilt levees on the east bank near the Waiehu industrial area under this alternative. We recommend that unavoidable impacts to the stream ecosystem be mitigated by flow restoration. To offset the anticipated loss of ecosystem function due to channel modification, the Service recommendation is to restore flows sufficient to create a continuously flowing stream throughout the lower stream to sea at least 50 percent of the time. In the absence of mitigation, project-related habitat loss and severe dewatering of the lower Iao Stream channel will persist. Flow restoration will require that the Corps and local project sponsor cooperate with a variety of other parties to retain adequate volumes of water that is currently diverted out of the stream, thereby restoring flow.

In the event that Alternative 3 is selected, it will result in the elimination of natural cobble and boulder substrate and intermittent pool-riffle habitat in the 2,195 m (7,200 ft) reach of stream lying within the project area. The proposed construction under this alternative, in combination with the existing channel alteration, results in a total of 2,957 m (9,700 ft) of natural channel of Iao Stream being eliminated and replaced with man-made material (primarily cement). Alternative 3 will create one of the longest cement-lined stream channels in the State. This channel modification will create a significant loss of natural ecosystem function and will greatly inhibit, and possibly eliminate, successful upstream migration by several native aquatic species. To mitigate this anticipated impact, we recommend that the stream's flow characteristics be restored to a condition whereby the channel contains flowing water from the headwaters to the sea at least 80 percent of the time. This period of time is considered adequate to allow successful upstream migration of sufficient numbers of native stream species, and downstream dispersal of newly-hatched larva.

We recognize that determination of the corresponding volume of water needed to support the recommended flow-duration benchmarks may require a lengthy technical analysis. These benchmark recommendations are based upon increasing the amount of time that Iao Stream flows from its headwaters to the sea, and they assume that volumes would be sufficient to support adequate depths and water quality characteristics for instream migration of fish and invertebrates. Because of a lack of hydrologic data regarding flow in the lower watershed, flow-duration benchmarks are surrogate for the actual *quantity* of water that would be required to achieve appropriate compensatory mitigation. Despite potential technical and water resource management challenges, we strongly recommend that flow restoration be made integral to the flood control project. This mitigation feature is consistent with the resource protection requirements of the CWA and the FWCA. A foray into water resource allocation and management by the Corps and the County may be complex and fraught with a variety of legal and administrative challenges. However, in order to achieve success in many projects across the nation, the Corps has grown into and accepted its role as a principal Federal agency in instream flow management and stream ecosystem restoration. The expansion of the Corps into this role in Hawaii is consistent with this national precedent, and the Service recommends that this proposed mitigation requirement be strenuously pursued in concert with planning and development of other features of the Iao Stream Flood Control Project.

Consistent with Corps mitigation guidance, we recommend that flow restoration be subject to long-term monitoring and evaluated according to clearly defined performance standards. These standards should be integral to an adaptive management approach so that the mitigation plan may be modified to ensure resource protection goals are achieved. For example, management of flow duration to prolong success of upstream migration of aquatic organisms should be a critical goal of the restored flows. Likewise, changes in management strategies to better support riparian vegetation to provide shade to flowing water within the channel should be subject to modification in response to changing conditions, such as rainfall.

Other mitigation scenarios, including off-site mitigation, are possible. However, finding opportunities to adequately compensate for and restore the impaired ecosystem functions specifically lost due to the proposed project in the Iao watershed would require more extensive, and potentially more expensive, mitigation in order to comply with Service and Corps mitigation policy and guidance such as the CWA section 401(b) regulations, RGL 2-02, and proposed regional compensatory mitigation guidelines described in PN # 200400448. If an alternative mitigation plan is deemed most appropriate and pursued by the Corps, the Service is willing to provide technical assistance in scoping and planning various alternative mitigation plans.

REFERENCES CITED

Barbour, M., J Stribling, J. Gerritsen, J.R. Karr. 1996. Biological Criteria: Technical Guidance for Streams and Small Rivers, revised ed. EPA 822-B-96-001. US EPA, Office of Water, Washington, DC

Benbow M.E. 1999. Natural history and bioenergetics of an endemic Hawaiian chironomid: fluctuating stability in a stochastic environment. Dissertation, University of Dayton, Dayton, OH.

Benbow M.E., A.J. Burky and C.M. Way. 1997. Larval habitat preference of the endemic Hawaiian midge, *Telmatogeton torrenticola* Terry (Telmatogetoninae). Hydrobiologia, 346, 129-136

Benbow, M.E., A.J. Burky and C.M. Way. 2003. The life cycle of a torrenticolous chironomid (*Telmatogeton torrenticola* Terry) endemic to Hawaii: stream flow and microhabitat effects. Annales de Limnologie – International Journal of Limnology 39(2): 103-114

Department of Land and Natural Resources, Division of Aquatic Resources. 2001. Freshwater fisheries research and surveys: surveys, monitoring and habitat studies of native freshwater species on the Island of Maui. Project No. F-14-25, Job 5 (Study VII). 6 pp.

Department of Land and Natural Resources, Division of Aquatic Resources. 1999. Freshwater fisheries research and surveys: surveys, monitoring and habitat studies of native freshwater species on the Island of Maui. Project No. F-14-23, Job 5 (Study VII). 7 pp. plus suppl. info.

Department of Land and Natural Resources. 1991. Hawaii stream assessment; a preliminary appraisal of Hawaii's stream resources. A report prepared by the Hawaii Cooperative National Parks Study Unit for the Commission on Water Resource Management, Hawaii Department of Land and Natural Resources, Honolulu HI

Ego, K. 1951-56. Life history of fresh water gobies. Fresh Water Game Fish Management Research Project F-4-R. Hawaii Division of Fish & Game.

Giambelluca, T. W., M. A. Nullet, and T. A. Schroeder. 1986. Rainfall atlas of Hawai`i. Technical Report R76, Division of Water and Land Development, Department of Land and Natural Resources.

HIDOH–Stream Bioassessment Program. 1998. Biological Assessment and Habitat Characterization of Waimanalo Stream: Establishing Environmental Goals and a TMDL for Watershed Management. Environmental Planning Office, Hawai'I Department of Health. 36 pp

Ha, P. and R.A. Kinzie III. 1996. Breeding biology of the endemic Hawaiian freshwater goby *Awaous guamensis*. Env. Biol. Fish. 45:383-396

Karr, J. R. & E. W. Chu. 1999. Restoring Life In Running Waters: Better Biological Monitoring. Washington, D.C., Island Press. 206 pp

Kido, M.H., G.C. Smith, and D.E. Heacock. 2001. The Hawaiian stream bioassessment protocol (HSBP) version 3.01: a manual for biological monitoring and assessment of Hawaiian streams. 44 pp

Kinzie, III, R. A. 1990. Species profiles: life histories and environmental requirements of coastal vertebrates and invertebrates, Pacific Ocean region. Part 3. Amphidromous macrofauna of Hawaiian Island streams. Biol. Rept. TR EL-89-10. Technical Report EL-89-10, U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS.

McIntosh M.D., M.E. Benbow and A.J. Burky. 2002. Effects of stream diversion on riffle macroinvertebrate communities in a Maui, Hawaii, stream. Riv. Res. Appl., 18, 569-581

McDowall, R.M. 1988. Diadromy in Fishes. Portland (OR): Timber Press

Norton, S.E., A.S. Timbol, and J.D. Parrish. 1978. Stream channel modification in Hawaii. Part A: Statewide inventory of streams, habitat factors and associated biota. Part B: Effect of channelization on the distribution and abundance of fauna in selected streams. Prepared for U.S. Fish & Wildlife Service, U.S. Department of the Interior. 157 pp & 47 pp

Shade, Pat J. 1997. Water budget for the Iao area, island of Maui, Hawaii: U.S. Geological Survey Water-Resources Investigations Report 97-4244, 25 pp

Timbol, A.S. and J.A. Maciolek. 1978. Stream Channel Modifications in Hawaii, Part. A: Statewide Inventory of Streams; Habitat Factors and Associated Biota. FWS/OBS-78/16, April 1978. Hawaii Cooperative Fisheries Unit, University of Hawaii, Contract No. 14-16-0008-1199, U.S. Fish and Wildlife Service, U.S. Department of the Interior.

Parrish, J.D., J.A. Maciolek, A.S. Timbol, C.B. Hathaway Jr., and S.E. Norton. 1978. Stream channel modification in Hawaii, Part D: Summary Report. Columbia (MO): U.S. Fish and Wildlife Service National Stream Alteration Team, FWS/OBS-78/19

Radtke, R. L., R. A. Kinzie III, and S. D. Folsom. 1988. Age at recruitment of Hawaiian freshwater gobies. Env. Biol. Fish. 23:205-213

U.S. Fish and Wildlife Service. 1981. U.S. Fish and Wildlife Service Mitigation Policy. Federal Register. Vol. 46, No. 15. pp. 7644-7663

U.S. Army Corps of Engineers. 2002. Continuing eligibility inspection report. Iao Stream flood control project for FY03. 20 pp

Wilcox, C. 1996. Sugar water: Hawaii's plantation ditches. University of Hawaii Press. Honolulu. 191 pp

Yamamoto, M.N. and A.W. Tagawa. 2000. Hawaii's native and freshwater animals. Mutual Publishing, Honolulu. 200 pp

FIGURES

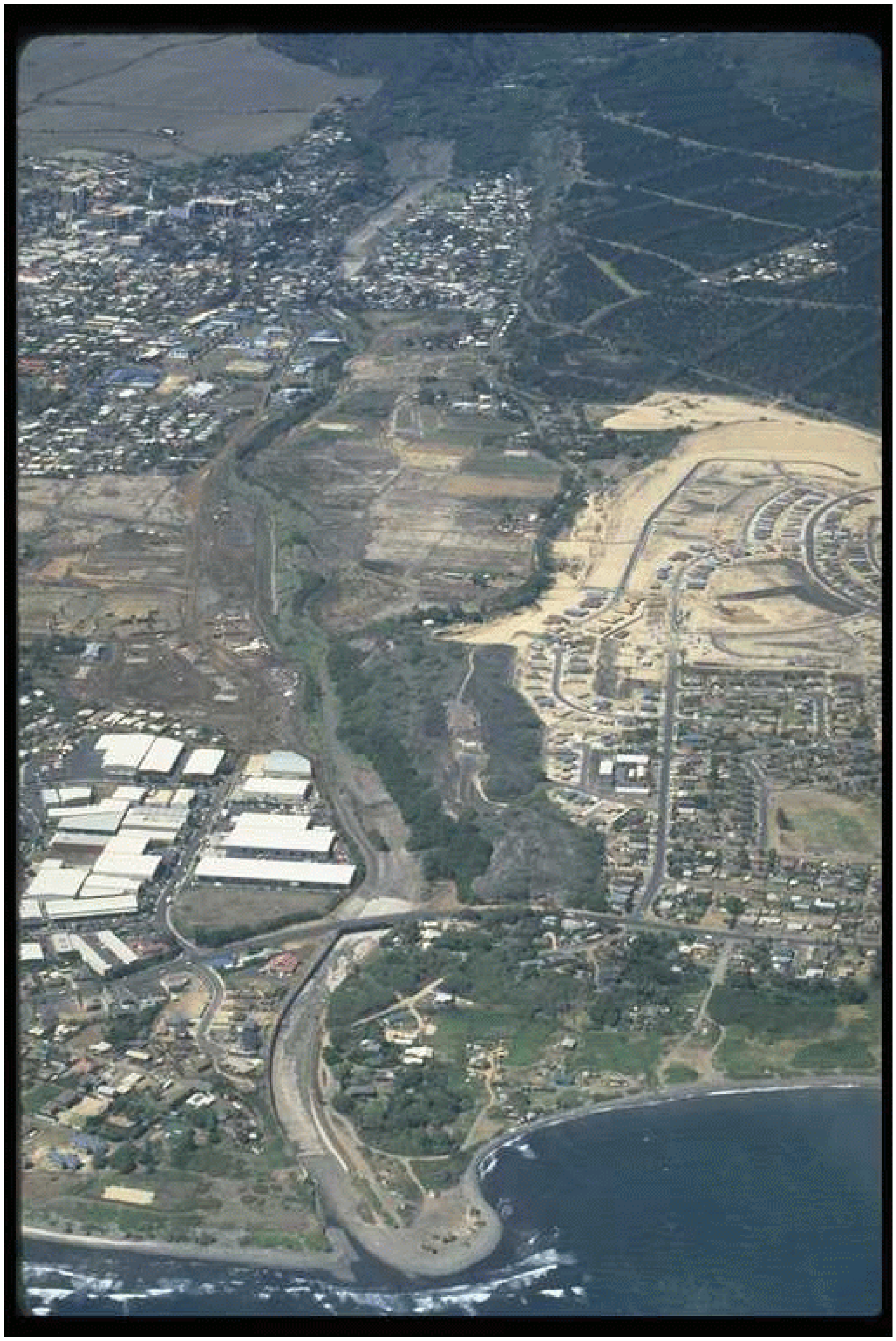


Figure 1. Iao Stream Flood Control Project.

Figure 2. Habitat characterization scores for Iao and other representative Hawaiian streams.

Figure 3. Basaltic cobble and boulder inclusions in existing concrete-lined channel, these features were an attempt to create microhabitat for upstream migrating native organisms.

Figure 4. Large *Awaous guamensis* speared at Waiehu Street bridge. These adult fish have moved downstream into the dewatered and channelized section of Iao Stream and then became stranded as flows terminate due to water withdrawal.

Figure 5. Fish trap installed by local residents near Waiehu street bridge. Fish such as those in figure 3 will become stranded and then captured in this depressional feature when flows terminate due to water withdrawal.

APPENDIX I

Habitat Assessment Data Sheet

Primary Habitat Characteristics -- Possible score of 0 - 20 .

SUBSTRATE

Sand/sediment rare and localized. 0-9% of wetted substrate	Sand/sediment uncommon. 10-19% of wetted substrate.	Sand/sediments widespread. 20-49% of wetted substrate.	Sand/sediments widespread. 50-100% of wetted substrate
SCORE (16-20)	(11-15)	(6-10)	(0-6)

EMBEDDEDNESS

Large interstitial spaces having high volume water flow.	Interstitial spaces limited in size and extent. 25-50% embedded.	Interstitial spaces small and uncommon. 50-75% embedded.	Interstitial spaces rare, >75% embedded.
SCORE (16-20)	(11-15)	(6-10)	(0-6)

VELOCITY-DEPTH

Fast deep, fast shallow, slow deep, slow shallow -- all flows present.	3 of the 4 conditions present.	2 of the 4 conditions present.	One dominant velocity-depth condition.
SCORE (16-20)	(11-15)	(6-10)	(0-6)

Secondary Habitat Characteristics -- Possible score of 0 - 15 .

CHANNEL SHAPE

Deep U-shaped.	Shallow U-shaped.	Broad, flat.	Man-made channel.
SCORE (12-15)	(8-11)	(4-7)	(0-3)

WIDTH TO DEPTH RATIO

Less than 1:8.	Ratio of 1:8 to 1:13.	Ratio of 1:13 to 1:23.	Greater than 1:23.
SCORE (12-15)	(8-11)	(4-7)	(0-3)

POOL TO RIFFLE RATIO

Frequent alternation of habitat types. Ratio of 1:1 to 1:2.	Some alteration of habitat types. Ratios of 1:2 to 1.5.	Habitat types rarely alternate. Ratios of 1:5 to 1:20.	Homogeneous habitat. Ratio <1:20.
SCORE (12-15)	(8-11)	(4-7)	(0-3)

Tertiary Habitat Characteristics -- Possible score of 0 - 10 .

SOIL STABILITY

Stable, no erosion evident.	Little erosion, older eroded areas recovered.	Eroded areas moderate in size and extent.	Unstable, many eroded areas.
SCORE (9-10)	(6-8)	(3-5)	(0-2)

VEGETATION

Vegetation disruption not evident, all "potential plant biomass" intact.	Vegetation disruption has occurred in small localized areas, most "potential plant biomass" remains.	Disruption obvious, widespread, patches of bare soil: little "potential plant biomass" remains	Plant removal severe, mostly bare soil or closely cropped plants; lawns, hedges, crops.
SCORE (9-10)	(6-8)	(3-5)	(0-2)

RIPARIAN ZONE

Riparian zone >4 times stream width, no human impacts.	Riparian zone 2-4 times stream width, minimal human impacts	Riparian zone 1 times stream width, widespread human impacts	Little or no riparian zone (pavement, lawn, cement channel lining, etc)
SCORE (9-10)	(6-8)	(3-5)	(0-2)

TOTAL SCORE:

APPENDIX II

BMPs developed for construction of the Iao Stream Flood Control Project should incorporate specific guidance on the following:

- in-stream construction should be scheduled to occur during low-flow time periods; at the onset of periods of persistent or torrential rain in any season, construction should be halted, and exposed erodible areas should be secured;

- project-related materials (fill, revetment rock, pipe etc.) should not be stockpiled in a stream channel or adjacent riparian zone;

- all project-related materials and equipment (backhoes, trucks, etc) placed in the water should be free of pollutants;

- contamination (including alien species introductions or disposal of trash or debris) in stream channels, riparian areas, or adjacent marine environments should not result from project-related activities;

- fueling of project-related vehicles and equipment should take place away from the water and a contingency plan to control petroleum products accidentally spilled during the project should be developed. Absorbent pads and containment booms should be stored on-site to facilitate the clean-up of petroleum spills; and

- turbidity and siltation from project-related work should be minimized and contained to within the vicinity of the site through the appropriate use of effective silt containment devices and the curtailment of work during adverse weather conditions.

Appendix B:

Archaeological Reconnaissance Survey and Limited Subsurface Testing

ARCHAEOLOGICAL RECONNAISSANCE SURVEY AND LIMITED SUBSURFACE TESTING FOR THE ALTERNATIVE CHANNEL ALIGNMENT, `ĪAO STREAM FLOOD CONTROL, `ĪAO VALLEY, ISLAND OF MAUI, HAWAI`I

Prepared by:
Bee Burgett, B.A.
and
Robert L. Spear, Ph.D.

Revised August 2003

Prepared for:
U.S. Army Engineer District
Corps of Engineers, Building 252
Fort Shafter, Hawai`i 96858-5440

FINAL REPORT
Delivery Order No. 041

SCS / CRMS, Inc.

Scientific Consultant Services / Cultural Resource Management Services • 711 Kapiolani Blvd., Suite 975 • Honolulu, Hawai`i 96813

CONTRACT NO. DACA83-95-D-0004

ABSTRACT

SCS/CRMS, Inc. was contracted by the U.S. Army Corps of Engineers, Pacific Ocean Division (CEPOD) to provide archaeological reconnaissance survey and limited subsurface testing for the alternative channel alignment, `Īao Stream Flood Control Project within `Īao Valley, Island of Maui, Hawai`i. Research goals centered upon initial identification and mapping of any archaeological sites or features occurring within a portion of `Īao Stream Valley and second, if sites were identified, to conduct subsurface testing at the sites to examine the age and extent of cultural deposits associated with a particular site. Excavations were also to be conducted to determine the temporal and spatial relationship of architectural features on intra-site and inter-site scales.

A 100% reconnaissance survey of the project area revealed only one site (State Site Number 50-50-04-4755; TMK 3-4-32:1). The site is composed of three features. The three features (designated as Features A, B, and C) consist of a concrete foundation with concrete troughs, a soil-filled terrace and retaining wall, and wall remnant, respectively. These features form a small, presumably historic habitation complex-activity area. A majority of these features, particularly the basalt cobble and boulder-formed walls, exist in state of poor-fair preservational condition. The excavation of three test units at the site's three features revealed predominantly historic and recent materials, the latter likely being associated with modern debris strewn across the surface of the site. Structurally and materially, the site is most probably a post-Contact, late 19th or early 20th century, agricultural site. Local residents suggest the site was associated with a former piggery.

Overall, the project area was relatively void of visible architectural and/or surface remains, this being the effect of heavy landscape modifications, both cultural and natural processes, to the project area within the last 100 years. However, floodplain agriculture has likely been practiced in the area for hundreds of years with archaeological signatures to these activities being buried in the present floodplain. After an assessment of the project area's archaeological features and materials, it appears fair to state that the surface of the project area is of low archaeological sensitivity. Remnant agricultural soils and/or botanical information related to traditional and historic-period agriculture may yet occur within subsurface contexts of the `Īao Valley floodplain.

The identified site, 50-50-04-4755, is significant under Criterion D and has provided a modest amount of information pertaining to post-Contact agricultural use and limited habitation the `Īao Valley project area parcel. Sufficient information has now been obtained from recording and excavations at the site. No further work is considered necessary or is recommended for the one site.

THIS PAGE INTENTIONALLY LEFT BLANK

TABLE OF CONTENTS

LIST OF FIGURES

THIS PAGE INTENTIONALLY LEFT BLANK

1.0 INTRODUCTION

SCS/CRMS, Inc. was contracted by the U.S. Army Corps of Engineers, Pacific Ocean Division (CEPOD) to provide archaeological reconnaissance survey and limited subsurface testing for the alternative channel alignment, `Īao Stream Flood Control Project within `Īao Valley, Island of Maui, Hawai`i (Figures 1 and 2). Fieldwork was conducted over a five day period between November 30 and December 4, 1998 by Ms. Bee Burgett and Mr. John Riesdorf. Dr. Robert L. Spear was the overall project supervisor.

The focus of research centered upon initial identification and mapping of any archaeological sites or features occurring within a portion of `Īao Stream Valley and second, if sites were identified, to conduct subsurface testing at the sites to examine the age and extent of cultural deposits associated with a particular site.

Briefly, a 100% reconnaissance survey of the project area revealed one historic site (State Site Number 50-50-04-4755) composed of three features (Figure 3). Excavation at the site revealed only historic items. It will be further proven below that the site is most probably a post-Contact, late 19th or early 20th century, agricultural site. Local residents suggest the site to be associated with a piggery. No other testing was done on the flood plain to assess the presence/absence of traditional-period taro agriculture sites as may be gleaned through agricultural soil horizons or botanical analysis. Overall, the project area was relatively void of visible architectural and/or surface remains, this being the effect of heavy landscape modifications to the project area within the last 100 years. Sugar cane, road construction, and other activities occurring in the recent past are quite evident across the parcel and may have caused disturbance or disruption to other archaeological sites that may have previously occurred within the project area. There remains the possibility that traditional and historic-period agricultural signatures could be present within flood plain strata.

In general, the project area lies within `Īao Valley, Wailuku Ahupua`a [TMK 3-3:02 through 3-4:36], and runs between the upvalley Spreckels Ditch location to a point some 4,700 feet (1,422 meters) downstream (see Figure 1). Project area elevations range from 210 to 80 feet (64 to 24 meters) amsl (above mean sea level) and extend for approximately 13 acres from the southwest to northeast, the *makai* extent of the parcel being some 0.50 to 0.75 kilometers from the ocean and Kahului Bay. The northern portion of the project area occurs adjacent to existing family dwellings while the southern extent lies within the valley, below other existing dwellings. The eastern and western boundaries of the project area are both contained within `Īao Valley, below existing housing units (see Figure 1).

More specifically, the alternative channel alignment extends from the concrete-lined stream channel located beneath the Spreckels Ditch flume (Figure 4), at the upslope end to c. 1,220 m from the ocean at the northeast end of the corridor (Figures 5 and 6). A leveled area between the end of the concrete stream channel and the stream spillway, the latter occurring some 251 m to the northeast, consists of a fenced flood plain. The level area between the flood plain fence and an unsurfaced road leading northwest from `Īao Stream to Pi`ihana Road is currently utilized as pasture land.

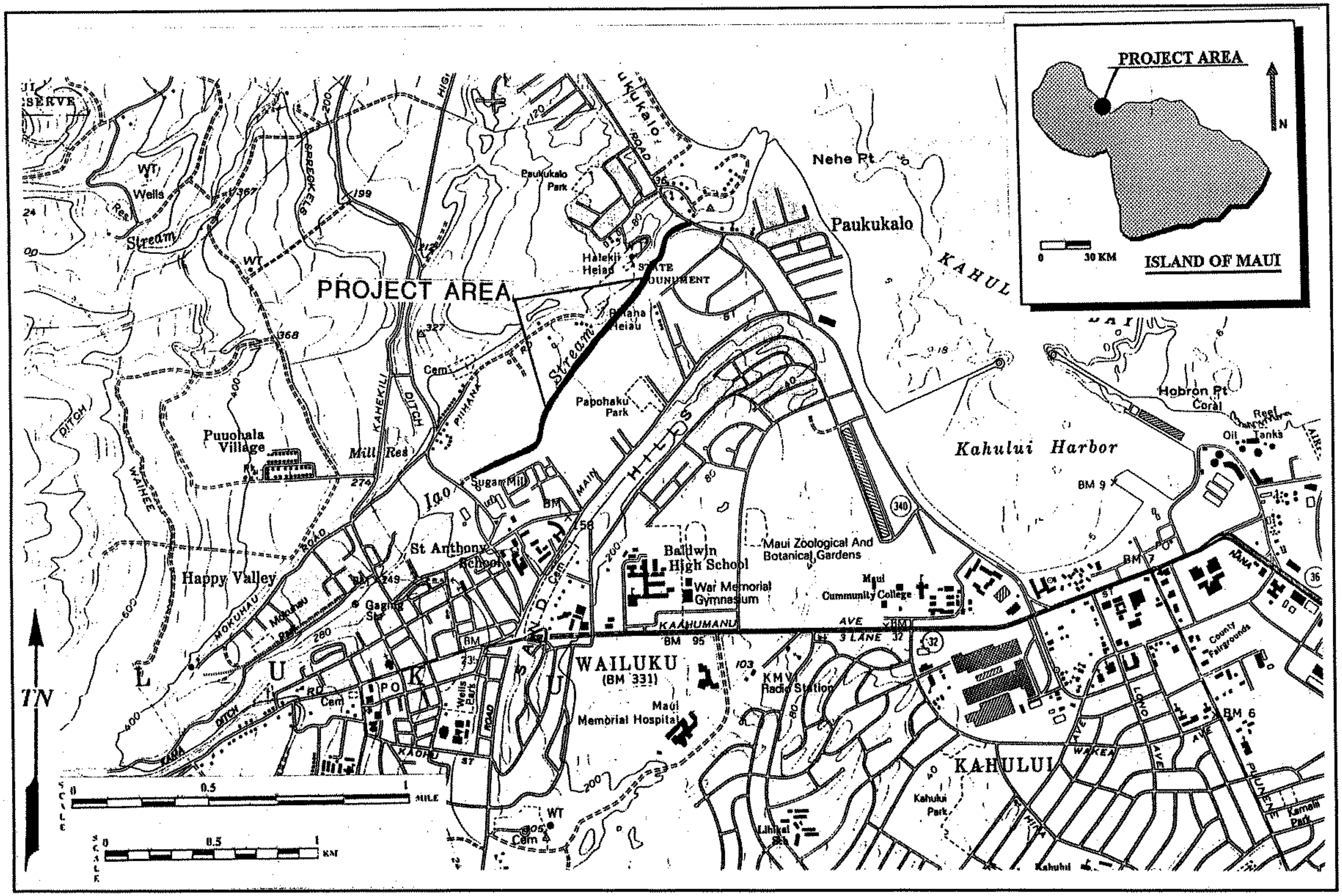


Figure 1: USGS Wailuku Quadrangle Showing Project Area.

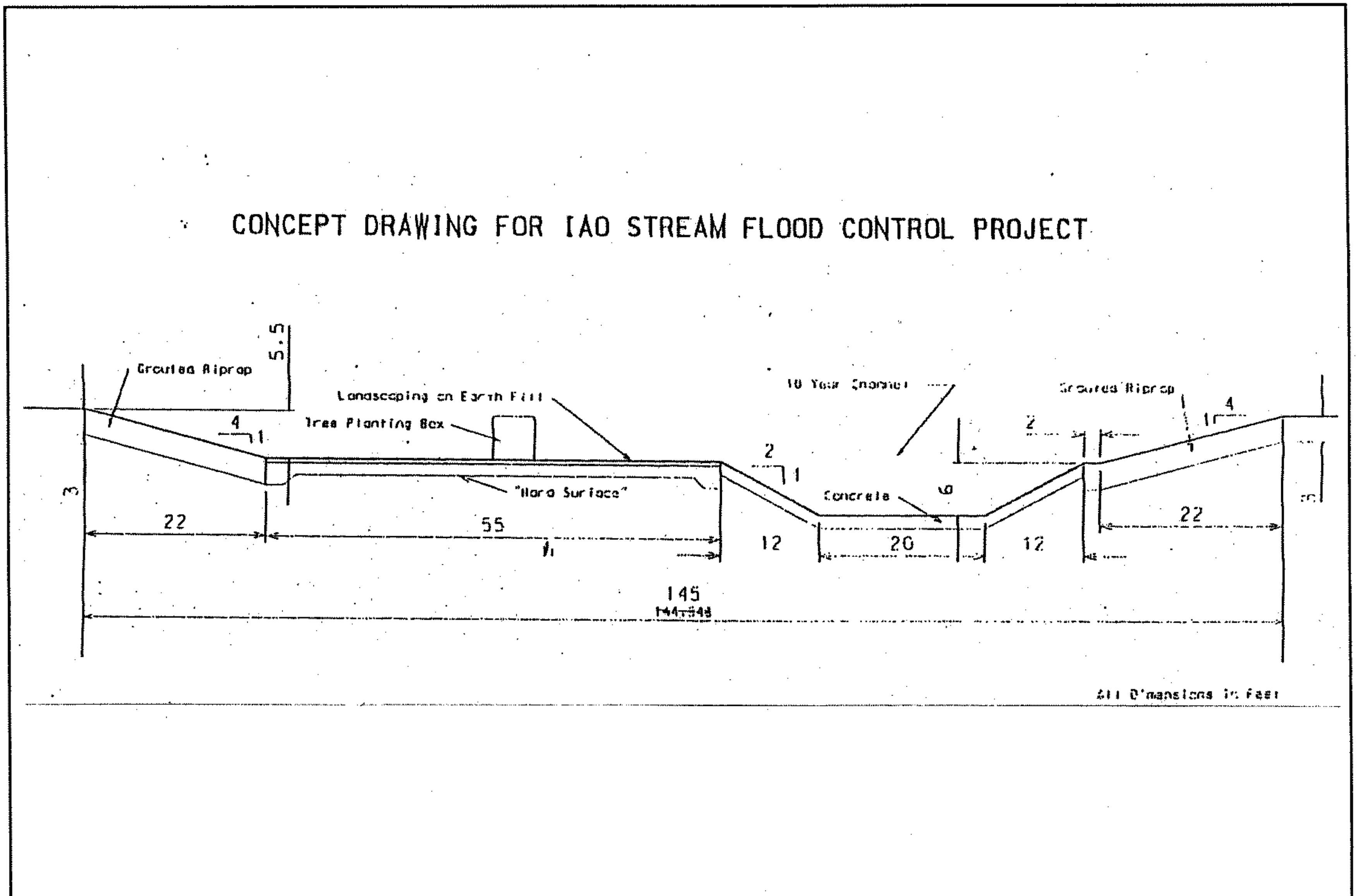


Figure 2: Profile of the Concept Drawing for the ʻĪao Stream Flood Control Project. (Map by U.S. Army Corps of Engineers)

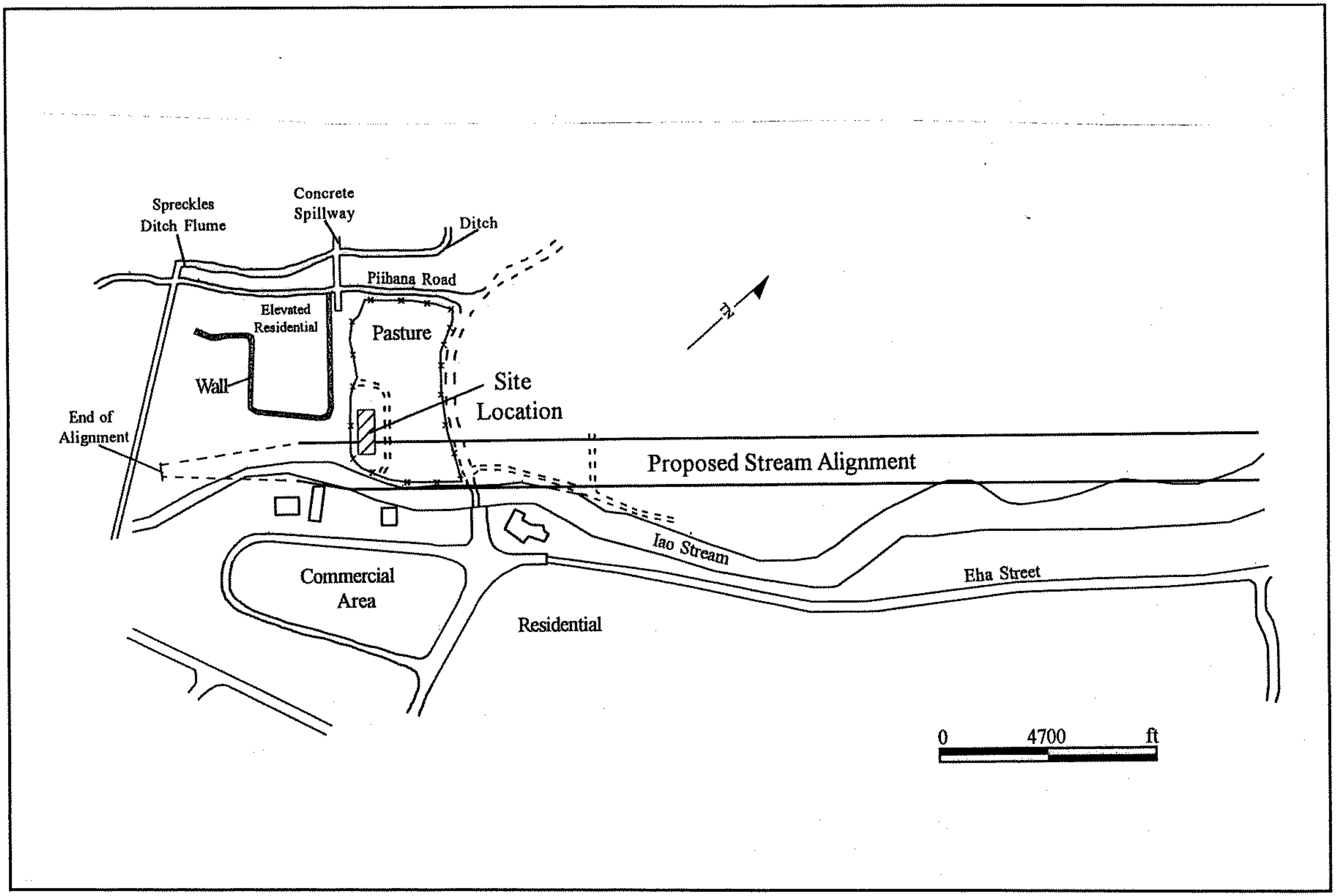


Figure 3: Planview Map Showing Project Area.

Figure 4: Photograph of Spreckels Ditch Western Survey Area, West of the Stream Alignment Corridor. View to West.

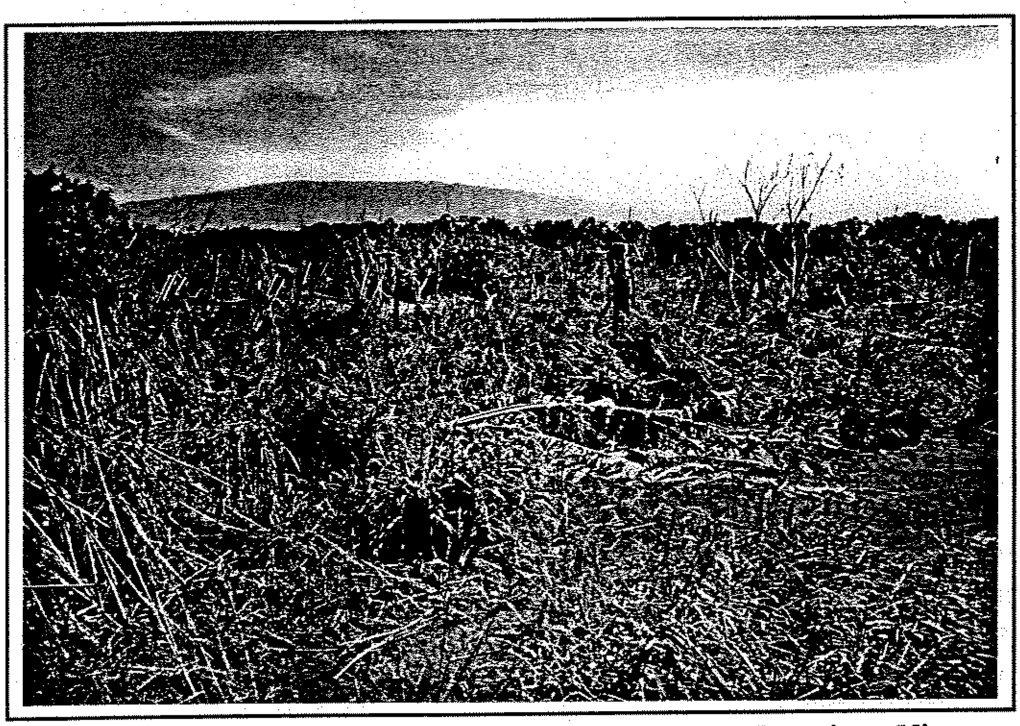


Figure 5: Photograph of Project Area Mid-Point Survey Location. View to East.

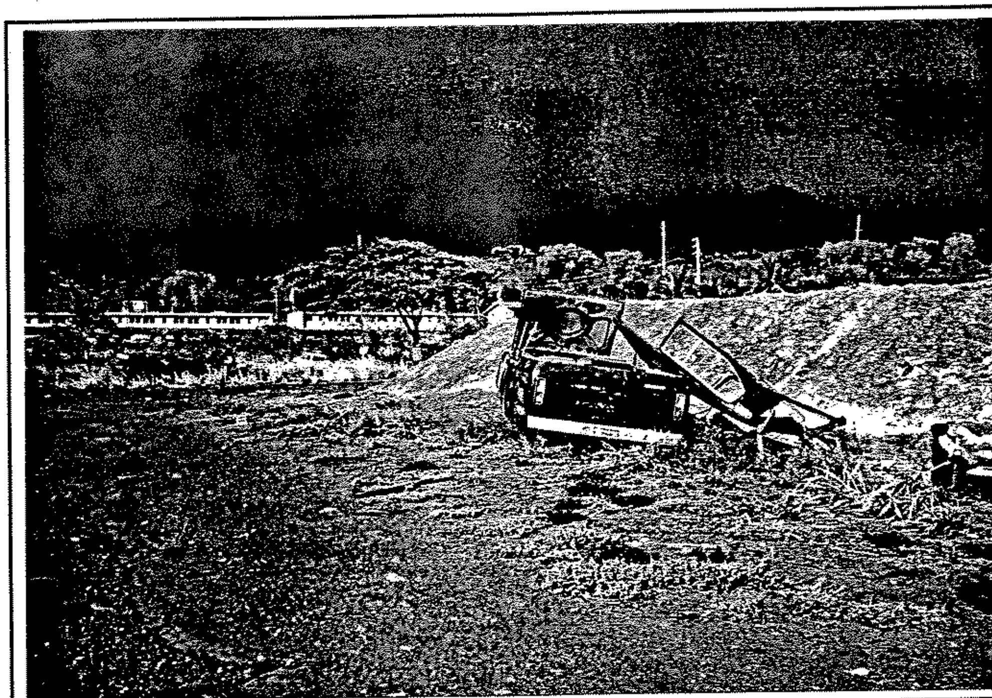


Figure 6: Photograph of Southwestern End of Alignment Corridor Survey Area. View to Southwest.

Cultivated gardens occupy approximately 162 m of the corridor on the northeast side of the road (Figure 7), the gardens terminating at the intersection of a service road, the latter of which is oriented northwest-southeast through the parcel. Northeast of this overgrown service road, the project area is covered with tall dry grass and scattered *koa haole* (*Luceana glauca*) trees. Uneven ground surfaces, pushed and piled cobbles and boulders, and a small bulldozed building depict one example of intensive ground alteration activities occurring on the project parcel (Figure 8). A small corral and a piggery, presently in use, are located on the southeast side of the corridor alignment, approximately 650 m from the northeastern end of the corridor (Figure 9). Beyond the piggery, the ground cover consists of dense, dry grass and small to medium sized *koa haole* trees that proceed to the berm above ʻĪao Stream at the northeastern end of the corridor alignment. Additionally, throughout the stream alignment corridor, from the project area's southwest end to the piggery, short sections of sugar cane field drip lines are visible in open areas that do not have significant ground cover.

1.1 ARCHAEOLOGICAL SENSITIVITY

As the present project area had not been previously exposed to systematic archaeological research in the past, a conservative approach to archaeological sensitivity determinations was taken. It was assumed, *a priori*, that the project was sensitive for several reasons. First, archaeologically unknown areas should typically be ascribed as being sensitive simply to the enigmatic nature of the land parcel being investigated. The second *caveat* supporting a high sensitivity designation is from information gleaned from previous archival research and

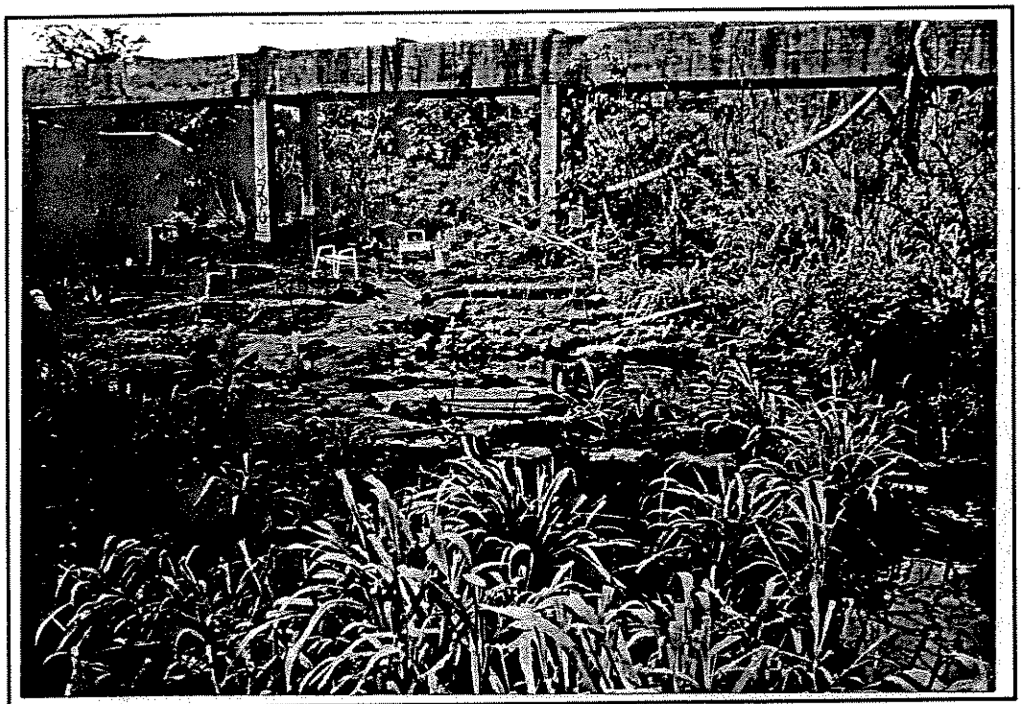


Figure 7: Photograph of Garden Plot near Flume. View to Southwest.

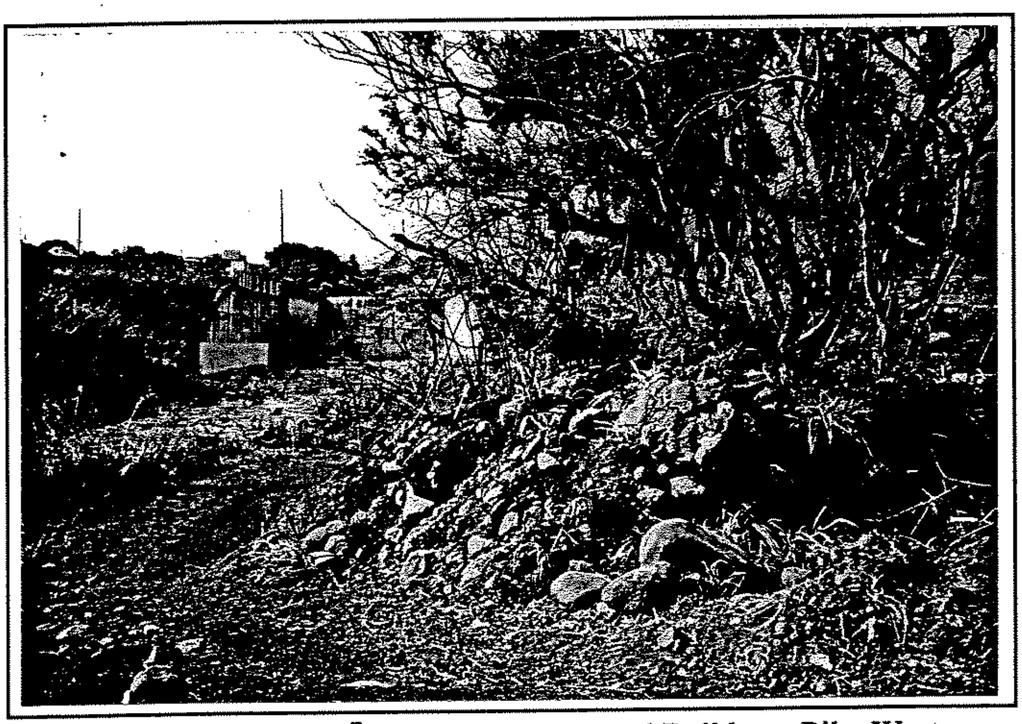


Figure 8: Photograph of `Īao Stream, Flume, and Bulldozer Pile, Western Survey Area. View to South.

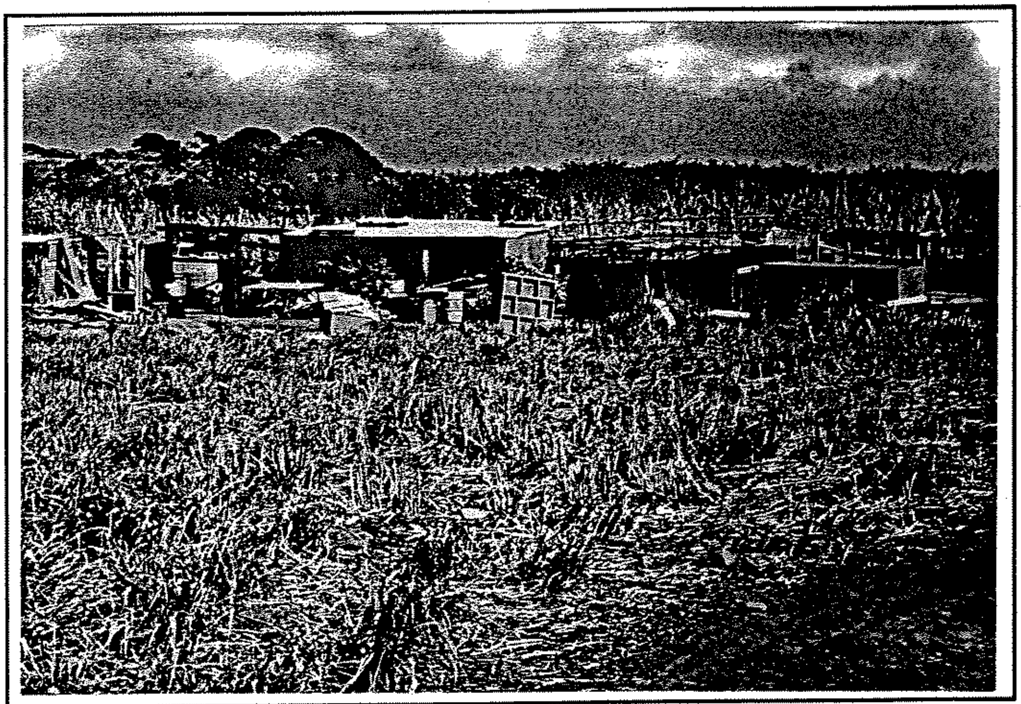


Figure 9: Photograph of Present-Day Pig Farm, Western ʻĪao Valley Survey Area. View to North.

archaeological work near the project area. The large concentration of Land Commission Awa (LCA) bounding the present project area lends credence to the interpretation that the project parcel and environs were subject to, at the least, historic-period activities such as taro cultivati It seems reasonable to assume that specific LCAs associated with agriculture and such likely represent pre- Māhele land utilization as well. Foremost among recorded LCAs are features a structures associated with traditional agricultural areas and historic-period land use and habitation. Thus, the present project area was deemed as archaeologically sensitive prior to fieldwork.

2.0 ENVIRONMENTAL SETTING

The project area is wholly located within `Īao Valley, Wailuku District, Island of Maui, Hawai`i. The project parcel encompasses a sum total of approximately 13 acres in Wailuku Ahupua`a, the project parcel extending upvalley from the coastline (see Figure 1). Topographical undulation and elevational variation across the narrow project area reveals slightly different climatic, vegetative, and hydrological regimes. Wailuku Ahupua`a itself covers an area of approximately 1,395 acres and is bounded by the Pacific Ocean to its northeast, Waiehu Ahupua`a and Waiehu Valley to the northwest, Waikapu Ahupua`a and Wailuku Town to the southeast, and, at upper `Īao Valley reaches, is bounded by Lahaina District (Kauaula Ahupua`a) (see Figure 1).

2.1 CLIMATE

Rainfall within the project area averages 20 inches per month during winter months and 3 to 5 inches per month during the summer season (Price 1983:62). Giambelluca *et al.* (1986) note that the Wailuku area, in general, receives some 500 mm of precipitation per year. Importantly, precipitation increases with ascending (upvalley) distance from the coastline. This variation follows normal orographic patterns noted for windward areas of Maui, the prevailing wind throughout the year being east-northeasterly trade winds. The winter months also bring a corresponding decrease in average daily temperatures while summer months see the highest mean temperatures.

2.2 TOPOGRAPHY AND SOILS

The topography of the project area is moderately sloping within the valley, the sidewalls of the valley being generally U-shaped erosional cuts. Project area elevations range from 210 ft. amsl (64 m) at its most *mauka* location to approximately 80 ft. amsl (24 m) at its most *makai* location. The coastline is approximately 0.50 to 0.75 km from this *makai* extent. `Īao Valley stream, a perennial stream, is only slightly meandering and runs through the center of the valley and the project area parcel (see Figure 1). Two narrow flood plain areas lie on either side of the stream, a modest amount of flood plain amenable to small-scale agricultural pursuits if so desired. Suggestive of land use, the stream has in the past, and continues to, deposit young alluvial soils along its banks, these silty clay soils having likely been profitably utilized for agricultural pursuits (e.g., sugarcane cultivation, taro production) in the past.

Geologically, `Īao Valley is composed of younger alluvium with lithified calcareous sand dunes resting on alluvial fans near the shoreline and along the eastern and western borders of the project area. Macdonald *et al.* (1983:387) state that the cliffs forming the back of `Īao Valley coincide with the former boundary of a caldera, and lavas which formerly filled the caldera have been partly gouged by stream erosion. In addition, the geologists reveal that the rough terrain on the sides and floor of the valley is composed of moderately well consolidated colluvium and alluvium deposited at a former stage of higher base level and now is being removed by renewed stream erosion. More graphic geologic characteristics of the area are summarized by Macdonald *et al.* (1983:380-401).

Foote *et al.* (1972:Plate 99) provide specific information regarding soils and sediments occurr within the 'Īao Valley project area. The subject area and environs are dominated by three soi series: Pulehu cobbly clay loam, 'Īao cobbly silty clay, and 'Īao silty clay. The Pulehu series generally occurring on slopes with a gradient of 0-3%, consists of well-drained soils on alluvi fans, stream terraces, and in basins. These soils developed in alluvium washed from basic igneous rock and are commonly utilized for sugarcane cultivation, pasture, and homesites. 'Ī cobbly silty clay also occurs within the project area. This series occurs on slopes with a gradi of 3-7% and consists of well-drained soils (with cobblestone intrusions) on valley fill and allu fans. Also derived from basic igneous rock, this soil series of most often associated with sugarcane cultivation and housesites.

The third soil series within the project area, 'Īao silty clay, occurs on slopes with a gradient o 3% and is essentially the same as the 'Īao cobbly silty clay series described above. The difference between the two is that 'Īao silty clay contains few, if any, cobble intrusions and is characterized by slow runoff. This soil series, considered to have only a slight erosional haza is predominantly utilized for sugarcane cultivation. These three soil series, combined with th fact that 'Īao Stream is a perennial or permanent stream, provide an area conducive to agricul pursuits, as was likely the case from traditional through modern times.

As will be shown below, excavations at Site -4755 revealed several subsurface strata compos of silty clay, these likely being associated with the Foote *et al.* (1972) designation of the soil series "'Īao silty clay." Few clastics occurred within the excavated matrix, the latter of which was very compacted. The compaction of the silty clay may have been a function of traditiona and/or historic use of the area, most likely the latter however, as the site was most probably utilized as a piggery. Continued utilization of the surface led to a compaction of the soil. It is possible, however, that the site's surface was compacted by mechanical means at some point time, even though lower layers remained compacted yet undisturbed by machinery.

2.3 VEGETATION

The vegetative regime within the project area, as is also described above, generally consists o many naturalized species. The project parcel may be best characterized as coastal dry forest (Wagner *et al.* 1990:62) and consists of at least nine plant species: Bermuda grass (*Cynodon* bristly foxtail (*Setaria verticillata* L.), finger grass (*Chloris* L.), *kiawe* (*Prosopis pallida*), klu (*Acacia farnesiana* L.), lantana or *lakana* (*Lantana camara* L.), *koa haole* (*Leucaena leucocephala*), sand bur (*Cenchrus* L.; endemic), and natal red top (*Rhynchely trum repens* Wild.). Connolly's (1974) archaeological survey of portions of 'Īao Valley (upvalley from the present project) revealed the presence of twenty-nine plant species, the largest concentrations vegetation being represented by *koa haole*, *kukui* nut trees (candlenut tree or *Aleurites moluccana*), and *lakana*. Reconnaissance of the project area in 1998 revealed that the primar vegetation occurring throughout the alignment corridor consisted of grasses and *koa haole.*

It is absolutely reasonable to state that the paleo-environment differed substantially from the present vegetative regime of 'Īao Valley. Besides the numerous introduced plants (during bo prehistoric and historic times), traditional land use and agricultural practices may have resulted in a shift from a *Pritchardia* sp. (*Loulu* palm) dominated forest to a grass, shrub, and fern dominated coastal plain from A.D. 1000 to 1200 (Athens and Ward 1993; see also Athens 1997). In addition, much historic-period vegetation in the area was presumably cleared prior to the cultivation of sugarcane. As seen above, a majority of the flora species listed above are naturalized species, those having been introduced from outside the Hawaiian Islands. Initial human contact and settlement of the Hawaiian Island chain initiated alterations of the floral landscape, these changes having increased multifold through present times.

THIS PAGE INTENTIONALLY LEFT BLANK

3.0 TRADITIONAL AND HISTORICAL SETTING

`Īao Valley and by extension, Wailuku Ahupua`a and Wailuku District, are frequently mentioned in historical texts and oral tradition accounts as being politically, ceremonially, and geographically important areas during traditional times (Cordy 1981, 1996; Kirch 1985). Wailuku was considered a "chiefly center" (Sterling 1998:90) with many of the chiefs and much of the area's population residing near or within portions of `Īao Valley. The many ***heiau*** constructed in the area point to the ceremonial and/or religious importance of the area during pre-Contact times. During historic times, after the numerous battles in the area, the large concentration of Land Commission Awards granted in lower `Īao Valley also attest to a sizeable population base and the importance of the lands for cultivation through time. More recent land use in the area included sugarcane cultivation, this practice being intensified during the late 19th century, military use of the area during World War II times, and at present, the lands being utilized for family housing and water channels, among other pursuits.

3.1 PREHISTORY

Archaeological settlement data indicates that initial colonization and occupation of the Hawaiian Islands first occurred on the windward sides of the main islands, with populations eventually settling into drier leeward areas at later periods (Kirch 1985). In the Waihe`e and Waiehu areas of Maui, adjacent to and northwest of the current project area, Kirch (1985:87) notes that "a number of coastal dune midden sites have been reported, and at least one of these contained pearl-shell fishhooks similar to those from the Bellows Site, eroding from the wave-cut midden." The Bellows site, located on the windward coast of O`ahu, has yielded dates of occupation, albeit controversial, from A.D. 300-600 (Pearson *et al.* 1971), one of the earliest dated sites in the Hawaiian Islands. Research within Wailuku Ahupua`a and especially near `Īao Valley (windward locations) indicates that the area was likely settled between c. A.D. 1100 (Kirch 1985:142) and A.D. 1200 (Fredericksen and Fredericksen 1996).

One of the earliest references for `Īao Valley itself refers to a Maui king in power during the A.D. 1400s (Sterling 1998:84). The king, Kaka`e, was held in such reverence that commoners could not look upon him or suffer punishment by death. King Kaka`e thus became a hermit within `Īao Valley during the 1400s so that his subjects could live without fear of condemnation. It was supposedly this king that also created a royal burial grounds (*Kapela*), an enigmatic place that was designated for himself and worthy successors as a sacred burial area.

Connolly (1974:5) states that the pre-Contact valley [`Īao] had a large population base with "most people residing in a settlement near `Īao Needle". Supposedly, the subsistence base of this population consisted of fish and taro, with Kahului Harbor and the coast close by and ***lo`i*** systems lining `Īao Valley's stream banks. Prehistoric ditches or *`auwai* were utilized in taro cultivation (Connolly 1974:5). Sterling (1998:86) adds that two *`auwai* within the valley "have existed immemorially and were evidently constructed for the purpose of irrigating ***kalo*** on the plains which stretch away to the northward and southward of the [`Īao] river. Several minor *`auwai* have, since ancient times, tapped the river at different points lower down and spread the water through the lands in the gulch on either side of the river bed." Handy (in Sterling 1998 further notes that "From Waihee and Wailuku Valley, in ancient times, was the largest continuous area of wet taro cultivation in the islands." Cheever (1851:124) writes: "The wh valley of Wailuku, cultivated terrace after terrace, gleaming with running waters and standing pools, is a spectacle of uncommon beauty to one that has a position a little above it."

Recent archaeological research (Fredericksen and Fredericksen 1996:52) has revealed that habitation sites along what is now Lower Main Street in Wailuku, "are associated with the ric taro producing lands in the Lower `Īao River flood plain, and the extensive cultivation system present in `Īao Valley." These habitation sites have been dated to the A.D. 15th through 17th centuries. The `Īao Valley area was not only renowned for its agricultural base during prehist times but its ceremonial and political base as well (see also Cordy 1996; Donham 1996).

During the mid and late 18th century, the Halekii-Pihana *heiau* complex was constructed, Hale Heiau itself supposedly designed by a Hawaiian named "Kiha" (Sterling 1998:89). These monuments, designated as State Site No. 50-50-04-522 and occurring along the northwest fla of the current project area, are described as very important *heiau* within Hawaiian history. Ye (1983:7) notes an interesting cycle where Kamehameha I's wife was born there, Kahekili live there, and Kekaulike died there. Thrum (1909:46) reported that Kamehameha I evoked his w god at Pihana Heiau after his warriors defeated Kalanikupuli's forces during the Battle of `Īao 1790. The two *heiau* are primarily associated with Kahekili, who is connected with the Halek Pihana complex between c. A.D. 1765-1790, and Kamehameha, during his conquering of Ma in 1792 (Yent 1983:18).

Importantly, Halekii and Pihana Heiau are the only remaining pre-Contact Hawaiian structure religious and historical importance in the Wailuku-Kahului area that are easily accessible to th public (Estioko-Griffin and Yent 1986:3). As stated, the area within and adjacent to the curre project is known not only for its religious and/or ceremonial significance, but for its political prominence as well.

The Fredericksen's (1996:52) report that politically, Wailuku [village] was known as a central settlement for high ranking chiefs and their retinue. The Wailuku area was also witness to ma battles, from the Battles of `Īao and Sand Hills to the Battles of Kepaniwai and Kakanilua. Th most famous battle was that of Kepaniwai where Kamehameha I, in July, 1790, finally wreste control of Maui Island. Kamehameha I and his warriors landed at the Kawela portion of Kahu Bay and proceeded up `Īao and other valleys to score a decisive victory. "Wailuku", meaning "water of destruction", succinctly describes the area in which many of these major battles occurred. Of additional note is that in the Kauahea area of `Īao Valley (southeast of `Īao Strea below Pihana Heiau-supposedly within the current project area), warriors apparently dwelt an were "trained in war skills and there was a boxing site in the time of Kahekili" (Sterling 1998:89).

Thus, the present project area was, during prehistoric times, within and adjacent to cultivated lands, battle grounds, political and population centers, and spiritual loci. Traditional use of th lands continued uninterrupted through historic times, albeit on a less intensive scale.

3.2 HISTORICAL `ĪAO VALLEY

The Wailuku area, as Kirch (1985:134) also notes, was an important center of political development during late prehistoric and early historic times and was the seat of powerful chiefs, including Kahekili, arch-rival of Kamehameha. Kamehameha I's unification of the Hawaiian Islands in 1790 brought Maui under the political control of its first non-Maui chief during July of that year. The last king of Maui was Kahekili II, son of King Kekaulike, both supposedly having been interred at the sacred burial grounds in upper `Īao Valley. By the early historic period, significant natural and cultural changes had taken place, not only due to contact with westerners, but also because of internal social and environmental restructuring and external social and environmental factors (e.g., foreign species being introduced as well as foreign ideologies). These combined to have a severe impact on Hawaiian environments, land-tenure, and social structures.

Several periods of various land utilization strategies occurred within `Īao Valley and more succinctly, within and near the present project area. Between 1778 and 1848, traditional land use occurred within `Īao Valley, albeit on a smaller scale, as the "Conquest" period began and the Sandalwood and Whaling trades dominated political and commercial activity within the islands (see Kirch and Sahlins 1992). Quite another conspicuous effect of the growing influence of foreigners in the Hawaiian Islands was the systematic division of lands, the Great Māhele. The Land Commission oversaw land divisions of three groups: Crown Lands (king), Konohiki Lands, and Government Lands, all of which were, in theory, open to the prerogative of native tenants. The awarded land claims bordering `Īao Valley, particularly those adjacent to the project area, were numerous in quantity and concentrated on the plateau above the stream valley, along the top of its sidewalls.

Sterling (1998:86) notes that "The district of Wailuku was once thickly settled, *kuleanas* to the number of over 400 were granted to natives and others. A large portion of these cultivated *kalo* with the aid of water from the river." Archival research of the current project area and environs (TMK 3-4-20, 21, 22, 23, 24, 30, 31, 32) has revealed that in 1848, Wailuku area residents submitted 199 land claims, 127 of these being awarded by the Land Commission (Waihona `Aina Corporation 1998). As such, an immense number of LCAs were encountered during archival research of the project area and environs. Only a small representative sample of the awards are listed, the LCA information provided by the Waihona `Aina Corporation (1998). The representative, random sample consists of LCAs 407, 3255, 3464, 3890, and 4452, all located on the south side of `Īao Valley. LCAs 3891 and 6409 are located on the north side of `Īao Valley (Note: N.T.=Native Testimony; N.R.=Native Register).

No. 407, Kaauwai, N.R. 136v2

> Lot 4. I forgot the fourth of our lots, from Kahauolopua. I am his heir and executor. It is makai of the Government Road going to the sugar mill. Owa is the name of that land. This place will be surveyed as one of my places to farm. It adjoins my place, and it is the government's and I have thought to occupy for a long time, if it is agreed to.
> KAAUWAI
> Wailuku, Island of Maui

N.T. 140-141v2

No. 407, Kaauwai

Napela, sworn by the Word of God, This place is at Owa. I have not known who had given this land to Kahauolohua, but we know the characteristics of konohiki. We can never refuse his idea for he is the konohiki of Owa. He had lived there in the year 18: and from that time to the day W. Richards asked me to survey that land because all o: those places is an acre and is for sugar cane cultivation. Kehanolohua built his enclos when the sugar cane planting was over. From the time the lot was completed to this d the length of time he has lived at Umieu and at Halaula together with the things made Kaauwai's hands.

Malaihi, sworn, by the Bible, It [Kaauwai's land] is on the west of the footpath to Kahawai, on the north is K. Ana's property, on the east is Namakeha's place and on th south is the road for cattle wagons. This was idle land formerly and a portion of it has extended into a portion which is said to be an acre. From the year 1839.

Later in the month of October in the year 1846 was the hookupu of the land month. A this time Nailiili gave me the responsibility to ask the farmers to give in dollars for th patches and when they did not comply, the patches may be returned. At a later time I to Kauhapa for he was a farmer under a mooaina overseer, "Nailiili has told me to ask you for the tax of your patches." Kauhapa said, "Wait, when the patches are complete will return [them]" and I agreed with him. Later after this I reported to Nailiili that Kauhapa had returned the patches and he told me that the patches were for Ane ma to which I had said, "Yes." I told Keahi, "Kauhapa's patches have been returned", then h told me to take those patches.

At that time Kauhapa returned [patches] to Ane because he had received his land from her, so Ane's husband began to cultivate the land with the presumption that the patche were for them. So I told Keahi what was happening to the patches and he requested th work on those patches. I hired some men from the prison to work in those patches and land was acquired by the Konohiki Keahi, so I said to Keahi that he would have to do work on the l that I could not do because of my close relatives who might probably te me to do as I please and I would do likewise. Later my wife would chide me and beca she would not part with things belonging to her parents, I had ceased engaging in Frid work.

When I was a Friday overseer, Puniho was a Friday man and on the Fridays he did no come, I would check off for his day's work. Later when I met him I would ask him, "I you paid for your Friday obligation?" "Yes," he would say with a request that I give h some patches in order to increase his number of patches. I refused [him] by saying the was no extra patch and that he had only working days; therefore, he came on some da and would compensate for other working days. He did tell me that his patches were ve small and I was very sorry about it. He also said that his working day would be profit if I would give him more patches. "I have only three patches and three small pools", he continued to say. I asked him whether he had some patches at some other locality and that they may be large ones He answered that they were not large, and were of the same size as the ones we have here.

Where are those patches? They are at Kalua which is a "ku", then I asked him, "What do you think, Would it be right with you to return the patches? He answered, "I have been thinking about a sale with Malaihi because we have talked with each other and he wants some of my patches.

[Award 407; R.P. 5530; Halaula Wailuku; 7 ap.; 2.41 Acs; Imiau Wailuku; 1 ap.; .32 Ac.; Kalua Wailuku; 3 ap.; 1.25 Ac. 29 rods; Owa Wailuku; 3 ap.; 8.25 Acs 21 rods; Pohakuuhi Wailuku; 1 ap.; 1 rood 19 rods

No. 3255, Hoopiiaina, N.R. 50v6

Greetings to the Land Commissioners: I hereby state my claim. It was good of you to send your message in the Eleele, to make claims for land, lo`i and kula. There is a small mound - the house is there. The total number of lo`is at Pohoiki is 23, given by Opu. One kula is at Pohoiki. At Kaulupala are 25 /lo`i?/, 1 kula.
That is my claim.
HOOPIIAINA
Wailuku, December 25, 1847

F.T. 415v7

Cl. 3255, Hoopiiaina

Keahi, sworn, I know the lands of the claimant. They consist of two pieces in Wailuku, Maui.
No. 1 is one moo of kalo land in the ili of Kaulupala.
No. 2 is one loi in the ili of Kukuikalimaka.
The claimant received these lands from his parents and has held it [them] ever since the days of Kamehameha I. His title has never been disputed. There are 5 poalimas in it.

No. 1 is bounded
Mauka by the ili of Kiwela
Waihee by the creek of Wailuku
Makai by Kealoha & Kaumu's land
Maalaea by the ili of Kukuialamana.

No. 2 is bounded:
Mauka by the ili of Kiiwela
Waihee by Peahi's land
Makai by Lelo's land
Maalaea by Paele's land.

N.T. 608-609v9

No. 3255, Hoopliaina

Keahi, sworn, I know his two parcels of land in Wailuku.

Parcel 1. Taro mo`o at Kaulupala.

Parcel 2. 1 lo`i at Kukuialaimaka.

His land was from the makuas, from the time of Kamehameha I. He has occupied the: continuously. There is no opposition.

[No.] 1 is bounded:

Mauka by the `Ili of Kiwela
Waihee, by stream
Makai by Kealoha and Kaumu
Maalaea by the `Ili of Kukuialaimaka.

[No.] 2 is bounded:

Mauka by the `Ili of Kiwela
Waihee by Peahi
Makai by Lelo
Maalaea by Paele.

[Award 3255; R.P. 3347; Kaulupala Wailuku; 1 ap.; 5.8 Acs]

No. 3464, Kamakaoolea, N.R. 85v6

Hear ye, ye Land Commissioners: I hereby tell of my lo`is. In Nehe are 8 lo`i and a ku which I received from Kakumanaana. from Kahula I received 3 lo`i. from Kaianui I received 4 lo`i. From Paele, at Papohaku, I received 2 lo`i and 3 hala clumps.

Farewell to the Land Commissioners.

KAMAKAOOLEA

Wailuku, 10 January 1848

F.T. 415-416v7

Cl. 3464, Kamakaoolea

Nalehu, sworn, I know the lands of the claimant. They consist of 6 pieces of land in Wailuku, Maui.

No. 1 is a house lot & kalo & kula land in the ili of Neha.
No. 2 is one loi in the ili of Nehe.
No. 3 is one loi in the ili of Nehe.
No. 4 is three loi of kalo in the ili of Nehe.
No. 5 is a section of kalo & kula in Nehe.
No. 6 is two lois in the ili of Papohaku.

The claimant received the first 5 pieces from Kumamaawa in the days of Kamehameh His title has never been disputed. The last piece he received from Paele in the year 18 and his title there has not been disputed.

No. 1 is bounded:
Mauka by Kahula's land
Waihee by pa aina
Makai by paahao
Maalaea by my land.

No. 2 is bounded:
Mauka by Kaiakailoa's land
On the other three sides by Kahula's land.

No. 3 is bounded:
Mauka by Paele's land
Waihee by Kahula's land
On the other two sides by Kaianui's land.

No. 4 is bounded:
Mauka by Kaianui's land
Waihee by the same
Makai by Kalaiwehea's land
Maalaea by my land.

No. 5 is bounded:
Mauka & Waihee sides by the pa aina
Makai by Kaiakailoa's land
Maalaea by Kalaiwehea & Naea's land.

No. 6 is bounded:
Mauka by Kalawaianui's land
Waihee by paahao
Makai by Moo's land
Maalaea by Paele's land.

N.T. 609v9

No. 3464, Kamakaoolea, July 9, 1849
Nalehu, sworn, I know his six parcels of land at Wailuku.
Parcel 1. 2 lo`i and house site and kula at Nehe.
Parcel 2. 1 lo`i in the `Ili of Nehe.
Parcel 3. 1 lo`i in the `Ili of Nehe.
Parcel 4. 3 lo`i in the `Ili of Nehe.
Parcel 5. 1 pauku of taro in the `Ili of Nehe.
Parcel 6. 2 taro lo`i in the `Ili of Papohaku.

The first five parcels in the `Ili of Nehe were from Kekuamamaawa, from the time o Kamehameha II. Parcel 6 in the `Ili of Papohaku was from Paele in 1845. There is n opposition.

[No. 1] is bounded:
Mauka by Kahula
Waihee by the land boundary wall
Makai by lo`i pa`ahao
Maalaea by Nalehu.

[No.] 2 is bounded:
Mauka by Kaiakailoa
Waihee by Kahula
Makai by the same
Maalaea by the same.

[No.] 3 is bounded:
Mauka by Paele
Waihee by Kahula
Makai by Kaianui
Maalaea by the same.

[No.] 4 is bounded:
Mauka by Kaianui
Waihee by the same
Makai by Kalaiwehea
Maalaea by Nalehu.

[No.] 5 is bounded:
Mauka by the land boundary wall and stream
Waihee by the same
Makai by Kaiakailoa
Maalaea by Kalaiwehea also.

[No.] 6 is bounded:
Mauka by Kalawaianui
Waihee by lo`i pa`ahao
Makai by Mao
Maalaea by Paele.

[Award 3464; R.P. 5446; Nehe Wailuku; 4 ap.; 1.405 Acs]

No. 3890, Paoa, N.R. 133v6

Greetings to the Land Commissioners: A claim for lo`i and kula land in Wailuku. I, Paoa, hereby state that I have 38 lo`i and a kula at Lamalii iki, lying as follows: on the north, the seven lo`is, on the east, the sand ridge and the road, on the south, Lamalii nui, on the west, Lemukee. My right of occupancy was from Kalawaiahonu.

PAOA

Wailuku, 17 January 1848.

F.T. 458v7

Cl. 3890, Pooa

Kanekoa, sworn, I know the land of the claimant. It is one piece of kalo land in the ili of Lamalii iki, Wailuku, Maui. The claimant received it from Boaz Mahune in 1840 and he from the King. His title was never disputed. There are 2 poalima lois in it.

It is bounded:

Mauka by the ili of Lamalii Nui

Waihee & Makai sides by Kalawaiahonu's land

Maalaea by the Government lot.

N.T. 645v9

No. 3890, Pooa, July 12, 1849

Kanekoa, sworn, I know his land, one parcel of taro in the `Ili of Lamalii iki, Wailuku. It was from B. Mahune in 1840, and B. Mahune had it from the Mo`i. Two po`alima are in it.

It is bounded:

Mauka by Lamalii nui, an `Ili

Waihee by Kalawaiahonu

Makai by the same

Maalaea by Government lot.

[Award 3890; Lamaliiki Wailuku; 1 ap.; 2.45 Acs]

No. 3891, Paia, N.R. 133v6

Greetings to the Land Commissioners: I, Paia, hereby state my claim for 15 lo`i and a kula, at Pohakuli, lying as follows: on the north is the stream, on the east is Kaina's mo`o, on the south is Pohakea, on the west is Aimakalani's land. My right of occupancy was from Kanemano.

PAIA

Wailuku, 17 January 1848

F.T. 430v7

Cl. 3891, Paia, Wailuku, July 10th 1849

Kalimahauna, sworn, the claimant's land consists of two pieces in Wailuku, Maui but know one, which is 10 lois in the ili of Pohakuuli. The claimant received it from Kalawaiahonu, the konohiki in 1844. His possession has ever been peaceable. There : poalima loi in it.

It is bounded:
Mauka by Auimakalani's land
Waihee by the creek
Makai by Auimakalani's land
Maalaea by Paele's land.

Puhululu, sworn, I know the claimant's other piece of 4 lois. It is in the ili of Pauniu. : received it from me in 1844 and I received it from Kanoii who received it from his parents in ancient times. The claimant's title is not disputed.

It is bounded:
Mauka by Kalawaiahonu's land
Waihee & Makai sides by Kanoii's land
Maalaea by the creek of Wailuku.

N.T. 620-621v9

No. 3891, Paia, Wailuku, July 1O, 1849
Kalimahauna, sworn, I know of his one parcel of land in the `Ili of Pohakuuli, in Wailuku. It was from Kalawaiahonu in 1844. There is no opposition. One po`alima is it.

It is bounded:
Mauka by Auimakalani
Waihee by Kahawai
Makai by Auimakalani
Maalaea by Paele.

Puhululu, sworn, I know of four lo`is in the `Ili of Pauniu, in Wailuku. There is no opposition. His land was from Kanoii in 1844, and Kanoii got it from his makuas The no opposition.

It is bounded:
Mauka by Kalawaiahonu
Waihee by Kanoii
Makai by Kanoii and Naea
Maalaea by Kahawai.

[Award 3891; R.P. 7003; Pohakuuli Wailuku; 2 ap.; 1.04 Acs; Pauniu; 1 ap.; .15 Ac.]

No. 4452*M, [Hazaleleponi Kalama], C. Kanaina (for Kalama) Honolulu, Jan. 19, 1848 N.R. 603-605v3

To the President of the Land Commissioners, William L. Lee, Respectfully: By direction of Queen Hazaleleponi Kalama, I hereby present her claims for house lots which have not previously been given. Therefore I hereby describe her house lots and her right to them.

N.T. 187-188v10

No. 4452, Hazaleleponi Kalama

COPY HAZALELEPONI KALAMA'S DIVISION

Kula ahupuaa, Puna, Hawaii
Kapalaalaea ahupuaa, Kona, Hawaii
Kalahuipuaa ili of Waimea, Kohala, Hawaii
Anaehoomalu ili of Waimea, Kohala, Hawaii
Waipio ahupuaa, Hamakua, Hawaii

Kaohe ili for Wailuku, Maui
Puhiawaawa ili for Wailuku, Maui
Lemukee ili of Wailuku, Maui
Puohala, Wailuku, Maui
Manienie, Wailuku, Maui

Waikahalulu, Honolulu, Kona, Oahu
Kailua ahupuaa, Koolaupoko, Oahu
Kaneohe ahupuaa, Koolaupoko, Oahu.
Hakipuu ahupuaa, Koolaupoko, Oahu.

I have approved this land division, the lands listed above are for Hazaleleponi Kalama, and they may be presented to the land officeres.
(Sign) Kamehameha
Copied by S.P. Kalama (for H. Kalama) Secretary
Royal Palace, 11 February 1848
See page 358

[Award 4452; (Maui) R.P. 7299 Wailuku; R.P. 7303 Wailuku; R.P.; 7300 Wailuku; 7302 Wailuku; 7301 Wailuku; (Lahaina award no R.P.); (Hawaii) R.P. 7523; Anaehoomalu Waimea; 1 ap.; 866 Acs; R.P. 7529; Waipio Hamakua; R.P. 7522; Kalahuipuaa Waimea S. Kohala; 1 ap.; 359 Acs; R.P. 7483; Puna; Kula & Halekamahina; 3 ap.; 2902 Acs; No R.P.; Kapalaalaea N. Kona; 1 ap; Ahupuaa; (Oahu) R.P. 7482; Hakipuu Koolaupoko; R.P. 7427; Nuuanu Street Honolulu; R.P. 7530; Aienui Honolulu; R.P. 7213; Halehala Honolulu; R.P. 7983; Kailua Koolaupoko; R.P. 5683 & 7516 & 7220 & 7255; Waikahalulu Honolulu]

No. 6409, Kupanihi, Wailuku, 29 Jan. 1848, N.R. 368v6

Greetings to the Land Commissioners: I hereby tell you of my lo`is which are situated in the `ilis of Laie Maloo and `Iao.

At Laie maloo are 14 lo`i, also some dry places, some on the east of this `ili and som
the south side. These lo`is are not situated in one place.
At `Īao are 3 lo`i as follows:
on the north is the lo`i of Aki
on the east is the watercourse of Halu
on the south is the lo`i of Pa
on the west is the lo`i of Pa.

There are some hala clumps, also, at Laie, Opilopilo II.
KUPANIHI

F.T. 426v7
Cl. 6409, Kupanihi

Kaneiaulu, sworn, I know the land of the claimant. It is one piece of kalo land of 3 m in the ili of Laie, Wailuku, Maui. The claimant received this land from Kailihuna in t year 1835 and has held the same without dispute ever since. There is one poalima loi within this piece.

It is bounded:
Mauka by my land
Waihee by Government lot
Makai by Aki's land
Maalaea by my land.

N.T. 617v9
No. 6409, Kupanihi

Kaneiaulu, sworn, I know of one parcel of taro at Laie, in Wailuku. His land was fror Kailihiwa in 1835. There is no opposition. One po`alima is in it.

It is bounded:
Mauka by my land
Waihee by the government wall
Makai by Aki
Maalaea by my land and konohiki.

[Award 6409; R.P. 4988; Laie Wailuku; 2 ap.; 1.31 Acs]

As seen through a listing of only seven LCAs occurring adjacent to the project area, land use within and adjacent to the present project area was predominantly focused upon agricultural pursuits. The LCA information lists several categories of land use within and near the project through time, from "ancient" times through at least the middle of the 19th century. These incl *lo`i* systems (pondfield cultivation of irrigated taro), *kula* lands (dry land, not wet or taro land *hala* clumps (*Pandanus odoratissimus* or screw pine; the leaves provide material for weaving baskets or mats); *po`alima* (chiefly plantations; named such as workers generally worked on a chief's plantations specifically on Fridays). Several land divisions parcels were also claimed, from *`ili* (subdivision of *ahupua`a* lands) to *mo`o* (land subdivision of an *`ili*) and *apana* (land division of a *kuleana*). Several LCAs (407, 3255, and 3464) list house sites within their awarded claims.

Traditional land utilization within and adjacent to the `Īao Valley project area was, on an initially small scale, replaced by sugarcane cultivation during the 1850s. This small-scale cultivation was begun by Kamehameha III and further intensified by foreign plantation managers and owners such as Peck and others (see Sterling 1998:86). Many of the awarded LCAs in the area were under sugarcane cultivation by the mid 19th century (e.g, LCA 407). By the late 1800s, much of the land within and near `Īao Valley was planted in sugarcane. Sugarcane fields extended along the borders of `Īao Valley, within the valley, and even occurred between the Halekii-Pihana Heiau site. Connolly (1974:5) notes that in the early 1900s, the sugarcane industry dominated commerce and land use in the `Īao Valley area, a fair amount of water irrigation ditches, terraces, free standing walls, historic house sites, and mill structures having been constructed during this time. Agricultural terracing and a Portugese worker's camp were but several structures existing in the lower stream valley. The Portugese laborers "lived in the stream bed area, growing taro and other vegetables in the *lo`i* and working as laborers on the plantation. This population lived in a worker's camp until the flood of 1916" (Connolly 1974:5). This flood presumably ended habitation practices within lower `Īao Valley.

In 1912, a rock crusher was installed in `Īao Valley by Mr. Willie Crozier, an entrepreneur who was resolved to supply all of the rock needed for construction projects on Maui. This crusher, however, was also destroyed in the 1916 flood. The flood itself, generated within `Īao Valley, demolished taro *lo`i*, the rock crusher, the Portugese Camp, and, among other things, portions of the two *heiau*. Yent (1983:7) suggests that major erosion of both Halekii and Pihana Heiau was due to the 1916 flood, the western half of Halekii being eroded down the steep valley slope and the eastern half of being eroded by `Īao Stream. Importantly, archaeological remnants occurring in the valley (valley floor) would have also been dramatically effected by the flood as well.

Sugarcane cultivation continued in and near the valley after the flood though, with plantations rebuilding the water systems feeding the sugarcane fields (Connolly 1974:6). Cultivation of sugarcane dominated land use of the project area environs through the middle of this century. During World War II times, military training was done in *mauka* `Īao Valley areas while ranching also occurred. Remnants of these activities (and earlier historic occupations) include iron broilers and concrete foundation walls (large ovens), concrete-lined trenches, and concrete house pads (Bordner 1983:6-9). Later use of the area included the Hawaii National Guard constructing a water tank, pipeline, and dirt road across the surface of Halekii Heiau. Presently, the `Īao Valley project area loci is bordered by residential housing units, commercial buildings, and the Halekii-Pihana Heiau Complex.

THIS PAGE INTENTIONALLY LEFT BLANK

4.0 PREVIOUS ARCHAEOLOGICAL RESEARCH

Several archaeological projects have occurred on the flanks of `Īao Valley and closer to Wailuku, all of which are important in determining traditional and historic-period settlement patterns within the general area and more specifically, within the `Īao Valley project area (see Donham 1996). Only one study has been conducted directly within `Īao Valley near the current project area, an archaeological survey conducted in 1974 by Connolly for the first phase of the `Īao Valley Flood Control Project.

4.1 SPECIFIC PROJECTS

Initiatory research of an archaeological nature within Wailuku Ahupua`a was accomplished by Thrum (1909) who first identified the much investigated Halekii and Pihana Heiau. In addition to Thrum's work at the monumental structures, Stokes mapped the site in 1916. Walker also recorded the site in 1931, during his island-wide survey of Maui in which he identified many *heiau* within Wailuku Ahupua`a (Walker 1931). Emory was the next archaeologist working at this important site and during his 1959 campaign, reconstructed portions of Halekii and rendered another map of the Heiau. The most recent work at the site was accomplished by Yent (1983, 1984, 1995) who conducted systematic survey, mapping, and excavations as part of a restoration plan. Yent's (1995) work yielded explicit planviews of the site, detailed profiles of the *heiau,* and revealed construction techniques utilized to build the features.

Prior to the modern era, the only large-scale survey of Wailuku Ahupua`a and environs, albeit biased towards coastal structures, was conducted by Walker (1931). Recently, many other archaeological projects have been conducted in the area and have yielded much data regarding settlement pattern and land utilization within the *ahupua`a*. Kirch (1985:144) notes, however, that "more intensive study of these important regions will help to unravel the sequence of economic, social, and political change that led to the development of the powerful Maui chiefdoms witnessed by Cook and others".

Connolly (1974), as part of the initial `Īao Valley Flood Control Project (Phase I), conducted archaeological survey on a parcel located upvalley from the present project area. Connolly's survey augmented a preliminary reconnaissance of the study area by K. Moore of Bishop Museum in April, 1974, the latter noting the presence of stone structural remains thought to be taro or *lo`i* terraces. During survey, Connolly recorded two historic complexes composed of a substantial amount of terraces, free-standing walls, ditches, historic house foundations, and several stone mounds.

Identified by Connolly (1974) and distinguished as State Site No. 50-50-04-2978 (Wallace System Complex) and 50-50-04-2979 (North Terrace System Complex), the former site, located on the south stream bank of `Īao Valley, contained a site composed of twenty terraces, two irrigation ditches, one free-standing, diversionary wall, and two house foundations. The North Terrace System Complex consisted of a wet-land taro system represented by six taro terraces, two free-standing walls, and two stone mounds of unknown function. Connolly believed both sites (and all features) to have been constructed during historic times, the sites presumably constructed by Portugese workers living in a camp within the valley. Several interesting arti were also recovered during the survey and represent traditional taro processing: one, fracture basalt *poi* pounder and one, unfinished basalt *poi* pounder. Connolly's (1974) work in the 'Īa Valley streambed set one precedence for anticipated findings during the present study.

During May 1981, Bordner (1983) conducted archaeological reconnaissance and limited subsurface investigations at the Waiehu Housing Development, a parcel situated northwest a adjacent to the present project area. The Waiehu Housing Development abuts the Halekii an Pihana Heiau site. The reconnaissance revealed past World War II military use of the area (training grounds) and ranching activities. Empirical data representing this period included a iron broiler and concrete foundation walls (large ovens), a concrete-lined irrigation trench (sugarcane), concrete house pads, and several other mid-20th century structures. Limited subsurface testing in the parcel failed to yield any significant cultural layers, a majority of th matrix composed of consolidated sand. Bordner (1983) concluded that it was unlikely that n traditional activity (vis-a-vis agriculture) occurred on the parcel as the sandy matrix was detrimental to the cultivation of taro, particularly when compared to the alluvial soils near 'Ī Stream. Exclusively, evidence for historic-period land use was documented.

Yent (1983, 1995), following in the footsteps of the many archaeologists previously docume Halekii and Pihana Heiau (State Site No. 50-50-04-522), conducted systematic survey, mapp and excavations at the *heiau* site during several field excursions between 1983 and 1995. Th site, recommended for inclusion in the National Register of Historic Places, lies on the north side of 'Īao Valley Stream, or adjacent and northwest of the present project area. As stated previously in this document, the *heiau* site was especially important during traditional times ceremonial loci. The two *heiau* are located on a lithified sand dune ridge to the northwest of Stream, both structures suffering damage due to erosion caused by 'Īao Stream and the erodi sand dune (Yent 1983:1). These two complex structures have been approximately dated to t middle-late 18th century, construction of the features occurring prior to the arrival of foreigne the Hawaiian Islands. For a more detailed description of the sites interpretive themes, archaeological results from survey, mapping, and subsurface testing, and preservation recommendations, the reader is encouraged to review the works of Yent (1983, 1984, 1995) Estioko-Griffin and Yent (1986).

The most recent archaeological work conducted near the current project area was conducted the Fredericksens (1996) on Lower Main Street and Mill Street in Wailuku. This project are approximately 500 m to the east/southeast of the current 'Īao Valley study location. Excavat at State Site No. 50-50-04-4127 revealed two extensive, subsurface cultural deposits, both "overlain by fill from historic earthmoving activities associated with the construction of the Kahului Railroad and Lower Main Street" (Fredericksen and Fredericksen 1996). While the upper cultural deposit was disturbed by the aforementioned activities, the lower layer contai intact pre-Contact features and artifacts associated with a habitation function. Artifacts associated with fishhook manufacture, lithic tool utilization and production, and food prepar were recovered from Layer II deposits. The deposits were dated and it appears the site was occupied during the late pre-Contact period (A.D. 1570-1780). Importantly, this habitation site is likely associated with the lower `Īao River flood plain in which taro was presumably produced. Thus, habitation occurred above the valley floor while taro production for households occurred on the rich but narrow alluvial flood plains of `Īao Valley.

Finally, Cordy (1996) and Donham (1996) provide overview studies of prior archaeological work having been conducted in the area. Cordy (1996) discussed an overview of Māhele documents on land patterns in the `Īao Valley area that clearly showed that lower valley region contained irrigated taro fields throughout the flood plain and houses and associated grave sites at the base of the sand dunes bordering the sides of the flood plain. Donham (1996) also summarized that house sites occur along the base of the sand dunes, with population movement occurring up valley through time.

These recent archaeological studies, although few in number, provide much insight into the nature of traditional and historical activities occurring within and near the current `Īao Valley project area. Through past archaeological research, oral traditions, and historical records, the chronology and settlement pattern of the valley may be brought into focus.

THIS PAGE INTENTIONALLY LEFT BLANK

5.0 CHRONOLOGY AND SETTLEMENT PATTERN: `ĪAO VALLEY

The settlement pattern and timing of land utilization may be conveniently (and arbitrarily) divided into several general periods: traditional/pre-Contact settlement, the early historic period/early post-Contact, the recent historic, and present land use. Together, these periods create a synthesis of land use in and near the project area as well as provide a basis on which researchers explored succinct research questions during reconnaissance and sampling work.

5.1 HAWAIIAN SETTLEMENT AND LAND USE PERIOD

Wailuku Ahupua`a and its coastal environs are thought to have been initially settled c. A.D. 1100-1200, a concentration of incipient settlement primarily occurring near the coastline. Through time, settlement expanded to more inland locales, such as within various portions of `Īao Valley itself. The Wailuku area is considered to have been a chiefly and ceremonial center during pre-Contact times. Settlement, burial grounds, coastal exploitation of marine resources, and *lo`i* systems in `Īao Valley were supposedly common during pre-Contact times. Between A.D. 1500-1700, archaeological data indicates that habitation occurred near `Īao Valley, among other locales, with the valley itself utilized as taro-producing lands. The numerous ***heiau*** attest to the significance of the area (Halekii and Pihana Heiau) and war gods were invoked by Hawaiians at the temples (e.g., by Kamehameha I, for example). Many battles were fought within `Īao Valley, most poignantly the Battle of `Īao in which Kamehameha I gained complete control of the island, displacing the Maui chief before him. The unification of the Hawaiian Islands by Kamehameha I, coupled with an increasing influx of foreigners in the islands, ushered in the early historic period.

5.1.1 Early Historic Period

Besides the unification of the islands, perhaps the most significant development following Contact with westerners was the Great Māhele of 1848. Many awards were distributed in areas bordering `Īao Valley, most land being utilized for the irrigated cultivation of taro, acquiring leaves from *hala* trees, and for house sites resting near taro production areas. The LCAs listed for the project area and environs, some 129 awarded claims, were likely used on a continuous basis from pre-Kamehameha I times at least through the middle to late 19th century.

Another significant development was the cultivation of sugarcane which began in the `Īao Valley area during the 1850s. Sugarcane became the dominant crop cultivated in the area and provided occupational opportunities for both local and non-local residents. With sugarcane cultivation came irrigation and processing structures across the landscape, these being irrigation ditches, mills, and other infrastructures supporting the cash crop production. Sugarcane cultivation continued through the 20th century.

5.1.2 Recent Historic Period and Present Land Use

During the 20th century, sugarcane cultivation continued on an intensive scale. A Portugese worker camp was located within `Īao Valley, the camp providing residence to plantation workers. The 1916 flood erased this camp and a rock crusher installed several years previously. After the flood, the sugarcane plantations rebuilt many of the irrigation ditches and mill stations destı during the flood. Sugarcane continued to be the dominant activity in the ʻĪao Valley area, o small taro plots still being cultivated. To the southwest and *mauka* of the current project arı land was utilized during World War II as a military training area. In addition, ranching bec: viable activity in the ʻĪao Valley area, particularly in *mauka* areas below the precipitous clif the West Maui mountain range. At present, lands surrounding the project area are utilized f family housing and business buildings. The Halekii and Pihana Heiau area has been presen and restored. The project area within the lower valley, much which is overgrown with vegetation, remains relatively non-utilized at present.

Overall, the settlement pattern of the project area and environs suggests a range of site types associated with various landforms (see Cordy 1996 and Donham 1996 for settlement pattern summaries). For instance, irrigated *kalo* fields would occur on the flood plains where alluvi soil and hydrological output are both present in sufficient quantities (and quality) to allow fc successful cultivation. Related to a wholly different soil type, traditional subsurface habitati deposits with associated burial loci occur at the base of sand dunes adjacent to the flood plai Sand dunes occur on both sides of the stream valley flood plain. Traditional activity areas w also utilized during historic times. For example, sugar cane cultivation occurred on an indusı level in flood plain reaches from the 1850s. Even later, portions of the valley were utilized during World War II as training areas. A survey of all topographic features associated with ı valley has yielded variable land use patterns through time. The present survey sought to refi these patterns if evidence was indeed available.

6.0 RESEARCH DESIGN

6.1 RESEARCH QUESTIONS

The following research questions were posed prior to the introduction of field reconnaissance and limited excavation work. Fieldwork emphasis was placed in the empirical realm The questions are listed below and their answers are evaluated in further sections of the report.
The traditional and historical setting of Wailuku Ahupua`a and `Īao Valley in particular suggested that settlement and agricultural endeavors in the area occurred continuously for several hundred years, from perhaps as early as c. A.D. 1200/1300. Within the project area itself, agricultural features were thought to most fully represent traditional and historical land utilization within the parcel.

(1) If present, what is the type, timing, and extent of traditional architectural features within the `Īao Valley project area?

(2) Besides the expected potential of recovering agricultural features, what other structures or artifacts will be recovered from within the project area that allow us to infer settlement pattern and land utilization through time? This includes temporary and/or permanent habitation loci, ceremonial structures, etc.

At least 127 land claims were awarded within and near the present project area. These claims are represented by *lo`i* systems, house sites, and *kula* lands, among other land uses.

(3) Do the LCAs within the project area still contain structures or other remnants that allow for correlating the LCA with the feature and second, does the condition of the feature allow for interpreting and correlating land use and the LCA?

In 1916, a large flood swept through `Īao Valley, destroying many traditional and historic features within and bordering the valley:

(4) If present, to what extent have archaeological sites in the `Īao Valley project area been impacted by the flood? Secondarily, how have the sites been impacted by historic-period land modifications?

During the early 20th century, a Portugese camp supposedly existed within the lower valley portion of the project area:

(5) What historic remains occur within the parcel, whether structures or cultural material? Was the subject parcel continuously utilized from traditional times through modern times?

6.2 ANTICIPATED FINDINGS

Based upon previous archaeological research, LCA information, and other limited archival research of historical texts, several classes of archaeological features were thought to occur within the `Īao Valley project area. The lower valley parcel, encompassing `Īao Stream anc associated narrow, alluvial floodplains, was likely utilized for the cultivation of taro from traditional times. Archaeological available data relating to this agricultural practice would include, but not be limited to, stone and earthen terraces, alignments, free-standing walls, ai *`auwai* or water irrigation ditches. Artifacts suggested to accompany taro production may include lithic artifacts such as basalt cores, adzes, flakes, and, as has been recovered previoı *poi* pounders. Potentially, agricultural layers from traditional times through the present woı possibly be amenable to observation through the presence of oxidation and reduction layers well as charcoal layers depicting burning or clearing episodes prior to, or after, cultivation.

As has also been suggested by past research in the area, the `Īao Valley project parcel could contained evidence for temporary, small scale habitation from traditional through historic tiı Settlement pattern research indicated permanent habitation above the valley floor through tł early 20th century and worker's camps situated near the valley floor during historic times. Archaeological remains associated with these activities could include traditional lithic remai (adzes, flakes, etc.), faunal remains (subsistence), and charcoal denoting hearths (temporary campsites, etc.). Later period occupation could be reflected not only by the preceding artifa but also by structures associated with small-scale taro production (walls, etc.; see Connolly : and historic artifacts such as metal, ceramic, and glass assemblages.

LCA information gleaned from a small sample of LCAs near the project area indicates that n of the project parcel was utilized for agricultural pursuits (taro). Thus, archaeological availa data reflecting this land use could include stone alignments, terraces, *`auwai* or ditches, and a accompanying artifact assemblage composed of lithics (basalt cores, adzes, flakes). Agricult soils, represented by charcoal layers and/or oxidation and reduction layers, could potentially noted, these depicting specific agricultural use of the area over time.

It is presumed that 20th century debris, reflecting military and ranching activities within the general project area and more recent activities, could also have been present within the projec area.

However, as will be shown below, a number of archaeological structural and artifactual class listed above were not identified within the project area during the course of the present projec Briefly, this pattern is most probably due to intensive, historic-period landscape alterations within the project area and not due to the fact that the lands were never utilized from prehisto times through the present for agricultural and/or habitation pursuits.

7.0 METHODOLOGY

As specified in the Research Design for the present project (Dega 1998), a pedestrian survey was conducted through the 4,700 ft. long, 150 ft. wide corridor of the ʽĪao Stream alternative channel alignment (see Figure 1). Two-person sweeps were conducted through the entire project area, a focus on identifying and recording all structures across the landscape. Site boundaries were identified and clearly marked with surveyor's flagging tape, as well as recorded and located on U.S.G.S. topographic maps. Additionally, the one identified site was recorded by tape and compass and vegetation clearing within and around the site was restricted to that only allowing for site identification and site boundary determinations. All stages of the archaeological investigations were fully documented in a daily log and in photographic form as specified in Section 5.3.3 of the Scope of Work (SOW). Excavations were to be conducted at recorded sites following the completion of reconnaissance survey.

7.1 RECONNAISSANCE SURVEY

Near the southwestern edge of the project area (from the concrete stream channel below the Spreckels Ditch flume, to the spillway), the open area was inspected but marking flags were not distributed across the area. Following reconnaissance of the open area, the two-person fieldcrew began surveying by implementing southwest-northeast transects, the origination point for the transects occurring on the northeast side of an unsurfaced road, the road extending northwest from Imi Kala Street to Piihana Road (see Figure 4). Flagging tape marked the extent of each northeast-southwest transect surveyed. Surveyed transects continued to the intersection with ʽĪao Stream at the northeast end of the alignment corridor, an exception being a small section that passed through currently cultivated gardens. The cultivated garden areas, a bulldozed building, a corral, and fenced animal pens and enclosures were photographed and located on an alternative channel alignment map supplied by the client (see Figures 5-9).

Overall, one site, comprised of three surface features, was identified within the project area (see Figure 3). The site (50-50-04-4755; TMK 3-4-32:1) and its three component features were photographed, mapped in plan view, and recorded on standard site and feature forms. The site and constituent features were marked with flagging tape and the site location was plotted on the channel alignment map (see Figure 3). Surface artifacts distributed within and adjacent to the site were collected through two-person sweeps within the site and a 15 m radius of the site. Surficial artifact dispersions were plotted on a distributional, plan view map of the site.

7.2 EXCAVATIONS

Limited excavations were conducted at the site. A 0.50 by 0.50 m test unit (TU) was excavated at each of the site's three constituent features. The units were excavated by 10 cm, arbitrary levels within stratigraphic layers. All layer and level findings were recorded on excavation grid forms. Excavated soil was screened through 1/4 and 1/8-inch wire mesh and all ecofactual and artifactual materials identified from the screens were recorded and preserved. Of this screened material, at least 50% of the 1/4-inch and 25% of the 1/8-inch mesh sample was retained for laboratory analysis. Any non-retained portions were visually scanned for artifacts, midden, or other significant cultural remains. All observations were recorded on standard SCS/CRMS excavation forms and the depth of excavation from datum, plan views of cultural features, a location of *in situ* artifacts was recorded.

Recovered materials were separated into gross artifact and faunal categories and placed in st bags labeled with the project number, temporary site number, provenience of the find, and tl date of recovery. All cultural materials were then listed on standard bag list forms. Speciali procedures dealing with human osteological materials were not required at the site. At the completion of each excavation, photographs were taken of the unit location and the two wall each test unit. One wall of each unit was recorded in a stratigraphic profile drawing and described in conformance with U.S. Soil Conservation Service and Munsell Color Notation references. All three units were backfilled after all recordation was completed.

7.3 LABORATORY ANALYSIS

Recovered cultural materials and soil samples were forwarded to the SCS/CRMS laboratory Honolulu, O`ahu for analysis and curation. All retrieved artifact and midden samples were thoroughly cleaned in the laboratory. A sample of artifacts was photographically recorded, sketched, and identified. All metric attributes and weight were also recorded where appropri All data were clearly recorded on standard SCS/CRMS laboratory forms which also includec number and weight (as appropriate) of each constituent category.

While a maximum of two to four radiocarbon samples were budgeted for this project, no charcoal samples from the site were submitted for dating as little additional information wou have been gained from submitting the samples. The ubiquity of historic remains and the abs of traditional remains, among other indices, clearly revealed the historic age of the site.

All notes, maps, photographs, and cultural resources are temporarily being curated at SCS/CI laboratories until a suitable, permanent facility is located.

8.0 PROJECT RESULTS

As has been discussed above, expectations prior to fieldwork included the archaeological field crew potentially identifying several classes of pre-Contact and post-Contact structures and features, these primarily associated with agricultural pursuits and temporary and/or permanent habitation loci. Based on a preliminary drive through and brief inspection of portions of the project area, several landscape patterns were elucidated prior to systematic survey. Based upon the massive, overall surface modifications observed within the project area, expectations prior to fieldwork were amended. It was thus expected that only historic-period and/or modern agricultural features might be encountered during systematic survey. Project results generally conformed to those expectations.

8.1 OVERVIEW OF SITE 50-50-04-4755

One site, comprised of three constituent features, was identified in the project area during reconnaissance survey (Figure 10). The site was located along the northwestern side of the corridor near the spillway outflow path and fence (see Figure 3). The site and environs appeared to have been recently bulldozed, as evidenced by earthen berms and piled cobbles and boulders. A berm enclosed three sides of the site. The northeast and southwest berms were constructed of bare earth and scattered clumps of grass. These two berms contained waterworn cobbles, boulders, and pieces of concrete, together forming the Feature A structure or "complex". The northeast berm was covered with dry grass and scattered boulders. A large trash pile, comprised of soil, boulders, lumber, metal, automobile chassis' and engine parts, modern household items and furniture, drip-line hose lengths, and plastic pipe was located c. 23.00 m. to the southeast of the berm, between the site berm and the service road following the course of 'Īao Stream as it proceeds downvalley. The uneven ground surface between the berm and the trash pile was littered with corrugated roofing pieces, lumber, carpet pieces, household fabrics, and large stones. The condition of the site, coupled with observable remnants, revealed an obvious historic and/or recent temporal affiliation for the site.

8.2 SITE DESCRIPTION

Site 50-50-04-4755 consists of one concrete building foundation slab, one terrace and retainments, and one short section of a stacked wall. The site boundaries occur within an enclosed area measuring c. 52.50 m. by 23.30 m and is oriented northwest-southeast (305/ 125 degrees) (see Figure 10). As stated above, a U-shaped earthen berm encloses three sides of the site. The berm varies in width from 2.75 to 8.2 m, reaches a variable height of c. 0.70 to 2.00 m above the outer surrounding soil surface, and rises 0.46 to 2.20 m above the inside surface of the enclosure. Near the southwestern berm, a basalt edge-altered flake was recovered, the flake exhibiting use-wear as a cutting tool and a retouched edge. The northwestern portion of the site is open (non-bermed) and lies c. 1.20 m above the adjacent pasture land and nearby road. Two traditional artifacts, fragments of possible grinding stones, were retrieved from the sloping surface of the berm beyond the site, near the road. A permanent site marker was placed at the southwestern flank of Feature A.

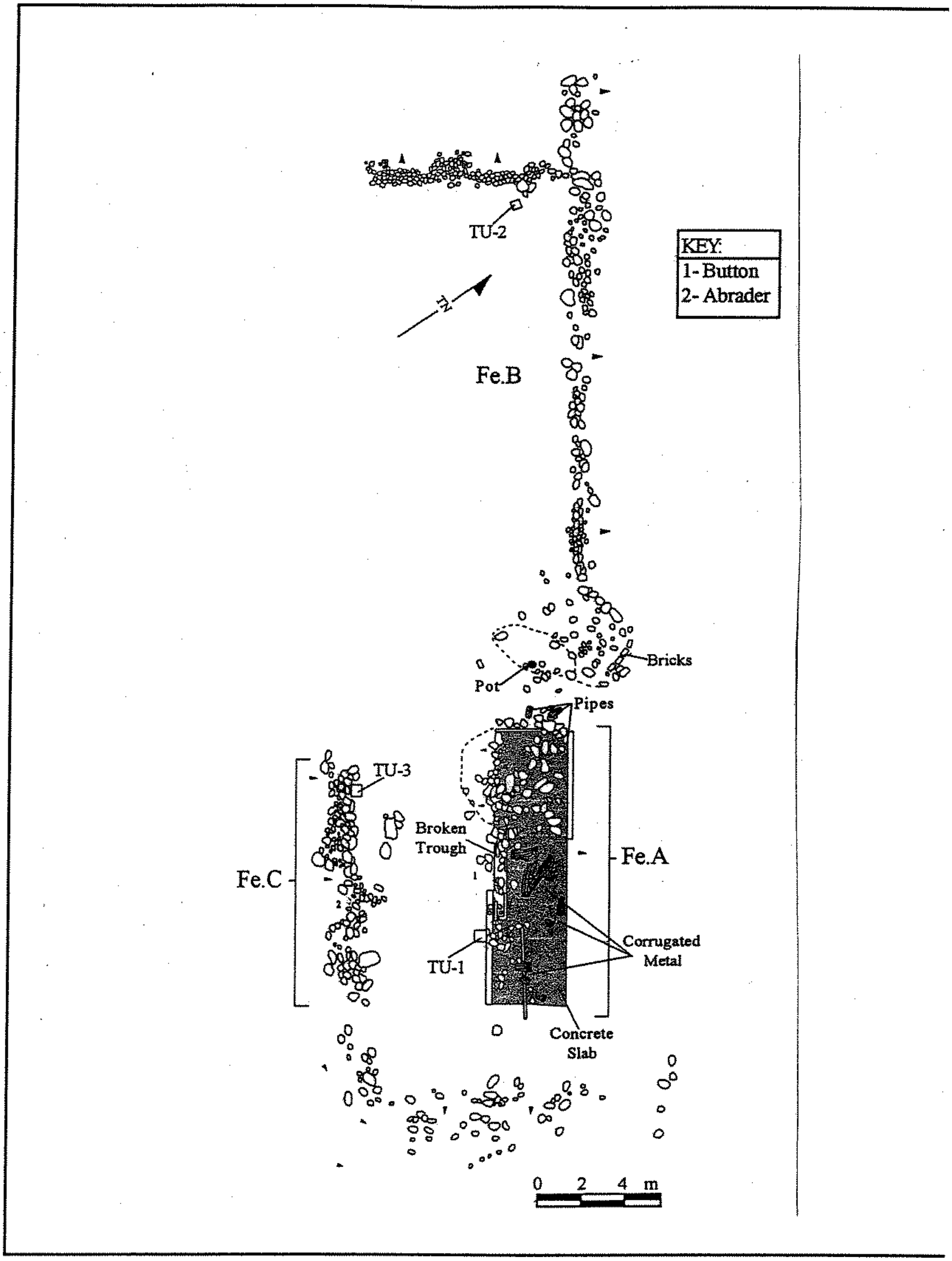


Figure 10: Planview Map of Site 4755 Composed of Features A through C and Test Units 1 through 3.

8.3 FEATURE DESCRIPTIONS

Feature A consisted of a concrete building foundation slab with remnants of two low, concrete troughs incorporated into the southwestern side of the foundation (see Figure 10; Figures 11 and 12). The troughs measure a variable 1.3-2.0 m long, are 0.40 m. wide, and have been partially filled with waterworn cobbles (Figure 13). The foundation slab itself measures 12.60 m long by 3.70 m wide. A 0.58 m high mound of soil, with waterworn stones and one piece of rusted water pipe on the surface, covers the northwestern 4.50 m of the foundation slab and extends 1.25 m beyond the southwestern edge of the platform. Rusted corrugated metal roofing, a 2.50 m length of rusted, 2 inch pipe, one child's tennis shoe, and a scattering of waterworn cobbles litter the slab surface. A feature marker was placed at the southwestern flank of the foundation slab. Test Unit-1 (TU), a 0.50 x 0.50 m unit, was placed directly against the southwestern edge of Feature A (Figure 14).

Feature B was a 19.00 m. long, soil-filled terrace confined by low retaining walls on its northeastern and northwestern sides (see Figure 10). The northeast side of the wall is constructed of three to five courses of stacked, medium to large size, waterworn cobbles (Figure 15). The wall increases in height from 0.36 m along its southeastern flank to 0.65 m near the wall's northwestern wall juncture. Along the northwestern portion of the wall, a 2.80 m long section of the feature has been disturbed and exists in a state of partial collapse. The southeastern flank of the wall articulates with a 7.00 m alignment of small boulders and concrete blocks, together, these confining a portion of a 0.25 m high, 6.00 m long dirt pile (Figure 16). A crushed aluminum pot, a metal pipe section, and a modest concentration of scattered cobbles lie on the surface of the dirt pile. The Feature B identification marker was placed between wall cobbles at the southeastern end of the linear wall.

The retaining wall across the northwestern flank of the terrace extends 9.10 m from the wall junction to within 1.00 m of the dirt berm base that defines the southwestern portion of the site. The retaining wall was constructed of four courses of medium-sized, waterworn cobbles. The cobbles were stacked to a maximum 0.52 m. high. Two, 2.00 m sections of the wall, one section occurring in the central portion of the feature, the other occurring at the northeastern end of the feature, are partially collapsed (see Figure 16). TU-2 was excavated in the northwest corner of the terrace (see Figure 10). On the surface of TU-2, one basalt abrader was recovered prior to unit excavation. The abrader fragment was square in planview and exhibited two altered edges that formed a corner at the proximal edge of the tool.

Feature C consisted of a 5.00 m long by 0.60 m high wall remnant (see Figure 10; Figure 17). The feature was evident within the northeastern, interior face of the U-shaped berm. The wall section was constructed of 2-3 courses of waterworn, basalt cobbles and boulders. Scattered cobbles and boulders are present, for a distance of 10.00 m, on both the berm face and the enclosure surface, southeast of the wall section. A permanent marker denoting Feature C was placed between wall stones, just above TU-3. TU-3 was positioned against a flat base stone at the northwest end of the wall section (Figure 18).

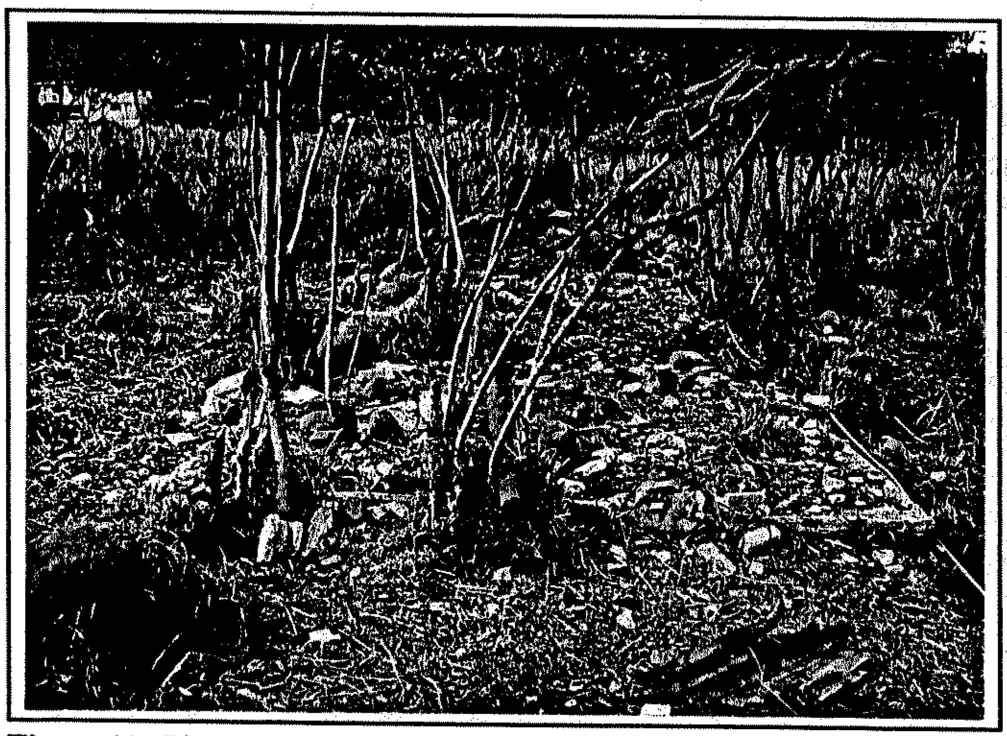


Figure 11: Photograph of Feature A Building Foundation and Concrete Slabs. View to Northwest.

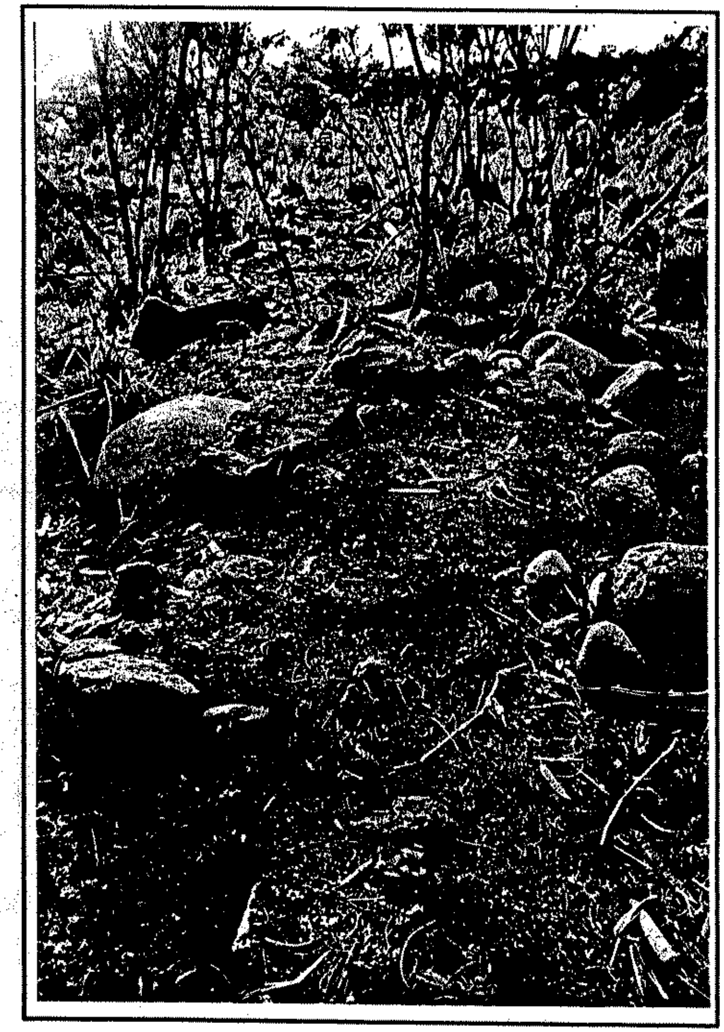


Figure 12: Photograph of Feature A Building Foundation. View to Southwest.

Figure 13: Photograph of Feature A Trough. Note: Cobbles inserted into Trough. View to Southeast.

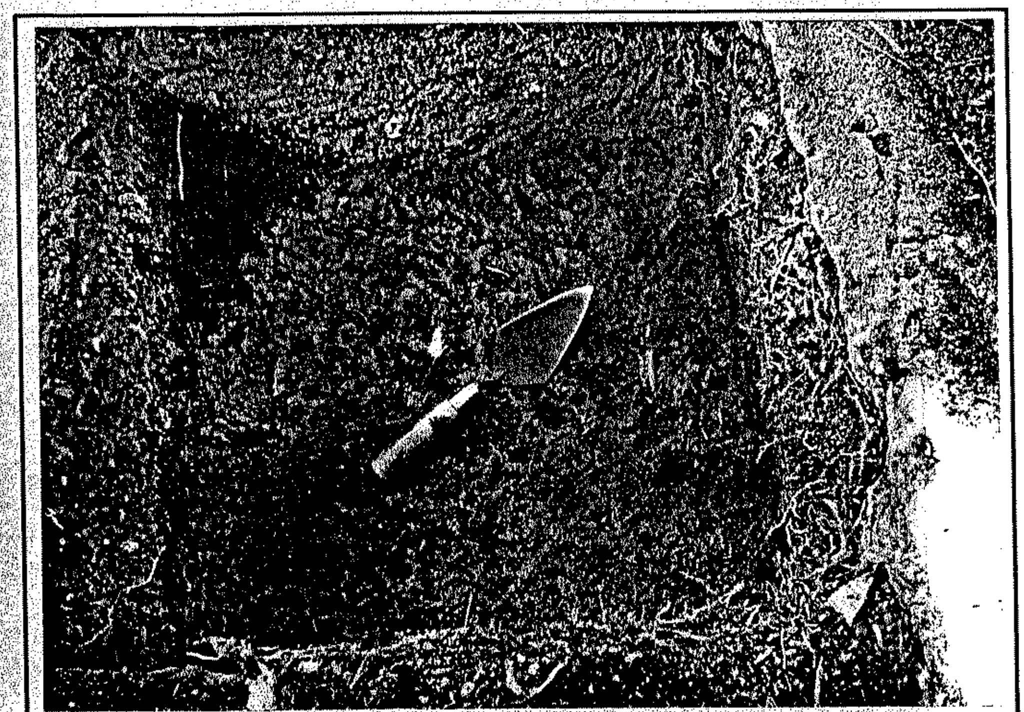


Figure 14: Photograph of TU-1, Feature A, at 60 cmbd (basal layer). Note: Concrete Foundation at Northeast Unit Portion. View to Northwest.

Figure 15: Photograph of Feature B, East-West Wall Facing. View to Southwest.

Figure 16: Photograph of Feature B, East-West Wall. View to Southeast.

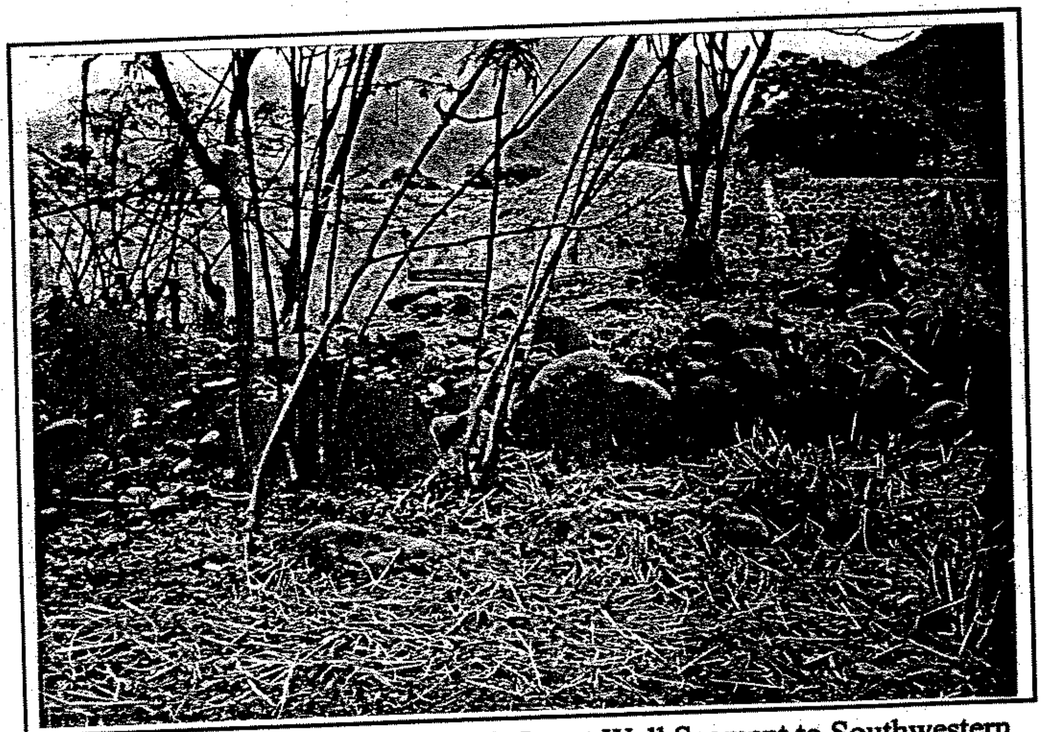


Figure 17: Photograph of Feature C, Intact Wall Segment to Southwestern Berm. View to Southwest.

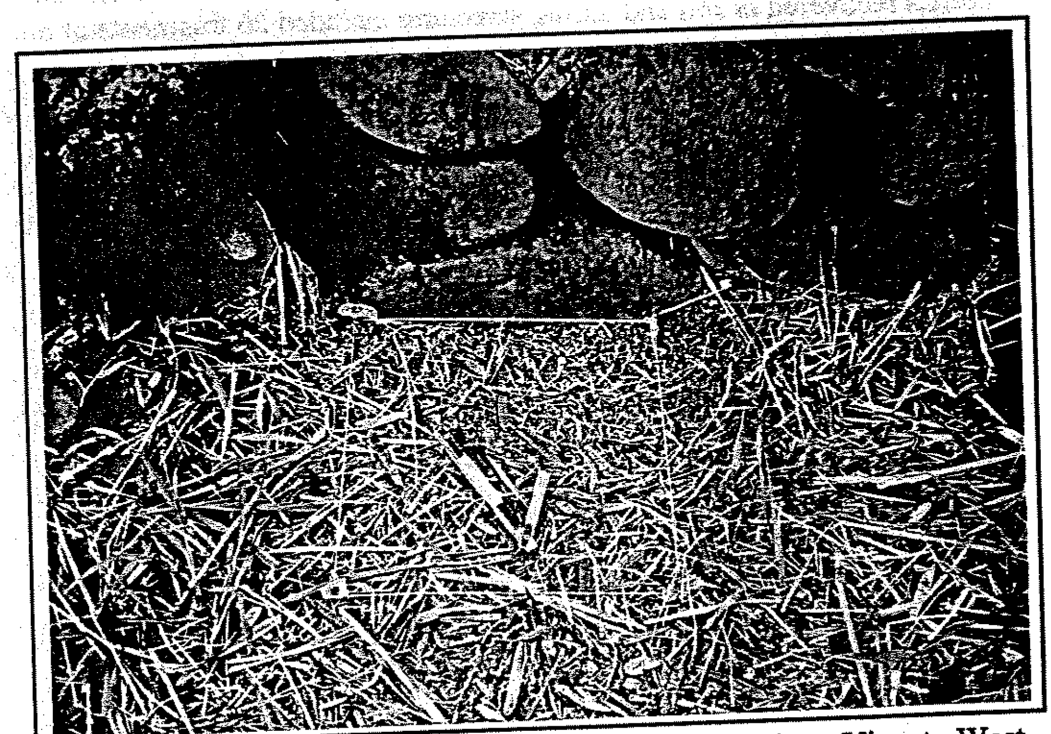


Figure 18: Photograph of TU-3, Feature C, Pre-Excavation. View to West.

8.4 TEST EXCAVATIONS

Three TUs, each measuring 0.50 by 0.50 m, were excavated at Site 4755 (see Figure 10). One test unit was placed at each of the three features and was excavated from a surface datum. All three TUs were excavated by arbitrary levels within natural stratigraphic layers. All test unit excavations were terminated within sterile strata at a fairly minimal depth below surface. It is was determined in the field that the site was culturally sterile from a maximum 0.40-0.60 cmbd. Excavations provided some corollary information between surface remnants and artifacts and those occurring within subsurface contexts. A variety of artifact classes were identified during excavation, a majority unequivocally representing historic-period and more recent use of the area The artifacts have been tabulated and are presented in Appendix A. Faunal remains inventory and charcoal inventory are given in Appendices B and C.

Test Unit-1

TU-1 was excavated within Feature A to explore the relationship between the feature's recent architecture and subsurface deposits and to determine the presence/absence of subsurface cultural materials, particularly to see if a correlation existed between the historic materials on the surface and potentially prehistoric and/or historic materials below the surface (see Figure 14). The unit datum was set at 0.32 m above the surface. Excavation of the unit to basal depths revealed two layers (Figure 19):

> Layer I (0.30 - 0.52 mbd) was composed of Dark brown (10YR 3/3) hard-packed silty clay. The layer contained broken pieces of concrete and basalt pebbles. Cultural materials recovered *in situ* and during screening included 26 fragments of metal (square and round-headed nail fragments, one lead bullet casing and unidentified metallic fragments), three ceramic sherds (two porcelain and one earthenware), one brown, modern beer bottle, 6.6 g of machine cut medium to large mammal and sparse amounts of bird and vertebrate remains, 6.5 g of charcoal, and one very worn marine shell fragment (not collected). Historic artifacts clearly dominated cultural materials occurring within the layer, this being representative of historic debris littered across the site's surface.
>
> Layer II (0.52 -0.60 + mbd) consisted of Dark brown (10YR 4/3) hard-packed silty clay. The layer contained three classes of cultural material including minimal amounts of charcoal flecking (0.1 g), faunal remains (5.8 g of bird and mammal bone), and two small fragments of decomposing shell at the interface of Layers I and II (not collected). Excavation of the unit terminated at 0.60 mbd.

Test Unit-2

TU-2 was excavated within the Feature B terrace section to explore the relationship between the feature's various architectural sets (see Figures 10 and 16). Additionally, excavation of the feature was utilized to determine the presence/absence of subsurface cultural materials. As stated above, one basalt abrader fragment was recovered from the surface of TU-2. The unit datum was set at the present surface (0.00 m). Excavation of the unit to basal depths revealed one layer (Figures 20 and 21).

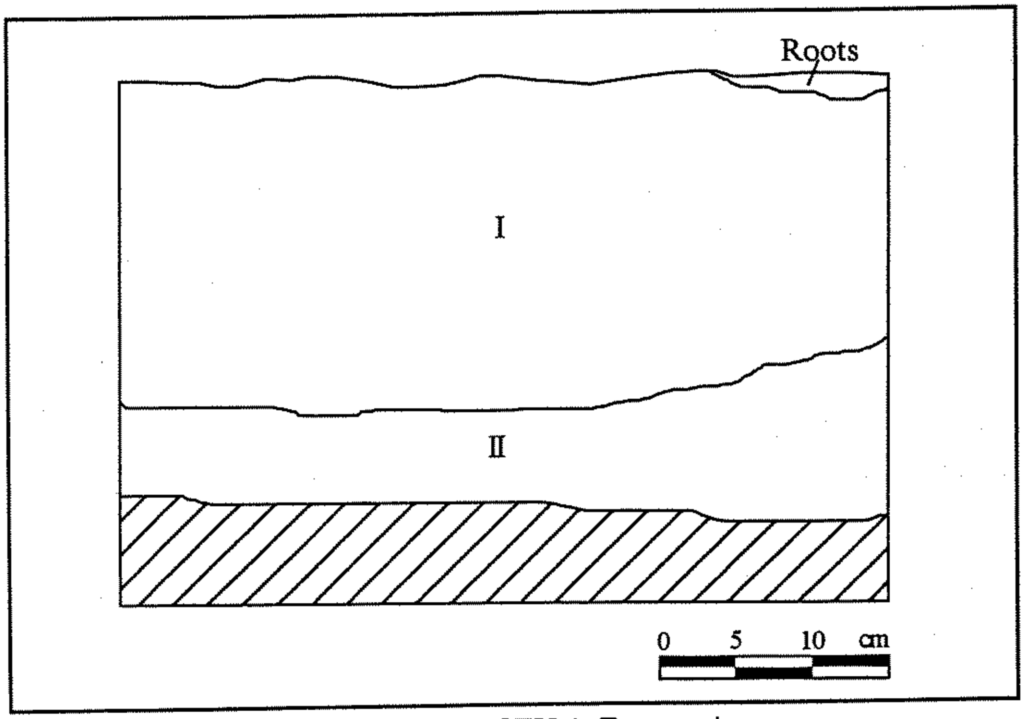


Figure 19: Northwest Wall Profile of TU-1, Feature A.

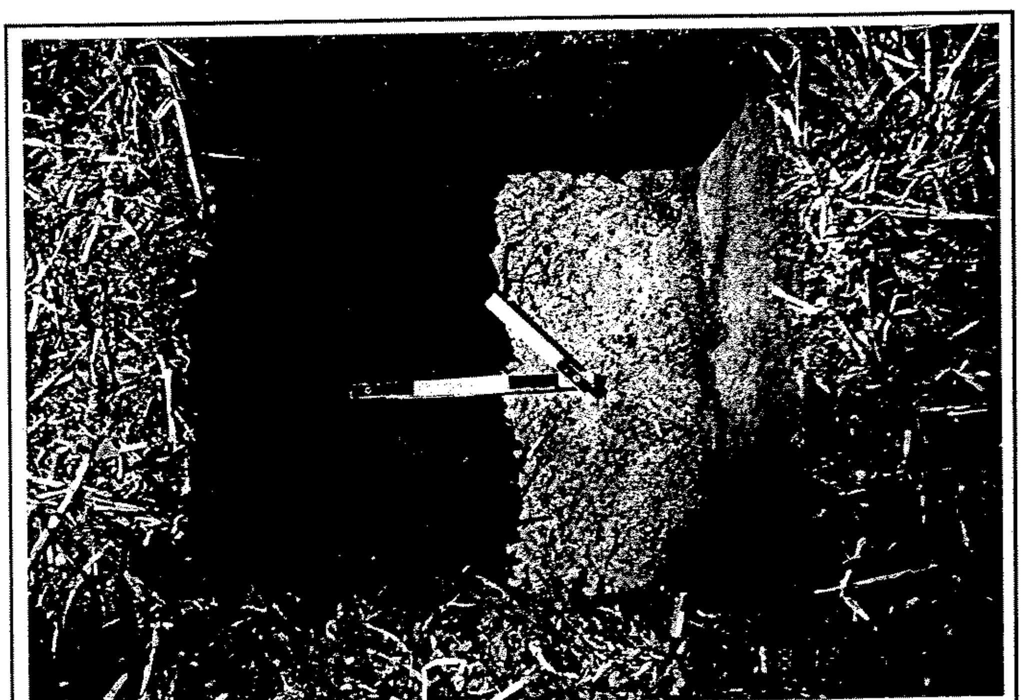


Figure 20: Photograph of Feature B, TU-2, Post-Excavation. View to West.

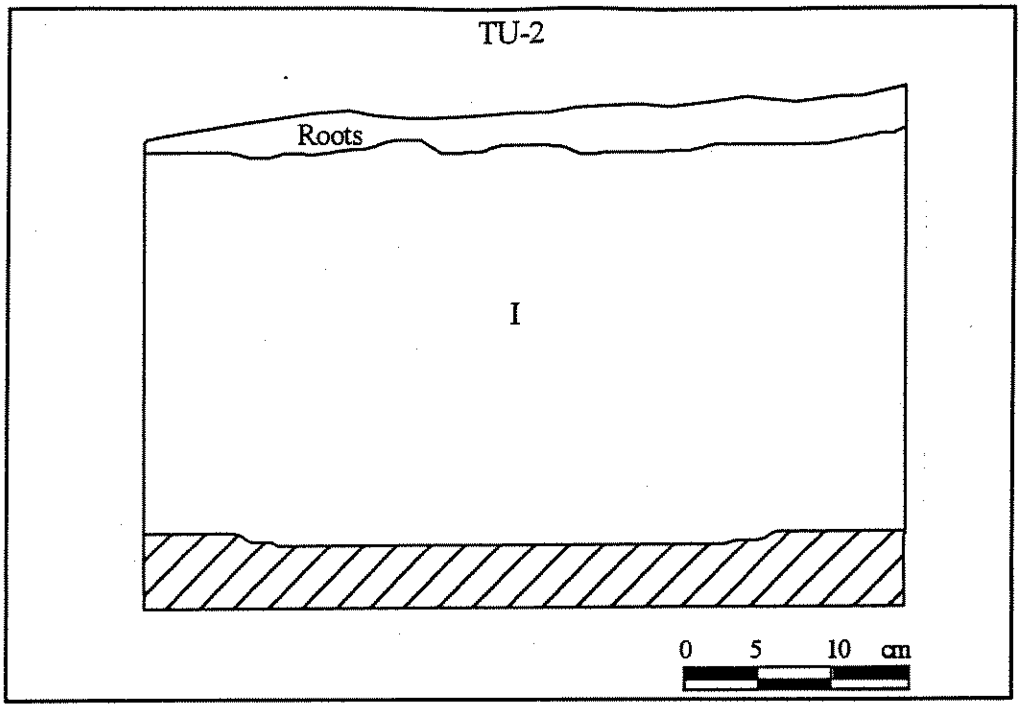


Figure 21: West Wall Profile of TU-2, Feature B.

Layer I (0.00 - 0.30 + mbd) consisted of Dark brown (10YR 4/3) hard-packed silty clay. The layer contained grass roots near the surface (a typical O-horizon characteristic) and few clastics (basalt pebbles). TU-2 was culturally sterile and excavations of the unit terminated at 0.30 mbd.

Test Unit-3

TU-3 was excavated within Feature C to explore the relationship between surface architecture (retaining wall) and possible subsurface architecture, the latter being an extension of the surface retainment wall (see Figures 10 and 18). Excavations were also done to determine the presence/absence of subsurface cultural materials, particularly to see if a correlation existed between the historic materials on the surface and potentially prehistoric and/or historic materials below the surface. The unit datum was set at 0.00 m above the surface, or on the present ground surface. Excavation of the unit to basal depths (0.040 mbd) revealed two layers and the greatest concentration of cultural materials of the three excavated units (Figure 22).

Layer I (0.00 -0.40 mbd) was composed of Dark yellowish brown (10YR 3/4) silty clay. The matrix contained a variety of mostly historic materials: 297 rusted metallic sheet fragments, 15 square and round-headed nails, 16 unidentified rusted metal fragments, one metal bottle cap, one porcelain tea cup, one porcelain sherd, 9 shards of glass, two modern bottles, and an unidentified glass top or stopper. Faunal remains recovered from the layer included 27.8 g of various mammal and bird bone, some 50% of this small assemblage composed of unidentified medium or large mammal.

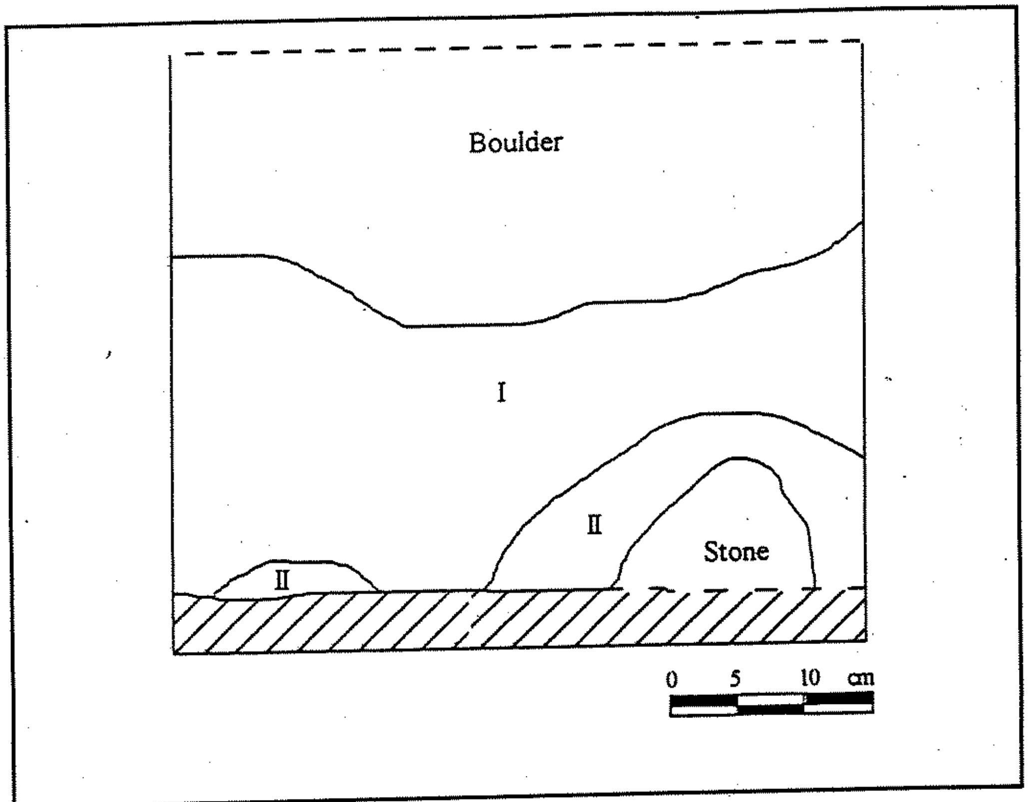


Figure 22: Southwest Wall Profile of TU-3, Feature C.

Layer II (0.27 - 0.40 mbd), a Yellowish red (10YR 4/6) silty clay with an uneven horizontal and vertical extent, was present mainly in the northwestern portion of the unit. The layer was sterile and excavation of TU-3 was terminated at 0.40 mbd.

THIS PAGE INTENTIONALLY LEFT BLANK

9.0 DISCUSSION AND CONCLUSIONS

SCS/CRMS, Inc. was contracted by the U.S. Army Corps of Engineers, Pacific Ocean Division (CEPOD) to provide archaeological reconnaissance survey and limited subsurface testing for the alternative channel alignment, ʻĪao Stream Flood Control Project within ʻĪao Valley, Island of Maui, Hawaiʻi. Research goals centered upon initial identification and mapping of any archaeological sites or features occurring within the modest portion of ʻĪao Stream Valley and second, if sites were identified, to conduct subsurface testing at the sites to examine the age and extent of cultural deposits associated with a particular site. Excavations were also to be conducted to determine the temporal and spatial relationship of architectural features on intra-site and inter-site scales.

Overall, the project area was relatively void of visible architectural and/or surface remains, this being the effect of heavy landscape modifications, both cultural and natural processes, to the project area within the last 100 years. A focus on obtaining subsurface data in the floodplains related to traditional and historic cultivation was eliminated several years after this survey was completed due to the impossibility of private land owners agreeing to let archaeologists excavate their individual plots. Nonetheless, sugar cane, road construction, and other activities occurring in the recent past are quite evident across the parcel and may have caused disturbance or disruption to other archaeological sites that may have previously occurred within the project area. As has been shown previously (Yent 1983), the flood of 1916 created much disturbance to several *heiau* structures occurring *above* the stream valley floor. Extrapolating then, it appears reasonable to expect that flood damage would have been greater within the valley itself.

A 100% reconnaissance survey of the project area revealed only one site (State Site Number 50-50-04-4755; TMK 3-4-32:1). The site is composed of three features. The three features (designated as Features A, B, and C) consist of a concrete foundation with concrete troughs, a soil-filled terrace and retaining wall, and wall remnant, respectively. These features form a small, presumably historic habitation complex-activity area. A majority of these features, particularly the basalt cobble and boulder-formed walls, exist in state of poor-fair preservation condition.

The excavation of three test units at the site's three features revealed predominantly historic and recent materials, the latter likely being associated with modern debris strewn across the surface of the site. Structurally and materially, the site is most probably a post-Contact, late 19th or early 20th century, agricultural site. Local residents suggest the site was associated with a small piggery that was formerly in operation several decades ago.

Residential usage may be indicated by several classes of household materials retrieved from slightly below the surface at TU-3: metallic fragments (including nails), a teacup fragment, a cosmetic bottle top, and clear glass and colored glass fragments. The trash pile and scattered, recent household items occurring across the surface of the site and its environs appears to be associated with the site. However, it is possible, and perhaps likely, that most of the surface debris could have been pushed by a bulldozer from a presently-cleared area just northeast of the dirt road that extends along the northeast side of the site.

The earthen berms bordering the southwest and southeast sides of the site appear to be have been created at a later time than the berm along the northeast side. The northeast berm is covered with tall grass, but only sparse grass clumps were present on the loose soil of the other two berms. Additionally, the southwest berm, composing a portion of the site, proceeds to the road adjacent tc the site and above the stream for c. 23 m to the southwest. Two traditional artifacts, fragments of possible grinding stones, were retrieved from the sloping surface of the berm, beyond the site (Figure 23). One additional artifact, a fragment of fine grain basalt displaying one ground surface, was recovered from the outer slope of the southeast berm. The three artifacts found on the berms and the basalt abrader recovered on the site surface are the only indication of possible traditional or prehistoric presence in the project area and appear to have been recovered in a secondary context, their primary context disturbed by modern bulldozing activities in the area.

Figure 23: Photograph of Bulldozer-Pushed Berm to the Southwest of Site 4755. View to Southwest.

The project area location, overall, proceeds across a fairly level flood plain adjacent to the perennial 'Īao Valley stream. These factors indicate the suitability of the area for *taro* cultivation. That taro cultivation in the area continued from prehistoric times into the historic period has been documented on maps and in examinations of Land Commission Awards. However, the stream is, at present, considerably lower than the level of the flood plain and no evidence of taro fields or *'auwai* was encountered.

The lack of surface evidence for either *lo'i* or *'auwai* throughout the project area is likely explained by the long history of sugar cane cultivation in the area. While individual taro fields on the southeast side of 'Īao Stream in lower Wailuku Town continued to be tended into the early

1900s, by the latter half of the 19th century, much of the flood plain area on the northwest side of the stream had been taken over by sugar plantations. Evidence of the former cane fields is still immanently present in the form of drip line irrigation hoses that can be seen protruding above the soil surface in all visible areas of the project area not masked by dense vegetation. Large boulder piles, generally resulting from surface leveling, and deep plow zones typically associated with sugar cane field preparation, were not present in the project area however. Many cobbles and boulders were recorded as occurring near the southwest end of cultivated gardens and in the pushed, earthen berm above the stream at the northeast end of the alignment corridor. The entire corridor and former sugar cane fields appear to have been leveled and cleared in the recent past. However, this evidence does not preclude the fact that former cultivation soils (i.e., for *lo`i*) may indeed remain in the flood plain. Archival studies, such as were completed by Cordy (1996), have proven that irrigated taro production was conducted on a large scale within the valley during traditional times. If, in the future, access is granted to several privately-owned flood plain parcels, then analysis of such soils and associated botanical material may be undertaken.

A meeting between the US Army Corps of Engineers, Honolulu District, and the County of Maui Department of Public Works and Waste Management was held on May 9th, 2003 to present to the county `Īao Stream Flood Control alternatives. These alternatives are presented in Appendix D.

THIS PAGE INTENTIONALLY LEFT BLANK

10.0 SIGNIFICANCE ASSESSMENTS

The identified site, 50-50-04-4755, is significant under Criterion D which includes sites that have yielded, or are likely to yield, information important to research on history or prehistory. The site has provided a modest amount of information pertaining to post-Contact agricultural use and limited habitation the `Īao Valley project area parcel.

While proven primarily through archival work that the `Īao Valley landscape was subject to intensive taro production during traditional and early historic times, there is the possibility that signatures for such activities remain on the flood plain. The fact that sugar cane cultivation destroyed these signatures can only be proven through subsurface testing. As such, if future testing does lead to the identification of significant subsurface deposits associated with the famous agricultural fields of the `Īao Valley, significance assessments for the valley must be amended.

THIS PAGE INTENTIONALLY LEFT BLANK

11.0 RECOMMENDATIONS

Although the one site was initially assessed as significant under Criterion D, this based upon archaeological work conducted at the site, sufficient information has now been obtained from recording and excavations at the site so the latter may be considered no longer significant. No further work is considered necessary or is recommended for the site. If, in the future, permission is granted by private landowners to excavate portions of the flood plain, such permission should be readily accepted to assess the presence/absence of archaeological signatures within such domains. There is a very good chance that agricultural soils and/or botanical materials such as pollen or phytoliths could have survived intensive sugar cane cultivation. If so, an empirical record supporting presently suggested settlement patterns may be tenable.

THIS PAGE INTENTIONALLY LEFT BLANK

12.0 REFERENCES

Athens. J.S.

1997 Hawaiian Native Lowland Vegetation in Prehistory. In *Historical Ecology in the Pacific Islands: Prehistoric Environment and Landscape Change*, ed. By P.V. Kirch and T.L. Hunt. Yale University Press, New Haven.

Athens, E.S., and J. Ward

1993 Environmental Change and Prehistoric Polynesian Settlement in Hawai`i. *Asian Perspectives* 32:205-223.

Bordner, R.

1983 *Archaeological Reconnaissance and Subsurface Testing: Waiehu Housing Development (TMK: 3-3-01:10 and 92).* Environmental Impact Study Corp. MS. On file State Historic Preservation Division, Honolulu.

Cheever, Rev. H.T.

1851 *Life in the Sandwich Islands: or, The Heart of the Pacific, As it Was and Is.* A.S. Barnes (New York) and H.W. Darby (Cincinnati).

Connolly, R.D. III

1974 *Phase I Archaeological Survey of `Īao Valley Flood-Control-Project Area, Maui.* MS. Report 100374, B.P. Bishop Museum, Honolulu.

Cordy, R.H.

1981 *A Study of Prehistoric Social Change: The Development of Complex Societies in the Hawaiian Islands.* Academic Press, New York.

1996 *Settlement Patterns of Wailuku Ahupua`a from Mahele Records.* Paper Presented at the 9th Annual Conference for the Society of Hawaiian Archaeology in Wailea, Maui.

Dega, M.F.

1998 *Research Design for Archaeological Reconnaissance Survey and Limited Subsurface Testing for the Alternative Channel Alignment, `Īao Stream Flood Control, `Īao Valley, Island of Maui, Hawai`i.* Scientific Consultant Services/Cultural Resource Management Services, Inc., Honolulu, Hawai`i.

Donham, T.

1996 *A Summary of Archaeological Finds in Wailuku Showing Settlement Patterns.* Paper Presented at the 9th Annual Conference for the Society of Hawaiian Archaeology in Wailea, Maui.

Estioko-Griffin A., and M. Yent
1986 *Management and Interpretive Plans for Halekii-Pihana Heiau State Monument* (Draft). Division of State Parks, Department of Land and Natural Resources. Ms. on file State Historic Preservation Division, Honolulu.

Foote, D.E., E.L. Hill, S. Nakamura, and F. Stephens
1972 *Soils Survey of the Islands of Kauai, Oahu, Maui, Molokai, and Lanai, State of Hawaii*. U.S. Department of Agriculture, Soil Conservation Service, Washington, D.C.

Fredericksen, E.M., and D.L. Fredericksen
1996 *Archaeological Data Recovery Report on Site 50-50-04-4127, Lower Main and Mill Streets, Wailuku Ahupua`a, Wailuku District, Maui Island (TMK 3-4-39: por. 81 & 82)*. Ms. on file State Historic Preservation Division, Honolulu.

Giambelluca, T.W., M.A. Nullet, and T.A. Schroeder
1986 *Rainfall Atlas of Hawaii*. Department of Land and Natural Resources, Honolulu.

Kirch, P.V.
1985 *Feathered Gods and Fishhooks: An Introduction to Hawaiian Archaeology and Prehistory*. University of Hawaii Press, Honolulu.

Kirch P.V., and M. Sahlins
1992 *Anahulu: The Anthropology of History in the Kingdom of Hawaii*, Volume 1, Historical Ethnography by Marshall Sahlins. University of Chicago Press, Chicago.

Macdonald, G.A., A.T. Abbott, and F.L. Peterson
1983 *Volcanoes in the Sea: The Geology of Hawaii*. University of Hawaii Press, Honolulu.

Pearson, R.J., P.V. Kirch, and M. Pietrusewsky
1971 An Early Prehistoric Site at Bellows Beach, Waimanalo, Oahu, Hawaiian Islands. *Archaeology and Physical Anthropology in Oceania* VI(3):204-234.

Price, S.
1983 Climate. In *Atlas of Hawaii* (2nd edition), ed. By R.W. Armstrong. University of Hawaii Press, Honolulu.

Sterling, E.P.
1998 *Sites of Maui*. Bishop Museum Press, Honolulu.

Thrum, T.
1909 *Heiaus and Heiau Sites Throughout the Hawaiian Sites*. Hawaiian Annual, Honolulu.

Wagner, W.L., D.R. Herbst, and S.H. Sohmer
1990 *Manual of the Flowering Plants of Hawai'i*, Volume 1. Bishop Museum Special Publication 83. University of Hawaii Press and Bishop Museum Press, Honolulu.

Walker, W.
1931 *Archaeology of Maui*. Department of Anthropology, Bishop Museum, Honolulu.

Yent, M.
1983 *Halekii-Pihana State Monument Phase I: Archaeological Testing and the Development of Interpretive Themes*. Ms. on file State Historic Preservation Division, Honolulu.

1984 *Additional Archaeological Testing at Halekii-Pihana State Monument, Paukukalo-Waiehu, Wailuku, Maui*. Ms. on file State Historic Preservation Division, Honolulu.

1995 *Archaeological Restoration Plan: Portion of Pihana Heiau, Halekii-Pihana Heiau State Monument, Paukukalo, Wailuku, Maui (TMK: 3-4-30: 4)*. Ms. on file State Historic Preservation Division, Honolulu.

Waihona 'Aina Corporation
1998 *Māhele Database*. Honolulu, Hawaii.

THIS PAGE INTENTIONALLY LEFT BLANK

APPENDIX A

Site 4755 Artifact Inventory List

Unit #	Feature	Layer Level	Lot #	Art. #	Material	Function	Bag #	Length cm	Width cm	Thickness cm	Weight gm	Lot Count	Comments
TU-1	A	I/1	27		Ceramic	Unknown	2				0.4	1	White glazed ceramic
TU-1	A	I/1	28		Metal	Unknown	2				0.2	4	Ferrous metal fragments
TU-1	A	I/1		3	Bone	Unknown	2				5.8		2 rib and 4 undetermined bone frags. Of med. Or large mammal, all worked
TU-1	A	I/1	1		Metal	Miscellaneous	3				7.7	16	15 unidentified metal frags., 1 bent
TU-1	A	I/1	2		Glass	Bottle	3				0.4	1	Brown bottle glass
TU-1	A	I/1	3		Ceramic	Unknown	3				2.1	1	Brown ceramic with gloss
TU-1	A	I/1	4		Metal	Miscellaneous	6				1.7	7	5 unidentified metal frags., 2 nail
TU-1	A	I/1	5		Ceramic	Unknown	6				0.4	1	Brown, no gloss
TU-1	A	I/2	6		Metal	Unknown	10				0.9	1	Unidentified metal fragment
TU-1	A	I/2	7		Metal	Miscellaneous	11				22.5	7	4 nail frags. (1 bent), 2 bottlecap frags, 1 rifle bullet projectile
TU-1		I/2		4	Bone	Unknown	12				19.6		1 limb, 1 rib and 23 undetermined bone frags. of med./large Vertebrate all worked with undetermined implement
TU-1	A	I/2	8		Metal	Unknown	13				0.7	1	Nail fragment
TU-1	A	I/2	9		Glass	Bottle	13				0.3	1	Clear bottle glass
TU-1	A	I/2	10		Ceramic	Unknown	13				0.1	1	White glossy ceramic
TU-1	A	I/2	11		Metal	Miscellaneous	15				0.8	2	1 unidentified metal frag., 1 nail frag. (bent)
TU-1	A	I/2	12		Glass	Bottle	15				0.2	1	Clear bottle glass
TU-1	A	I/2	13		Plastic	Button	18				1.1	1	Cream colored, 4 holes
TU-2	C	Surface		1	Basalt	Abrader	19	5.24	5.16	1.68	69.7		Basalt frag, square planview; 2 altered edges form corner; 1 worked
TU-3	C	I/1	14		Metal	Unknown	20				50.1	107	106 unidentified metal fragments, 1 nail frag.
TU-3	C	I/2	15		Metal	Miscellaneous	21				177.9	184	175 unidentified metal frags., 7 nail frags., 2 small, j-shaped objects
TU-3	C	I/2	16		Glass	Candlestick(?) & Bottle	22				15.2	8	7 clear pcs., 2 brown (1 with writing: LAW... -USE OF)
TU-3	C	I/2		5	Metal	Nail	23				0.4		Fragment of ferrous metal square nail
TU-3	C	I/2		6	Bone	Unknown	23				5.4		1 rib and 5 undetermined fragments of med./large mammal, worked bone
TU-3	C	I/2	29		Metal	Unknown	23				1.1		Ferrous metal fragments
TU-3	C	I/2	17		Ceramic	Tea cup	24				19.7	1	Glossy white ceramic shard with green, red, & gold paint
TU-3	C	I/3	18		Glass	Bottle	25				10.1	9	Clear bottle glass
TU-3	C	I/3	19		Ceramic	Unknown	25				3.8	5	5 white glossy shards, 2 with green

TU-3	C	I/3	20		Glass	Bottle cork	26				14.3	1	Light green, complete
TU-3	C	I/3		7	Bone	Unknown	27				31.5		3 limb and 7 undetermined frags. of med./large mammal, worked bone
TU-3	C	I/3	21		Metal	Miscellaneous	28				33.4	22	2 nails, 3 nail frags., 1 nut, 16 unidentified metal frags.
TU-3	C	I/4	22		Metal	Miscellaneous	29				15.9	8	5 unidentified metal frags., 1 nail, 1 nail frag., 1 bottle cap
TU-3	C	I/4		8	Bone	Unknown	30				11.6		5 undetermined bone fragments of med./large mammal, all worked
TU-3	C	I/4	23		Glass	Bottle	31				14.9	3	Clear bottle glass
TU-3	C	I/4	24		Ceramic	Cup(?)	31				7.0	1	Glossy white ceramic shard
TU-3	C	I/1	25		Metal	Unknown	33				0.5	3	3 unidentified metal frags.
TU-3	C	I/1	26		Metal	Unknown	34				0.5	3	3 unidentified metal frags.
SW Berm		Surface		2	Basalt	EAF	37	4.70	2.93	1.65	34.4		1 use-wear retouched edge, straight, bifacial; used as cutting tool

THIS PAGE INTENTIONALLY LEFT BLANK

APPENDIX B
Site 4755 Faunal Remains Inventory List

SITE	BS-1	BS-1	BS-1	BS-1	BS-1	TOTAL
UNIT	TU-1	TU-1	TU-3	TU-3	TU-3	
FEATURE	A	A	C	C	C	
LAYER/LEVEL	I/1	I/2	I/2	I/3	I/4	
AVES						
Medium or Large Bird	0.5	2.5	0.5			3.5
MAMMALIA						
Medium or Large Mammal	6.6	2.4	5.8	14.0	1.5	30.3
Rattus exulans			0.3			0.3
Sus scrofa	0.7					0.7
Carangid	0.01	0.2				0.21
Tetraodontid	0.3					0.3
Scombrid				0.8		0.8
VERTEBRATE						
Medium or Small Vertebrate	0.5	0.7	4.9			6.1
TOTAL	8.61	5.8	11.5	14.8	1.5	42.21

APPENDIX C
Site 4755 Charcoal Inventory List

Bag #	Site	Feature	Unit	Layer/ Level	Sample	Weight (gms)
7	BS-1	A	TU-1	I/1	Charcoal	6.5
16	BS-1	A	TU-1	I/2	Charcoal	0.1
32	BS-1	C	TU-3	I/1-2-3-4	Charcoal	9.7

Bag #	Site	Feature	Unit	Layer/ Level	Sample	Weight (gms)
7	BS-1	A	TU-1	I/1	Charcoal	6.5
16	BS-1	A	TU-1	I/2	Charcoal	0.1
32	BS-1	C	TU-3	I/1-2-3-4	Charcoal	9.7

US Army Corps
of Engineers
Honolulu District

IAO STREAM FLOOD CONTROL PROJECT

PRESENTATION OF ALTERNATIVES
TO
COUNTY OF MAUI
DEPARTMENT OF PUBLIC WORKS and
WASTE MANAGEMENT

MAY 9, 2003

IAO STREAM FLOOD CONTROL PROJECT
MEETING WITH PROJECT SPONSOR, MAUI DPW & WM
WAILUKU, MAUI
MAY 9, 2003
9:00 - 10:30 AM

AGENDA

1. Introductions .... All

2. Purpose of Meeting .... Warren
   - Presentation of Alternatives and Cost
   - Feedback on Preferred Plan

3. Brief History and Background .... Sharon

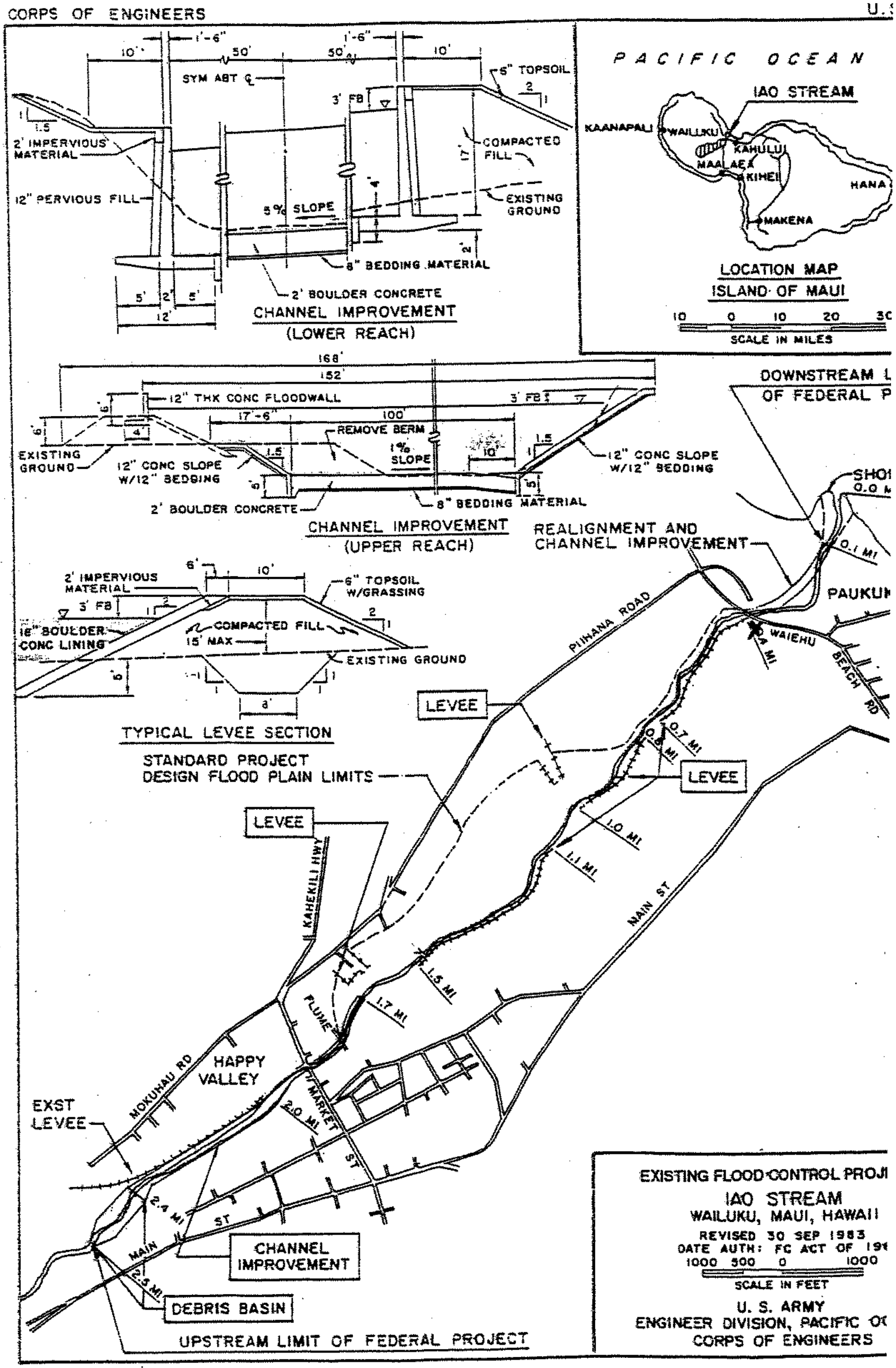
4. Current Status
   - Existing Condition & Flood Plain .... Jim
   - Alternatives Developed (1, 2, 3 & 4) .... Jim
   - Structures .... Jim
     - Baffle Blocks
     - Drop Structure
     - Bridge/ Waterline (1, 2 & 3)
   - Viable Alternatives (1 & 3) .... Jim/Warren
   - Estimated Costs .... Warren
   - Cost Share .... Warren

5. Schedule
   - Scoping .... Environet
   - DDR (Selected Plan) .... Warren/Jim
   - EA .... Warren/Environet

6. Sponsor Input/ Recommendations .... Joe/ DPW
   - Drop Structure
   - Bridge Replacement
   - Preferred Plan

7. Close .... Target 10:30 AM

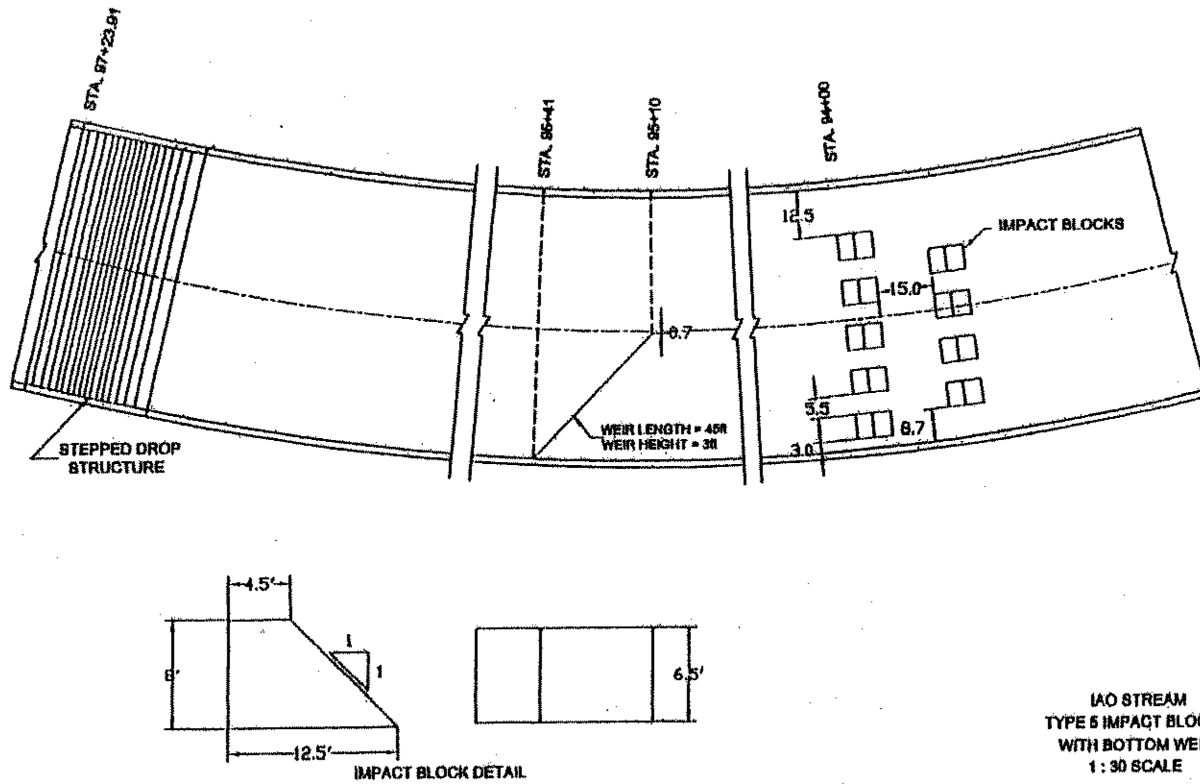
EXISTING FLOOD CONTROL PROJECT



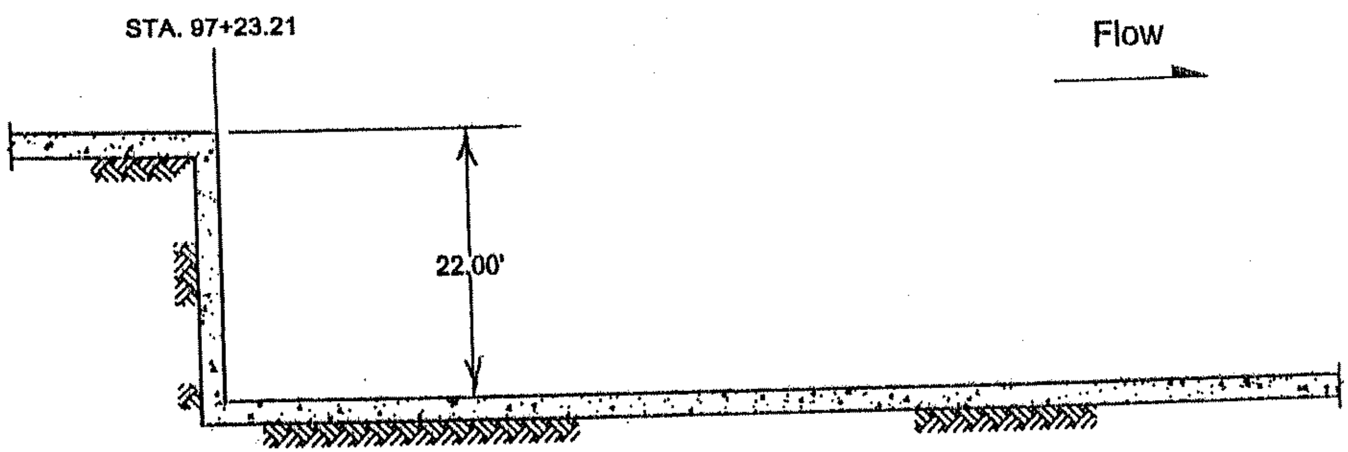
HYDRAULIC STRUCTURES

BAFFLE BLOCKS (STATION 94+00)
This structure consists of nine concrete blocks that would be constructed at the downstream end of the existing rectangular concrete channel. These baffle blocks are required to slow down the high velocity flows before they enter the middle reach of the project with the levee system. These blocks are required for each of the alternatives. The estimated construction cost of the blocks is $30,000.

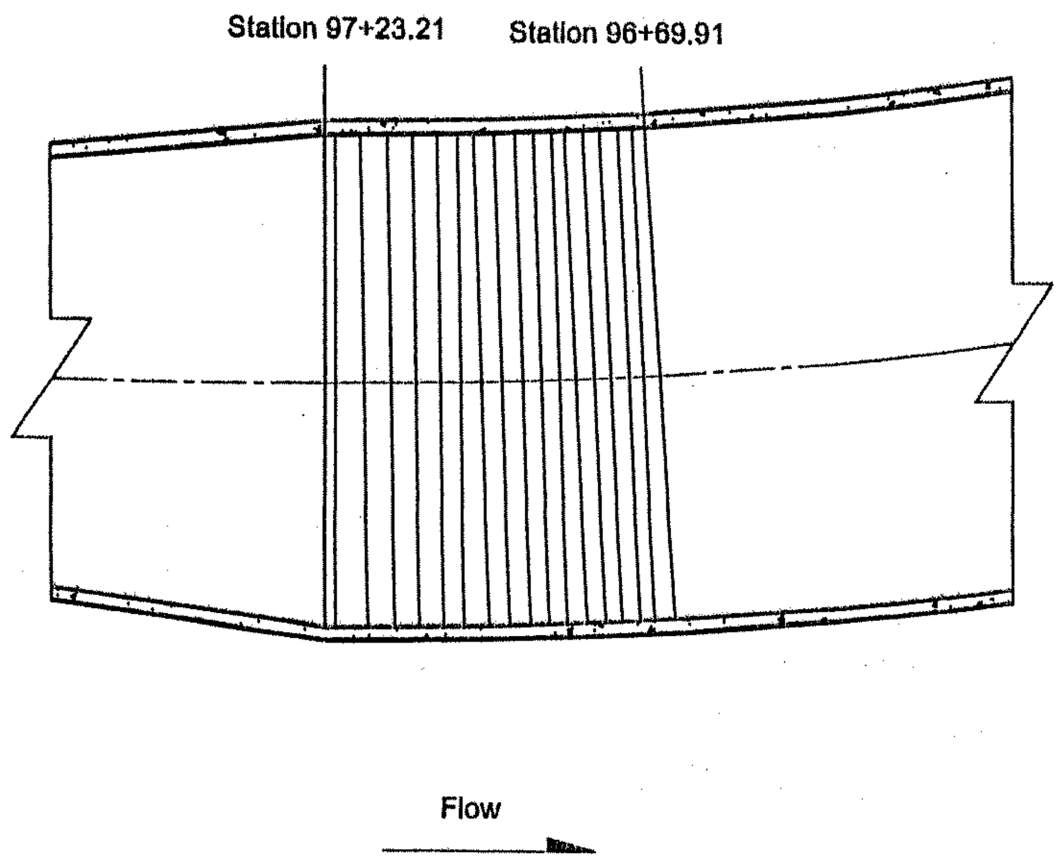
DROP STRUCTURE (STATION 97+23)
This structure would eliminate the 22-ft vertical drop that exists at the end of the rectangular channel. This structure is not required for hydraulic reasons, but may be desirable for safety or fish passage reasons. The decision on this structure will likely be driven by the sponsor's desires and the public interest review comments. The estimated construction cost of the drop structure is $154,000.



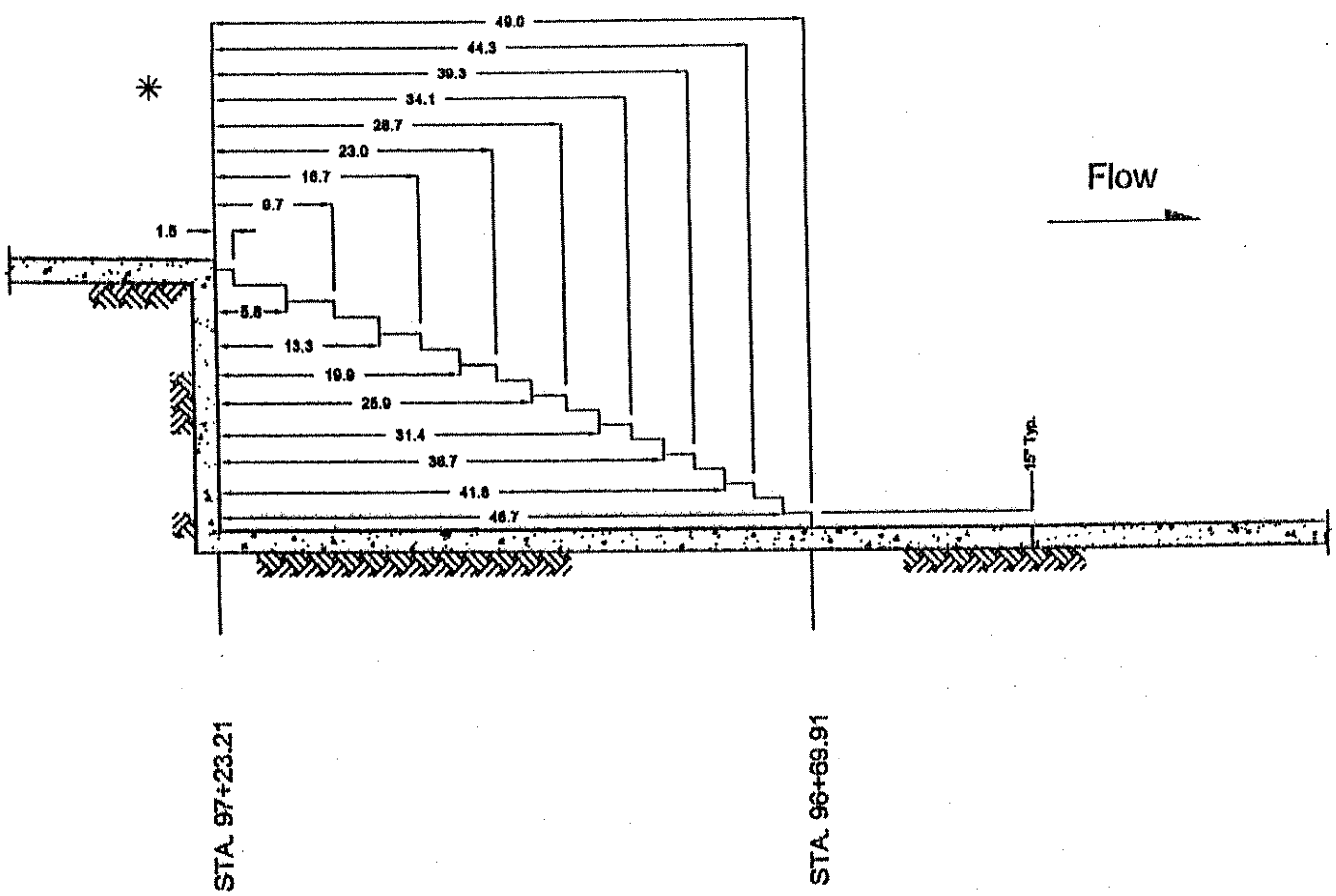
IAO STREAM
TYPE 5 IMPACT BLOCKS
WITH BOTTOM WEIR
1 : 30 SCALE



Iao Stream
Vertical Drop
Section View



Iao Stream
Stepped Drop Structure
Plan View



Iao Stream
Revised Step Drop Structure
Section View

* Dimensions are in prototype feet

ALTERNATIVE 1

Trapezoidal Concrete Channel Following Existing Alignment

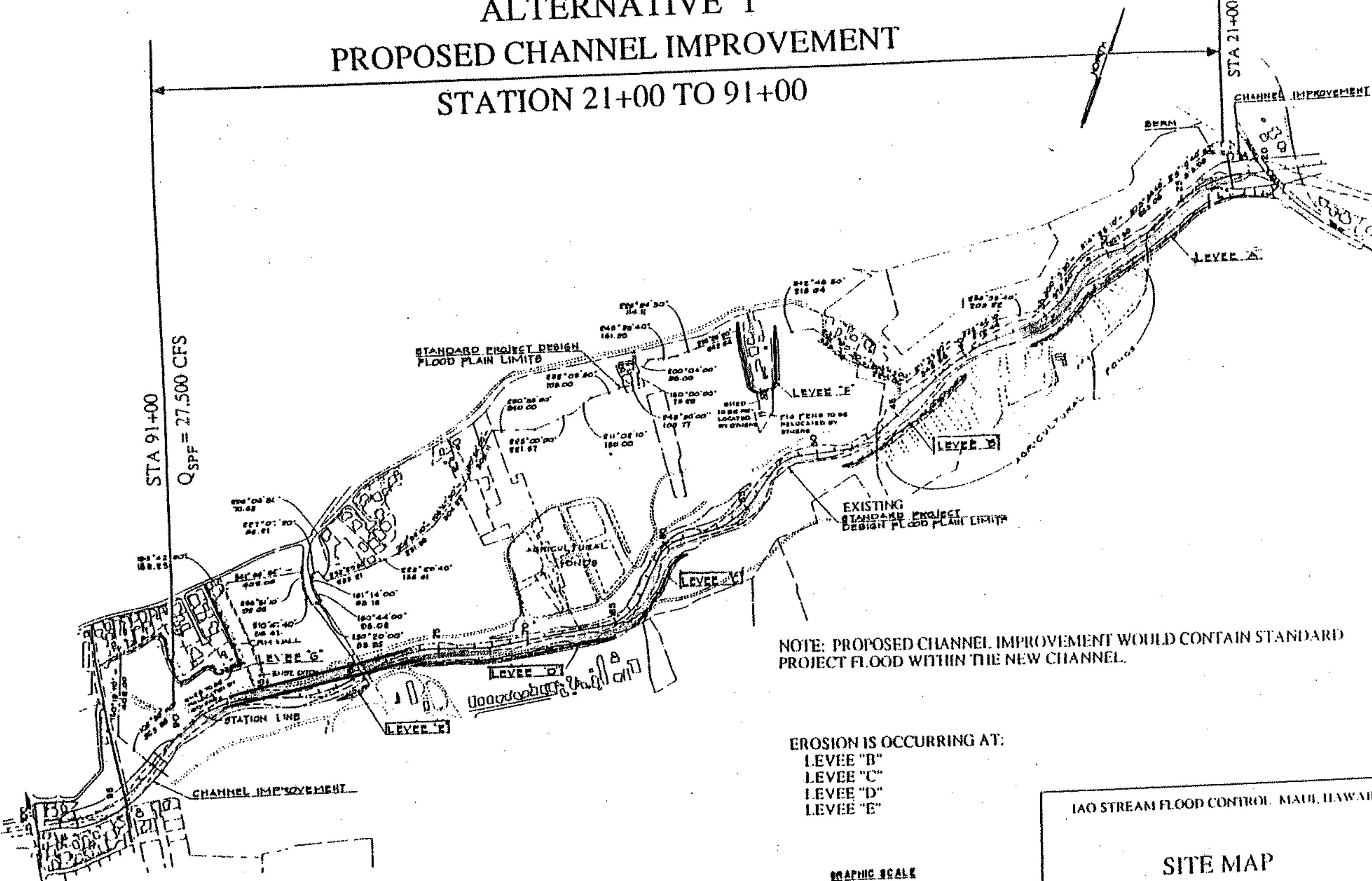
Description. This alternative consists of a trapezoidal, concrete-lined channel with a 40-foot bottom width. The channel would mostly follow the existing stream alignment from station 21+00 to station 91+00 for a distance of about 7,000 feet. From station 76+40 to 86+60, however, the channel would be realigned to the north to avoid affecting structures that have been constructed on the right bank. The channel will have a top width of the approximately 90 feet and will include interior splitter walls at all channel curves. All design flows would be contained within the channel, eliminating the floodplain on the left bank of the project. All the levees could possibly be de-authorized through separate action. Estimated construction cost is $21.1 million.

Advantages. This alternative would meet the project purpose and is viable from an engineering and cost perspective. This channel would also be easier to maintain than Alternatives 3 or 4.

Disadvantages. The resource agencies may object to the conversion of a natural stream bottom to a concrete invert.

- This alternative will be considered for more detailed evaluation in the Design Documentation Report.

ALTERNATIVE 1
PROPOSED CHANNEL IMPROVEMENT
STATION 21+00 TO 91+00



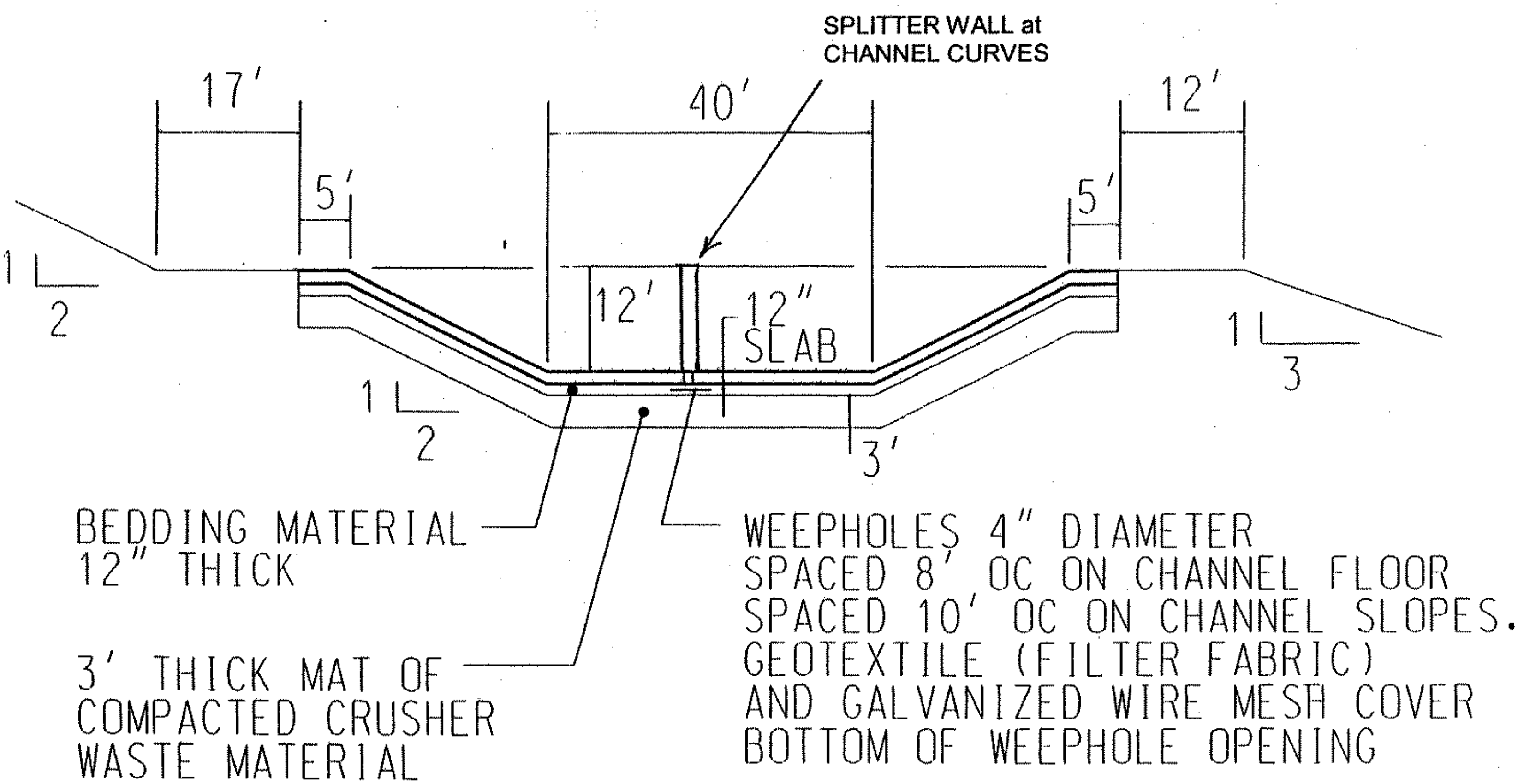
NOTE: PROPOSED CHANNEL IMPROVEMENT WOULD CONTAIN STANDARD PROJECT FLOOD WITHIN THE NEW CHANNEL.

EROSION IS OCCURRING AT:
- LEVEE "B"
- LEVEE "C"
- LEVEE "D"
- LEVEE "E"

IAO STREAM FLOOD CONTROL MAUI, HAWAII

SITE MAP

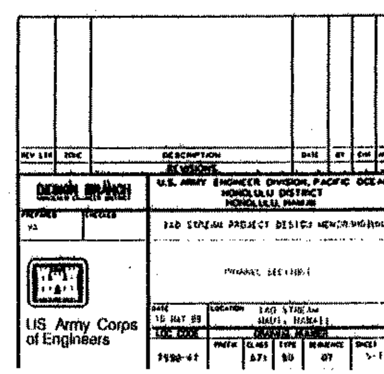
US ARMY ENGINEER DISTRICT HONOLULU



TYPICAL CHANNEL SECTION - ALTERNATIVE 1

16 12 8 4 0 16 32FT

SCALE: 1/16" = 1'-0"



ALTERNATIVE 2

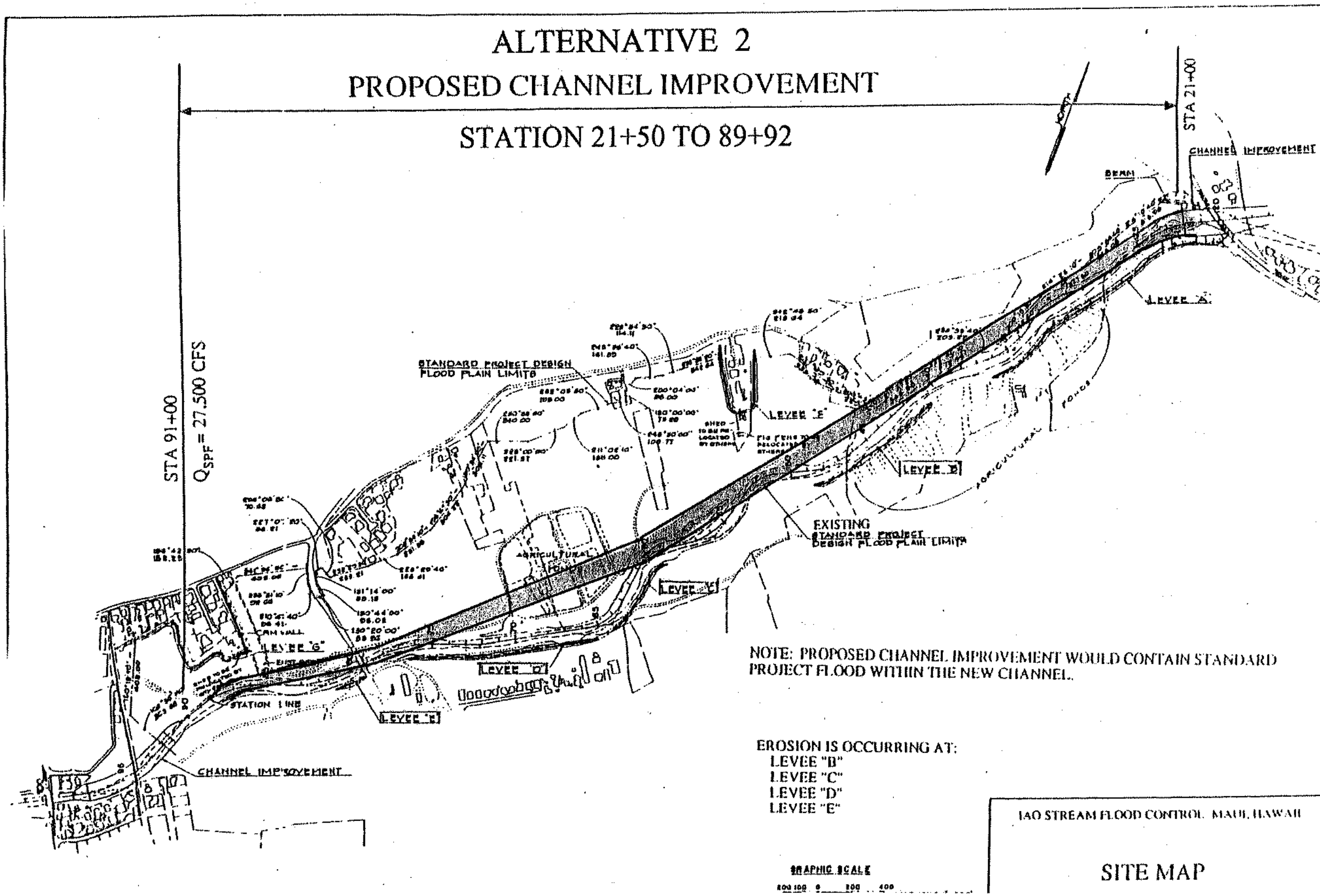
Rectangular and Compound Channel Along Straight Alignment

Description. This alternative consists of a rectangular and compound, concrete-lined channel with a 20-foot bottom width from station 21+50 to station 89+92. It would include a straightened alignment and a shallower 55-foot wide grass-lined channel adjacent to it to handle larger storms. Total top width of this channel is approximately 145 feet. Design flows would be contained within this channel, eliminating the flood plain on the left bank of the project. All the levees could possibly be de-authorized through separate action. This alternative has an estimated construction cost of $29.5 million.

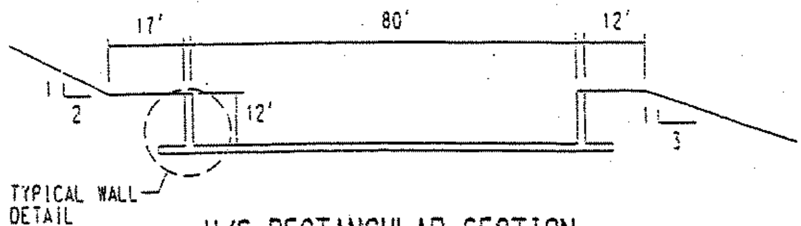
Advantages. This alternative would meet the project purpose and would be the easiest to maintain.

Disadvantages. This alternative would cost the most and would likely elicit strenuous objections from the resource agencies.

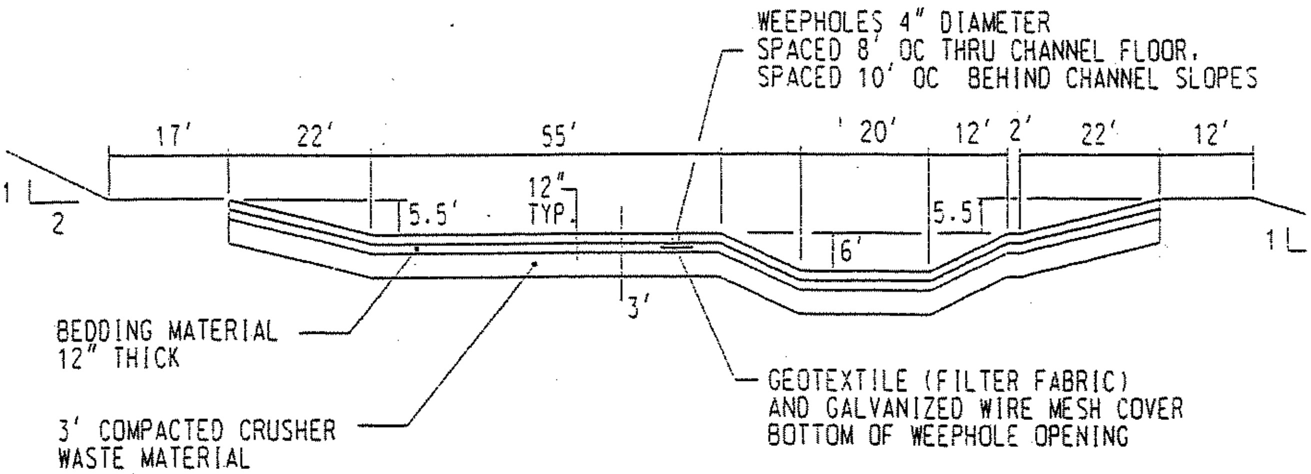
- This alternative will not be carried forward for detailed evaluation.


ALTERNATIVE 2
PROPOSED CHANNEL IMPROVEMENT
STATION 21+50 TO 89+92
STA 91+00
Q_{SPF} = 27,500 CFS
STA 21+00
CHANNEL IMPROVEMENT
BERM
LEVEE "A"
LEVEE "B"
LEVEE "C"
LEVEE "D"
LEVEE "E"
LEVEE "G"
STANDARD PROJECT DESIGN
FLOOD PLAIN LIMITS
EXISTING
STANDARD PROJECT
DESIGN FLOOD PLAIN LIMITS
AGRICULTURAL
STATION LINE
CHANNEL IMPROVEMENT
NOTE: PROPOSED CHANNEL IMPROVEMENT WOULD CONTAIN STANDARD
PROJECT FLOOD WITHIN THE NEW CHANNEL.
EROSION IS OCCURRING AT:
LEVEE "B"
LEVEE "C"
LEVEE "D"
LEVEE "E"
GRAPHIC SCALE
IAO STREAM FLOOD CONTROL MAUI, HAWAII
SITE MAP

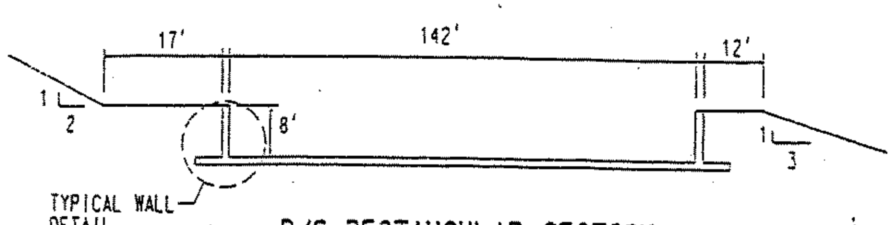
ALTERNATIVE 2



U/S RECTANGULAR SECTION

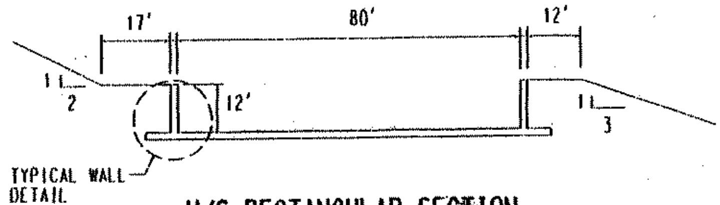


NEW TRAPEZOIDAL SECTION



D/S RECTANGULAR SECTION

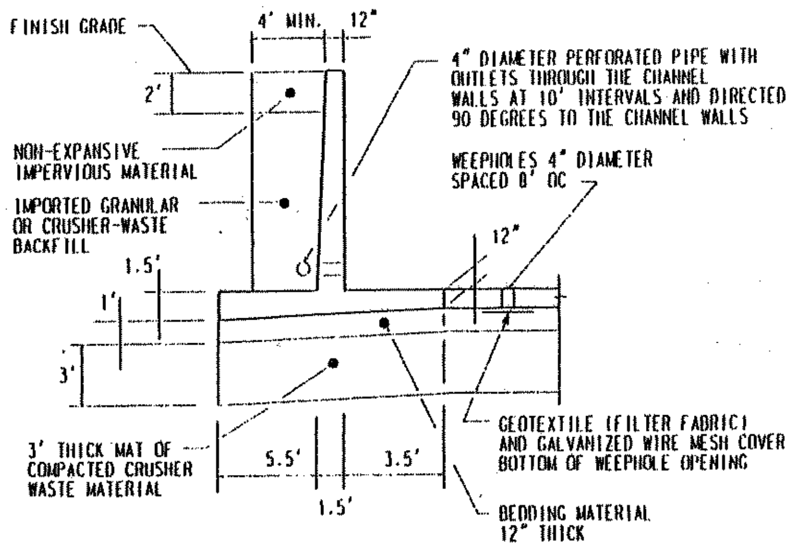
Channel Cross-Section	Reach
U/S Rectangular Channel	72+18 - 89+92
Transition to Compound Chan	60+37 - 72+18
Compound Channel	37+62 - 60+37
Transition to Rectangular Chan	28+45 - 37+62
D/S Rectangular Channel	21+50 - 28+45
Total Channel Length	6,842 feet



U/S RECTANGULAR SECTION

ALTERNATIVE 2

16 12 8 4 0 16 32FT
SCALE:1/16"=1'-0"



TYPICAL WALL DETAIL

4 3 2 1 0 4 8FT
SCALE:1/4"=1'-0"

REVISIONS

U.S. ARMY ENGINEER DIVISION, PACIFIC OCEAN
HONOLULU DISTRICT
HONOLULU, HAWAII

US Army Corps of Engineers

ALTERNATIVE 3

Grouted Boulder Invert Channel Following Existing Alignment

Description. This alternative would mostly follow the alignment of the existing stream from station 21+00 to station 91+00 and would contain up to the 10-year flood event within the structural improvements. From station 76+40 to 86+60, however, the channel would be realigned to the north to avoid affecting structures that have been constructed on the right bank. The plan would use the existing levees as part of the project and would retain the floodplain on the left bank. The median base width range would be 20- to 50 feet. For the proposed condition, the typical stream stabilization improvements would consist of large stones in the main channel low flow section with roller compacted concrete stream bank protection on a 1.5:1 (H;V) to 5:1 bank slope. Channel lining, retaining walls, and raising the levee walls would be necessary due to the excessive flow velocities and higher flood levels. This channel design is considered the "environmental alternative" and would have an estimated construction cost of $19.0 million.

Advantages. This alternative would meet the project purpose and is viable from an engineering and cost perspective. This alternative might be more acceptable than a concrete channel to the resource agencies;

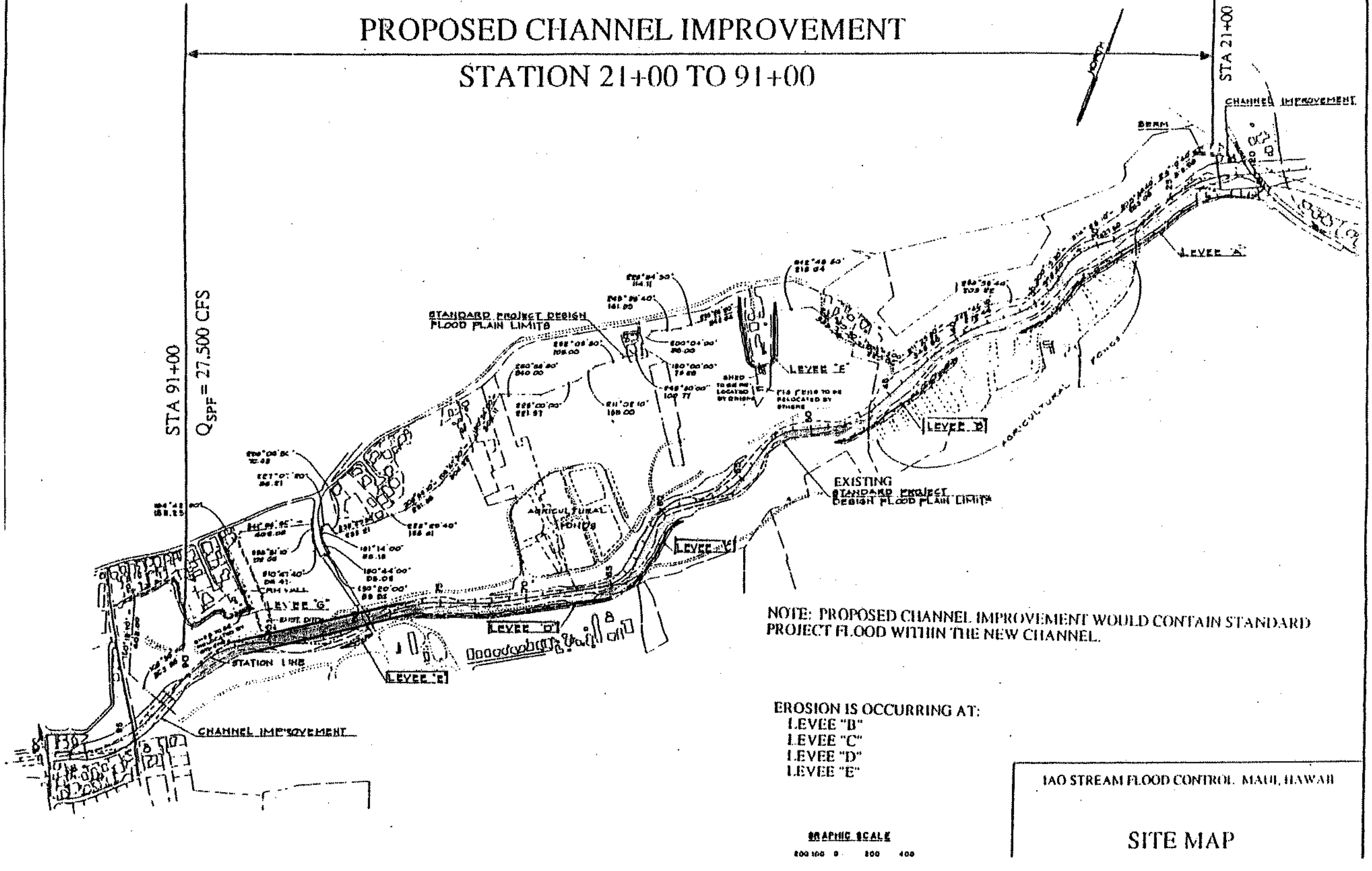
Disadvantages. This alternative would be more difficult to maintain than one with a concrete invert.

- This alternative will be considered for more detailed evaluation in the Design Documentation Report.

ALTERNATIVE 3

PROPOSED CHANNEL IMPROVEMENT

STATION 21+00 TO 91+00



ALTERNATIVE 3

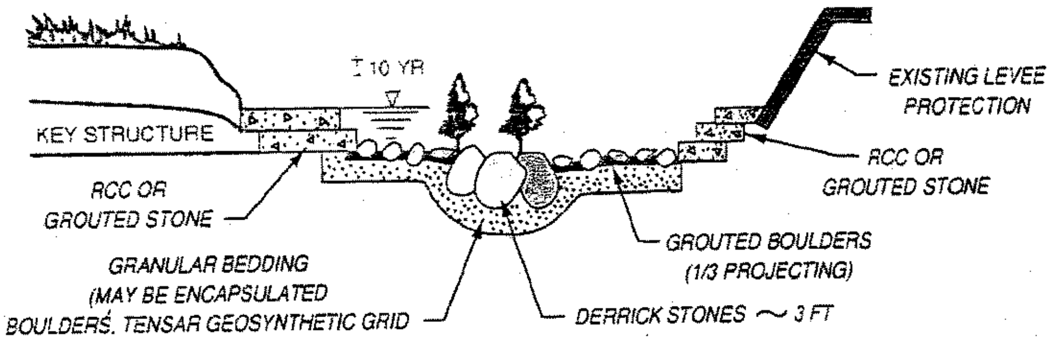


Figure 1 Cross section of armored channel adjacent to existing levee

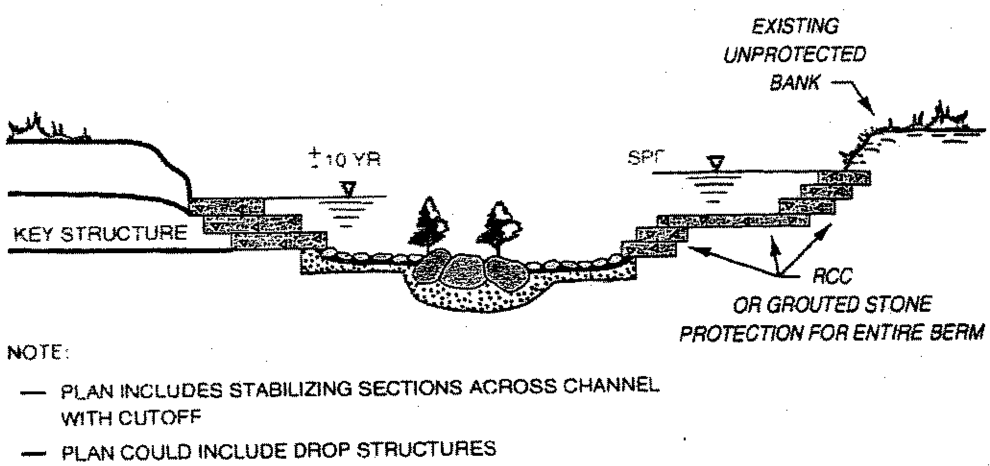


Figure 2 Cross section of armored channel adjacent to unprotected bank

ALTERNATIVE 4

Levee Toe Repairs

Description. This alternative (originally designed in April 1992) consists of widening the basal stream area, flattening the slope of the left bank, and reconstructing the levee toe with concrete riprap filling the void under the levee toe. A CRM cutoff wall would be constructed fronting the existing levees. This plan would retain the floodplain on the left bank. The estimated project cost in October 1991 price levels is $6.6 million.

Advantages. This alternative has the lowest estimated construction cost.

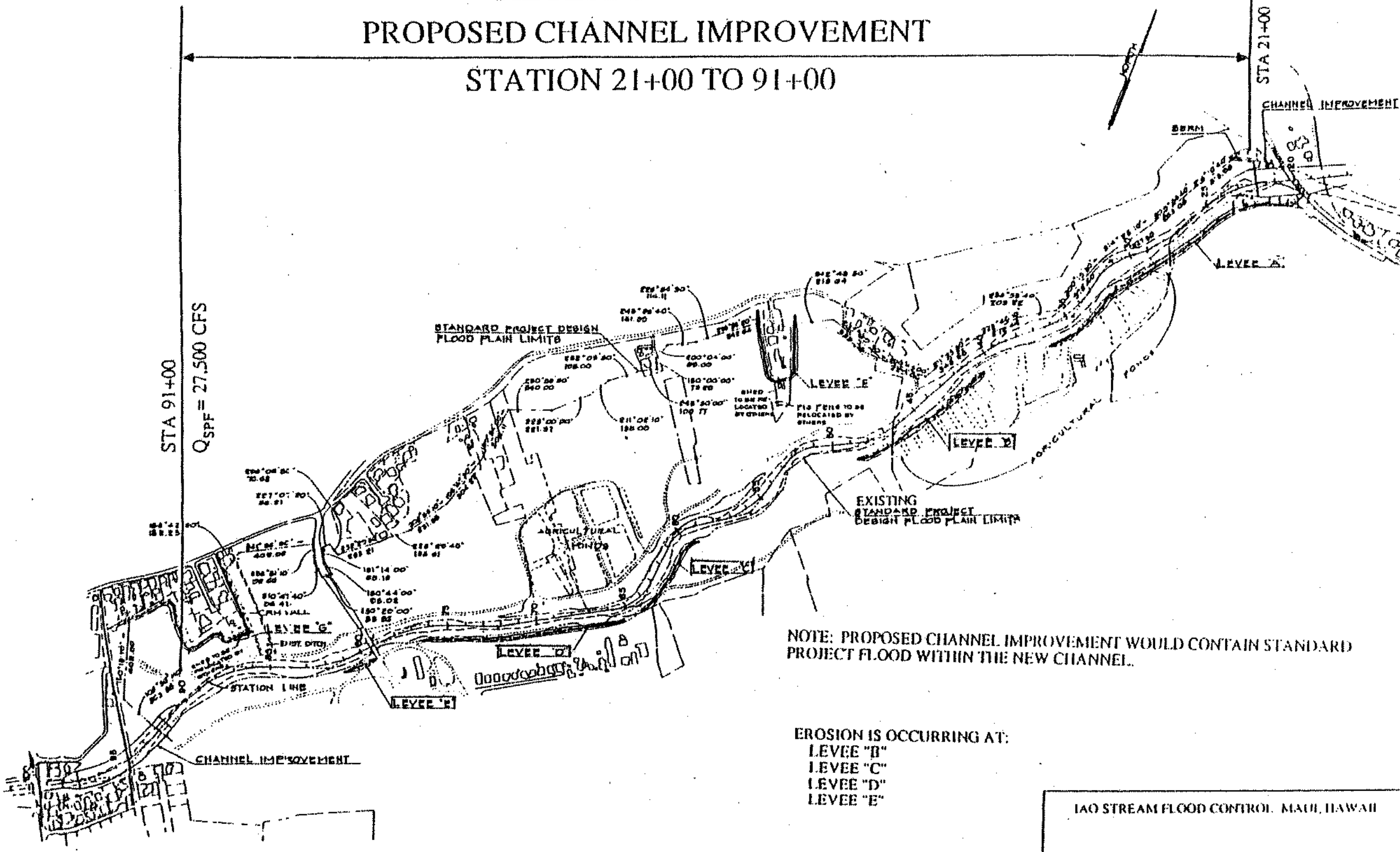
Disadvantages. This alternative would not meet the project purpose because erosion of the levees'foundations would continue to occur and the risk of any levee failing would remain. This alternative requires the highest maintenance cost that would be necessary for the life of the project.

- This alternative will not be carried forward into detailed evaluation.

ALTERNATIVE 4

PROPOSED CHANNEL IMPROVEMENT

STATION 21+00 TO 91+00



NOTE: PROPOSED CHANNEL IMPROVEMENT WOULD CONTAIN STANDARD PROJECT FLOOD WITHIN THE NEW CHANNEL.

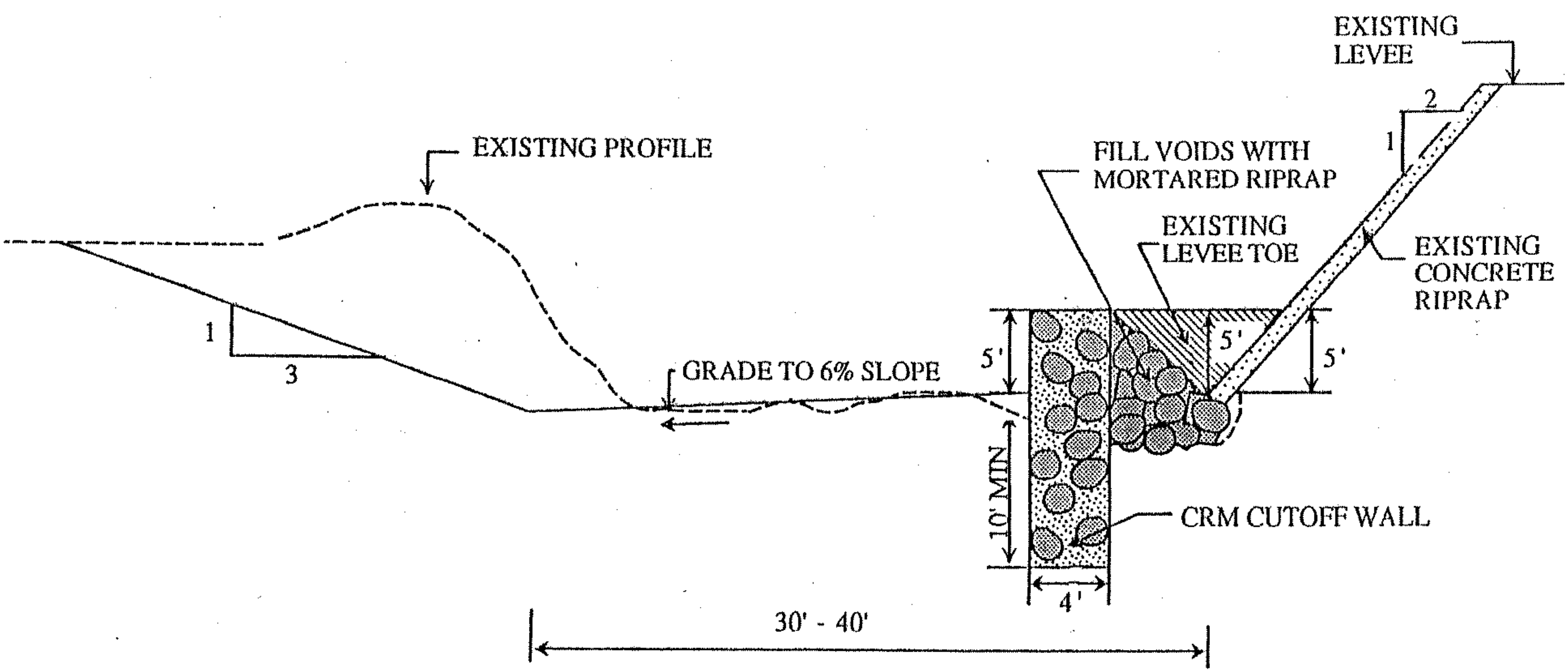
EROSION IS OCCURRING AT:
- LEVEE "B"
- LEVEE "C"
- LEVEE "D"
- LEVEE "E"

IAO STREAM FLOOD CONTROL MAUI, HAWAII

SITE MAP

US ARMY ENGINEER DISTRICT HONOLULU

ALTERNATIVE 4



SCALE 1" = 10'

IAO STREAM FLOOD CONTROL PROJECT
MAUI, HAWAII

TYPICAL MODIFIED SECTION

SUMMARY COMPARISON OF ALTERNATIVES IN MEETING PLANNING OBJECTIVES

		Alternative 1	Alternative 2	Alternative 3	Alternative 4
1	**Level of Flood Protection**	SPF Protection	SPF Protection	SPF Protection	SPF Protection, but risk of structural failure
2	**Utilization of Flood Plain**	Flood plain may be utilized for other purposes	Flood plain may be utilized for other purposes.	Left bank remains a restricted flood plain	Left bank remains a restricted flood plain
3	**Visual Aesthetics**	Concrete channel replaces natural stream	Concrete channel replaces natural stream	Most similar in appearance and function as natural stream	Retains natural stream bottom
4	**Ease of Maintenance**	Easiest to maintain	Somewhat easy to maintain	Difficult to maintain	Difficult to maintain, and require continual repairs of levees
5	**Environmental Acceptability**	May not be acceptable	Not likely to be accepted	Most favorable	May be acceptable
6	**Technical Adequacy**	Meets project purpose	Meets project purpose	Meets project purpose	Does not meet project purpose; risk of failure remains
7	**Cost**	2nd highest cost	Most expensive	3rd highest cost	Least expensive

Appendix C:

Cultural Impact Assessment

Draft Report

Oral History Studies for the Determination of Traditional Cultural Properties and Cultural Impact Assessment for the `Iao Flood Control Project, Maui Island, Hawaii

Contract No. DACA83-02-D-0005
Task Order 0004

Prepared for
E&C, Environmental Tech Branch
United States Army Engineer District, Honolulu, Bldg. 230
Fort Shafter, Hawaii 96858-5440

Prepared by

Social Research Pacific, Inc.
667 Old Mokapu Road
Kailua, HI 96734

December 5, 2003

TABLE OF CONTENTS

List of Figures and Tables

1.0 Introduction

At the request of the U.S. Army Corps of Engineers, Honolulu Engineer District, under Contract No. DACA83-02-D-0005 (Task Order 0004), Social Research Pacific, Inc., completed "Oral History Studies for the Determination of Traditional Cultural Properties and Cultural Impact Assessment for the ʻĪ`ao Flood Control Project, Maui Island, Hawaii." The study was done between August 12 and November 15, 2003. This draft report presents the findings of this study.

The U.S. Army Corps of Engineers is conducting a Feasibility Study and Environmental Assessment (EA) for flood control measures in the ʻĪ`ao Stream Drainage on the southern end of Maui Island. The determination of Traditional Cultural Properties (TCPs) and Cultural Impact Assessment (CIA) partially fulfill the requirements for an EA as specified by Section 106 of the National Historic Preservation Act (NHPA) of 1966, as amended, and Chapter 343 of the State Constitution of Hawai`i (HRS and Act 50).

The major tasks involved in completion of this TCP/CIA included: 1) preparation of a Work Plan (WP); 2) archival and record searches; 3) field study (collection of oral histories from native Hawaiians knowledgeable about traditional uses of the area, survey of area residents to identify potential cultural impacts, and attendance at scoping and public meetings); 4) description and assessment of Traditional Cultural Properties (TCPs) identified during field studies; and 5) preparation of this report.

1.1 Goal and Purpose of Study

The goal of this project was twofold: 1) to identify potential TCPs through archival searches and oral histories; and 2) to complete a CIA that addresses the potential impacts of the proposed project. The completed TCP/CIA study also meets both federal and State of Hawaii NEPA requirements for the ʻĪ`ao Flood Control Project in the documentation of an Environmental Assessment.

Archaeological work completed for an earlier phase of this project by Scientific Consultant Services, Inc. (SCS 1999), indicated that potentially significant Native Hawaiian cultural remnants, eligible for the National Register of Historic Places, were likely to be present in the project area. More recent archaeological investigations upstream of the current project area (Haun and Associates 2002), found traditional Hawaiian residential and agricultural sites. Along with known historical uses and archaeological sites in the vicinity of the project area, portions of the flood plains within the streambed are presently used as for small-scale agricultural and subsistence purposes. There also remain a handful of land owners on parcels originally given during the Land Commission Awards [LCA); most of these are located north (*mauka*) of the project area. Knowledge about traditional and historic land uses along ‘Ī`ao Stream made it likely that TCPs would be found in the vicinity of the project area.

Land use along ‘Ī`ao Stream is primarily residential. This is particularly true for the upper and lower portions of the stream. Within the immediate vicinity of the project area, particularly along the southern flanks of the stream, there are a large number of commercial interests. Based on observations of current impacts, the residents and businesses along the southern flanks will be most directly impacted by any future flood control measures. This area also forms the primary user group identified by this study. The potential impacts and cultural concerns that area residents (and other user groups) relate directly to the proposed project forms the basis for the cultural impact assessment.

1.2 Project Location

‘Ī`ao Valley lies within Wailuku a*hupua‘a*, in the northeastern portion of Maui Island (Figure 1). The project area includes only that portion of ‘Ī`ao Stream which has not previously been upgraded; it extends approximately 7,200 lineal feet between Market Street and Waiehu Beach Road, in Wailuku town. The remainder of the stream, immediately above and downstream of the project area, is already lined in concrete (previous improvements). Among the options being considered in the present EA, is concrete lining of the portion of the stream that forms the project area.

While the stream proper runs as a fairly narrow channel, the width of the streambed (floor) varies significantly. In the north-central portion of the project area (between Pihana Street and the active stream flow channel) lays a flood plain that is currently used as both pastureland and for growing vegetables (Burgett and Dega 1999:5). Along with a very large banana patch, newly planted cultivars such as taro can also be seen in the flood plain area. Along the upper, westernmost portion of Pihana Street are residential units; a few small businesses can be found along Market Street, on either side of the bridge. A Hawaiian Homes Lands subdivision lies along the eastern, lower portion, of Pihana Street, ending at Waiehu Beach Road.

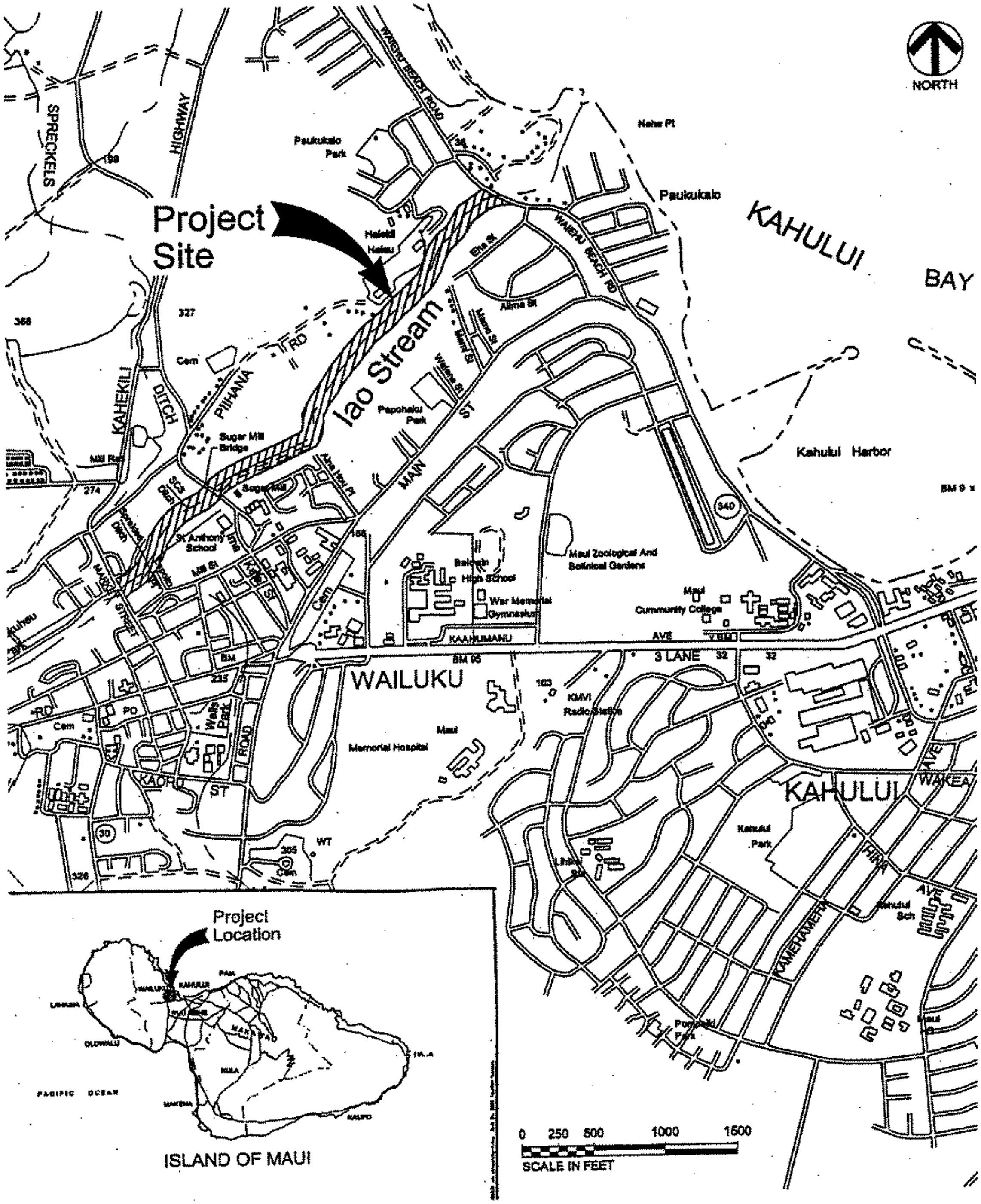


Figure 1. Map of Project Area showing the Iao Stream Hydraulic Design (M&E Pacific, Inc. 2000).

The area along the southern flanks of ʻĪao Stream is a mixture of residences and business/commercial interests. Part of this area makes up the Wailuku Industrial Park and the Millyard (formerly Mill Camp) business complex (Figure 2). Residential units are found nestled

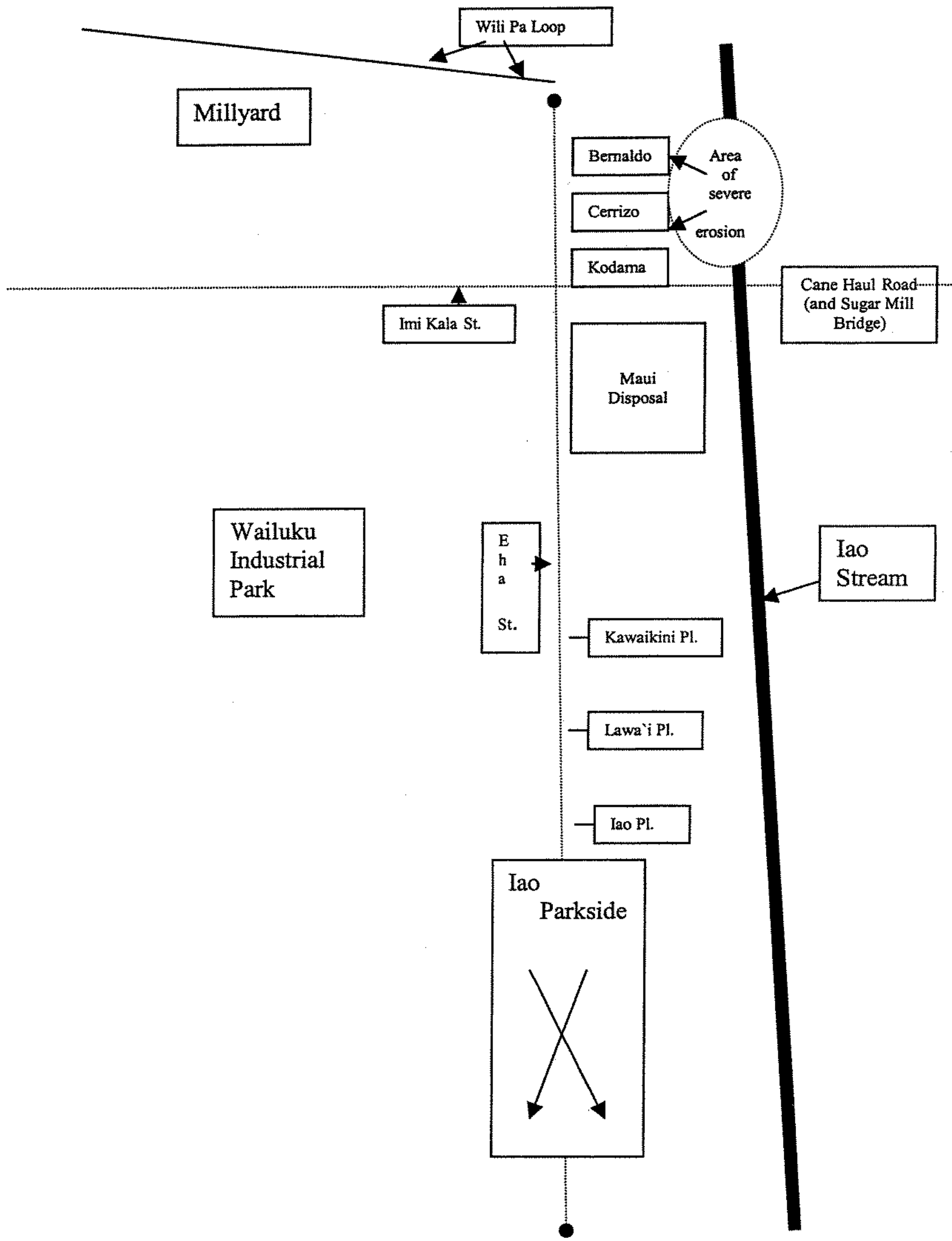


Figure 2. Location of Selected Sites in the Project Area

between commercial buildings and ‘Ῑao Parkside; the latter is an extensive condominium development that borders on the southeastern flanks of the project area.

1.3 Federal Guidelines for Identifying TCPs

Federal guidelines define (identify) what properties constitute a TCP. In the *Guidelines for Evaluating and Documenting Traditional Cultural Properties* (National Register Bulletin No.38) a TCP is defined as:

> "...[a traditional cultural property is generally] one that is eligible for inclusion in the National Register because of its association with cultural practices or beliefs of a living community that (a) are rooted in that community's history, and (b) are important in maintaining the continuing cultural identify of the community" (Parker and King 1995:2).

The process of identifying a Traditional Cultural Property calls for a "systematic study, just as most other kinds of historic properties" (Parker and King 1995:5). The ultimate goal of identifying a TCP is to evaluate its eligibility to the National Register of Historic Places... "its significance (former and present) must be at the very least, mentioned in planning federal, federally assisted, and federally licensed undertakings" (ibid 1995:4). An interview with knowledgeable sources is among the primary method for identifying TCPs. Among the individuals contacted were *kūpuna* (Hawaiian elders) from Maui Island who can identify properties of cultural/historical significance in ‘Ῑao Valley. Along with interviews, information about TCPs was gathered from written and archival (mostly photographic) sources. These data helped identify areas/properties in ‘Ῑao Valley that have cultural/historical significance and satisfy the criteria established for TCPs, and areas/properties of local cultural importance that do not meet the criteria. Both categories are discussed in later sections of this report.

1.4 State of Hawai‘i Guidelines for Cultural Impact Assessments

Articles IX and XII of the State Constitution of Hawai‘i (Chapter 343, HRS), require government agencies to promote and preserve cultural beliefs, practices, and resources of native Hawaiians and other ethnic groups. As such, preparers of environmental impact assessments and statements need to study the impacts of a proposed action on cultural practices and features associated with a project area. The "Guidelines for Assessing Cultural Impacts", (Appendix A) adopted by the Environmental Council of the State of Hawai‘i, on November 19, 1997, identifies the protocol for conducting cultural assessments. The impacts addressed by this study look at the potential cultural impacts of the proposed flood control project on the resident community. The evaluation of potential cultural impact(s) of the flood control project is based primarily on the results of a questionnaire-based survey done among residents and organizations in the Wailuku area. Some of these individuals participated in the EA Scoping Meeting, held in Wailuku on August 12, 2003. The results of this survey are presented in Section 4.0 of this report.

2.0 The Study Approach

Since the purpose of this study was twofold - identification of TCPs and completion of a CIA – the data needed to complete the project involved gathering information from both historical and present sources. Hence, the study approach taken was both ethnohistorical and ethnographic in nature. The categories of data gathered included: 1) historical information from written/archival sources; 2) oral information (on TCPs and traditional land uses) from Hawaiian *küpuna* familiar with the project area; and 3) a questionnaire-based survey of individuals and groups who are current "users" of the project area.

The primary objective of the TCP study was to:

- identify potential areas, features and/or sites of traditional (Native Hawaiian) significance within the vicinity of the project area.

The primary objectives of this CIA was to:

- identify current cultural uses of the 'Ï ao Flood Control Project area;
- identify user groups at that would be affected (culturally impacted) by the proposed project;
- conduct interviews with individuals and groups to identify these potential affects; and
- assess the level of impact(s) from these potential affects on cultural practices in the area.

2.1 Tasks Completed

Data gathered for this study combined available background information on the cultural and historical make-up of the project area, with results of the oral interviews and the questionnaire-based survey. Specifically, the following tasks were completed:

1. gathering of background data (written traditional/cultural and historical data on the project area)
2. designing a survey questionnaire
3. field research
   - identification of primary user/interest groups and stakeholders, particularly residents and businesses that were most likely to be directly impacted by the proposed project
   - administration of survey questionnaire
   - oral interviews (individual and group meetings)
   - general community observations
   - field visits to the project area.
4. quantitative and qualitative analyses of data gathered from field research and general background information
5. development of recommendations based on the findings
6. preparation of this draft report

2.1.1 Background Data

Background data was gathered from the initial stages of the project up to the present. Interviews were completed on the island of Maui between the months of September and November 2003 (see Appendix B for transcripts of the interviews). The survey of residents, households, businesses and other potentially affected 'user groups' for the CIA survey was completed alongside the field site visits and oral interviews. All but two oral interviews were held in person; the remaining two were completed via telephone.

2.1.2 Survey Questionnaire

A one-page survey questionnaire (Appendix C) was developed to gather information for the CIA component of this study. Its primary purpose was to gather responses about the possible cultural impacts any individual and/or business may experience as a result of the proposed flood control project; secondarily, it served as a tool for obtaining information about TCPs in the project area. The questionnaire was administered in person, as well as via telephone (a few individuals were unable to meet in person). Individuals attending the 'Ïao Flood Control Project Scoping Meeting, held in Wailuku on August 12, 2003, were also contacted.

2.1.3 Field Research

One of the initial tasks of this study was to identify (a) *küpuna* and knowledgeable others about TCPs in the area, and (b) individuals and groups likely to be impacted by the proposed project. Most of the contacts for identifying TCPs did not live in the immediate vicinity of the project area, while nearly all of the individuals to whom the questionnaire was administered, lived and/or worked immediately adjacent to the project area. The latter included residents and businesses along 'Ïao Stream. Interviews were held at individual residences, at places of business as well as at other convenient meeting places. In some cases, meetings were completed in group settings. Throughout the field research phase, general observations were made within and around the project area (several individuals were approached after being observed in the immediate vicinity of the project area).

2.1.3.1 Oral Interviews

All individuals who provided oral interviews about TCPs in the project area have consented to the sharing of their information (the CIA did not entail formal interviews). Two of these interviews were recorded on audiocassette (see Appendix B); the remainder was recorded in written form. The identification of Hawaiian *küpuna* for the island of Maui came from previous oral history research on the island, the Office of Hawaiian Affairs (OHA), the State Historic Preservation Office (SHPO) on Maui, and the Maui Historical Society (Appendix D). Additionally, there were residents who have taken an interest in the TCPs of 'Ïao Valley that provided useful information.

3.0 Traditional and Current Land Uses of 'Ïao Flood Control Project Area and Surrounding Vicinities

'Ïao Valley, as with the remainder of Wailuku *ahupua'a* is known to have numerous traditional and historic sites of significance. Many of these are not located within the project area however, they may have had significant association with features in the project area. The next two sections review the significance of Wailuku *ahupua'a* and 'Ïao Valley, first in its historical context, and second in its present day.

3.1 Traditional Hawaiian Uses of ʻĪao Valley and Wailuku *ahupuaʻa*: Written and Oral Accounts

In a recent historical literature review of the traditional land uses of Kahului Harbor, Tomonari-Tuggle and Welch (in Prasad and Tomonari-Tuggle 1999) discuss the importance of the Wailuku area. The project area falls within the traditional *ahupuaʻa* of Wailuku in the district of Wailuku. The district encompasses the eastern flank of the West Maui Mountains and all of the isthmus between east and west Maui, including the coastal stretches of both Kahului Bay on the north and Mäʻalaea Bay on the south. The *ahupuaʻa* of Wailuku covers the coastal area of Kahului Bay, all of ʻĪao Valley, and the north half of the isthmus.

Handy and Handy (1972:272) call Wailuku district *Na Wai ʻEha*, "The Four Waters," after the four major streams and taro-growing areas of windward West Maui: Waikapü, Wailuku, Waiehu, and Waiheʻe. Based on the account of a native Hawaiian of "considerable age," a writer at the turn-of-the-century described the district (Paradise of the Pacific, September 1900, in Silva n.d.,10):

> The district was called Nawaieha (the four streams) and was famous throughout the group, not only for the magnificence of Kahekili's court but for the vastness of its products. The shores of Kahului harbor, from Waihee Point to Haiku, were surrounded with the grass huts of the fishermen and of those connected with the innumerable war canoes of the king. Myriads of cocoanut [sic] trees lined the beach from Kahakuloa to Wailuku, the trunks of many of which are found in the marshes at Wailuku at this day, the trees having been destroyed by a conquering army from Hawaii.

In the late prehistoric period, a time of frequent warfare among the chiefs of Maui, Oʻahu, and Hawaiʻi, Wailuku was a chiefly center and a site of decisive battles. In 1736, the fatally ill Maui chief Kekaulike heard that the Hawaiʻi chief Alapaʻi was planning to invade his island. He and his retinue retreated from Kaupo to Kula and then to Wailuku where the Maui chief died at Halekiʻi Heiau. There, his body was burned and his ashes thrown into ʻĪao Stream (Speakman 1978:13, in Kennedy et al. 1993).

Between 1765 and 1793, Kahekili was chief of the island (as well as Oʻahu, Molokaʻi, and Länaʻi). Late in his rule, war broke out between Kahekili and the chief of Hawaiʻi, who led a force of special warriors in an invasion of Maui. Kahekili awaited the outcome of the battle at his residence in Wailuku. Kamehameha fought one of his first battles with European weapons on the plains of

Wailuku. "The bay from Kahului to Hopukoa was filled with war canoes. For two days there was constant fighting in which many of the most skillful warriors of Maui took part, but Kamehameha brought up the cannon, Lopaka, with men to haul it and the white men, John Young and Isaac Davis, to handle it; and there was great slaughter (Kamakau 1961:148). But Wailuku was also a place where chiefs passed their quiet times. In the 1760s, "the chiefs of Wailuku passed their time in the surf of Kehu and Ka'akau" (Kamakau (1961:83). 'Ī'ī (1959:135) identifies "the surfs of Kaleholeho, Kaakau-pohaku, and Paukukalo" in Wailuku as some of the attractive locations for this sport.

Written and oral traditions associated with 'Ï'ao Valley clearly point out the area's unique significance to Native Hawaiian culture. 'Ï'ao was the name of Maui and Hina's daughter, whose lover was turned into a pillar of salt ('Ï'ao Needle) by Maui. Numerous chiefs are said to be buried at Oloeio, a cave located in 'Ï'ao Valley (Fornander 1996) that served as a royal burial grounds (*kapela*). Some of the biggest battles in Hawaiian history (Battle of'Ï'ao, Battle of Kepaniwai, Kamehameha I's victory in 'Ï'ao) were fought within and around 'Ï'ao Valley. Wailuku *ahupua'a*, which translates to "water [of] destruction" (Pukui et al. 1976:225), and Wailuku District were ceremonial and political centers for Hawaiian chiefs (Kirch 1985). Wailuku was considered a "chiefly center" (Sterling 1998:90), with many of the chiefs and area's population residing near or within portions of 'Ï'ao Valley.

Traditional land use of 'Ï'ao included intense cultivation of taro; many *lo'i* systems line the stream banks of 'Ï'ao Valley. A total of sixty-six LCAs, primarily taro patch *kuleana*, and thirty-nine *po'alima* are located between the old Wailuku Mill site and Paukükalo, on the southern side of 'Ï'ao Stream (Fredericksen 2001:4). Two *'auwai* (prehistoric ditches), were "constructed for the purpose of irrigating *kalo* on the plains which stretch away to the northward and southward of the ['Ï'ao] river" (Sterling 1998:86). Much of the historical literature supports extensive taro cultivation in greater Wailuku Valley. Habitation sites along Lower Main Street in Wailuku "are associated with the rich taro producing lands in the Lower 'Iao River flood plain, and the extensive cultivation systems present in 'Iao Valley" (Burgett and Dega 1999:14). Taro from Wailuku *ahupua'a* also supplied other areas of the island. For instance, areas such as Kahikinui were not suitable for taro cultivation, therefore its people would trade ocean food sources for taro with their distant neighbors in Wailuku. It is highly likely that similar trade arrangements existed with other parts of the island that were unsuitable for cultivating taro.

A maps prepared by Monsarrat in the 1880s offer 'snapshots' of late 19th century history of Wailuku *ahupua`a* and 'Ī`ao Valley. Figure 3 is a portion of Monsarrat's 1888 map that shows 'Ī`ao Stream

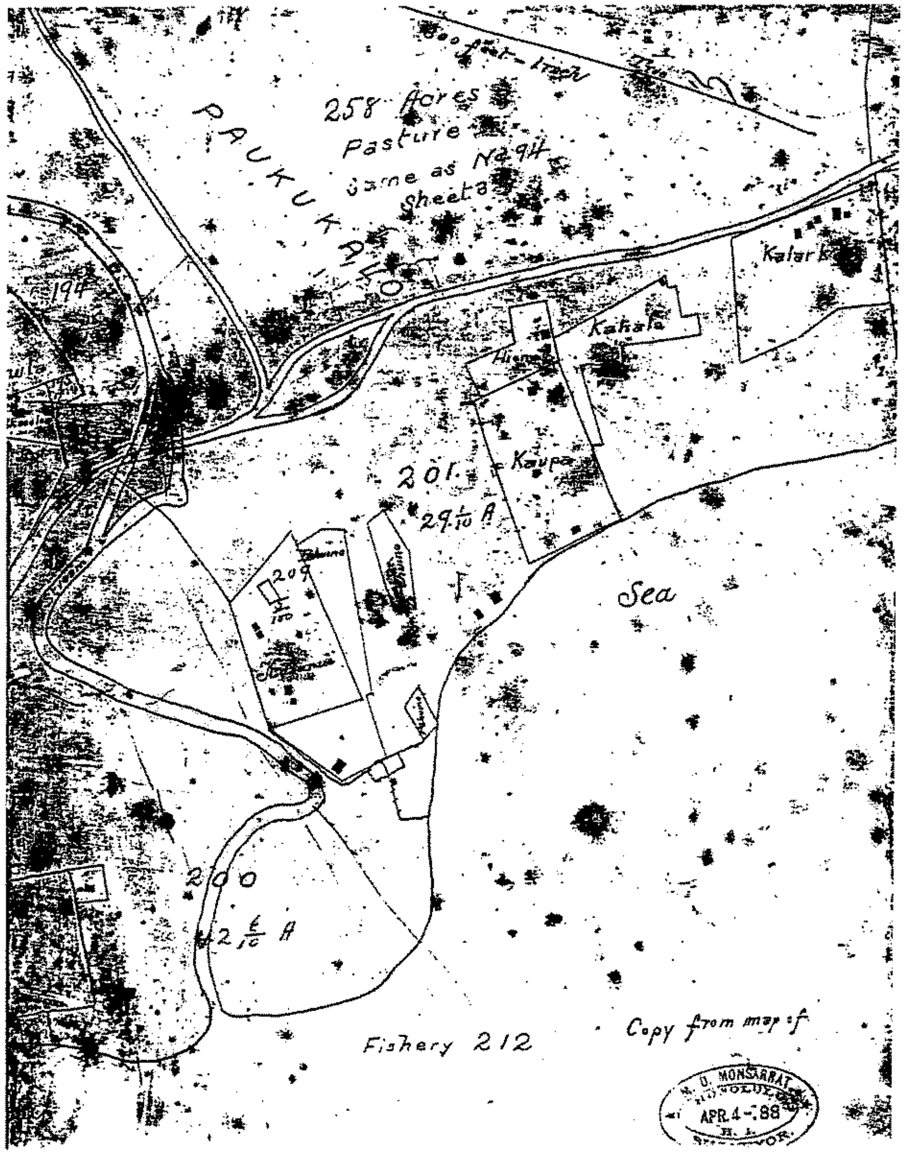


Figure 3. Portion of Monsarrat's 1888 map showing 'Ī`ao Stream and Paukūkalo.

curving around *kuleana* lots in the Paukūkalo area, and emptying into Kahului Bay. An earlier map (1882) shows all the traditional Hawaiian land divisions are shown on this map – district, *kalana, ahupua`a, ili, mo`o (mo`o `āina)* and *paukū (kuleana)*. There are also a large number of subdivisions (areas with names that are no longer known or used) along either side of 'Ī`ao Stream. According to Bob Hobdy (pers. comm.) who has done extensive research relocating sites identified on early historic maps, these were likely to be *mo`o*. Altogether, he identified a total of twenty-six *mo`o* along 'Ī`ao Stream. The *mo`o* are attached to wetland taro cultivation; each one is serviced by its own *`auwai*, and includes several *kuleana* (ibid). In a similar map of Honokohau from the 1930s, Hobdy saw complete descriptions of *kuleana, mo`o* and the *`auwai*. Each *`auwai* coming off Honokohau Stream showed a cluster of *lo`i* and multiple *kuleana* within the *mo`o*.

In addition to *lo`i*, there are two *heiau* in the immediate vicinity of the project area. The Haleki`i-Pihana Heiau State Monument can be easily seen on the northwest flank of 'Ī`ao Stream, along the lower portion of the project area. This is the third largest structure on Maui, after Pi`ilanihale *Heiau* in Hana, and Loaloa *Heiau* in Kaupo (Kolb and Keau 1990:5). Other heiau are known to have existed in the area, however, as noted by Winslow Walker, all but two (Haleki`i and Pihana) of the known *heiau* were still standing during his initial archaeological survey of Wailuku. Keahuku, Olokua, Olopio, Malena, Pohakuokahi, Lelemako, Kawelowelo, Kaulupala, Palamaihiki, and Oloolokalani could not be found (Walker 1931:146-148, in Fredericksen 2001:11-12). Halekii-Pihana *heiau* sits at the edge of lithified sand dunes, which itself is a significant prehistoric burial site that runs semi-parallel to 'Ī`ao Stream and mid-way up Wailuku *ahupua`a*. Early historic burials are also known from Mahalani Cemetery, located between the *Pu`u One Dunes* and the flood plains along the project area portion of 'Ī`ao Stream. According to its President, King Kekaulike's wife is buried at the cemetery along with burials are from the later historic, plantation period (W. Cockett, pers. comm.).

Traditional uses of the land area can also be seen in the travel routes taken by people. At least one prehistoric-historic trail, crossing the saddle to the western side of the island, is known to exist in the back of Wailuku Valley. The trail is believed to have been used by a fighting chief who escaped by taking it to cross the saddle to Olowalu. Na Ala Hele, the group tasked with locating/identifying ancient trails throughout the islands, has found many similar trails in and out of the gulches of Maui. As a member of Na Ala Hele, Bob Hobdy (pers. comm.) says that trails along the gulches are most visible due to the terrain on which they sit; those in flat areas or bottom lands are less known since they were most likely to have been converted into roadways for buggies and cars.

Many of the elders, including long-term area residents, discuss what was likely found in the Wailuku before changes were introduced by the sugar plantations. These are sites and features that no longer exist or have been greatly disturbed. *Küpuna* Charlie Keau knows of many previous traditional sites throughout the Wailuku area, including *heiau*, fishing shrines (*ko`a*), trails, and *lo`i*. Charlie grew up in Paukükalo, which was good for fishing and picking *limu*. He recalls that the old folks really liked Paukükalo and how dramatically the area has changed since construction of the Maui Community

Center. Charlie remembers that old timers used to put their canoes out from "Kalo Grounds," the present day location of Maui Beach Hotel in Kahului. Some of these people also lived underneath the nearby trees. Members of the Duarte family, with multiple generations living in 'Ī'ao Valley, recall some prehistoric and historic features used by Hawaiian families; these, too however, no longer exist. Kaahumanu Church, the oldest church in Wailuku, was deliberately built on the foundation of Kahekili's *heiau*. (Ashdown 1970:34). More recently, Bob Hobdy has seen areas that contained extensive rock walls, delineating small units of land, bulldozed in Waikapu`u. Likewise, the old *`auwai* system was most likely destroyed when irrigation ditches were placed for sugar plantations.

Recent studies within the immediate vicinity of the project area indicate that traditional, prehistoric features and sites are not likely to be found. During the Phase I archaeological survey of the Flood-Control Project Area, Connolly (1974) noted that "no positive structural evidence of a prehistoric occupation was observed…all of these structural remains–considered with the surface-artifact and midden remains, and the known ethno-historical materials appeared to be principally historic (post-European contact) in age" (1974:Abstract). The boundaries of Phase I border on the eastern-most boundary of the current project area.

3.1.1 Land-Use Changes resulting from Changes in Land Ownership

The first commercial activity in the Wailuku area appears to have been cattle ranching. As early as 1845, large herds of cattle were roaming the Kahului Isthmus (Barrere 1975:52). The cattle, under royal *kapu* which kept the herd from being harmed, were very destructive to the environment (ibid). In the 1830s, there was also an attempt to grow cotton. Although the environment was additionally impacted by the attempt, cotton growing also met with little success (Fredericksen 2001:4).

During the mid-19th century Mahele or division of lands, Wailuku was designated as Crown Lands claimed by the Kamehameha III. Numerous Land Commission awards to commoners were given out in the area around Wailuku and 'Iao Valley. In 1878, through his friendship with King Kalākaua, Claus Speckles secured a lease of 40,000 acres of land, among which was a portion of Wailuku *ahupua'a*. In 1882, he acquired fee simple title to all of the *ahupua'a* through Grant 3343 (Kennedy et al. 1992:12). That same year, Speckles built the Waihe`e ditch and founded the Hawaiian Commercial and Sugar Company (HC&S), which quickly became the largest and best-equipped sugar plantation in the islands (Kuykendall 1967:60). Figure 4 shows that by 1937, the majority of Wailuku was designated as "ranch land", being used primarily for sugar.

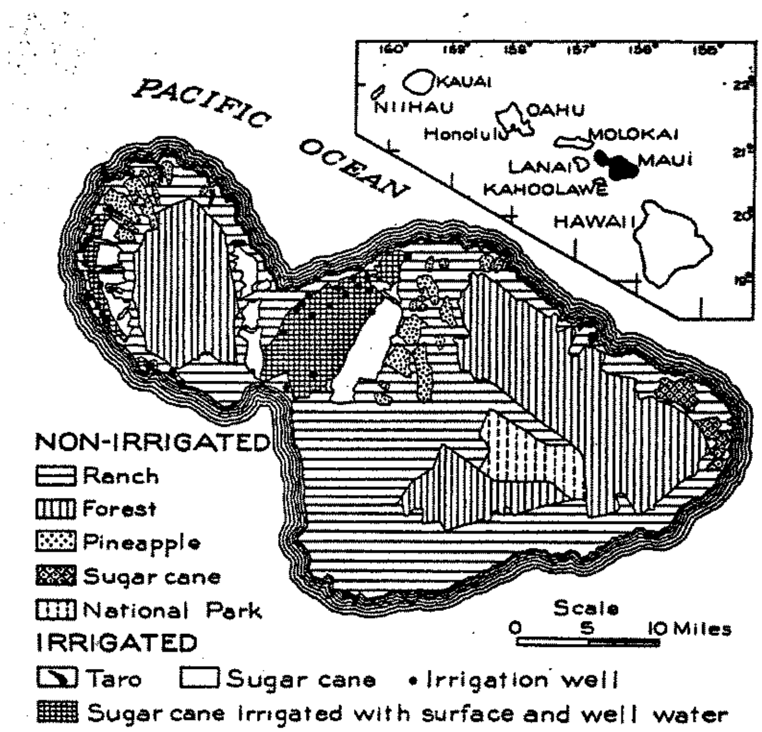


Figure 4. Land Utilization on Maui in 1937 (Source: Territorial Planning Board 1939, in Stearns and MacDonald 1942).

On a smaller-scale, change to land use has also been brought about by the U.S. military's use of the Wailuku area. As with many areas on Maui (e.g. Pu`unene Air Station, Naval Air Station Kahului [NASKA], the U.S. Marine Camp in Hailemaile), military use of the island intensified during World War II. Like the commercial farming ventures before them, the military has brought about fairly permanent changes to land use. Gordon and W. Cockett recall the Army Camp that was set up in Paukükalo, bordering Pihana and near the Haleki`i-Pihana heiau, shortly after World War II. The area is now mostly Hawaiian homesteads. A portion of this earlier camp may also be the present day location of the Hawaii National Guard Camp Site and Rifle Range (c.f. Yent 1995:2-3). An undated photo below (Figure 5) shows another camp set up along Kahului Harbor, before reaching Waiehu and Paukükalo. Kahului Harbor served as the main port of entry for military ships during WWII.

Written and oral histories tell of the traditional significance of Wailuku. Once an area of great traditional significance to Native Hawaiians, Wailuku went on to become a major sugar

Figure 5. Village at Paukükalo c.1946, showing military barracks at upper left, fronting the Pu`u One Dunes (Courtesy of Bailey House Museum).

cultivation/production area, to its present day residential and business use. Sugar plantations dominated the Wailuku landscape, especially along ‘Ī`ao Stream, for much of the very late 19th and early 20th centuries. These changes in land use have significantly compromised the existence of prehistoric, traditional archaeological features. According to Haun and Henry (2002), the density per acre value of archaeological sites and features are relatively low due to the extensive impact of plantation agriculture and urbanization (Hahn and Henry 2002:17). The following section briefly discusses current land use within the immediate vicinity of the project area.

3.2 Current Uses of the Project Area

Current uses of the project area differ dramatically from its traditional uses. The change has come about in several stages. If for instance, the maps prepared by Monsarrat in the late 19th century depict a true picture of land use in that day, than along with the prehistoric uses, the intermediate phase of land use is also long gone. Sugar has left its imprint primarily in the form of water diversions (dikes, ditches), and other structural remnants such as bridges and a few old buildings. But these are becoming less obvious with the rather rapid level of urban development in the Wailuku area. Present day land uses identified during this study fall into three categories:

Residential

Commercial

Recreational

Farming

Residential development along 'Ῑao Stream extends from Kahului Bay to the far western (*mauka*) sections of the valley. The most dense residential settlement is along the lower (*makai*) portions of the stream, in the areas of Waiehu, 'Iao Parkside, Happy Valley, Pihana, Millyard and the Hawaiian Homestead bordering on the Haleki'i-Pihana Heiau. Along the northern corridor of the project area, which extends from Millyard to Waiehu Beach Road (see Fig. 2), there is continuous housing except for within the flood plain bordering Pihana. The southern corridor of the project area consists of both residential and commercial properties. Many of the homes in Pihana date back to the plantation period; there are three known *kuleana* lots. According to Winifred Cockett, a third generation Pihana resident and *kuleana* lot owner, the remaining two lots are between her property and the *heiau*. The remainder of the Pihana area is largely settled by non-Hawaiians whose ancestors may have once worked for the sugar plantation.

Commercial development is restricted largely to the southern corridor of the project area. (There are a few older businesses such as Takamiya Store, in upper Pihana, just outside the northern corridor of the project area). Eha Street (Fig. 2) which runs parallel to the project area, is a mixture of newly built homes (within last three years), the 'Iao Parkside condominium complex, and several businesses at either end of the project area portion of this roadway. Older homes exist on both the *mauka* (above Millyard) and *makai* (below Waiehu Beach Road) ends of the southern corridor of the project area. The types of businesses vary significantly. At the eastern most end of the project area is Sak & Save Supermarket; at the western most end, is Maui Waste Disposal and several legal, accounting and real estate firms. A levee, which also serves as the maintenance road for Maui County vehicles, separates many of the homes from the stream. It is this levee and maintenance road, along with the streambed, that also serves as a recreational area.

Farming is occurring within the flood plain area in Pihana; it is restricted to the northern corridor of the stream. A total of four farms, all on leasehold land, were identified. These are mostly banana and papaya patches owned by farmers of Filipino descent. A newly established horse stable, operated by one of the Hawaiian homeowners, lies adjacent to a *kuleana* lot. Several families have backyard/kitchen gardens but none of these are near the stream area.

Recreational uses of the project area consist primarily of walking/jogging (on the maintenance road), bicycling and dirt bike/small motorcycle use. There are occasional boogie boarders and swimmers in the stream but they are confined to areas where water level gets high enough to be used for these activities. Of the area residents interviewed, only two used the levee maintenance road for leisure walks; the majority of those who appear to use the area regularly for recreational purposes do not live adjacent to the stream. Fishing within the project area portion of ʻĪao Stream does not seem to take place.

This mixture of land use along the project area does not seem to be in conflict with one another in any way. While noise from the dirt bikes and their use of people's backyards has been a problem, most individuals have put up fences and would be pleased to see the area improved for further recreational use.

4.0 Identification of Traditional Cultural Properties and Cultural Impacts

One of the two goals of this project was to identify TCPs and oral traditions associated with ʻĪao Valley that meet the criteria established in the National Register; the second was to complete a CIA of the potential effects of the proposed project. While no TCPs were identified in the project area, oral and written history indicates TCPs within the general vicinity of the project area; they also identify historic properties that hold local cultural significance. The following sections present the findings of this study, first addressing TCPs, and second, the CIA.

4.1 Traditional Cultural Properties in the Project Area: Findings

Although no specific features that can be classified as a TCP were located within the project area, the overall traditional significance of Wailuku is to be noted. There has been substantial change to this cultural landscape, yet remnants of its highly significant past remain. The following discussion on TCPs is presented in a question/answer format to simplify the essential findings of this study.

Were any new Traditional Cultural Properties identified within the Project area?

No, not any that can be identified. This question was asked during each field interview, especially with Hawaiian *kūpuna*. At present, no one can identify any TCPs within the immediate vicinity of the project area.

Are there any existing TCPs within the general vicinity of the project area?

Yes, there are *heiau*, fresh water springs, burials, and *loi*. While some have already been labeled as a TCP, the remaining qualify based on significance criteria. These are as follows:

1. Haleki`i-Pihana Heiau State Monument lies above the northeastern corridor of the project area, in the *ahupua`a* of Paukükalo. *Haleki`i* means the "house of images", and *Pihana* means "fullness", is believed to be the only complex remaining of pre-contact Hawaiian structure of religious and historical importance in the Wailuku-Kahului area (Yent 1995:1). Some area residents refer to Pihana as "Pi`ihanakalani", which means "ascending into heaven" (M.J.K. Kolb and G.M. Murakami 1994:61). The *heiau* (Figure 6), State of Hawaii Site number 50-50-04-592, is under the jurisdiction of the Division of State Parks.

2. A second *heiau* or *ko`a* (fishing shrine) is believed to have been located at Mele-ha`a-ko`a, the Singing Reef. According to Ashdown, whose father had a house, corrals and slaughterhouse near the shrine, it was "along the old road between Wailuku and Kahului by the present Maui Dry Goods building in the area called Kawela" (Ashdown 1970:38). She adds that the shrines and temple were ruined, and "most of the buildings taken out to sea" in the tidal wave of 1946 (ibid). According to D. Sevilla, the remnants of this *heiau* may presently lie on private property near the shoreline.

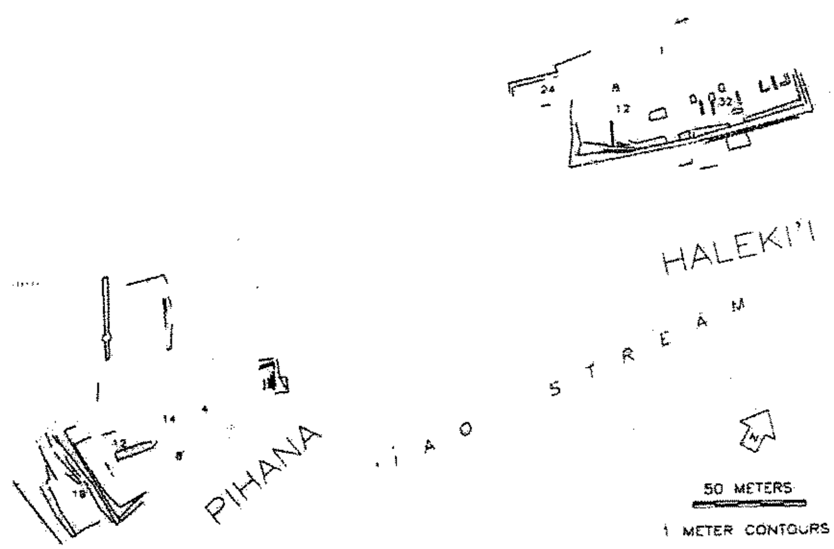


Figure 6. Location of the Halekii-Pihana Complex, along ‘Ï`ao Stream (Source: Kolb and Murakami 1994).

3. A fresh water spring, presently known as Waiola, located on the Sevilla property in Waiehu (Tax Map Key No. 3-3001-054), is believed to be part of an ancient fish pond (Commission on Water Resource Management, 1990). The true name of the spring is no longer known (C. Keau and D. Sevilla, pers. comm.) but some refer to it as Waiola. C. Keau believes the name may have been "Wailuku" (pers. comm..). The spring measures six feet wide and five feet deep. There are three main sections to the spring, most of which are separated by stone walls (Fig. 7). The spring was dry

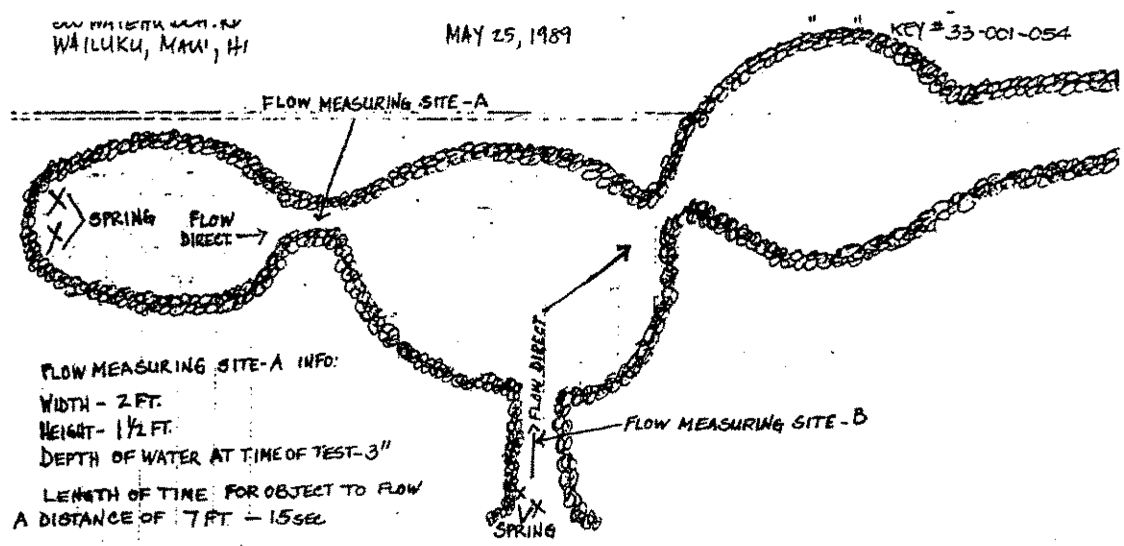


Figure 7. Waiola Spring, Waiehu, Maui (Source: Commission on Water Resource Management, 1990).

during the time this study was being conducted. According to D. Sevilla (pers. comm.), a mullet (fish) pond lay immediately east (*makai*) of Waiola, on the Kekona property. However, "Uncle Kekona filled up the pond once the water started to dry up" (ibid). The absence of water in both Waiola and the mullet pond are believed to have occurred after the diversion was placed in ʻĪʻao Stream.

4. Burials in the *ahupuaʻa* of Waiehu and Wailuku. As briefly discussed in section 3.1, prehistoric and historic burials are known from the vicinity of the project area. Most of these have been identified from the *Puʻu One* sand dunes that lie north of the project area; some are also known from Mahalani Cemetery (the majority of these burials are believed to be from the plantation era). A recent excavation a *kuleana* lot in the north easternmost corner of the flood plain area (down slope from the *heiau* complex), led to the discovery of several burials. According to W. Cockett (pers. comm.), who identified the area in which the burials were located, there will be no further ground disturbance for the sake of the burials.

5. Ancient and historic period *loi* are known to exist upstream of the project area. M. Duarte (pers. comm.) recalls several Hawaiians who used to grow taro nearby the Duarte residence. Many of these individuals had *kuleana* lots and *kuleana* water rights. As observed behind the 'Tropical Gardens of Maui', many of these *kuleana* still have *po`alima* within their boundaries. At present, *loi* are known from several family lots but the majority of taro appears to be grown in the adjacent *ahupua`a* of Waihee and Kahakuloa.

Based on observations and the information gathered fro *kūpuna* and knowledgeable individuals/residents, traditional land uses of the project area have been discontinued. 'Ī`ao Stream, or Wailuku River as once called by some of the older area residents, was known as a source for *o`opu* and *opai*, water for *loi*, and swimming/washing. However, none of these activities are currently taking place. While development along the stream's banks has changed accessibility to 'Ī`ao, earlier diversion measures have also brought about significant changes. The latter will be briefly addressed as known impacts to the project area in this report (c.f. the Environmental Assessment being prepared for the current project for a more detailed, in-depth review of diversion-related impacts).

As with traditional uses of the project area, land uses associated with the historic period also no longer take place. Both fishing and recreational uses (swimming/washing) were known to take place during the early to mid-1900s. Farming along the stream banks (raising hogs and cattle) was known up until shortly after the initial diversion measures. (The Duarte family, who live further upstream of the project area, maintained a hog farm until approximately two months ago). Historic uses of the project area, such as washing cars in the stream near Waiehu Beach Road, also appear to have been fairly common until recently. Rose Duey (pers. comm.) recalls that Waiehu Beach Road was at one time a rock and pebble roadway that crossed through 'Ī`ao Stream. In the event the water was too high, cars had to pull over and wait until their vehicles could safely cross the stream (ibid). Often on such occasions, their father would pull over the car/truck so it could be washed in the stream. Several other individuals recall Waiehu Beach Road before it was cemented; many remember driving across or having to wait for the water level in 'Ī`ao to go down. Kanji Wakamatsu, present owner of the Wakamatsu Fish Store in Wailuku, recalls catching *o`opu* and catfish, and picking *hi`iwai*, between Market Street and Waiehu Beach Road (K. Wakamatsu, pers. comm.). He would sell his catch to the Chinese families that lived in a camp near Paukūkalo. "The fish were large size, and the *hi`iwai* were 'big enough to use as whistles" (ibid).

4.2 Cultural Impacts from the Proposed Flood Control Project

The following section summarizes the major issues or cultural impacts identified through the survey questionnaire and interviews; it is presented in both quantitative and qualitative format. First, the issues and/or impacts are addressed in question/answer format; these were not questions asked directly but are the result of people's perceptions of the proposed project. (Many of the people interviewed were not aware of the flood control project until approached for this survey). Second, results of the questionnaire are presented in table format to show a numerical breakdown of the survey population's responses.

4.2.1 Is flooding of 'Ï`ao Stream a concern (fear) for area residents?

Generally, no. While most area residents have witnessed the 'flash' floods that can occur of 'Ï`ao Stream, they do not feel further channelization is necessary. This was true of both the relatively new short-term residents, and the long-term, older residents who have witnessed at least one or two large floods. K. Wakamatsu, now 84 years old, recalls a young boy being swept away during the flood in the 1940s. The Cocketts remember a storm in the 1950s when pigs were floating in the stream, and the water level reached their doorstep (at their current home in the floodplain). In this undated photo (Figure 8), Ashdown captured the impact of a major flood/storm on a house in the flood plain area, and the cane haul bridge (possibly the same location as the bridge shown in Figure 2). The photograph notes 'cane'and 'part of Iao Mts.', in the upper left corner.

Several present day residents have become familiar with the 'tell-tale' signs of impending floods. John Duey who lives in the upper portion of 'Ï`ao Valley, and Emmett Rodrigues who lives in the lower portion of the valley within the project area, know that when gray clouds and heavy rains occur up in the mountains, it is time to watch for the water to come rushing downstream. Some of these individuals have timed the sequence of events (development of clouds, rainfall) in order to prepare for the heavy flow that passes near their residence.

Figure 8. Aftermath of the 1950 Flood, photo taken by Inez Ashdown (Courtesy of Bailey House Museum).

Unlike the upper portions of the valley where flooding can impact homes along the stream banks, in the project area itself, there does not appear to be great concern about flooding. Previous flood control measures have acted to protect the stream banks from overflowing, but it is also a matter of experience. Residences (and residents) in the upper portion of the valley have likely been there for several generations, whereas most of the residences and businesses along the project area portion of ʻĪao Stream have been built within the past three to ten years. The people higher up in the valley have witnessed many more flood related events, whereas, the people in the lower portion have likely been present only since the initial flood control measures were put in place. Many of the present day residents who live off of Eha Street, are new to the area...hence they are not aware of the potential dangers from major floods. Most, however, have witnessed flash floods that periodically occur.

While flooding may not be a major concern, the erosion caused by heavy, rapid moving stream water, is. This is particularly true for the businesses located in the immediate 'erosion path', along Wili Pa Loop (Figure 2). Much of the area adjacent (immediately downstream) to these businesses are somewhat protected by concrete lining along the streambanks. However, there are no protective barriers lining the streambank behind the buildings housing these businesses.

Tables 1 through 6 present the quantitative results of the survey questionnaire. Included in the survey population are individuals with whom interviews were held for the identification of TCPs. A total of thirty two residents/business owners were approached and/or interviewed about the proposed project, including representatives of the four primary businesses within and across Wili Pa Loop (two of which have experienced severe erosion by the present stream flow). And important factor to note is that the majority of the people interviewed/surveyed were not aware of the proposed Flood Control Project. This will be discussed further in the conclusions.

Table 1. Population Surveyed, by Approximate Area of Residence

Participants in the Survey	Total
Men	21
Women	11
Total	32
Place of Residence	
Within immediate vicinity of Project Area	21
Wailuku side	15
Pihana side	06
Wailuku (general)	07
Outside of Wailuku *ahupua`a*	04

Table 2. Quantifiable Responses to Survey Questions[1]

	Yes	No	Unable to comment
Do you live near *'Ī`ao* Stream	15	17	
Do you use *'Ī`ao* Stream for recreational and/or subsistence purposes?	02	29	
Have you witnessed any changes to the stream over the years (e.g. stream flow, erosion, floods, etc.)?	11	21	
Are you familiar with the proposed flood control project (and or measures)?	05	27	
Are you familiar with any or all of the alignments (alternatives) proposed?	05[1]	27	
Do you have a preference for any one alterative	07[2]	17	8

1 All of these individuals had either attended or were aware of the Public Scoping Meeting, or had red newspaper announcements about the proposed project.

2 Includes individuals to whom the diagrams of the proposed alternatives were shown for the first time.

Table 3. Uses of *'Ĩao* Stream in the Vicinity of the Project Area[1]

1.	Recreational (bicycling, dirt biking, jogging, swimming, boogie boarding)
2.	Farming (presently done only in the flood plain)
3.	Fishing and food gathering (catching/gathering *O'opu, opai,* or *hi'iwai* in the stream beds)

[1] Activities identified as either known about or personally performed, in order of occurrence.

Table 4. Knowledge about Traditional Uses and/or Sites along *'Ĩao* Stream[1]

	Yes	No
Do you know of any traditional uses of *'Ĩao* Stream?	07	25
Are you familiar with any traditional sites/features along the stream and/or within the flood plains area?	02	30
Would the proposed flood control affect/impact any of these traditional sites or features	0	

[1] The sites known to most people are *Haleki'i-Pihana Heiau*, the *Pu'u One Sand Dunes*, and the spring located behind the Sevilla property; all of these are outside of the project area.

4.2.2 *Are further flood control measures perceived as being needed?*

While the survey questionnaire did not include this question, based on the responses and inquiries made by the interviewees, the issue of whether or not further flood control measures are necessary became important. This question was formulated based on the lack of response or absence of knowledge about the proposed project. Table 5 summarizes the general response that was received.

Table 5. How would you Characterize the Effect(s) of Further Flood Control Measures for 'Ĩao Stream?

Necessary (Positive)	09
Not necessary (Negative)	21[1]
No opinion/unable to judge	02

[1] five individuals saw negative effects as a result of the "cumulative" impacts of stream channelization and/or diversion techniques.

An overwhelming number of the people interviewed saw no need for further stream channelization and/or alignment. Part of this judgment appears to be based on past and existing experiences and observations of 'Ĩao Stream; there is also great support for wanting the stream to be reverted back to its more original form. The latter includes many newcomers to the area, several of whom enjoy and/or chose to live along the stream. Perhaps not so surprisingly, it also includes a significant number of the *kūpuna* and long term residents.

Table 6. Suggestions/Observations on how the Corps of Engineers can help the Community better Understand the Flood Control Project

		Frequency
1.	Provide further information about the proposed project[1]	16
2.	Hold [another] public meeting where the alternatives can be reviewed	07
3.	Help stop the erosion	11
4.	Identify who will benefit for these measures	04
5.	Restore the stream by placing back the animals that once lived in it	14

[1] seven individuals acknowledged that they were aware of the Public Scoping Meeting but just were not able to or did not attend.

The following is a summary of the potential negative and positive cultural impacts identified:

4.3 Summary and Recommendations: Cultural [impact] Mitigations and Enhancements

Potential Long-term "Direct" Cultural Impacts (Negative) from the Proposed 'Ī`ao Flood Control Project

1. Continued reduction or additional decrease in water flow. Most people would like to see a return of some regular flow of water. Further flood measures are seen as possibly further reducing water flow.
2. Additional concrete/cementing within streambed will add aggravate existing hazards, e.g. further compounding erosion action along stream banks. At present, physical impacts of erosion are greatest along the southeastern portion of the project area. (Many doubt the potential positive impacts from new flood control measures based on these impacts that are likely from previous channelization measures).
3. Further channelization measures will further discourage the return of original stream biota (e.g. *o`opu, opai* and *hi`iwai*). For people who are familiar with the biota of 'Ī`ao Stream, or know of the various animals that are found in fresh water, there is a desire to see these return to the stream. This is part of the greater desire to help return the stream to its earlier, pre-channelization, stage. There are also a few people who would like to enhance the stream by [re]introducing some of these species (some of this has already been done by the Hawaii Division of Aquatic Resources).

Potential Short-term "Indirect" Cultural Impacts (Negative) from the Proposed 'Ī`ao Flood Control Project

1. Inconveniences to area residents as a result of construction activities in the streambed, e.g. re-directing of traffic, dust and noise.
2. Restricted access to the maintenance road and stream for walking, biking and other recreational uses.

No Cultural Impacts (Positive) from the Proposed 'Ī`ao Flood Control Project

1. Threat of potential floods will be further removed.
2. Recreational features can be included as part of the flood control measures, e.g. walkways and safer guidelines for kids whom swim/bike within and along the streambed
3. Aesthetic value of the stream will increase with safer and more pleasant surroundings.
4. Measures can include improvements to existing water flow patterns, thereby allowing some of the original stream fauna to return. (While there isn't a direct desire to fish/gather in the stream, there is a strong desire to have it return to a more natural, biologically thriving system).

No Cultural Impacts to known Traditional Cultural Properties in the Vicinity of the Proposed 'Ī`ao Flood Control Project Area

No immediate/direct changes are foreseen to known Traditional Cultural Properties within the vicinity of the project area as a result of the proposed project. The only TCP that lies immediately along the banks of the 'Ī`ao Stream is the Haleki`i-Pihana Heiau State Monument. This site is situated well above the stream bank. However, if flood control measures lead to severe erosion along the stream bank that lies directly below the monument, the land area on which the *heiau* sits may be compromised. The potential impacts to the heiau should be monitored on a continuous basis. Other features and sites such as Mahalani Cemetery and the *Pu`u One* Sand Dunes are not likely to be affected by future flood control measures.

4.3.1 Recommendations

Based on requests made and observations, the following are recommended:

- Repair cement cracking along existing wall (off `Iao Place). At least two residents pointed to these cracks that lie behind their property. Both have concerns about the further widening of the cracks and the potential for water-flow to be compromised during heavy flows (e.g. flash floods).
- Help contain (repair) the eroding of the streambank along Wili Pa Loop.

- Incorporate recreational features and/or visual enhancement to the stream's levee. This can be done with the community's input and assistance.
- Schedule another meeting prior to implementation of any measures. While this may not dramatically increase the attendance of area residents, it allows individuals a second opportunity to participate in the 'decision-making' process.
- Clarify which agency is responsible for maintaining the stream (clearing of debris, etc.), and general contact information for area residents.

4.3.2 General Concerns/Issues

It would appear that most people who live and work along 'Ï`ao Stream have become familiar with the stream's somewhat 'predictable' nature as it concerns the occasional flash floods. As discussed earlier, a few people have become rather savvy to the expectations resulting from heavy rain pours can lead to.

No one interviewed currently uses the streambed for recreational activities; at least two residents use the access/levee road for leisurely walks but this is on a limited basis. The majority of individuals who seem to use the streambed are either children or from homes located away from the levee road. Some people expressed concerns over who will maintain/upkeep the stream in the event there is debris build-up. There isn't a clear knowledge about who is responsible; the question of whether it's the County, the State or the Corps of Engineers often arose. Most are concerned about erosion and/or feel sympathy with the owners of the land being impacted, several see it as the owner's responsibility for purchasing lands that had the potential to erode. Several have questioned diversion of water by the large companies and the county, and water rights access. There is a fair amount of distrust of the companies requesting water diversions (e.g. Wailuku Sugar Company), and their future intentions (e.g. directing water towards Kihei/Makena side, for further housing development, etc.).

In general, flood control does not seem to be a concern/issue, including for those residents and businesses living along the access/levee road. The concern over erosion is far greater, particularly for the two businesses directly affected. The community appears to be more concerned (or desires) about the social/recreational values of the stream. If control measures are enacted, there would be a greater sense of accomplishment (and cooperation) if it was done in consideration of the community's present needs and desires. This opinion was fairly common, from both the newcomers and the individuals who have experienced flooding, either at 'Ï`ao or elsewhere.

REFERENCES CITED

Ashdown, Inez MacPhee
1970 Ke Alaloa O Maui: Authentic History and Legends of the Valley Isle. Handbook prepared by author, Ulupalakua,Maui.

Burgett, Bee and Michael F. Dega
1999 Archaeological Reconnaissance Survey and Limited Subsurface Testing for the Alternative Channel Alignment, `Iao Stream Flood Control, `Iao Valley, Island of Maui, Hawai`i. Report prepared by Scientific Consultant Services, Inc., for U.S. Army Engineer District, Ft. Shafter, Hawaii.

Commission on Water Resource Management
1990 Registration of Spring Diversion Works and Declaration of Water Use, Form 8810-2, for Waiola Spring, Maui, April 25, 1990. Copy on file with Commission on Water Resource Management, Department of Land and Natural Resources, State of Hawaii.

Connolly, Robert D.
1974 Phase I Archaeological Survey of Iao Valley Flood-Control-Project Area, Maui. Report prepared for Bernice P. Bishop Museum, for National Park Service and U.S. Army Corps of Engineers, Honolulu.

Environmental Council, State of Hawaii
1998 Guidelines for Assessing Cultural Impacts. November 19, 1997.

Fornander, A.
1996 A account of the Polynesian Race Its Origins and Migrations, Vol. 2. London. Trubner and Co., Ludgate Hill.

Fredericksen, Demaris L.
2000 An Archaeological Inventory Survey for Main Street Promenade – Phase 2, Wailuku *ahupua`a*, Wailuku District, Maui Island. Report prepared for Lisa and Robert Joslin, Wailuku, Maui.

Handy, E.S. and Elizabeth Handy
1972 *Native Planters of Old Hawaii: Their Life, Lore, and Environment*. Bernice P. Bishop Museum Bulletin 233. Bishop Museum Press, Honolulu.

Harden, M.J.
1999 *Voices of Wisdom: Hawaiian Elders Speak*. Aka Press, Kula, Hawaii.

Haun, Alan E. and Dave Henry
2002 Archaeological Inventory Survey TMK: 3-3-02:30 and TMK 3-5-01:50, Land of Wailuku, Wailuku District, Island of Maui. Report prepared for Bob Horcajo, Wailuku, Hawaii.

ʻĪʻī, John Papa
1959 *Fragments of Hawaiian History.* Bishop Museum Press, Honolulu.

Kamakau, Samuel M.
1992 Ruling Chiefs of Hawaii: Revised Edition. The Kamehameha Schools Press, Honolulu.

Kirch, P.V.
1985 *Feathered Gods and Fishhooks: An Introduction to Hawaiian Archaeology and Prehistory.* University of Hawaii Press, Honolulu.

Kolb Michael J. and Charles Keau
1990 Preliminary Report of Excavations at Halekii-Pihana Heiau State Monument, Wailuku, Maui, Hawaii. Unpublished manuscript on file at Bailey House Museum, Wailuku, Maui.

Kolb, M.J.K. and G.M. Murakami
1994 Cultural Dynamics and the Ritual Role of Woods in Precontact Hawaii. In *Asian Perspectives* 331:57-78.

Kuykendall, R.S.
1967 *The Hawaiian Kingdom: Volume III, 1874-1893, The Kalakaua Dynasty.* University of Hawaii Press, Honolulu.

Parker, P.L. and King, T.E.
1995 *Guidelines for Evaluating and Documenting Traditional Cultural Properties.* National Register Bulletin 38, National Park Service.

Prasad, Usha K. and Myra Tomonari-Tuggle
1999 Evaluation of Traditional and Historical Land Uses in the Kahului Airport Area. Report prepared by International Archaeological Research Institute, Inc., for Ed K. Noda and Associates.

Pukui, Mary Kawena, Samuel H. Elbert, and Esther T. Mookini
1976 *Place Names of Hawaii.* Honolulu: University of Hawaii Press.

Silva, Carol
n.d. Historical Report, Halekii-Pihana State Monument, Wailuku, Maui. In the files of the State Historic Preservation Division, Honolulu.

Stearns, Harold T. and Gordon A. MacDonald
1942 *Geology and Ground-Water Resources of the Island of Maui, Hawaii, Bulletin 7.* Geological Survey, U.S. Dept. of the Interior.

Sterling, Elspeth P.
2000 *Sites of Maui.* Bishop Museum Press. Honolulu.

Yent, Martha
1995 Archaeological Restoration Plan: Portion of Pihana Heiau, Halekii-Pihana Heiau State Monument, Paukukalo, Wailuku, Maui. Report prepared for the Division of State Parks, Department of Land and Natural Resources.

APPENDIX A

GUIDELINES FOR ASSESSING CULTURAL IMPACTS Adopted by the Environmental Council, State of Hawaii November 19, 1997

I.

INTRODUCTION

It is the policy of the State of Hawaii under Chapter 343, HRS, to alert decision makers, through the environmental assessment process, about significant environmental effects which may result from the implementation of certain actions. An environmental assessment of cultural impacts gathers information about cultural practices and cultural features that may be affected by actions subject to Chapter 343, and promotes responsible decision making. Articles IX and XII of the State Constitution, other state laws, and the courts of the state require government agencies to promote and preserve cultural beliefs, practices, and resources of native Hawaiians and other ethnic groups. Chapter 343 also requires environmental assessment of cultural resources, in determining the significance of a proposed project.

The Environmental Council encourages preparers of environmental assessments and environmental impact statements to analyze the impact of a proposed action on cultural practices and features associated with the project area. The Council provides the following methodology and content protocol as guidance for any assessment of a project that may significantly affect cultural resources.

II.

CULTURAL IMPACT ASSESSMENT METHODOLOGY

Cultural impacts differ from other types of impacts assessed in environmental assessments or environmental impact statements. A cultural impact assessment includes information relating to the practices and beliefs of a particular cultural or ethnic group or groups.

Such information may be obtained through scoping, community meetings, ethnographic interviews and oral histories. Information provided by knowledgeable informants, including traditional cultural practitioners, can be applied to the analysis of cultural impacts in conjunction with information concerning cultural practices and features obtained through consultation and from documentary research.

In scoping the cultural portion of an environmental assessment, the geographical extent of the inquiry should, in most instances, be greater than the area over which the proposed action will take place. This is to ensure that cultural practices which may not occur within the boundaries of the project area, but which may nonetheless be affected, are included in the assessment. Thus, for example, a proposed action that may not physically alter gathering practices, but may affect access to gathering areas would be included in the assessment. An ahupua'a is usually the appropriate geographical unit to begin an assessment of cultural impacts of a proposed action, particularly if it includes all of the types of cultural practices associated with the project area. In some cases, cultural practices are likely to extend beyond the ahupua'a and the geographical extent of the study area should take into account those cultural practices.

The historical period studied in a cultural impact assessment should commence with the initial presence in the area of the particular group whose cultural practices and features are being assessed. The types of cultural practices and beliefs subject to assessment may include subsistence, commercial, residential, agricultural, access-related, recreational, and religious and spiritual customs.

The types of cultural resources subject to assessment may include traditional cultural properties or other types of historic sites, both man made and natural, including submerged cultural resources, which support such cultural practices and beliefs.

The Environmental Council recommends that preparers of assessments analyzing cultural impacts adopt the following protocol:

(1) identify and consult with individuals and organizations with expertise concerning the types of cultural resources, practices and beliefs found within the broad geographical area, e.g., district or ahupua 'a;

(2) identify and consult with individuals and organizations with knowledge of the area potentially affected by the proposed action;

(3) receive information from or conduct ethnographic interviews and oral histories with persons having knowledge of the potentially affected area;

(4) conduct ethnographic, historical, anthropological, sociological, and other culturally related documentary research;

(5) identify and describe the cultural resources, practices and beliefs located within the potentially affected area; and

(6) assess the impact of the proposed action, alternatives to the proposed action, and mitigation measures, on the cultural resources, practices and beliefs identified.

Interviews and oral histories with knowledgeable individuals may be recorded, if consent is given, and field visits by preparers accompanied by informants are encouraged. Persons interviewed should be afforded an opportunity to review the record of the interview, and consent to publish the record should be obtained whenever possible. For example, the precise location of human burials are likely to be withheld from a cultural impact assessment, but it is important that the document identify the impact a project would have on the burials. At times an informant may provide information only on the condition that it remain in confidence. The wishes of the informant should be respected.

Primary source materials reviewed and analyzed may include, as appropriate: Mahele, land court, census and tax records, including testimonies; vital statistics records; family histories and genealogies; previously published or recorded ethnographic interviews and oral histories; community studies, old maps and photographs; and other archival documents, including correspondence, newspaper or almanac articles, and visitor journals. Secondary source materials such as historical, sociological, and anthropological texts, manuscripts, and similar materials, published and unpublished, should also be consulted. Other materials which should be examined include prior land use proposals, decisions, and rulings which pertain to the study area.

III. CULTURAL IMP ACT ASSESSMENT CONTENTS

In addition to the content requirements for environmental assessments and environmental impact statements, which are set out in HAR §§ 11-200-10 and 16 through 18, the portion of the assessment concerning cultural impacts should address, but not necessarily be limited to, the following matters:

1. A discussion of the methods applied and results of consultation with individuals and organizations identified by the preparer as being familiar with cultural practices and features associated with the project area, including any constraints or limitations which might have affected the quality of the information obtained.

2. A description of methods adopted by the preparer to identify, locate, and select the persons interviewed, including a discussion of the level of effort undertaken.

3. Ethnographic and oral history interview procedures, including the circumstances under which the interviews were conducted, and any constraints or limitations which might have affected the quality of the information obtained.

4. Biographical information concerning the individuals and organizations consulted, their particular expertise, and their historical and genealogical relationship to the project area, as well as information concerning the persons submitting information or interviewed, their particular knowledge and cultural expertise, if any, and their historical and genealogical relationship to the project area.

5. A discussion concerning historical and cultural source materials consulted, the institutions and repositories searched, and the level of effort undertaken. This discussion should include, if appropriate, the particular perspective of the authors, any opposing views, and any other relevant constraints, limitations or biases.

6. A discussion concerning the cultural resources, practices and beliefs identified, and, for resources and practices, their location within the broad geographical area in which the proposed action is located, as well as their direct or indirect significance or connection to the project site.

7. A discussion concerning the nature of the cultural practices and beliefs, and the significance of the cultural resources within the project area, affected directly or indirectly by the proposed project.

8. An explanation of confidential information that has been withheld from public disclosure in the assessment.

9. A discussion concerning any conflicting information in regard to identified cultural resources, practices and beliefs.

10. An analysis of the potential effect of any proposed physical alteration on cultural resources, practices or beliefs; the potential of the proposed action to isolate cultural resources, practices or beliefs from their setting; and the potential of the proposed action to introduce elements which may alter the setting in which cultural practices take place.

11. A bibliography of references, and attached records of interviews which were allowed to be disclosed.

The inclusion of this information will help make environmental assessments and environmental impact statements complete and meet the requirements of Chapter 343, HRS. If you have any questions, please call us at 586-4185.

APPENDIX B

Transcripts of Oral Interviews completed for
TCP and CIA Study of `Iao Flood Control Project

(to be inserted)

APPENDIX C

Questionnaire for Oral History Studies for the Determination of Traditional Cultural Properties and Cultural Impact Assessment for the `Iao Flood Control Project, Maui Island, Hawaii

Name: ______________________________ **Contact #** (optional): ____________________

Place of Residence: ____

1. Do you live near `Iao Stream? Yes_______ No_______
   Adjacent to levee _______ Nearby _______

2. How much time have your spent around the stream area?______________________________

3. Do you use `Iao Stream for recreational and/or subsistence purposes?
   If yes, describe activity____

4. Do you know of any traditional uses of `Iao Stream?____________________________

   a.. Are you familiar with any of the traditional sites/features along the stream and/or within the flood plains area?
   If yes, list here (provide complete description)
   ____
   ____

5. Have you witnessed any changes to the stream over the years (e.g., stream flow, erosion, floods, etc.)?
   If yes, describe the change____
   ____

6. Do you feel flood control efforts are necessary for `Iao Stream? Yes_____ No______
   Have you observed any of the activities:______________________________________

7. Are you familiar with the proposal to repair erosion along the stream? Yes_____ No_____
   If yes, is there one particular proposed alignment you favor others? (List by #)
   Why____
   Which other alternative alignment would want to see?______________________________

   a. Will one or any of these alternatives impact your use of the stream?
   If YES, then how?____

8. Do you think that any of the proposed flood control measures will affect traditional sites/features along the stream?

8. Do you think that any of the proposed flood control measures will affect traditional sites/features along the stream?
   If YES, then how?____

9. In general, how would you characterize the effect(s) of the proposed flood control measures for `Iao Stream?

   a. Positive: ______________________
   a. Negative:______________________
   b. None foreseen:__________________
   c. Unable to form opinion:_____________

10. Do you have any concerns/issues about the proposed flood control measures?

   ____
   ____

1. Do you have any suggestions/observations of what the Corps of Engineers can do to help the community better understand their proposal(s) for `Iao Stream?

   ____
   ____

2. Is there anything else you would like to add or say?

   ____
   ____

APPENDIX D

List of Individuals Interviewed and/or Contacted for Oral History Studies for the Identification of TCPs in the `Iao Flood Control Project, Maui Island, Hawaii

3. Charles Keau
4. Sam Ka`a`ai
5. Ned Purdy, Division of Forestry
6. Skippy Hau, area resident and employee of Department of Land and Natural Resources
7. John Duey
8. Rose Duey
9. Bob Hobdy, Division of Forestry
10. Ed Lindsey
11. Duke Sevilla, area resident
12. Kaimu Willstein, Office of Hawaiian Affairs
13. Melissa Kykendall, State Historic Preservation Office, Maui
14. Leona Ryder, `Iao Valley School
15. Manual and Margaret Duarte
16. Manual Duarte Jr.
17. Joe Duarte (Manual's nephew)
18. Charlie Duarte
19. Takamiya Family
20. Kamita family
21. Honda family
22. Kanji Wakamatsu (Wakamatsu Fish Market)
23. Gordon Cockett
24. Winifred Cockett
25. Tom Cerizo
26. Alan K. Bernaldo
27. Ken and Beverly Kurokawa
28. Greg Apa
29. Emmett Rodrigues

Appendix D:

Hazardous, Toxic, and Radioactive Waste Assessment

HAZARDOUS, TOXIC AND RADIOACTIVE WASTE (HTRW) INITIAL ASSESSMENT FOR IAO STREAM FLOOD CONTROL PROJECT MODIFICATION WAILUKU, MAUI, HAWAII

January 13, 1997

1. PURPOSE

An HTRW initial assessment was conducted for the study area as required by U.S. Army Corps of Engineers regulations (ER 1165-2-132) to address the existence of, or potential for, HTRW contamination which could impact, or be impacted by, the proposed improvements to the Iao Stream Flood Control Project.

For the purposes of ER 1165-2-132, HTRW is defined as any material listed as a hazardous substance under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA, Public Law 96-510, 42 U.S.C.A. 9601 et seq.), except for dredged material and sediments beneath navigable waters proposed for dredging. Section 6.b of ER 1165-2-132 states as policy that construction of Corps Civil Works projects in HTRW-contaminated areas should be avoided where practicable.

2. STUDY AREA AND PLANNED MODIFICATION

The Iao Stream Flood Control project is located on the western portion of the Island of Maui, in the town of Wailuku. The stream drains an area of approximately 9.4 square miles. The existing flood control project consists of a debris basin located 2.5 miles upstream from the stream mouth, a 3,500-foot long concrete channel downstream from the debris basin, levees along the right bank and floodplain management along 6,950 feet of the left bank and stream realignment for a 1,730-foot reach to the shoreline.

The planned modification consists of extending the concrete channel from the end of the existing channel to the Waiehu Beach Road bridge. The concrete channel would have a bottom width of 40 feet, two horizontal to one vertical side slopes and would be about twelve feet deep.

3. METHODS

This preliminary assessment is based upon a review of existing documents, the results of agency interviews and observations made during site visits on 5 July, 1996 and 10 January, 1997.

3.1 Existing documents

Existing environmental and planning documents for previous development of the Iao Stream Flood Control Project were reviewed for information about known or potential sources of contamination in the study area.

3.2 Interviews

Telephone interviews about HTRW problems, including violations or other actions associated with the study area, were conducted with staff of the agencies listed. below.

Department of Health (DOH), State of Hawaii
- Solid and Hazardous Waste Branch
  - Hazardous Waste Section
  - Office of Solid Waste Management
  - Underground Storage Tank Section
- Hazard Evaluation and Emergency Response Office

Environmental Protection Agency, Honolulu

U.S. Fish and Wildlife Service, Honolulu

3.3 Site visit

A site visit to the study area was conducted on 5 July, 1996 and again on 10 January, 1997 by Corps of Engineers staff to look for indications of potential HTRW. Accessible areas along the proposed modification reach and the existing project reach including the debris basin were visually surveyed for partially buried containers, discolored soil, seeping liquids, films on water, abnormal or dead vegetation or animals, suspect odors, dead-end pipes, abnormal grading, fills, depressions, or other evidence of possible contamination.

4. RESULTS

4.1 Stream reach

The area along Iao Stream has not been designated as a CERCLA action site, nor did the search of the DOH data base indicate any spills or other HTRW activity in the immediate area. Material excavated from the stream channel and its margins will likely be used for fill in other sections of the project. During the site visits there was no physical evidence to indicate that any of this material contained HTRW. Excess quantities of this material will likely be disposed in the County land fill and it will be subject to testing and evaluation for suitability for such disposal in accordance with the appropriate guidelines and criteria adopted by the U. S. Environmental Protection Agency.

4.2 Contractor's work and storage area

Although the contractor's work and storage area has not yet been designated, several potential areas were surveyed during the 10 January 1997 site visit. There was no evidence to indicate contamination by HTRW in these areas, and the DOH data base did not indicate any HTRW activity in these areas. If an area not previously surveyed is selected for the contractor's work and storage area it will be surveyed for HTRW.

5. CONCLUSION

Since no response actions and no National Priority List sites under CERCLA have been identified for the project area, any material which might be excavated will not be considered HTRW. The material will still be subject to testing and evaluation as appropriate in accordance with federal and State of Hawaii regulations if the material is to be placed in the County landfill.

6. REFERENCES

U.S. Department of the Army, U.S. Army Engineer District , Honolulu, 1966. Report on survey for flood control and allied purposes on Iao Stream, Wailuku, Maui, Hawaii. 5 April, 1966. Honolulu, Hawaii.

U.S. Department of the Army, U.S. Army Engineer District , Honolulu, 1975. Final environmental statement, flood control and allied purposes Iao Stream, Maui, Hawaii. April 1975. Honolulu, Hawaii.

U.S. Department of the Army, U.S. Army Engineer District , Honolulu, 1995. Modifications to Completed Project Report for the Iao Stream Flood Control Project, Maui, Hawaii. A memorandum report to the Commander, U.S. Army Engineer Division, Pacific Ocean. 23 April, 1992. Honolulu, Hawaii.

U.S. Department of the Army, U.S. Army Engineer District , Honolulu, 1995. Modifications to Completed Project Report for the Iao Stream Flood Control Project, Maui, Hawaii. A memorandum report to the Commander, U.S. Army Engineer Division, Pacific Ocean. 28 March, 1995. Honolulu, Hawaii.

U.S. Department of the Army, U.S. Army Engineer District , Honolulu, 1996. Iao Stream Flood Control Project, Maui, Hawaii, Design Deficiency Report. A memorandum report to the Commander, U.S. Army Engineer Division, Pacific Ocean. 08 December, 1995. Honolulu, Hawaii.

CEPOH-PP (415-15k) 21 August 2002

MEMORANDUM FOR COMMANDING GENERAL, PACIFIC OCEAN DIVISION, ATTN: CEPOD-MM, FORT SHAFTER, HI 96858-5440

SUBJECT: Honolulu Engineer District (POH) Project Review Board (PRB) Executive Summary

1. Date of District PRB Meeting: 8 August 2002

2. Report for the Month of: August 2002

3. PRB Participants: See enclosure.

4. The POH PRB considered all PRB projects and discussed upward reportable and command interest projects, with focus on red and amber projects. Highlights of these discussions follow:

a. **Name of Project: FY02 DLA PN003002 Replace Hydrant Fuel System, Hickam AFB, HI (R. Inouye)**

(1) Reason for submitting to POD: For information only and amber.

(2) Discussion: Contract awarded to Nova Group, Inc. on 30 July 2002 in the amount of $25,750,000. Awaiting funding from the Hickam BCE for awarding of the Government Options to remediate the excessed contaminated soils and liquids to be encountered during construction.

(3) Recognition and Management of Issues: None.

b. **Name of Project: FY99 OMAF Clear Veg/Expl Ord DE 2/3, Bellows AFB (R. Inouye)**

(1) Reason for submitting to POD: For information only and green.

(2) Discussion: UXB completed its cleanup required under the consent decree on 6 August 2002. UXB will be completing and submitting its draft final clearance report for review and comments. Briefing for COL Riggle and COL Hoarn scheduled for 12 August 2002 at 1500 hrs.

(3) Recognition and Management of Issues: Resolve issue on clearance requirement. Continue communications with Joe Ryan and complete FOIA action with him.

(a) District Action: None.

(b) Division Action Requested: None.

(c) HQUSACE Action Requested: None.

c. **Name of Project: FY98 OMA Pkg A-57 Repair Sewer Force Main, Fort Shafter, HI (K. Cabalce)**

(1) Reason for submitting to POD: For information only and red.

(2) Discussion: A-E check in the amount of $50K was received as part of the A-E settlement agreement. These funds will be used to pay the cost of the corrective repairs to the broken liner. Negotiations with the contractor is stalemated. DPW was briefed on Friday, 26 July. PDT is developing a course of action to implement the DPW preferred course of action.

(3) Recognition and Management of Issues: None.

d. **Name of Project: Whole Barracks Infantry Brigade FY00 MCA PN 46902 Phase 2A, Schofield Bks, HI (K. Cabalce)**

(1) Reason for submitting to POD: Upward reportable and green.

(2) Discussion: Design for Pump Station No. 2 stand-by power generator is being finalized. Award of stand-by generator construction is scheduled for early October 2002. Design for 1 mgal water tank is being reviewed. Water tank was reprogrammed to FY04, but may be dropped by ACSIM. Coordinating with DOIM to insure that telecom infrastructure meets local standards. DOIM is slow in providing the proper local standards and construction is continuing without the availability of the local standards.

(3) Recognition and Management of Issues: None.

e. **Name of Project: FY02 MCA PN 55038 WBR Aviation Brigade, Phase 6A, Wheeler AAF, HI (C. Tomihara)**

(1) Reason for submitting to POD: Upward reportable and green.

(2) Discussion: Discussion questions generated from the Source Evaluation Board were forwarded to Contractor. SEB scheduled to reconvene on 14 August 2002. Post closing amendment to incorporate review comments from 100% design being processed. Submission date of 23 August 2002 for price proposals will be delayed.

(3) Recognition and Management of Issues: None.

f. **Name of Project: FY02 MCA PN 053761 Consolidated Command and Range Control Building, Pohakuloa Training Area, HI (R. Tamashiro)**

(1) Reason for submitting to POD: For information only and green.

(2) Discussion: This project calls for a command and range control building--10,010 SF facility to include admin offices, conference room, military police station, special rooms and related facilities for range control functions. The project is scheduled for award in FY02 through a design/build process. An A-E completed the preliminary concept (15%) design and Design Branch prepared the design/build RFP. The RFP was advertised on 3 June, and the proposals were submitted on 26 July 2002. All offerors did not submit sufficient data to comply with the minimum technical criteria of the RFP, therefore the price proposals could not be revealed. Clarifications will be requested from each offeror and the award date rescheduled to 20 September 2002 vice 31 August 2002.

(3) Recognition and Management of Issues: None.

g. **Name of Project: FY03 and beyond MCA Transformation Program, 2nd Brigade, U.S. Army HI (L. Kawasaki)**

(1) Reason for submitting to POD: Command interest and green.

(2) Discussion: POH held a kick-off meeting with the Transformation Office on 8 August 2002 to develop a program management plan (PgMP) for the SBCT Program. Meetings will continue on a bi-weekly basis to further develop the PgMP and to resolve issues that cannot be solved by the PDTs. The next meeting will be held with Huntsville District on Wednesday, 21 August 2002. Potential agenda items for the meeting are to set a vision and mission for the program; and to discuss Huntsville District's capabilities and overall role in the Hawaii Transformation projects. POH staff also continues to provide support to USAG-HI Transformation Office in revising and completing DD1391s for projects programmed in FY05 through FY07. Details continue to be coordinated with the proponents, as well as NEPA actions.

(3) Recognition and Management of Issues:

(a) District Action Required: Maintain smooth coordination with the IBCT Transformation cell, POD, and USARPAC.

(b) Division Action Requested: Coordinate with USARPAC and HQUSACE on projects with critical schedules.

(c) HQUSACE Action Requested: Coordinate with ACSIM and Congressional offices on projects with critical schedules.

h. **Name of Project: FY98 MCA PN44839 WBR, Ph 1D1/1D2, Schofield Bks, HI (L. Oh)**

(1) Reason for submitting to POD: Upward reportable and green.

(2) Discussion: Mold has appeared on the sisal wall coverings in the two soldier community buildings and two barracks modules. The mold was tested to determine cause and possible health risks. Results of the test indicated no immediate health threat provided the mold growth is controlled. As for the cause, coupled with Hawaii's high humidity climate, heat from the laundry area, enclosed air conditioning, and the sisal material itself, has created an environment conducive to mold growth.

(3) Recognition and Management of Issues:

(a) District Action Required: PDT will meet within the month to recommend permanent solution to remove and prevent further mold growth.

(b) Division Action Requested: None.

(c) HQUSACE Action Requested: None.

i. **Name of Project: FY04 MCA PN57226 Drum Road Upgrade, Helemano, HI (M. Smith)**

(1) Reason for submitting to POD: Upward reportable and green.

(2) Discussion: Received Code 3 23 May 2002 with a PA of $72.0M. ENG Form 3086 due 1 July 2002. Per USAG-HI Transformation Office, this project to be programmed for incremental funding over two years, $50.0M in FY04, remaining balance of $22.0M in FY05.

(3) Recognition and Management of Issues:

(a) District Action Required: None.

(b) Division Action Requested: None.

(c) HQUSACE Action Requested: None.

j. **Name of Project: FY2002 South Range Land Acquisition, Schofield Bks, HI (C. Adams)**

(1) Reason for submitting to POD: Upward reportable, command interest and green.

(2) Discussion: Received Customer comments on EA SOW on 5 July 2002. Belt Collins submitted Revised Final Documents AA and EA and revised Waiver request on 8 July 2002. Belt Collins will submit Final EBS 4 weeks after receiving ROE to complete site survey. The DD1391 was changed so that the Land Acquisition Project is now 1402 acres. PA revised to $24M. Project is FY04 that is expected to be pulled up to FY03. PPMD requested $307,000 for the Environmental Assessment. POH received MIPR on 6 August 2002 for EA. EC-E has revised the SOW per customer comments and will send SOW to Contracting Division on or before 15 August 2002. Customer has been told that POH does believe land can be acquired before 1 October 2003. OSD waiver is expected to be approved before 1 September 2002.

(3) Recognition and Management of Issues:

(a) District Action Requested: Continue effort to shorten NEPA process time by managing government review periods.

(b) Division Action Requested: None.

(c) HQUSACE Action Requested: None.

k. **Name of Project: FY2002 MCA PN054095 Kahuku Windmill Land Purchase, Schofield Bks, HI (C. Adams)**

(1) Reason for submitting to POD: Upward reportable, command interest and amber.

(2) Discussion: NEPA is missing EBS. The Installation signed EBS and sent to USARPAC on 8 August 2002. Government appraisal was revised to $858K. HQUSACE requires both NEPA documentation and government approved appraisal before issuing real estate directive. Campbell Estate made offer to sell for $990,000 on 12 July 2002. Acquisition date has been extended from 31 July to 30 September 2002.

(3) Recognition and Management of Issues:

(a) District Action Requested: Continue to pursue acquisition. Keep all parties informed.

(b) Division Action Requested: None.

(c) HQUSACE Action Requested: None.

l. **Name of Project: FY2002 MCA PN52148 Land Purchase and Condemn, Schofield Bks, HI (C. Adams)**

(1) Reason for submitting to POD: Upward reportable, command interest and amber.

(2) Discussion: Purchase 1,010,629 acres in PTA. Need NEPA document (EA). NEPA documentation was sent to USARPAC on 8 July 2002. Appraisal was contracted through the Sacramento District. Government appraisal was received for $2.7M. Sacramento found errors in appraisal and asked the contractor to redo the appraisal; revised appraisal is $2.0M. Reprogramming will be required. The acquisition date has been extended from 30 July 2002 to 14 February 2003.

(3) Recognition and Management of Issues:

(a) District Action Requested: Continue to pursue acquisition.

(b) Division Action Requested: None.

(c) HQUSACE Action Requested: None.

m. **Name of Project: FY01 MAI Repair Damage Quarters (Qtrs), Palm Circle, Various Qtrs, Palm Circle, Fort Shafter, HI (T. Luke)**

(1) Reason for submitting to POD: Command interest and green.

(2) Discussion:

Qtrs #5: Task order awarded on 22 March 2001. Start date of 25 October 2002 has been postponed by DPW. No change in status. Awaiting start date.

Qtrs #9: All work complete.

Qtrs #11: Task order awarded on 15 May 2002. Final inspection held 7 August 2002.

Qtrs #3: Task order awarded on 10 June 2002. Final inspection held 7 August 2002.

Qtrs#17: Funds received on 30 May 2002. Site visit for design team scheduled on 26 June 2002. Site visit with the Contractor held on 10 July 2002. Negotiations with contractor on going. Electrical analysis being performed by in-house EE.

(3) Recognition and Management of Issues: None.

n. **Name of Project: FY00 NMD PN BMDO-54206, In-Flight Interceptor Communications System (IFICS) Data Terminal, Kwajalein Island, USAKA. PA = $4.4M (R. Leong)**

(1) Reason for submitting to POD: For information only and green.

(2) Discussion: FM-200 system modification has been negotiated and awarded. New contract BOD is 29 September 2002 (originally 27 August 2002), with some of the FM-200 work to be completed NLT 20 October 2002. The customer has acknowledged that these dates are acceptable, since the IFICS equipment will arrive o/a 28 October 2002 for installation. KRO is coordinating final testing with the follow-on equipment contractor.

(3) Recognition and Management of Issues: Partial BOD of the storage area is being considered to satisfy the customer's needs.

o. **Name of Project: TAMC Program Summary (O. Okada/R. Kurashige)**

(1) Reason for submitting to POD: For information only and green.

(2) Discussion: Program continues toward FY02 year end execution. Projects are running late, but we are making best efforts to execute. Meetings and site visits to be scheduled for week of 12 August 2002 scoping of next year's design projects.

(3) Recognition and Management of Issues: None.

p. **Name of Project: FY06 DMFO Biomedical Research Center, TAMC (O. Okada/R. Kurashige)**

(1) Reason for submitting to POD: For information only and green.

(2) Discussion: There is language in the Senate Rpt. 107-202 - Military Construction Appropriation Bill, 2003 saying "...that not less than $2 million be made available for the design of the facility." However, TAMC anticipates that based on the current project amount, P&D funding of $4.5 million is needed.

(3) Recognition and Management of Issues: None.

q. **Name of Project: FY01 MCA/BUP PN 52265/52266 WBR, Quad F, Phase 4A, Schofield Bks, HI (G. Kuioka)**

(1) Reason for submitting to POD: For information only and green.

(2) Discussion: Conjunctively funded MCA - $43.8M and BUP (OMA) - $21M. Award date: 28 December 2001.

(3) Recognition and Management of Issues: Several issues of concern:

Demolition plans reviewed. Contractor started demolition on 24 July 2002.

Review of 50% design completed 19 July 2002.

Ongoing discussion with ACES (dining facilities authority) regarding two deviations from standard design by occupant. Formal waiver may be needed.

(a) District Action Requested: None.

(b) Division Action Requested: Participation in discussion with ACES and USACE regarding dining facility revisions.

(c) HQUSACE Action Requested: None.

r. **Name of Project: FY00 Miscellaneous Renovations, Building 525, Fort Shafter, HI (G. Kuioka)**

(1) Reason for submitting to POD: Information only and green.

(2) Discussion: The renovation contract was awarded to Aylward on 30 September 2001 for $499K. The Contractor started work 1 March 2002. SHPO has submitted a letter to define their restrictions. Except for minor check list items, restrooms completed. Lanai screens being installed. Safety issues regarding railing for new stairway being discussed. New office windows (fire rated glass) fronting lanai stairwells not yet installed.

(3) Recognition and Management of Issues: None.

s. **Name of Project: Palau Compact Road Project, Republic of Palau (ROP) (D. Kern)**

(1) Reason for submitting to POD: Upward reportable and amber.

(2) Discussion: After a dry spell January-April 2002, rainy weather has returned with the resultant reduction in progress. Contractor-hired aggregate barge ran aground 29 June near West Channel. Resource agencies assessing damage to corals. Request for Equitable Adjustment (REA) received on 30 March. Backup information on the REA has been collected and is now in analysis. Contracting Officer's Final Decision (COFD) due 1 August. Engineer

Research and Development Center (ERDC) conducted an outbrief of proposed Traffic Compacted Reinforced Fill initiative findings at the District on 13 June. POH-Daewoo meeting held 7 August 2002. Daewoo will continue their claim. POH will suspend actions on test fills to validate a TCF method. Daewoo can still independently pursue TCF. Safety: an accident on 25 June (dump truck rear-ending another) resulted in about $2K property damage and only minor injury to one driver. Actual percent complete: 46%.

(3) Recognition and Management of Issues: Several offices (OC, Contracting and Construction Services) are working to determine if REA has merit.

(a) District Action Requested: Action scheduled for completion 1 August 2002. Preliminary report to DOI on findings due 23 July 2002.

(b) Division Action Requested: None.

(c) HQUSACE Action Requested: None.

t. **Name of Project: Kaumalapau Harbor, Lanai, HI (J. Hatashima)**

(1) Reason for submitting to POD: For information only and amber.

(2) Discussion: The current plan of improvements provides for reshaping and rebuilding the existing breakwater to an approximate length of 320 feet with an estimated construction cost of $15,000,000. The Final EA has been completed. The contract documents have been finalized. The conditional Section 401 Water Quality Certification was received 22 July 2002. The Division's comments on the draft decision document are being incorporated. Comments from the State AG's office are being incorporated into the draft PCA. The award of construction contract is April 2003.

(3) Recognition and Management of Issues:

(a) District Action Required: Intensive management on the approvals of PCA and decision document to maintain the current project schedule.

(b) Division Action Requested: None.

(c) HQUSACE Action Requested: None.

u. **Name of Project: Kikiaola SBH, Kauai, HI (S. Ishikawa)**

(1) Reason for submitting to POD: Upward reportable and amber.

x. **Name of Project: Waikiki Beach Erosion Control Study, Honolulu, HI (M. Yoshimoto)**

(1) Reason for submitting to POD: For information only and green.

(2) Discussion: The Waikiki Beach Erosion Control Project was originally authorized for construction by the River and Harbor Act of 1965 (Public Law 89-298). Reevaluation report completed and submitted to POD for review with a recommendation of continued Federal participation in PED phase. If the report is approved by HQUSACE/ASA(CW), PED phase will be initiated in FY03 using funds provided by FY02 Congressional add.

(3) Recognition and Management of Issues:

(a) District Action Requested: Report completion will slip from the projected May 2002 to July 2002.

(b) Division Action Requested: None.

(c) HQUSACE Action Requested: None.

y. **Name of Project: Kahului Deep Draft Harbor, HI (O&M - Maintenance & Repair) (P. Tom)**

(1) Reason for submitting to POD: For information only and green.

(2) Discussion:

(a) Construction Mod #1 awarded on 25 April 2002, in the amount of $133,310 - majority of existing armor stones found to be unsalvageable as originally thought; mod requires the contractor to purchase new armor stones.

(b) Construction Mod #2 awarded on 13 June 2002, in the amount of $205,695 - at no fault of the construction contractor, existing toe stones have become dislodged from the revetment structure; mod requires the contractor to reset toe stones and remove and reset adjacent armor stones. Contractor re-started construction work on 1 July 2002; targeted construction completion date scheduled for 31 July 2002.

(c) Construction Mod #3 to be awarded on or about 12 August 2002, in the amount of $64,173. This work entails the repair of an additional 75 feet of revetment and is similar to the type of repair done in Construction Mod #2.

(d) Contractor's target completion date to complete all repair work, including work on all construction mod items, is scheduled for early September 2002.

(3) Recognition and Management of Issues:

(a) District Action Requested:

(1) Remaining funds received from POA and reprogrammed available POH CW O&M FY02 funds used to fund and execute Construction Mod #2.

(2) Part of the original $160K in funds transferred from POA to POH in June 2002, with assistance from POD, to accelerate POH design work for Manele Harbor Maintenance Dredging Project and the Port Allen Breakwater Repair Project, will be reprogrammed to fund Construction Mod #3. Design work on the Manele project will continue, however, design work on the Port Allen project will be deferred until FY04.

(b) Division Action Requested: POD facilitated transfer of available funds ($250K) from POA to execute Construction Mod #1.

(c) HQUSACE Action Requested: None.

z. **Name of Project: Tanapag Village PCB Contamination, Tanapag Saipan, CNMI (C. Adams)**

(1) Reason for submitting to POD: Upward reportable, command interest and amber.

(2) Discussion: The unit started processing soil on 20 April 2002. Contractor has treated 20,500 tons as of 8 August 2002. Harmon Slappy is on site doing ordnance avoidance while the stockpiles are being screened and crushed. Mod #8 will bring total tonnage to be cleaned to 20,750. Contractor is scheduled to have cleaned 20,750 tons by the end of 12 August 2002. An additional 5,000 tons has been identified requiring an additional $1.41M before the end of the FY. If additional funds are not received before 10 August 2002 contractor will have to go on standby or demobilizes until additional funds are obtained. The Work Plan for groundwater investigation was revised by Wil Chee and resubmitted to EPA on 10 June 2002 for approval.

(3) Recognition and Management of Issues:

(a) District Action Requested: Continue to coordinate processing of the soil.

(b) Division Action Requested: Continue to seek additional funding to complete the project.

(c) HQUSACE Action Requested: Provide funding.

aa. **Name of Project: FY2001 DESC RA Waikakalaua and Kipapa Tank Farms and Pipeline Cleaning, Oahu, HI (F. Nakahara)**

(1) Reason for submitting to POD: For information, command interest and green.

(2) Discussion: Defueling operations continues. Launch and receive sites being investigated. Pigging operations planned for next month.

(3) Recognition and Management of Issues: None.

bb. **Name of Project: FY2002 E-007 Makua Military Reservation EIS, Makua, Oahu, HI (G. Takishita)**

(1) Reason for submitting to POD: For information only and green.

(2) Discussion: POH has been tasked to prepare the EIS for military training activities at Makua Military Reservation, Oahu, Hawaii. The EIS will be conducted IAW the Settlement Agreement and Stipulated Order between Malama Makua and the United States Department of Defense, filed 4 October 2001. Current status: NOI published 20 March 2002, public scoping meetings held on 9 & 13 April 2002 and transcripts posted at public libraries. Phase II contract for the EIS awarded to Tetra Tech. The draft Decision of Proposed Action & Alternatives (DOPAA) review comments are being incorporated into the final DOPAA document. Draft Sampling and Analysis Plans (SAPs) were submitted 8 June for 60-day public comment period. SAP review comments were due and received on 6 August 2002. The review comments are currently being consolidated and analyzed. Current completion date is 6 February 2004.

(3) Recognition and Management of Issues: Burn Plan for UXO Clearance/Archaeological Survey scheduled for September, EA for plan execution in progress. I/O public briefings were held on 16 & 18 July 2002.

(a) District Action Requested: AAR scheduled for 14 November 2003.

(b) Division Action Requested: None.

(c) HQUSACE Action Requested: None.

cc. **Name of Project: DERP/FUDS Waikoloa Maneuver Area, Waikoloa Village and Surrounding Areas, Island of HI (C. Streck)**

(1) Reason for submitting to POD: For information only and green.

(2) Discussion: Construction support for County of Hawaii/Waikoloa Village Association road programmed. HND acquisition plan for clean-up contract completed and submitted to HQ, reviewed, revised, and accepted August 2002. Preliminary construction schedule received from Department of Hawaiian Homelands for project at Lalamilo to be supported through ordnance safety construction support. Notice to be published for ordnance clearance project end of August 2002. Pre-bid site visit scheduled mid-September 2002.

(3) Recognition and Management of Issues:

(a) District Action Requested: None.

(b) Division Action Requested: None.

(c) HQUSACE Action Requested: None.

dd. **Name of Project: SBCT EIS, Various Locations, HI (E. Nagasawa)**

(1) Reason for submitting to POD: For information only and green.

(2) Discussion: All seven scheduled scoping meetings have been held, and last day to submit comments extended to 29 June 2002. To date we have 100 speakers at the scoping meetings, and received 30 letters, 17 email comments, 11 website comments, 1 petition, and 214 form letters. Draft EIS scheduled for public review 19 February 2003; the Final EIS for public review, 15 August 2003; and completion of the EIS/Record of Decision date on 8 October 2003. Completed botanical and cultural surveys for PTA and lower PTA Tank Trail on non-Parker Ranch lands. Botanical surveys complete for Parker Ranch Keamuku land; however, and the cultural surveys are at 60%. Draft Biological Assessment (BA) under review with suspense of 4 September 2002, and the Final BA to be submitted to USFWS in January 2003. Biological Opinion from USFWS expected in May 2003.

(3) Recognition and Management of Issues: None.

5. Specific Issues Submitted for action/information: None.

6. PRB Chairman Comments: None.

Encl

RAY H. JYO, P.E.
Deputy District Engineer for
Programs and Project Management

CEPOH-PP
SUBJECT: POH PRB Executive Summary

DISTRIBUTION VIA EMAIL:
BG Ronald L. Johnson, CEPOD-DE
COL Terry R Youngbluth, CEPOD-CS
Mr. Thomas Ushijima, CEPOD-MM
Mr. Adrian Au, CEPOD-MM
Mr. Andrew Constantaras, CEPOD-CW-T
Mr. Paul Yoo, CEPOD-CW-P
Mr. David Lau, CEPOD-CW-P
Ms. Helen Stupplebeen, CEPOD-MM-M
LTC David C. Press, CEPOH-DE
MAJ Scott A. Schriner, CEPOH-DD
Mr. Ray Jyo, CEPOH-PP
Mr. Wendell Awada, CEPOH-PP-E
Mr. James Bersson, CEPOH-EC
Mr. Samuel Song, CEPOH-EC
Mr. David Kam, CEPOH-CT
Mr. Vincent Faggioli, CEPOH-OC
Ms. Pat Billington, CEPOH-OC
Ms. Janice Brissette, CEPOH-RM
Mr. Randall Tsuneyoshi, CEPOH-RE
Ms. Monica Kaji, CEPOH-DB
Mr. Douglas MaKitten, CEPOH-PA
Mr. Andrew Kohashi, CEPOH-PP-A
Mr. Paul Mizue, CEPOH-PP-C
Mr. Richard Raber, CEPOH-PP-M
Mr. Glen Takishita, CEPOH-PP
Mr. David Lindsey, CEPOH-PP-A
Mr. Kenneth Cabalce, CEPOH-PP-A
Ms. Karen Chang, CEPOH-PP-A
Mr. Jon Hosaka, CEPOH-PP-A
Mr. Lawrence Kawasaki, CEPOH-PP-A
Ms. Tammy Luke, CEPOH-PP-A
Ms. Lynette Oh, CEPOH-PP-A
Mr. Roy Tamashiro, CEPOH-PP-A
Mr. Clyde Tomihara, CEPOH-PP-A
Mr. Robert Inouye, CEPOH-PP-D
Mr. Randall Kurashige, CEPOH-PP-D
Mr. Rodney Leong, CEPOH-PP-D
Mr. Olson Okada, CEPOH-PP-D
Mr. Mark Smith, CEPOH-PP-D
Mr. Charles Adams, CEPOH-PP-E
Ms. Beth Miura, CEPOH-PP-E
Mr. Earl Nagasawa, CEPOH-PP-E

Mr. Frederick Nakahara, CEPOH-PP-E
Mr. Charles Streck, CEPOH-PP-E
Ms. Helene Takemoto, CEPOH-PP-E
Mr. Edward Yamada, CEPOH-EC-E
Mr. Leslie Asuka, CEPOH-PP-C
Mr. Joseph Barboo, CEPOH-PP-C
Mr. Derek Chow, CEPOH-PP-C
Mr. James Hatashima, CEPOH-PP-C
Ms. Sharon Ishikawa, CEPOH-PP-C
Mr. David Kern, CEPOH-PP-C
Mr. Gordon Kuioka, CEPOH-PP-C
Mr. Harold Nakaoka, CEPOH-PP-C
Mr. Milton Yoshimoto, CEPOH-PP-C
Mr. James Pennaz, CEPOH-EC-T
Mr. Stanley Boc, CEPOH-EC-T
Mr. Patrick Tom, CEPOH-EC-T

ROSTER OF ATTENDEES
POH PROJECT REVIEW BOARD (PRB)
8 AUGUST 2002, 0830 HRS, RM 322, CONFERENCE ROOM

PRB Members or Alternates

LTC David C. Press
CEPOH-DE

MAJ Scott A. Schriner
CEPOH-DD

Mr. Ray H. Jyo
CEPOH-PP

Mr. Wendell S. Awada
CEPOH-PP-Z

Mr. James L. Bersson
CEPOH-EC

Mr. Samuel C. S. Song*
CEPOH-EC-Z

Mr. Vincent J. Faggioli
CEPOH-OC

Mr. David Y. Kam
CEPOH-CT

Mr. Robert W. Lau*
CEPOH-RM

*Alternate

Other Attendees

Ms. Monica Kaji
Mr. Douglas MaKitten
Mr. Richard Raber
Mr. Michael Sakai
Mr. Andrew Kohashi
Mr. Frederick Nakahara
Mr. Robert Inouye
Mr. Jon Hosaka
Mr. Mark Smith
Mr. Charles Adams
Mr. Rodney Leong
Mr. Olson Okada
Mr. Gordon Kuioka
Mr. James Hatashima
Ms. Sharon Ishikawa
Mr. Milton Yoshimoto
Mr. Earl Nagasawa

Encl

Appendix E:

Water Quality Baseline Monitoring Program Reports

WATER QUALITY BASELINE MONITORING PROGRAM

IAO STREAM FLOOD CONTROL PROJECT

WAILUKU, MAUI, HAWAII

REPORT 2-96
October 29, 1996

Prepared for

U.S. ARMY ENGINEER DISTRICT, HONOLULU
Bldg. 230
Fort Shafter, HI 96858-5440

by

Marine Research Consultants
4467 Sierra Dr.
Honolulu, HI 96816

November 1, 1996

PURPOSE and METHODS

The purpose of the program is to conduct water sampling and analyses at specified sampling stations as part of the pre-construction planning for modification to the Iao Stream flood Control Project, on Maui, Hawaii. The water sampling and analyses is to be conducted at four stations located in the nearshore ocean off of the mouth of Iao Stream. The goal of the sampling program is to obtain a representative group of samples that will define the dimensions of the envelope of natural variability in oceanic water quality constituents that may be affected by future construction of the flood control features in upper Iao Stream. The establishment of this baseline data set is a necessary prerequisite for determining if, and to what extent, construction of the flood control features is altering ocean water quality beyond the level of natural variability.

As specified by the Corps of Engineers, the baseline water quality monitoring is comprised of sampling at five (4) stations; Stations 1 and 3 are located approximately 25 m (80 feet) from the shoreline off the southern and northern sides of the mouth of Iao Stream, respectively. Stations 2 and 4 are located approximately 75 m (240 feet) from the shoreline off the southern and northern sides of the mouth of Iao Stream, respectively (see Figure 1).

In order to obtain a representative sampling that has equal chance of encountering all conditions of tide and weather, each sampling is conducted at a set time. The time selected is every fourth Tuesday at 10:30. The initial sampling was conducted at this time on October 1, 1996.

The area off of Iao Stream is composed of a shallow, boulder covered bottom with a gradual slope. During many conditions of sea and swell, breaking surf occurs along the shoreline in the region of sampling. As a result, use of a boat to collect samples is prohibitive. Sampling, therefore, is conducted by divers swimming from shore and opening bottles at the desired locations. Sampling locations are determined by triangulation with shoreline landmarks. Latitude and longitude at each of the sampling points were determined with a hand-held global positioning system (GPS) during the initial sampling (see Figure 1).

At each sampling water was collected in 1-liter pre-washed sampling bottles in the approximate center of the water column. pH was measured in the field immediately following sample collection using a field meter. Sample splits were stored on ice and returned to Honolulu for other analyses. Turbidity was measured on a 90 degree nephelometer with a precision of 0.01 nephelometric turbidity units (n.t.u). Total suspended solids (TSS) was determined gravimetrically. All laboratory analyses are conducted by Marine Analytical Specialists (Laboratory Certification NO. HI-0009).

RESULTS and DISCUSSION

Table 1 shows results of the water quality constituents collected on October 29, 1996. Weather and sea conditions consisted of strong northeasterly tradewinds and waves of 3-5 feet breaking in the nearshore zone. As a result of the strong winds and large waves, nearshore waters in the area of sampling were extremely turbid with very limited visibility. Samples were collected during a falling tide at a height of approximately +1.0 feet. Samples 1 and 3 were collected in the region where waves were breaking; samples 2 and 4 were collected seaward of the break.

Results of water sampling reveal no distinct patterns. Turbidity and pH were similar at all stations. TSS and pH were slightly higher at Stations 1 and 2 on the south side of the stream mouth, compared to stations 3 and 4 on the north side of the stream. TSS, however, was slightly lower at Stations 1 and 2 compared to Stations 3 and 4.

Appendix A shows cumulative results of all surveys to date at Iao Stream. The previous survey on October 1, 1996 was conducted during conditions with calm winds and substantially smaller surf than on October 29. It can be seen that TSS and turbidity on October 29 were approximately 2 to 4 fold higher than on October 1. It is apparent that the increased turbulence has a direct effect on suspended material in the water column.

The next phase of monitoring will be conducted on November 19, 1996.

Steven Dollar, Ph.D.
Principal Investigator

TABLE 1. Water quality measurements off of the mouth of Iao Stream, M
Collection Date: October 29, 1996; 10:30
For station locations see Figure 1.

Sample ID	TSS (mg/l)	Turb (ntu)	pH (rel)
IAO-1	3.20	0.38	8.091
IAO-2	4.00	0.30	8.111
IAO-3	4.07	0.26	8.071
IAO-4	4.87	0.25	8.079

WATER QUALITY BASELINE MONITORING PROGRAM

IAO STREAM FLOOD CONTROL PROJECT

WAILUKU, MAUI, HAWAII

REPORT 3-96
November 26, 1996

Prepared for

U.S. ARMY ENGINEER DISTRICT, HONOLULU
Bldg. 230
Fort Shafter, HI 96858-5440

by

Marine Research Consultants
4467 Sierra Dr.
Honolulu, HI 96816

December 15, 1996

PURPOSE and METHODS

The purpose of the program is to conduct water sampling and analyses at specified sampling stations as part of the pre-construction planning for modification to the Iao Stream flood Control Project, on Maui, Hawaii. The water sampling and analyses is conducted at four stations located in the nearshore ocean off of the mouth of Iao Stream. The goal of the sampling program is to obtain a representative group of samples that will define the dimensions of the envelope of natural variability in oceanic water quality constituents that may be affected by future construction of the flood control features in upper Iao Stream. The establishment of this baseline data set is a necessary prerequisite for determining if, and to what extent, construction of the flood control features is altering ocean water quality beyond the level of natural variability.

As specified by the Corps of Engineers, the baseline water quality monitoring is comprised of sampling at five (4) stations; Stations 1 and 3 are located approximately 25 m (80 feet) from the shoreline off the southern and northern sides of the mouth of Iao Stream, respectively. Stations 2 and 4 are located approximately 75 m (240 feet) from the shoreline off the southern and northern sides of the mouth of Iao Stream, respectively (see Figure 1).

In order to obtain a representative sampling that has equal chance of encountering all conditions of tide and weather, each sampling is conducted at a set time. The time selected is every fourth Tuesday at 10:30. The initial sampling was conducted at this time on October 1, 1996.

The area off of Iao Stream is composed of a shallow, boulder covered bottom with a gradual slope. During many conditions of sea and swell, breaking surf occurs along the shoreline in the region of sampling. As a result, use of a boat to collect samples is prohibitive. Sampling, therefore, is conducted by divers swimming from shore and opening bottles at the desired locations. Sampling locations are determined by triangulation with shoreline landmarks. Latitude and longitude at each of the sampling points were determined with a hand-held global positioning system (GPS) during the initial sampling (see Figure 1).

At each sampling water was collected in 1-liter pre-washed sampling bottles in the approximate center of the water column. pH was measured in the field immediately following sample collection using a field meter. Sample splits were stored on ice and returned to Honolulu for other analyses. Turbidity was measured on a 90 degree nephelometer with a precision of 0.01 nephelometric turbidity units (n.t.u). Total suspended solids (TSS) was determined gravimetrically. All laboratory analyses are conducted by Marine Analytical Specialists (Laboratory Certification NO. HI-0009).

RESULTS and DISCUSSION

Table 1 shows results of the water quality constituents collected on November 26, 1996. Weather and sea conditions consisted of strong northeasterly tradewinds of 10-15 knots, and waves of 1-2 feet breaking in the nearshore zone. As a result of the moderately strong winds and breaking waves, nearshore waters in the area of sampling were extremely turbid with very limited visibility. Samples were collected during a falling tide at a height of approximately +1.0 feet. Samples 1 and 3 were collected in the region where waves were breaking; samples 2 and 4 were collected seaward of the break. During the sampling, there was a small discharge of stream water to the ocean from Iao stream. While no rain occurred during the 24-hour period preceding the sampling, torrential rains, flooding and very large surf occurred during a period approximately two weeks prior to the monitoring.

Results of water sampling reveal no distinct patterns. TSS and pH were slightly higher at stations 1 and 2 on the south side of the stream mouth, compared to stations 3 and 4 on the north side of the stream. Turbidity, on the other hand, was slightly higher at stations 3 and 4 on the north side of the stream mouth. TSS was also slightly higher at both inshore stations (1 and 3) compared to the corresponding offshore stations (2 and 4). Turbidity did not reflect the same pattern with a value higher at station 4 compared to station 3.

Appendix A shows cumulative results of all surveys to date at Iao Stream. The initial survey on October 1, 1996 was conducted during conditions with calm winds and substantially smaller surf than on the subsequent samplings on October 29 and November 26, 1996. It can be seen that TSS and turbidity on October 29 and November 26 were approximately 2 to 4 fold higher than on

October 1. It is apparent that the increased turbulence from wave action has a direct effect on suspended material in the water column.

The next phase of monitoring will be conducted on December 24, 1996.

Steven Dollar, Ph.D.
Principal Investigator

TABLE 1. Water quality measurements off of the mouth of Iao Stream, M
Collection Date: November 26, 1996; 10:30
For station locations see Figure 1.

Sample ID	TSS (mg/l)	Turb (ntu)	pH (rel)
IAO-1	4.60	0.18	8.208
IAO-2	3.53	0.17	8.214
IAO-3	2.93	0.22	8.186
IAO-4	1.60	0.39	8.179

WATER QUALITY BASELINE MONITORING PROGRAM

IAO STREAM FLOOD CONTROL PROJECT

WAILUKU, MAUI, HAWAII

REPORT 4-96
December 24, 1996

Prepared for

U.S. ARMY ENGINEER DISTRICT, HONOLULU
Bldg. 230
Fort Shafter, HI 96858-5440

by

Marine Research Consultants
4467 Sierra Dr.
Honolulu, HI 96816

January 5, 1997

PURPOSE and METHODS

The purpose of the program is to conduct water sampling and analyses at specified sampling stations as part of the pre-construction planning for modification to the Iao Stream flood Control Project, on Maui, Hawaii. The water sampling and analyses is conducted at four stations located in the nearshore ocean off of the mouth of Iao Stream. The goal of the sampling program is to obtain a representative group of samples that will define the dimensions of the envelope of natural variability in oceanic water quality constituents that may be affected by future construction of the flood control features in upper Iao Stream. The establishment of this baseline data set is a necessary prerequisite for determining if, and to what extent, construction of the flood control features is altering ocean water quality beyond the level of natural variability.

As specified by the Corps of Engineers, the baseline water quality monitoring is comprised of sampling at four (4) stations; Stations 1 and 3 are located approximately 25 m (80 feet) from the shoreline off the southern and northern sides of the mouth of Iao Stream, respectively. Stations 2 and 4 are located approximately 75 m (240 feet) from the shoreline off the southern and northern sides of the mouth of Iao Stream, respectively (see Figure 1).

In order to obtain a representative sampling that has equal chance of encountering all conditions of tide and weather, each sampling is conducted at a set time. The time selected is every fourth Tuesday at 10:30. The initial sampling was conducted at this time on October 1, 1996.

The area off of Iao Stream is composed of a shallow, boulder covered bottom with a gradual slope. During many conditions of sea and swell, breaking surf occurs along the shoreline in the region of sampling. As a result, use of a boat to collect samples is prohibitive. Sampling, therefore, is conducted by divers swimming from shore and opening bottles at the desired locations. Sampling locations are determined by triangulation with shoreline landmarks. Latitude and longitude at each of the sampling points were determined with a hand-held global positioning system (GPS) during the initial sampling (see Figure 1).

At each sampling site water was collected in 1-liter pre-washed sampling bottles in the approximate center of the water column. pH was measured in the field immediately following sample collection using a field meter. Sample splits were stored on ice and returned to Honolulu for other analyses. Turbidity was measured on a 90 degree nephelometer with a precision of 0.01 nephelometric turbidity units (n.t.u). Total suspended solids (TSS) was determined gravimetrically. All laboratory analyses are conducted by Marine Analytical Specialists (Laboratory Certification NO. HI-0009).

RESULTS and DISCUSSION

Table 1 shows results of the water quality constituents collected on December 24, 1996. Weather conditions consisted of heavy rain that had fallen for several days prior to sampling and continued during the sampling. As a result of the heavy prolonged rain, there was high flow through Iao Stream to the ocean during the sampling. Water flowing into the ocean from the stream was observed to be clear with little visible turbidity or suspended material. Sea conditions consisted of no wind and waves of 2-4 feet breaking in the nearshore zone. Even with the breaking waves, nearshore waters in the area of sampling were relatively clear, especially considering the amount of stream water entering the ocean. Samples were collected during a falling tide at a height of approximately +0.4 feet. Samples 1 and 3 were collected in the region where waves were breaking; samples 2 and 4 were collected seaward of the break. During the sampling, there was a major discharge of stream water to the ocean from Iao stream.

Results of water sampling reveal distinctly elevated TSS at Station 2 compared to the other three sites. Other measurements show no distinct pattern with respect to proximity to the shoreline or to location on either side of the stream.

Appendix A shows cumulative results of all surveys to date at Iao Stream. The initial survey on October 1, 1996 was conducted during conditions with calm winds and substantially smaller surf than on the subsequent samplings on October 29 and November 26, 1996. It can be seen that TSS and turbidity on October 29 and November 26 were approximately 2 to 4 fold higher than on October 1. It is apparent that the increased turbulence from wave action has a direct effect on suspended material in the water column. The survey conducted on December 24 occurred during both high surf and high stream flow. It can be seen in Appendix A that turbidity is elevated by approximately an order of magnitude at Stations 1-3 in December compared to the other three sampling periods. The measure of turbidity at Station 2 in December of 16.4 mg/L is also substantially elevated compared to all measurements in previous surveys.

The next phase of monitoring will be conducted on January 21, 1996.

______________________________ ____________

Steven Dollar, Ph.D.
Principal Investigator

TABLE 1. Water quality measurements off of the mouth of Iao Stream, M
Collection Date: December 24, 1996; 10:30
For station locations see Figure 1.

Sample ID	TSS (mg/l)	Turb (ntu)	pH (rel)
IAO-1	2.67	1.80	7.943
IAO-2	16.40	1.35	7.969
IAO-3	3.47	2.20	8.161
IAO-4	5.27	0.51	8.149

WATER QUALITY BASELINE MONITORING PROGRAM

IAO STREAM FLOOD CONTROL PROJECT

WAILUKU, MAUI, HAWAII

REPORT 1-97
January 21, 1997

Prepared for

U.S. ARMY ENGINEER DISTRICT, HONOLULU
Bldg. 230
Fort Shafter, HI 96858-5440

by

Marine Research Consultants
4467 Sierra Dr.
Honolulu, HI 96816

February 5, 1997

PURPOSE and METHODS

The purpose of the program is to conduct water sampling and analyses at specified sampling stations as part of the pre-construction planning for modification to the Iao Stream flood Control Project, on Maui, Hawaii. The water sampling and analyses is conducted at four stations located in the nearshore ocean off of the mouth of Iao Stream. The goal of the sampling program is to obtain a representative group of samples that will define the dimensions of the envelope of natural variability in oceanic water quality constituents that may be affected by future construction of the flood control features in upper Iao Stream. The establishment of this baseline data set is a necessary prerequisite for determining if, and to what extent, construction of the flood control features is altering ocean water quality beyond the level of natural variability.

As specified by the Corps of Engineers, the baseline water quality monitoring is comprised of sampling at four (4) stations; Stations 1 and 3 are located approximately 25 m (80 feet) from the shoreline off the southern and northern sides of the mouth of Iao Stream, respectively. Stations 2 and 4 are located approximately 75 m (240 feet) from the shoreline off the southern and northern sides of the mouth of Iao Stream, respectively (see Figure 1).

In order to obtain a representative sampling that has equal chance of encountering all conditions of tide and weather, each sampling is conducted at a set time. The time selected is every fourth Tuesday at 10:30. The initial sampling was conducted at this time on October 1, 1996.

The area off of Iao Stream is composed of a shallow, boulder covered bottom with a gradual slope. During many conditions of sea and swell, breaking surf occurs along the shoreline in the region of sampling. As a result, use of a boat to collect samples is prohibitive. Sampling, therefore, is conducted by divers swimming from shore and opening bottles at the desired locations. Sampling locations are determined by triangulation with shoreline landmarks. Latitude and longitude at each of the sampling points were determined with a hand-held global positioning system (GPS) during the initial sampling (see Figure 1).

At each sampling site water was collected in 1-liter pre-washed sampling bottles in the approximate center of the water column. pH was measured in the field immediately following sample collection using a field meter. Sample splits were stored on ice and returned to Honolulu for other analyses. Turbidity was measured on a 90 degree nephelometer with a precision of 0.01 nephelometric turbidity units (n.t.u). Total suspended solids (TSS) was determined gravimetrically. All laboratory analyses are conducted by Marine Analytical Specialists (Laboratory Certification NO. HI-0009).

RESULTS and DISCUSSION

Table 1 shows results of the water quality constituents collected on January 21, 1997. Weather conditions consisted of sunny skies with south winds of 8-10 knots. While no rainfall occurred in the 24-hour period preceding sampling, heavy rain had fallen during the previous week, and stopped approximately 48 hours prior to sampling. As a result of the heavy prolonged rain, there was high flow through Iao Stream to the ocean during the sampling. Water flowing into the ocean from the stream was observed to be clear with little visible turbidity or suspended material. Sea conditions were calm with waves of 1-2 feet breaking in the nearshore zone. Even with the breaking waves, nearshore waters in the area of sampling were relatively clear, especially considering the amount of stream water entering the ocean. Samples were collected during a falling tide at a height of approximately +0.4 feet. Samples 1 and 3 were collected in the region where waves were breaking; samples 2 and 4 were collected seaward of the break. During the sampling, there was discharge of stream water to the ocean from Iao stream.

Results of water sampling reveal distinctly elevated TSS and turbidity at Station 1 compared to the other three sites. Other measurements show no distinct pattern with respect to proximity to the shoreline or to location on either side of the stream.

Appendix A shows cumulative results of all surveys to date at Iao Stream. The initial survey on October 1, 1996 was conducted during conditions with calm

winds and substantially smaller surf than on the subsequent samplings on October 29 and November 26, 1996. It can be seen that TSS and turbidity on October 29 and November 26 were approximately 2 to 4 fold higher than on October 1. It is apparent that the increased turbulence from wave action has a direct effect on suspended material in the water column. The survey conducted on December 24 occurred during both high surf and high stream flow. It can be seen in Appendix A that turbidity is elevated by approximately an order of magnitude at Stations 1-3 in December compared to the other three sampling periods. The measure of turbidity at Station 2 in December of 16.4 mg/L is also substantially elevated compared to all measurements
in previous surveys. While stream flow also occurred during the January 1997 sampling, it can be seen in Appendix 1 that TSS and turbidity were among the lowest of all samplings. It appears that the prolonged period of rain that may have washed much of the particulate material from the stream bed in the days prior to sampling, and the low surf height may result in relatively low levels of turbidity and suspended material in the nearshore water column.

The next phase of monitoring will be conducted on February 18, 1997.

Steven Dollar, Ph.D.
Principal Investigator

TABLE 1. Water quality measurements off of the mouth of Iao Stream, M
Collection Date: January 21, 1997; 10:30
For station locations see Figure 1.

Sample ID	TSS (mg/l)	Turb (ntu)	pH (rel)
IAO-1	2.67	0.26	8.183
IAO-2	0.80	0.14	8.159
IAO-3	0.67	0.15	8.167
IAO-4	0.73	0.14	8.152

WATER QUALITY BASELINE MONITORING PROGRAM

IAO STREAM FLOOD CONTROL PROJECT

WAILUKU, MAUI, HAWAII

REPORT 2-97
February 18, 1997

Prepared for

U.S. ARMY ENGINEER DISTRICT, HONOLULU
Bldg. 230
Fort Shafter, HI 96858-5440

by

Marine Research Consultants
4467 Sierra Dr.
Honolulu, HI 96816

March 21, 1997

PURPOSE and METHODS

The purpose of the program is to conduct water sampling and analyses at specified sampling stations as part of the pre-construction planning for modification to the Iao Stream flood Control Project, on Maui, Hawaii. The water sampling and analyses is conducted at four stations located in the nearshore ocean off of the mouth of Iao Stream. The goal of the sampling program is to obtain a representative group of samples that will define the dimensions of the envelope of natural variability in oceanic water quality constituents that may be affected by future construction of the flood control features in upper Iao Stream. The establishment of this baseline data set is a necessary prerequisite for determining if, and to what extent, construction of the flood control features is altering ocean water quality beyond the level of natural variability.

As specified by the Corps of Engineers, the baseline water quality monitoring is comprised of sampling at four (4) stations; Stations 1 and 3 are located approximately 25 m (80 feet) from the shoreline off the southern and northern sides of the mouth of Iao Stream, respectively. Stations 2 and 4 are located approximately 75 m (240 feet) from the shoreline off the southern and northern sides of the mouth of Iao Stream, respectively (see Figure 1).

In order to obtain a representative sampling that has equal chance of encountering all conditions of tide and weather, each sampling is conducted at a set time. The time selected is every fourth Tuesday at 10:30. The initial sampling was conducted at this time on October 1, 1996.

The area off of Iao Stream is composed of a shallow, boulder covered bottom with a gradual slope. During many conditions of sea and swell, breaking surf occurs along the shoreline in the region of sampling. As a result, use of a boat to collect samples is prohibitive. Sampling, therefore, is conducted by divers swimming from shore and opening bottles at the desired locations. Sampling locations are determined by triangulation with shoreline landmarks. Latitude and longitude at each of the sampling points were determined with a hand-held global positioning system (GPS) during the initial sampling (see Figure 1).

At each sampling site water was collected in 1-liter pre-washed sampling bottles in the approximate center of the water column. pH was measured in the field immediately following sample collection using a field meter. Sample splits were stored on ice and returned to Honolulu for other analyses. Turbidity was measured on a 90 degree nephelometer with a precision of 0.01 nephelometric turbidity units (n.t.u). Total suspended solids (TSS) was determined gravimetrically. All laboratory analyses are conducted by Marine Analytical Specialists (Laboratory Certification NO. HI-0009).

RESULTS and DISCUSSION

Table 1 shows results of the water quality constituents collected on February 18, 1997. Weather conditions consisted of sunny skies with northeast winds of 10-12 knots. Sea conditions were choppy with waves of approximately 1-2 feet breaking in the nearshore zone. No rain occurred during the sampling nor for the 24-hr. period preceding the sampling. No water was flowing from the stream. Samples were collected during a rising tide at a height of approximately +0.8 feet. Samples 1 and 3 were collected in the region where waves were breaking; samples 2 and 4 were collected seaward of the break.

Results of water sampling reveal distinctly elevated TSS and turbidity at Stations 1 and compared to Stations 3 and 4. Turbidity was elevated at Station 1 compared to the other three sites. pH showed no distinct pattern with respect to proximity to the shoreline or to location on either side of the stream.

Appendix A shows cumulative results of all surveys to date at Iao Stream. The initial survey on October 1, 1996 was conducted during conditions with calm winds and substantially smaller surf than on the subsequent samplings on October 29 and November 26, 1996. It can be seen that TSS and turbidity on October 29 and November 26 were approximately 2 to 4 fold higher than on October 1. It is apparent that the increased turbulence from wave action has a direct effect on suspended material in the water column. The survey conducted on December 24 occurred during both high surf and high stream flow. It can be seen in Appendix A that turbidity is elevated by approximately an order of magnitude at Stations 1-3 in December compared to the other three sampling periods. The measure of turbidity at Station 2 in December of 16.4 mg/L is also substantially elevated compared to all measurements in previous surveys. While stream flow also occurred during the January 1997 samplings, it can be seen in Appendix 1 that TSS and turbidity were among the lowest of all samplings on these dates. It appears that the prolonged period of rain that may have washed much of the particulate material from the stream bed in the days prior to sampling, and the low surf height may result in relatively low levels of turbidity and suspended material in the nearshore water column. With no stream flow during the February 1997 sampling, and small wave height, there were characteristically low values of suspended material in the water column.

The next phase of monitoring will be conducted on March 18, 1997.

Steven Dollar, Ph.D.
Principal Investigator

TABLE 1. Water quality measurements off of the mouth of Iao Stream, M
Collection Date: February 18, 1997; 10:00
For station locations see Figure 1.

Sample ID	TSS (mg/l)	Turb (ntu)	pH (rel)
IAO-1	1.93	0.23	8.199
IAO-2	1.33	0.16	8.223
IAO-3	0.73	0.16	8.238
IAO-4	0.67	0.15	8.193

WATER QUALITY BASELINE MONITORING PROGRAM

IAO STREAM FLOOD CONTROL PROJECT

WAILUKU, MAUI, HAWAII

REPORT 3-97
March 18, 1997

Prepared for

U.S. ARMY ENGINEER DISTRICT, HONOLULU
Bldg. 230
Fort Shafter, HI 96858-5440

by

Marine Research Consultants
4467 Sierra Dr.
Honolulu, HI 96816

March 31, 1997

PURPOSE and METHODS

The purpose of the program is to conduct water sampling and analyses at specified sampling stations as part of the pre-construction planning for modification to the Iao Stream flood Control Project, on Maui, Hawaii. The water sampling and analyses is conducted at four stations located in the nearshore ocean off of the mouth of Iao Stream. The goal of the sampling program is to obtain a representative group of samples that will define the dimensions of the envelope of natural variability in oceanic water quality constituents that may be affected by future construction of the flood control features in upper Iao Stream. The establishment of this baseline data set is a necessary prerequisite for determining if, and to what extent, construction of the flood control features is altering ocean water quality beyond the level of natural variability.

As specified by the Corps of Engineers, the baseline water quality monitoring is comprised of sampling at four (4) stations; Stations 1 and 3 are located approximately 25 m (80 feet) from the shoreline off the southern and northern sides of the mouth of Iao Stream, respectively. Stations 2 and 4 are located approximately 75 m (240 feet) from the shoreline off the southern and northern sides of the mouth of Iao Stream, respectively (see Figure 1).

In order to obtain a representative sampling that has equal chance of encountering all conditions of tide and weather, each sampling is conducted at a set time. The time selected is every fourth Tuesday at 10:30. The initial sampling was conducted at this time on October 1, 1996.

The area off of Iao Stream is composed of a shallow, boulder covered bottom with a gradual slope. During many conditions of sea and swell, breaking surf occurs along the shoreline in the region of sampling. As a result, use of a boat to collect samples is prohibitive. Sampling, therefore, is conducted by divers swimming from shore and opening bottles at the desired locations. Sampling locations are determined by triangulation with shoreline landmarks. Latitude and longitude at each of the sampling points were determined with a hand-held global positioning system (GPS) during the initial sampling (see Figure 1).

At each sampling site water was collected in 1-liter pre-washed sampling bottles in the approximate center of the water column. pH was measured in the field immediately following sample collection using a field meter. Sample splits were stored on ice and returned to Honolulu for other analyses. Turbidity was measured on a 90 degree nephelometer with a precision of 0.01 nephelometric turbidity units (n.t.u). Total suspended solids (TSS) was determined gravimetrically. All laboratory analyses are conducted by Marine Analytical Specialists (Laboratory Certification NO. HI-0009).

RESULTS and DISCUSSION

Table 1 shows results of the water quality constituents collected on March 18, 1997. Weather conditions consisted of sunny skies with north winds of 10-12 knots. Sea conditions were choppy with waves of approximately 2-3 feet breaking in the nearshore zone. A storm front passed through Maui during the two days prior to sampling with rainfall accumulations of about 1.4". As a result, Iao stream was flowing during the sampling. Stream water appeared clear with little suspended particulate material, while nearshore ocean water appeared turbid. Samples were collected during a rising tide at a height of approximately +1.0 feet. Samples 1 and 3 were collected in the region where waves were breaking; samples 2 and 4 were collected seaward of the break.

Results of water sampling reveal somewhat higher TSS, turbidity and pH at Stations 1 and 2 compared to corresponding Stations 3 and 4. Appendix A shows cumulative results of all surveys to date at Iao Stream. The initial survey on October 1, 1996 was conducted during conditions with calm winds and substantially smaller surf than on the subsequent samplings on October 29 and November 26, 1996. It can be seen that TSS and turbidity on October 29 and November 26 were approximately 2 to 4 fold higher than on October 1. It is apparent that the increased turbulence from wave action has a direct effect on suspended material in the water column. The survey conducted on December 24 occurred during both high surf and high stream flow. It can be seen in Appendix A that turbidity is elevated by approximately an order of magnitude at Stations 1-3 in December compared to the other three sampling periods. The measure of turbidity at Station 2 in December of 16.4 mg/L is also substantially elevated compared to all measurements in previous surveys.

While stream flow also occurred during the January 1997 samplings, it can be seen in Appendix 1 that TSS and turbidity were among the lowest of all samplings on these dates. It appears that the prolonged period of rain that may have washed much of the particulate material from the stream bed in the days prior to sampling, and the low surf height may result in relatively low levels of turbidity and suspended material in the nearshore water column. With no stream flow during the February 1997 sampling, and small wave height, there were characteristically low values of suspended material in the water column. Recent rain and stream flow during the March survey resulted again in elevated TSS and turbidity compared to periods of no stream flow.

The next phase of monitoring will be conducted on April 15, 1997.

Steven Dollar, Ph.D.
Principal Investigator

TABLE 1. Water quality measurements off of the mouth of Iao Stream, M
Collection Date: March 18, 1997; 10:00
For station locations see Figure 1.

Sample ID	TSS (mg/l)	Turb (ntu)	pH (rel)
IAO-1	5.33	0.39	8.166
IAO-2	4.67	0.28	8.115
IAO-3	4.93	0.32	8.155
IAO-4	3.87	0.22	8.111

WATER QUALITY BASELINE MONITORING PROGRAM

IAO STREAM FLOOD CONTROL PROJECT

WAILUKU, MAUI, HAWAII

REPORT 4-97
April 15, 1997

Prepared for

U.S. ARMY ENGINEER DISTRICT, HONOLULU
Bldg. 230
Fort Shafter, HI 96858-5440

by

Marine Research Consultants
4467 Sierra Dr.
Honolulu, HI 96816

May 11, 1997

PURPOSE and METHODS

The purpose of the program is to conduct water sampling and analyses at specified sampling stations as part of the pre-construction planning for modification to the Iao Stream flood Control Project, on Maui, Hawaii. The water sampling and analyses is conducted at four stations located in the nearshore ocean off of the mouth of Iao Stream. The goal of the sampling program is to obtain a representative group of samples that will define the dimensions of the envelope of natural variability in oceanic water quality constituents that may be affected by future construction of the flood control features in upper Iao Stream. The establishment of this baseline data set is a necessary prerequisite for determining if, and to what extent, construction of the flood control features is altering ocean water quality beyond the level of natural variability.

As specified by the Corps of Engineers, the baseline water quality monitoring is comprised of sampling at four (4) stations; Stations 1 and 3 are located approximately 25 m (80 feet) from the shoreline off the southern and northern sides of the mouth of Iao Stream, respectively. Stations 2 and 4 are located approximately 75 m (240 feet) from the shoreline off the southern and northern sides of the mouth of Iao Stream, respectively (see Figure 1).

In order to obtain a representative sampling that has equal chance of encountering all conditions of tide and weather, each sampling is conducted at a set time. The time selected is every fourth Tuesday at 10:30. The initial sampling was conducted at this time on October 1, 1996.

The area off of Iao Stream is composed of a shallow, boulder covered bottom with a gradual slope. During many conditions of sea and swell, breaking surf occurs along the shoreline in the region of sampling. As a result, use of a boat to collect samples is prohibitive. Sampling, therefore, is conducted by divers swimming from shore and opening bottles at the desired locations. Sampling locations are determined by triangulation with shoreline landmarks. Latitude and longitude at each of the sampling points were determined with a hand-held global positioning system (GPS) during the initial sampling (see Figure 1).

At each sampling site water was collected in 1-liter pre-washed sampling bottles in the approximate center of the water column. pH was measured in the field immediately following sample collection using a field meter. Sample splits were stored on ice and returned to Honolulu for other analyses. Turbidity was measured on a 90 degree nephelometer with a precision of 0.01 nephelometric turbidity units (n.t.u). Total suspended solids (TSS) was determined gravimetrically. All laboratory analyses are conducted by Marine Analytical Specialists (Laboratory Certification NO. HI-0009).

RESULTS and DISCUSSION

Table 1 shows results of the water quality constituents collected on April 15, 1997. Weather conditions consisted of sunny skies with northeast winds of 5-10 knots. Sea conditions were choppy with waves of approximately 2-3 feet breaking in the nearshore zone. No rainfall had occurred in the 48 hours preceding the sampling, and no stream flow was entering the ocean at the time of monitoring. Samples were collected during a rising tide at a height of approximately +0.8 feet. Samples 1 and 3 were collected in the region where waves were breaking; samples 2 and 4 were collected seaward of the break.

Results of water sampling reveal somewhat higher TSS and turbidity at Stations 1 and 4 compared to Stations 2 and 3. Appendix A shows cumulative results of all surveys to date at Iao Stream. It can be seen that the values of TSS and turbidity for the April 1997 survey are among the lowest of any survey. The initial survey on October 1, 1996 was conducted during conditions that were similar to the April survey; calm winds and small surf. During samplings on October 29 and November 26, 1996 wind and surf were substantially greater. It can be seen that TSS and turbidity on October 29 and November 26 were approximately 2 to 4 fold higher than on October 1 and April 15. It is apparent that the increased turbulence from wave action has a direct effect on suspended material in the water column. The survey conducted on December 24 occurred during both high surf and high stream flow. It can be seen in Appendix A that turbidity is elevated by approximately an order of magnitude at Stations 1-3 in December compared to the other three sampling periods. The measure of turbidity at Station 2 in

December of 16.4 mg/L is also substantially elevated compared to all measurements in previous surveys.

While stream flow also occurred during the January 1997 samplings, it can be seen in Appendix 1 that TSS and turbidity were among the lowest of all samplings on these dates. It appears that the prolonged period of rain that may have washed much of the particulate material from the stream bed in the days prior to sampling, and the low surf height may result in relatively low levels of turbidity and suspended material in the nearshore water column.

The next phase of monitoring will be conducted on May 13, 1997.

Steven Dollar, Ph.D.
Principal Investigator

TABLE 1. Water quality measurements off of the mouth of Iao Stream, M
Collection Date: April 15, 1997; 10:00
For station locations see Figure 1.

Sample ID	TSS (mg/l)	Turb (ntu)	pH (rel)
IAO-1	1.33	0.15	8.138
IAO-2	0.73	0.12	8.148
IAO-3	0.67	0.11	8.155
IAO-4	1.93	0.17	8.128

WATER QUALITY BASELINE MONITORING PROGRAM

IAO STREAM FLOOD CONTROL PROJECT

WAILUKU, MAUI, HAWAII

REPORT 5-97
May 15, 1997

Prepared for

U.S. ARMY ENGINEER DISTRICT, HONOLULU
Bldg. 230
Fort Shafter, HI 96858-5440

by

Marine Research Consultants
4467 Sierra Dr.
Honolulu, HI 96816

May 30, 1997

PURPOSE and METHODS

The purpose of the program is to conduct water sampling and analyses at specified sampling stations as part of the pre-construction planning for modification to the Iao Stream flood Control Project, on Maui, Hawaii. The water sampling and analyses is conducted at four stations located in the nearshore ocean off of the mouth of Iao Stream. The goal of the sampling program is to obtain a representative group of samples that will define the dimensions of the envelope of natural variability in oceanic water quality constituents that may be affected by future construction of the flood control features in upper Iao Stream. The establishment of this baseline data set is a necessary prerequisite for determining if, and to what extent, construction of the flood control features is altering ocean water quality beyond the level of natural variability.

As specified by the Corps of Engineers, the baseline water quality monitoring is comprised of sampling at four (4) stations; Stations 1 and 3 are located approximately 25 m (80 feet) from the shoreline off the southern and northern sides of the mouth of Iao Stream, respectively. Stations 2 and 4 are located approximately 75 m (240 feet) from the shoreline off the southern and northern sides of the mouth of Iao Stream, respectively (see Figure 1).

In order to obtain a representative sampling that has equal chance of encountering all conditions of tide and weather, each sampling is conducted at a set time. The time selected is every fourth Tuesday at 10:30. The initial sampling was conducted at this time on October 1, 1996.

The area off of Iao Stream is composed of a shallow, boulder covered bottom with a gradual slope. During many conditions of sea and swell, breaking surf occurs along the shoreline in the region of sampling. As a result, use of a boat to collect samples is prohibitive. Sampling, therefore, is conducted by divers swimming from shore and opening bottles at the desired locations. Sampling locations are determined by triangulation with shoreline landmarks. Latitude and longitude at each of the sampling points were determined with a hand-held global positioning system (GPS) during the initial sampling (see Figure 1).

At each sampling site water was collected in 1-liter pre-washed sampling bottles in the approximate center of the water column. pH was measured in the field immediately following sample collection using a field meter. Sample splits were stored on ice and returned to Honolulu for other analyses. Turbidity was measured on a 90 degree nephelometer with a precision of 0.01 nephelometric turbidity units (n.t.u). Total suspended solids (TSS) was determined gravimetrically. All laboratory analyses are conducted by Marine Analytical Specialists (Laboratory Certification NO. HI-0009).

RESULTS and DISCUSSION

Table 1 shows results of the water quality constituents collected on May 15, 1997. Weather conditions consisted of partly cloudy skies with northeast winds of 5-10 knots. Sea conditions consisted of a slight wind chop with waves of approximately 2-3 feet breaking in the nearshore zone. No rainfall had occurred in the coastal area during the 48 hours preceding the sampling. However, there was stream flow entering the ocean at the time of monitoring, presumably from rainfall at higher elevations. Samples were collected during a rising tide at a height of approximately +0.6 feet. Samples 1 and 3 were collected in the region where waves were breaking; samples 2 and 4 were collected seaward of the break.

Results of water sampling reveal somewhat higher TSS and turbidity at Stations 1 and 3 compared to Stations 2 and 4. Appendix A shows cumulative results of all surveys to date at Iao Stream. It can be seen that the values of TSS and turbidity for the May 1997 survey ranged from the lowest values of any survey (0.73 mg/L at station 2) near the highest (3.87 mg/L at Station 1). Observation of the water draining from the stream flowed through the area of Station 1. It is apparent that the increased turbulence from wave action and stream flow has a direct effect on suspended material in the water column at Station 1 compared to the more offshore site at Station 2.

While stream flow also occurred during the January 1997 samplings, it can be seen in Appendix 1 that TSS and turbidity were among the lowest of all samplings on these dates. It appears that the prolonged period of rain that may have washed much of the particulate material from the stream bed in the days prior to sampling, and the low surf height may result in relatively low levels of turbidity and suspended material in the nearshore water column.

The next phase of monitoring will be conducted on June 10, 1997.

Steven Dollar, Ph.D.
Principal Investigator

TABLE 1. Water quality measurements off of the mouth of Iao Stream, M
Collection Date: May 15, 1997; 10:00
For station locations see Figure 1.

Sample ID	TSS (mg/l)	Turb (ntu)	pH (rel)
IAO-1	3.87	0.25	8.202
IAO-2	0.73	0.11	8.143
IAO-3	2.00	0.18	8.150
IAO-4	1.87	0.17	8.126

WATER QUALITY BASELINE MONITORING PROGRAM

IAO STREAM FLOOD CONTROL PROJECT

WAILUKU, MAUI, HAWAII

REPORT 6-97
June 10, 1997

Prepared for

U.S. ARMY ENGINEER DISTRICT, HONOLULU
Bldg. 230
Fort Shafter, HI 96858-5440

by

Marine Research Consultants
4467 Sierra Dr.
Honolulu, HI 96816

June 30, 1997

PURPOSE and METHODS

The purpose of the program is to conduct water sampling and analyses at specified sampling stations as part of the pre-construction planning for modification to the Iao Stream flood Control Project, on Maui, Hawaii. The water sampling and analyses is conducted at four stations located in the nearshore ocean off of the mouth of Iao Stream. The goal of the sampling program is to obtain a representative group of samples that will define the dimensions of the envelope of natural variability in oceanic water quality constituents that may be affected by future construction of the flood control features in upper Iao Stream. The establishment of this baseline data set is a necessary prerequisite for determining if, and to what extent, construction of the flood control features is altering ocean water quality beyond the level of natural variability.

As specified by the Corps of Engineers, the baseline water quality monitoring is comprised of sampling at four (4) stations; Stations 1 and 3 are located approximately 25 m (80 feet) from the shoreline off the southern and northern sides of the mouth of Iao Stream, respectively. Stations 2 and 4 are located approximately 75 m (240 feet) from the shoreline off the southern and northern sides of the mouth of Iao Stream, respectively (see Figure 1).

In order to obtain a representative sampling that has equal chance of encountering all conditions of tide and weather, each sampling is conducted at a set time. The time selected is every fourth Tuesday at 10:30. The initial sampling was conducted at this time on October 1, 1996.

The area off of Iao Stream is composed of a shallow, boulder covered bottom with a gradual slope. During many conditions of sea and swell, breaking surf occurs along the shoreline in the region of sampling. As a result, use of a boat to collect samples is prohibitive. Sampling, therefore, is conducted by divers swimming from shore and opening bottles at the desired locations. Sampling locations are determined by triangulation with shoreline landmarks. Latitude and longitude at each of the sampling points were determined with a hand-held global positioning system (GPS) during the initial sampling (see Figure 1).

At each sampling site water was collected in 1-liter pre-washed sampling bottles in the approximate center of the water column. pH was measured in the field immediately following sample collection using a field meter. Sample splits were stored on ice and returned to Honolulu for other analyses. Turbidity was measured on a 90 degree nephelometer with a precision of 0.01 nephelometric turbidity units (n.t.u). Total suspended solids (TSS) was determined gravimetrically. All laboratory analyses are conducted by Marine Analytical Specialists (Laboratory Certification NO. HI-0009).

RESULTS and DISCUSSION

Table 1 shows results of the water quality constituents collected on June 10, 1997. Weather conditions consisted of sunny skies with northeast winds of 15-20 knots. Sea conditions consisted of a moderate wind chop with waves of approximately 2-3 feet breaking in the nearshore zone. Rainfall had occurred in upland elevations but not in the coastal area during the 48 hours preceding the sampling. As a result of the upland rainfall there was stream flow entering the ocean at the time of monitoring. Samples were collected during a slightly falling tide at a height of approximately +0.5 feet. Samples 1 and 3 were collected in the region where waves were breaking; samples 2 and 4 were collected seaward of the break.

Results of water sampling reveal somewhat higher TSS and turbidity at Stations 1 and 3 compared to Stations 2 and 4 (Table 1). Appendix A shows cumulative results of all surveys to date at Iao Stream. It can be seen that the values of TSS and turbidity for the June 1997 survey were very consistent for entire data set. Turbidity ranged from 0.19 to 0.24 n.t.u., while TSS ranged from 2.07 to 3.00 mg/L. In past surveys, there was often considerable differences between TSS and turbidity in the inshore stations compared to the offshore stations. Increased turbulence from wave action and stream flow often has a direct effect on suspended material in the water column at Stations 1 and 3 compared to the more offshore sites at Stations 2 and 4. Such was not the case in the present survey.

While stream flow also occurred during the January 1997 samplings, it can be seen in Appendix 1 that TSS and turbidity were among the lowest of all samplings on these dates. It appears that the prolonged period of rain during January 1997 may have washed much of the particulate material from the stream bed in the days prior to sampling, and the low surf height may result in relatively low levels of turbidity and suspended material in the nearshore water column. During the present sampling, rainfall preceding the sampling was substantially lower than in January, while values of TSS and turbidity were higher.

The next phase of monitoring will be conducted on July 8, 1997.

Steven Dollar, Ph.D.
Principal Investigator

TABLE 1. Water quality measurements off of the mouth of Iao Stream, M
Collection Date: June 10, 1997; 10:00
For station locations see Figure 1.

Sample ID	TSS (mg/l)	Turb (ntu)	pH (rel)
IAO-1	3.00	0.24	8.334
IAO-2	2.33	0.20	8.171
IAO-3	2.67	0.23	8.200
IAO-4	2.07	0.19	8.174

WATER QUALITY BASELINE MONITORING PROGRAM

IAO STREAM FLOOD CONTROL PROJECT

WAILUKU, MAUI, HAWAII

REPORT 7-97
July 8, 1997

Prepared for

U.S. ARMY ENGINEER DISTRICT, HONOLULU
Bldg. 230
Fort Shafter, HI 96858-5440

by

Marine Research Consultants
4467 Sierra Dr.
Honolulu, HI 96816

August 12, 1997

PURPOSE and METHODS

The purpose of the program is to conduct water sampling and analyses at specified sampling stations as part of the pre-construction planning for modification to the Iao Stream flood Control Project, on Maui, Hawaii. The water sampling and analyses is conducted at four stations located in the nearshore ocean off of the mouth of Iao Stream. The goal of the sampling program is to obtain a representative group of samples that will define the dimensions of the envelope of natural variability in oceanic water quality constituents that may be affected by future construction of the flood control features in upper Iao Stream. The establishment of this baseline data set is a necessary prerequisite for determining if, and to what extent, construction of the flood control features is altering ocean water quality beyond the level of natural variability.

As specified by the Corps of Engineers, the baseline water quality monitoring is comprised of sampling at four (4) stations; Stations 1 and 3 are located approximately 25 m (80 feet) from the shoreline off the southern and northern sides of the mouth of Iao Stream, respectively. Stations 2 and 4 are located approximately 75 m (240 feet) from the shoreline off the southern and northern sides of the mouth of Iao Stream, respectively (see Figure 1).

In order to obtain a representative sampling that has equal chance of encountering all conditions of tide and weather, each sampling is conducted at a set time. The time selected is every fourth Tuesday at 10:30. The initial sampling was conducted at this time on October 1, 1996.

The area off of Iao Stream is composed of a shallow, boulder covered bottom with a gradual slope. During many conditions of sea and swell, breaking surf occurs along the shoreline in the region of sampling. As a result, use of a boat to collect samples is prohibitive. Sampling, therefore, is conducted by divers swimming from shore and opening bottles at the desired locations. Sampling locations are determined by triangulation with shoreline landmarks. Latitude and longitude at each of the sampling points were determined with a hand-held global positioning system (GPS) during the initial sampling (see Figure 1).

At each sampling site water was collected in 1-liter pre-washed sampling bottles in the approximate center of the water column. pH was measured in the field immediately following sample collection using a field meter. Sample splits were stored on ice and returned to Honolulu for other analyses. Turbidity was measured on a 90 degree nephelometer with a precision of 0.01 nephelometric turbidity units (n.t.u). Total suspended solids (TSS) was determined gravimetrically. All laboratory analyses are conducted by Marine Analytical Specialists (Laboratory Certification NO. HI-0009).

RESULTS and DISCUSSION

Table 1 shows results of the water quality constituents collected on July 8, 1997. Weather conditions consisted of sunny skies with northeast winds of 8-10 knots. Sea conditions consisted of a moderate wind chop with waves of approximately 1-2 feet breaking in the nearshore zone. Rainfall had occurred in upland elevations and at the coastal area during the 48 hours preceding the sampling (0.03" recorded). As a result of the rainfall there was stream flow entering the ocean at the time of monitoring. Samples were collected during a slightly falling tide at a height of approximately +0.5 feet. Samples 1 and 3 were collected in the region where waves were breaking; samples 2 and 4 were collected seaward of the break.

Results of water sampling reveal somewhat higher TSS at Stations 1 and 2 compared to Stations 3 and 4, and higher turbidity at Stations 1 and 3 compared to Stations 2 and 4 (Table 1). Thus, TSS was elevated at the Stations located to the south of the stream mouth, while turbidity was elevated at the inshore stations compared to the offshore stations.

Appendix A shows cumulative results of all surveys to date at Iao Stream. It can be seen that the values of TSS and turbidity for the July 1997 survey were among the highest for entire data set. Stream flow occurring during the sampling appears to be the cause of the elevated TSS and turbidity. While stream flow also occurred during the January 1997 samplings, it can be seen in Appendix 1 that TSS and turbidity were among the lowest of all samplings on these dates. It appears that the prolonged period of rain during January 1997 may have washed much of the particulate material from the stream bed in the days prior to sampling, and the low surf height may result in relatively low levels of turbidity and suspended material in the nearshore water column. During the present sampling, rainfall preceding the sampling was substantially lower than in January, while values of TSS and turbidity were higher.

The next phase of monitoring will be conducted on August 5, 1997.

Steven Dollar, Ph.D.
Principal Investigator

TABLE 1. Water quality measurements off of the mouth of Iao Stream, M
Collection Date: July 8, 1997; 10:00
For station locations see Figure 1.

Sample ID	TSS (mg/l)	Turb (ntu)	pH (rel)
IAO-1	6.53	0.60	8.317
IAO-2	4.87	0.27	8.227
IAO-3	2.67	0.43	8.305
IAO-4	4.07	0.20	8.178

WATER QUALITY BASELINE MONITORING PROGRAM

IAO STREAM FLOOD CONTROL PROJECT

WAILUKU, MAUI, HAWAII

REPORT 8-97
August 5, 1997

Prepared for

U.S. ARMY ENGINEER DISTRICT, HONOLULU
Bldg. 230
Fort Shafter, HI 96858-5440

by

Marine Research Consultants
4467 Sierra Dr.
Honolulu, HI 96816

August 15, 1997

PURPOSE and METHODS

The purpose of the program is to conduct water sampling and analyses at specified sampling stations as part of the pre-construction planning for modification to the Iao Stream flood Control Project, on Maui, Hawaii. The water sampling and analyses is conducted at four stations located in the nearshore ocean off of the mouth of Iao Stream. The goal of the sampling program is to obtain a representative group of samples that will define the dimensions of the envelope of natural variability in oceanic water quality constituents that may be affected by future construction of the flood control features in upper Iao Stream. The establishment of this baseline data set is a necessary prerequisite for determining if, and to what extent, construction of the flood control features is altering ocean water quality beyond the level of natural variability.

As specified by the Corps of Engineers, the baseline water quality monitoring is comprised of sampling at four (4) stations; Stations 1 and 3 are located approximately 25 m (80 feet) from the shoreline off the southern and northern sides of the mouth of Iao Stream, respectively. Stations 2 and 4 are located approximately 75 m (240 feet) from the shoreline off the southern and northern sides of the mouth of Iao Stream, respectively (see Figure 1).

In order to obtain a representative sampling that has equal chance of encountering all conditions of tide and weather, each sampling is conducted at a set time. The time selected is every fourth Tuesday at 10:30. The initial sampling was conducted at this time on October 1, 1996.

The area off of Iao Stream is composed of a shallow, boulder covered bottom with a gradual slope. During many conditions of sea and swell, breaking surf occurs along the shoreline in the region of sampling. As a result, use of a boat to collect samples is prohibitive. Sampling, therefore, is conducted by divers swimming from shore and opening bottles at the desired locations. Sampling locations are determined by triangulation with shoreline landmarks. Latitude and longitude at each of the sampling points were determined with a hand-held global positioning system (GPS) during the initial sampling (see Figure 1).

At each sampling site water was collected in 1-liter pre-washed sampling bottles in the approximate center of the water column. pH was measured in the field immediately following sample collection using a field meter. Sample splits were stored on ice and returned to Honolulu for other analyses. Turbidity was measured on a 90 degree nephelometer with a precision of 0.01 nephelometric turbidity units (n.t.u). Total suspended solids (TSS) was determined gravimetrically. All laboratory analyses are conducted by Marine Analytical Specialists (Laboratory Certification NO. HI-0009).

RESULTS and DISCUSSION

Table 1 shows results of the water quality constituents collected on August 5, 1997. Weather conditions consisted of sunny skies with northeast winds of 10-15 knots. Sea conditions consisted of a moderate wind chop with waves of approximately 1-2 feet breaking in the nearshore zone. No rainfall had occurred in upland elevations or at the coastal area during the 48 hours preceding the sampling (0.03". As a result there was no stream flow entering the ocean at the time of monitoring. Samples were collected during a slightly falling tide at a height of approximately +0.6 feet. Samples 1 and 3 were collected in the region where waves were breaking; samples 2 and 4 were collected seaward of the break.

Results of water sampling reveal slightly higher TSS and turbidity at Station 3 compared to Stations 1, 2 and 4. Thus, TSS and turbidity was elevated at the inshore station to the north of the stream mouth, but not at the inshore stations to the south of the stream mouth. pH was essentially the same at all sampling locations.

Appendix A shows cumulative results of all surveys to date at Iao Stream. It can be seen that the values of TSS and turbidity for the August 1997 survey were typical of other dry months when stream flow was not entering the ocean. During periods when stream flow was entering the ocean, such as in July 1997, values of turbidity and TSS were among the highest in the cumulative data set. However, while stream flow also occurred during the January 1997 samplings, it can be seen in Appendix 1 that TSS and turbidity were among the lowest of all samplings on these dates. It appears that the prolonged period of rain during January 1997 may have washed much of the particulate material from the stream bed in the days prior to sampling, and the low surf height may result in relatively low levels of turbidity and suspended material in the nearshore water column.

The next phase of monitoring will be conducted on September 2, 1997.

Steven Dollar, Ph.D.
Principal Investigator

TABLE 1. Water quality measurements off of the mouth of Iao Stream, M
Collection Date: August 5, 1997; 10:00
For station locations see Figure 1.

Sample ID	TSS (mg/l)	Turb (ntu)	pH (rel)
IAO-1	2.07	0.18	8.204
2	2.47	0.19	8.182
3	3.00	0.29	8.207
4	2.33	0.21	8.180

WATER QUALITY BASELINE MONITORING PROGRAM

IAO STREAM FLOOD CONTROL PROJECT

WAILUKU, MAUI, HAWAII

REPORT 9-97
September 2, 1997

Prepared for

U.S. ARMY ENGINEER DISTRICT, HONOLULU
Bldg. 230
Fort Shafter, HI 96858-5440

by

Marine Research Consultants
4467 Sierra Dr.
Honolulu, HI 96816

September 30, 1997

PURPOSE and METHODS

The purpose of the program is to conduct water sampling and analyses at specified sampling stations as part of the pre-construction planning for modification to the Iao Stream flood Control Project, on Maui, Hawaii. The water sampling and analyses is conducted at four stations located in the nearshore ocean off of the mouth of Iao Stream. The goal of the sampling program is to obtain a representative group of samples that will define the dimensions of the envelope of natural variability in oceanic water quality constituents that may be affected by future construction of the flood control features in upper Iao Stream. The establishment of this baseline data set is a necessary prerequisite for determining if, and to what extent, construction of the flood control features is altering ocean water quality beyond the level of natural variability.

As specified by the Corps of Engineers, the baseline water quality monitoring is comprised of sampling at four (4) stations; Stations 1 and 3 are located approximately 25 m (80 feet) from the shoreline off the southern and northern sides of the mouth of Iao Stream, respectively. Stations 2 and 4 are located approximately 75 m (240 feet) from the shoreline off the southern and northern sides of the mouth of Iao Stream, respectively (see Figure 1).

In order to obtain a representative sampling that has equal chance of encountering all conditions of tide and weather, each sampling is conducted at a set time. The time selected is every fourth Tuesday at 10:30. The initial sampling was conducted at this time on October 1, 1996.

The area off of Iao Stream is composed of a shallow, boulder covered bottom with a gradual slope. During many conditions of sea and swell, breaking surf occurs along the shoreline in the region of sampling. As a result, use of a boat to collect samples is prohibitive. Sampling, therefore, is conducted by divers swimming from shore and opening bottles at the desired locations. Sampling locations are determined by triangulation with shoreline landmarks. Latitude and longitude at each of the sampling points were determined with a hand-held global positioning system (GPS) during the initial sampling (see Figure 1).

At each sampling site water was collected in 1-liter pre-washed sampling bottles in the approximate center of the water column. pH was measured in the field immediately following sample collection using a field meter. Sample splits were stored on ice and returned to Honolulu for other analyses. Turbidity was measured on a 90 degree nephelometer with a precision of 0.01 nephelometric turbidity units (n.t.u). Total suspended solids (TSS) was determined gravimetrically. All laboratory analyses are conducted by Marine Analytical Specialists (Laboratory Certification NO. HI-0009).

RESULTS and DISCUSSION

Table 1 shows results of the water quality constituents collected on September 2, 1997. Weather conditions consisted of sunny skies with northwest winds of approximately 5 knots. Sea conditions were calm with waves of approximately 1 foot breaking in the nearshore zone. No rainfall had occurred in upland elevations or at the coastal area during the 48 hours preceding the sampling. As a result there was no stream flow entering the ocean at the time of monitoring. Samples were collected during a slightly falling tide at a height of approximately +0.6 feet. Samples 1 and 3 were collected in the region where waves were breaking; samples 2 and 4 were collected seaward of the break.

Results of water sampling reveal slightly higher TSS and turbidity at Stations 2 and 4 compared to Stations 1 and 2. Thus, TSS and turbidity was elevated at the offshore stations to both the north and south of the stream mouth compared to the inshore stations. pH was also slightly lower at Stations 2 and 4 compared to Stations 1 and 3.

Appendix A shows cumulative results of all surveys to date at Iao Stream. It can be seen that the values of TSS and turbidity were often elevated in the inshore stations relative to the offshore stations, presumably as a result of resuspension of particulate material in the nearshore zone of wave impact. This pattern is reversed in the September 2, 1997 survey when TSS and turbidity were elevated in the offshore station relative to the inshore stations. The reversed pattern may be a result of the small surf breaking during the survey which resulted in comparatively little resuspension of particulates.

The September 2, 1997 was conducted during a period of no stream flow. During periods when stream flow was entering the ocean, such as in July 1997, values of turbidity and TSS were among the highest in the cumulative data set. However, while stream flow also occurred during the January 1997 samplings, it can be seen in Appendix 1 that TSS and turbidity were among the lowest of all samplings on these dates. It appears that the prolonged period of rain during January 1997 may have washed much of the particulate material from the stream bed in the days prior to sampling, and the low surf height may result in relatively low levels of turbidity and suspended material in the nearshore water column.

The next, and last, phase of monitoring will be conducted on September 30, 1997.

Steven Dollar, Ph.D.
Principal Investigator

TABLE 1. Water quality measurements off of the mouth of Iao Stream, M
Collection Date: September 2, 1997; 10:00
For station locations see Figure 1.

Sample ID	TSS (mg/l)	Turb (ntu)	pH (rel)
IAO-1	2.67	0.19	8.149
2	3.93	0.25	8.066
3	2.00	0.16	8.141
4	3.45	0.23	8.086

WATER QUALITY BASELINE MONITORING PROGRAM

IAO STREAM FLOOD CONTROL PROJECT

WAILUKU, MAUI, HAWAII

REPORT 10-97
September 30, 1997

Prepared for

U.S. ARMY ENGINEER DISTRICT, HONOLULU
Bldg. 230
Fort Shafter, HI 96858-5440

by

Marine Research Consultants
4467 Sierra Dr.
Honolulu, HI 96816

October 10, 1997

PURPOSE and METHODS

The purpose of the program is to conduct water sampling and analyses at specified sampling stations as part of the pre-construction planning for modification to the Iao Stream flood Control Project, on Maui, Hawaii. The water sampling and analyses is conducted at four stations located in the nearshore ocean off of the mouth of Iao Stream. The goal of the sampling program is to obtain a representative group of samples that will define the dimensions of the envelope of natural variability in oceanic water quality constituents that may be affected by future construction of the flood control features in upper Iao Stream. The establishment of this baseline data set is a necessary prerequisite for determining if, and to what extent, construction of the flood control features is altering ocean water quality beyond the level of natural variability.

As specified by the Corps of Engineers, the baseline water quality monitoring is comprised of sampling at four (4) stations; Stations 1 and 3 are located approximately 25 m (80 feet) from the shoreline off the southern and northern sides of the mouth of Iao Stream, respectively. Stations 2 and 4 are located approximately 75 m (240 feet) from the shoreline off the southern and northern sides of the mouth of Iao Stream, respectively (see Figure 1).

In order to obtain a representative sampling that has equal chance of encountering all conditions of tide and weather, each sampling is conducted at a set time. The time selected is every fourth Tuesday at 10:30. The initial sampling was conducted at this time on October 1, 1996.

The area off of Iao Stream is composed of a shallow, boulder covered bottom with a gradual slope. During many conditions of sea and swell, breaking surf occurs along the shoreline in the region of sampling. As a result, use of a boat to collect samples is prohibitive. Sampling, therefore, is conducted by divers swimming from shore and opening bottles at the desired locations. Sampling locations are determined by triangulation with shoreline landmarks. Latitude and longitude at each of the sampling points were determined with a hand-held global positioning system (GPS) during the initial sampling (see Figure 1).

At each sampling site water was collected in 1-liter pre-washed sampling bottles in the approximate center of the water column. pH was measured in the field immediately following sample collection using a field meter. Sample splits were stored on ice and returned to Honolulu for other analyses. Turbidity was measured on a 90 degree nephelometer with a precision of 0.01 nephelometric turbidity units (n.t.u). Total suspended solids (TSS) was determined gravimetrically. All laboratory analyses are conducted by Marine Analytical Specialists (Laboratory Certification NO. HI-0009).

RESULTS and DISCUSSION

Table 1 shows results of the water quality constituents collected on September 30, 1997. Weather conditions consisted of sunny skies with northwest winds of approximately 10-12 knots. Sea conditions were slightly choppy with waves of approximately 1 foot breaking in the nearshore zone. No rainfall had occurred in upland elevations or at the coastal area during the 48 hours preceding the sampling. As a result there was no stream flow entering the ocean at the time of monitoring. Samples were collected during a rising tide at a height of approximately +1.0 feet. Samples 1 and 3 were collected in the region where waves were breaking; samples 2 and 4 were collected seaward of the break.

Results of water sampling reveal slightly higher TSS and turbidity at Stations 2 and 4 compared to Stations 1 and 2. Thus, TSS and turbidity was elevated at the offshore stations to both the north and south of the stream mouth compared to the inshore stations. pH was also slightly lower at Stations 2 and 4 compared to Stations 1 and 3.

Appendix A shows cumulative results of all surveys to date at Iao Stream. It can be seen that the values of TSS and turbidity were often elevated in the inshore stations relative to the offshore stations, presumably as a result of resuspension of particulate material in the nearshore zone of wave impact. This pattern is reversed in the September 2 and September 30, 1997 surveys when TSS and turbidity were elevated in the offshore station relative to the inshore stations. The reversed pattern may be a result of the small surf breaking during the survey which resulted in comparatively little resuspension of particulates.

The September 30, 1997 was conducted during a period of no stream flow. During periods when stream flow was entering the ocean, such as in July 1997, values of turbidity and TSS were among the highest in the cumulative data set. However, while stream flow also occurred during the January 1997 samplings, it can be seen in Appendix 1 that TSS and turbidity were among the lowest of all samplings on these dates. It appears that the prolonged period of rain during January 1997 may have washed much of the particulate material from the stream bed in the days prior to sampling, and the low surf height may result in relatively low levels of turbidity and suspended material in the nearshore water column.

Table 2 shows the results of all fourteen surveys by station, along with maximum, minimums, geometric means and standard deviations of each constituent.

Steven Dollar, Ph.D.
Principal Investigator

TABLE 1. Water quality measurements off of the moutl
Collection Date: September 30, 1997; 10:00
For station locations see Figure 1.

Sample ID	TSS (mg/l)	Turb (ntu)	pH (rel)
IAO-1	1.93	0.12	8.191
2	2.20	0.14	8.182
3	1.87	0.12	8.211
4	2.73	0.18	8.111

Appendix F:

Coastal Zone Management Act Chapter 205 A, HRS Evaluation Report

HAWAIʻI COASTAL ZONE MANAGEMENT PROGRAM

Hawaiʻi Coastal Zone Management (CZM) Program, Chapter 205A, HRS, was publicized in response to the Federal Coastal Zone Management Act of 1972. The CZM area consists of the entire state of Hawaiʻi, including all marine waters seaward to the extent of the state's police power and management authority. The objective of the act is to protect, preserve, and restore scenic, historic, and recreational resources as well as implementing the state's ocean resources management plan and protecting coastal ecosystems. The act involves a system of permits to manage development within the coastal areas and encourages public participation.

The objective and policies of the CZM in relation to the proposed action alternatives are listed below. Possible short-term and long-term impacts of the project are examined in the following analysis.

Recreational resources

Objective: Provide coastal recreational opportunities accessible to the public.

Federal regulation 36 CFR 327, supplemented by Army regulation ER 1130-2-504, contains guidelines for rules and regulations regarding USACE public use of water resource development projects. The policy of the Army is to "…manage the natural, cultural and developed resources of each project in the public interest, providing the public with safe and healthful recreational opportunities while protecting and enhancing these resources."

1) Improve coordination and funding of coastal recreational planning and management; and

The objective of the proposed project is flood control. Planning and funding of coastal recreational opportunities are subject to regulations stated above, and management of coastal recreational areas is not within the scope of the proposed project.

2) Provide adequate, accessible, and diverse recreational opportunities in the coastal zone management area by:

a) Protecting coastal resources uniquely suited for recreational activities that cannot be provided in other areas;

There are no coastal recreational areas within the project area, or in the immediate vicinity of the project area.

b) Requiring replacement of coastal resources having significant recreational value including, but not limited to, surfing sites, fishponds, and sand beaches, when such resources will be unavoidably damaged by development; or requiring reasonable monetary compensation to the State for recreation when replacement is not feasible or desirable;

Alternatives do not involve adverse impacts to existing recreational resources.

c) Providing and managing adequate public access, consistent with conservation of natural resources, to and along shorelines with recreational value;

Short term land use impacts may be generated from construction activities which may limit access to and from public and/or recreational areas for use by the community. USACE will require its contractor to work closely with local police and fire authorities and provide early planning for alternate routes, as well as traffic control plan.

d) Providing an adequate supply of shoreline parks and other recreational facilities suitable for public recreation;

The objective of the proposed project is flood control, and supplying shoreline parks and other recreational facilities is not within the scope of this project.

The project will not decrease the number of recreational facilities currently available in the project area. Providing additional coastal recreational opportunities is subject to funding as well as state and local requirements.

e) Ensuring public recreational uses of county, state, and federally owned or controlled shoreline lands and waters having recreational value consistent with public safety standards and conservation of natural resources;

Ensuring consistency between recreational value and public safety/conservation is not within the scope of this project.

f) Adopting water quality standards and regulating point and non-point sources of pollution to protect, and where feasible, restore the recreational value of coastal waters;

All available action alternatives involve short-term construction related impacts, and would involve a discharge into waters of the United States. The preparation of a Section 404(b) (1) evaluation by the USACE, and a Section 401 State Water Quality Certification (WQC), as well as a National Pollutant Discharge Elimination System (NPDES) permit from the State of Hawai'i Department of Health (DOH) will keep possible pollution to accepted levels. In addition, soil management measures in accordance with County standards will be implemented to further monitor runoff discharges during construction into nearby shores. Adherence to Federal, state, and local regulations, as well as monitoring of proposed construction activities via jurisdictional permits, will allow negligible amounts of suspended sediment to enter the ocean as a result of construction activities. The required permits for the proposed project are discussed in detail in Section 9.0 of the Environmental Assessment.

g) Developing new shoreline recreational opportunities, where appropriate, such as artificial lagoons, artificial beaches, and artificial reefs for surfing and fishing; and

The objective of the proposed project is flood control, and supplying additional shoreline parks and other recreational facilities is not within the scope of this project. Providing additional coastal recreational opportunities are subject to funding as well as state and local requirements.

h) Encouraging reasonable dedication of shoreline areas with recreational value for public use as part of discretionary approvals or permits by the land use commission, board of land and natural resources, and county authorities; and crediting such dedication against the requirements of section 46-6.

The objective of the proposed project is flood control, and supplying additional shoreline parks and other recreational facilities is not within the scope of this project. Providing additional coastal recreational opportunities are subject to funding as well as state and local requirements.

Historic resources

Objective: Protect, preserve, and, where desirable, restore those natural and manmade historic and prehistoric resources in the coastal zone management area that are significant in Hawaiian and American history and culture.

1) Identify and analyze significant archaeological resources;

Undisturbed areas within the vicinity of ‘Īao Stream are predicted to still contain intact prehistoric and historic cultural deposits that have survived modern agricultural use. It is expected that such remains and deposits would still be extant in undisturbed areas.

One resource of cultural significance was identified in the near vicinity of the project site. The Haleki`i-Pihana *Heiau* State Monument lies on the northwest flank of the ‘Īao Stream, along the lower portion of the project area. The location of this *heiau* has been identified as a potentially high erosion area, and inadequate flood control measures may compromise the land on which the *heiau* is situated. Alternatives I and III are preferred over Alternative V in order to protect the *heiau* from flood and erosion damage.

2) Maximize information retention through preservation of remains and artifacts or salvage operations; and

Alternatives I, III and V will be designed to avoid identified archeological sites, and will include a suitable buffer zone during excavation and other earthmoving activities as well as monitoring by a qualified archaeologist during construction activities in the vicinity of the ‘Imi Kālā Street bridge. If avoidance of designated archaeological sites cannot be avoided, a data recovery plan will be composed and implemented by a qualified archeologist.

3) Support state goals for protection, restoration, interpretation, and display of historic resources.

Alternatives I, III and V will be designed to avoid identified archeological sites, and will include a suitable buffer zone during excavation and other earthmoving activities as well as monitoring by a qualified archaeologist during construction activities in the vicinity of the ‘Imi Kālā Street bridge. If avoidance of designated archaeological sites cannot be avoided, a data recovery plan will be composed and implemented by a qualified archeologist, and archeological technicians will be assigned to assist in monitoring and the facilitation of any earthmoving activities.

Scenic and open space resources

Objective: Protect, preserve, and, where desirable, restore or improve the quality of coastal scenic and open space resources.

1) Identify valued scenic resources in the coastal zone management area;

The ‘Īao Stream is situated in the ‘Īao Valley, a 6.2 acre park seeped in Hawaiian history and beauty. The valley is a steep, eroded caldera of the West Maui Mountains occupied by lush green vegetation. With the exception of the existing concrete lined channels and water diversions that occupy 30 percent of the stream, it remains mostly undeveloped. The ‘Īao Stream remains a natural beauty and tourist attraction of Maui.

2) Ensure that new developments are compatible with their visual environment by designing and locating such developments to minimize the alteration of natural landforms and existing public views to and along the shoreline;

Short term visual impacts will be generated by construction activities. Temporary construction fences may be installed to minimize visibility to the public.

Long term visual impacts differ depending on the alternative chosen. As all proposed action alternatives involve some degree of re-alignment and channelization, existing visual elements of the natural environment will be impacted. Alternative III is the recommended action as this design involves the least amount of alternation to the natural environment and will have a positive impact on existing public views.

3) Preserve, maintain, and, where desirable, improve and restore shoreline open space and scenic resources; and

Alternative V would effectively remove all man-made flood control improvements since 1981. With time, the stream would be restored to a completely natural condition which may or may not become more aesthetically pleasing than its current state. This alternative, however, does not provide protection from flooding or erosion, which would further degrade the quality of the stream and surrounding environment. Alternative III is the recommended action as this design involves the least amount of alternation to the natural environment and will have a minimal impact on public views. The improvement and restoration of shoreline open space and scenic resources is not within the scope of this project.

4) Encourage those developments that are not coastal dependent to locate in inland areas.

This is not applicable to the proposed project.

Coastal ecosystems

Objective: Protect valuable coastal ecosystems, including reefs, from disruption and minimize adverse impacts on all coastal ecosystems.

The Endangered Species Act of 1973 (50 CFR 402), Section 7, requires Federal agencies to consult with other agencies to insure that any action authorized, funded, or carried out by such agency is not likely to jeopardize the continued existence of any endangered species or threatened species or result in the destruction or adverse modification of habitat of such species.

Executive Order (EO) 13089 on Coastal Reef Protection directs Federal agencies to protect and manage U.S. coral reef ecosystems by identifying actions that may affect these ecosystems and to protect and enhance them to the extent permissible by law.

The Fish and Wildlife Coordination Act of 1946 states that projects by any agency under Federal permit or license that involves the "waters of any stream or other body of water (which) are proposed or authorized, permitted or licensed to be impounded, diverted . . . or otherwise controlled or modified" must consult with the Fish and Wildlife Service and the fish and wildlife agencies of the States where the project is to take place.

USACE, ER 1130-2-540 states that consultation and environmental maintenance is to be undertaken for the purpose of preventing loss and/or damage to wildlife/environmental resources.

1) Exercise an overall conservation ethic, and practice stewardship in the protection, use, and development of marine and coastal resources;

The above listed Federal and Army regulations are guidelines utilized in the development of this project which provide conservation ethic and stewardship in protection of valuable coastal ecosystems.

2) Improve the technical basis for natural resource management;

The objective of the proposed project is flood control, and improving technical basis for natural resource management is not within the scope of this project.

3) Preserve valuable coastal ecosystems, including reefs, of significant biological or economic importance;

EO 13089 on Coastal Reef Protection directs Federal agencies to protect and manage U.S. coral reef ecosystems, by identifying actions that may affect these ecosystems and to protect and enhance them to the extent permissible by law.

All available action alternatives involve short-term construction related impacts, and would involve a discharge into the ocean which may affect existing coastal ecosystems. The preparation of a Section 404(b) (1) evaluation by the USACE, and a Section 401 State Water Quality Certification (WQC), as well as a National Pollutant Discharge Elimination System (NPDES) permit from the State of Hawaiʻi DOH will keep possible pollution to accepted levels. In addition, soil management measures in accordance with County standards will be implemented to further monitor runoff discharges during construction into nearby shores. Adherence to Federal, state, and local regulations, as well as monitoring of proposed construction activities via jurisdictional permits, will allow negligible amounts of suspended sediment to enter the ocean as a result of construction activities. Information on required permits for the proposed project is presented in detail in Section 9.0 of the Environmental Assessment.

4) Minimize disruption or degradation of coastal water ecosystems by effective regulation of stream diversions, channelization, and similar land and water uses, recognizing competing water needs; and

The USFWS FWCA 2b report submitted to the USACE in 2006 concluded that all project alternatives share the potential for temporary construction-related impacts. During the period of construction, earthmoving and related activities would create a risk for the entry of terriginous sediments into the stream channel and adjacent near shore marine waters. This is especially the case during periods of wet weather. A variety of voluntary and regulatory controls function to minimize this risk. Runoff is inevitable, however, during torrential rains which occur regularly, but unpredictably in Hawaiʻi. Development of site-specific Best Management Practices (BMPs) are integral elements in the planning and application process for CWA section 404 permits and the concurrent CWA section 401 Water Quality Certification administered by the HDOH Clean Water Branch.

The USFWS 2006 report also strongly recommended that water use patterns in the area be reallocated such that stream flow be restored no less than 80 percent of the time. In a follow-up discussion between USFWS, USACE, and the COM, stream flow restoration was discussed and was recognized as being outside the authority or purpose of the USACE. Mitigation measures proposed by the USACE include alignment of the low-flow channel along vegetated stream banks to allow overhanging vegetation to shade the channel and reduce water temperatures, and a retrofit of improved portions of the channel that are currently lacking low-flow design elements or that pose a hindrance to migration of aquatic organisms. These mitigation measures have been agreed to by the USFWS in a recent revised mitigation recommendation letter (Appendix J of the main EA document) as sufficient compensation for unavoidable impacts to the natural environment.

Alternative III is designed to facilitate upstream and downstream migration of aquatic organisms, given sufficient water flow. Stream flow restoration is a topic that is currently under discussion by state and federal resource agencies, community groups, and private entities that hold licenses for diversion and out-of-stream consumptive use of 'Īao Stream water. This decision is outside the function and authority of the USACE, however. If and when stream flow is partially restored, the low-flow design elements of Alternative III will function to enhance passage of native stream fauna.

5) Promote water quantity and quality planning and management practices that reflect the tolerance of fresh water and marine ecosystems and maintain and enhance water quality through the development and implementation of point and non-point source water pollution control measures.

Water quality during the construction phase of the project will be maintained within acceptable levels with the preparation of a Section 404(b) (1) evaluation by the USACE, and a Section 401 State Water Quality Certification (WQC), as well as a National Pollutant Discharge Elimination System (NPDES) permit from the State of Hawai'i DOH. In addition, soil management measures in accordance with County standards will be implemented to further monitor runoff discharges during construction into nearby shores. Adherence to Federal, state, and local regulations, as well as monitoring of proposed construction activities via jurisdictional permits, will allow negligible amounts of suspended sediment to enter the ocean as a result of construction activities. Information on required permits for the proposed project is presented in detail in Section 9.0 of the Environmental Assessment.

The objective of the proposed project is flood control, and the planning and management of marine ecosystems is not within the scope of this project.

Economic uses

Objective: Provide public or private facilities and improvements important to the State's economy in suitable locations.

1) Concentrate coastal dependent development in appropriate areas;

The objective of the proposed project is flood control, and no structures are proposed as part of this project. Concentrating land use developments to appropriate areas is not within the scope of this project.

2) Ensure that coastal dependent development such as harbors and ports, and coastal related development such as visitor industry facilities and energy generating facilities, are located, designed, and constructed to minimize adverse social, visual, and environmental impacts in the coastal zone management area; and

The objective of the proposed project is flood control, and no structures are proposed as part of this project. This section does not apply to the project.

3) Direct the location and expansion of coastal dependent developments to areas presently designated and used for such developments and permit reasonable long-term growth at such areas, and permit coastal dependent development outside of presently designated areas when:

Use of presently designated locations is not feasible;

b) Adverse environmental effects are minimized; and

c) The development is important to the State's economy.

The objective of the proposed project is flood control, and no structures or coastal dependent developments are proposed as part of this project. This section does not apply to the project.

Coastal hazards

Objective: Reduce hazard to life and property from tsunami, storm waves, stream flooding, erosion, subsidence, and pollution.

Under the legislative authority of the Flood Control Act of 1948, Section 205, Public Law 80-858, as amended, 33 U.S.C. 701s; Public Law 93-251, as amended; Public Laws 97-140 and 99-662, the USACE is authorized to implement flood damage reduction improvements to the 'Īao Stream that meet or exceed Standard Project Flood (SPF) requirements to protect the existing Wailuku community.

1) Develop and communicate adequate information about storm wave, tsunami, flood, erosion, subsidence, and point and non-point source pollution hazards;

National Environmental Policy Act (NEPA) of 1969, as amended, CEQ regulations (40 CFR 1500-1508); ER 200-2-2, Environmental Quality Procedures for Implementing NEPA; and Chapter 343, HRS and Act 50, as amended, require public involvement and agency consultation at various stages of the development of the EA process.

2) Control development in areas subject to storm wave, tsunami, flood, erosion, hurricane, wind, subsidence, and point and non-point source pollution hazards;

The control of future development projects in flood prone areas is the jurisdiction of the County of Maui, and is not within the scope of this project.

3) Ensure that developments comply with requirements of the Federal Flood Insurance Program; and

The proposed project consists of flood control measures and does not involve structures or buildings that are subject to development requirements for flood prone areas.

4) Prevent coastal flooding from inland projects.

The proposed project is to prevent flooding from streams and is not related to prevention of coastal flooding from inland projects.

Managing development

Objective: Improve the development review process, communication, and public participation in the management of coastal resources and hazards.

NEPA of 1969, as amended, CEQ regulations (40 CFR 1500-1508); ER 200-2-2, Environmental Quality Procedures for Implementing NEPA; and Chapter 343, HRS and Act 50, as amended, require public involvement and agency consultation at various stages of the development of the EA process.

1) Use, implement, and enforce existing law effectively to the maximum extent possible in managing present and future coastal zone development;

The use, implementation, and enforcement of existing law to regulate coastal zone development is within the scope of the County of Maui.

2) Facilitate timely processing of applications for development permits and resolve overlapping or conflicting permit requirements; and

Facilitation of processing development permits and other requirements is within the scope of the County of Maui.

3) Communicate the potential short and long-term impacts of proposed significant coastal developments early in their life cycle and in terms understandable to the public to facilitate public participation in the planning and review process.

A public and agency scoping meeting was held in August, 2003. An additional public informational meeting will be scheduled to discuss the draft report and the recommended plan. A public notice will be circulated prior to the scheduled meeting to notify the public of the time and place. All comments received for this draft report will be documented in the final feasibility report.

Public participation

Objective: Stimulate public awareness, education, and participation in coastal management.

NEPA of 1969, as amended, CEQ regulations (40 CFR 1500-1508); ER 200-2-2, Environmental Quality Procedures for Implementing NEPA; and Chapter 343, HRS and Act 50, as amended, require public involvement and agency consultation at various stages of the development of the EA process.

1) Promote public involvement in coastal zone management processes;

A public and agency scoping meeting was held in August, 2003. A second public informational meeting will be scheduled in the future to discuss the draft report. Public notices will be posted prior to this meeting.

2) Disseminate information on coastal management issues by means of educational materials, published reports, staff contact, and public workshops for persons and organizations concerned with coastal issues, developments, and government activities; and

A public and agency scoping meeting was held in August, 2003. An additional public informational meeting will be scheduled to discuss the draft Environmental Assessment and the recommended action. A public notice will be circulated prior to the scheduled meeting to notify the public of the time and place.

3) Organize workshops, policy dialogues, and site-specific mediations to respond to coastal issues and conflicts.

Workshops and additional community meetings will be scheduled as deemed necessary.

Beach protection

Objective: Protect beaches for public use and recreation.

1) Locate new structures inland from the shoreline setback to conserve open space, minimize interference with natural shoreline processes, and minimize loss of improvements due to erosion;

Part of the objective of the proposed project is to minimize existing erosion problems related to seasonal flooding. No structures are proposed near the shoreline for this project that would interfere with natural shoreline processes.

2) Prohibit construction of private erosion-protection structures seaward of the shoreline, except when they result in improved aesthetic and engineering solutions to erosion at the sites and do not interfere with existing recreational and waterline activities; and

The proposed Federal flood control project takes into account aesthetic impacts to the surrounding community. Alternative III is recommended for minimal impact to visual and recreational activities, and does not include construction of structures seaward of the shoreline.

3) Minimize the construction of public erosion-protection structures seaward of the shoreline.

The proposed project design does not involve erosion prevention structures seaward of the shoreline.

Marine resources

Objective: Promote the protection, use, and development of marine and coastal resources to assure their sustainability.

1) Ensure that the use and development of marine and coastal resources are ecologically and environmentally sound and economically beneficial;

The objective of the proposed project is flood control. Ensuring the ecologically, environmentally, and economically sound development of marine and coastal resources and activities is not within the scope of this project.

2) Coordinate the management of marine and coastal resources and activities to improve effectiveness and efficiency;

The objective of the proposed project is flood control. The coordination of management of marine and coastal resources and activities is not within the scope of this project.

3) Assert and articulate the interests of the State as a partner with Federal agencies in the sound management of ocean resources within the United States exclusive economic zone;

In the USFWS FWCA report submitted in 2006, the agency indicated that copies of the report had been transmitted to the U.S. Environmental Protection Agency, The Hawai‘i Department of Health Clean Water Branch and Environmental Planning Office; the State of Hawai‘i Department of Land and Natural Resources Division of Aquatic Resources and Division of Forestry and Wildlife; and the Hawai‘i Department of Business, Economic Development and Tourism’s Coastal Zone Management Program.

4) Promote research, study, and understanding of ocean processes, marine life, and other ocean resources in order to acquire and inventory information necessary to understand how ocean development activities relate to and impact upon ocean and coastal resources; and

The objective of the proposed project is flood control, and the promotion of research and study of marine life and other ocean resources as they relate to ocean and coastal resources is not within the scope of this project.

5) Encourage research and development of new, innovative technologies for exploring, using, or protecting marine and coastal resources. [L 1977, c 188, pt of §3; am L 1993, c 258, §1; am L 1994, c 3, §1; am L 1995, c 104, §5; am L 2001, c 169, §3]

The objective of the proposed project is flood control, and the promotion of new and innovative technologies in regards to exploring and protection of marine and coastal resources is not within the scope of this project.

Appendix G:

Section 404(b)1 Analysis

Section 404(b)1 Analysis
ʻĪao Stream Flood Control Project

1.0 PROJECT DESCRIPTION

The United States (US) Army Corps of Engineers (USACE) is conducting an Environmental Assessment (EA) for the modification of the ʻĪao Stream Flood Control Project, Wailuku, Maui, Hawaiʻi, completed in 1981. During the years 1981-1989, severe flood damage caused erosion that compromised channel stability and weakened portions of the existing levees. As a result of this damage, the ʻĪao Stream Flood Control Project of 1981 requires upgrades and modifications, as future flood events may cause damage to life and property in areas of Wailuku town. Certification that the ʻĪao Stream Flood Control Project can pass a 100-year frequency flood of approximately 19,200 cfs with 90% probability is required by the FEMA prior to February 2009 or the area protected by the project will revert to a flood hazard area.

The USACE has determined that the damages incurred to the 1981 Flood Control Project during the years immediately following the completion of the project are due to design deficiencies to the original project. Under the legislative authority of the Flood Control Act of 1948, Section 205, Public Law (PL) 80-858, as amended, 33 United States Code (USC) 701s; PL 93-251, as amended; PL 97-140 and PL 99-662, the USACE is authorized to implement flood damage reduction improvements to the ʻĪao Stream that meet or exceed Standard Project Flood (SPF)[1] requirements to protect the existing Wailuku community. The project was designed for SPF protection with a peak discharge of 27,500 cubic feet per second (cfs) at the downstream limit of the project (250 feet (ft) upstream from the mouth of the stream) and 26,000 cfs at the upstream limit of the project (2.5 miles upstream from the mouth of the stream).

1.1 Location and General Description

The ʻĪao Stream drainage basin is a 10 square mile area that begins at the boundary between the Lahaina and Wailuku Judicial districts and extends along the crests of the Kahoolewa and Kapilau Ridges to the Pacific Ocean. The basin is eight miles long and averages 1.25 miles in width. It is characterized by two major topographic features: a coastal plain that extends about three miles inland, and ʻĪao Valley, the largest valley in West Maui, which extends from the coastal plain to the summit of Puʻu Kukui at an elevation of 5,800 ft above sea level.

The ʻĪao Stream Flood Control Project was initiated in 1977 and completed in 1981. The stream drains into a steep valley with stream flows at the upstream project limit conveyed into a debris basin. The 1981 ʻĪao Stream Flood Control Project consists of a debris

[1] The SPF is the flood that may be expected from the most severe combination of meteorologic and hydrologic conditions that are considered to be reasonably characteristic of the geographical region involved, excluding extremely rare combinations. The SPF represents a "standard" against which the degree of protection selected for a project may be judged and compared with protection provided at similar projects in other localities. The SPF for the ʻĪao Stream is estimated as approximately 27,500 cfs.

basin located 2.5 miles upstream from the stream mouth, a 3,500-foot long channel downstream from the debris basin: levees along the left and right bank, flood plain management along 6,950 ft of the left bank, and stream realignment for a 1,730-foot reach to the shoreline. In the flood plain management reach, levees are located on the right stream bank and are offset up to 80 ft beyond the existing stream bank. The proposed improvements to the 1981 Flood Control Project extend from above Waiehu Beach Road to the debris basin at the upstream limits of the project, a distance of approximately 2.5 miles.

The lower portion of the ‘Īao Stream in its current state (i.e., the area downstream from the water diversion structure) is not conducive to aquatic life. Due to the diversion of water from the stream, and also due to the intermittent nature of the stream itself, the stream below the diversion structure is absent of water approximately 90 percent of the time. Were it not for the efforts of a local aquatic biologist to capture organisms from ponded areas near the ocean outlet and physically transport them to the upper reaches of the stream, there would likely be no instream migration of aquatic organisms from the ocean to upstream areas. In some concrete-lined portions of the stream, a low-flow channel has been constructed. This low-flow element has been identified as a positive feature for aquatic organisms, particularly where shade is present. Other barriers to instream migration of aquatic organisms include the 22-foot drop structure at Station 97+23, concrete-lined portions without a low-flow channel, and a few smooth elevation drops that lack sufficient rugosity for migrating organisms to grasp or rest.

The preferred alternative (Alternative III) involves converting 7,200 ft of natural stream bed to a roller compacted concrete -lined channel. The channel has been designed to include low-flow elements that will enhance passage of aquatic organisms during periods of stream flow. While United States Fish and Wildlife Service originally viewed the proposed alternative as a significant environmental impact, subsequent discussions between the USACE and USFWS identified ways to mitigate these impacts to an acceptable level. As a result of these discussions, the proposed alternative includes several additional design features and retrofitting of existing concrete-lined portions of the stream that are outside the project area. USFWS provided concurrence with these proposed mitigation measures in a revised mitigation recommendation letter

1.2 Authority and Purpose

The 1981 ‘Īao Stream Flood Control project was authorized by the Flood Control Act of 1968 and completed in October of 1981. The original project consisted of a debris basin, channel improvements, diversion levees, and flood plain management.

During the construction phase in January 1980 a flood occurred that caused extensive erosion of the sacrificial berm and undermined portions of the completed levees. As a result, the streamside slope of the levees was extended with a concrete riprap slope lining into the streambed. Considered to be a state of the art design at that time, the toe of the cutoff walls was imbedded 5 ft in depth as provided in the project design document.

Shortly after project completion, stream flows occurred that caused erosion of the stream bottom along an approximately 7,000 foot reach between the concrete channel and the

Waiehu Beach Road. The erosion undermined the project levee with scour depths extending to a maximum of 6 ft below the existing boulder concrete slope lining. In July 1982, the Honolulu District Corps of Engineers requested that corrective work be approved to extend the boulder concrete slope protection from the damaged portion to a minimum of 5 ft below the eroded stream bottom. The Office of the Chief of Engineers granted approval for this work in January 1983. The corrective work was completed in November 1983 under the Productive Employment Appropriation Act of 1983 and authorized under Section 205 of the Flood Control Act of 1948, PL 80-858, as amended. The stream channel has since eroded 5 ft below the 1983 repair. The USACE subsequently decided to conduct a reconnaissance study to investigate solutions to the recurring problems that are slowly undermining areas of the levee. In March 1995, a report was submitted by USACE recommending modification to 'Īao Stream to replace the existing levee system with a trapezoidal concrete-lined channel (7,200 ft long).

A slope stability analysis was performed in 1997 to determine the stability of two areas identified as possible locations of levee failure. Stability analysis indicates instability may occur after flood waters have receded at Station 40+00. This assumes the 1996 slope geometry is further eroded to steepen the slope and deepen the stream bottom. Should a standard project flood occur prior to any repairs, flood waters would be able to pass through this portion of the levee and enter into adjacent housing areas. Water passing will further erode the levee.

The existing stream channel has a relatively narrow width of 40 to 60 ft, is boulder lined, and dry about 90% of the time. Levees with a surface of grouted riprap are interspersed along the right bank. The channel has an average slope of 2.6%. This steep stream channel results in critical and supercritical flows in the stream. The average channel velocity through the unlined portion of the stream varies between 8 and 32 feet per second with an average velocity in excess of 20 fps during annual floods. These high velocities have eroded the channel bed and caused severe undermining of the existing levees. To date, no flow larger than a 4% event has occurred in 'Īao Stream since construction was completed in 1981.

Certification that the 'Īao Stream Flood Control Project can pass a 100-year frequency flood of approximately 19,200 cfs with 90% probability is required by the FEMA prior to February 2009 or the area protected by the project will revert to a flood hazard area. A government agency responsible for levee construction or a Registered Professional Engineer must provide this certification. In its present condition, the project cannot be certified as providing 100-year flood protection.

Repeated floods in this area have caused high stream flows, undermining the existing flood plain levees in key locations. High stream flows resulted in downcutting of the natural streambed and erosion of the base of the east bank levee structure. Several residential and commercial structures along the right bank are in danger of being undercut if streambank erosion continues, as is the heiau along the lower reach of the left bank. The USACE has determined that the damages incurred by the 1981 Flood Control Project during the years immediately following the completion of the project are due to design deficiencies of the original project.

The purpose of the proposed action is to find a solution to stop levee and streambed erosion and to protect adjoining property from flooding during major storm events. A secondary objective is to maintain habitat for aquatic species passage by keeping a low-flow channel as recommended by the USACE Committee on Channel Stabilization. The estimated lifespan of the Flood Control Project is anticipated to be between 50 and 100 years. Five alternatives and a no action alternative have been formulated for consideration. Of these alternatives, three were considered for further evaluation in the EA.

1.3 Alternatives Considered

Section 404(b)1 guidelines of the Clean Water Act require that "except as provided under section 404(b)2, no discharge of dredged or fill material shall be permitted if there is a practicable alternative to the proposed discharge which would have less adverse impact on the aquatic ecosystem, so long as the alternative does not have other significant adverse environmental consequences." The guidelines consider an alternative practicable "if it is available and capable of being done after taking into consideration cost, existing technology, and logistics in light of overall project purposes."

The six alternatives initially considered for this project were: I) Trapezoidal Concrete-Lined Channel, II) Rectangular and Compound Channel, III) Roller Compacted Concrete and Boulder Invert Channel Following Existing Alignment, IV) Levee Reconstruction, V) Removal of Flood Control Improvements, and VI) No Action. Alternatives II, IV, and VI did not meet the project objectives and are thus not considered "practicable alternatives" and as such have been dropped from further consideration. Details of the remaining alternatives are provided below.

1.3.1 Alternative I: Trapezoidal Concrete-Lined Channel.

This alternative would contain up to the SPF within the improved channel. Alternative I consists of a trapezoidal, concrete-lined channel with a 40-foot bottom width, 90-foot top width and interior splitter walls at channel curves. The new channel would mainly follow the existing stream alignment Station 22+00 (0.5 miles upstream from the stream mouth) to 92+02 (1.8 miles upstream from the stream mouth), for a distance of 7,200 ft. The channel would also be realigned to the north between Stations 76+40 to 86+60 (an approximate 950-foot length extending east and west of the 'Imi Kālā Street Bridge) to avoid affecting structures that have been constructed on the right bank. All design flows up to the standard project flood would be contained within the channel, thereby eliminating the need for the existing floodplain on the left bank and making the land available for development. Negative environmental impacts include potential objections by public and resource agencies with regard to the conversion of a natural stream bottom to a concrete-lined invert (70% conversion). Total project cost is estimated at $38.8 million. This alternative would achieve project objectives and is considered to be feasible from an engineering and economic perspective. Therefore, this alternative was further analyzed.

1.3.2 Alternative III: Roller Compacted Concrete and Boulder Invert Channel Following Existing Alignment.

This alternative was designed for SPF protection with a peak design discharge of 27,500 cfs downstream at Station 22+00 (0.5 miles upstream from the stream mouth) and 26,000 cfs upstream at Station 92+02. Typical stream stabilization improvements would consist of boulders in the main channel low flow section with RCC stream bank protection, in order to replicate a more natural stream invert. Design elements would be included into existing and planned channel segments to facilitate the movement of native fish and other aquatic organisms. Total project length extends from Station 22+00 to the debris basin (2.5 miles upstream from the shore). Modifications are described in more detail below:

A new ground water recharge basin and diversion levee were considered for inclusion by partially blocking the low flow outlets at the existing debris basin located approximately 1,100 ft upstream of Market Street at Station 127+00 and adding a levee on the left bank upstream of the existing debris basin. Water would pond in the debris basin and help facilitate percolation into the ʻĪao aquifer during rainy season. This mitigation was dropped from consideration following the recommendation of USFWS and DLNR-DAR personnel citing the presence of the recharge basin would have negative impacts on aquatic organisms.

Modify the drop structure between Stations 96+74.21 and 97+23.21. A new stepped drop structure would eliminate the dangerous 22-foot vertical drop and improve passage of in-stream fish (*ʻoʻopu*) and other aquatic organisms.

Modify existing low flow concrete channels with small blocks to break up high velocity flows and facilitate fish passage.

Add hydraulic improvements to the concrete channel between Stations 92+02 and 95+41. These improvements include baffle blocks and a weir within the existing concrete channel to more evenly distribute flow.

Incorporate RCC side slopes and a 20-foot wide grouted boulder invert channel that would mainly follow the alignment of the existing stream between Stations 22+00 and 92+02 (approximately 7,200 ft long). The median base width range would vary between 40 to 60 ft.

Include stream realignment and widening between Stations 76+02 and 85+30. The channel would be realigned to the north on the left bank to avoid existing structures to the right bank and be widened to reduce water surface profile at the ʻImi Kālā Street Bridge. As a result of the channel widening, the 10-year flood (i.e., the low flow condition of 7,200 cfs) will be contained within the channel but floods greater than 7,200 cfs and up to the SPF of 27,500 cfs will spread out on the existing left bank flood plain area.

Construct a low flow boulder channel within the RCC portion. The 20-foot wide low flow channel would use boulders embedded in concrete to replicate a more natural streambed substrate. Retrofit design elements have also been included to facilitate the movement of native organisms through the modified channel area. These elements include a step structure at the 22-foot vertical drop (Station 97+23), widening existing low-flow channel areas, installing low-flow channel segments in existing flat-bottomed cement channel segments and in the center of the existing debris basin, blocks along the sloped portions of the existing channel to provide a resting place for climbing organisms, and an alignment along the vegetated portions of the left bank to provide shade and reduce water temperatures. These mitigation measures have been proposed as compensation for unavoidable impacts, and have been agreed to in a revised mitigation recommendation letter by the USFWS.

Incorporate right bank levee raises. The existing right bank levee would be raised at Stations 45+37 to 48+85 by 4.5 ft using a concrete rubble masonry (CRM) wall on top of the existing earth levee and up to 0.7 ft at Stations 25+62 to 26+46. The 0.7-foot raise can be accomplished using earth levee fill material. Adjacent land uses that may have an impact to their viewscape by the levee raises include warehouses in the vicinity of the 0.7 foot levee raise and residential townhomes in the vicinity of the 4.5 foot levee raise. The impact to the viewscape of the warehouses would be minimal, but the impact to the townhomes would be noticeable. The modified levee would look similar to the levee built for the Kawainui marsh restoration on Oahu.

Channel lining, retaining walls, and raising the levee walls would be necessary due to the excessive flow velocities and higher flood levels. This alternative would achieve project objectives and is considered to be feasible from an engineering and cost perspective. Total project cost is estimated at $30.0 million. Alternative III is considered the "environmental alternative" because it would minimize or otherwise mitigate for negative environmental impacts to the project area. Therefore, Alternative III is the recommended alternative (reformulated plan) as it would best reduce the flooding problems and minimize or mitigate for environmental impacts.

1.3.3 Alternative V: Removal of Flood Control Improvements.

This would include removal of all existing man-made improvements to the existing channel and returning the stream to its original natural state. The community of Wailuku would be placed back into the flood plain, with no flood protection levees. A state-of-the-art flooding warning system would replace man-made flood control devices. The estimated project cost for this alternative is $34.5 million. This estimate does not include the costs of relocating residents in flood-prone areas, which would be required for this alternative and would be expected to be quite substantial given the costs of real estate in Maui. Although this alternative does not meet project objectives from an engineering perspective, there is an expressed public support for this alternative due to its environmental benefits, and the alternative was carried forward for further evaluation. Despite its public support, this alternative was not selected due to potential for loss of life and protection to urbanized areas.

2.0 FACTUAL DETERMINATION

2.1 Physical Substrate Determinations

2.1.1 Sediment type

Soils in the area of Wailuku retain a high organic matter, and are composed of clay, silt, and sand, mixed with varying degrees of gravel, cobble, and boulders. Major soil types in the vicinity of the stream include ʻĪao silty clay, 0 to 3 percent slopes (IaA), Puuone sand, 7 to 30 percent slopes (PZUE), Pulehu cobbly clay loam, 0 to 3 percent slopes (PtA), ʻĪao cobbly silty clay, 3 to 7 percent slopes (IbB), Jaucas sand, saline, 0 to 12 percent slopes (JcC), and stony alluvial land (rSM). In its current state, the ʻĪao Stream bed is experiencing extreme erosion of the right bank in the vicinity of station 82+12. The channel has dropped up to nine feet in some locations, and is being actively graded on a regular basis by the County of Maui to prevent accelerated erosion. This erosion is likely contributing to sedimentation of the near shore marine environment at the mouth of the ʻĪao Stream. While some degree of erosion and sedimentation is natural for any stream system, the erosion experienced during flood events is excessive. Of the proposed alternatives, I and III would eliminate this excessive erosion and resulting sedimentation, but Alternative V would potentially exacerbate it. For Alternative III, anticipated changes to deposition of terrigenous sediments at downstream locations would be minor.

2.1.2 Physical Affects on Benthos

In its current state, the ʻĪao Stream is experiencing extreme streambank erosion that leads to sedimentation. Alternatives I and III would effectively eliminate the erosion and associated sedimentation, while Alternative V would exacerbate the current situation. All three alternatives would have short-term sedimentation impacts during construction, although these can be mitigated through the incorporation of best management practices (BMPs) by the construction contractor.

Alternatives I and III include the concrete lining of an additional 7,200 feet of channel, which would replace the current natural benthic substrate in this area. Alternative I would involve smooth concrete, while Alternative III would replace the natural stream bed with RCC walls and a low-flow boulder invert channel that is envisioned to be of sufficient rugosity to create microhabitat conditions that are more suitable than flat unshaded concrete for upstream migrating organisms. Alternative V does not involve any channel hardening, but would instead remove concrete improvements at the upper and lower reaches of the project.

2.1.3 Actions to be Taken to Minimize Impacts

The general contractor is required to use silt containment devices and other best management practices (BMPs) to control turbidity to the maximum extent practicable. The USACE will monitor the marine water quality at the mouth of the stream before, during, and after construction to assure water quality standards are not exceeded.

2.2 WATER CIRCULATION, FLUCTUATIONS, AND SALINITY DETERMINATIONS

2.2.1 Water Chemistry

A temporary increase in turbidity would be expected during construction activities for all alternatives. This would depend, however, on whether water flow was occurring in the stream channel at the time of construction. No significant changes to salinity or other water quality parameters are anticipated in the stream, however during large freshwater discharge episodes into Kahului Bay, minor changes in salinity and other water quality parameters may be temporarily experienced in the nearshore environment. No significant alteration of color, odor, or taste is anticipated.

Alternatives I and III both involve paving 7,200 feet of natural stream bottom with concrete, but Alternative III incorporates a more natural substrate construction that would allow colonization by aquatic benthic communities and plants. While both alternatives provide the potential for changes in water chemistry due to the alteration of the natural stream bed, Alternative III provides the highest level of engineering controls to mitigate these changes. Alternative III comes with the recommendation to maintain adequate vegetation to maintain lower water temperatures. This vegetation would also assist in removing nutrients from stream water, and trapping water-borne particulates in place.

Alternative V involves removing all man-made, concrete-paved sections of the project area. While this would most likely enhance the removal of nutrients and pollutants in the stream system, the problematic streambank erosion along the entire length of the project area would continue and result in a heavy load of sedimentation. Additionally, this alternative does not provide adequate flood protection and is thus not a practicable alternative.

2.2.2 Current Patterns and Circulation

The length of ‘Īao Stream comprising the project area is devoid of water flow approximately 80 to 90 percent of the time (USFWS, 2006). Occasional high rainfall events provide sufficient water volume to overflow upstream water diversion structures, and water flow through the project area is temporarily restored. Previous investigations of the nearshore coastal environment, however, reported moderately strong winds and breaking waves in nearshore waters resulting in high turbidity close to the mouth of the stream. Constant wave action and strong winds would most likely provide sufficient flushing of the nearshore coastal environment, and any stream discharge would most likely have a negligible effect.

Of the alternatives considered, Alternative I would result in a straightened, concrete lined smooth channel that would result in the fastest and most direct conveyance of streamwater to the ocean during heavy rainfall events. Alternative III would also result in a concrete-lined channel, but with a boulder invert low-flow channel that will help facilitate stream flows during times of scarcer water availability. Alternative V, with a completely restored natural stream bed, would lead to slower water movement and natural percolation of some of the water through the subsurface.

2.2.3 Actions to be Taken to Minimize the Impacts

The general contractor is required to use silt containment devices and other best management practices (BMPs) to control turbidity to the maximum extent practicable. The USACE will monitor the marine water quality at the mouth of the stream before, during, and after construction to assure water quality standards are not exceeded.

Changes to current patterns and water circulation in Kahului Bay would most likely be negligible. No actions are required to minimize impacts.

2.3 Suspended Particulate / Turbidity Determinations

The ʻĪao Stream currently experiences streambank erosion during high rainfall events. This erosion would likely result in a high degree of suspended particulate in the stream. Alternative I, with a smooth bottom, concrete-lined stream bed would eliminate most of the streambank erosion, but would result in the highest level of suspended particulates due to a faster rate of water flow and lack of vegetation or other rugged features that would trap sediment and particulates. Alternative III would eliminate most of the streambank erosion, and would also provide a vegetative buffer on the flood plain and habitat for natural aquatic plant life on the channel bottom, which would help trap and anchor particulates in place. Alternative V would not provide substantial reduction of sedimentation and streambank erosion. The natural buffering capacity of the restored natural streambed would not be sufficient to mitigate the volume of sedimentation anticipated with continued streambank erosion during high rainfall events.

2.3.1 Expected Changes at Discharge Site

Previous investigations of the nearshore coastal environment reported high levels of turbidity related to constant wave action and moderate winds. These conditions were reported consistently across multiple sampling events, both in the presence and in the absence of stream flow. The controlling factor for turbidity appeared to be wave action, with lower turbidity observed on calmer days. Turbidity and total suspended solids were higher at the nearshore stations (80 feet from the mouth of ʻĪao Stream) as compared to the seaward sites (240 feet from the mouth of ʻĪao Stream). The wind speed and constant wave action likely provide sufficient energy to re-suspend existing benthic sediments in the nearshore coastal environment. This high energy system would also likely provide sufficient water movement to regularly flush the area. Of the alternatives considered, Alternatives I and III would most likely result in a net reduction in suspended sediment entering the nearshore system, although during construction there would likely be an increase in sedimentation. The existing highly turbid nearshore system is not anticipated to be significantly affected.

2.3.2 Effects on Chemical and Physical Properties of the Water Column

The proposed project is not anticipated to have a significant effect on light penetration, dissolved oxygen, toxic metals and organics, or pathogens.

2.3.3 Effects on Biota

The length of ‘Īao Stream comprising the project area is devoid of water flow approximately 80 to 90 percent of the time (USFWS, 2006). Occasional high rainfall events provide sufficient water volume to overflow upstream water diversion structures, and water flow through the project area is temporarily restored. Migrating larval recruits that attempt to travel upstream to areas of perennially flowing water are reported as largely unsuccessful under the current conditions. Other mature fish that attempt to travel downstream to spawn in the ocean are also only partially successful due to sporadic water flow. The floodplan on the west bank supports vegetation, and within-stream vegetation provides some amount of shading that regulates water temperature to a range suitable for upstream migrating organisms.

Of the alternatives considered, Alternatives III provides an invert channel of sufficient rugosity to both facilitate water flow during times of scarce water availability and create microhabitat conditions with vegetative growth that are more suitable for organisms. The floodplain would also be left in place under this alternative. Alternative I eliminates the flood plan, and does not provide a suitable environment for migrating organisms. Alternative V would restore that natural stream bottom, but would not address the streambank erosion and is not considered a practicable alternative.

2.3.4 Actions to be Taken to Minimize the Impacts

The general contractor is required to use silt containment devices and other best management practices (BMPs) to control turbidity to the maximum extent practicable. The USACE will monitor the marine water quality at the mouth of the stream before, during, and after construction to assure water quality standards are not exceeded.

2.4 Aquatic Ecosystem and Organism Determinations

The project area includes a series of riffle and pool formations on boulder and cobble substrate. Under 404(b)1 guidelines and regulations, a high relative value is placed on these complexes, identified as special aquatic sites. Eliminating riffle and pool complexes is generally recognized as leading to impacts such as reducing aeration and filtration capabilities, reducing stream habitat diversity, reducing fish and wildlife populations through sedimentation and the creation of unsuitable habitat, scouring or sedimentation of riffles and pools, and reduction of water-holding capacity of streams resulting in rapid runoff from a watershed. Alternative V would not disturb the riffle and pool complexes; however this alternative does not provide for stream bank stabilization and does not meet project objectives. Alternatives I and III both involve converting the natural substrate to a concrete lined channel, with Alternative III providing the best strategy to reduce the negative impacts listed above.

Alternative III retains the flood plain on the west bank to provide a buffer during high flow events and natural filtration. Alternative III also reduces the impacts to the natural stream bottom and riparian vegetation anticipated under Alternative I by incorporating several mitigation measures agreed to by the USFWS. During periods of moderate to low stream discharge, water would be entrained in a low-flow channel that is envisioned to be of sufficient rugosity to create microhabitat conditions that are more suitable than flat unshaded concrete for upstream migrating organisms. Where possible, the low-flow channel would be aligned close to the stream bank so that existing vegetation could provide shade to the channel. In addition, non-woody vegetation could grow among the grouted boulders that form the low-flow channel. This streambank and channel vegetation, if appropriately managed, would function to provide critical shade and maintain lower water temperatures.

In their draft FWCA report, USFWS expressed concerns that converting 7,200 ft of natural alluvial stream bed to a RCC and boulder invert channel would have a negative impact on the ‘Īao Stream and cumulatively to the hydrologic landscape of north-shore Maui. USFWS also noted that although they would recommend Alternative V or IV as the preferred alternative, they do not meet the project requirements and thus would likely be removed from consideration. In that case, USFWS recommended selection of Alternative III as the preferred alternative, emphasizing that “the goal of the mitigation flow would be to re-establish continuous flow of ‘Īao Stream to the sea no less than 80% of the time and to enhance flow duration to maximize survival of migratory aquatic organisms.” In a follow-up discussion between USFWS, USACE, and the COM, stream flow restoration was discussed and was recognized as being outside the authority or purpose of the USACE. Retrofit design elements have also been included to facilitate the movement of native organisms through the modified channel area. A site visit was conducted on 3/31/2008 to identify these areas and measures. These elements include a step structure at the 22-foot vertical drop (Station 97+23), widening existing low-flow channel areas, installing low-flow channel segments in existing flat-bottomed cement channel segments and in the center of the existing debris basin, blocks along the sloped portions of the existing channel to provide a resting place for climbing organisms, and an alignment along the vegetated portions of the left bank to provide shade and reduce water temperatures. These mitigation measures have been proposed as compensation for unavoidable impacts, and have been agreed to in a revised mitigation recommendation letter by the USFWS.

Alternative III is designed to facilitate upstream and downstream migration of aquatic organisms, given sufficient water flow. Stream flow restoration is a topic that is currently under discussion by the CWRM, state and federal resource agencies, community groups, and private entities that hold licenses for diversion and out-of-stream consumptive use of ‘Īao Stream Water. This decision is outside the function and authority of the USACE, however. If and when stream flow is partially restored, the low-flow design elements of Alternative III will function to enhance passage of stream fauna.

Coral reefs are reported to occur in the coastal environment adjacent to the mouth of the ‘Īao Stream, although not in the immediate vicinity. A series of regular water quality monitoring events consistently found the waters in the immediate vicinity of the ‘Īao

Stream to be extremely turbid with limited visibility. The substrate reported at the monitoring stations (from 80 to 240 feet adjacent to the stream mouth) consisted of a shallow, boulder-covered bottom with a gradual slope. The highly turbid water conditions currently present in this area are not conducive to coral reef growth, as corals require relatively clear, nutrient-poor waters to thrive. Some increase in turbidity would be inevitable during construction activities, although BMPs would be implemented to mitigate sedimentation to the extent practicable. Following construction, Alternative III would likely provide a net reduction in sedimentation immediately following high water flow events due to its elimination of excessive stream bank erosion.

2.5 Proposed Discharge Site Determinations

Release of sediment into waters of the United States would most likely occur during periods of construction. The general contractor will be required to use silt containment devices and other BMPs to control turbidity to the maximum extent practicable. The USACE will monitor the marine water quality at the mouth of the stream before, during, and after construction to assure water quality standards are not exceeded.

2.6 Determination of Cumulative Effects on the Aquatic Ecosystem

Cumulative impacts resulting from the incremental consequences of the proposed project when added to other past and reasonably foreseeable future actions were considered in the EA. The County of Maui is planning an upgrade to the existing 'Imi Kālā Street Bridge. This project has necessitated the inclusion of several revisions to the original proposed 'Īao Stream Flood Control Project. Notable revisions include the stream bank excavation and channel widening in the area directly upstream from the bridge. Although the bridge upgrade project has changed the scope of the proposed Flood Control Project, this is not considered a cumulative impact to the natural or social environment, other than the benefit to the community of having an improved bridge.

The County is also planning to extend 'Imi Kālā Street to connect to Kahekili Highway, as part of the development of the Hale Mua affordable housing subdivision. This may cause changes to traffic in the vicinity of the proposed project, but not as a result of any of the project design elements.

No other projects are planned for the channel or in the vicinity of the channel that would compound or increase the impact of the proposed project. Areas surrounding the channel are being developed into residential and commercial communities; however these developments are not anticipated to have a significant cumulative impact on the proposed project.

2.7 Determination of Secondary Effects on the Aquatic Ecosystem

Secondary impacts are those that are caused by an action and are later in time or farther removed in distance but are still reasonably foreseeable. These impacts are induced directly or indirectly by the proposed project. Secondary effects to the aquatic ecosystem considered in this analysis include potential impacts to the downstream coral reef community. No significant adverse effects to downstream coral reefs were identified.

Appendix H:

Agency Communication

DEPARTMENT OF THE ARMY
PACIFIC OCEAN DIVISION, CORPS OF ENGINEERS
FT. SHAFTER, HAWAII 96858-5440

REPLY TO
ATTENTION OF

March 8, 1996

Planning and Operations Division

Mr. Gene Nitta
Pacific Area Office
National Marine Fisheries Service
2570 Dole Street
Honolulu, Hawaii 96822-2396

Dear Mr. Nitta:

The U.S. Army Corps of Engineers is planning a modification of the Iao Stream Flood Control project, Maui, Hawaii. The modification is required to correct undermining of the levee toe resulting from natural streambed erosion processes in the stream.

The modification will consist of concrete lining the affected reach from river station 91+50 to 21+50. The bottom would be 40 feet wide with sloping sides and would be about 12 feet deep (see enclosed Figures).

An environmental document is in preparation for this project to update the Final Environmental Statement of April 1975.

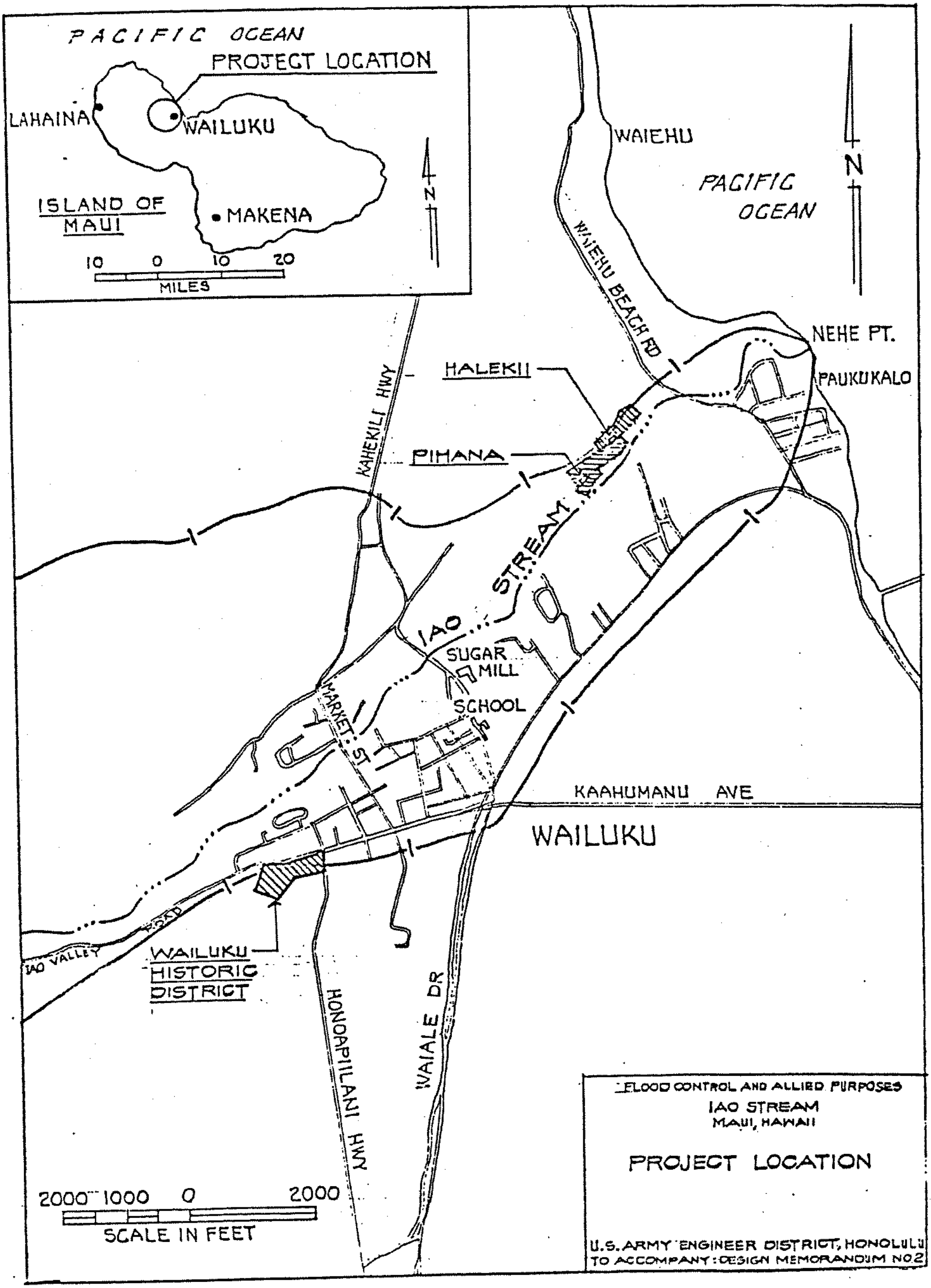
Because this project is about one-half mile inland, we believe that no candidate, proposed, or listed threatened or endangered species for which NMFS is responsible will be affected adversely, and that formal consultation under Section 7 of the Endangered Species Act is not required. In fact, we believe that by reducing the amount of sediment entering the ocean during storms, the project will have a benificial effect. We would appreciate your concurrence with this determination.

Should you have any questions, please contact Mr. Bill Lennan at 438-2264 or Ms. Sharon Okamoto at 438-2249 of my planning staff.

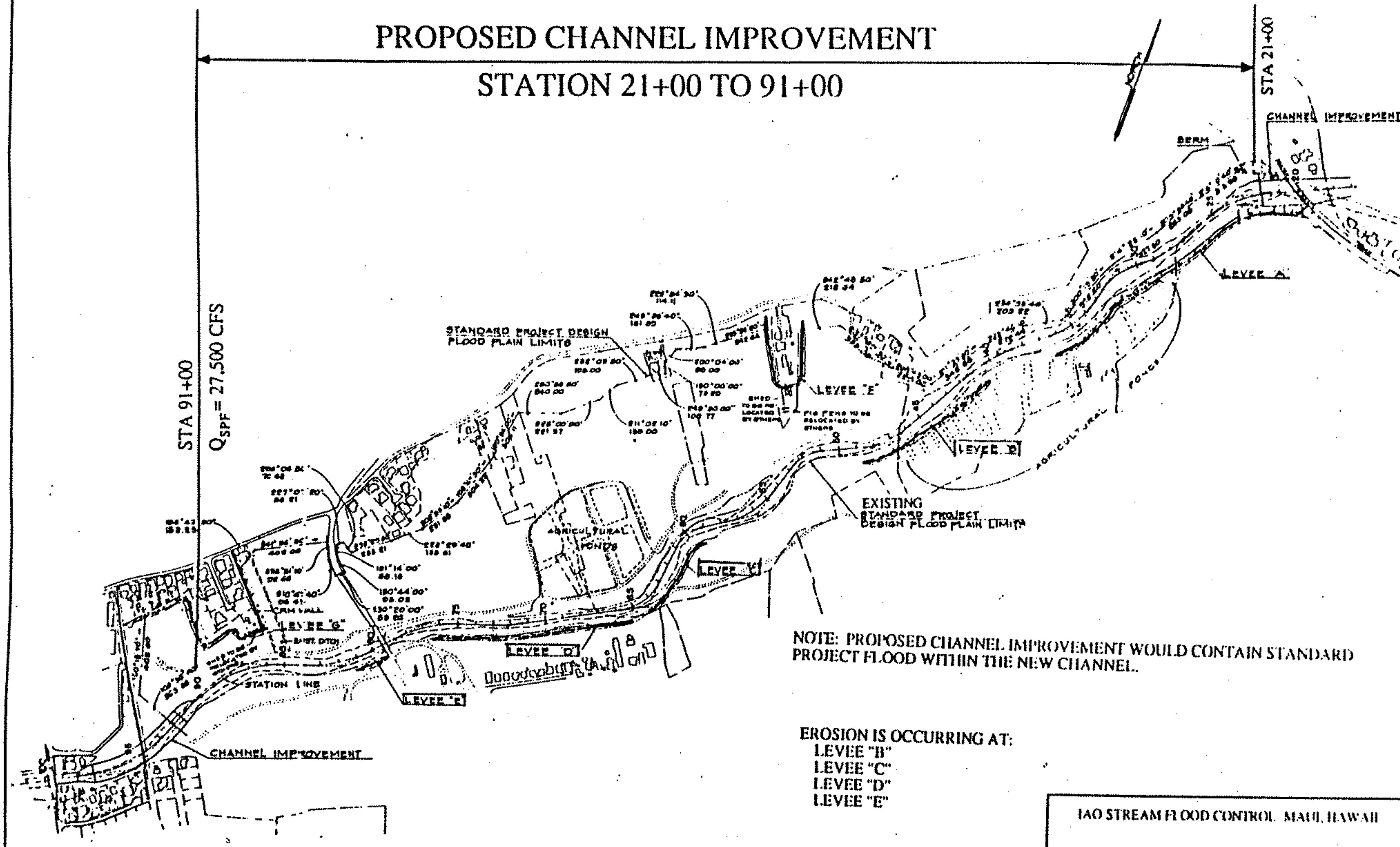
Sincerely,

Ray H. Jyo, P.E.
Director, Engineering
and Technical Services

Enclosure



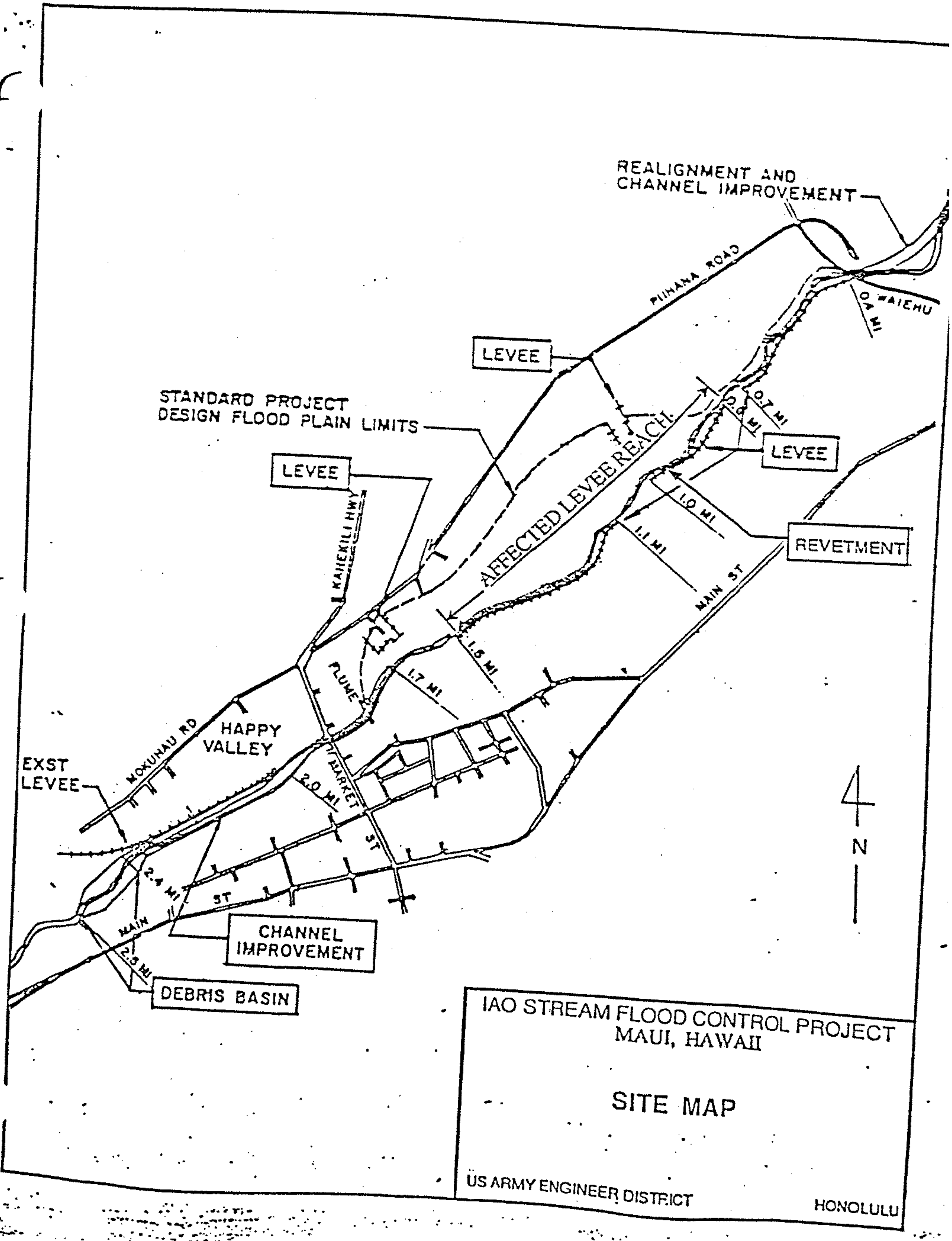
PACIFIC OCEAN
PROJECT LOCATION
LAHAINA
WAILUKU
ISLAND OF MAUI
MAKENA
10 0 10 20
MILES
N
WAIEHU
PACIFIC OCEAN
N
WAIEHU BEACH RD
NEHE PT.
PAUKUKALO
HALEKII
PIHANA
KAHEKILI HWY
IAO STREAM
SUGAR MILL
SCHOOL
MARKET ST
KAAHUMANU AVE
WAILUKU
IAO VALLEY ROAD
WAILUKU HISTORIC DISTRICT
HONOAPIILANI HWY
WAIALE DR
2000 1000 0 2000
SCALE IN FEET
FLOOD CONTROL AND ALLIED PURPOSES
IAO STREAM
MAUI, HAWAII
PROJECT LOCATION
U.S. ARMY ENGINEER DISTRICT, HONOLULU
TO ACCOMPANY: DESIGN MEMORANDUM NO. 2



IAO STREAM FLOOD CONTROL MAUI, HAWAII

SITE MAP

US ARMY ENGINEER DISTRICT HONOLULU


REALIGNMENT AND
CHANNEL IMPROVEMENT
PIIHANA ROAD
WAIEHU
0.4 MI
LEVEE
STANDARD PROJECT
DESIGN FLOOD PLAIN LIMITS
AFFECTED LEVEE REACH
0.6 MI
0.7 MI
LEVEE
LEVEE
KAHEKILI HWY
1.0 MI
1.1 MI
REVETMENT
MAIN ST
1.6 MI
FLUME
1.7 MI
HAPPY
VALLEY
MOKUHAU RD
EXST
LEVEE
MARKET
ST
2.0 MI
2.4 MI
ST
MAIN
2.5 MI
CHANNEL
IMPROVEMENT
DEBRIS BASIN
N
IAO STREAM FLOOD CONTROL PROJECT
MAUI, HAWAII
SITE MAP
US ARMY ENGINEER DISTRICT
HONOLULU

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Southwest Region
501 West Ocean Boulevard, Suite 4200
Long Beach, California 90802-4213
TEL (310) 980-4000; FAX (310) 980-4018

March 19, 1996 F/SW033:ETN

Mr. Ray H. Jyo, P.E.
Director of Engineering and Technical Services
U.S. Army Engineer District - Honolulu
Fort Shafter, Hawaii 96858-5440

Dear Mr. Jyo:

Thank you for your letter regarding the proposed modification of the Iao Stream Flood Control project, Maui, Hawaii. The modifications would correct undermining of the levee toe resulting from natural streambed erosion processes. Critical habitat for any listed species under the jurisdiction of the National Marine Fisheries Service has not been designated or proposed within or near the project site. Based on available information I concur that the proposed project will benefit listed marine species by reducing the amount of sediment entering the nearshore environment. Accordingly, Section 7 consultation for this project will not be necessary.

The Section 7 consultation process for this project must be reinitiated if new species are listed that may be affected by the proposed activities or the activities affect listed species or critical habitat in a manner or to an extent not previously considered. I may be reached at 808/973-2987 should there be any further questions.

Sincerely,

Eugene T. Nitta
Protected Species Program
Coordinator

cc: F/SWO3 - Lecky

OFFICE	ACTION	INFO
Dir of Engrg		
Deputy		
Secretary		
Cost		
DSC		
Env		
Fin		
Plng		
Svcs		
Tech		

PP-A

OFFICE	ACTION	INFO
2 Dir of Engrg	Tech Svcs	2
1 Deputy		2
Secretary		
Cost		
~~Doc Mgt~~		
Env		
~~FM&S~~		
3 Ping		5344
Svcs		
Tech		

United States Department of the Interior

FISH AND WILDLIFE SERVICE

PACIFIC ISLANDS ECOREGION
300 ALA MOANA BOULEVARD, ROOM 3108
BOX 50088
HONOLULU, HAWAII 96850
PHONE: (808) 541-3441 FAX: (808) 541-3470

In Reply Refer To: JMB

JUL - 1 1996

Bill
Sharon
file 7/8

Mr. Ray H. Jyo, P.E.
Director of Engineering and
Technical Services
Planning and Operations Division
U.S. Army Corps of Engineers
Fort Shafter, Hawaii 96858-5440

Re: Planning Aid Letter, Iao Stream Flood Control Project Modifications, Maui, Hawaii

Dear Mr. Jyo:

This Planning Aid Letter for proposed modifications to the Iao Stream Flood Control Project, Maui, Hawaii transmits U.S. Fish and Wildlife Service (Service) information and concerns regarding the proposed project and was prepared under the authority of the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 *et seq.*). The U.S. Army Corps of Engineers Honolulu District (HED) proposes to correct continued erosion of the streambed and levee toes by lining approximately 7,000 linear feet of the lower reaches of Iao Stream.

Information was gathered through a review of our files, maps prepared by the Hawaii Heritage Program of The Nature Conservancy, and a May 13, 1996, site visit conducted by Service biologists. The visit included the debris basin and lined stream sections immediately downstream. During the site visit, several individuals of a native goby (*Awaous guamensis, 'o'opu nakea*) as well as the introduced crustacean *Macrobrachium lar* were observed in the debris basin, indicating that the present stream configuration allows some juveniles of these species to recruit to the stream above the project limits. However, at the low flow conditions observed during the site visit, the exposed nature of the low-flow channel appear to make the lined portions of the stream unsuitable for most aquatic life. It appears that Service recommendations agreed to by HED in the original project, specifically that closely-spaced boulders be embedded in the low flow channel (Memorandum for Record, 5 March 1976, enclosed), were not implemented. Unlined portions of the stream bed within the project area may harbor native invertebrates or fishes, although this was not determined during the brief site visit.

The Service is concerned that lining of the entire stream channel below the debris basin may render Iao stream uninhabitable by native aquatic species that require connection with the ocean during their life cycle. This is partly due to the shallow, barren low flow channel provided for in the plans. At low flow rates, water in such channels rapidly heats and loses dissolved oxygen. Designs for the proposed project should be presented which would allow larger perennial flows by closing existing diversions and that would provide eddies and sheltered overhangs within the low flow channel to allow upstream migration of juvenile stream organisms.

The Service concurs with your determination that there are no proposed or listed threatened or endangered species within the project area. Therefore, formal consultation under section 7 of the Endangered Species Act is not required. However, there is a potential for two candidate species (*Megalagrion pacificum* and *M. xanthomelas*) to occur in the project area. Surveys conducted as part of the Scope of Work will determine their presence or absence.

The March 3, 1996, Scope of Work submitted to the Service is adequate and accepted with the exception of the cost estimate. The Service does not require funding for this Planning Aid Letter but does require three (3) additional biologist-days to prepare the draft and final 2(b) reports. A revised cost estimate of $13,897 is attached.

We were unable to locate any 2(b) report prepared by the Service for the original project. Our file contains several Service letters commenting on the draft Environmental Impact Statement and General Design Memorandum. Copies of these letters are available on request.

We look forward to working with HED on the design and implementation of this project. If you have any questions regarding this Planning Aid Letter, please contact Fish and Wildlife Biologist Jeff Burgett at (808) 541-3441.

Sincerely,

Brooks Harper

Brooks Harper
Field Supervisor
Ecological Services

Enclosures

cc: DAR, Maui (w/o enclosures)

COST ESTIMATE
FISH AND WILDLIFE COORDINATION ACT REPORT
IAO STREAM FLOOD CONTROL PROJECT MODIFICATIONS
MAUI, HAWAII
June 28, 1996

1. Field Expenses

4 days @ $500	$ 2,000
2 RT airfare Honolulu-Maui @ $140/RT	$ 280
4 days perdiem @ 175/day	$ 700
2 days car rental @ 45/day	$90
TOTAL FIELD COST	$ 3,070

2. Report Preparation

10 days @ $500/biologist day [draft 2(b)]	$ 5,000
4 days @ $500/biologist day [Final 2(b)]	$ 2,000
TOTAL REPORT PREPARATION	$ 7,000
SUBTOTAL	$ 10,070
38% Overhead	$ 3,827
TOTAL	$13,897

PODED-P

5 March 1976

MEMORANDUM FOR RECORD

SUBJECT: Iao Stream Flood Control Project, Maui, Hawaii
Coordination with U.S. Fish and Wildlife Service (FWS)

1. A Phase II coordination meeting was held with representatives of the USFWS to review the detailed design of the subject project and to obtain their views on the plan design. Attending the meeting were Mr. Maurice Taylor and Mr. Mike Nishimoto of FWS, and Mr. Clarence Lee and Ms Ruby Mizue of POD.

2. Mr. Lee reviewed the design of the proposed plan of improvements, describing each of the structures and the deviations from the plan discussed during Phase I. Essentially, the plan concept has not changed, but the availability of more detailed topographic maps and the refinement of the design have resulted in minor modifications and alterations in lengths, heights, and widths of certain structures.

3. In general, the FWS concurred with the present design, although several areas of concern were pointed out, and these concerns are summarized as follows:

a. The 15-foot drop structure may be an obstacle to migratory species. While some species of gobies are capable of migrating over vertical obstacles of considerable height, it is not certain that all the species in Iao Stream, particularly the rare and endangered ones, would be able to accomplish the migration. Mr. Lee pointed out that the drop structure has been reduced 10 feet from the 25-foot high drop structure proposed in Phase I studies. The drop structure is required to reduce flow velocities sufficiently and allow for preservation of the downstream sections in their natural condition. Elimination of the drop structure would essentially require complete channelization of the downstream sections.

As an alternative suggestion, Mr. Taylor recommended that the surface of the drop structure be as rough as possible. Attempts will be made by Mr. Taylor to monitor the effect of the drop structure on fish migration subsequent to project implementation. Furthermore, all concrete channel sections over which the low flows pass should be kept as rough as possible. Mr. Lee concurred that this could be done by specifying the type of finish in the construction contract.

5 March 1976

PODED-P
SUBJECT: Iao Stream Flood Control Project, Maui, Hawaii
Coordination with U.S. Fish and Wildlife Service (FWS)

b. Regarding the boulder-concrete lining of certain channel sections, Mr. Nishimoto questioned the spacing of the boulders. He recommended that spacing be as close as possible to maximize shade and places of shelter for aquatic species. In the low flow channel, he suggested that spacing be 6 inches or less between boulders. Mr. Lee agreed that the spacing would be specified in the contract as described.

4. Mr. Lee concluded the meeting by noting that construction is scheduled to begin in FY 77, provided that funds are available. He will send a summary of the recent changes in the plan to Mr. Taylor with a request for formal comments to be included in the Phase II General Design Memorandum.

Ruby Mizue
RUBY MIZUE

DEPARTMENT OF THE ARMY
PACIFIC OCEAN DIVISION, CORPS OF ENGINEERS
FT. SHAFTER, HAWAII 96858-5440

March 29, 1996

REPLY TO
ATTENTION OF

Planning and Operations Division

Don Hibbard, Ph.D.
Deputy State Historic Preservation Officer
State Historic Preservation Division
Department of Land and Natural Resources
33 South King Street, 6th Floor
Honolulu, Hawaii 96813

Dear Dr. Hibbard:

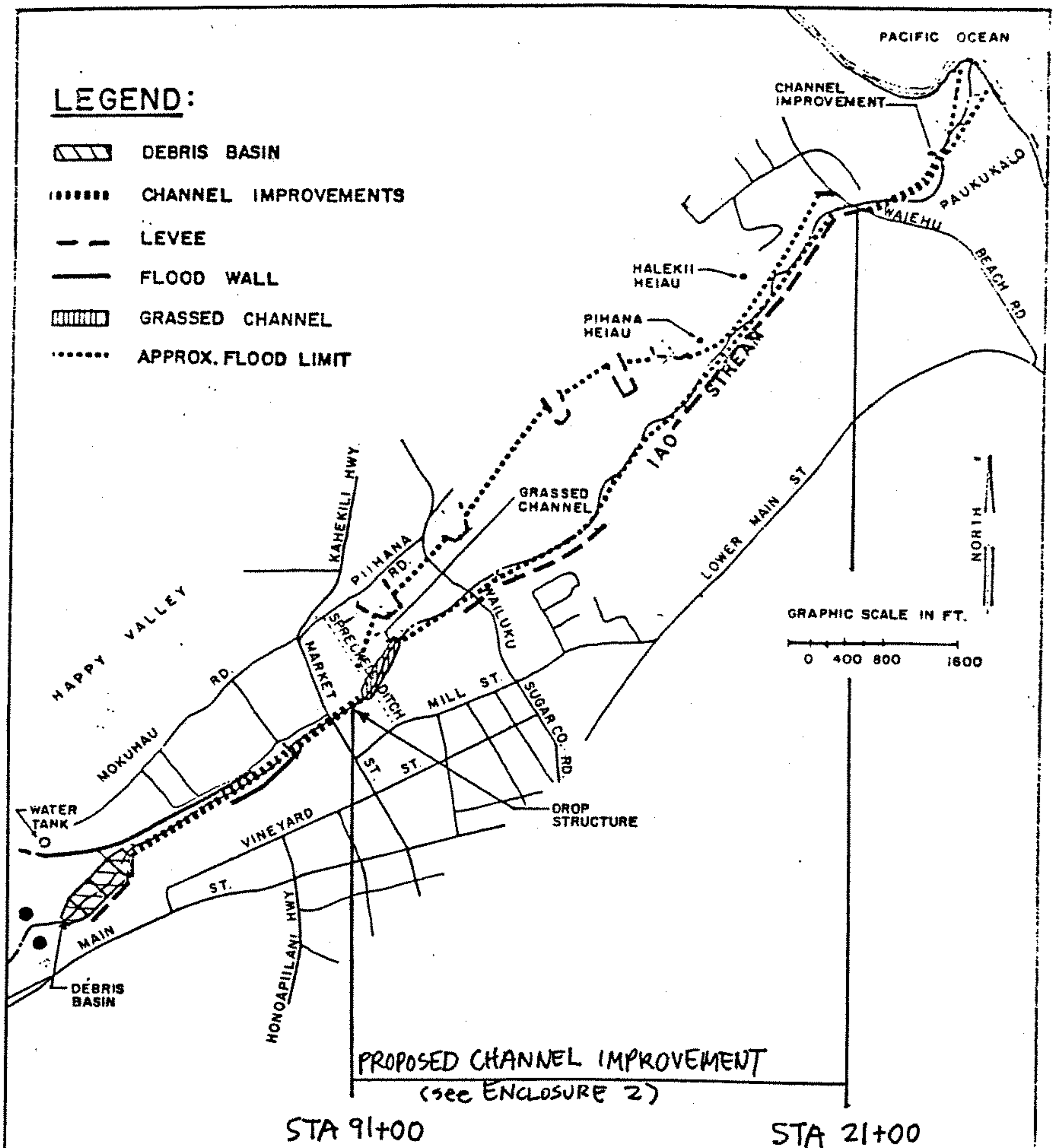
The U.S. Army Corps of Engineers, Honolulu Engineer District has assessed the potential effects of proposed modifications to the Iao Stream Flood Control Project area at Iao Stream, Wailuku, Maui Island (enclosures). The entire proposed undertaking consists of concrete drainage channel modifications confined to instream sections of the drainage way. Previous Section 106 consultation between the U.S. National Park Service and the President's Advisory Council on Historic Preservation in 1974 resulted in the Bishop Museum's identification of 2 historic properties in the uppermost portion of Iao Stream. This report is referenced in your library under Connolly, Robert, 1974, *Phase I Archaeological Survey of Iao Valley Flood Control Project Area, Maui*, Bishop Museum Manuscript Report 100374. This initial assessment did not identify any surface historic properties at the present project location and subsequent construction of the Iao Stream flood control improvements did not discover any unanticipated historic properties within the entire stream flow channel. Currently designated historic properties consisting of the Wailuku Historic District, Halekii and Pihana heiau, the Wallace System Complex, and the North Terrace System Complex are not located within the project area, nor will they be directly or indirectly impacted by any activities associated with construction of the proposed undertaking (enclosure). We request your comments and concurrence in determining that pursuant to 36 CFR Sections 800.4 and 800.5 of the regulations of the President's Advisory Council on Historic Preservation this proposed undertaking for flood control channel modifications at Iao Stream, Wailuku, Maui Island, will have No Effect on any identified or potential historic properties.

Thank you for your timely response in order that we may proceed to finalize the supplementary dEA and dFONSI and complete the Section 106 compliance process. If you have any further questions or comments, please contact Mr. Farley K. Watanabe, Staff Archaeologist at 438-7007 of my Planning & Operations Division.

Sincerely,

Ray H. Jyo, P.E.
Director of Engineering
and Technical Services

Enclosures



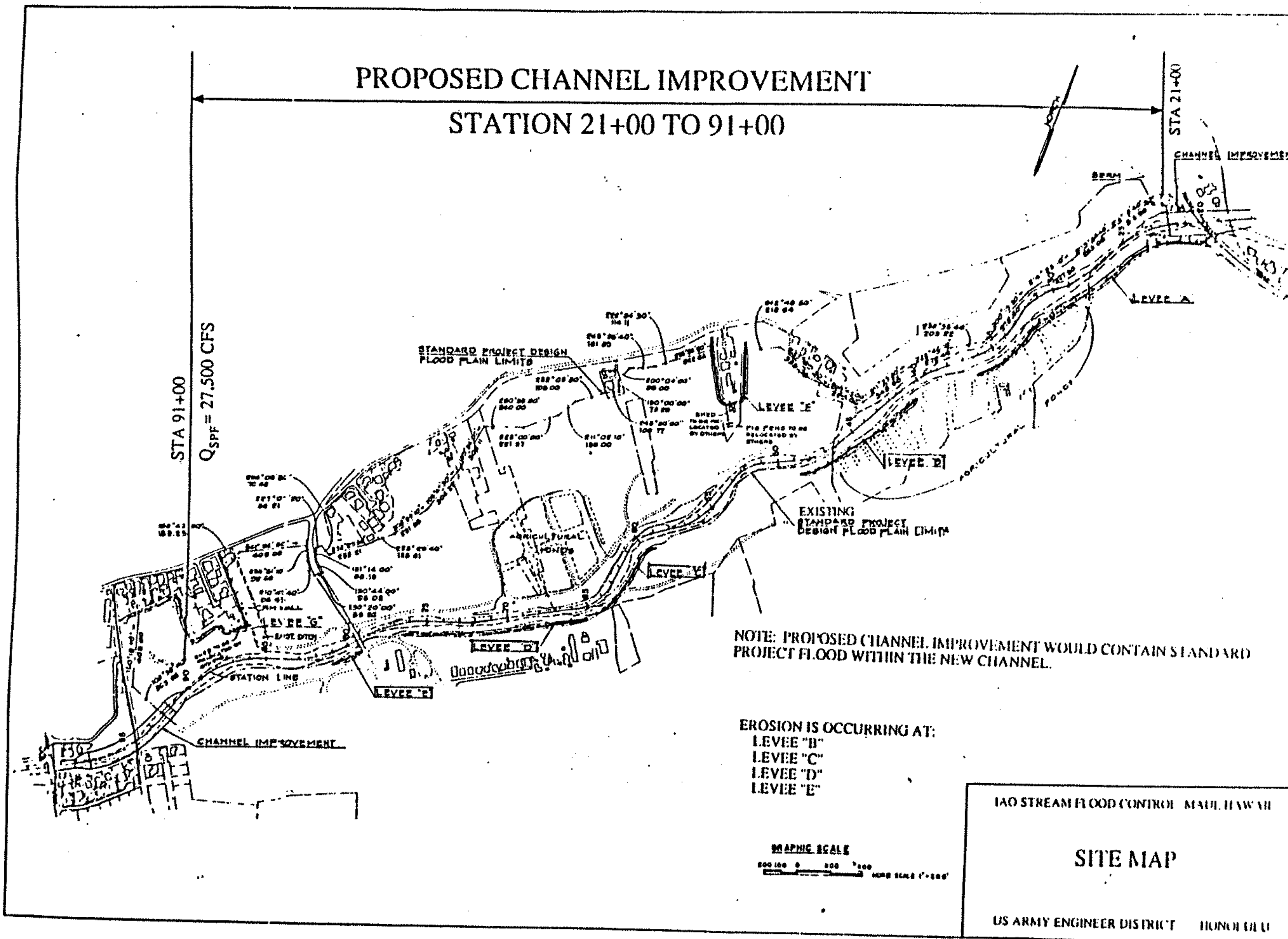
FLOOD CONTROL AND ALLIED PURPOSES
IAO STREAM
MAUI, HAWAII

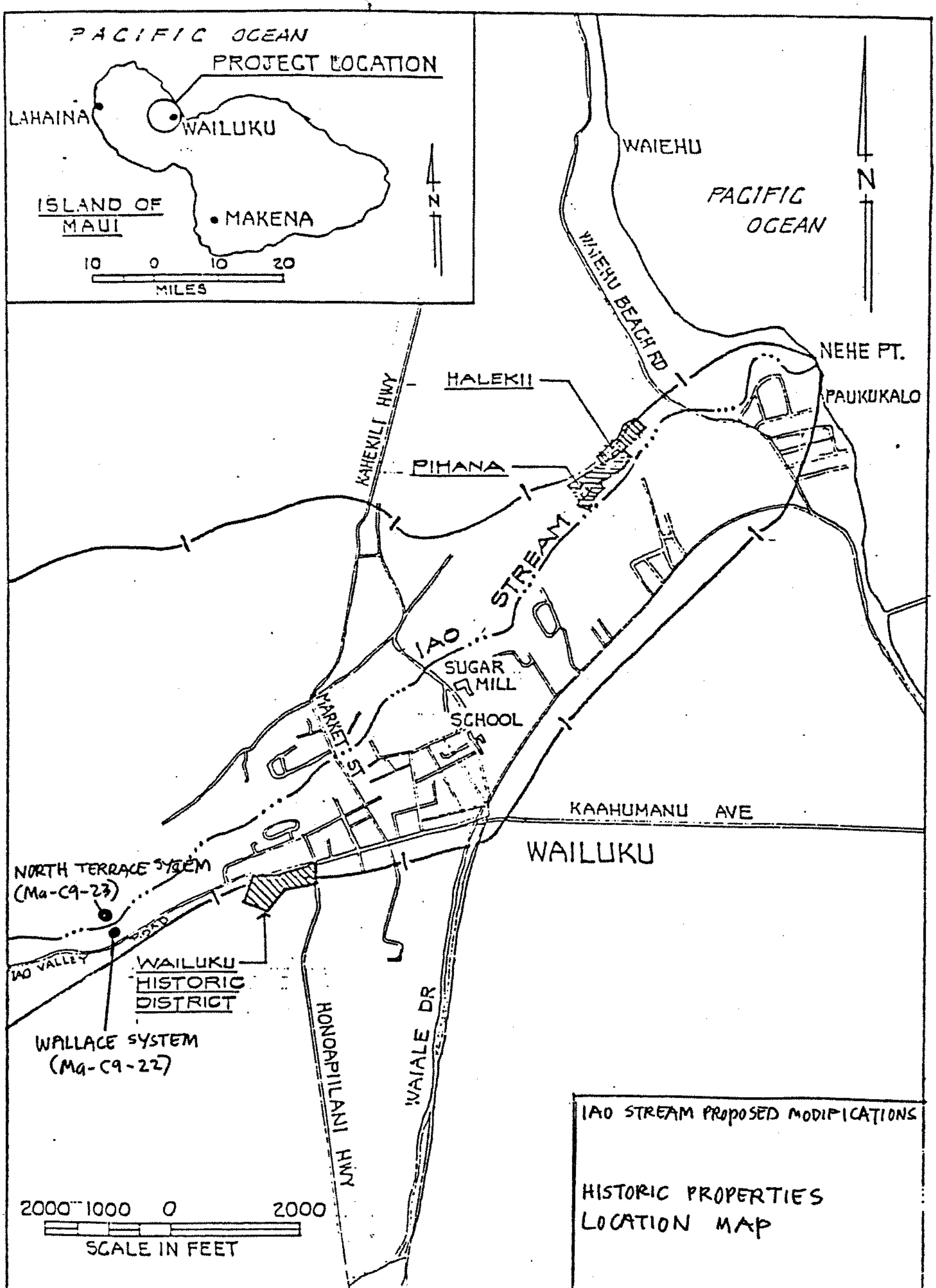
ORIGINAL PROJECT AREA, ALTERNATIVE PLAN B

U.S. ARMY ENGINEER DISTRICT, HONOLULU
TO ACCOMPANY DESIGN MEMORANDUM NO. 2

Enclosure 1.

Enclosure 2.


PROPOSED CHANNEL IMPROVEMENT
STATION 21+00 TO 91+00
STA 21+00
STA 91+00
Q_{SPF} = 27,500 CFS
CHANNEL IMPROVEMENT
BERM
LEVEE "A"
LEVEE "B"
LEVEE "C"
LEVEE "D"
LEVEE "E"
LEVEE "F"
LEVEE "G"
STANDARD PROJECT DESIGN FLOOD PLAIN LIMITS
EXISTING STANDARD PROJECT DESIGN FLOOD PLAIN LIMITS
AGRICULTURAL PONDS
STATION LINE
CHANNEL IMPROVEMENT
NOTE: PROPOSED CHANNEL IMPROVEMENT WOULD CONTAIN STANDARD PROJECT FLOOD WITHIN THE NEW CHANNEL.
EROSION IS OCCURRING AT:
LEVEE "B"
LEVEE "C"
LEVEE "D"
LEVEE "E"
GRAPHIC SCALE
IAO STREAM FLOOD CONTROL MAUI, HAWAII
SITE MAP
US ARMY ENGINEER DISTRICT HONOLULU


PACIFIC OCEAN
PROJECT LOCATION
LAHAINA
WAILUKU
ISLAND OF MAUI
MAKENA
10 0 10 20
MILES
N
WAIEHU
PACIFIC OCEAN
N
WAIEHU BEACH RD
NEHE PT.
PAUKUKALO
HALEKII
PIHANA
KAHEKILI HWY
IAO STREAM
SUGAR MILL
SCHOOL
MARKET ST
KAAHUMANU AVE
WAILUKU
NORTH TERRACE SYSTEM
(Ma-C9-23)
IAO VALLEY ROAD
WAILUKU HISTORIC DISTRICT
WALLACE SYSTEM
(Ma-C9-22)
HONOAPIILANI HWY
WAIALE DR
2000 1000 0 2000
SCALE IN FEET
IAO STREAM PROPOSED MODIFICATIONS
HISTORIC PROPERTIES
LOCATION MAP

Enclosure 3.

BENJAMIN J. CAYETANO
GOVERNOR OF HAWAII

MICHAEL D. WILSON, CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES

DEPUTY
GILBERT COLOMA-AGARAN

STATE OF HAWAII

DEPARTMENT OF LAND AND NATURAL RESOURCES

STATE HISTORIC PRESERVATION DIVISION
33 SOUTH KING STREET, 6TH FLOOR
HONOLULU, HAWAII 96813

REF: HP-JEN

JUN 17 1996

Mr. Ray H. Jyo, Director of Engineering
Planning and Operations Division
Department of the Army
U.S. Army Engineer District, Honolulu
Ft. Shafter, Hawaii 96858-5440

LOG NO: 17189
DOC NO: 9606KD04

Dear Mr. Jyo:

SUBJECT: **National Historic Preservation Act, Section 106 Review of the Iao Stream Flood Control Project Modifications**
Wailuku, Wailuku District, Maui

The Corps of Engineers proposes to make improvements along sections of the existing Iao Stream channel, in an area between Market Street and Waiehu Beach Road in Wailuku. The improvements will be confined to the existing concrete channel area and are within the previously impacted zone of the Iao Flood Control Project.

As indicated in your letter, the proposed improvements will not occur within or near areas of known historic sites. We concur with your determination that the project will have "no effect" on historic sites.

Please contact Ms. Theresa K. Donham at 243-5169 if you have any questions.

Aloha,

Gilbert D. Coloma-Agaran
for MICHAEL D. WILSON,
State Historic Preservation Officer

KD:jen

OFFICE	ACTION	INFO
Dir of Engrg	Tech Svcs	JN
Deputy		
Secretary		
Const		
Contr		
Env		
Eng		19
Svcs		
Tech		

DEPARTMENT OF THE ARMY
PACIFIC OCEAN DIVISION, CORPS OF ENGINEERS
FT. SHAFTER, HAWAII 96858-5440
March 8, 1996

REPLY TO
ATTENTION OF

Planning and Operations Division

Gregory Pai, Ph.D.
Director
Office of State Planning
P.O. Box 3540
Honolulu, Hawaii 96811-3540

Dear Dr. Pai:

The U.S. Army Corps of Engineers, Honolulu District, is planning a modification of the Iao Stream Flood Control project, Maui, Hawaii. The modification is required to correct undermining of the levee toe resulting from natural streambed erosion processes in the stream.

The modification will consist of concrete lining the affected reach from river station 91+50 to 21+50. The bottom would be 40 feet wide with sloping sides, and would be about 12 feet deep (see enclosed report).

An environmental document is in preparation for this project to update the Final Environmental Statement issued in April 1975.

a. There were no impacts to endangered, threatened, proposed or candidate species identified during the original study, and none are anticipated; however coordination has been initiated with the U.S. Fish and Wildlife Service and the National Marine Fisheries Service.

b. Endemic stream organisms will continue to be affected by the present withdrawal of water from the stream for agricultural purposes; however, the project will include "low flow" provisions to take advantage of water which might become available in the future.

c. The construction contractor will be required to comply with our standard environmental protection clauses contained in the contract specifications, including protection of water quality, cultural resources protection, etc.

d. The State Historic Preservation Officer has concurred with our determination that the project will have no effect on historic properties.

e. The concrete channel will be contained within the footprint of the existing channel.

We assume a CZM Consistency Determination was issued for the original project, but we have been unable to find a copy in our files. Since the project will be within the footprint of the original project, we believe that the original consistency determination is still valid for this project and that a new consistency determination will not be required. We would appreciate your concurrence with our determination.

Should you have any questions, please feel free to contact Mr. Bill Lennan at 438-2264 or Ms. Sharon Okamoto at 438-2249 of my planning staff.

Sincerely,

Ray H. Jyo, P.E.
Director of Engineering
and Technical Services

Enclosures

PP-J SO 6/25

OFFICE OF STATE PLANNING

Office of the Governor

BENJAMIN J. CAYETANO, Governor

MAILING ADDRESS: P.O. BOX 3540, HONOLULU, HAWAII 96811-3540
STREET ADDRESS: 250 SOUTH HOTEL STREET, 4TH FLOOR
TELEPHONE: (808) 587-2846, 587-2800

FAX: Director's Office 587-2848
Planning Division 587-2824

Ref. No. Z-0134

OFFICE	ACTION	INFO
Dir of Engrg		
Deputy		
Secretary		
Cost		
~~Doc~~		
Env		
~~TM&S~~		
Plng		25
Svcs		
Tech		

June 18, 1996

Mr. Ray H. Jyo, P.E.
Director of Engineering
Department of the Army
Pacific Ocean Division, Corps of Engineers
Ft. Shafter, Hawaii 96858-5440

Dear Mr. Jyo:

Subject: Hawaii Coastal Zone Management (CZM) Program Federal Consistency Review for Modifications to the Iao Stream Flood Control Project, Maui, Hawaii

The proposal to construct modifications to the existing Iao Stream flood control project should be evaluated for consistency with Hawaii's CZM Program and a consistency determination submitted for review. We did not review the original flood control project for CZM consistency because it was started prior to the establishment of the Hawaii CZM Program. Due to this fact and because the proposed modifications will significantly change the existing conditions we cannot consider the proposal as a modification to an existing CZM consistency determination.

It is our understanding that an environmental document is being prepared for the proposed modifications. Please submit the environmental document and the CZM consistency determination to our CZM Program. We will try to complete our review as expeditiously as possible. Thank you for your cooperation in complying with Hawaii's CZM Program. If you have any questions, please call our CZM office at 587-2878.

Sincerely,

Gregory G.Y. Pai, Ph.D.
Director

cc: U.S. National Marine Fisheries Service, Pacific Area Office
U.S. Fish and Wildlife Service, Pacific Islands Ecoregion
Department of Health, Clean Water Branch
Department of Land & Natural Resources
  Planning & Technical Services Branch
  Commission on Water Resource Management
Planning Department, County of Maui

DEPARTMENT OF THE ARMY
U. S. ARMY ENGINEER DISTRICT, HONOLULU
FT. SHAFTER, HAWAII 96858-5440

29 July, 2005

REPLY TO
ATTENTION OF
Environmental Technical Branch
Engineering and Construction Division

President
Central Maui Hawaiian Civic Club
P.O. Box 483
Kahalui, Hawaii 96733

Dear Sir:

The U.S. Army Engineer District, Honolulu (POH) is proposing to undertake a flood control project on the lower (makai) segments of Iao Stream (multiple TMK) in Wailuku, Maui Island (Figure 1). Five (5) alternatives are being considered as flood control measures and, for the most part, these measures are confined to the stream channel proper and certain areas of the northern banks of the stream in the upper (mauka) section of the project area. No modification is being envisioned along the banks of the stream in the lower portion (makai) of the project area, across from the area encompassing Halekii Heiau.

Typical cross-sections of the flood control measures are illustrated in Figures 2, 3, and 4. Alternative 1 will result in a trapezoidal concrete-lined channel. Alternative 2 will consist of a rectangular concrete-lined channel plus approximately 50-feet wide modification on the left (north) bank floodplain. Alternative 3 will have the channel concrete lined with boulder inverts and modifications to the left bank flood plain, again about 50 feet wide. Alternative 4 will consist of levee construction with toe repairs. The fifth alternative would leave the channel in its natural state with the removal of all existing flood control features.

Archaeologist from my Environmental Technical Branch visited the project area with the State Historic Preservation Office Maui Island staff archaeologist, Dr. Melissa Kirkendall. During the site visit, it was determined that potential significant subsurface cultural resources may be present in the floodplain banks along the upper sections of the project area. Proposed modification of the floodplain banks in these upper areas may potentially impact these buried significant cultural resources. It was determined that a program of archaeological monitoring during construction should ensure that these resources will not be adversely impacted by the flood control construction activities.

A cultural impact study (CIS) was also undertaken for this project. The CIS included personal interviews of a number of native Hawaiian cultural experts knowledgeable in the folklore of the project area and its surroundings. The study identified no areas of traditional importance within the project area; however, this conclusion is still in draft format and a copy of this report will be submitted to your office for review and comments. A copy of the final report will then be furnished to your office.

Based on the above information, POH has made the determination that the proposed Iao Stream Flood Control Project will have "no adverse effect on historic properties", provided a program of archaeological monitoring accompanies construction activities at the upper portion of the project area. Furthermore, an archaeological monitoring plan will need to be compiled for review and acceptance by your office prior to the start of any construction activities. Furthermore, the archaeological monitoring will be undertaken by a reputable archaeological firm with prolonged experience in Hawaiian archaeology. In compliance with the National Historic Preservation Act of 1966, pursuant to implementing regulations 36 CFR Part 800 (NHPA), your concurrence to this determination is being requested. POH is also requesting concurrence from the Hawaii State Historic Preservation Officer and the Office of Hawaiian Affairs, in accordance with the NHPA.

Should you require any additional information, please contact Kanalei Shun at 438-7000.

Sincerely,

James L. Bersson
Chief, Engineering and
Construction Division

Enclosures (4)

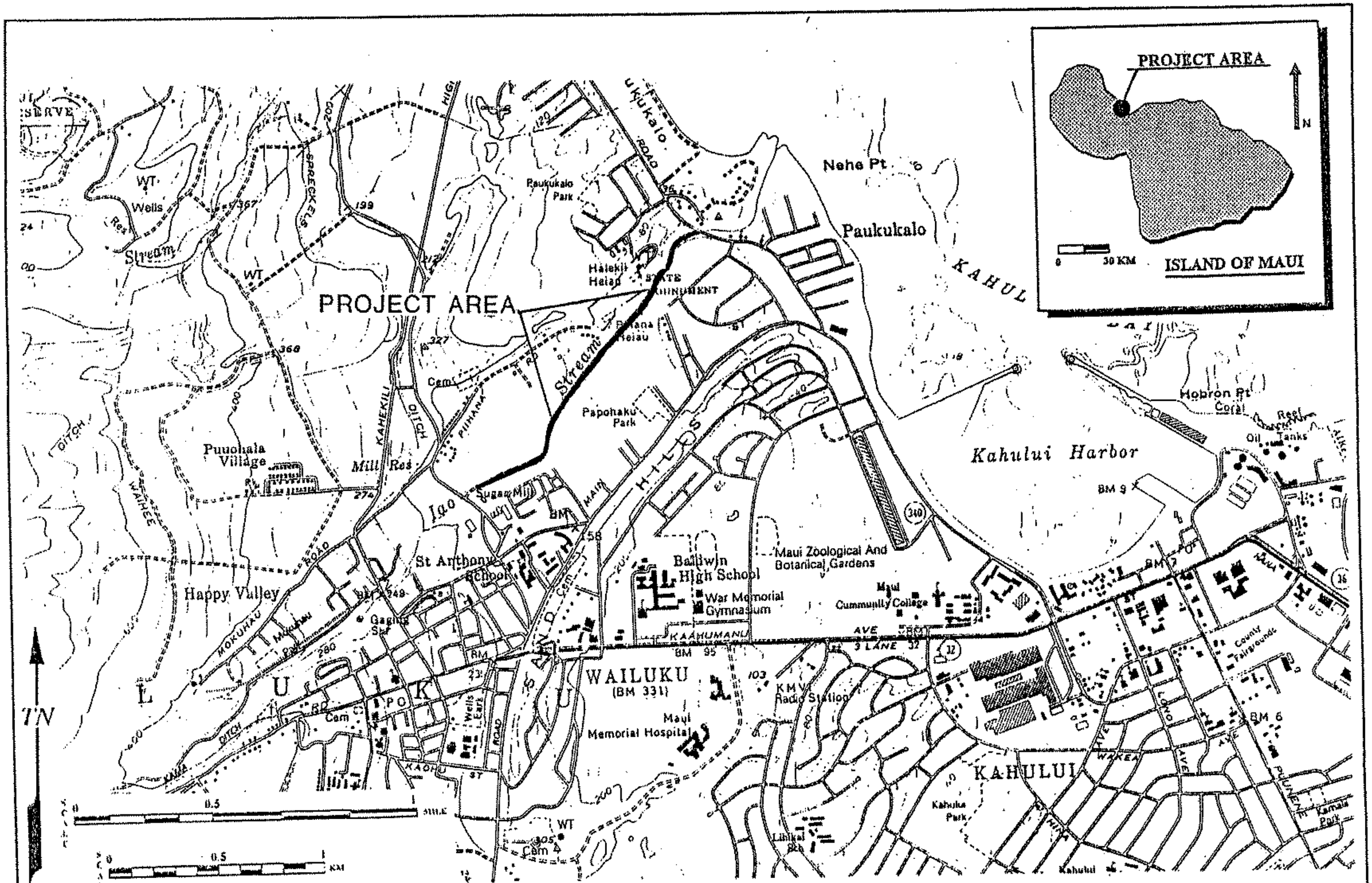
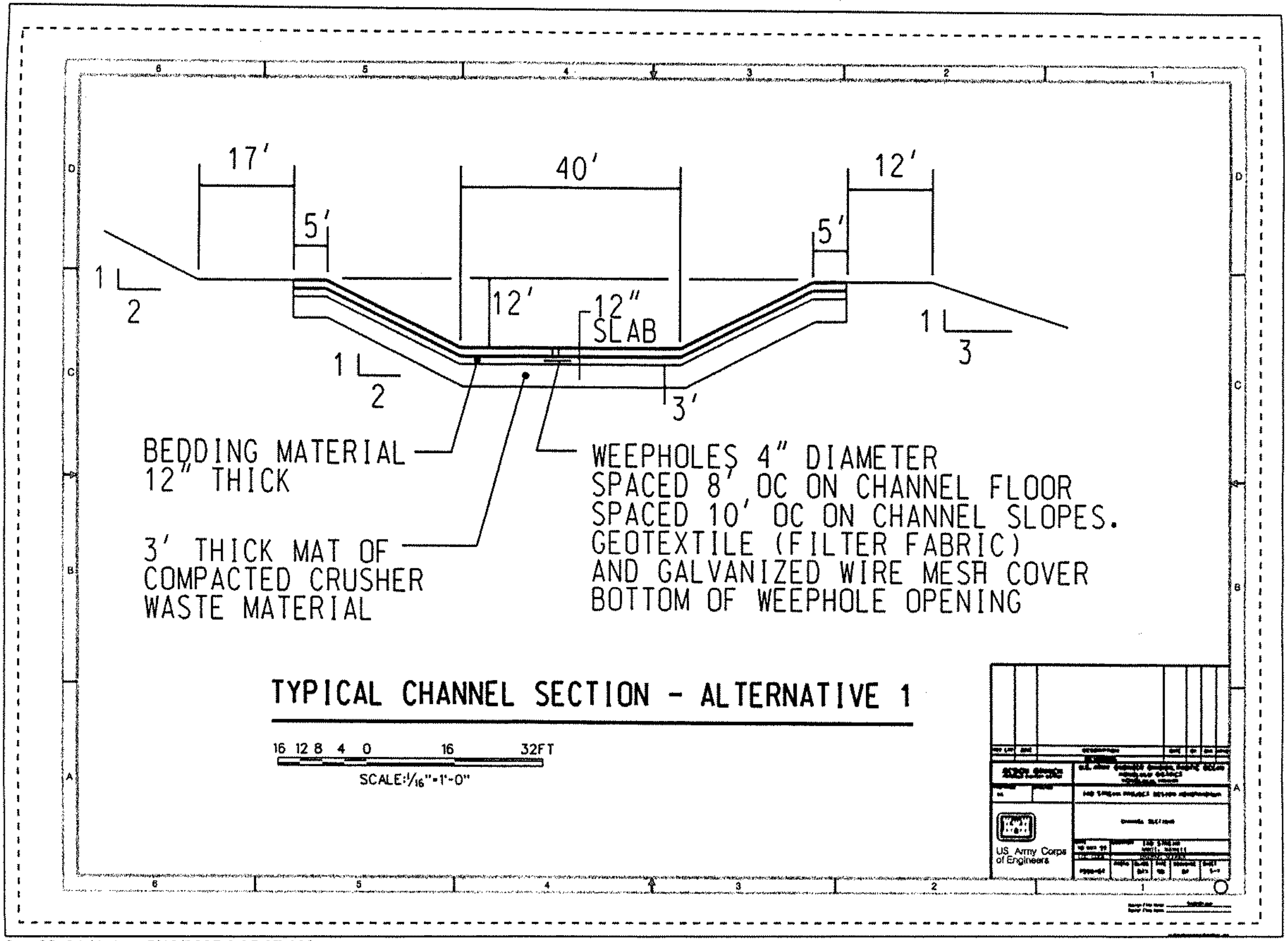


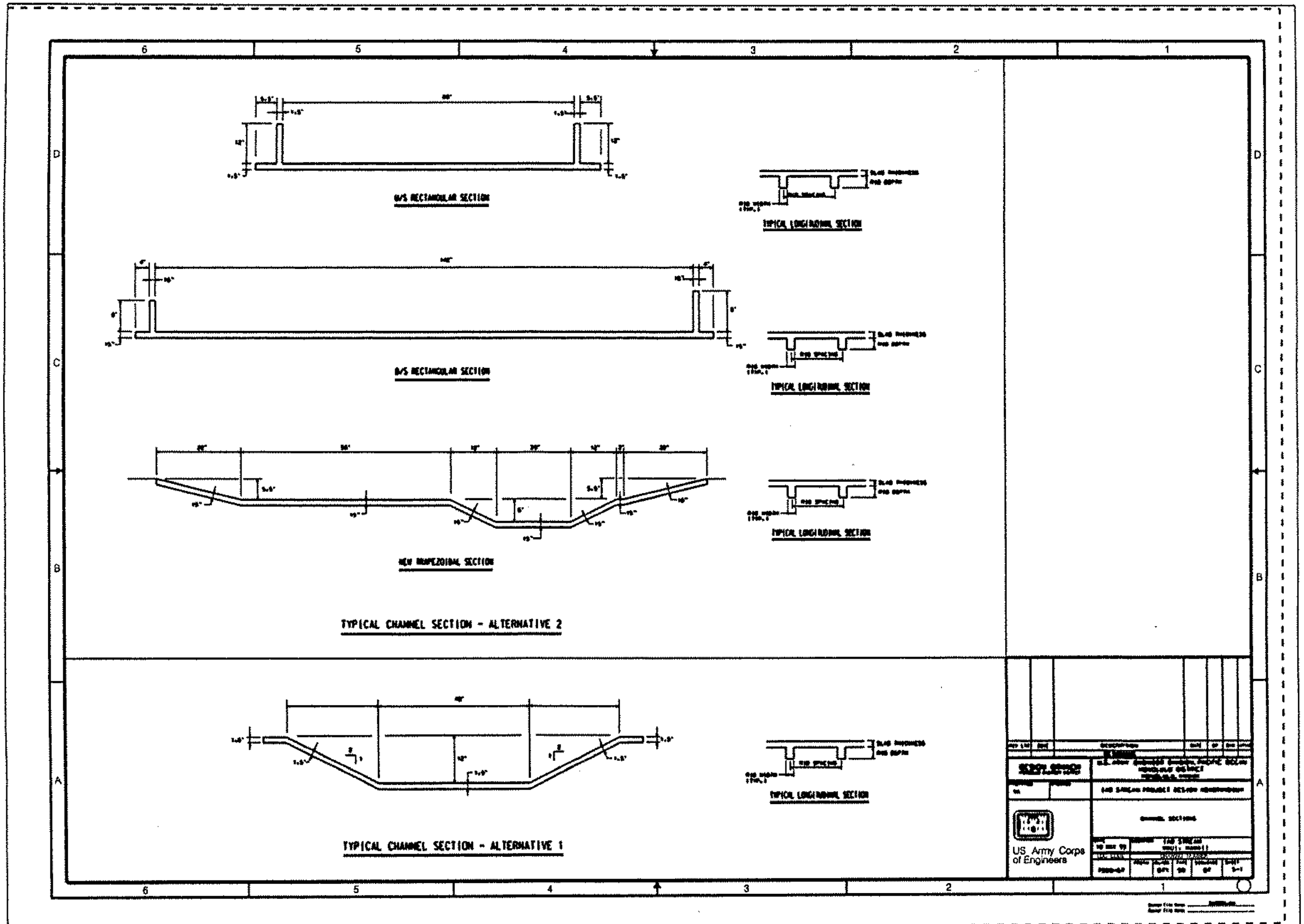
Figure 1: USGS Wailuku Quadrangle Showing Project Area.

FIG. 2



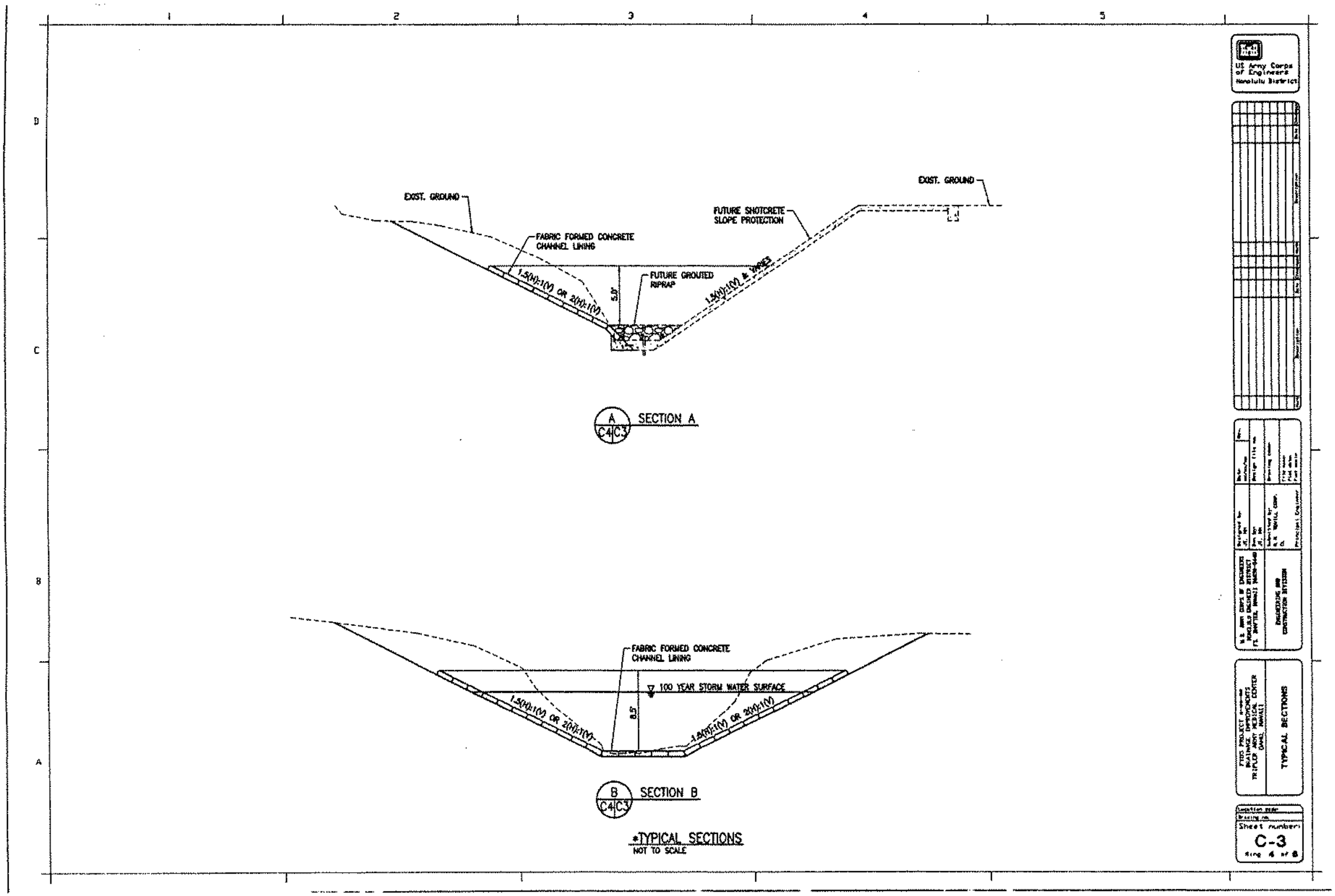
9ma02s01d1.dgn 5/10/2005 8:25:37 AM

FIG. 3



9ma02s01.dgn 5/10/2005 8:26:57 AM

FIG. 4



EXIST. GROUND
FABRIC FORMED CONCRETE CHANNEL LINING
1.5(H):1(V) OR 2(H):1(V)
5.0'
FUTURE GROUTED RIPRAP
1.5(H):1(V) & VARIES
FUTURE SHOTCRETE SLOPE PROTECTION
EXIST. GROUND
SECTION A
FABRIC FORMED CONCRETE CHANNEL LINING
100 YEAR STORM WATER SURFACE
8.5'
1.5(H):1(V) OR 2(H):1(V)
1.4(H):1(V) OR 2(H):1(V)
SECTION B
*TYPICAL SECTIONS
NOT TO SCALE
US Army Corps of Engineers Honolulu District
TYPICAL SECTIONS
ENGINEERING AND CONSTRUCTION DIVISION
Sheet number:
C-3

DEPARTMENT OF THE ARMY
U. S. ARMY ENGINEER DISTRICT, HONOLULU
FT. SHAFTER, HAWAII 96858-5440

29 July, 2005

REPLY TO
ATTENTION OF
Environmental Technical Branch
Engineering and Construction Division

Mr. Clyde Namuo, Administrator
Office of Hawaiian Affairs
711 Kapiolani Blvd, Suite 500
Honolulu, Hawaii 96813

Dear Mr. Namuo:

The U.S. Army Engineer District, Honolulu (POH) is proposing to undertake a flood control project on the lower (makai) segments of Iao Stream (multiple TMK) in Wailuku, Maui Island (Figure 1). Five (5) alternatives are being considered as flood control measures and, for the most part, these measures are confined to the stream channel proper and certain areas of the northern banks of the stream in the upper (mauka) section of the project area. No modification is being envisioned along the banks of the stream in the lower portion (makai) of the project area, across from the area encompassing Halekii Heiau.

Typical cross-sections of the flood control measures are illustrated in Figures 2, 3, and 4. Alternative 1 will result in a trapezoidal concrete-lined channel. Alternative 2 will consist of a rectangular concrete-lined channel plus approximately 50-feet wide modification on the left (north) bank floodplain. Alternative 3 will have the channel concrete lined with boulder inverts and modifications to the left bank flood plain, again about 50 feet wide. Alternative 4 will consist of levee construction with toe repairs. The fifth alternative would leave the channel in its natural state with the removal of all existing flood control features.

Archaeologist from my Environmental Technical Branch visited the project area with the State Historic Preservation Office Maui Island staff archaeologist, Dr. Melissa Kirkendall. During the site visit, it was determined that potential significant subsurface cultural resources may be present in the floodplain banks along the upper sections of the project area. Proposed modification of the floodplain banks in these upper areas may potentially impact these buried significant cultural resources. It was determined that a program of archaeological monitoring during construction should ensure that these resources will not be adversely impacted by the flood control construction activities.

A cultural impact study (CIS) was also undertaken for this project. The CIS included personal interviews of a number of native Hawaiian cultural experts knowledgeable in the folklore of the project area and its surroundings. The study identified no areas of traditional importance within the project area; however, this conclusion is still in draft format and a copy of this report will be submitted to your office for review and comments. A copy of the final report will then be furnished to your office.

Based on the above information, POH has made the determination that the proposed Iao Stream Flood Control Project will have "no adverse effect on historic properties", provided a program of archaeological monitoring accompanies construction activities at the upper portion of the project area. Furthermore, an archaeological monitoring plan will need to be compiled for review and acceptance by your office prior to the start of any construction activities. Furthermore, the archaeological monitoring will be undertaken by a reputable archaeological firm with prolonged experience in Hawaiian archaeology. In compliance with the National Historic Preservation Act of 1966, pursuant to implementing regulations 36 CFR Part 800 (NHPA), your concurrence to this determination is being requested. POH is also requesting concurrence from the Hawaii State Historic Preservation Officer and the Central Maui Hawaiian Civic Club, in accordance with the NHPA.

Should you require any additional information, please contact Kanalei Shun at 438-7000.

Sincerely,

James L. Bersson
Chief, Engineering and
Construction Division

Enclosures (4)

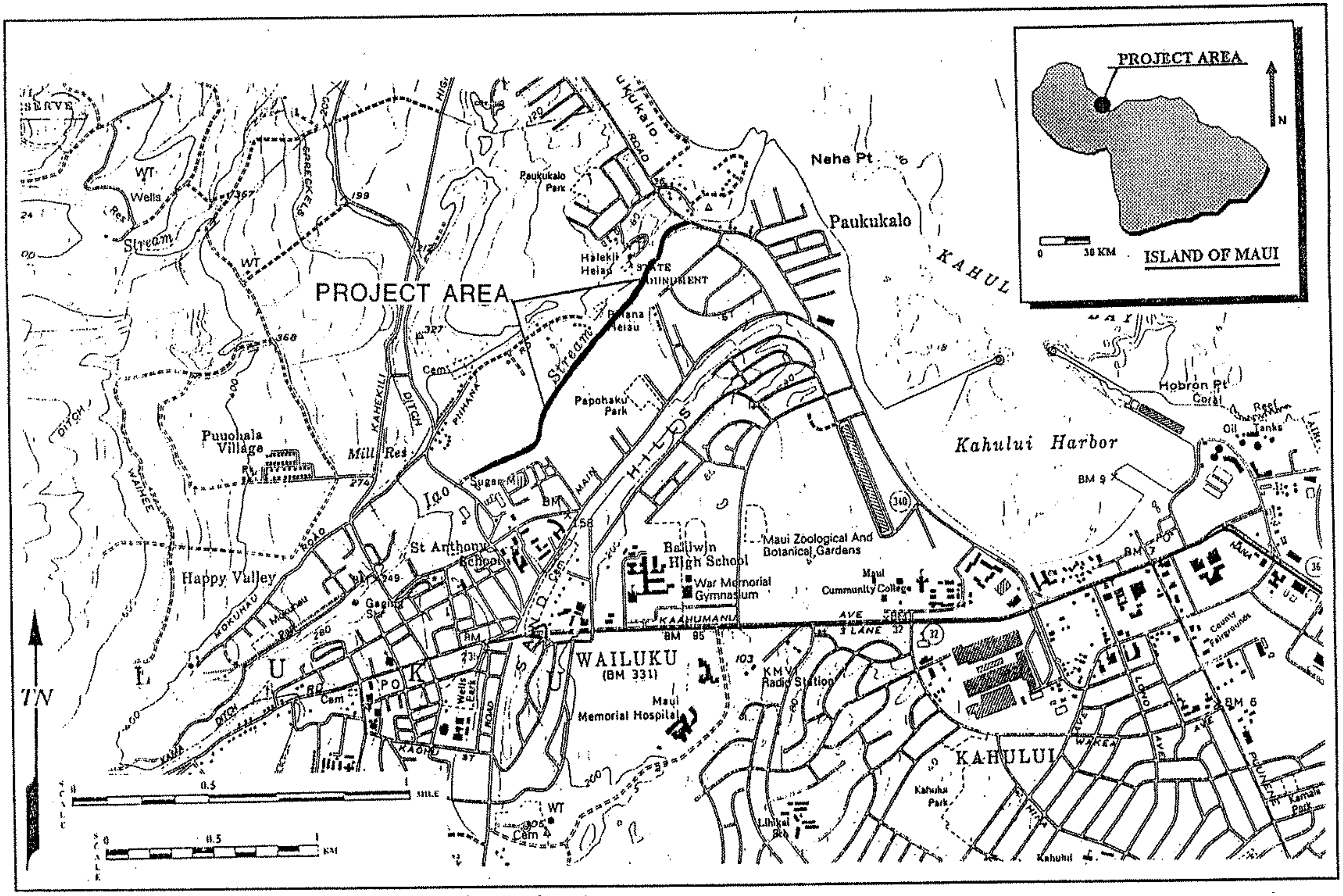
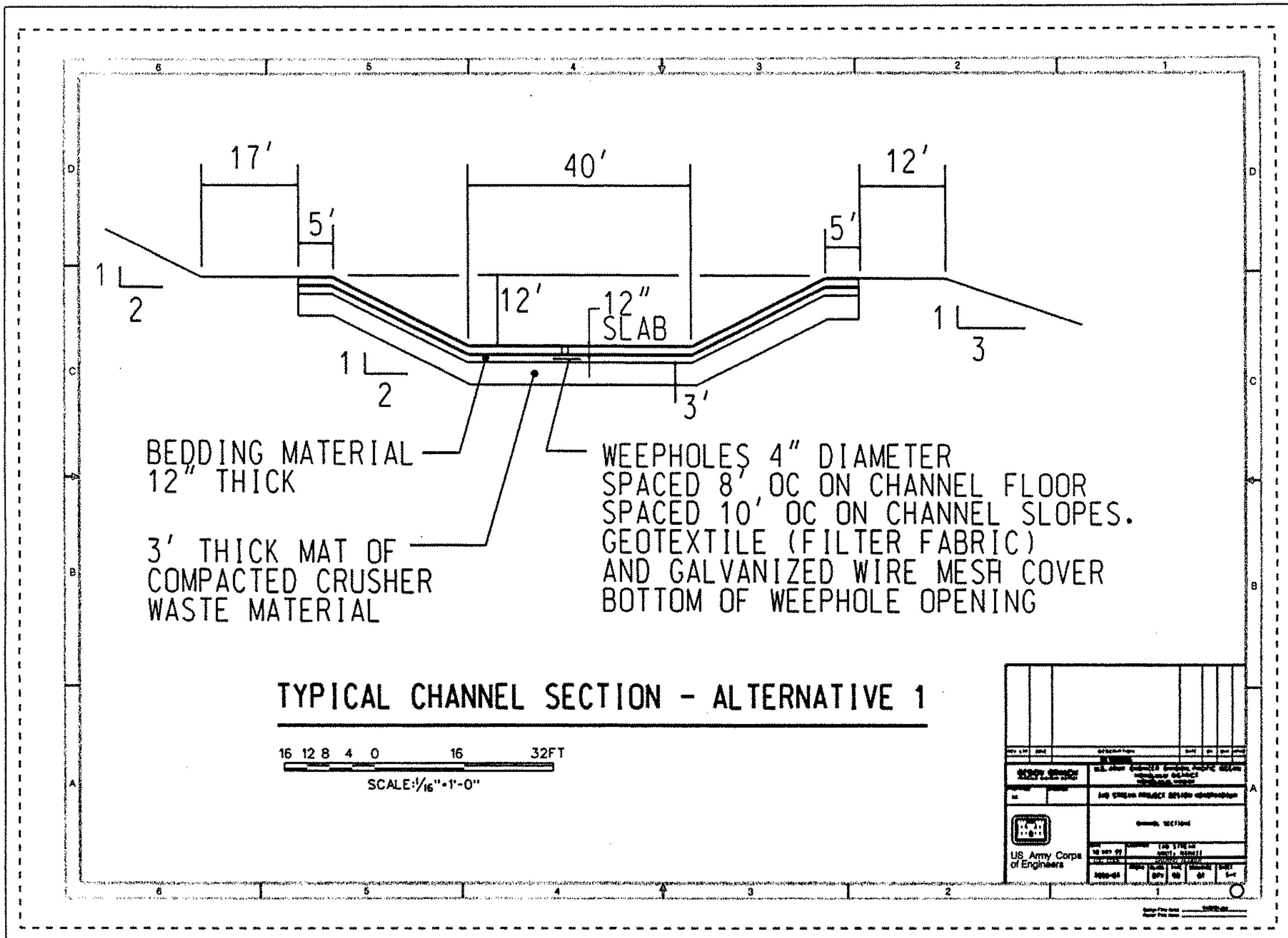


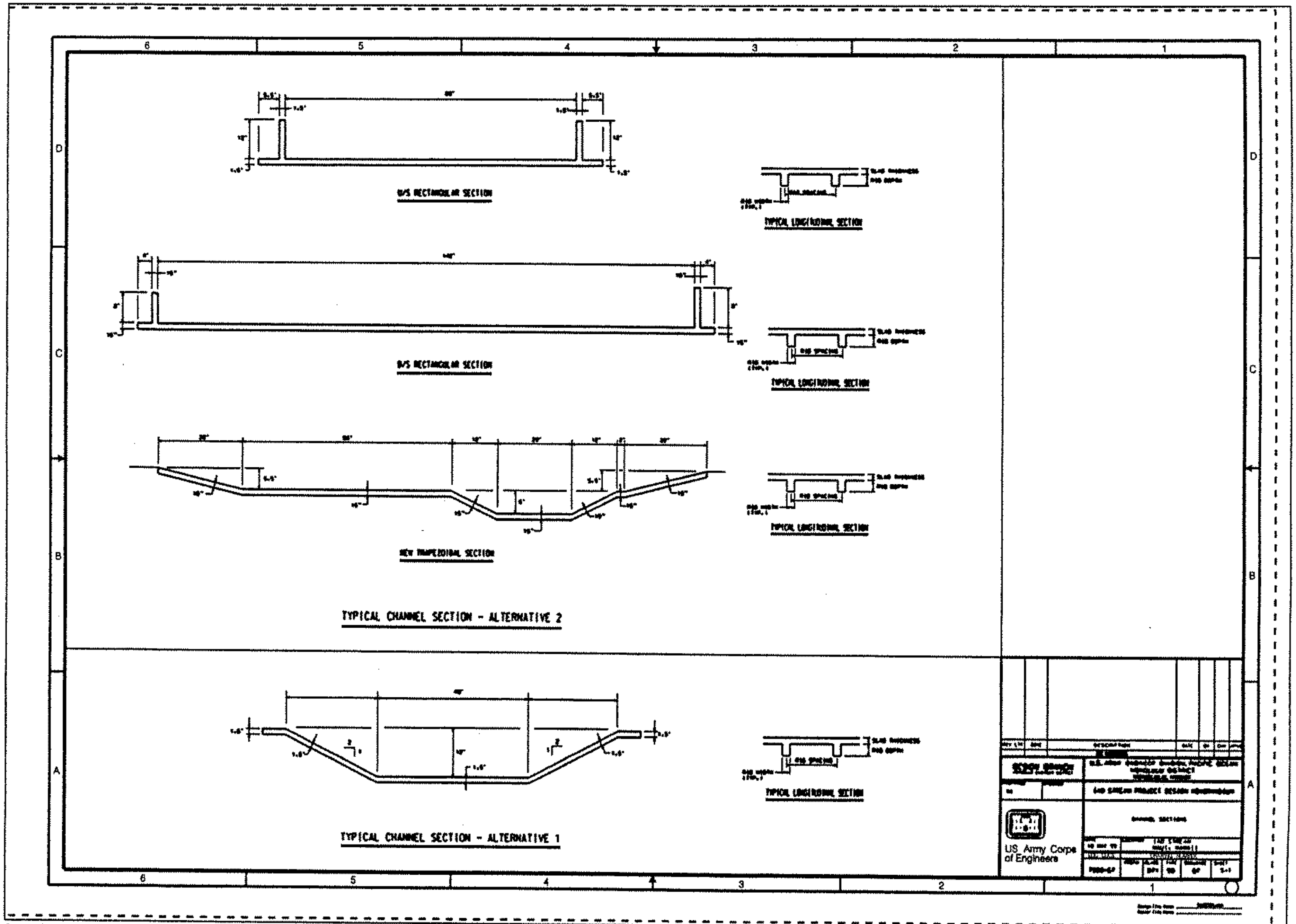
Figure 1: USGS Wailuku Quadrangle Showing Project Area.

FIG. 2



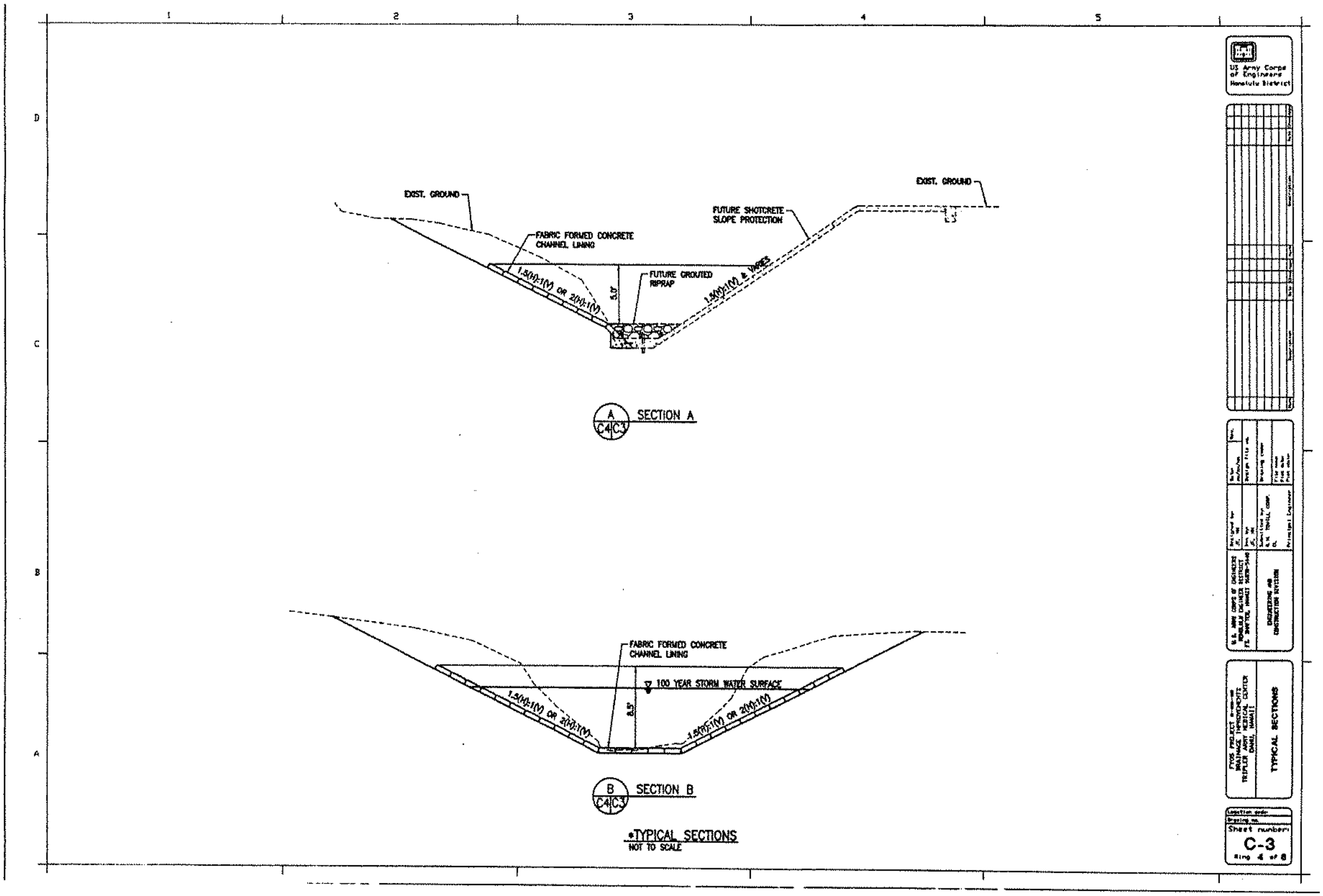
9ma02s01d1.dgn 5/10/2005 8:25:37 AM

FIG. 3



9ma02s01.dgn 5/10/2005 8:26:57 AM

FIG. 4


EXIST. GROUND
FABRIC FORMED CONCRETE CHANNEL LINING
1.5(H):1(V) OR 2(H):1(V)
5.0'
FUTURE GROUTED RIPRAP
1.5(H):1(V) & VARIES
FUTURE SHOTCRETE SLOPE PROTECTION
EXIST. GROUND
A C4 C3 SECTION A
FABRIC FORMED CONCRETE CHANNEL LINING
100 YEAR STORM WATER SURFACE
8.5'
1.5(H):1(V) OR 2(H):1(V)
1.5(H):1(V) OR 2(H):1(V)
B C4 C3 SECTION B
*TYPICAL SECTIONS
NOT TO SCALE
US Army Corps of Engineers Honolulu District
TYPICAL SECTIONS
Sheet number:
C-3

DEPARTMENT OF THE ARMY
U. S. ARMY ENGINEER DISTRICT, HONOLULU
FT. SHAFTER, HAWAII 96858-5440

29 July, 2005

REPLY TO
ATTENTION OF
Environmental Technical Branch
Engineering and Construction Division

Mr. Peter Young
Chairman and State Historic Preservation Officer
Department of Land and Natural Resources
Kakuhihewa Building, Room 555
601 Kamokila Boulevard
Kapolei, Hawaii 96707

Dear Mr. Young:

The U.S. Army Engineer District, Honolulu (POH) is proposing to undertake a flood control project on the lower (makai) segments of Iao Stream (multiple TMK) in Wailuku, Maui Island (Figure 1). Five (5) alternatives are being considered as flood control measures and, for the most part, these measures are confined to the stream channel proper and certain areas of the northern banks of the stream in the upper (mauka) section of the project area. No modification is being envisioned along the banks of the stream in the lower portion (makai) of the project area, across from the area encompassing Halekii Heiau.

Typical cross-sections of the flood control measures are illustrated in Figures 2, 3, and 4. Alternative 1 will result in a trapezoidal concrete-lined channel. Alternative 2 will consist of a rectangular concrete-lined channel plus approximately 50-feet wide modification of the left (north) bank floodplain. Alternative 3 will have the channel concrete lined with boulder inverts and modifications to the left bank flood plain, again about 50 feet wide. Alternative 4 will consist of levee construction with toe repairs. The fifth alternative would leave the channel in its natural state with the removal of all existing flood control features.

Mr. Kanalei Shun from my Environmental Technical Branch discussed the proposed alternatives with your Maui Staff Archaeologist, Dr. Melissa Kirkendall, with a site visit occurring in August of 2004. During the site inspection, it was determined that potential significant subsurface cultural resources may be present in the floodplain banks along the upper sections of the project area. Proposed modification of the floodplain banks in these upper areas may potentially impact these buried cultural resources. To ensure no adverse impact will result to these resources from flood control construction activities, a program of archaeological monitoring during construction is being proposed. An archaeological monitoring plan will be compiled for review and acceptance by your office prior to the start of any construction activities and the archaeological monitoring will be undertaken by a reputable archaeological firm with prolonged experience in Hawaiian archaeology.

The proposed archaeological monitoring program should ensure that the Iao Stream Flood Control Project will result in a "no adverse effect to historic properties" determination. In compliance with the National Historic Preservation Act of 1966, pursuant to implementing regulations 36 CFR Part 800 (NHPA), your concurrence to this determination is being requested. POH is also requesting concurrence from the Office of Hawaiian Affairs and the Central Maui Hawaiian Civic Club, in accordance with the NHPA.

Should you require any additional information, please contact Kanalei Shun at 438-7000.

Sincerely,

James L. Bersson
Chief, Engineering and
Construction Division

Enclosures (4)

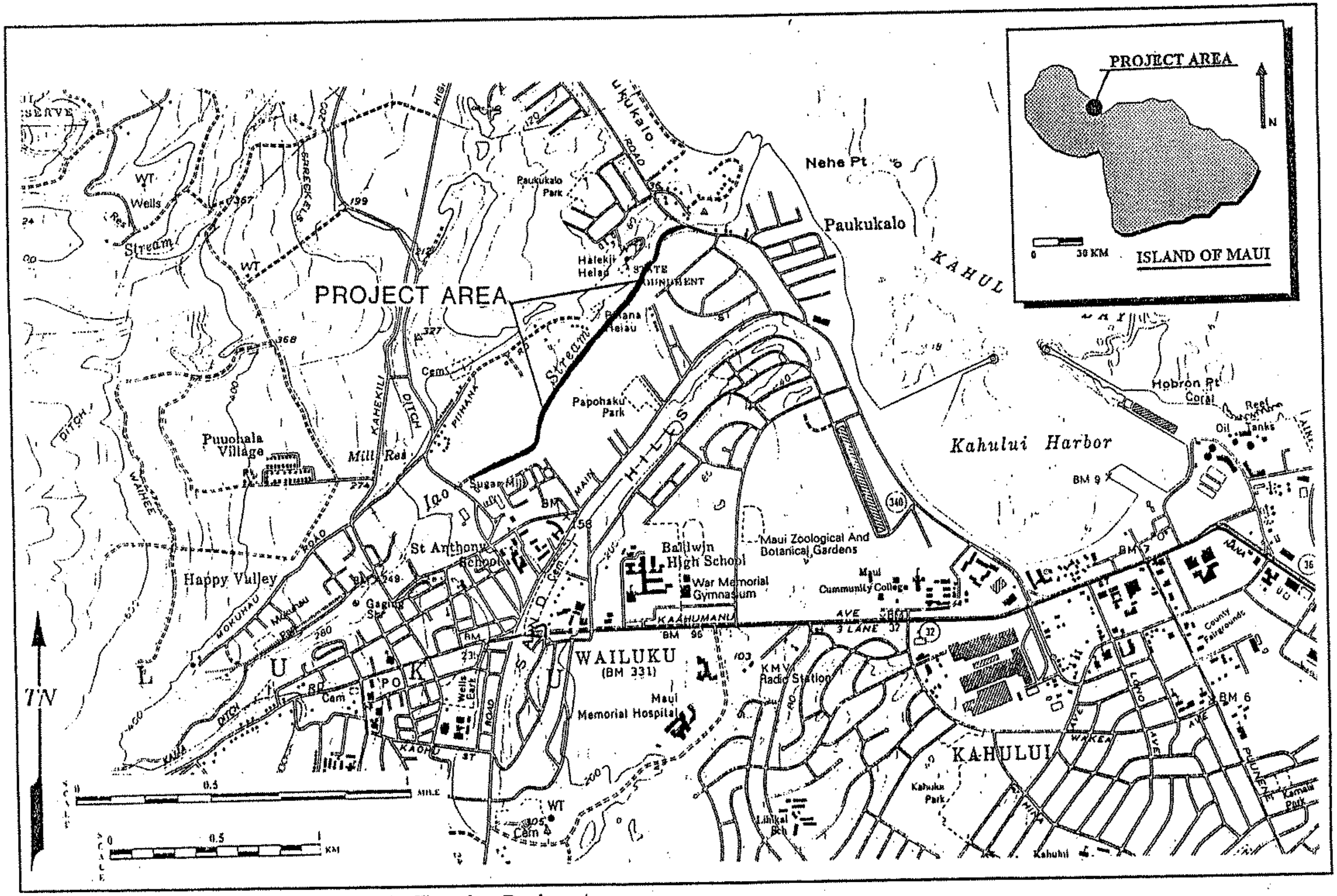
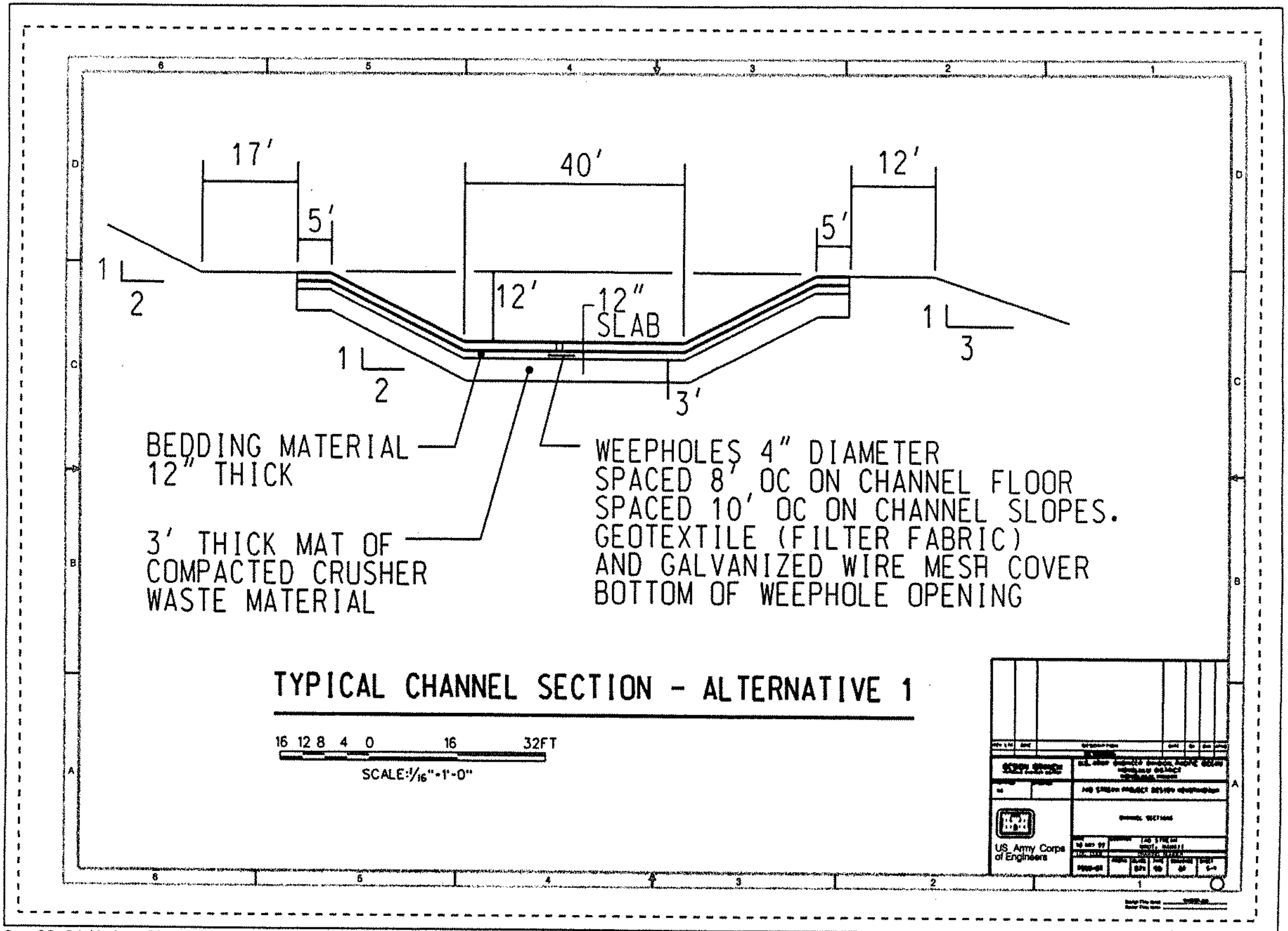


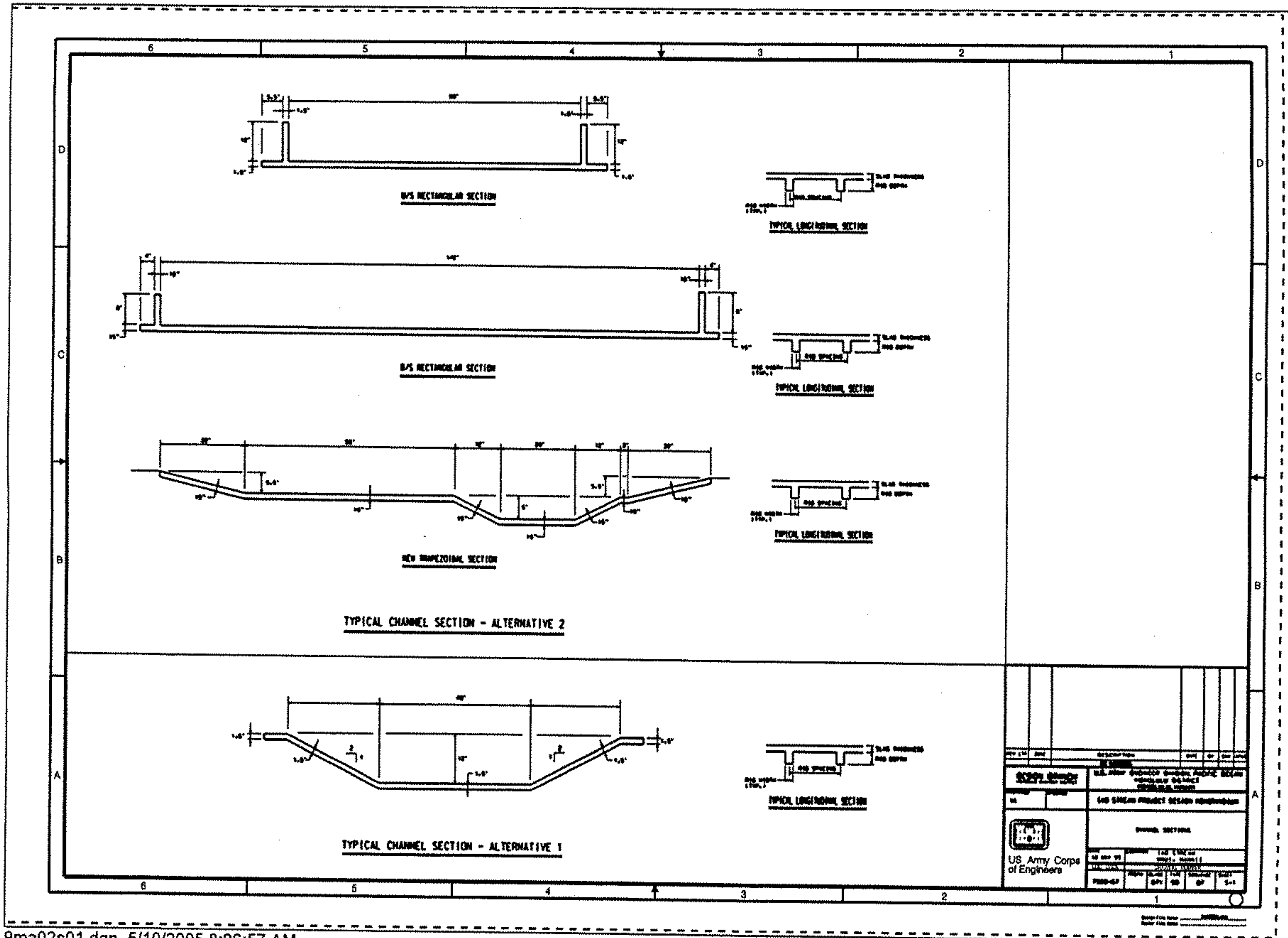
Figure 1: USGS Wailuku Quadrangle Showing Project Area.

FIG. 2



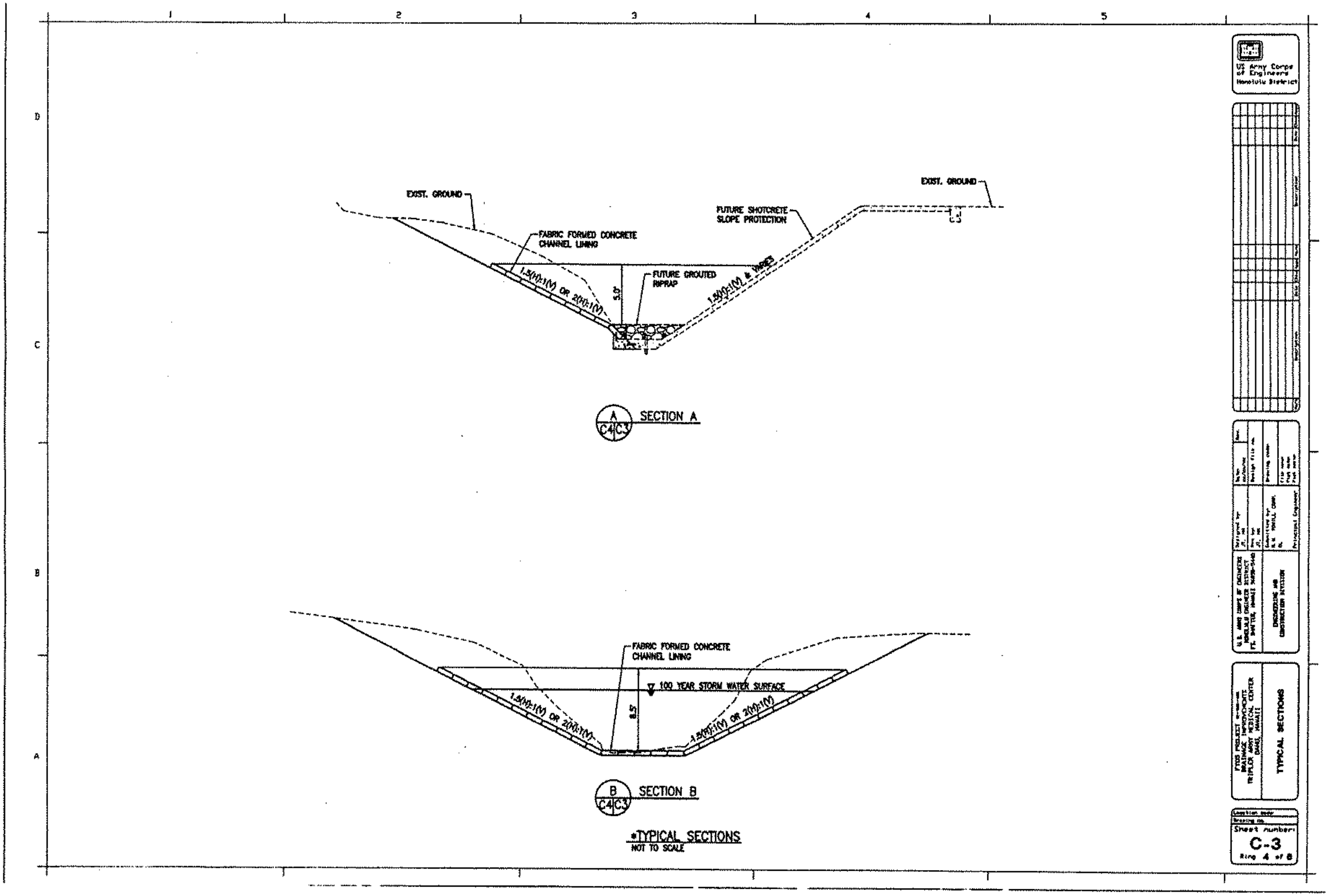
9ma02s01d1.dgn 5/10/2005 8:25:37 AM

FIG. 3



9ma02s01.dgn 5/10/2005 8:26:57 AM

FIG. 4


EXIST. GROUND
FABRIC FORMED CONCRETE CHANNEL LINING
1.5(H):1(V) OR 2(H):1(V)
5.5'
FUTURE GROUTED RIPRAP
1.5(H):1(V) & VARIES
FUTURE SHOTCRETE SLOPE PROTECTION
EXIST. GROUND
A C4 C3 SECTION A
FABRIC FORMED CONCRETE CHANNEL LINING
100 YEAR STORM WATER SURFACE
8.5'
1.5(H):1(V) OR 2(H):1(V)
1.5(H):1(V) OR 2(H):1(V)
B C4 C3 SECTION B
*TYPICAL SECTIONS
NOT TO SCALE
US Army Corps of Engineers Honolulu District
TYPICAL SECTIONS
Sheet number:
C-3
Ring 4 of 8

DEPARTMENT OF THE ARMY
U.S. ARMY ENGINEER DISTRICT, HONOLULU
FORT SHAFTER, HAWAII 96858-5440

September 10, 2007

REPLY TO

Engineering and Construction Division

Ms. Laura H. Thielen
Interim Chairman and State Historic Preservation Officer
Department of Land and Natural Resources
Kakuhihewa Building, Room 555
601 Kamokila Boulevard
Kapolei, Hawaii 96707

Dear Ms. Thielen:

The U.S. Army Engineer District, Honolulu (POH) is proposing to undertake a flood control project on the lower segments of Iao Stream (multiple TMK) in Wailuku, Maui Island (Figures 1, 2a, 2b, and 2c). The project area begins on the makai (east) end of Waiehu Beach Road The project was designed for Standard Project Flood (SPF) protection with a peak design discharge of 27,500 cubic feet/second (cfs) downstream at Station 22+00 and 26,000 cfs upstream at Station 92+02 (Figures 3-6). Five (5) alternatives are being considered for the flood control measures, and Alternative III has been proposed as the most viable based on engineering and cost benefits. A summary of the work under Alternative III is attached herein as Enclosure 1. Work proposed under Alternative III is an undertaking requiring consultation in compliance with Section 106 of the National Historic Preservation Act of 1966, as amended, pursuant to implementing regulations 36 CFR Part 800. The purpose of this letter is to initiate the Section 106 consultation process.

The area of potential effect (APE) of most of the work proposed under Alternative III is confined to the already highly disturbed stream channel. This work, listed under items 3-5, 7, and 9 in Enclosure 1, consists of modification to the existing channel. Such work should not affect any significant cultural resources as none is anticipated to be present within the stream channel itself.

The remaining work, listed under items 1, 2, 6, and 8, will entail new construction and/or construction excavations. A diversion levee in the form of a trapezoidal-shaped structure, 500 feet long, 65 feet wide, and 9 feet high, and a new ground water recharge basin are being proposed for construction at the upper end of the project area (see Figures 7a and 7b). Stream re-alignment and widening, anticipated to be no more than 30 feet wide, is being proposed between Stations 76+00 and 85+30 where the left (north) bank of the stream (see Figure 6) will be widen to reduce water surface profile to accommodate the County's proposed Imi Kala Bridge expansion construction. The areas of potential effect for this work is within the Iao Stream flood plain, and in the immediate vicinity of the channel. Based on previous archaeological investigations and historical accounts, prehistoric remains, except for *auwai* to feed taro loi, would not be anticipated to be present this type of terrain. Visual inspection of the stream channel's north embankment in the Imi Kala bridge location found no evidence to indicate potential presence of an *auwai* system. Thus, a determination can be made that this new construction work will not affect potentially surface or subsurface historic sites. However, to ensure that such will remain the case, POH is recommending that a professional archaeological monitor be present during construction excavation activities associated with any work in this area. Lastly, the raising of the right bank levee in the area between stations 45+37 to 48+85 and 25+62 to 26+46 are add-ons to existing levee and should not impact any cultural resources.

Thus, POH has made the determination that the proposed modification actions to the floodplain banks and immediate adjacent areas of the existing Iao Stream channel will have no affect to historic sites. To ensure no adverse impact will result to potentially significant subsurface cultural resources from construction activities to the north embankment in the Imi Kala bridge area, a program of archaeological monitoring during construction is being proposed. An archaeological monitoring plan will be compiled for review and acceptance by your office prior to the start of any construction; the archaeological monitoring will be undertaken by a reputable archaeological firm with prolonged experience in Hawaiian archaeology. The proposed archaeological monitoring program should ensure that the Alternative III will result in a "no effect to historic properties" determination. In compliance with the National Historic Preservation Act of 1966, pursuant to implementing regulations 36 CFR Part 800 (NHPA), your concurrence to this determination is being requested. POH is also requesting concurrence from the Office of Hawaiian Affairs, the Maui County Cultural Resources Commission, and the Central Maui Hawaiian Civic Club, in accordance with the NHPA.

We are also forwarding a copy of this letter to Mr. Stanley Solamilo, Maui County Cultural Resources Commission Minute, Maui County Planning Department, 250 S. High Street, Wailuku, Hawaii 96793. If you require any additional information, please contact Mr. Kanalei Shun at 438-7000.

Sincerely,

Todd C. Barnes, P.E.
Chief, Engineering and
Construction Division

Enclosures

IAO STREAM FLOOD CONTROL PROJECT, MAUI.

ALTERNATIVE III

The project was designed for Standard Project Flood (SPF) protection with a peak design discharge of 27,500 cfs downstream at Station 22+00 and 26,000 cfs upstream at Station 92+02. Modifications are described below:

1. Construct a diversion levee, 500 feet long, 65 feet wide, and 9 feet tall on the left bank just upstream of the existing debris basin (top of project).

2. A new ground water recharge basin would be constructed by partially blocking the low flow outlets at the existing debris basin located approximately 1,100 feet upstream of Market Street at the top of the project. Water would pond in the debris basin and help facilitate percolation into the Iao aquifer during rainy season.

3. Modify drop structure between Stations 96+74.21 and 97+23.21. A new stepped drop structure would eliminate the dangerous 22-foot vertical drop and improve in-stream fish (*oopu*) passage.

4. Hydraulic improvements to the concrete channel between Stations 92+02 and 95+41. These improvements include baffle blocks and a weir within the existing concrete channel to more evenly distribute flow.

5. Roller compacted concrete (RCC) side slopes and a grouted boulder invert channel that would mainly follow the alignment of the existing stream between Stations 22+00 and 92+02 (approximately 7,000 feet long). The median base width range would vary between 60 to 80 feet.

6. Stream realignment and widening between Stations 76+02 and 85+30. The channel would be realigned to the north on the left bank to avoid existing structures to the right bank and be widened to reduce water surface profile at the Imi Kala Street Bridge.

7. Low Flow Boulder Channel within the RCC. The low flow channel would use boulders embedded in concrete to replicate a more natural Hawaiian stream and facilitate the movement of native fish through the modified channel area.

8. Right Bank Levee Raise. The existing right bank levee would be raised at Stations 45+37 to 48+85 by 4.5 feet and up to additional 0.7 feet at Stations 25+62 to 26+46 using a Concrete Rubble Masonry wall on top of the existing earth levee.

9. Downstream Channel Modifications between Stations 4+76 and 19+00. This modification would cover the existing boulder concrete invert with concrete to smooth the surface and prevent overtopping of the channel walls by the design flood. A low flow boulder channel would remain within this modified section.

Note: Channel lining, retaining walls, and raising the levee walls would be necessary due to the excessive flow velocities and higher flood levels. This alternative would achieve project objectives and is considered to be feasible from an engineering and cost perspective. Alternative III is considered the "environmental alternative" since it would minimize negative environmental impacts to the project area, by best reducing the flooding problems and minimizing environmental impacts.

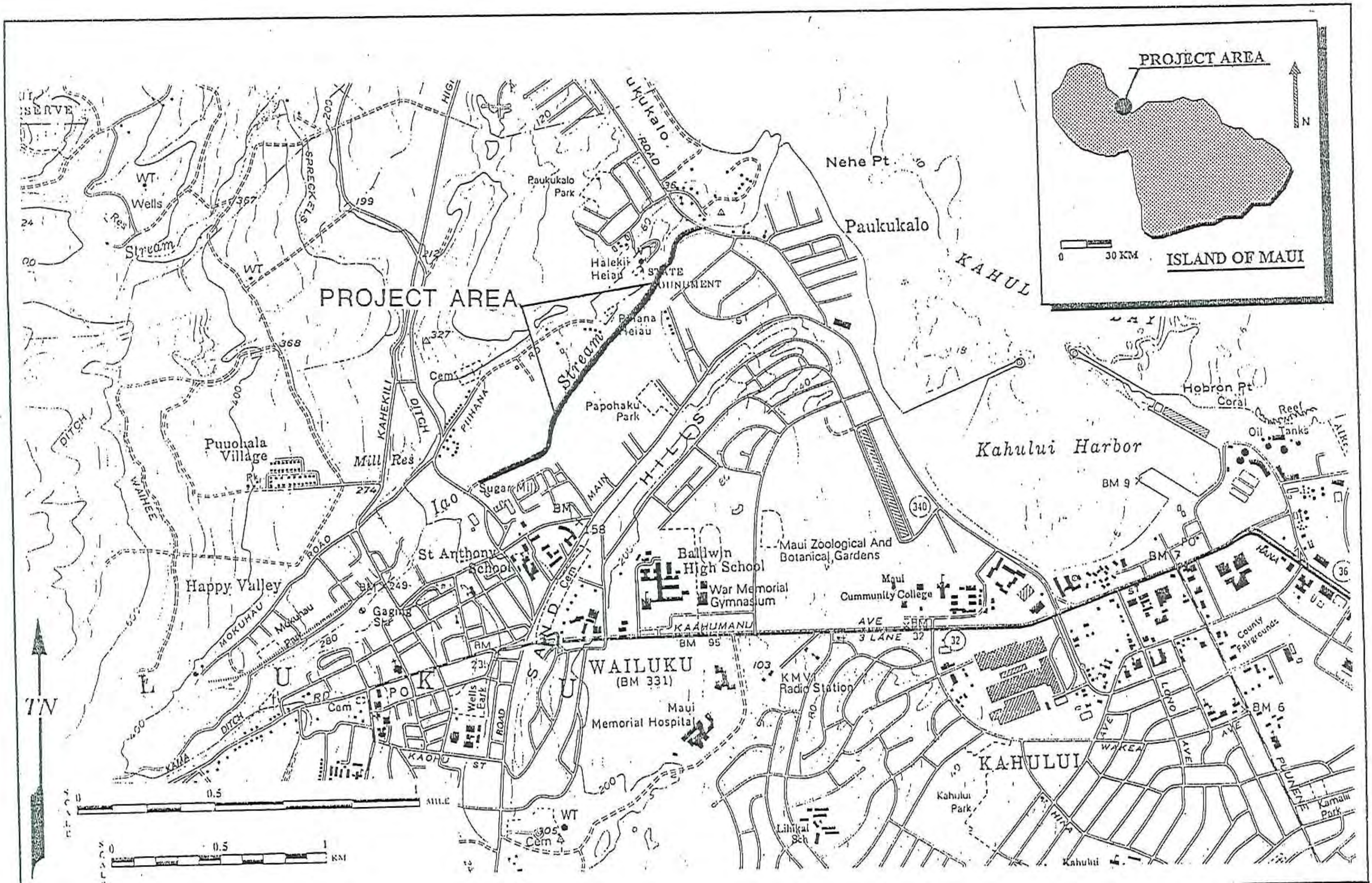


Figure 1: USGS Wailuku Quadrangle Showing Project Area.

Figure 2a: Maui Tax Key Map showing lower sections of the Iao Stream channel.

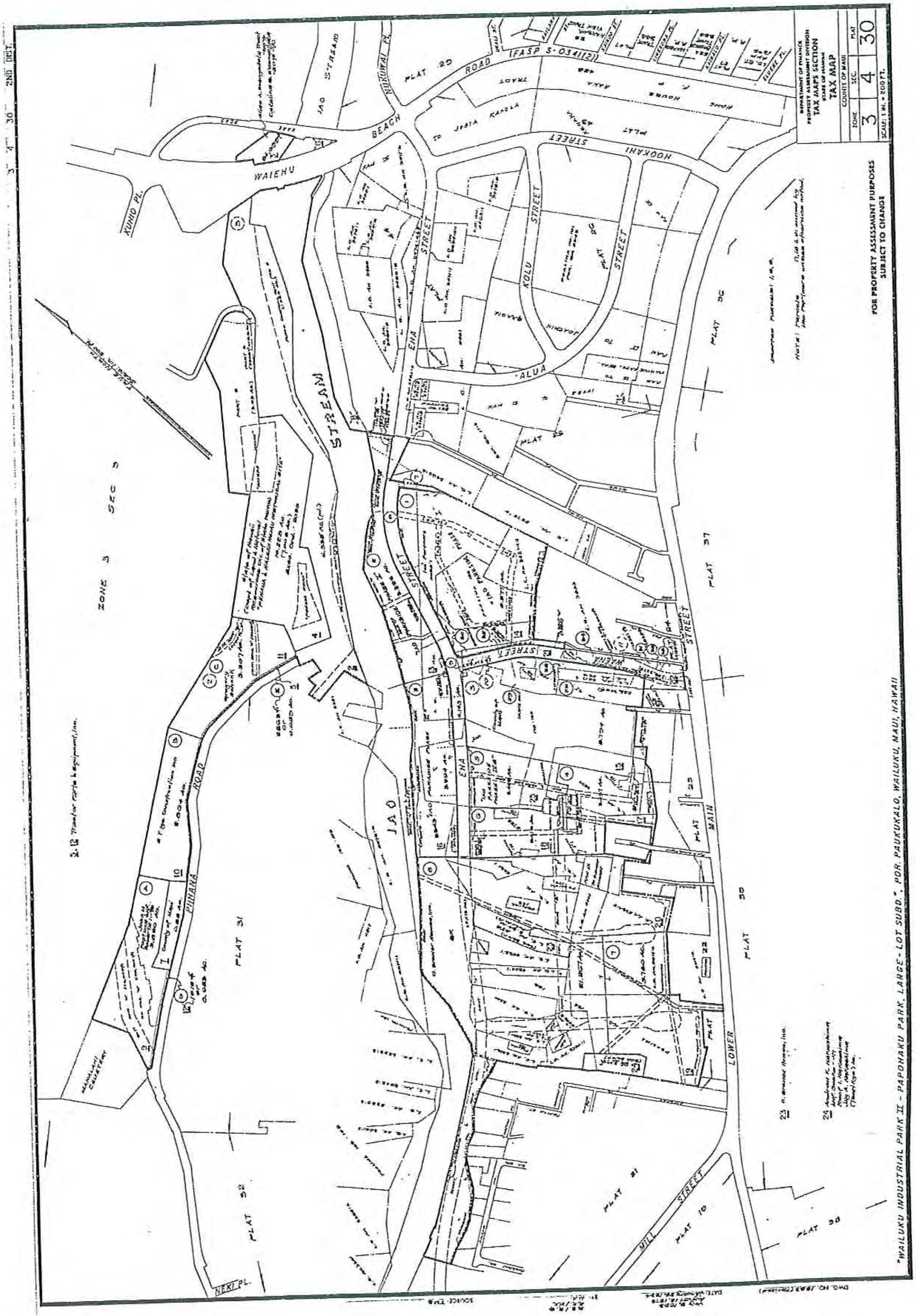


Figure 2b: Maui Tax Key Map showing lower sections of the Iao Stream channel.

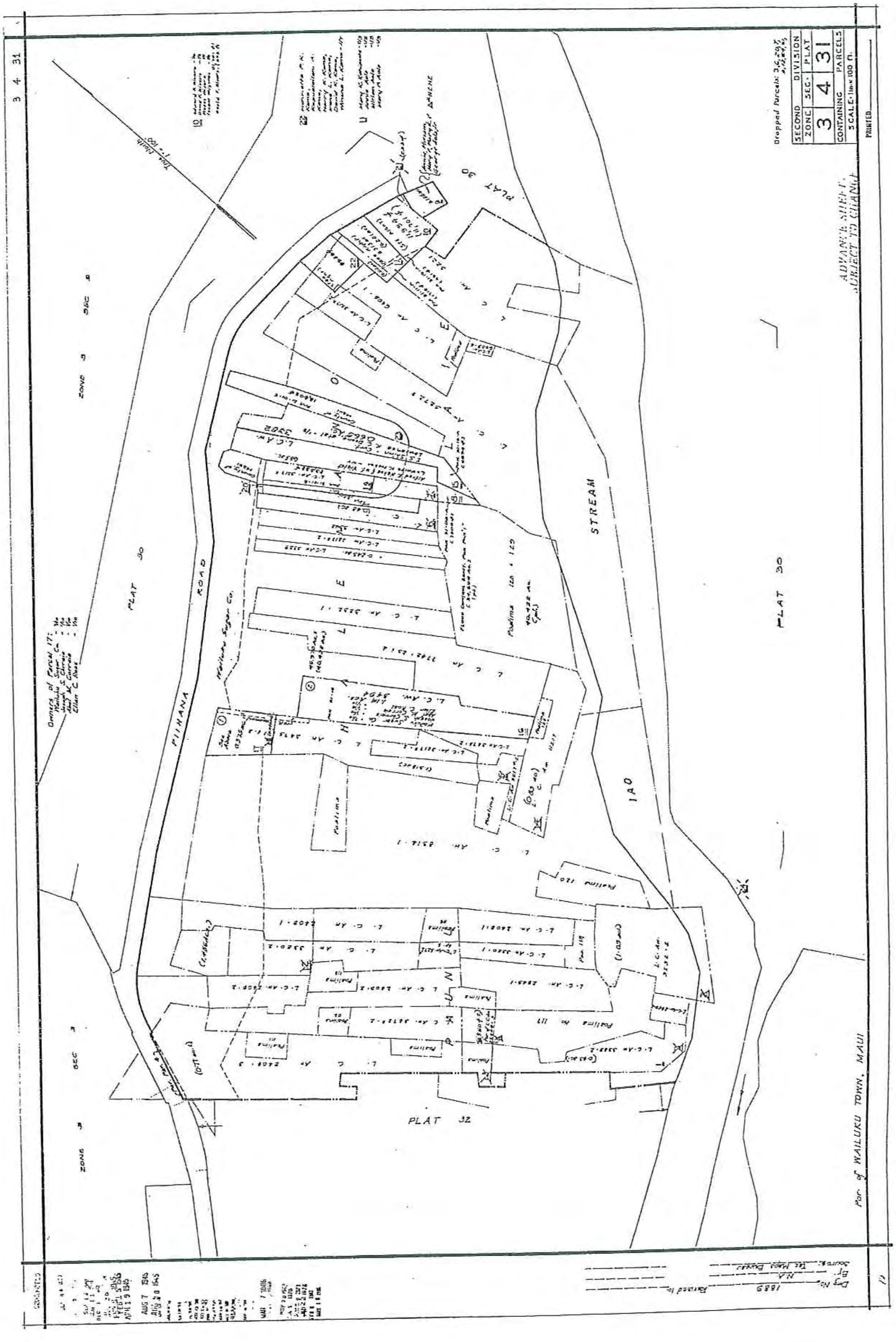
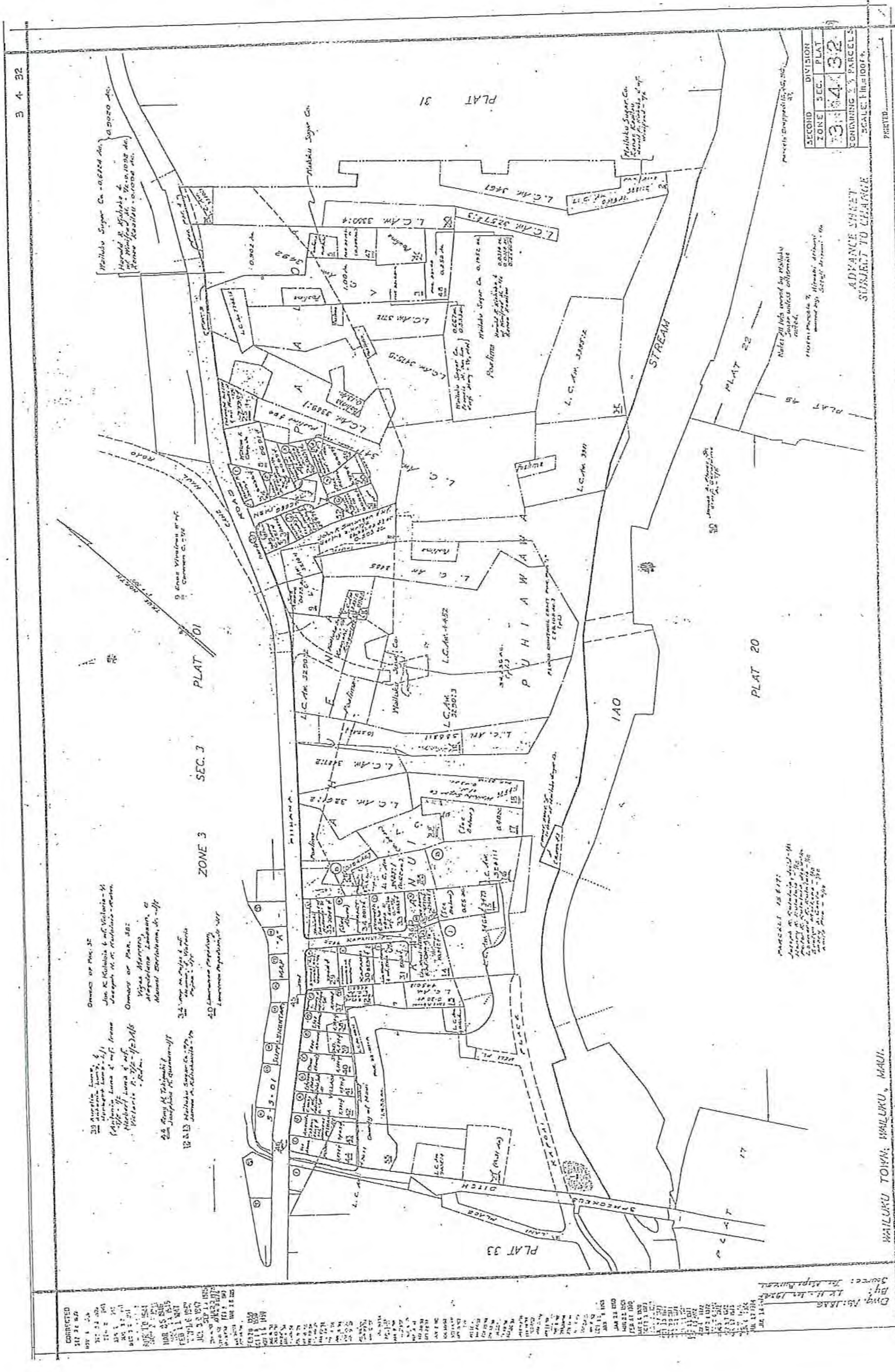
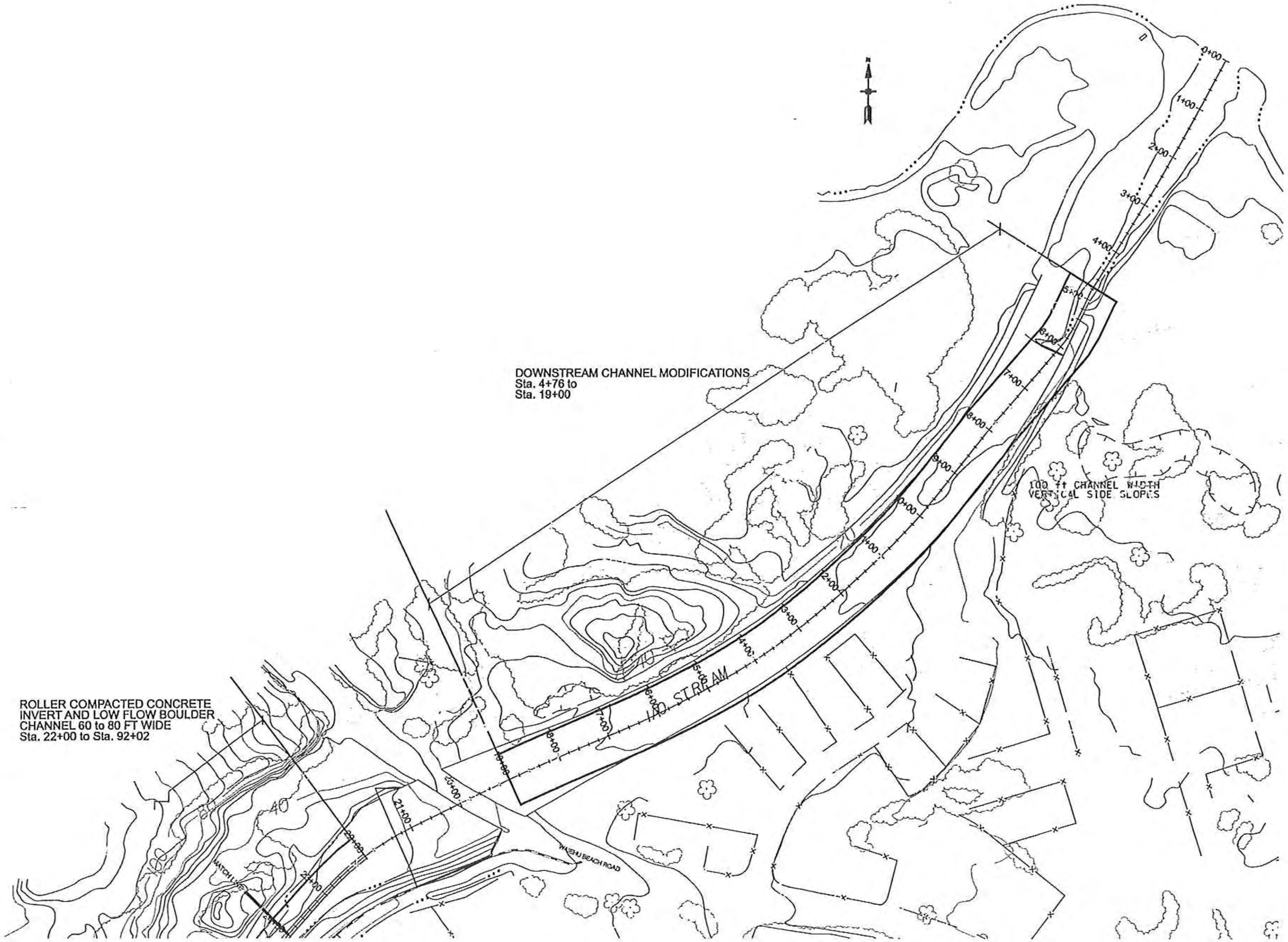


Figure 2c: Maui Tax Key Map showing lower sections of the Iao Stream channel.





FEASIBILITY STUDY
IAO STREAM FLOOD CONTROL
WAILUKU, MAUI, HAWAII

SITE PLAN
STA. 0+00 to STA 24+00

U.S. ARMY, CORPS OF ENGINEERS,
HONOLULU DISTRICT

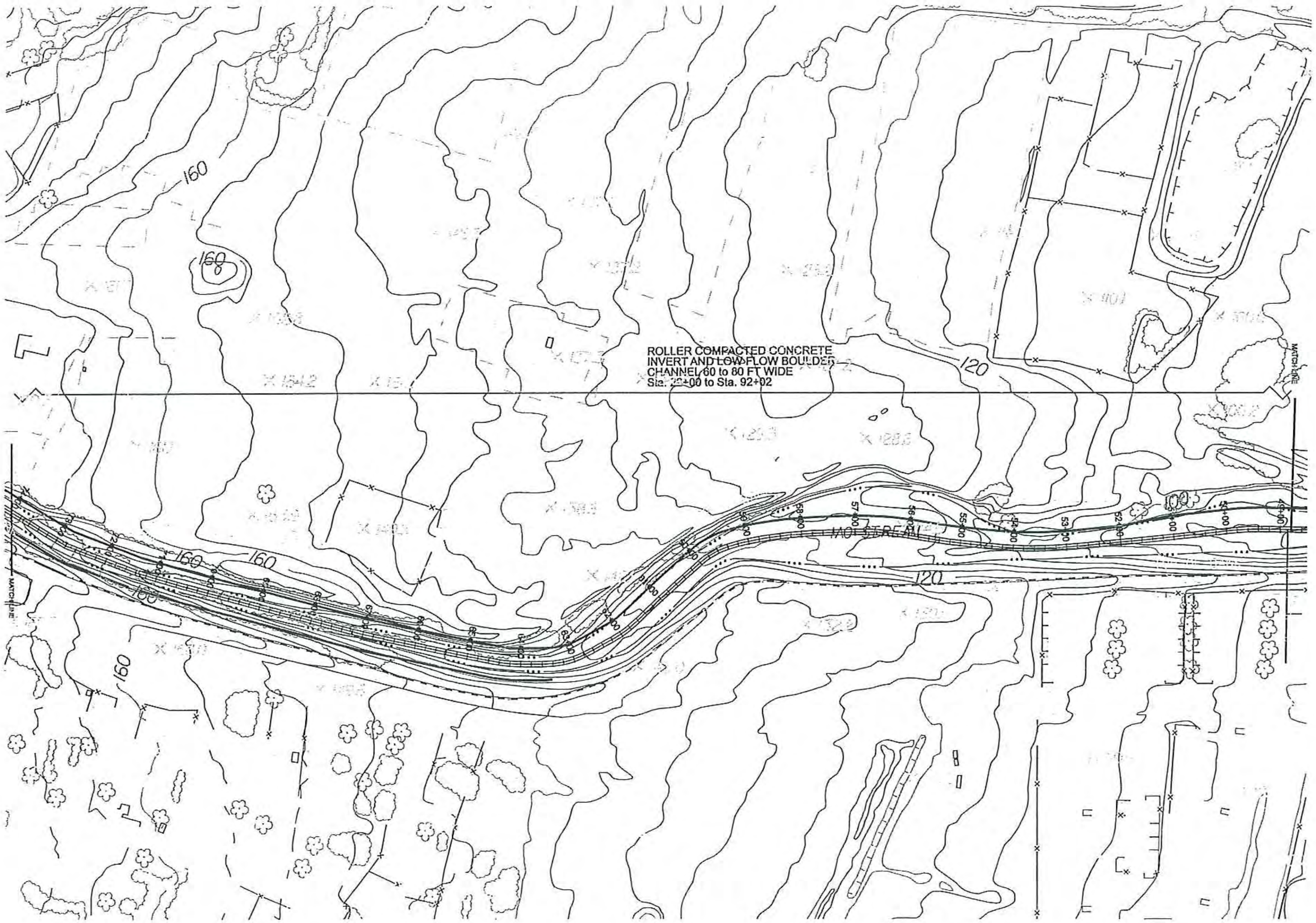
FIGURE 3. Site Plan for Station 0+00 to Station 24+00.

FEASIBILITY STUDY
IAO STREAM FLOOD CONTROL
WAILUKU, MAUI, HAWAII

SITE PLAN
STA. 24+00 to STA. 49+00

U.S. ARMY, CORPS OF ENGINEERS,
HONOLULU DISTRICT

FIGURE 4. Site Plan for Station 24+00 to Station 49+00.



FEASIBILITY STUDY
IAO STREAM FLOOD CONTROL
WAILUKU, MAUI, HAWAII

SITE PLAN
STA. 49+00 to STA. 74+00

U.S. ARMY, CORPS OF ENGINEERS,
HONOLULU DISTRICT

FIGURE 5. Site Plan for Station 49+00 to Station 74+00.

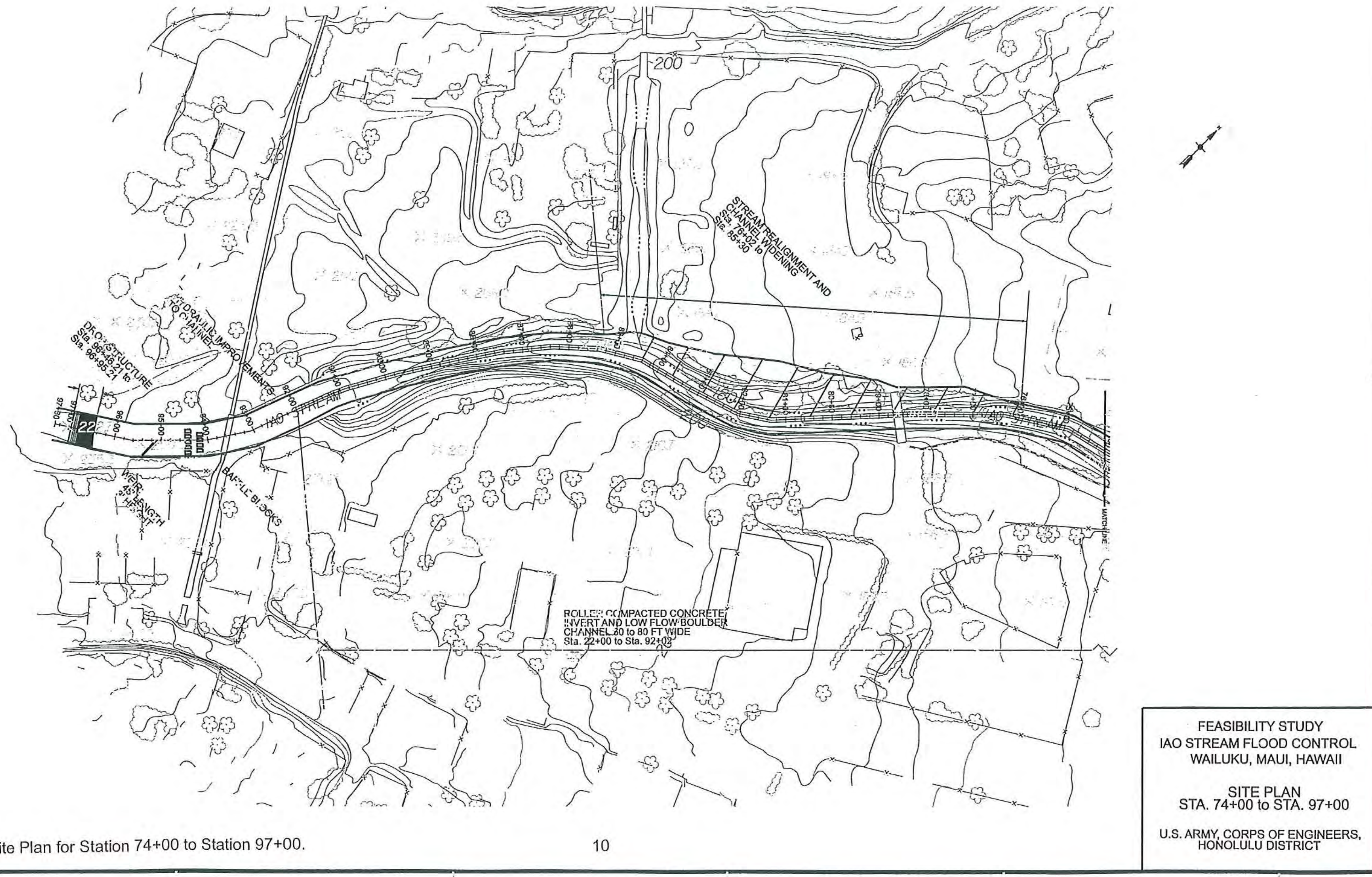
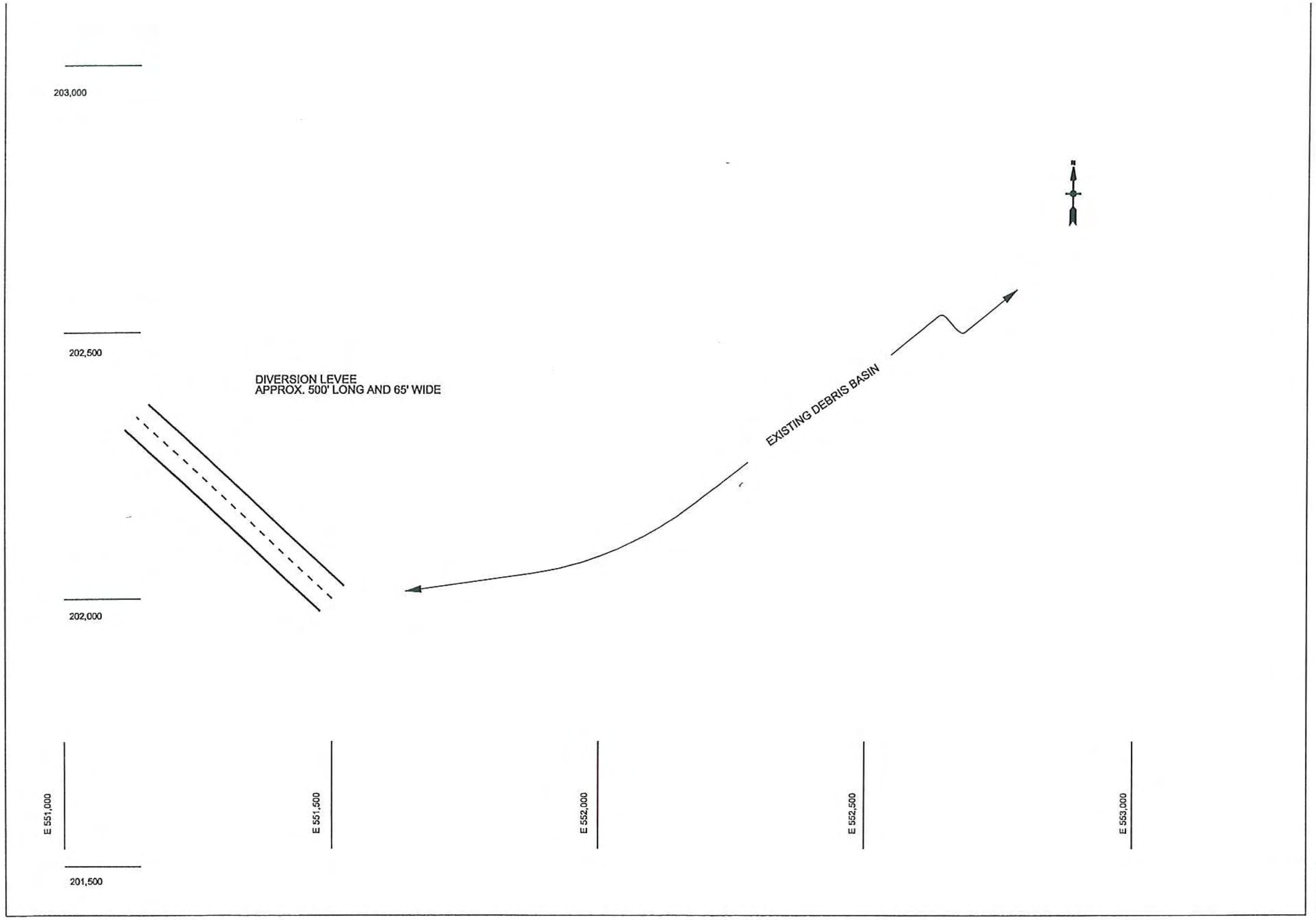


FIGURE 6. Site Plan for Station 74+00 to Station 97+00.



FEASIBILITY STUDY
IAO STREAM FLOOD CONTROL
WAILUKU, MAUI, HAWAII

SITE PLAN
DIVERSION LEVEE

U.S. ARMY, CORPS OF ENGINEERS,
HONOLULU DISTRICT

FIGURE 7a Site Plan – Diversion Levee

FIGURE 7b. Site Plan - Diversion Levee

DEPARTMENT OF THE ARMY
U.S. ARMY ENGINEER DISTRICT, HONOLULU
FORT SHAFTER, HAWAII 96858-5440

September 10, 2007

REPLY TO

Engineering and Construction Division

Mr. Clyde W. Namu'o
Administrator
Office of Hawaiian Affairs
711 Kapiolani Blvd, Suite 500
Honolulu, Hawaii 96813

Dear Mr. Namu'o:

The U.S. Army Engineer District, Honolulu (POH) is proposing to undertake a flood control project on the lower segments of Iao Stream (multiple TMK) in Wailuku, Maui Island (Figures 1, 2a, 2b, and 2c). The project area begins on the makai (east) end of Waiehu Beach Road The project was designed for Standard Project Flood (SPF) protection with a peak design discharge of 27,500 cubic feet/second (cfs) downstream at Station 22+00 and 26,000 cfs upstream at Station 92+02 (Figures 3-6). Five (5) alternatives are being considered for the flood control measures, and Alternative III has been proposed as the most viable based on engineering and cost benefits. A summary of the work under Alternative III is attached herein as Enclosure 1. Work proposed under Alternative III is an undertaking requiring consultation in compliance with Section 106 of the National Historic Preservation Act of 1966, as amended, pursuant to implementing regulations 36 CFR Part 800. The purpose of this letter is to initiate the Section 106 consultation process.

The area of potential effect (APE) of most of the work proposed under Alternative III is confined to the already highly disturbed stream channel. This work, listed under items 3-5, 7, and 9 in Enclosure 1, consists of modification to the existing channel. Such work should not affect any significant cultural resources as none is anticipated to be present within the stream channel itself.

The remaining work, listed under items 1, 2, 6, and 8, will entail new construction and/or construction excavations. A diversion levee in the form of a trapezoidal-shaped structure, 500 feet long, 65 feet wide, and 9 feet high, and a new ground water recharge basin are being proposed for construction at the upper end of the project area (see Figures 7a and 7b). Stream re-alignment and widening, anticipated to be no more than 30 feet wide, is being proposed between Stations 76+00 and 85+30 where the left (north) bank of the stream (see Figure 6) will be widen to reduce water surface profile to accommodate the County's proposed Imi Kala Bridge expansion construction. The areas of potential effect for this work is within the Iao Stream flood plain, and in the immediate vicinity of the channel. Based on previous archaeological investigations and historical accounts, prehistoric remains, except for *auwai* to feed taro loi, would not be anticipated to be present this type of terrain. Visual inspection of the stream channel's north embankment in the Imi Kala bridge location found no evidence to indicate potential presence of an *auwai* system. Thus, a determination can be made that this new construction work will not affect potentially surface or subsurface historic sites. However, to ensure that such will remain the case, POH is recommending that a professional archaeological monitor be present during construction excavation activities associated with any work in this area. Lastly, the raising of the right bank levee in the area between stations 45+37 to 48+85 and 25+62 to 26+46 are add-ons to existing levee and should not impact any cultural resources.

Thus, POH has made the determination that the proposed modification actions to the floodplain banks and immediate adjacent areas of the existing Iao Stream channel will have no affect to historic sites. To ensure no adverse impact will result to potentially significant subsurface cultural resources from construction activities to the north embankment in the Imi Kala bridge area, a program of archaeological monitoring during construction is being proposed. An archaeological monitoring plan will be compiled for review and acceptance by your office prior to the start of any construction; the archaeological monitoring will be undertaken by a reputable archaeological firm with prolonged experience in Hawaiian archaeology. The proposed archaeological monitoring program should ensure that the Alternative III will result in a "no effect to historic properties" determination. In compliance with the National Historic Preservation Act of 1966, pursuant to implementing regulations 36 CFR Part 800 (NHPA), your concurrence to this determination is being requested. POH is also requesting concurrence from the Hawaii State Historic Preservation Office, the Maui County Cultural Resources Commission, and the Central Maui Hawaiian Civic Club, in accordance with the NHPA.

We are also forwarding a copy of this letter to Mr. Stanley Solamilo, Maui County Cultural Resources Commission Minute, Maui County Planning Department, 250 S. High Street, Wailuku, Hawaii 96793. If you require any additional information, please contact Mr. Kanalei Shun at 438-7000.

Sincerely,

Todd C. Barnes, P.E.
Chief, Engineering and
Construction Division

Enclosures

DEPARTMENT OF THE ARMY
U.S. ARMY ENGINEER DISTRICT, HONOLULU
FORT SHAFTER, HAWAII 96858-5440

October 5, 2007

REPLY TO
ATTENTION OF:

Engineering and Construction Division

Ms. Laura H. Thielen
Interim Chairman and State Historic Preservation Officer
Department of Land and Natural Resources
Kakuhihewa Building, Room 555
601 Kamokila Boulevard
Kapolei, Hawaii 96707

Dear Ms. Thielen:

Enclosed for your review and comment is a copy of the Cultural Impact Assessment (CIA) report that was compiled as part of the U.S. Army Engineer District, Honolulu (POH) Iao Stream Flood Control Project. The study was conducted by our Small Business contractor, Social Research Pacific, Inc., for the Environmental Assessment (EA) being prepared by POH for the project in compliance with the National Environmental Policy Act (NEPA). The CIA study was performed in accordance with Chapter 343 of the Hawaii Revised Statute and with the "Guidelines for Assessing Cultural Impacts" adopted in 1977 by the Environmental Council of the State of Hawaii.

In our 5 September 2007 letter to your office, POH initiated consultation for the project with your office in compliance with Section 106 of the National Historic Preservation Act of 1966, as amended, pursuant to implementing regulations 36 CFR Part 800. We await your response to our letter.

A copy of this report is also being forwarded to the Office of Hawaiian Affairs, the Maui County Cultural Resources Commission, the Central Maui Hawaiian Civic Club, and the President of the Association of Hawaiian Civic Clubs for review and comment. If you require any additional information, please contact Mr. Kanalei Shun at 438-7000.

Sincerely,

Curtis I. Yokoyama, S.E., P.E.
Chief, Engineering and
Construction Division

Enclosure

PHONE (808) 594-1888

FAX (808) 594-1865

STATE OF HAWAI'I
OFFICE OF HAWAIIAN AFFAIRS
711 KAPI'OLANI BOULEVARD, SUITE 500
HONOLULU, HAWAI'I 96813

HRD07/3219B

October 30, 2007

Curtis Yokoyama, Chief
Department of the Army
U.S. Army Engineer District
Fort Shafter, Hawai'i 96858-5440

RE: Cultural Impact Assesment for 'Iao Stream Flood Control Project, Maui, Hawai'i.

Dear Mr. Yokoyama,

The Office of Hawaiian Affairs (OHA) is in receipt of your request for written comments regarding the Cultural Impact Statement (CIS) for the 'Iao Stream flood control project on Maui. We have the following comments:

OHA requests that the TMK number for this project be given so that we can determine whether this project will impact any of our ceded lands.

This CIS was sent to us separate from the environmental assessment (EA) for which it is to be incorporated into. OHA recognizes that this was done in order to begin the consultation process; however, it is not particularly useful to do so. It is difficult to review a CIS out of context form its associated project. Further, OHA understands that the EA for this CIS will be released soon and we will review it at that time. That being said, OHA wishes to make clear that we are always pleased to see an applicant working on a CIS and as such are happy to assist with its preparation. However, the review of the CIS as a stand-alone document is not the intent of the environmental review process and, as said, a bit difficult.

OHA also notes that the invitation to comment mentions that a Section 106 consultation was initiated by the U.S. Army Engineer District on September 5, 2007. However, our agency has no record of receiving this document and as such, does not recognize the initiation of the 106 process as of now.

In terms of the CIS, OHA appreciates that a number of sources were consulted in preparation of this document including archival searches, field studies, oral histories from kūpuna in the area, public scoping meetings and surveys. However, there are numerous lo'i, heiau, and other culturally significant sites in the area as well as constitutionally protected Native Hawaiian rights being practiced in the area. As such, OHA both compliments the research done for the CIS, while reserving the right to further comment for the EA.

Thank you for the opportunity to comment. If you have any further questions or concerns please contact Grant Arnold at (808) 594-0239 or granta@oha.org.

Sincerely,

Clyde W. Nāmu'o
Administrator

C: Thelma Shimaoka, Community Resource Coordinator
Office of Hawaiian Affairs, Maui Office
140 Ho'ohana St., Ste. 206
Kahului, Hawai'i 96732

DEPARTMENT OF THE ARMY
U.S. ARMY ENGINEER DISTRICT, HONOLULU
FORT SHAFTER, HAWAII 96858-5440

October 5, 2007

REPLY TO
ATTENTION OF:

Engineering and Construction Division

Mr. Clyde W. Namu'o
Administrator
Office of Hawaiian Affairs
711 Kapiolani Blvd, Suite 500
Honolulu, Hawaii 96813

Dear Mr. Namu'o:

Enclosed for your review and comment is a copy of the Cultural Impact Assessment (CIA) report that was compiled as part of the U.S. Army Engineer District, Honolulu (POH) Iao Stream Flood Control Project. The study was conducted by our Small Business contractor, Social Research Pacific, Inc., for the Environmental Assessment (EA) being prepared by POH for the project in compliance with the National Environmental Policy Act (NEPA). The CIA study was performed in accordance with Chapter 343 of the Hawaii Revised Statute and with the "Guidelines for Assessing Cultural Impacts" adopted by the Environmental Council of the State of Hawaii in 1997.

In our 5 September 2007 letter to your office, POH initiated consultation for the project with your office in compliance with Section 106 of the National Historic Preservation Act of 1966, as amended, pursuant to implementing regulations 36 CFR Part 800. We await your response to our letter.

A copy of this report is also being forwarded to the State of Hawaii Historic Preservation Office, the Maui County Cultural Resources Commission, the Central Maui Hawaiian Civic Club, and the President of the Association of Hawaiian Civic Clubs for their review and comment. If you require any additional information, please contact Mr. Kanalei Shun at 438-7000.

Sincerely,

Curtis I. Yokoyama, S.E., P.E.
Chief, Engineering and
Construction Division

Enclosure

K. Shun
CEPOH-EC-E

D. Nakamura
CEPOH-EC-E

E. Kozuma
CEPOH-EC-Z

C. Yokoyama
CEPOH-EC

Rtn to Onuma
CEPOH-EC-E
File/Distr

November 5, 2007

Engineering and Construction Division

Mr. Clyde W. Namu'o
Administrator
Office of Hawaiian Affairs
711 Kapiolani Blvd, Suite 500
Honolulu, Hawaii 96813

Dear Mr. Namu'o:

It has been brought to our notice that your office may not have received our letter dated September 10, 2007, with its attachment. We are re-sending a copy of this letter in case you had not as yet received it. If you have received the letter, then please disregard this one.

We would appreciate a response to our September 10, 2007 letter. If you have further questions, please contact Mr. Kanalei Shun, Environmental Branch at (808)438-7000 or electronically at kanalei.shun@poh01.usace.army.mil.

Sincerely,

Curtis I. Yokoyama, S.E., P.E.
Chief, Engineering and
Construction Division

Enclosures

INTERNAL REVIEW OFFICE	
OFFICE FILE NUMBERS	
FILE #	DESCRIPTION
1a	Office File Numbers
1c	Office Inspections and Surveys
1f	Office Organization Files
1q	Office Property Records
1x	Office Civilian Personnel Time and Attendance Files
1aa	Office Supervisory or Manager Employee Records
1hh	Office Temporary Duty Travel
1oo	Policies and Procedures
1-1e	Operating Budgets
1-201a	Inspection, Survey, and Staff Visit Coordination Files
11-2a	Internal Control Systems
11-7a	Internal Review and Audit Files
36-2c	AAA Audit Reporting Files

7004 2510 0005 7838 4589

U.S. Postal Service™
CERTIFIED MAIL™ RECEIPT
(Domestic Mail Only; No Insurance Coverage Provided)

For delivery information visit our website at www.usps.com®

OFFICIAL USE

Postage	$
Certified Fee	
Return Receipt Fee (Endorsement Required)	
Restricted Delivery Fee (Endorsement Required)	
Total Postage & Fees	$

Postmark Here

NOV 9 2007

Sent To
Mr. V. R. Hinano Rodrigues

Street, Apt. No.; or PO Box No. 130 Mahalani St

City, State, ZIP+4
Wailuku, HI 96793

PS Form 3800, June 2002 See Reverse for Instructions

SENDER: COMPLETE THIS SECTION

- Complete items 1, 2, and 3. Also complete item 4 if Restricted Delivery is desired.
- Print your name and address on the reverse so that we can return the card to you.
- Attach this card to the back of the mailpiece, or on the front if space permits.

1. Article Addressed to:

Mr. V. R. Hinano Roddrigues
130 Mahalani St.
Wailuku, HI 96793

COMPLETE THIS SECTION ON DELIVERY

A. Signature
X [signature] ☑ Agent ☐ Addressee

B. Received by (Printed Name) Russell Sparks

C. Date of Delivery 11/07/07

D. Is delivery address different from item 1? ☐ Yes
If YES, enter delivery address below: ☐ No

3. Service Type
☒ Certified Mail ☐ Express Mail
☐ Registered ☒ Return Receipt for Merchandise
☐ Insured Mail ☐ C.O.D.

4. Restricted Delivery? (Extra Fee) ☐ Yes

2. Article Number
(Transfer from service label) 7004 2510 0005 7838 4589

PS Form 3811, February 2004 Domestic Return Receipt 102595-02-M-1540

IAO STREAM FLOOD CONTROL PROJECT

SENDER: *COMPLETE THIS SECTION*

- Complete items 1, 2, and 3. Also complete item 4 if Restricted Delivery is desired.
- Print your name and address on the reverse so that we can return the card to you.
- Attach this card to the back of the mailpiece, or on the front if space permits.

1. Article Addressed to:

Mr. Clyde W. Namu'o
711 Kapiolani Blvd., Suite 500
Honolulu, HI 96813

COMPLETE THIS SECTION ON DELIVERY

A. Signature
X [signature] ☐ Agent ☐ Addressee

B. Received by (*Printed Name*) Ashton Saipai C. Date of Delivery 11/8/07

D. Is delivery address different from item 1? ☐ Yes
If YES, enter delivery address below: ☐ No

3. Service Type
☒ Certified Mail ☐ Express Mail
☐ Registered ☐ Return Receipt for Merchandise
☐ Insured Mail ☐ C.O.D.

4. Restricted Delivery? (*Extra Fee*) ☐ Yes

2. Article Number (*Transfer from service label*) 7004 2510 0005 7838 4602

PS Form 3811, February 2004 Domestic Return Receipt 102595-02-M-1540

7004 2510 0005 7838 4602

U.S. Postal Service™
CERTIFIED MAIL™ RECEIPT
(Domestic Mail Only; No Insurance Coverage Provided)

For delivery information visit our website at www.usps.com®

HONOLULU HI 96813
OFFICIAL USE

Postage	$ $1.31	0016
Certified Fee	$2.65	01
Return Receipt Fee (Endorsement Required)	$2.15	Postmark Here
Restricted Delivery Fee (Endorsement Required)	$0.00	
Total Postage & Fees	$ $6.11	11/07/2007

FT. SHAFTER, HONOLULU, HI 96858 NOV 7 2007 USPS

Sent To Mr. Clyde W. Namu'o
Street, Apt. No.; or PO Box No. 711 Kapiolani Blvd., Suite 500
City, State, ZIP+4 Honolulu, HI 96813

PS Form 3800, June 2002 See Reverse for Instructions

IAO STREAM FLOOD CONTROL PROJECT

Appendix I:

Trip Report, 3-4-2008 Site Walk

CEPOH-PP-C 31 March 2008

MEMORANDUM FOR RECORD

SUBJECT: IAO STREAM SITE VISIT, 4 MARCH 2008.

1. A site visit was held at Iao Stream on 4 March 2008 with representatives from US Fish and Wildlife Service, DLNR Division of Aquatic Resources, County of Maui, and the US Army Corps of Engineers. The following people attended:

Mike Dean	County of Maui	270-7745
Sonia Garcia	Environet, Inc (For COE)	833-2225
Jeffrey Herod	US Fish and Wildlife Service	792-0462
Wendy Kobashigawa	County of Maui	270-7745
Skippy Hau	DLNR Div of Aquatic Resources	243-5834
Jim Pennaz	Corps of Engineers	438-8599
Nani Shimabuku	Corps of Engineers	438-2940
Gordon Smith	US Fish and Wildlife Service	

2. The purpose of the site visit was to discuss potential project modifications which might facilitate migration of aquatic stream fauna in Iao Stream. The group observed Iao Stream from the ocean to just above the debris basin (Sta 0+00 to 120+00). A summary of these discussions is as follows:

a. Mouth of Iao Stream (Approximate Sta 0+00). At the bottom of the project, a large debris field of boulders has filled in the area between the channel invert and ocean. The original channel design had a drop of approximately three feet between the channel invert and estuary area. Boulders from channel erosion have now filled this area and created a more natural transition from the channel to the estuary area. No changes are proposed in this area.

b. Low Flow Channel Under Waiehu Beach Road Bridge (Approximate Sta 20+00). The low flow channel from the stream mouth to the Waiehu Beach Road bridge is a boulder concrete channel and is considered acceptable. However, the low flow channel under the bridge has been repaired and modified from its original shape by placement of concrete in the invert. Skippy Hau indicated that this channel is an important resting place for aquatic animals because of the shade provided by Waiehu Beach Road Bridge. He recommended that this portion of the low flow channel be modified to a five feet wide boulder concrete type channel with more roughness.

c. Proposed Low Flow Channel in Roller Compacted Concrete (RCC) Channel (Sta 22+00 to 94+00). The recommended design is a 20 ft wide boulder concrete low flow channel with a level invert. Gordon Smith recommended that this channel be modified to a width of 14 to 16 feet and be sloped towards one side. The channel depth should be at least 18 to 20 inches deep at its deepest point. The low flow channel should be placed along the left bank area unless more shade exists on the right bank. Purpose of the recommendation is to provide shaded areas.

d. Drop Structure (Sta 97+23). The existing 20 feet drop structure will be modified with a stair step type structure to improve overall channel safety. Recommendations from Gordon Smith and Skippy Hau are to continue the low flow channel from upstream along the right bank of the stair step structure. At the bottom of the structure, a new low flow channel will be formed along the toe of the new stair step structure connecting the right bank low flow channel to the existing left bank low flow channel.

e. Concrete Channel Upstream of Market Street Bridge (various locations). Recommendations here are to install small blocks in smooth portions of the low flow channel. The blocks should be doweled into the existing surface. Purpose of the small blocks would be to reduce flow velocities and provide resting areas for migrating animals.

f. Debris Basin Ground Water Recharge. The proposed plan will install a small dam at the debris dam outlets. The low dam will back water into the debris basin and allow more groundwater recharge. This proposed plan is based on community input at an earlier public meeting. Both Skippy Hau and Gordon Smith recommended against this plan because the backwater will create habitat for undesirable species, as well as, remove important low stream flows from the low flow channel. In addition, the small dam will make it more difficult for aquatic migration during low flows.

3. Items discussed during site visit will be discussed further in-house.

Nani Shimabuku
Project Manager

Appendix J:

Fish and Wildlife Revised Mitigation Recommendations Letter

United States Department of the Interior

FISH AND WILDLIFE SERVICE

Pacific Islands Fish and Wildlife Office
300 Ala Moana Boulevard, Room 3-122, Box 50088
Honolulu, Hawaii 96850

In Reply Refer To:
12200-2008-FA-0127

Lt. Colonel Charles H. Klinge
District Engineer, Honolulu
U.S. Army Corps of Engineers
Building 230
Ft. Shafter, HI 96858-5440

Subject: Revised Fish and Wildlife Coordination Act Mitigation Recommendations for the Iao Stream Flood Control Project, Wailuku, Maui, Hawaii

Dear Lieutenant Colonel Klinge:

The Fish and Wildlife Coordination Act of 1934 [16 U.S.C. 661 *et seq*.; 48 Stat. 401], as amended (FWCA), was established to provide a framework for the consideration of fish and wildlife conservation measures to be incorporated into Federal and federally permitted or licensed water resources development projects. In January 2006, the U.S. Fish and Wildlife Service (Service) provided a Draft FWCA section 2(b) investigation report describing the significant fish and wildlife resources found within the proposed project area and recommendations for mitigation of unavoidable resource impacts anticipated to result from the proposed Iao Stream Flood Control Project. In coordination with U.S. Army Corps of Engineers (Corps) staff, we are providing the following *revised* mitigation recommendations for the proposed project. These recommendations were prepared under the authority of and in accordance with provisions of the FWCA and the Federal Clean Water Act of 1977 [33 U.S.C. 1251 *et seq.*; 62 stat. 1155], as amended (CWA). These comments are also consistent with the National Environmental Policy Act of 1969 [42 U.S.C. 4321 *et seq*.; 83 Stat. 852], as amended (NEPA), and other authorities mandating concern for environmental values.

The purpose of the proposed project is to increase the engineered flood protection capacity of the existing Iao Stream Flood Control and Related Improvements Project, which was constructed in 1979-1981. The existing project consists of a debris basin, an upper segment that is cement-lined and straightened (1,100 feet [ft] in length); a middle segment that is straightened, not lined with cement and bound by a levy on one side (7,200 ft in length); and a lower segment that is straightened, lined with cement and concrete-rubble masonry (CRM), and is 1,400 ft in length.

Five alternatives are under consideration: Alternatives 1 and 2 call for straightening and installing a poured-cement lining over the un-lined middle segment of stream (7,200 ft). Alternative 3 also calls for a cement lining of the same middle segment of the stream. Under this alternative, the planned construction method would be via roller-compacted concrete (RCC), and a low-flow channel would be constructed using irregular boulder- and cobble-sized rock to form micro-habitat and refugia for fish and invertebrates and to facilitate upstream fish passage through the newly lined channel. The design specifications for Alternative 3 minimize, but do not completely eliminate, the anticipated environmental impacts of the proposed project. Alternative 4 calls for repair and reconstruction of damaged levee toes and would increase levee heights in key flood-prone areas. However, this alternative does not achieve the desired level of flood protection. Alternative 5 consists of complete removal of existing flood control infrastructure and includes installation of a flood warning system. This alternative was put forward in response to public support for restoration of natural ecosystem function in the Iao Stream watershed. However, in our review of flow characteristics and fluvial geomorphology of lower Iao Stream, this alternative is not viable without the addition of a property acquisition component to allow for a dedicated stream corridor to accommodate flooding and allow for natural meandering of the stream channel.

Because the proposed project is considered a modification of an existing project, the Corps plans to prepare an Environmental Assessment under NEPA. The extent of anticipated environmental impacts due to this modification, as envisioned for Alternatives 1, 2 or 3, will result in the cumulative loss of 9,700 linear ft of natural stream bottom habitat. This is far more than the habitat impacts attributed to the original flood control project, which resulted in loss of 2,500 ft of natural stream. From an environmental review standpoint, this presents an unusual situation in which the proposed modification will result in the elimination of almost four times more linear stream habitat than the original project. As stated in prior correspondence, if Alternatives 1, 2, or 3 are pursued to completion, the Iao Stream Flood Control Project will confine the lower reach of Iao Stream into the longest cement-lined stream channel on Maui, and create one of the longest cement channels in the State.

Regulatory Considerations

The Corps Regulatory Branch issues a CWA section 404 permit for any project that results in discharge of material into a waterbody that falls under their jurisdiction, and the project's environmental planning record must demonstrate that the Least Environmentally Damaging Practicable Alternative is chosen through a planning process that, among other considerations, *avoids* resource impacts wherever possible, *minimizes* unavoidable impacts, and *compensates* for all unavoidable resource losses. Recent guidance specifies that mitigation features designed to compensate for unavoidable impacts to jurisdictional waters are to be based on replacement of lost environmental functions, as considered in a watershed-wide context (Corps Regulatory Guidance Letter [RGL] 02-02). Mitigation planning that conforms to the CWA requirement for functional replacement is described in a variety of Corps and U.S. Environmental Protection Agency (EPA) administrative rules.

Although the Corps' Civil Works Branch is exempted from the requirements of CWA section 404 permits, the environmental protection requirements of section 404 still apply, and these requirements must be addressed in the project's NEPA disclosure documentation. The basis for this analysis is set forth in the CWA 404(b)(1) guidelines and the substantive elements of a

404(b)1 analysis must be included in a project's NEPA document. When avoidance and minimization of impacts to waters of the U.S. are not adequate to offset anticipated project-related natural resource impacts, compensatory mitigation is required as outlined in a 1990 Corps-EPA Memorandum of Understanding that describes the 404(b)(1) analysis requirements. A related requirement is the need for a 401(c) Water Quality Certification issued by the state water quality agency to assure that the project will not violate state-administered water quality standards.

In our opinion, and as described in our FWCA 2(b) report, the impacts anticipated to result from the Corps' preferred alternative (Alternative 3) cannot be avoided through minimization alone, unavoidable impacts must be addressed through compensatory actions. This alternative, which calls for roller-compacted concrete and grouted rip-rap throughout the project area, will result in an unavoidable and permanent **loss of 7,200 feet of pool/riffle stream habitat**.

Substantial guidance is available to develop compensatory mitigation adequate to offset this anticipated loss of aquatic resources in the mitigation plan requirements set forth in the Honolulu District Regulatory Branch Compensatory Mitigation and Monitoring Guidelines. This guidance was developed to conform to RGL 02–02. These planning requirements are further clarified by newly-adopted comprehensive Corps–EPA Regulations ("Compensatory Mitigation for Losses of Aquatic Resources" Federal Register 73:70 [Thursday, April 10, 2008] pg. 19593), which became effective earlier this month. Our mitigation recommendations for the Iao Stream Flood Control Project have been revised consistent with these regulatory considerations and are described below.

<u>Mitigation Recommendations</u>

The Iao Stream Flood Control Project has been reviewed by the Service at various stages since its inception in 1968. Because of its very high likelihood of success, the most frequently recommended method of compensatory mitigation was stream flow restoration. The suggestion to restore depleted flows date back to the early 1970s when the project was first reviewed. In 2006, our FWCA 2(b) report suggested pursuing the following mitigation scenario for the Corps' preferred alternative (Alternative 3):

> "1) creation and implementation of a flow restoration agreement between a number of partners including the Corps, DLNR–CWRM [Hawaii Department of Land and Natural Resources – Commission on Water Resource Management], the County of Maui, and private entities that hold licenses for diversion and out-of-stream consumptive use of Iao Stream water;
>
> 2) engineering and reconstruction of at least four existing diversion structures to allow managed minimum stream flows to remain in the stream and allow for passage of aquatic organisms; and
>
> 3) management in perpetuity of the flow restoration conditions to enhance support of aquatic organisms, including instream water volumes and in-channel riparian vegetation by the County as an integral element of the flood control project."

The goal of the recommended flow restoration was to provide for continuous stream flow to the sea 80 percent of the time.

Surface waters within the State of Hawaii are considered a public trust resource and the use of surface waters falls under State jurisdiction. Central Maui streams were recently designated as the State's first Surface Water Resource Management Area by the State of Hawaii Commission on Water Resource Management (COWRM) and this process is expected to lead to a re-allocation of offstream use of water resources. The deliberations to re-allocate water among competing uses, which include offstream agricultural use, native Hawaiian water claims, and environmental restoration, are proceeding under a quasi-judicial contested-case hearing format. This process will likely continue for several years before resolution of all water use claims are realized. In light of the uncertainty regarding water allocation in central Maui, and in coordination with Corps engineering and planning staff, alternative avenues to adequately develop a mitigation plan for the Iao Stream Flood Control Project were pursued.

Functional evaluation

For the purpose of evaluation of the freshwater aquatic habitats in Iao Stream, eight species of migratory native Hawaiian stream organisms known to occur in the stream were used as evaluation species. These organisms serve as biological indicators of stream function because they require cold, clean, high-quality flowing water and clean sandy or rocky substrate. This group of animals includes five species of fish and three species of invertebrates. All of these species require passage through the stream channel at two time-periods during the course of their life history, which takes place as follows: eggs are laid in the stream on clean rocky substrate, just-hatched larvae are carried by the stream to the sea, larvae develop and recruit to stream mouths and undergo metamorphosis, post-larvae undertake an upstream migration to inland reaches of streams. Because the pelvic fins of the fishes are modified to form a suction cup and the invertebrates can climb by clinging to substrate, several of these species are capable of ascending vertical or even overhanging waterfalls and can be found at high elevations in the watersheds as adults.

Under current conditions, a limited number of upstream migrating fish and invertebrates successfully ascend through the Iao Stream channel to reach middle and upper reaches where stream water quality, water quantity, and habitat conditions are sufficient to support native aquatic life. Recent observations by Service biologists indicated low numbers of *Awaos guamensis*, *Sicyopterus stimpsoni* and *Lentipes concolor* above the proposed project reach. Because the stream is severely de-watered, only exhibits continuous flow to the sea about 30% of the time, has 2,500 ft of cement channel, and has 7,200 ft of straightened channel, it is remarkable that any upstream migrants can ascend the stream to reach suitable habitat at all.

As an alternative to flow restoration, we recommend that structural features that enhance the upstream passage of migratory organisms be incorporated into the project as compensatory mitigation to offset unavoidable project impacts. Alternative 3 includes a low-flow channel and near-bank vegetation management to provide shade. In consultation with the Corps and County of Maui planning staff, the following additional mitigation actions are recommended:

1. Install a boulder- and cobble-lined, low-flow channel in the existing flat-bottomed cement channel extending from the upper end of the existing CRM channel under the Waiehu Beach Road bridge, upstream to the bottom of the proposed RCC low-flow channel (approximately 300 ft in length);

2. Design the new boulder- and cobble-lined, low-flow channel to meander within the proposed RCC channel to maximize exposure to shade created by steep banks. The low-flow channel will typically be adjacent to steeper, more heavily vegetated banks and will maximize the time period of either morning or evening shade;

3. Install a boulder- and cobble-lined, low-flow channel extending from the upper end of the RCC channel to the bottom of the drop-structure steps (approximately 350 ft in length);

4. Modify the 25-ft drop structure to form a stepped fish passage structure to facilitate upstream fish and invertebrate migration;

5. Modify the steepest areas of existing concrete channels with small irregularly-placed blocks to break up high-velocity flows and facilitate fish passage at five steep channel areas above the North Market Street Bridge;

6. Install and maintain a low-flow, boulder- and cobble-lined channel in natural substrate through the center of the debris basin (approximately 1200 ft): and

7. Commitment by the Corps and local sponsor to inform water resource regulatory agencies and water users that enhanced fish passage is an integral part of the project design and that flow restoration should be incorporated into management of the Iao watershed.

The construction and maintenance of these structural features will greatly improve the probability of successful upstream migration of native stream macrofauna in lower Iao Stream channel under both current and probable future flow regimes. We recommend that the above recommendations be incorporated into a Mitigation Plan developed to conform to Corps guidance. The plan should describe the construction details of the proposed structural features (low-flow channel widths and depths, construction boulder and cobble sizes, vegetation management regimes to be adopted by the local sponsor, and an aquatic resource monitoring plan that emphasizes before-and-after project documentation of upstream migration of fish and invertebrates). We are available to provide additional technical support for mitigation planning for the project.

We appreciate the opportunity to provide mitigation planning recommendations for the proposed project. If you have questions regarding these recommendations, please contact Fish and Wildlife Biologist Gordon Smith 808/792-9400.

Sincerely,

Patrick Leonard
Field Supervisor

cc: Dan Polhemus, HDAR
Skippy Hau, HDAR–Maui
Alec Wong, CWB
Wendy Wiltse, EPA
Gerry Davis, NMFS

COPIED CORRESPONDENCE --- DO NOT MAIL

Dan Polhemus, Ph.D.
Division of Aquatic Resources
Hawaii Department of Land and Natural Resources
1151 Punchbowl Street, Room 330
Honolulu, HI 96813

Skippy Hau
Division of Aquatic Resources
Hawaii Department of Land and Natural Resources
130 Mahalani Street
Wailuku, Maui, HI 96793

Alec Wong, Branch Chief
Clean Water Branch
Hawaii Department of Health
919 Ala Moana Blvd., Room 301
Honolulu, HI 96814

Wendy Wiltse
Pacific Islands Contact Office
U.S. Environmental Protection Agency, Region IX
300 Ala Moana Blvd., Suite 5-152
Box 50003
Honolulu, HI 96850

Gerry Davis
Pacific Islands Regional Office
National Marine Fisheries Service
U.S. Department of Commerce
1601 Kapiolani Blvd., Suite 1110
Honolulu, HI 96814-4700

Appendix K:

Economic Update

Iao Stream Flood Control Project
Wailuku, Island of Maui, State of Hawaii
Economic Update
September 12, 2008

1. Background. The purpose of this economic analysis is to update the benefits and costs attributable to modifications to the Iao Stream Flood Control Project in the town of Wailuku on the island of Maui. Storms occurring in 1989 caused extensive damage to the project's levee system. In order to prevent potential failure of the flood control project during a storm event, modifications are imperative. Project failure will cause the resulting flood waters to inundate essentially the same area as if there was no project. The constructed project has instilled a sense of security in the Wailuku community and a project failure would result considerable property damage and possible loss of life.

In 1974, a General Design Memorandum was prepared which included an economic evaluation for the Iao Stream flood control project. At that time, there were 263 residential and commercial structures subject to flooding. The study area was surveyed again in August 1992 to take into account the changes that had occurred since 1974. The result of that survey and the subsequent economic analysis were incorporated into a report titled "Modifications to Completed Project Report for the Iao Stream Flood Control Project, Maui, Hawaii (March 28, 1995)". The report identified 510 residential and commercial structures in the 222-year Standard Project Flood (SPF) floodplain with a total depreciated value for structure of $38.9 million and total content value of $69.8 million at an October 1992 price level. Since 1992, a significant amount of development has taken place in the study area.

This update evaluates the economic benefits and costs of modifications to the Iao Stream Flood Control Project. These modifications are expected to reduce inundation damage to structures, contents and automobiles, the cost of emergency services, damages to yards and outside property, and the administrative costs of flood insurance. Although these modifications are also expected to reduce losses based on the value of motorists' and passengers' time lost due to road blockages and detours, these additional benefit categories have not been evaluated. In addition, this analysis addresses risk and uncertainty of both the engineering and economic data from which project benefits are derived.

2. General. This economic analysis compares the benefits and costs related to three of the five alternative plans proposed for Iao Stream Flood Control Project. Flood plain management, including flood control and prevention, contributes to the National Economic Development (NED) objective by improving the net productivity of flood-prone land resources. This occurs from an increase in the output of goods and services and/or by reducing the cost of using the land resources. These improvements in economic efficiency, or project benefits, are estimated by comparing the most likely future conditions without the project (the "without-project" condition) with the most likely future conditions resulting from the implementation of flood damage reduction measures (the "with-project" condition).

In this economic analysis, both costs and benefits are expressed at an estimated October 2007 price level. Costs and benefits occurring at different points in time are converted to an average annual equivalent basis over a 50-year period of analysis using the federal discount rate prescribed for water resources projects. This rate is currently set at 4.875 percent. The project base-year, or first year of project operation, is FY2013. The 50-year period of analysis is from FY2013 through FY2062, inclusive.

The objective of this economic analysis is to determine the alternative that will reasonably maximize net NED benefits. This is accomplished by comparing the average annual benefits and costs of the alternatives being considered. The alternative with a benefit-cost ratio greater than one and the highest net benefits will be designated as the NED alternative.

3. Alternatives. The five alternatives initially considered in the Engineering Documentation Report (main report) are described briefly below in Table 1. Detailed descriptions of the various alternatives are provided in the main report. Of these, only the performance of Alternative 3 was evaluated in detail using the Hydrologic Engineering Center Flood Damage Analysis (HEC-FDA) computer program. Alternatives 1 and 2 are assumed to provide the same benefits as Alternative 3 when designed for the same degree of protection.

Table 1. Iao Stream Alternative Plans

	Description
Alternative 1	Trapezoidal Concrete-Lined Channel
Alternative 2	Rectangular and Compound Channel
Alternative 3	Roller Compacted Concrete and Boulder Invert Channel along Existing Alignment
Alternative 4	Levee Reconstruction
Alternative 5	Removal of Flood Control Improvements

Alternative 4, levee reconstruction, is not considered a viable solution since it does not address erosion and undermining of levees. It is therefore not included in the NED analysis.

Alternative 5, removal of the existing flood control improvements and the restoration of the stream to its original natural condition, will remove all existing project flood control features for flooding events of all frequencies. Although for the purposes of this comparison it is assumed to have zero NED benefits, it is likely to have negative benefits to the extent that flooding events with a return period of less than 25-years are likely to cause damage in excess of the without project condition. Consequently it will not be analyzed in this NED analysis.

4. Methodology. Inundation damages are computed by combining an inventory of structures in the floodplain with the anticipated extent and effects of the flooding from various storms in the without-project alternative and with-project alternatives. Flooding associated with 1-year, 10-year, 25-year, 20-year, 50-year, 100-year, and 222-year events were estimated using the Corps of Engineers' HEC-RAS computer software. The areas of flooding and the flooding depths associated with the different events were computed as discussed in the main report.

This analysis assumes that in the without-project condition the existing levees along the right bank of Iao Stream will fail in a flood event of 25-year of greater return period but not in the case of smaller events. This is expected to cause flooding along the entire length of the over-bank as a result of levee and bank failure in one or two places. In order to represent this condition, levees were specified in the HEC-FDA model to represent both levees and river banks, with levee heights artificially set halfway between the 20-year and 25-year flood stages.

For the with-project condition, levee heights were set to reflect the levee and river bank elevations of Alternative 3, which are the same as those now existing along Iao Stream. A list of levee heights specified in the HEC-FDA model for the without-project and with-project conditions is provided in Table 2.

Table 2. Levee Heights as Specified in the HEC-FDA Model

	Without-Project Levee Height (feet)	With-Project Levee Height (feet)
Reach 1	14.39	20.15
Reach 2	41.03	52.80
Reach 3	61.22	72.80
Reach 4	88.43	95.80
Reach 5	111.83	118.63
Reach 6	139.50	144.87
Reach 7	147.63	154.80
Reach 8	179.60	186.20

In order to determine the economic effects of flooding on structures in the floodplain, structure values, content values, first floor elevations, depth-damage curves, and the estimated water surface profiles for different frequency events were entered into the Corps' Hydrologic Engineering Center Flood Damage Analysis (HEC-FDA) computer program. HEC-FDA compares the flood heights for different events with the first floor elevations for each structure in the flood plain. This determines the height of the flood waters at each structure for any given flood event. HEC-FDA analyzes the percent damages to each structure and its contents associated with each level of flooding. The percent damages are multiplied by the structure or content value to arrive at dollar damages. This procedure is performed for every structure in the flood plain, with results consolidated by reach and integrated over the range of probabilities that flooding of different intensities will occur.

The HEC-FDA program also explicitly takes into consideration the uncertainty of the variables involved in calculating flood damages. The hydrologic, hydraulic, and economic data used in flood damage analysis are not known with certainty. To model these uncertainties, the probability distributions of the pertinent variables are input into the HEC-FDA program. The program then applies Monte Carlo simulation techniques to the data using discharge-probability, stage-discharge, and stage-damage functions containing these distributions. By conducting a large number of iterations, the program computes the expected value of damages while specifically accounting for the uncertainties in the underlying data. The expected average annual damages for each alternative are calculated by first summing damages by reach and by damage category, and then aggregating damages.

5. Structure Inventory. The structure inventory for this economic update is composed of all residential and commercial buildings in the SPF floodplain. Structures were identified by the use of a geographical information system (GIS) map with layers for county tax map key (TMK) parcels, the SPF floodplain, an aerial survey topographic map with 5-foot contour lines, and aerial photographs of the project area. The residential category includes single-family residences, and also multi-unit low-rise condominium and apartment buildings. The commercial structures category includes buildings serving commercial, industrial, and public purposes.

The study area is located in Wailuku along Iao Stream on the north coast of the island of Maui. Structures in the SPF-year floodplain are located within an area approximately bounded by Iao Stream to the Northwest, Lower Main Street and Mill Street to the Southeast, Imi Kala Street to the Southwest, and Kahului Bay to the Northeast. The ground elevations range from about 186 feet above Mean Sea Level (MSL) at the upstream end of the study area to about eight feet above MSL near Kahului Bay. There are about 362 single family residential structures (SFRs) in the 222-year floodplain. The average age of SFRs is about 31 years, and about a third were built since 2000. In addition to the SFRs, 45 multi-unit residential structures containing 464 condominium units were built between 1993 and 2002. The total replacement cost less depreciation value of residential structures in the 222-year floodplain is about $111 million and total contents value is about $43 million. The total replacement costs less depreciation of commercial structures in the 222-year floodplain is about $83 million and the total commercial contents value is about $121 million. The residential and commercial structures together have a replacement cost less depreciation value of about $194 million and damageable contents worth about $164 million.

For the purposes of this analysis, the flood plain was divided into eight reaches, all on the right bank of Iao Stream. The location of each reach along Iao Stream and a description of structure type types are shown in Table 3. Figure 1 illustrates the location of reaches within the floodplain. Figure 2 shows the location of structures in the SPF floodplain.

Table 3. Damage Reaches

	Location	Structure Inventory in Reach
Reach 1	shoreline to Sta. 16+75 (downstream of Waiehu Beach Road)	Mostly older SFRs
Reach 2	Sta. 16+75 to 33+08 at Momi Lane	Mostly commercial and industrial structures
Reach 3	Sta 33+08 to 38+97	Largely residential, contains both SFRs and multi-unit residential structures
Reach 4	Sta. 38+97 and 49+03	Largely residential, contains both SFRs and multi-unit residential structures
Reach 5	Sta. 49+03 to 59+03	Some multi-unit residential structures and many newer SFRs
Reach 6	Sta. 59+03 to 65+03	Some multi-unit residential structures and many newer SFRs
Reach 7	Sta. 65+03 to 73+01	Three SFRs
Reach 8	Sta. 73+01 to 80+12	One SFR

Both residential and commercial areas of the floodplain are fully built out, with little room available for construction of new structures without demolition of existing structures. This study therefore assumes that no significant changes will occur to the structure inventories or other assets on which damage categories are based, and that future conditions will be the same as present conditions for the purposes of calculating damages or costs.

In order to estimate flood damages to structures and their contents, it was necessary to identify the following information for each structure in the floodplain:

- The location or river station of each structure along the length of the stream;
- The first floor elevation of each structure;
- The depreciated replacement value of each structure;
- Depth-damage relationships for each type of structure that describe the effect of flooding at various depths on the structure and its contents.

The river station of each structure was calculated using a GIS map showing the location of structures and the floodplain cross sections with their associated river stations. The GIS measurement tool was used to interpolate the approximate river station for each structure using the river stations assigned to the nearest upstream and downstream cross sections.

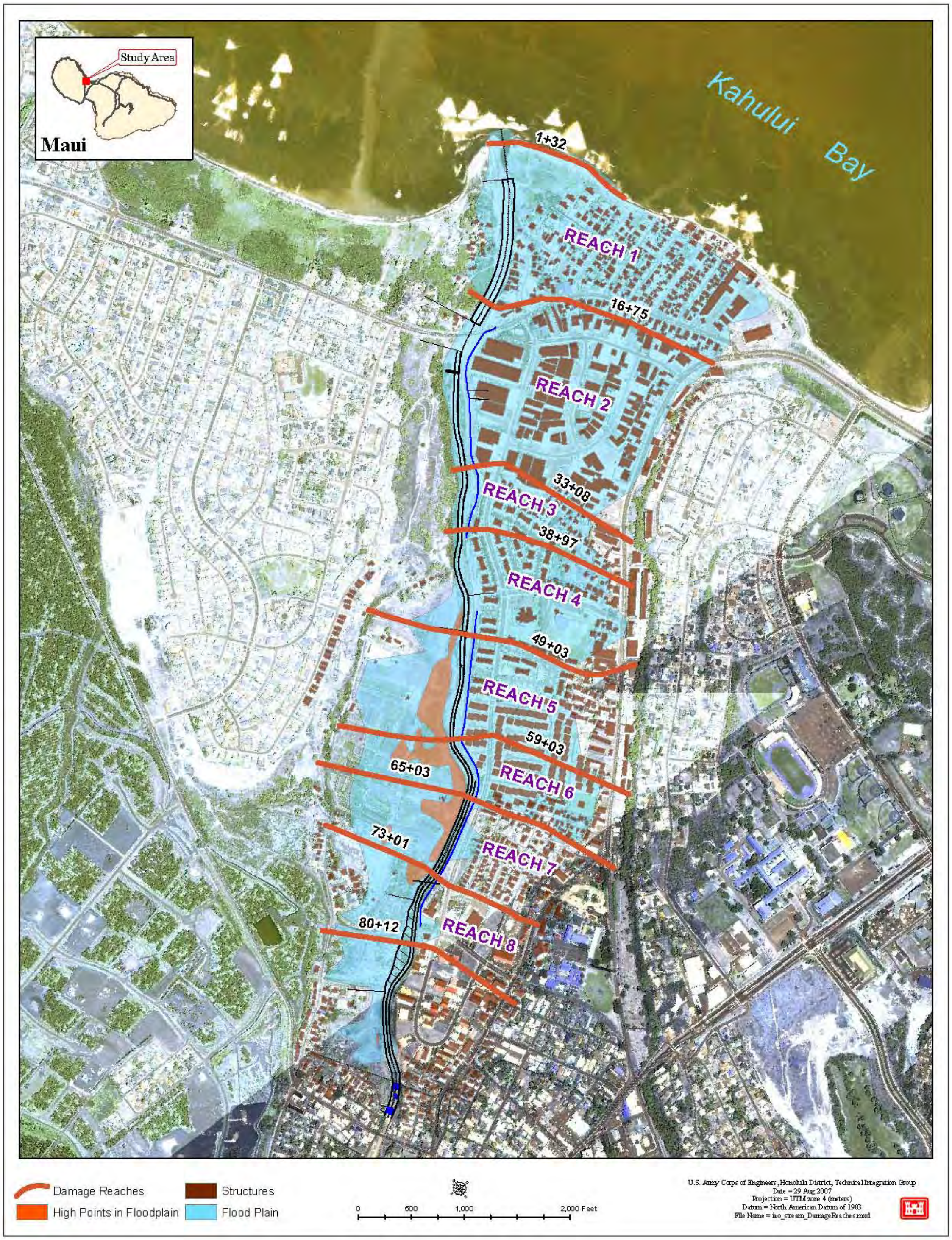


Figure 1. Damage Reaches.

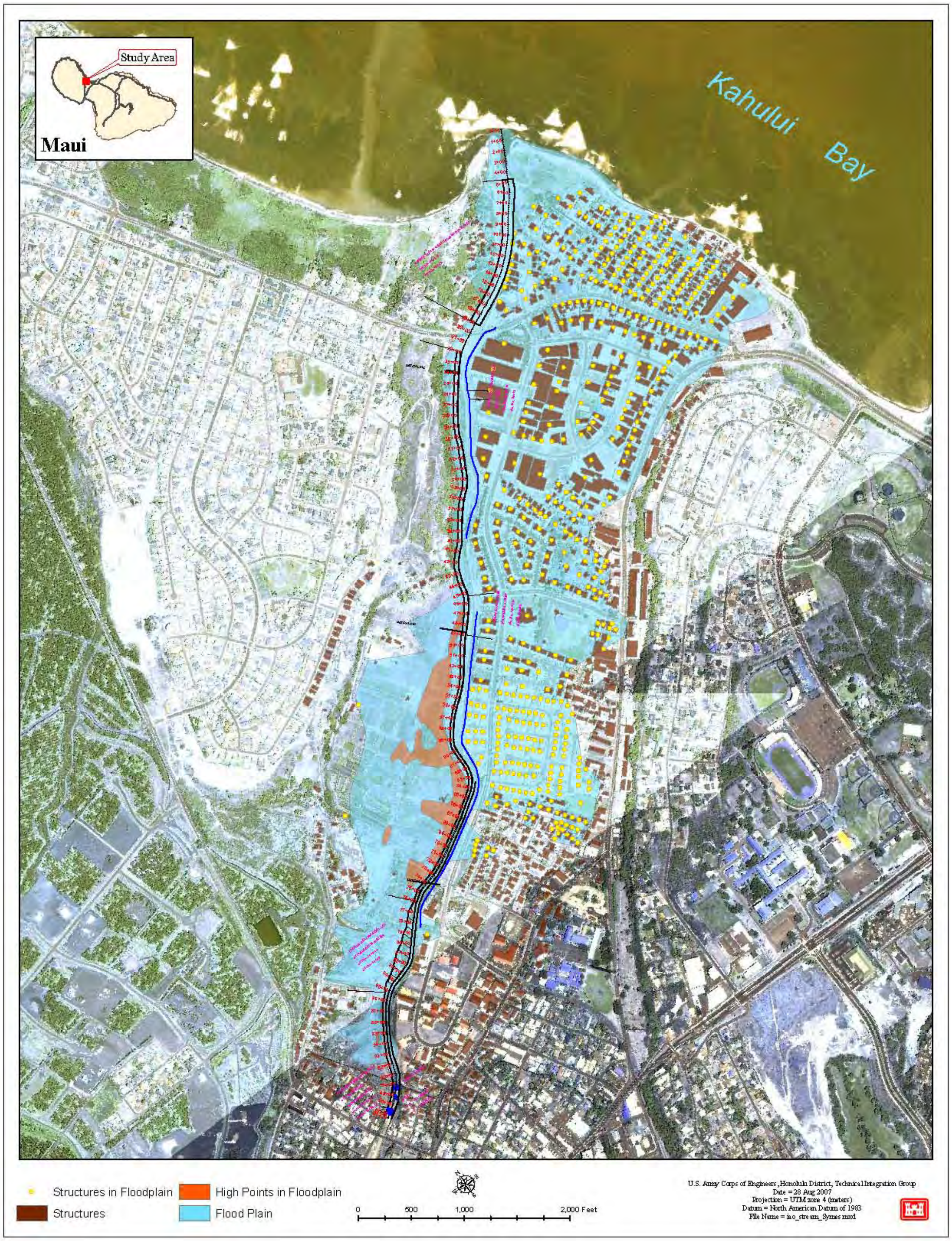


Figure 2. Location of structures in the Standard Project Flood (222-year) Floodplain.

Where appropriate, structure data gathered for the 1995 study was used for structures in existence at that time. For example, first floor elevation data gathered for the 1995 study was used in this analysis. Ground elevation of new structures not in place during the 1995 study was estimated using aerial contour maps. Height of first floor above ground for new structures was determined during a site visit in January 2004.

Structure values are based on 2008 property tax assessed values. According to "Procedural Guidelines for Estimating Residential and Business Structure Value for Use in Flood Damage Estimations (IWR 95-R-9, April 1995, page 43)," tax assessment data can be used as a proxy for depreciated replacement value when the assessment (1) has been performed recently, (2) gives consideration to effective age, remaining life, etc., (3) assesses land and improvements separately, and (4) when the economic depreciation is negligible. Telephone discussions in 2004 with Mr. Scott Teruya of the Maui County Real Property Tax Division confirmed that Maui tax assessments meet these conditions[1].

5.1 Single Family Residential Structure Values. In order to test the validity of using tax assessment values for SFRs in the Iao Stream floodplain, depreciated replacement values (DRVs) of a random sample of 38 properties were calculated using Marshall and Swift Residential Estimator (RE7) software. The following details of each property were obtained from property tax databases downloaded from the County of Maui web site[2]:

Year built
Living area (square feet)
Number of stories
Framing (Masonry, Double Wall, Wood/Single Wall, etc.)
Foundation Type (Concrete, Wood Piers, Hollow Tile)
Exterior Siding or Finish
Roof Material
Installed Air Conditioning
Number of Plumbing Fixtures

In order to calculate DRVs, RE7 also requires estimates of the quality and condition of each structure, and its effective age. Based on site visits, construction quality was assumed to be "fair" for older single-wall wooden homes, "average" for double-wall and masonry homes constructed more than 20 years ago, and "good" for homes less than 20 years. With the exception of homes built within the last 10 years, the condition was assumed to be average. All homes built less than 10 years ago are located along Iao Loop and adjacent streets, and appear to be in very good condition. Effective age was estimated using Tables 7, 8, and 9 from IWR 95-R-9 based on building age, framing type, quality and condition.

---

[1] See exception noted below for multi-unit condominium structures.
[2] http://webmail.co.maui.hi.us/com/webload/Extracts.htm as of 6/24/07.

For the 37 structures in the sample the standard deviation of the percent difference between tax assessment values and DRVs calculated using RE7 was 11.5%, which was used as the uncertainty value for SFR structure value in HEC-FDA.

Based on the methodology described above, the total depreciated replacement value (DRV) of single-family residence structures in the SPF floodplain is about $56,680,200, and the total value of contents of single-family residences is about $22,672,080. The average DRV of individual single-family residential structures is about $157,000 and the average value of contents per structure is about $63,000. Table 4 presents the number of single-family residential structures and total DRV and contents value for each reach, as well as average DRV and contents value for structures within each reach.

Table 4. Single Family Residences – Count and Values by Reach

	Single-Family Residential Structures (no.)	**Depreciated Replacement Value ($)**	**Average Depreciated Replacement Value ($)**	**Contents Value ($)**	**Average Contents Value ($)**
Reach 1	155	21,953,800	141,637	8,781,520	56,655
Reach 2	8	1,114,300	139,288	445,720	55,715
Reach 3	32	2,796,700	87,397	1,118,680	34,959
Reach 4	19	1,916,100	100,847	766,440	40,339
Reach 5	69	14,792,500	214,384	5,917,000	85,754
Reach 6	75	13,257,900	176,772	5,303,160	70,709
Reach 7	3	463,300	154,433	185,320	61,773
Reach 8	1	385,600	385,600	154,240	154,240
Total/ Average	**362**	56,680,200	156,575	22,672,080	62,630

5.2 Multi-Unit Residential Structure Values. Forty-five of the newer structures in SPF floodplain are two-story multi-unit structures with eight or twelve condominium units each. These structures were built between 1993 and 2002 and are two-story, wood frame structures with plywood sheathing. The average living space per structure is 8045 square feet. Using this data, the new replacement cost per square foot was calculated as $154.77 in October 2007 dollars using Marshall and Swift Commercial Estimator software (CE7). Tax assessment data was not used because the Maui County Real Property Tax Division does not attempt to accurately parse the overall assessed value of condominiums between land and improvements, although they do report values in both these categories[3].

[3] Phone conversation between Douglas Symes, Regional Economist, Honolulu District, U.S. Army Corps of Engineers and Mr. Wes Yoshioka, Appraiser, Maui County Real Property Tax Division, 12:50pm, 7/27/2007.

These buildings have been well maintained, and properties on the Island of Maui have appreciated rapidly in recent years. Using Marshall and Swift's methodology, the effective age was calculated to be 3 years for structures built in 2002 and 8 years for structures built in 1993 through 1996. The equivalent depreciation is 1% and 3% respectively for structures of good construction quality with an expected life of 55 years, which indicates DRVs of $153.22 per square foot for structures built in 2002 and $150.13 per square foot for structures built between 1993 and 1996.

The value of these buildings also depends on the condition of the condominiums within each building. However, the condition of individual condominiums is unknown. In order to estimate the uncertainty of the DRVs for these structures, the effective age was allowed to randomly vary between zero (indicating all newly remodeled units) and 14 years (the actual age of a structure built in 1993). This is equivalent to depreciation between 0% and 7%. The standard deviation of the difference between DRVs using Marshall and Swift's methodology and the alternative methodology of randomly varying depreciation between zero and 7% was 2.12%, based on thirty iterations using the Excel software (formula =rand()*.07) for the amount of depreciation applied to each structure in the alternative method.

The total DRV of multi-unit residential structures in the SPF floodplain is about $54,451,845, with an average DRV of about $1,210,041 and average contents of about $447,715. Table 5 presents the number of multi-unit residential structures and total DRV and contents values for each reach as well as average DRV and average contents value for structures within each reach.

Table 5. Multi-Unit Residential Structures – Count and Values by Reach

	Multi-unit Residential Structures (no.)	**Depreciated Replacement Value ($)**	**Average Depreciated Replacement Value ($)**	**Contents Value ($)**	**Average Contents Value ($)**
Reach 1	0	0	0	0	0
Reach 2	0	0	0	0	0
Reach 3	9	9,755,696	1,083,966	3,609,608	401,068
Reach 4	23	27,187,081	1,182,047	10,059,220	437,357
Reach 5	13	17,509,068	1,346,851	6,478,355	498,335
Reach 6	0	0	0	0	0
Reach 7	0	0	0	0	0
Reach 8	0	0	0	0	0
Average			1,210,041		447,715
Total	**45**	54,451,845		20,147,183	

5.3 Commercial Structure Values. The 222-year flood plain contains 103 tax parcels with one or more commercial structures. Commercial structures were assigned to the categories of depth-damage function developed by the New Orleans District of the

U.S. Army Corps of Engineers (MVN), as listed in Table 6 below. Where multiple structures existed on one tax parcel, the predominate usage was assigned to all structures on the parcel. Structure and first floor elevation data gathered for the 1995 study was used for structures in existence at that time. New structures were added to the inventory during a site visit in January 2004.

Table 6. Occupancy Types

Occupancy Type	HEC/FDA Name
Eating and recreation	EAT
Grocery and gas stations	GROC
Professional businesses	PROF
Public and semi-public	PUBL
Repairs and home use	REPA
Retail and personal services	RETA
Warehouse/contractor services	WARE

As with SFRs, 2008 property tax data was used to estimate the depreciated replacement values of commercial structures on each tax parcel. Table 7 presents the number of tax parcels per reach with commercial structures, the total and average depreciated replacement costs of structures per parcel within each reach, and the total and average value of contents. The total DRV of commercial structures in the 222-year floodplain was calculated to be about $84 million, and the total value of commercial contents was estimated to be about $120 million.

Table 7. Commercial Structures and Contents by Reach

	Tax Parcels with Commercial Structures (no.)	Depreciated Replacement Value of Structures By Reach ($)	Average Depreciated Replacement Value of Structures per Parcel ($)	Contents Value By Reach ($)	Average Contents Value per Parcel ($)
Reach 1	17	10,066,600	592,153	14,116,410	830,377
Reach 2	77	64,894,500	842,786	93,377,905	1,212,700
Reach 3	4	5,459,500	1,364,875	9,117,308	2,279,327
Reach 4	4	3,230,400	807,600	4,287,993	1,071,998
Reach 5	0	0	0	0	
Reach 6	1	1,300	1,300	1,482	1,482
Reach 7	0	0	0	0	
Reach 8	0	0	0	0	
Average			812,158		1,173,797
Total	103	83,652,300		120,901,098	

In order to estimate the uncertainty of the using tax assessment data for commercial structures, a random sample of twenty tax parcels was evaluated using CE7 and the resulting DRVs were compared with the tax assessments of buildings on each parcel. The standard deviation of the percent difference between these paired values was 20.08%.

6. Depth-Damage Functions for Structures and Contents.

6.1 Residential Depth-Damage Functions. The effects of flooding on the structures in the various reaches were estimated using depth-damage relationships. These depth-damage "curves" relate the depth of flooding to the damage likely to be caused to the structure and its contents, expressed as a percentage of the structure value. The curves used in this study for SFRs are from the Economic Guidance Memorandum 04-01, "Generic Depth-Damage Relationships for Residential Structures with Basements (Institute for Water Resources (IWR), 2004)". They are based on data from approximately one thousand homes flooded between 1996 and 1998 in major flooding events in different parts of the country. Structure and contents damage curves for one-story residences without basements were used for the majority of residential structures in this study. Different curves are provided for two-or-more-story residences and split-level residences.

The generic depth damage curves supplied by IWR include depth-damage relationships for residential contents. These curves provide mean values for the contents damaged as a percent of structure value, and the associated standard deviations for the three types of single family residential structures that were used in this study.

Because the multi-unit residential structures in the Iao Stream floodplain are similar in structure to large two story residential homes (although somewhat larger), the IWR depth damage curves for SFR structures with two or more stories without basements were used to estimate structure and content damages.

6.2 Depth Damage Functions for Commercial Structures and Contents. Depth damage functions for commercial structures and contents developed for the New Orleans District of the Corps of Engineers were used to evaluate damages to commercial structures and contents[4].

7.0 Inundation Damage to Residential and Commercial Structures and Contents. HEC-FDA software was used to evaluate structure and content damages to residential and commercial structures. Average annual damages by reach to residential structures and contents are presented in Table 8. In the without-project condition, the total expected annual structure and content damage is about $923,000. If Alternative 3 is constructed, total expected annual damages are about $4,000. Total Damages prevented for

---

[4] GEC, "Depth-Damage Relationships for Structures, Contents, and Vehicles and Content-to-Structure Value Ratios (CSVRs) in Support of the Jefferson and Orleans Flood Control Feasibility Studies," Baton Rouge, Louisiana, June 1996.

residential structures and contents are the difference between without-project and with-project expected annual damages, or about $919,000.

Table 8. Inundation Damage to Residential Structures and Contents.

	Without-Project Damages ($)	With-Project Damages (Alternative 3) ($)	Damages Prevented ($)
Reach 1	218,640	3,500	215,140
Reach 2	30,810	0	30,810
Reach 3	14,150	0	14,150
Reach 4	118,120	0	118,120
Reach 5	233,060	10	233,050
Reach 6	304,730	750	303,980
Reach 7	160	10	150
Reach 8	3,120	0	3,120
Total	922,790	4,270	918,520
Rounded	**923,000**	**4,000**	**919,000**

Damages by reach to commercial structures and contents are presented in Table 9. In the without-project condition, the total expected annual structure and content damage is about $1,438,000. If Alternative 3 is constructed, total expected annual damages are $2,000. The benefits are the difference between without-project and with-project expected annual damages, or about 1,436,000.

Table 9. Inundation Damage to Commercial Structures and Contents.

	Without-Project Damages ($)	With-Project Damages (Alternative 3) ($)	Damages Prevented ($)
Reach 1	133,110	1,780	131,330
Reach 2	1,250,000	0	1,250,000
Reach 3	0	0	0
Reach 4	54,680	0	54,680
Reach 5	0	0	0
Reach 6	0	0	0
Reach 7	0	0	0
Reach 8	0	0	0
Total	1,437,790	1,780	1,436,010
Rounded	**1,438,000**	**2,000**	**1,436,000**

8. Damages to Motor Vehicles. In addition to structural and content damages to residential and commercial structures, flooding also causes damages to motor vehicles. In order to estimate the damages to a vehicle in the flood plain, the analyst must know four things: the parked elevation of the vehicle, the height of floodwaters at the vehicle's location, the value of the vehicle, and the appropriate depth-damage curve to describe the percent of vehicle damage likely to be caused by flooding. To aggregate vehicle damages over the flood plain, the number of vehicles at each location must also be estimated.

8.1 Vehicle Elevation. The parking elevation for vehicles associated with residential structures was measured with a hand level relative to the first floor elevation for the 48% of residential structures surveyed. For the remaining 52% of structures, the first floor elevations were known with a maximum standard deviation of 0.102 feet, so parking elevations were estimated by subtracting the average difference between structure first floor elevations and parking elevations for the surveyed structures in the same reach. The standard error of these estimated elevations was calculated for each reach as the square root of the sum of (1) the variance associated with the techniques used to measure the parking elevations which were directly measured, (2) the variance of the difference between first floor elevations and measured parking elevations in the reach, and (3) the variance associated with measurement of first floor elevations using an automatic level.

8.2 Height of Floodwaters at Vehicle Location. The HEC-FDA program calculates flooding depth by comparing the elevation of a structure (in this case, a motor vehicle) with the height of floodwater for a given frequency event at the location along the stream station where the structure is located. In this analysis, vehicles associated with a particular building were assigned the same location as the building. Because only residential vehicles are considered in this damage category, and the majority of homes have parking either in an attached garage or carport, the assumption is a reasonable one. Elevation of parked cars associated with residential structures is assumed to be the same as the first floor elevation of the associated structure. Since carports, garages, and street parking all tend to be at a lower elevation than the first floor of the typical residence, this assumption is conservative and may tend to understate damage to vehicles.

8.3 Vehicle Depth-Damage Function. This analysis uses depth damage curves and associated probability distribution functions[5] developed by the New Orleans District of the U.S. Army Corps of Engineers (MVN) to estimate the effects of flooding on parked cars. A panel of experts with experience dealing with flood damaged vehicles, in this case two car-dealership operators, was asked to estimate vehicle values and percent damage at various flooding depths for new or nearly new compact, mid-sized, and full-sized cars. The six resulting damage estimates was averaged for flood levels between 0.5 feet and 3 feet to give the depth-damage relationship described in Table 10:

---

[5] GCE, Inc., "Depth-Damage Relationships for Structures, Contents, and Vehicles and Content-to-Structure Value Ratios (CSRVs) in Support of the Jefferson and Orleans Flood Control Feasibility Studies," Baton Rouge, Louisiana, June 1996.

Table 10. MVN Vehicle Depth Damage Function.

Flood Level (feet above road surface)	Damage (Percent of Value)
0.5	2.3%
1.0	22.8%
1.5	54.2%
2.0	95.8%
3.0	100%

This analysis assumes that the MVN depth-damage relationships identified above are representative of the effects of flooding on vehicles in the Iao Stream floodplain. A discussion of the uncertainty of these estimates is provided in Section 16.2.3.

8.4 Number of Vehicles at Residential Locations. According to data from the 2000 Census, there are about 1.6 vehicles per occupied housing unit in Census Tract 309.02, which is largely the same as the study area. However, since people drive to work, shop, take children to school, and perform many other driving activities which take them away from home, the average number of vehicles likely to be at the typical housing unit at any given time will be less that the average number of vehicles owned by household residents. About 41% of the residents of the study area are aged 16 or older, employed, do not work at home, and travel to work by car or other private vehicle. However, because about 19% of these workers carpool with one or more other commuters, each worker commuting by car represents 0.90 vehicles. Applying these proportions to the average household of 2.83 persons in the Iao Stream study area, the average number of vehicles per household used for commuting equals:

2.83 persons per household x 41% commuting x 0.90 carpooling factor = 1.04 vehicles per household used to commute to work.

Also according to the 2000 Census, the average time spent traveling to work is about half an hour. Assuming that, on average, workers will work eight hours per day, five days per week, and will take an extra hour shopping or completing other errands as part of their daily commute, each vehicle used to commute to work will be away from its home parking location in the Iao Stream study area 50 hours per week or about 30% of the time.

Because households use automobiles for many other activities besides commuting to work, this analysis makes a simplifying assumption in the absence of data that all vehicles in the study area are away from their home parking locations about 66 hours per week, or about 40% of the time. Therefore the average number of vehicles that will be parked at a residence at any given time is:

1.6 vehicles per occupied household x ((1 – 40 % time away from home) = 0.96 vehicles, or about one vehicle per household at any given time.

8.5 Estimating the Average Value of Vehicles. The average price of all used vehicles sold in the U.S. is reported in the 2006 Used Car Market Report (UCMR) by Manheim Auctions. The UCMR reports that the average price of used vehicles in 2005 was $8,315, and the average price of new vehicles was $24,275. Updating these values to FY 2008 using CPI-U for used and new vehicles respectively gives average prices of $8,324 for used vehicles and $24,192 for new vehicles at a 2008 price level.

According to the Bureau of Transportation Statistics, U.S. households owned a total of 247 million motor vehicles in 2005. Of these, the 2006 UCMR reports that 17 million or about 6.9% were purchased new in 2005.

This analysis assumes that (1) vehicles in the Iao Stream floodplain have the same distribution of value as vehicles in the U.S. as a whole, (2) the average value of used vehicles owned by U.S. households is equal to the average price of used vehicles reported by Manheim, and (3) that at any given time, the average value of the new vehicles purchased during the preceding 12 months is 90% of the average 2005 price of new vehicles reported by Manheim. Taking the weighted average of the value of used vehicles and vehicles purchased new during the preceding 12 months gives an average value for all vehicles of ($8,324 x 93.1%) + ($24,192 x 90% x 6.9%) = $9,251, or about $9,300.

Using the estimated one vehicle per household present at any given time, the average value of vehicles present at each single family residential structure or individual condominium is $9,251 or about $9,300.

8.6 Number of Vehicles at Commercial Locations. Vehicles at commercial establishments were not included in this analysis. Although it is likely that some vehicles parked at commercial establishments will also be damaged during a flooding event, it is not possible to estimate the number of vehicles parked at commercial establishments without additional field surveys, which are beyond the resources available for this project. Estimates of vehicle damages may therefore be considered conservative.

8.7 Inundation Damage to Vehicles. Vehicle damages under the without-project and with-project conditions and damages prevented were evaluated with the HEC-FDA computer program and are presented in Table 11.

Table 11. Inundation Damage to Vehicles.

	Without-Project Damages ($)	With-Project Damages (Alternative 3) ($)	Damages Prevented ($)
Reach 1	21,710	380	21,330
Reach 2	2,720	0	2,720
Reach 3	2,090	0	2,090
Reach 4	21,360	0	21,360
Reach 5	19,960	0	19,960
Reach 6	20,330	600	19,730
Reach 7	10	0	10
Reach 8	130	0	130
Total	88,310	980	87,330
Rounded	**88,000**	**1,000**	**87,000**

9.0 Yard and Outside Property Damage for Residences. Besides damages to automobiles, structures, and contents, the residents of the Iao Stream area will also suffer damages to their yards and other outside property after a major flooding event. This is especially true for those yards inundated by mud as well as water. A Corps survey of residents in Niu Valley on the Island of Oahu soon after the 1988 New Year's Eve flood revealed that out of a total of 171 homes in the flood plain, 149 of them suffered yard damages. Owners of 144 homes (97 percent) reported mud in their yards. A more recent survey asked Niu Valley homeowners about the cost, in both dollars and time spent, involved in rehabilitating their yards and other outside property. Responses put the average expenditures to repair damages at about $4,040 at an October 1987 price level. The length of time spent repairing yards and other property averaged 110 hours.

Because without-project flooding along Iao Stream is only expected in a 25-year or larger event which will also involve levee failure, residents may experience damage to yards and outside property similar to that experienced by residents of Niu Valley. Consequently, the average cost and time spent to repair yards and other property from Niu Valley are used in this analysis.

Damages to yards were determined by comparing flood heights with first floor elevations using the HEC-FDA software. The Niu Valley survey taken right after the 8 1988 flood indicated that mud was deposited on yards with flood waters as low as four inches. It is assumed that this phenomenon will also occur in the Iao Stream floodplain during the various events, and that lots which experience flooding over the first floor structure elevation will also sustain damages to their yards and other outside property.

The total cost for repairing flood damage is the monetary expenditure plus the value of time spent by the resident. The average monetary expenditure by homeowners in Niu

Valley who suffered damage to their yards was $4,040 at an October 1987 price level. The average time spent on clean up and repair was 110 hours. Landscaping and grounds-keeping workers in Hawaii made about $13.68 per hour as of May 2007[6]. Using this hourly rate, 110 hours spent in yard clean up and repair amount to 110 hours x $12.51 per hour = $1,505. Before these two expenditure figures can be summed, they must be adjusted to a common price level using the Honolulu Consumer Price Index. Using the 90.9% increase in Honolulu CPI-U between the second half of 1987 and the second half of 2007, the $4,040 average costs for repairing yard damages was updated to $4,040 x 1.909 = $7,712 at approximately the October 2007 price level. The total expenditure per lot is then $7,712 + $1,505 = $9,217, or about $9,200.

Although only the mean value of yard damage which occurred in the 1988 Niu Valley flood is know, it seems likely that damages varied considerably from one yard to another. In the absence of data, this analysis assumes that the uncertainty of damages may be characterized by a symmetrical triangular distribution with a most likely value equal to the updated average damages from the Niu Valley flood, a minimum value of zero, and a maximum value equal to 200% of the average damages.

Without-project and with-project yard and outside property damages for each reach were calculated by the HEC-FDA program, and are presented in Table 12. Total without-project average annual damage to yards and outside property is $72,630, or about $73,000 and with-project damage is $360, or about $0 (rounded) with the project in place. Benefits, or the reduction in damages and cleanup costs, are about $72,000.

Table 12. Yards and Outside Property Damage.

	Without-Project DamagesDamages ($)	**With-Project Damages (Alternative 3) ($)**	**Damages Prevented ($)**
Reach 1	25,310	310	25,000
Reach 2	2,480	0	2,480
Reach 3	2,620	0	2,620
Reach 4	7,980	0	7,980
Reach 5	15,660	0	15,660
Reach 6	18,400	50	18,350
Reach 7	30	0	30
Reach 8	150	0	150
Total	72,630	360	72,270
Rounded	**73,000**	**0**	**72,000**

[6] Bureau of Labor Statistics, http://www.bls.gov/oes/current/oes_1500001.htm#b37-0000, as of 8/13/08.

10. Emergency Costs. In the event of flooding, some residents of the Iao Stream floodplain may require emergency assistance, during or after the event. There is no emergency assistance data for previous flooding events at Iao Stream, so the emergency costs for the 1988 New Year's flood in Niu Valley on the Island of Oahu have been generalized to Iao Stream for this study.

Emergency assistance to the residents of Niu Valley included Red Cross assistance, Federal Emergency Management Administration grants, and Armed Forces and church group donations of their manpower and supplies. These costs totaled $264,000 for the relief effort in 1988.

To determine the cost per structure using this figure, it was necessary to estimate the number of Niu Valley homes flooded in the 1988 storm. According to the records collected after the flood, 108 homes in Niu Valley had water over the first floor. Dividing the total cost of these emergency relief services by the estimated number of homes with water over the first floor gives an average per structure emergency assistance cost of about $2,400 at an October 1987 price level. This figure was updated to about $4,600 at approximately an October 2007 price level, using the Honolulu Consumer Price Index[7].

This analysis assumes that residents in the Iao Stream floodplain whose homes are inundated by flood waters above the first floor level will, on average, require $4,400 emergency assistance. A depth damage function for the HEC-FDA program was developed which assigned zero damages to a flooding depth of zero inches above the first floor elevation and $4,600 to any flooding depth one inch or more above the first floor elevation. The uncertainty of first floor elevations is the same as described above for residential structure first floor elevations.

Although no data was available for this analysis with respect to the variability of emergency costs which occurred in the 1988 Niu Valley flood, it seems likely that emergency costs varied considerably. In the absence of data, this analysis assumes that the uncertainty of damages may be characterized by a symmetrical triangular distribution with a most likely value equal to the updated average damages from the Niu Valley flood, a minimum value of zero, and a maximum value equal to 200% of the average damages.

The expected annual emergency costs under without-project and with-project conditions were calculated by the HEC-FDA model as described earlier and are listed in Table 13 below by damage reach. Total average annual without-project emergency costs are about $38,000, and total with-project emergency costs are $170, or about $0 when rounded. The difference between these, the total average annual benefits, are about $38,000.

[7] CPI/U-HON (1987/second half) = 116.5; CPI/U-HON (2007/second half) = 222.39.

Table 13. Emergency Costs.

	Without-Project Costs ($)	With-Project Costs (Alternative 3) ($)	Costs Prevented ($)
Reach 1	13,410	150	13,260
Reach 2	1,260	0	1,260
Reach 3	1,390	0	1,390
Reach 4	4,080	0	4,080
Reach 5	8,200	0	8,200
Reach 6	9,430	20	9,410
Reach 7	10	0	20
Reach 8	80	0	80
Total	37,860	180	37,680
Rounded	**38,000**	**0**	**38,000**

11. Flood Insurance Operating Costs. A reduction in the operating cost of the National Flood Insurance Program (NFIP) can be claimed as a benefit for certain flood control projects. Benefits are attributed to those projects that have at least a 90 percent chance of containing the 100-year event. This will reduce the number of homes requiring insurance policies for flood damages and hence the operating costs necessary to process those policies. According to Economic Guidance Memorandum 06-04, the (latest guidance on flood insurance operating costs), the NFIP's average operating costs per policy was $192 for FY2006.

Every time the HEC-FDA program computes stage damage relationships, it writes an output file that can be used to identify structures which are flooded at or above the first floor level. In the without-project condition the output file indicates that 200 homes would be flooded above the first floor by a 100-year event, while in the with-project condition tyhere are no residential damages in any reach for a 100-year event. The reduction in flooding therefore affects 200 residential structures. However, typically only about 49% of homes in a 100 year flood plain carry a flood insurance policy[8], implying

[8] Dixon, Lloyd et al, "The National Flood Insurance Program's Market Penetration Rate: Estimates and Policy Implications," Rand Corporation, Santa Monica, CA 2006: 14-20. The 95% confidence interval of the 49% estimate of nationwide market penetration is 42% to 56%, which implies that the Standard deviation is about 3.5% (one quarter the range of the 95% confidence interval).

According to the 2000 Census, about 55% of the housing units in census districts 3.01 and 3.02 of Honolulu County have mortgages or other secured loans (Table HCT72. MORTGAGE STATUS, Census 2000 Summary File 4 (SF 4) - Sample Data). This analysis therefore assumes that 55% of the houses in the floodplain are mortgaged and subject to mandatory purchase of flood insurance, enforced by the lender.

A study released by the U.S. Federal Emergency Management Agency (FEMA) in 2000 found an overall compliance rate of 90 percent for mandatory flood insurance, based on a sample with a disproportionate number of coastal communities. (FEMA, Office of the Inspector General, "Opportunities to Enhance Compliance with Homeowner Flood Insurance Purchase Requirements," Washington DC, 2000).

that the number of policies held by homeowners in the Iao Stream floodplain is about 200 structures x 49% = 98 flood insurance policies.

The annual without-project NFIP operating costs are therefore 200 structures x 49% x $192 per policy = $18,816, or about $19,000. With-project NFIP costs are zero. Benefits, or the savings in with-project National Flood Insurance Program operating cost are therefore about $19,000.

12. **Benefits Summary**. Table 14 summarizes the without-project and Alternative 3 with- project damage and the resulting benefits. Total without-project damages are about $2,579,000. With-project damages are about $7,000. The total benefit for these damage categories is about $2,572,000. As noted earlier, Alternatives 1 through 4 are assumed to have identical benefits.

Table 14. Benefit Summary.

	Without Project Damages/Costs ($)	With Project Damages/Costs ($)	Benefits (Damages or Costs Prevented) ($)
Residential structures and contents	923,000	4,000	919,000
Commercial structures and contents	1,438,000	2,000	1,436,000
Vehicles	88,000	1,000	87,000
Yard and Outside Property Damage	73,000	0	73,000
Emergency Assistance Costs	38,000	0	38,000
Flood Insurance Operating Costs	19,000	0	19,000
Total	2,579,000	7,000	2,572,000

13. **Project Costs.** Table 15 lists the various costs involved in constructing and maintaining the improvements to the Iao Flood Control Project and changes in annual operating and maintenance costs associated with each alternative.

Combining this proportion with the 55% of housing units subject to mandatory flood insurance purchase gives a flood insurance coverage rate of 49.5%., which is very close to Lloyd et al above.

Table 15. Project Costs

	Alternatives		
	1	**2**	**3**
Project First Cost[1]	$40,641,882	$55,187,961	$30,809,128
Months of Construction	30	30	22
Interest During Construction (months, 4.875%, EOY)	$1,607,371	$2,208,762	$691,982
Investment Cost	$42,249,253	$57,396,723	$31,501,110
Amortized Investment Cost	$2,269,726	$3,083,483	$1,692,312
Difference in Annual O&M[2]	-$61,175	$0	$122,352
Total Average Annual Cost	$2,208,551	$3,083,483	$1,814,664
Total Average Annual Cost (Rounded)	$2,209,000	$3,083,000	$1,815,000

[1]Includes PED, S&A, EDC, and LERRD.
[2]The difference between without-project O&M of $152,939 per year and O&M for with-project alternatives.

The project first cost of each alternative includes the costs of all materials and services that will go into fixing the project. The interest during construction is based on the project first cost and is calculated using the prescribed discount rate of 4.875%, the estimated construction period, and end-of-year compounding. The investment cost is equal to the project first costs plus interest during construction. Investment cost is then amortized at the prescribed interest rate of 4.875% over the 50-year period of analysis. Annual operation and maintenance cost is then added to the amortized investment cost to get the total average annual cost of each alternative.

14. Benefit-Cost Ratios and Net Benefits. As noted in the Section 2 at the beginning of this economic update, two criteria are applied in order to choose the plan that reasonably maximizes NED benefits: the plan must have a benefit-to-cost ration greater than one, and must also have the greatest net benefits. Table 16 shows the average annual benefits, the average annual costs, the benefit-cost ratios and the net benefits of the three alternatives considered in the analysis (Alternative 4 was eliminated from consideration because itdoes not meet project objectives, and Alternative 5 was not analyzed because it is assumed to have a benefit/cost ratio of zero or less).

Table 16. Benefit-Cost Ratio and Net Benefits of Alternatives

	Alternatives		
	1	**2**	**3**
Average Annual Benefits	**2,572,000**	**2,572,000**	**2,572,000**
Average Annual Costs	$2,209,000	$3,083,000	$1,815,000
Benefit/Cost Ratio	1.2	0.8	1.4
Net Benefits (rounded)	$363,450	($511,480)	$757,340

15. National Economic Development (NED) Plan. According to the information in Table 16, Alternative 3 has a benefit-cost ratio greater than 1 and the highest net benefits. Therefore, the recommended plan is Alternative 3, with a benefit-cost ratio of 1.3.

16. Risk and Uncertainty. As noted above, the HEC-FDA software program explicitly takes into consideration the uncertainties related to the variables involved in calculating flood damages. The hydrologic, hydraulic, and economic data used in the flood damage analysis are not known with certainty. To take this into consideration, the probability distributions of the pertinent variables are input into the HEC-FDA program. The program applies Monte Carlo simulation techniques to sample from the quantified uncertainty in the applicable discharge-probability, stage-discharge, and stage-damage functions. By conducting a large number of iterations, the program computes expected values of damages while specifically accounting for the uncertainties in the underlying data. The expected average annual damages for each reach are then calculated using these figures.

16. 1 Structure, Vehicle, and Ground Elevations. First floor elevations were estimated using an aerial survey topographical map with five foot contours. According to “Risk-based Analysis for Flood-damage-reduction Studies” (EM 1110-2-1619, USACE, Washington, DC, August 1996), the standard deviation of the measurement error for such a map is 0.60 feet.

16.2 Depth-Damage Functions.

16.2.1 Residential Depth-Damage Functions. This analysis uses generic depth-damage functions with associated uncertainty parameters described in the U.S. Army Corps of Engineers Economic Guidance Memorandum (EGM) 04-01, “Generic Depth-Damage Relationships for Residential Structures with Basements.” The EGM also list depth-damage relationships for structures without basements, which were used in this analysis. Three types of structures without basements are described: one-story structures, two or more story structures, and split level structures. The standard deviation of measure error is listed for each level of flooding in the damage schedules.

16.2.2 Commercial Depth-Damage Functions. This analysis uses depth damage curves developed for the New Orleans District of the U.S. Army Corps of Engineers (MVN) to estimate the effects of flooding on commercial structures and contents. A panel of experts composed of one general contractor, one insurance adjuster, and one certified restorer was asked to estimate damages to three types of commercial structure construction at various flooding depths. Of the three types (metal frame walls, masonry walls, and wood or steel frame), the damage function for masonry walls under freshwater conditions were used in this study as best representing the commercial structures in the Iao Stream floodplain.

For each depth of flooding, the panel produced a maximum, minimum, and mean value of damage for the sample structure they were asked to evaluate. These values, expressed as a percent of structure value, were entered into the HEC-FDA program for each depth of flooding to produce a series of triangular distributions for structure damage. The MVN contractor also used a panel of experts to estimate depth-damage functions for commercial contents using similar methodology, with a triangular distribution of error based on minimum, mean, and maximum estimated of damage at different levels of flooding.

MVN's contractor interviewed nine managers and/or owners from each of eight different categories of commercial businesses concerning the value of commercial contents and the value of the structure in which the building was located. The value of the structures was also evaluated with Marshall and Swift software. The interviews were used to derive Content to Structure Value Ratios (VRCSVRs) for each category of business, as well as the variability of those CSVRs, expressed as standard deviations.

The reader is referred to the contractor's report for comprehensive explanations of methodologies used to derive commercial depth-damage functions for structures and contents, and associated risk and uncertainty values. Table 17 presents depth-damage functions with uncertainty parameters for all structure types, as used in the HEC-FDA model to evaluate Iao Stream.

16.2.3 Vehicle Depth-Damage Functions. This analysis uses depth damage curves[18] developed by a contractor for the New Orleans District of the U.S. Army Corps of Engineers (MVN) to estimate the effects of flooding on parked cars. A panel of experts with experience dealing with flood damaged vehicles, in this case two car-dealership operators, was asked to estimate vehicle values and percent damage at various flooding depths for new or nearly new compact, mid-sized, and full-sized cars. The six resulting damage estimates were averaged for flood levels between 0.5 feet and 3 feet, and the minimum and maximum estimates at each damage level were used as the minimum and maximum values of a triangular error distribution. Above 3 feet, all members of the panel estimated damage at 100%.

16.2.4 Yard and Outside Property Damage. Damages to yards were determined by comparing flood heights with ground elevations using the HEC-FDA software. The Niu Valley survey taken right after the 1987 flood indicates that mud was deposited on yards with flood waters as low as four inches. It is assumed that this phenomenon will also occur in the Iao Stream floodplain during the various events, and that lots which experience flooding of a foot over ground level or higher will also sustain damages to their yards and other outside property.

Although only the mean value of yard damage which occurred in the 1988 Niu Valley flood is known, it seems likely that damages varied considerably from one yard to another. In the absence of data, this analysis assumes that the uncertainty of damages may be characterized by a symmetrical triangular distribution with a most likely value equal to the updated average damages from the Niu Valley flood or about $9,200, a minimum value of zero, and a maximum value equal to 200% of the average damages.

16.2.5 Emergency Cost. This analysis assumes that residents of the Iao Stream floodplain whose homes are inundated by flood waters above the first floor level will, on average, require $4,600 of emergency assistance, based on similar flooding during the 1988 Niu Valley flood. A depth damage function for the HEC-FDA program was developed which assigned zero damages to a flooding depth of zero inches above the first floor elevation and $4,600 to any flooding depth over one inch above the first floor elevation. The uncertainty of first floor elevations is the same as described above for residential structure first floor elevations.

Although no data was available for this analysis with respect to the variability of emergency costs which occurred in the 1987 Niu Valley flood, it seems likely that emergency costs varied considerably. In the absence of data, this analysis assumes that the uncertainty of damages may be characterized by a symmetrical triangular distribution with a most likely value equal to the updated average damages from the Niu Valley flood or about $4,600, a minimum value of zero, and a maximum value equal to 200% of the average damages.

Table 17. Depth-damage functions from HEC-FDA model.

Occ_Name	Occ_Description	Cat_Name	Parameter	Start_Data																	
RETA	Retail and Personal Services	COM	Stage	-2	-1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
RETA			S	0	0	0.2	7.6	8.3	11.4	15	15.8	15.8	15.8	22.2	26.6	28.7	28.7	28.7	32.4	39.7	41.2
RETA			STL	0	0	0.1	5.7	6.2	8.6	12.8	13.4	13.4	13.4	18.9	22.6	24.4	27.3	27.3	30.1	37.7	39.1
RETA			STU	0	0	0.3	9.5	10.4	14.2	17.2	18.2	18.2	18.2	25.5	30.1	30.1	30.1	30.1	34	41.7	43.3
RETA			C	0	0	0	35.3	48.2	54.1	54.3	54.8	54.8	54.8	54.8	54.8	98.9	99.9	100	100	100	100
RETA			CTL	0	0	0	15.3	28.2	34.1	34.3	34.8	34.8	34.8	34.8	34.8	78.9	79.9	80	80	80	80
RETA			CTU	0	0	0	55.3	68.2	74.1	74.3	74.8	74.8	74.8	74.8	74.8	100	100	100	100	100	100
RETA			Struct	N		0.6		N		20.08		N	142	93.2			-901				
EAT	Eating and Recreation	COM	Stage	-2	-1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
EAT			S	0	0	0.2	7.6	8.3	11.4	15	15.8	15.8	15.8	22.2	26.6	28.7	28.7	28.7	32.4	39.7	41.2
EAT			STL	0	0	0.1	5.7	6.2	8.6	12.8	13.4	13.4	13.4	18.9	22.6	24.4	27.3	27.3	30.1	37.7	39.1
EAT			STU	0	0	0.3	9.5	10.4	14.2	17.2	18.2	18.2	18.2	25.5	30.1	30.1	30.1	30.1	34	41.7	43.3
EAT			C	0	0	0	27.5	60.8	81	88.6	89.5	92	92	97.8	97.8	97.8	97.8	97.8	97.8	97.8	97.8
EAT			CTL	0	0	0	17.5	50.8	71	78.6	79.5	82	82	87.8	87.8	87.8	87.8	87.8	87.8	87.8	87.8
EAT			CTU	0	0	0	37.5	70.8	91	98.6	99.5	100	100	100	100	100	100	100	100	100	100
EAT			Struct	N		0.6		N		20.08		N	114	48.2			-901				
GROC	Groceries and Gas Stations	COM	Stage	-2	-1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
GROC			S	0	0	0.2	7.6	8.3	11.4	15	15.8	15.8	15.8	22.2	26.6	28.7	28.7	28.7	32.4	39.7	41.2
GROC			STL	0	0	0.1	5.7	6.2	8.6	12.8	13.4	13.4	13.4	18.9	22.6	24.4	27.3	27.3	30.1	37.7	39.1
GROC			STU	0	0	0.3	9.5	10.4	14.2	17.2	18.2	18.2	18.2	25.5	30.1	30.1	30.1	30.1	34	41.7	43.3
GROC			C	0	0	0	33	73.6	81.4	84.8	87.6	96.3	96.3	98.3	98.3	98.3	98.3	98.3	98.3	98.3	98.3
GROC			CTL	0	0	0	28	68.6	76.4	79.8	82.6	91.3	91.3	93.3	93.3	93.3	93.3	93.3	93.3	93.3	93.3
GROC			CTU	0	0	0	38	78.6	86.4	89.8	92.6	100	100	100	100	100	100	100	100	100	100
GROC			Struct	N		0.6		N		20.08		N	127	48.2			-901				
WARE	Warehouses and Contractor Services	COM	Stage	-2	-1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
WARE			S	0	0	0.2	7.6	8.3	11.4	15	15.8	15.8	15.8	22.2	26.6	28.7	28.7	28.7	32.4	39.7	41.2
WARE			STL	0	0	0.1	5.7	6.2	8.6	12.8	13.4	13.4	13.4	18.9	22.6	24.4	27.3	27.3	30.1	37.7	39.1
WARE			STU	0	0	0.3	9.5	10.4	14.2	17.2	18.2	18.2	18.2	25.5	30.1	30.1	30.1	30.1	34	41.7	43.3
WARE			C	0	0	0	19.2	30.7	39.7	44.5	48.8	54.1	58.3	62.6	71.6	71.6	71.6	71.6	71.6	71.6	71.6
WARE			CTL	0	0	0	9.2	20.7	29.7	34.5	38.8	44.1	48.3	52.6	61.6	61.6	61.6	61.6	61.6	61.6	61.6
WARE			CTU	0	0	0	49.2	60.7	69.7	74.5	78.8	84.1	88.3	92.6	100	100	100	100	100	100	100
WARE			Struct	N		0.6		N		20.08		N	188	98.3			-901				
1ST-NB	1 story, no basement	RES	Stage	-2	-1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1ST-NB			S	0	2.5	13.4	23.3	32.1	40.1	47.1	53.2	58.6	63.2	67.2	70.5	73.2	75.4	77.2	78.5	79.5	80.2
1ST-NB			SN	0	2.7	2	1.6	1.6	1.8	1.9	2	2.1	2.2	2.3	2.4	2.7	3	3.3	3.7	4.1	4.5
1ST-NB			C	0	2.4	8.1	13.3	17.9	22	25.7	28.8	31.5	33.8	35.7	37.2	38.4	39.2	39.7	40	40	40
1ST-NB			CN	0	2.1	1.5	1.2	1.2	1.4	1.5	1.6	1.6	1.7	1.8	1.9	2.1	2.3	2.6	2.9	3.2	3.5
1ST-NB			Struct	N		0.6		N		11.53		N	100				-901				
AUTO		AUTO	Stage	0	0.5	1	1.5	2	3												
AUTO			S	0	2.3	22.8	54.2	95.8	100												
AUTO			STL	0	1.7	17.1	40.7	71.9	100												
AUTO			STU	0	2.9	28.5	67.8	100	100												
AUTO			Struct	N		0.6		T		22	260		0				-901				
2ST-NB	2 or more stories, no basement	RES	Stage	-2	-1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
2ST-NB			S	0	3	9.3	15.2	20.9	26.3	31.4	36.2	40.7	44.9	48.8	52.4	55.7	58.7	61.4	63.8	65.9	67.7
2ST-NB			SN	0	4.1	3.4	3	2.8	2.9	3.2	3.4	3.7	3.9	4	4.1	4.2	4.2	4.2	4.2	4.3	4.6
2ST-NB			C	0	1	5	8.7	12.2	15.5	18.5	21.3	23.9	26.3	28.4	30.3	32	33.4	34.7	35.6	36.4	36.9
2ST-NB			CN	0	3.5	2.9	2.6	2.5	2.5	2.7	3	3.2	3.3	3.4	3.5	3.5	3.5	3.5	3.5	3.6	3.8
2ST-NB			Struct	N		0.6		N		11.53		N	100				-901				
PROF	Professional Business	COM	Stage	-2	-1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
PROF			S	0	0	0.2	7.6	8.3	11.4	15	15.8	15.8	15.8	22.2	26.6	28.7	28.7	28.7	32.4	39.7	41.2
PROF			STL	0	0	0.1	5.7	6.2	8.6	12.8	13.4	13.4	13.4	18.9	22.6	24.4	27.3	27.3	30.1	37.7	39.1
PROF			STU	0	0	0.3	9.5	10.4	14.2	17.2	18.2	18.2	18.2	25.5	30.1	30.1	30.1	30.1	34	41.7	43.3
PROF			C	0	0	0	25.8	45.7	94.1	96.9	99.3	99.3	99.3	99.3	99.3	99.3	99.3	99.3	99.3	99.3	99.3
PROF			CTL	0	0	0	13.3	33.2	81.6	84.4	86.8	86.8	86.8	86.8	86.8	86.8	86.8	86.8	86.8	86.8	86.8
PROF			CTU	0	0	0	38.3	58.2	100	100	100	100	100	100	100	100	100	100	100	100	100
PROF			Struct	N		0.6		N		20.08		N	43	13.8			-901				
REPA	Repairs and Home Use	COM	Stage	-2	-1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
REPA			S	0	0	0.2	7.6	8.3	11.4	15	15.8	15.8	15.8	22.2	26.6	28.7	28.7	28.7	32.4	39.7	41.2
REPA			STL	0	0	0.1	5.7	6.2	8.6	12.8	13.4	13.4	13.4	18.9	22.6	24.4	27.3	27.3	30.1	37.7	39.1
REPA			STU	0	0	0.3	9.5	10.4	14.2	17.2	18.2	18.2	18.2	25.5	30.1	30.1	30.1	30.1	34	41.7	43.3
REPA			C	0	0	0	17	44.6	59.6	64.8	86	93.8	93.8	93.8	93.8	93.8	93.8	93.8	93.8	93.8	93.8
REPA			CTL	0	0	0	7	34.6	49.6	54.8	76	83.8	83.8	83.8	83.8	83.8	83.8	83.8	83.8	83.8	83.8
REPA			CTU	0	0	0	27	54.6	69.6	74.8	96	100	100	100	100	100	100	100	100	100	100
REPA			Struct	N		0.6		N		20.08		N	206	102			-901				
MULT	Apartments 5 units and over	RES	Stage	-2	-1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
MULT			S	0	0	0.2	7.6	8.3	11.4	15	15.8	15.8	15.8	22.2	26.6	28.7	28.7	28.7	32.4	39.7	41.2
MULT			STL	0	0	0.1	5.7	6.2	8.6	12.8	13.4	13.4	13.4	18.9	22.6	24.4	27.3	27.3	30.1	37.7	39.1
MULT			STU	0	0	0.3	9.5	10.4	14.2	17.2	18.2	18.2	18.2	25.5	30.1	30.1	30.1	30.1	34	41.7	43.3
MULT			C	0	0	0	19.8	37.8	42.6	45.6	50	50	50	50	50	50	69.8	87.8	92.6	95.6	100
MULT			CTL	0	0	0	14.8	32.8	37.6	40.6	45	45	45	45	45	45	64.8	82.8	87.6	90.6	95
MULT			CTU	0	0	0	24.8	42.8	47.6	50.6	100	100	100	100	100	100	100	100	100	100	100
MULT			Struct	N		1.1		N		20.08		N	37	14.3			-901				
PUBL	public properties	COM	Stage	-2	-1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
PUBL			S	0	0	0.2	7.6	8.3	11.4	15	15.8	15.8	15.8	22.2	26.6	28.7	28.7	28.7	32.4	39.7	41.2
PUBL			STL	0	0	0.1	5.7	6.2	8.6	12.8	13.4	13.4	13.4	18.9	22.6	24.4	27.3	27.3	30.1	37.7	39.1
PUBL			STU	0	0	0.3	9.5	10.4	14.2	17.2	18.2	18.2	18.2	25.5	30.1	30.1	30.1	30.1	34	41.7	43.3
PUBL			C	0	0	0	5.1	17.5	49.8	50.1	51.8	57.6	57.6	57.6	57.6	57.8	59.4	69.2	69.6	69.7	78.9
PUBL			CTL	0	0	0	0	5	37.3	37.6	39.3	45.1	45.1	45.1	45.1	45.3	46.9	56.7	57.1	57.2	66.4

PUBL			CTU	0	0	0	17.6	30	62.3	62.6	64.3	70.1	70.1	70.1	70.1	70.3	71.9	81.7	82.1	82.2	91.4
PUBL			Struct	N		0.6		N		20.08		N	114	71.5			-901				
CONDO	Same as 2ST_NB	RES	Stage	-2	-1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CONDO			S	0	3	9.3	15.2	20.9	26.3	31.4	36.2	40.7	44.9	48.8	52.4	55.7	58.7	61.4	63.8	65.9	67.7
CONDO			SN	0	4.1	3.4	3	2.8	2.9	3.2	3.4	3.7	3.9	4	4.1	4.2	4.2	4.2	4.2	4.3	4.6
CONDO			C	0	1	5	8.7	12.2	15.5	18.5	21.3	23.9	26.3	28.4	30.3	32	33.4	34.7	35.6	36.4	36.9
CONDO			CN	0	3.5	2.9	2.6	2.5	2.5	2.7	3	3.2	3.3	3.4	3.5	3.5	3.5	3.5	3.5	3.6	3.8
CONDO			Struct	N		0.6		N		21.2		N	100	19.3			-901				
RES-E	emergency services	RES_E	Stage	0	0.1	2	3														
RES-E			S	0	100	100	100														
RES-E			STL	0	0	0	0														
RES-E			STU	0	200	200	200														
RES-E			Struct	N		0.6							-901				-901				
RES-Y	yard damage	RES_Y	Stage	0	0.5	2	3														
RES-Y			S	0	100	100	100														
RES-Y			STL	0	0	0	0														
RES-Y			STU	0	200	200	200														
RES-Y			Struct	N		0.6							-901				-901				

Table 17 (continued)

17. Risk and Uncertainty Parameters for Frequency/Discharge and Stage/Discharge Functions in HEC-FDA. The frequency/discharge function was entered using the "Graphical from WSP" command with years of record set at 20 years.

For the without-project condition, the Stage discharge function was entered using the "Retrieve from WSP" command with normal distribution of uncertainty and standard deviation entered as zero for zero flow, 0.6 feet standard deviation of error for discharges from 25-year and greater events and 0.1 for discharges below 25-year events (based on WSPs). The uncertainty of discharges below 25-year events was set low because the levees are not expected to fail in these circumstances. As noted in section above, the without-project condition is a simplified analysis, with the assumption that levees will fail in an event with a 25-year or greater return period.

In section 2.1.5 of the main report, the design criteria for levee heights is described as the greater of the existing bank or levee heights or the 222-year with-project Water Surface Profile (WSP) plus 3.2 feet. The 3.2 feet is based on waves about 2 feet high plus two 0.6 foot standard deviations of measurement error. Ideally, the effect of waves would be analyzed using a separate wave analysis function. However, although HEC-FDA documentation describes a wave height analysis function that is accessed via the Levee Features screen, the function does not work. Consequently, POH engineers increased the standard deviation of the with-project Stage-Discharg function to 1.6 feet for all discharge values greater than zero to allow for the additional uncertainty of waves.

18. Project Performance – Exceedance Probability and Long Term Risk. For flood damage analysis of streams with levees, HEC-FDA calculates the probability that the elevation of water in the channel will exceed the height of the levee (or river bank) during different probability events for each reach. The program also calculates the cumulative long term risk that water will exceed these "target stages" over periods of ten, twenty-five, and fifty years.

Table 18 below presents the calculated target stage and three kinds of exceedance probabilities for each reach under Alternative 3: the median and expected probabilities that the target stage will be exceeded in any given year; the long term risk, i.e., cumulative probability, that the target stage will be exceeded over a ten, twenty-five, or fifty-year period, and the conditional probability that the target stage will be exceeded should various frequency events occur.

Table 18. Probability Exceedance and Long-Term Risk

Plan	Reach Name	Target Stage	Target Stage Annual Exceedance Probability		Long-Term Risk (years)			Conditional Non-Exceedance Probability by Events					
			Median	Expected	10	25	50	10%	4%	2%	1%	0.4%	0.2%
Alternative 3	Reach 1	levee	0.001	0.0000	0.0019	0.0046	0.0092	0.9999	0.9999	0.9996	0.9965	0.9811	0.9613
	Reach 2	levee	0.001	0.0010	0.0097	0.0242	0.0477	0.9999	1.0000	1.0000	0.9999	0.9991	0.9985
	Reach 3	levee	0.001	0.0010	0.0097	0.0242	0.0477	0.9999	0.9999	1.0000	0.9998	0.9991	0.9984
	Reach 4	levee	0.001	0.0010	0.0097	0.0242	0.0477	0.9999	0.9999	0.9999	0.9998	0.9991	0.9984
	Reach 5	levee	0.001	0.0010	0.0097	0.0242	0.0478	0.9998	0.9999	0.9999	0.9999	0.9991	0.9984
	Reach 6	levee	0.001	0.0000	0.0012	0.0030	0.0060	0.9999	0.9999	0.9999	0.9994	0.9932	0.9866
	Reach 7	levee	0.001	0.0000	0.0010	0.0025	0.0051	1.0000	1.0000	1.0000	0.9999	0.9982	0.9961
	Reach 8	levee	0.001	0.0000	0.0010	0.0024	0.0049	0.9999	1.0000	1.0000	1.0000	0.9992	0.9984

Appendix L:

Real Estate Planning Report

REAL ESTATE PLANNING REPORT

FOR

IAO STREAM
FLOOD CONTROL PROJECT MODIFICATION

ISLAND OF MAUI
STATE OF HAWAII

PREPARED BY
JIM V. DOING
NORTHWESTERN DIVISION
16 November 2007

TABLE OF CONTENTS

EXECUTIVE SUMMARY

Authorized under Section 203 of the Flood Control Act of 1968 (Public Law 90-483), construction of the original Iao Stream Flood Control Project, including a debris basin, levees, a channel, and stream realignment was completed in 1981. Flooding between 1981 and 1989 caused damage to the original construction. A reconnaissance Study for the Iao Stream Flood Control Project Modification was approved by HQ USACE in December 1995.

Iao Stream is approximately 16 miles long and is located in the State of Hawaii, on the northwestern portion of the Island of Maui, and in the County of Maui. The modification project is located in Wailuku Village at the lower end of the stream, downstream of North Market Street.

Iao Stream is not a navigable watercourse. Construction of this modification project is to prevent flooding, not induce it. There is no necessity for relocation of public utilities. No relocations under PL 91-646 are anticipated. There are no known surface or subsurface minerals that would affect the construction, operation and maintenance of this modification project. The non-Federal sponsor, Maui County, has been assessed as to its capabilities to acquire the necessary land, easements, right-of-way, relocations, and disposal (LERRD) interests and is considered fully capable of acquiring the necessary interests. Also, Maui County has been notified in writing of the risks of acquiring the LERRD before the execution of the Project Cooperation Agreement (PCA) and the Government's formal notice to proceed with the acquisition. Zoning is agricultural, residential, and industrial and there are no changes required for the project. Environmental Impacts are addressed in other sections of the Engineering Documentation Report. Landowner's attitudes indicated adversity to this project.

The modification project will require 4.78 acres of permanent channel improvement easements, 0.32 acre of perpetual joint use road easements, and 2.06 acres of temporary work area easements. The non-Federal sponsor has approved the Government's standard easement estates for the necessary easements. There are multiple owners involved. The baseline cost estimate for real estate includes $118,400 for the easements, a 30% contingency in the amount of $35,500 and $240,000 for administrative costs, totaling $394,000. A detailed schedule of all land acquisition milestones, approved by the Project Manager and the non-Federal sponsor, is also included in the report.

The information provided in this report meets the requirements of ER 405-1-12, Chapter 12, Section 12-16c.

1. AUTHORITY/PURPOSE

The initial Iao Stream Flood Control Project was authorized by the Flood Control Act of 1968 (PL 90-483). In compliance with Section 221 of the Flood Control Act of 1970, a local cooperation agreement was executed with the non-Federal sponsor, the County of Maui, on 23 May 1976. The construction of a debris basin, a channel, levees along the right bank, and stream realignment was completed in 1981.

Between 1981 and 1989 flood damage caused erosion that compromised channel stability and weakened portions of the existing levees. The Corps of Engineers conducted a Reconnaissance Study on modifying the existing flood control project. The study was approved by HQ USACE in December 1995.

This Real Estate Planning Report is for the proposed Iao Stream Flood Control Project Modification. This REPR will be included as a part of the Engineering Documentation Report.

2. DESCRIPTION

Iao Stream is located in the Village of Wailuku, Island of Maui, State of Hawaii. It is about 16 miles long and falls from an elevation of 5,788 feet to sea level. The subject modification area is located at the lower end of the stream, downstream of North Market Street to approximately the mouth. The right side of the stream is elevated above the flood way and is developed with industrial, residential and offices. The left side of the stream is flood way/flood plain and is mostly undeveloped. It is largely grown up in weeds and brush but with a few agricultural areas.

The proposed modification project will follow the existing alignment of the stream between stations 22+00 and 94+00 and will contain a 10 year flood within the structural improvements. The floodplain would remain on the left bank. The design is for a roller-compacted concrete and boulder invert channel with 60 to 80 foot bottoms. The channel lining and retaining wall will be raised because of the increased flow and higher flood levels.

The tracts required for the project modification perpetual channel improvement easements are as follows:

TMK	**Owner**	**Area in Square Feet**
234033029	A & B Hawaii, Inc.	1,997.4
233001003	Tracy, Mark W. & Carla	798.0
234032001	C. Brewer Homes	127,890.8
234033050	Maui Hostel LLC	2,469.2
234029030	Mary H. Amaral	1,223.8
234029036	Richard J. Hoehn	4,665.3
234033014	Wailuku Sugar	19,596.3
234033024	A & B Hawaii, Inc	1,880.7
233001025	Casey J. Del Dotto	1,008.6
234031001	Noenoe Lindsey	46,375.3
Total		207,905.4

In addition to these tracts, the project requires approximately 14,000 square feet of perpetual road access easement at a location to be determined during design. It also requires 2 temporary work area easements approximating 90,000 square feet, also at locations to be determined during design. This is also at an undetermined location. The total for all tracts is 311,905.4 square feet.

3. SPONSOR’S REAL ESTATE INTERESTS

The sponsor acquired the lands for the original project construction, therefore, those lands are not considered in this modification project. It has been determined that the estates acquired in the original project are sufficient for use in the modification project needs but credit will not be allowed for lands previously acquired for the original project.

4. ESTATES TO BE ACQUIRED

ROAD EASEMENT:

A perpetual and assignable easement and right-of-way in, on, over and across (the land described in Schedule A) (Tract Nos. __, __ and __.) for the location, construction, operation, maintenance alteration and replacement of (a) road(s) and appurtenances thereto; together with the right to trim, cut, fell and remove there from all tress, underbrush, obstructions and other vegetation, structures, or obstacles within the limits of the right-of-way; (reserving, however, to the owners, their heirs and assigns, the right to cross over or under the right-of-way as access to their adjoining land at the locations indicated in Schedule B); subject, however, to existing easements for public roads and highways, public utilities, railroads and pipelines.

TEMPORARY WORK AREA EASEMENT:

A temporary easement and right-of-way in, on, over and across (the land described in Schedule A) (Tracts Nos., and), for a period not to exceed__________, beginning with date possession of the land is granted to the United States, for use by the United States, its representatives, agents, and contractors as a (borrow area) (work area), including the right to borrow and/or deposit fill, spoil and waste material thereon). (move, store and remove equipment and supplies, and erect and. remove temporary * structures on the land and to perform any other work necessary and incident to the construction of the Project, together with the right to trim, cut, fell and remove, therefore all trees, underbrush, obstructions, and any other vegetation, structures, or obstacles within the limits of the right-of-way; reserving, however, to the landowners, their heirs and assigns, all such rights and privileges as may be used without interfering with or abridging the rights and easement hereby acquired; subject, however, to existing easements for public roads and highways, public utilities, railroads and pipelines.

CHANNEL IMPROVEMENT EASEMENTS

A perpetual and assignable right and easement to construct, operate, and maintain channel improvement works on, over and across (the land described in Schedule A) (Tract Nos. __, __, and __.) for the purposes as authorized by the Act of Congress approved _______, including the right to clear, cut, fell, remove and dispose of any and all timber, trees, underbrush, buildings, improvements and/or other obstructions therefore; to excavate dredge, cut away, and remove any or all of said land and to place thereon dredge or spoil material; and for such other purposes as may be required in connection with said work of improvement; reserving, however, to the owners, their heirs and assigns, all such rights and privileges as may be used without interfering with or abridging the rights and easement hereby acquired; subject, however, to existing easements for public roads and highways, public utilities, railroads and Pipelines.

5. FEDERAL PROJECTS/OWNERSHIP

The original Iao Stream Flood Control Project was a cost-shared project between the United States and a non-Federal sponsor, Maui County. The County still owns the interest acquired. There are no federal owned lands within the project requirement areas.

6. NAVIGATION SERVITUDE

Iao Stream is not considered a navigable river and the Navigation Servitude does not apply.

7. MAPS

Maps depicting the State of Hawaii and Island of Maui, the project area, the easements acquired for the original project and the required easements for the modification project are attached in the addendum.

8. FLOODING

The stream is a natural floodway and flood waters rise quickly with heavy rains on the mountain. Proposed construction, operation and maintenance of this project is to control flooding, and prevent loss of life and property damages. The design is intended to contain the 10 year flood within the structural improvements and the standard project flood within the designated floodplain and existing levees.

9. BASELINE COST ESTIMATE FOR REAL ESTATE

Fee Title…………………………………………………………………..$ 0

Perpetual Channel Improvement Easement……………………………………$ 106,160

Perpetual Joint Use Road Easement……………………………………………$ 4,000

Temporary Work Area Easement………………………………………………$ 8,240

Improvements……………………………………………………………..$ 0

Hazard Removals…………………………………………………………….$ 0

Mineral Rights……………………………………………………………….$ 0

Damages…………………………………………………………………..$ 0

Contingencies……………………………………………………………..$ 35,500

Relocations………………………………………………………………..$ 0

Uniform Relocation Assistance (PL 91-646)…………………………………..$ 0

Acquisition Administrative Costs……………………………………………$ 240,000

TOTAL COST……………………………………………………………….$ 394,000

10. PL 91-646 RELOCATION BENEFITS

No PL 91-646 benefits are anticipated for the project.

11. MINERALS

There are no surface of subsurface minerals known that would impact the project or acquisition.

12. ASSESSMENT OF SPONSOR'S ACQUISITION CAPABILITY

An assessment of the sponsor's acquisition capabilities to acquire the land necessary for this project is attached as an exhibit. Maui County is fully capable.

13. ZONING

The subject properties have four zoning classifications:

Agriculture- This is the primary zoning found on the tracts. It primarily applies to those properties located along the west (left) bank of the stream. Although zoned agriculture, very little of the property is used for crops, but it does have agricultural potential.

Conservation- This applies to one property.

Residential/Interim- This zoning applies to 5 parcels.

14. MILESTONES

The sponsor will begin preliminary acquisition work approximately 6 months prior to PCA execution as follows:

Survey/Maps/Title	90 Days	01 Oct 2009	01 Jan 2010
Legal Descriptions	30 Days	01 Jan 2010	01 Feb 2010
Appraisals	90 Days	01 Feb 2010	01 May 2010

Execution of the PCA is anticipated on or around 1 May 2010. The sponsor will complete acquisition of LERRD within 180 days after the PCA execution as follows:

Documentation	120 Days	01 May 2010	01 Sep 2010
Negotiations	60 Days	01 July 2010	01-Sep 2010
Final Subdivision	60 Days	01 Sep 2010	01 Nov 2010
Payments	90 Days	01 Sep 2010	01 Dec 2010
LERRD certification	21 Days	1 Dec 2010	22 Dec 2010

15. PUBLIC UTILITIES RELOCATIONS

There are no anticipated public utility relocations for this project.

16. ENVIRONMENTAL IMPACTS

Environmental impacts, if any, are discussed in other sections of the Engineering Documentation Report.

17. ATTITUDES OF LANDOWNWERS

During a public meeting held 12 August 2003, many members of the public opposed the project due to a disbelief of potential future flooding and potential damages to cultural resources and wildlife habitats.

18. NOTIFICATION TO SPONSOR

The non-Federal sponsor, Maui County, as been notified in writing about the risks of acquiring the LERRD for the project prior to the PCA execution and the Government's formal notice to proceed. The written notification is attached as an exhibit.

ADDENDUM

State Map

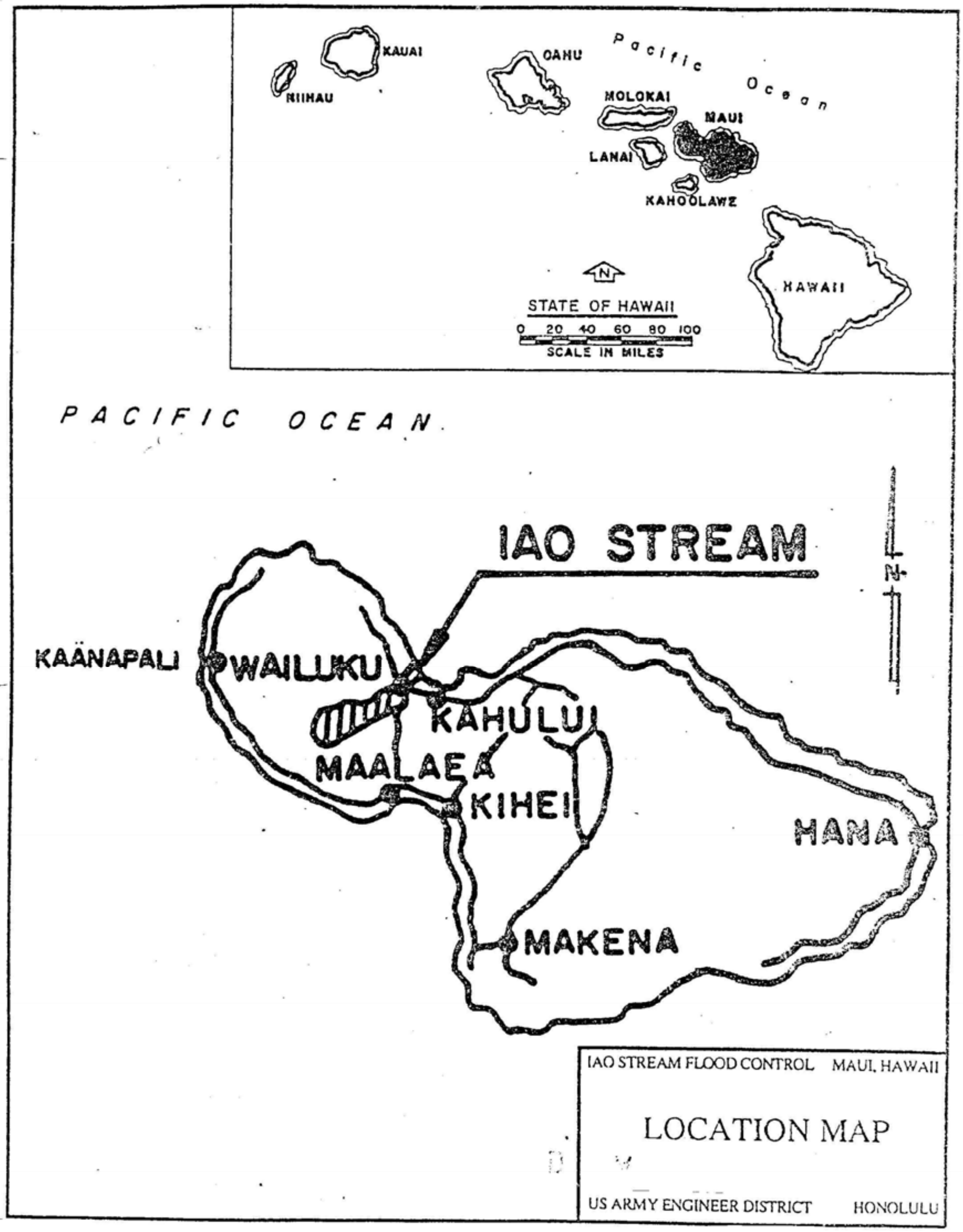
Area Map

Tract Map

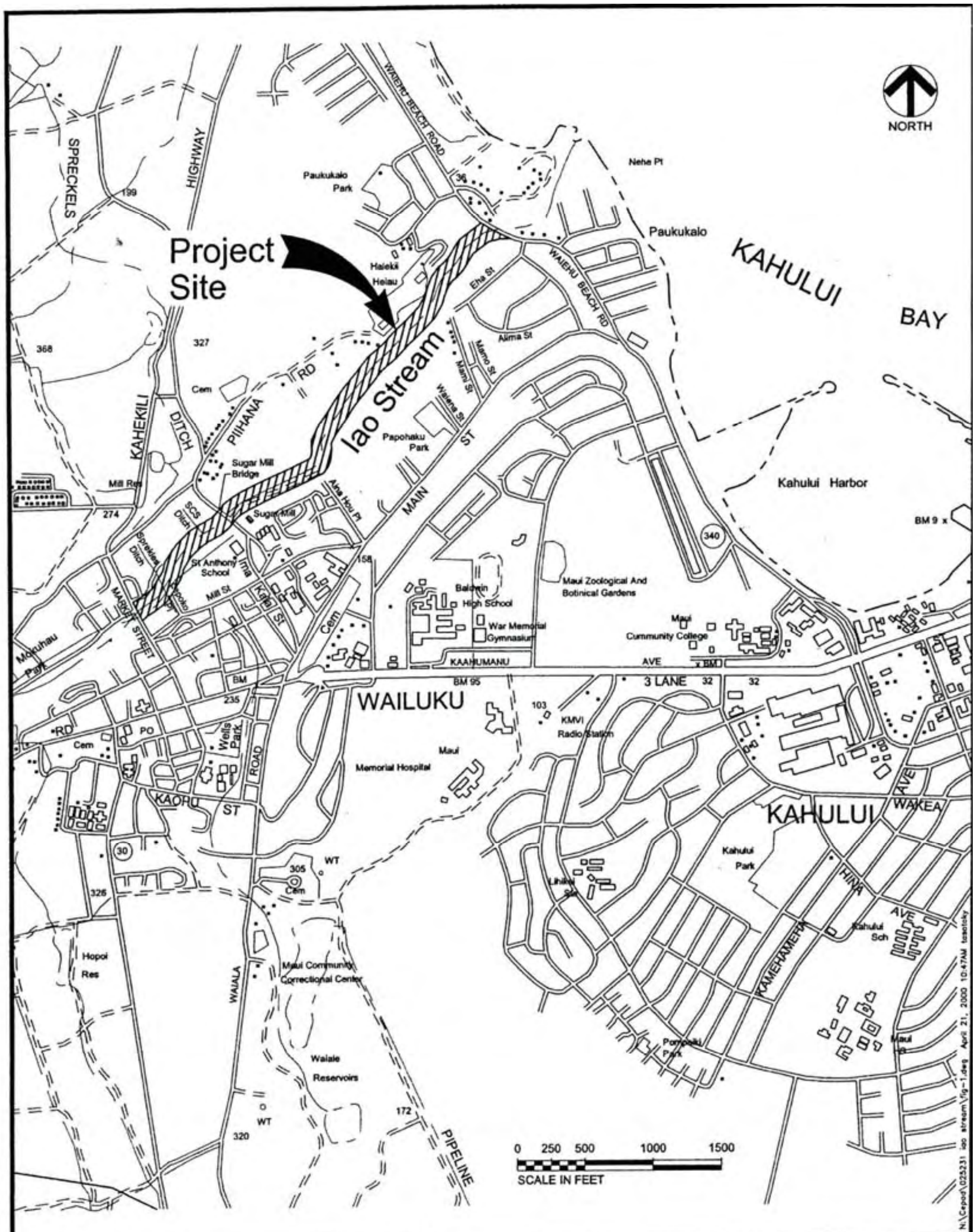
Assessment of Sponsor Capability

Letter to Sponsor

STATE MAP



KAUAI
NIIHAU
OAHU
Pacific Ocean
MOLOKAI
MAUI
LANAI
KAHOOLAWE
HAWAII
N
STATE OF HAWAII
0 20 40 60 80 100
SCALE IN MILES
PACIFIC OCEAN
IAO STREAM
N
KAANAPALI
WAILUKU
KAHULUI
MAALAEA
KIHEI
HANA
MAKENA
IAO STREAM FLOOD CONTROL MAUI, HAWAII
LOCATION MAP
US ARMY ENGINEER DISTRICT HONOLULU

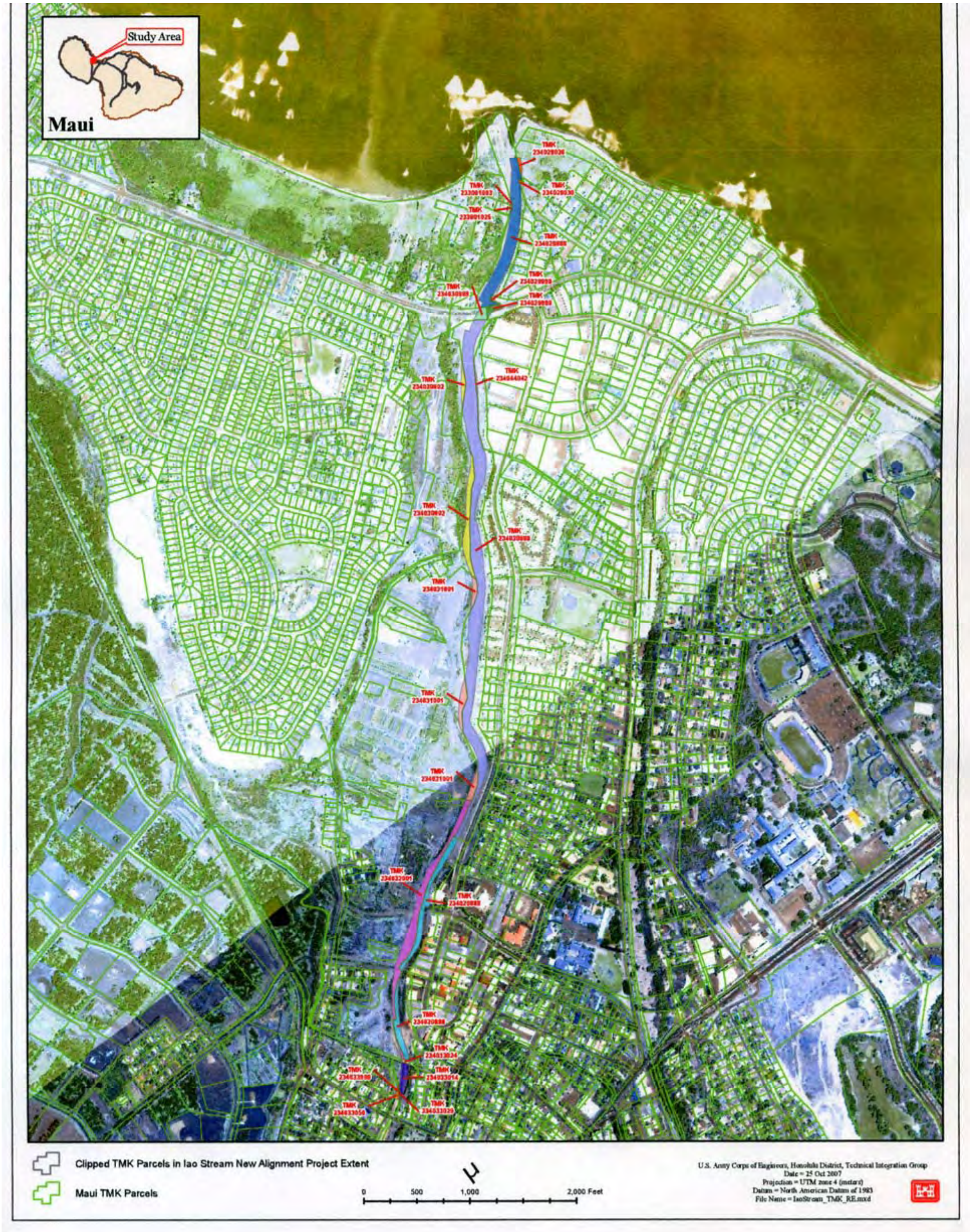


Source:

M&E Pacific, Inc.
ENGINEERS & ARCHITECTS
SUITE 500, PAUAHI TOWER · 1001 BISHOP ST., HONOLULU, HAWAII 96813

Figure 2
PROJECT SITE MAP
Iao Stream Hydraulic Design
Wailuku, Maui, Hawaii

Prepared By: M&E Pacific, Inc.
December 2000


Study Area
Maui
Clipped TMK Parcels in Iao Stream New Alignment Project Extent
Maui TMK Parcels
0
500
1,000
2,000 Feet
U.S. Army Corps of Engineers, Honolulu District, Technical Integration Group
Date = 25 Oct 2007
Projection = UTM zone 4 (meters)
Datum = North American Datum of 1983
File Name = IaoStream_TMK_RE.mxd

Maui, HI

ASSESSMENT OF NON FEDERAL SPONSOR'S
REAL ESTATE ACQUISITION CAPABILITY
FOR
IAO STREAM MODIFICATION PROJECT

YES	**NO**	
✓		**a. Does the non-Federal Sponsor have legal authority to acquire and hold title to real property for project purposes? Cite statutory authority: Hawaii Revised Statutes, Chapter 46**
✓		**b. Does the non-Federal sponsor have the power of eminent domain for this project? Cite statutory authority: Hawaii Revised Statutes, Chapter 101**
	✓	**c. Does the non-Federal sponsor have "quick-take" authority for this project? Cite statutory authority:**
	✓	**d. Are there any lands/interests in land required for the project that are located outside the non-Federal sponsor's political boundary?**
	✓	**e. Are any of the lands/interests in land required for the project owned by an entity whose property the sponsor cannot condemn? (If "yes", provide description on attached sheets.)**

ASSESSMENT OF NON-FEDERAL SPONSOR'S
REAL ESTATE ACQUISITION CAPABILITY

YES	NO	
	✓	a. Will the sponsor's in-house staff require training to become familiar with real estate requirements of Federal projects including P. L. 91-646, as amended?
		b. If the answer to (a) above is "yes", has a reasonable plan been developed to provide such training? (If "yes", provide description on attached sheets.)
✓		c. Does the sponsor's in-house staff have sufficient real estate acquisition experience to meet its responsibilities for the project?
✓		d. Is the sponsor's projected in-house staffing level sufficient considering it's other workload?
✓		e. Can the sponsor obtain contractor support, if required, in a timely fashion?
	✓	f. Will the sponsor likely request USACE assistance, if available, in acquiring real estate?
✓		g. Will the sponsor's staff be located within reasonable proximity to the project site?
✓		h. Is the sponsor confident it can provide real estate in time to meet contract-advertising dates for the project? If "no", provide explanation on an attached sheet.

ASSESSMENT OF NON-FEDERAL SPONSOR'S REAL ESTATE ACQUISITION CAPABILITY

With regard to this project, the sponsor is anticipated to be (check one):

Highly Capable

Fully Capable ✓

Moderately Capable

Marginally Capable

Insufficiently Capable (provide explanation on an attached sheet)

YES	NO	N/A	
✓			a. Has the sponsor performed satisfactorily on other USACE projects?
✓			b. Has the assessment been coordinated with the sponsor?
✓			c. Does the sponsor concur with this assessment? (If "no", provide explanation on attached sheet.)

PREPARED BY:

Cindy Y. Young

Cindy Y. Young,
Deputy Corporation Counsel
County of Maui
200 South High Street
Wailuku, Maui Hawaii 96793
Telephone: (808) 270-7740
Date: OCT 01 2004

REVIEWED AND APPROVED:

[signature]

Randall K. Tsuneyoshi
Chief, Real Estate Division
Honolulu District, Corps of Engineers

Date: OCT 12 2004

DEPARTMENT OF THE ARMY
U.S. ARMY ENGINEER DISTRICT, HONOLULU
FORT SHAFTER, HAWAII 96858-5440

REPLY TO
ATTENTION OF:

Real Estate Division

22 September 2004

Ms. Cary Yamashita
Chief, Engineering Division
County of Maui, DPW & Environmental Management
200 South High Street
Wailuku, Maui, Hawaii 96793

Dear Ms. Yamashita:

Reference the Iao Stream Flood Control Project Modification, where the County of Maui, as the non-Federal Sponsor, is responsible for ensuring that it possesses the authority to acquire and holds title for all real property required for the proposed project. Non-Federal sponsors shall provide 100 percent of the lands, easements, rights-of way, utility or public facility relocations, and dredge or excavated material disposal areas (LERRDs), and operation, maintenance, repair, rehabilitation and replacement.

We wish to advise you that there are risks associated with the acquisition of land prior to the execution of the Project Cooperation Agreement (PCA). The County of Maui will assume full and sole responsibility for any and all costs, responsibility or liability arising out of the acquisition effort. These risks generally include but may not be limited to the following:

a. Congress may not appropriate funds to construct the proposed project.

b. The proposed project may otherwise not be funded or approved for construction.

c. A PCA mutually agreeable to the non-Federal sponsor and the Government may not be executed and implemented.

d. The non-Federal sponsor may incur liability and expense by virtue of its ownership of contaminated lands, or interests therein, whether such liability should arise out of local, state, or Federal laws or regulations including liability arising out of CERCLA, as amended.

e. The non-Federal sponsor may acquire interests or estates that are later determined by the Government to be inappropriate, insufficient, or otherwise not required for the project.

f. The non-Federal sponsor may initially acquire insufficient or excessive real property acreage which may result in additional negotiations and/or benefit payments under P.L. 91-646 as well as the payment of additional fair market value to affected landowners which could have been avoided delaying the acquisition until after the PCA execution and the Government's notice to commence acquisition and performance of LERRD.

g. The non-Federal sponsor may incur costs or expenses in connection with its decision to acquire or perform LERRD in advance of the executed PCA and the Government's notice to proceed which may not be creditable under the provisions of Public Law 99-662 or the PCA.

If you have any questions, please contact Cindy Luciano at phone number 438-1306 or by email at Cindy.L.Luciano@poh01.usace.army.mil.

Sincerely,

Signed

Randall K. Tsuneyoshi
Chief, Real Estate Division