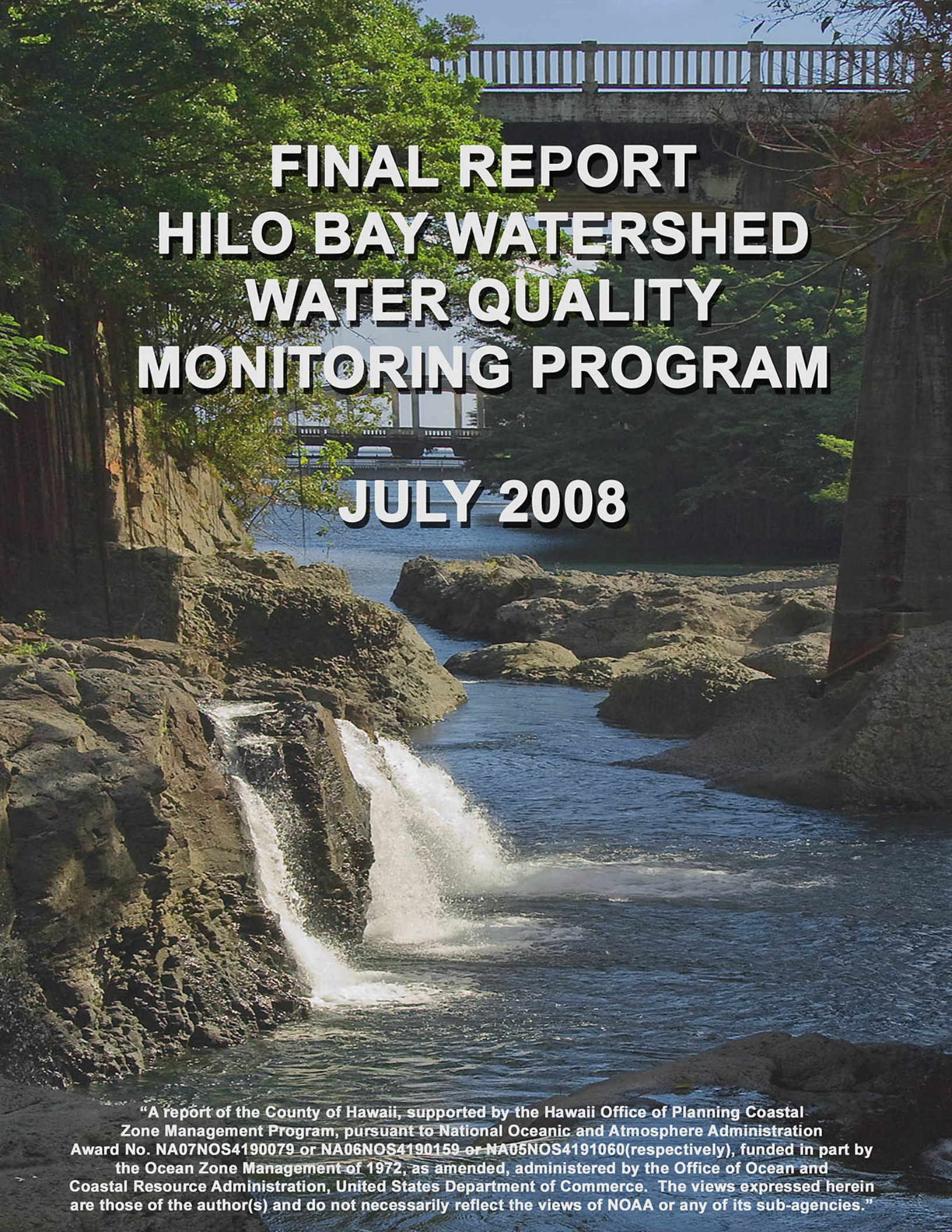

FINAL REPORT
HILO BAY WATERSHED WATER QUALITY MONITORING PROGRAM

JULY 2008

"A report of the County of Hawaii, supported by the Hawaii Office of Planning Coastal Zone Management Program, pursuant to National Oceanic and Atmosphere Administration Award No. NA07NOS4190079 or NA06NOS4190159 or NA05NOS4191060(respectively), funded in part by the Ocean Zone Management of 1972, as amended, administered by the Office of Ocean and Coastal Resource Administration, United States Department of Commerce. The views expressed herein are those of the author(s) and do not necessarily reflect the views of NOAA or any of its sub-agencies."

Hilo Bay Watershed Advisory Group Water Quality Monitoring Program

Final Report

Prepared by
Tom Young and Steve Godzsak
Primary Investigators

Submitted to Hawaii Coastal Zone Management

July 2008

I. Executive Summary

The Hilo Bay Watershed Advisory Group successfully implemented and completed a water quality monitoring project in 2008. The scope of work included collecting water quality samples for the Wailuku, Waiakea, Honolii, Pukihae, Maili, and Alenaio streams. The Waiakea springs, Kaumana springs, and Waiolama springs were also sampled. The samples were analyzed for total Nitrogen (TN), Nitrate + Nitrite (NO_3^- +NO_2^-), Ammonium (NH_4^+), total Phosphorous (TP), total suspended solids (TSS), and turbidity (NTU) and their levels compared to the State of Hawaii Criteria for streams.

The intent of the project was to sample the streams within the Hilo Bay watershed to assess the present conditions within this natural resource. Data collected here will help establish a baseline for the streams of the Hilo watershed for future comparisons.

The findings show that generally the water quality of the streams meet the criteria but that the Waiakea springs, Kaumana springs, and Waiolama springs consistently have elevated levels of nutrients, (total dissolved nitrogen, nitrates and nitrites) exceeding the state criteria. Kaumana Springs, in joining with the Ainako Stream, seem to elevate the levels of nutrients (total dissolved nitrogen, nitrates and nitrites) within this stream. The Kaluiiki branch of the Waipahoehoe stream at Akolea Road and the Waipahoehoe stream at Chong Bridge has elevated nitrate and nitrite that need to be understood. The source of nutrient to these streams is beyond the scope of the project and the Advisory Group is recommending further studies be undertaken to identify nutrient sources within these watersheds. Additionally, the use of wet and dry criteria based on calendar dates by the Hawaii Department of Health is problematic in that the weather patterns are not consistent and greatly influenced by storm patterns. The Advisory Group is recommending a program be established to continue the stream sampling and to expand the scope to include flow measurement.

The Hilo Bay Watershed Advisory Group thanks the National Oceanic and Atmospheric Administration (NOAA), and the State Coastal Zone Management, County of Hawaii Planning Department's Coastal Zone Management Team (CZM) for facilitating this effort and enabling this work to be accomplished.

Acknowledgements

The Hilo Bay Watershed Advisory Group and the water monitoring team acknowledge and thank the following agencies and individuals who made the Hilo Bay Watershed Water Quality Monitoring Project possible. They provided invaluable assistance in making this project successful.

Hawaii Coastal Zone Management Program
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The greater Hilo Bay Watershed is made up of two large watersheds, the Wailoa (2-61) 119,782 acres and the Wailuku (2-60) 142,463 acres along with five smaller watersheds: the Pukihae (2-59) 422 acres, Wainaku (2-58) 955 acres, Maile (2-57) 2,654 acres Honolii (2-56) 10,895 acres, and the Paukaa (2-58) with 422 acres for a total of 279,357 acres. These lands usage are designated as: Agriculture (AG), Conservation (CON), Urban (URB), or Rural (RUR).

Code	Watershed Unit	Designated Usage				Total Acres
		AG	CON	URB	RUR	
2-56	Honolii	2,966	7,872	57	0	10,895
2-57	Maile	1,706	921	27	0	2,654
2-55	Paukaa	351	0	71	0	422
2-59	Pukihae	1,743	376	67	0	2,186
2-61	Wailoa	19,803	89,864	10,115	0	119,782
2-60	Wailuku	35,707	105,961	795	0	142,463
2-58	Wainaku	778	0	177	0	955
Total		63,054	204,994	11309	0	279,357
	% Of Total	23%	73%	4%		100%

The watershed is made up of two distinct geological features separated by the Wailuku River.

The north side is the east flank of Mauna Kea and the geology is very old, and has well defined stream channels. The south side is made up of very young geology that has ill defined stream channels. In 1984 Mauna Loa erupted and for 22 days threatened Hilo. The flows came within 12 miles of Hilo stopping to the east of Saddle Road. This landscape has subterranean channels and fractured substrate that allow surface water to percolate underground forming several large springs in the near shore environment said to be the largest in the state. The young geology may have higher nutrient levels than older geological formations.

Figure 1. Greater Hilo Bay Watershed

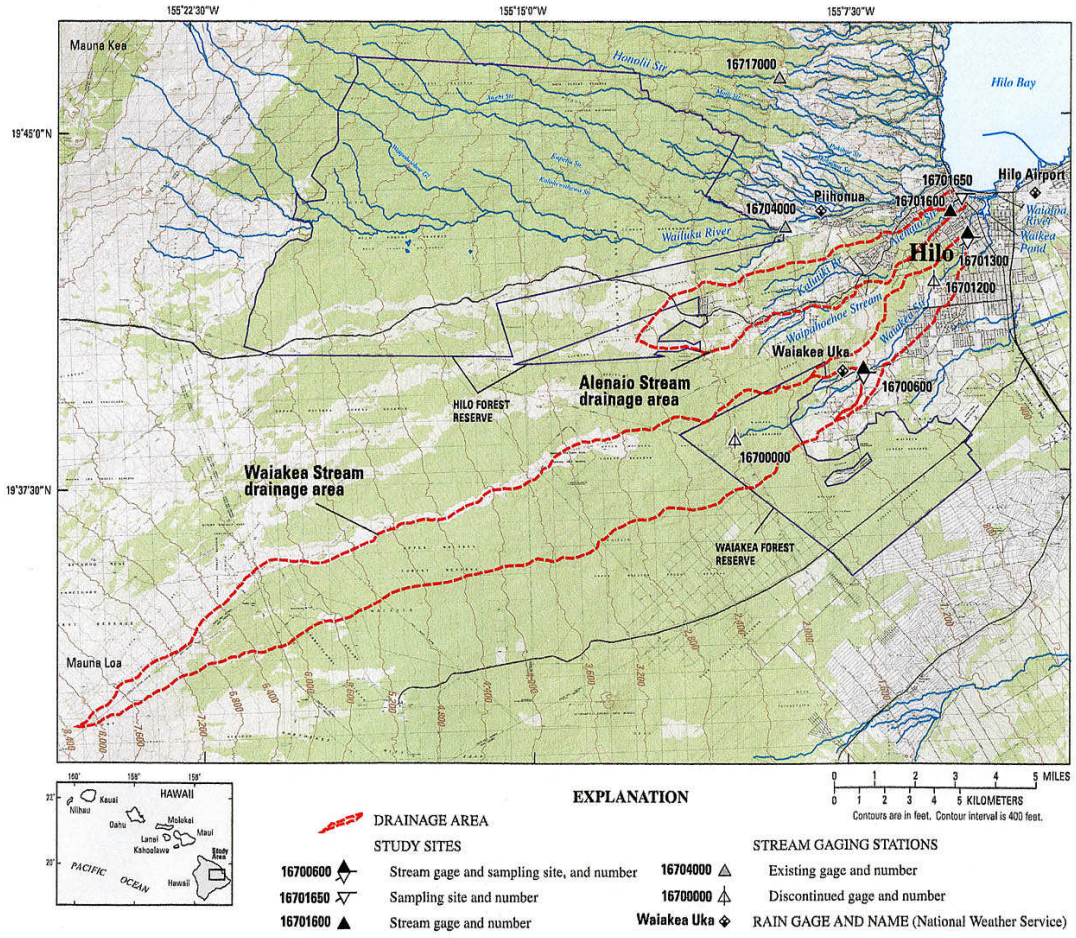


Figure 1. Map showing rain gages, stream-gaging sites, and stream-sampling sites used in this study, and the Waiakea and Alenaio drainage basins, Hilo area, Hawaii.

Wailoa Watershed

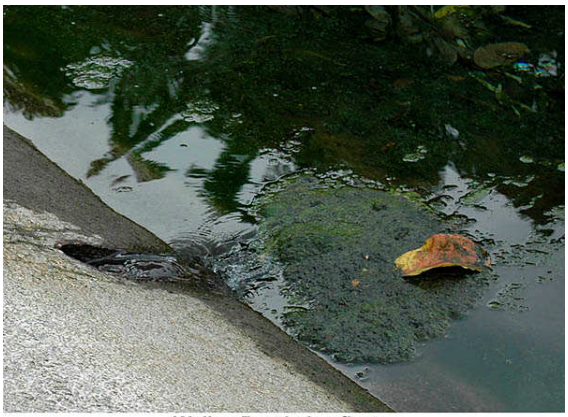
This watershed has two principal stream channels, the Waiakea and Alenaio and associated watersheds that enter the receiving waters of Hilo Bay thru the Wailoa River estuary, the Waiolama Sanitary Canal, and sometimes over the beach frontage road.

Waiakea Stream discharge area starts in the upper watershed near Mauna Loa. The stream starts close to Mountain View. The stream has ill defined

channels in the forested area. The stream is evident at Hoaka road south of Hilo. During protracted rainfall events or wet years flow is evident for less than a mile ending in a pasture above Kupulau Road. During the testing cycle we had flow in February stopping early in March continuing in mid March and continuing until May 19th when it dried up. The flow in February was at the tail end of a wet period and there was continuous flow in the entire reach for a few weeks. We were able to collect one set of samples for the entire reach. This stream is intermittent or ephemeral in the full reach but has more evidence of some flow (photo left) at Hoaka Road during normal rainfall patterns. During the collection process we saw some mosquito fish and dragon fly larvae. There was an absence of native aquatic biota along with a lack of the Tahitian prawn (Macro brachium Lar). Storm events produce a different scenario. During protracted storm events this dry stream becomes a raging torrent that does not respect any boundaries. The last flooding event in 2008 provides a different picture of this stream. Areas that have not been protected or hardened experienced extensive flooding. Prolonged intense rainfall on the first and second of November, 2000 brought a new dimension to flooding and erosion for this area. Rainfall was concentrated in Waiakea with totals of 32.47 inches recorded. Combined damages in excess of 70 million dollars for Kapapala and Waiakea were recorded. At Hoaka Road stream flow was braided and overflowed the road washing a house off its foundation and onto the road. At Kawailani Street the Waiakea Stream caused extensive damage resulting in requiring a new bridge to be built along with extensive stream channel hardening. It should be noted that the Federal Flood Insurance Maps had to be redrawn on account of this event.

Waiakea Pond (Estuary)

The Waiakea Stream in its lower reach is a modified storm water channel. The channel between Komohana and Kinoole streets has steep cut sides and a rocky bottom lacking in adequate habitat. Between Kinoole and Kilauea the entire channel has been hardened with concrete (photo right). This reach is a concrete storm channel that ends at the beginning of the tidally influenced Waiakea pond and recreational area. The hardened channel has relief holes in the sides and face that allow the spring that is evident to discharge into the Waiakea Estuary.



Wailoa Pond pipe flow

There are at least twenty five inch pipes that discharge along each side, a 16 inch pipe, plus several five inch pipes on the face of the last drop of the hardened channel bottom. The flow from the spring at low tide creates a fast flowing channel along one side of the gravel deposited from the last storm. It is evident from observation of the aquatic life that the species are mostly Mullet fry up to six inches and they are actively feeding in the entire reach. Schools of twenty five or more are seen swimming next to the bridge. The bottom area is populated with non-native Elodea, a tramp aquarium plant that seems to be doing very well. Some filamentous algae are present as would be expected.

Alenaio Stream and Flood Control Channel

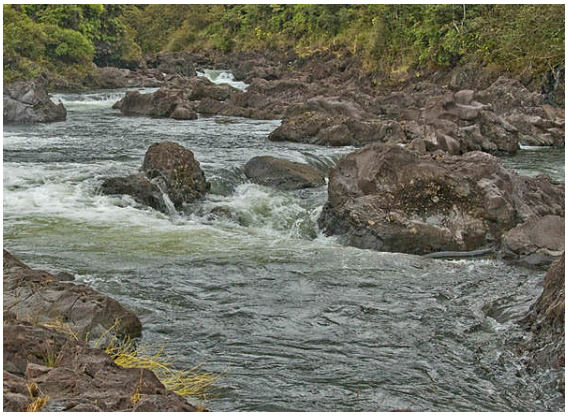
The Alenaio Stream is part of a larger system that starts high in the watershed near Saddle Road and borders the Wailuku River Watershed on the west side and the Waiakea Watershed in the east. There are three streams that converge to create the flow that will enter the Waiolama Sanitary Canal and eventually the Waiakea Pond. The Waipahoehoe Stream joins with the Kaluiki branch and an un-named stream below Akolea Road to form the headwaters of the Alenaio Stream. This stream crosses Kaumana Drive at Chong's Bridge. The stream at this point is mostly perennial from Wilder Road past Akolea Road under Chong's bridge and at some point north of the bridge it goes underground and becomes intermittent or ephemeral. The Alenaio Stream, according to conventional thought, starts at Moohouli Bridge (photo above) and continues north in a natural channel then enters an improved concrete channel under the Komohana Street Bridge through an extremely eroded stream channel until it reaches Kapiolani Street. At this point the channel becomes a concrete lined storm control channel that empties into Waiolama Spring and Waiolama Sanitary Canal. This stone lined channel was part of an attempt to drain the Waiolama River Complex after the area was filled in with dredge and fill material during the railroad construction and related projects around 1910 by the Territorial government. During extreme flooding conditions the flow

will over come the channel capacity and overflow onto a soccer field, cross the road, and enter the bay as the aerial view (photo right) of the November 2000 event demonstrates.

Waiolama Spring area at the end of the Alenaio Storm Channel

The Waiolama Spring supplies water to the Waiolama Sanitary Canal beginning at the end of the dry Alenaio concrete channel (photo left). The Waiolama Spring is the only evidence of the Waiolama River and fish ponds that were covered up during and after the construction and dredge and fill of the railroad and improvements to the harbor around 1910. This spring is tidally influenced and has been observed to have a complement of oopu and tilapia. The springs are evident in less than a foot of water. This spring is very productive and creates a flowing stream at low tide and at high tide it is overcome by the waters of the Wailoa Estuary and may become brackish.

Wailuku Watershed and River



The Wailuku watershed is the drainage basin for a large portion of Mauna Kea east flank. It has 142,463 acres and numerous streams that originate high on the arid slopes. Some of the higher streams along with the Wailuku River may carry water on occasion once a year but have been known to be dry for many years. As

the streams move down slope they start to pick up water from springs (around the 5,000 foot elevation) along with surface flow. Numerous streams form the network that culminates in to the Wailuku River (photo left). The geology is much older and has stable channels that have tremendous capacity to carry the storm flows without causing flooding. The sampling of the upper reach was accomplished thru the cooperation with the State Department of Natural Resources Forestry division along with the cooperation with the owner and operator of the upper Wailuku power plant. The lower sample site was the USGS site near Wainaku Avenue.

Ainako Stream and Kaumana Springs

Below Akolea Road there is a very productive spring that feeds Ainako Stream. The stream crosses Ainako Avenue then travels east behind De Silva School then enters the Kaumana Spring area. At this point the Kaumana Springs (three in all) join with the stream and continues until it crosses Wainuenue Avenue and ultimately enters the Wailuku River above Carvalho Park. Kaumana Spring (photo right) was one of the oldest developed water sources that provided drinking water to the town of Hilo. At some time in the mid 1960s the Department of Health closed off this water source because of contamination due to the build out of homes above the springs. The State of Hawaii Department of Land and Natural Resources Division of Water and Land Development (DOWALD) produced an inventory of Basic Water Resources Data: Island of Hawaii February 1970 Report R34. The following is an excerpt of that data. This data summarizes the nutrient constituents for Kaumana Springs for the periods listed.

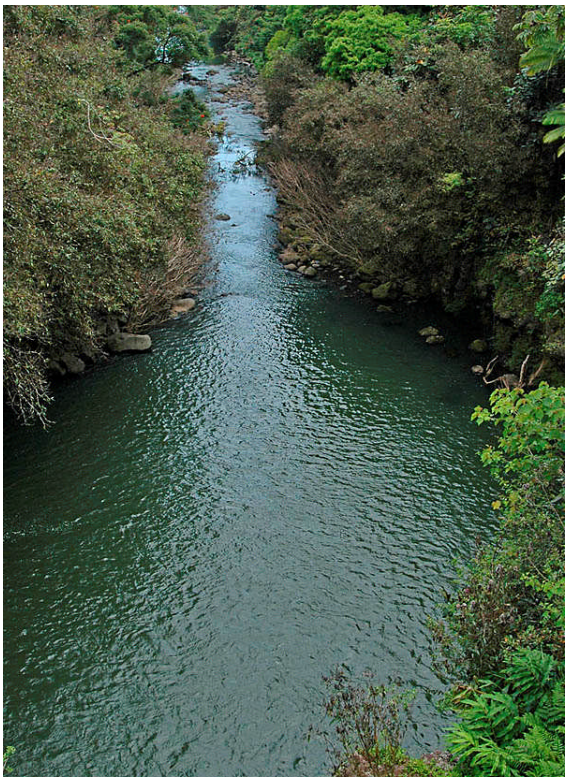
Figure 2. Historic water quality data for Kaumana Spring

Kaumana Spring DOWALD Water Quality Data Site no. 44

Date	1949	1950	1951	1952	1953	1955	1956	1960	1966
Nitrites	0	0	0.3	0	0	0	0	0	0.01
Nitrates	0.27	0.1	0.3	0.6	0.4	0.4	1.6	0	2.2

Note units for Nitrites and Nitrates are PPM

Pukihae, Maile, and Honolii Streams

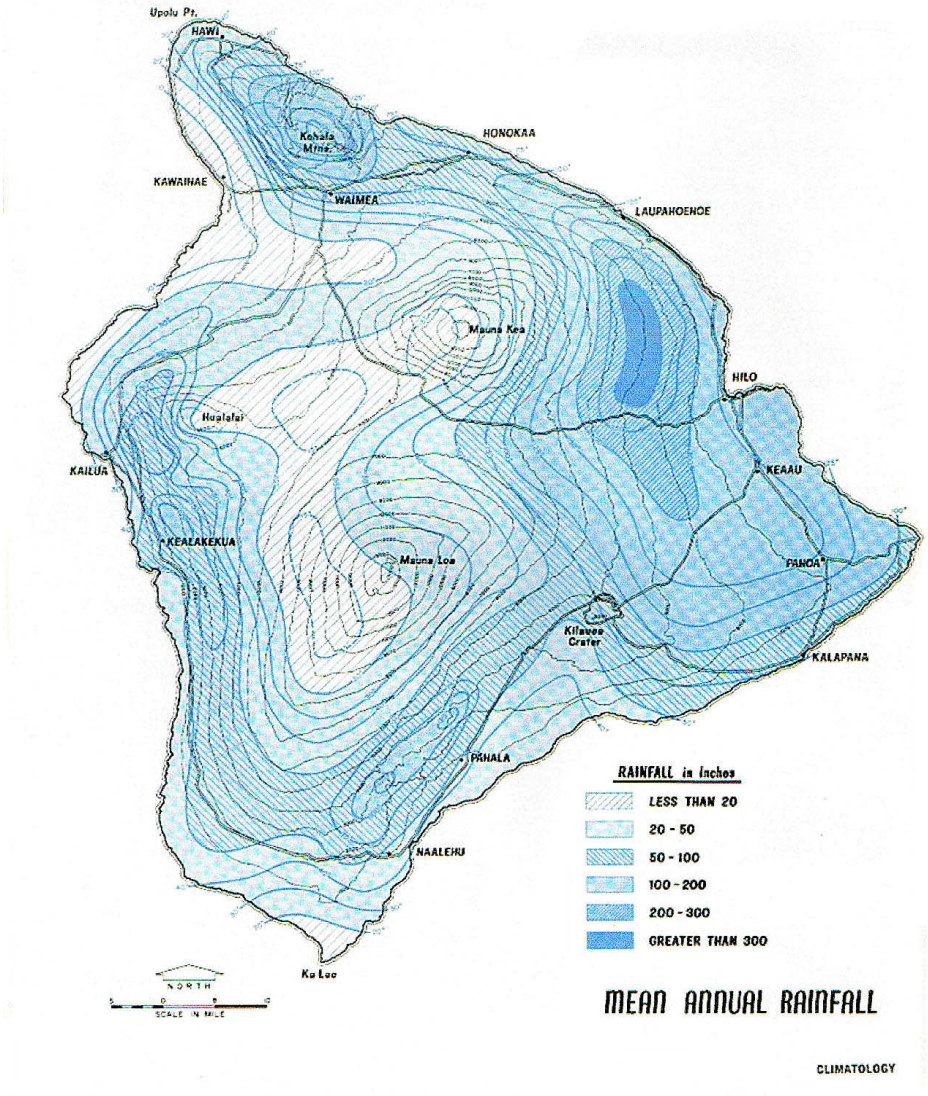


These streams are representative of the perennial streams that populate North Hilo until Manuwaiopae Stream in Laupahoehoe. Manuwaiopae is the last perennial stream in a northerly direction until the Wailoa River is reached in Waipio Valley. All other northern streams are intermittent or ephemeral. The Pukihae, Maile, and Honolii (photo left) streams are fed by springs and surface flow well up in the watershed. The streams are formed in well defined narrow gulches with numerous waterfalls. The largest stressor that we viewed while collecting samples was in-stream and stream side bank erosion. This type of land slide is inherent in this environment due to the flashy nature of the rainfall occurring within the watershed.

Hawaii Island Leeward Rainfall Patterns

The annual rainfall may reach 200 to 300 inches a year in the 2,000 to 3,000 foot elevation range. The rainfall in the upper reach and near the airport is less, reporting 100 to 200 hundred inches annually. Higher up slope the area tends to have a semi arid climate due to the orographic rainfall pattern of the larger

leeward Hawaiian Islands. General rainfall patterns have traditionally been heavy rainfall patterns from October until April and dry months of the year are from May until September. Large storm events associated with weather patterns that



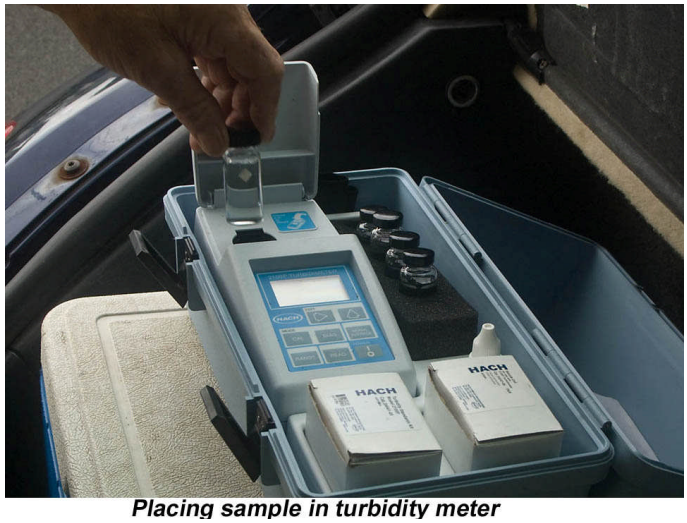
originate in the coastal areas of Mexico and Central America occur between June through November as tropical or hurricane driven storms. Kona storms are tropical cyclone low pressure systems without fronts. These events occur in the winter from November thru April. The rain fall patterns are characterized as trade driven or storm driven. The theory that Hawaii has a well defined wet and dry season can not be substantiated due to the changing weather patterns. Cyclical

ten year weather patterns associated with such phenomenon as variable solar activity, which may cause such events as El Niño or La Niña are possible causes of the variability of weather patterns. Historical animal studies in the last century suggested ten year variability of grouse and rabbit populations that may be linked to cyclical solar activity.

II. Work Performed

The purpose of this project was to sample numerous streams in the Hilo Bay Watershed and determine the overall water quality of those streams via collecting and analyzing water samples. Each sample was analyzed for total Nitrogen, Nitrate, Nitrite, Ammonium, total Phosphorous total suspended solids, and turbidity. Turbidity was measured in the field using the Hach Model 2100P meter. All other parameters were measured at the UHH Analytical Laboratory at the University of Hawaii at Hilo. The results of the tests could then be used to establish a set of Best Management Practices (BMPs) or, at a minimum, alert agencies of potential pollution situations requiring action.

The project was performed from January through June of 2008 with over 130 samples collected and analyzed from 18 distinct sites (reference Appendix C site maps).



Placing sample in turbidity meter

The site locations were selected with the assistance and recommendations of Clifford Furukado of the Department of Health. The work was predominately done in the wet season, but most of the ephemeral streams (Waikea, Alenaio) remained dry and thus provided few opportunities to collect water samples in those streams. These streams were closely monitored and sampling was done whenever flow was found. As it

became apparent that limited samples could be taken in these dry streams a decision was made to collect samples from the Waiakea Springs and Waiolama Springs, adding a new component to the scope of study.

The collection was typically performed in one day beginning early in the morning and ending late afternoon. One liter bottles were filled with water from each site and were placed in a chest filled with ice. The date, time, bottle identifier, water temperature, and turbidity were recorded on a site specific log sheet. At day's end the chest with full bottles was delivered to the lab. Lab results were e-mailed to us and those results tabulated in an Excel workbook (see Appendix A for raw lab data). The total number of days on which sampling occurred was 15.

Sampling Kaumana Spring

III. Summary/Conclusion

The project was successfully completed in the 6 month timeframe allowing a baseline water quality to be established. The overall water quality of the sampled streams met the state's water quality criteria with some exceptions. Water samples from Kaumana Spring, Waiakea Spring, and Waiolama Spring exhibit elevated nutrient levels (total nitrogen, nitrate + nitrite), exceeding state water quality standards for streams. The upper Ainako Stream had low levels of nutrients. The flow from Kaumana Springs in mixing with the middle Ainako Stream seemed to influence the lower Ainako Stream to the point of impairment, elevating the levels of nitrate + nitrite within the stream. The upper Kaluiiki Stream (Akolea Road site) and the Waipahoehoe Stream (Chong's Bridge) had elevated nutrient levels (nitrate + nitrite) to the point of impairment.

The study allowed the investigators the opportunity to view the dynamics of several streams of importance. The Waiakea, Alenaio, and Ainako streams all have productive springs within their reach. Each spring produced elevated amounts of total nitrogen, nitrate, and nitrite. These nutrients then influence the down stream water body to the point of impairment. The upper stream corridor of each stream is intermittent or ephemeral throughout the year. Each stream corridor is periodically a full flowing stream due to storms that are torrential and flashy in nature. These episodes of flooding are carving out deeper and wider stream channels within the very young Wailoa watershed. The erosion and associated soil transport add to the receiving waters turbid appearance. These three streams are ground water dominated during low flow and surface dominated during storms. The high flow is one of a raging torrent that is a floodway that carries eroded stream bank and stream channel material toward Hilo Bay.

The rest of the streams within the watershed show almost no impairment during normal flow, it is only when the storm flow occurs that the incidence of in stream and stream channel erosion occurs.

The investigators found no evidence of other stressors within this very large watershed. Each water quality parameter was analyzed with the following results.

Total Nitrogen

Total Nitrogen(TN) was measured at each site 6-8 times, except on the lower Waiakea and upper and lower Alenaio, where only one sample each was recorded. Those sites with elevated levels of Nitrogen are Waiakea Spring, Kaumana Spring, and Waiolama Spring. The actual measured levels for these specific sites are shown in the attached graph.

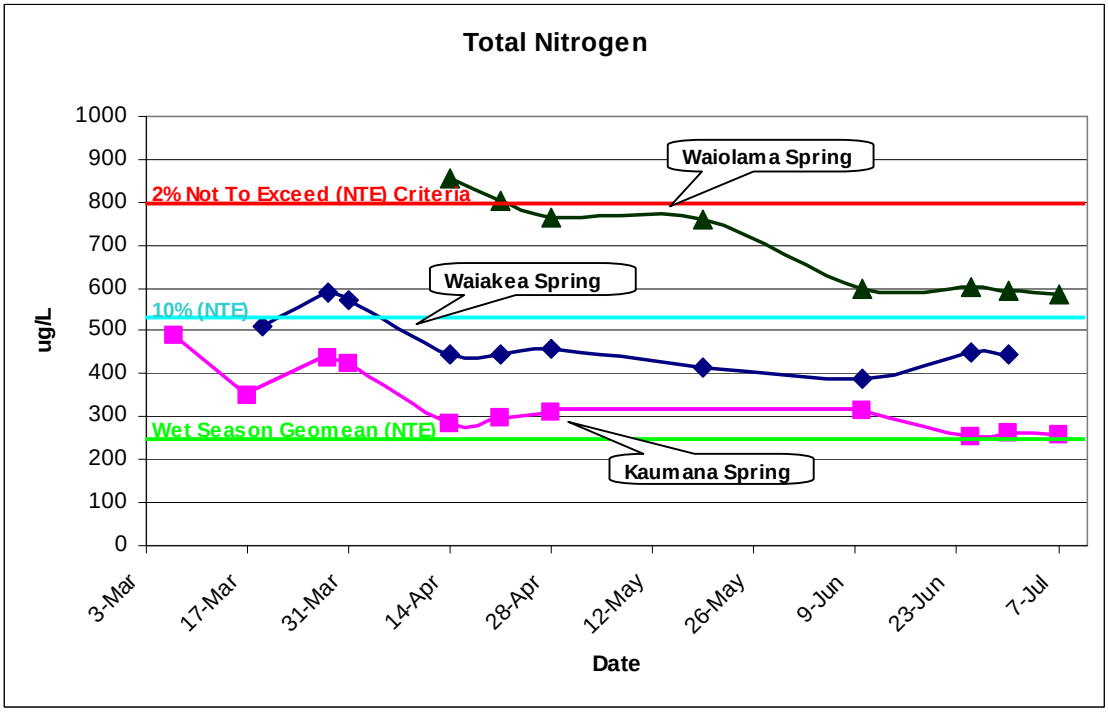


Figure 3. Total Nitrogen found in springs

Nitrates and Nitrites

The Waiakea, Kaumana, and Waiolama Springs all had elevated levels of nitrate + nitrite. The upper Kaluiiki Branch of the Waipahoehoe Stream (at Akolea Road) and the lower Waipahoehoe Stream (at Chong's Bridge) had elevated levels of nitrates and nitrites. It seems that the springs contribute to higher levels of nitrate and nitrite to the down stream waters.

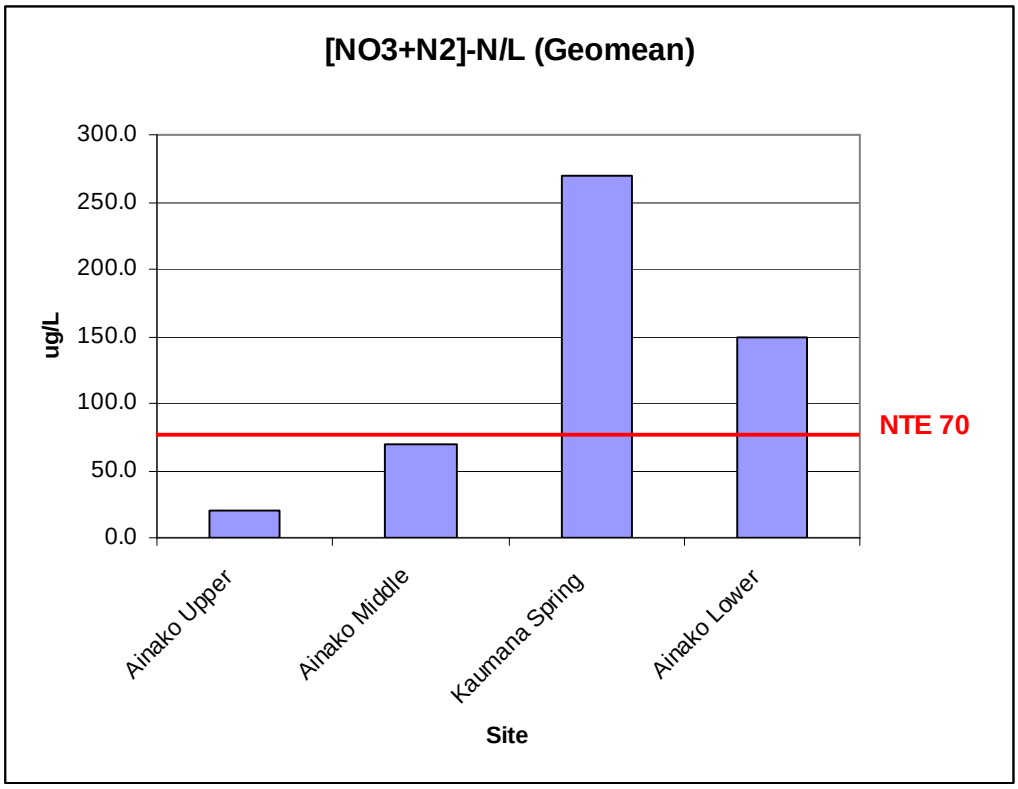


Figure 4. Geomean of organic levels found in Ainako Stream
Note: Not To Exceed (NTE) criteria level from State water quality standard

Turbidity

The total number of turbidity samples taken across all sites was 113 with an overall geometric mean of 0.70 NTU. This represents a very low overall turbidity in light of the samples being taken primarily during the wet season. The six sites with the highest turbidity levels are shown with their corresponding geometric mean in Figure 5. The highest single measurement was 6.26 NTU on the lower Honoli'i stream. The following chart compares turbidity at the upper and lower reaches of the Wailuku and Maile streams and also with the lower Pukaihae and Honolii. Access to the upper reaches of the Pukaihae and Honolii was not possible.

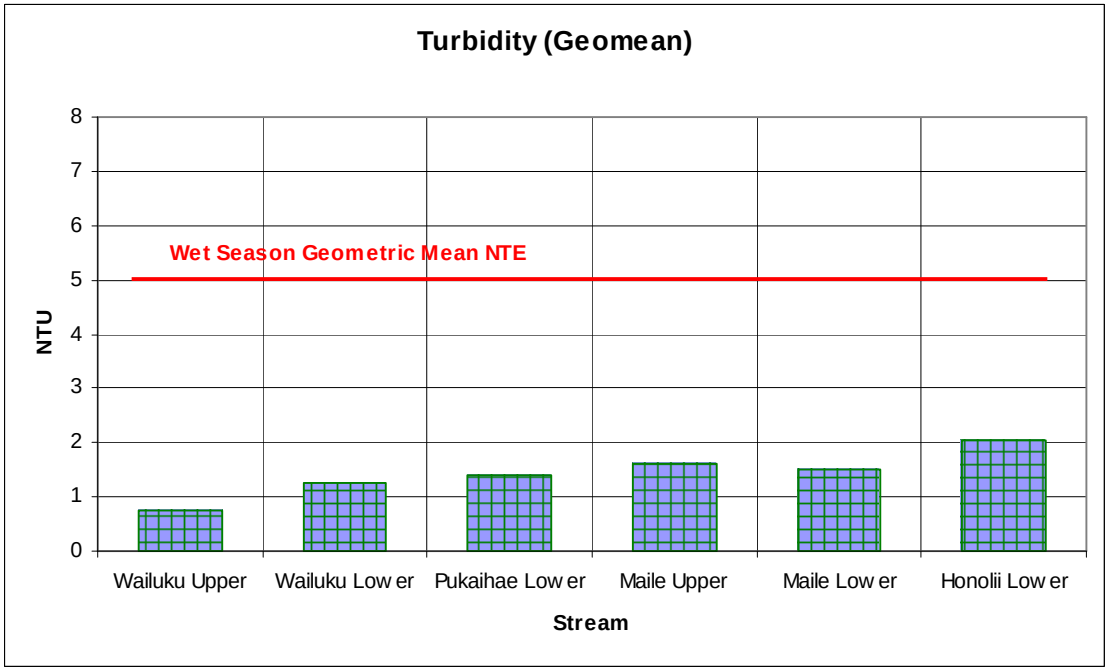
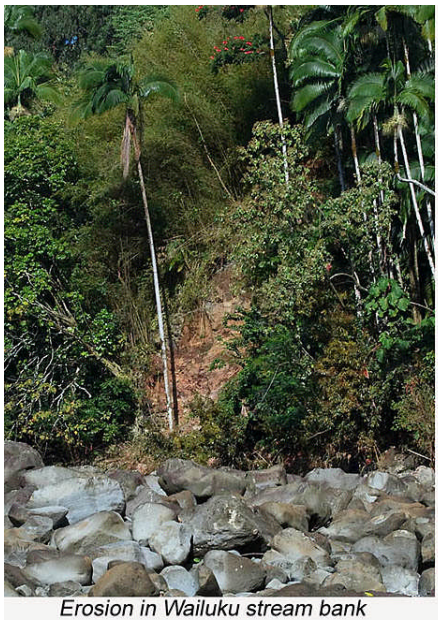


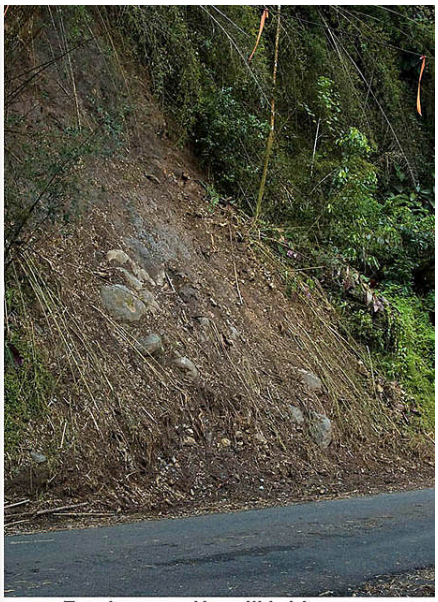
Figure 5. Stream turbidity

There were also incidents of poor water clarity noted, trash, and floating debris, particularly at Waiolama Spring. Photo at right shows a film floating on the surface that appears to be oil. Turbidity was 0.97 NTU on June 30, 2008, the day this film was observed.

During the course of collecting samples, a number of eroded areas along the Wailuku and Honoli'i stream banks were noted. This natural erosion is likely one of the primary causes for the elevated turbidity (brown color) seen during high rainfall events. When the erosion occurred is unknown.



Erosion in Wailuku stream bank



Erosion near Honolii bridge

Total Suspended Solids

The total number of samples taken for TSS was 110 resulting in an overall geometric mean of 0.83 mg/L. The highest value measured was 4.88 mg/L at Pukaihae stream. During the time that sampling was preformed the weather was mild and the only significant rainfall was at the time sampling started during February, this was at the end of the rainfall event.

Phosphorous

Phosphorus levels were consistently low during the testing cycle with few samples exceeding the detectable level. The instrumentation detection levels are 3µg/L.

Ammonium

Ammonium levels were consistently low during the testing cycle with few samples exceeding the detectable level. The instrumentation detection levels are 14µg/L.

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IV. Recommendations

The Hilo Bay Watershed Advisory Group recommends further studies be funded and field work undertaken to determine the sources of for high nutrient levels in the Waiolama Spring, Kaumana Spring, and the Waiakea Spring. The study should include flow information and brackish properties of the waters. The study might include taking samples from springs outside of the urban environment for comparison purposes. Furthermore, a study into the causes for stream turbidity under non-storm conditions and monitoring of stream bank erosion should be performed.

The Hilo Bay watershed Advisory Group will share this report with the community, stake holders and our partners thru our monthly outreach meetings held at the Mokupapapa Discovery Center. This report will be distributed to our partners as either as hard copies or CD and also placed on our new web site. It is the hope that this process would encourage other communities to involve them selves in this very important work.

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APPENDIX A - RAW DATA

Raw Data Chart Legend		
Chart Parameter	**Parameter Definition**	**Notes**
TDN	Total Nitrogen	in µgrams per liter
NO3 + NO2	Nitrates plus Nitrites	in µgrams per liter
NH4	Ammonium	in µgrams per liter
PO4	Phosphate	in µgrams per liter
TP	Total Phosphorous	in µgrams per liter
TSS	Total Suspended Solids	In mgrams per liter
nd	Not detectable	Concentration was less than instrument measuring capability
*	No test	
NTU	Nephelometric turbidity unit	
No flow	No or insufficient flow of water at site	
µg	micrograms	1 millionth of a gram

APPENDIX A - RAW DATA

Sheet (1)			HILO BAY WATERSHED WATER QUALITY DATA									
Shown as	2008	AM/PM	Number	Rain	F°	NTU	N ug/l	N ug/l	N ug/l	P ug/l	P ug/l	mg/l
Wailuku River Upper	Date	Time	Bottle	7 day	Temp	Turbidity	TDN	NO3+NO2	NH4	PO4	TP	TSS
(* No Test Preformed)	2/11	*	13	15.58	*	0.51	63	30	nd	nd	nd	0.36
	2/13	10:27	19	8.02	*	1.00	94	48	nd	nd	nd	0.72
	3/7	14:17	4	T	68°	0.10	100	43	17	nd	4	0.42
	3/17	14:21	10	0.76	65°	1.23	111	31	4	*	4	0.74
	3/28	11:10	21	0.65	68°	0.80	88	37	12	*	5	0.78
	3/31	09:37	28	0.37	69°	0.67	81	31	nd	*	nd	nd
	4/14	07:47	15	3.36	69°	0.67	84	28	nd	*	2	0.74
	4/21	09:22	20	2.19	66°	0.78	73	20	nd	*	4	0.14
	4/28	10:00	2	0.16	69°	2.67	92	41	nd	*	3	2.68
Sheet (2)			HILO BAY WATERSHED WATER QUALITY DATA									
Shown as	2008	AM/PM	Number	Rain	F°	NTU	N ug/l	N ug/l	N ug/l	P ug/l	P ug/l	mg/l
Waiakea Upper	Date	Time	Bottle	7 Day	Temp	Turbidity	TDN	NO3+NO2	NH4	PO4	TP	TSS
Hoaka Road	2/11	09:25	21	15.58	65°	0.73	151	91	nd	nd	nd	1.28
No Flow	3/7											
(* No Test Preformed)	3/18	11:00	20	1.46	65°	3.65	197	49	nd	*	4	2.9
	3/28	08:05	16	0.65	67°	0.83	103	35	7	*	nd	nd
	3/31	08:17	29	0.37	67°	0.27	77	7	7	*	3	0.54
	4/14	13:23	12	3.36	70°	0.39	69	2	nd	*	3	nd
	4/21	08:02	13	2.19	68°	0.98	71	13	nd	*	nd	0.42
	4/28	08:03	BR06	0.16	70°	0.5	67	34	nd	*	nd	0.68
	5/5	12:03	10	1.29	70°	2.58	111	20	27	*	4	*
	5/19	10:10	6	0.29	76°	0.7	104	66	5	nd	4	*
No Flow	6/10											
No Flow	6/25											
No Flow	6/30											

APPENDIX A - RAW DATA

Sheet (3)			HILO BAY WATERSHED WATER QUALITY DATA									
Shown as	**2008**	**AM/PM**	**Number**	**Rain**	**F°**	**NTU**	**N ug/l**	**N ug/l**	**N ug/l**	**P ug/l**	**P ug/l**	**mg/l**
Waiakea Lower	**Date**	**Time**	**Bottle**	**7 Day**	**Temp**	**Turbidity**	**TDN**	**NO3+NO2**	**NH4**	**PO4**	**TP**	**TSS**
By Dentist Office	2/13	09:44	23	8.02	0	0.92	90	55	nd	nd	nd	1.06
No Flow	3/7											
No Flow	3/17											
No Flow	3/28											
No Flow	3/31											
No Flow	4/14											
No Flow	4/21											
No Flow	4/28											
No Flow	5/5											
No Flow	5/19											
No Flow	6/10											
No Flow	6/25											
No Flow	6/30											
Sheet (4)			**HILO BAY WATERSHED WATER QUALITY DATA**									
Shown as	**2008**	**AM/PM**	**Number**	**Rain**	**F°**	**NTU**	**N ug/l**	**N ug/l**	**N ug/l**	**P ug/l**	**P ug/l**	**mg/l**
Alenaio Upper	**Date**	**Time**	**Bottle**	**7 Day**	**Temp**	**Turbidity**	**TDN**	**NO3+NO2**	**NH4**	**PO4**	**TP**	**TSS**
Mohoouli St	2/11	11:04	14	15.58	67°	0.85	189	132	27	nd	nd	0.56
No Flow	3/7											
No Flow	3/17											
No Flow	3/28											
No Flow	3/31											
No Flow	4/14											
No Flow	4/21											
No Flow	4/28											
No Flow	5/5											
No Flow	5/19											
No Flow	6/10											
No Flow	6/25											
No Flow	6/30											

APPENDIX A - RAW DATA

Sheet (5)			HILO BAY WATERSHED WATER QUALITY DATA									
Shown as	**2008**	**AM/PM**	**Number**	**Rain**	**F°**	**NTU**	**N ug/l**	**N ug/l**	**N ug/l**	**P ug/l**	**P ug/l**	**mg/l**
Alenaio Lower	**Date**	**Time**	**Bottle**	**7 Day**	**Temp**	**Turbidity**	**TDN**	**NO3+NO2**	**NH4**	**PO4**	**TP**	**TSS**
Cemetery	2/11	8.52	20	15.58	68°	1.01	128	140	nd	nd	nd	1.26
No Flow	3/7											
No Flow	3/17											
No Flow	3/28											
No Flow	3/31											
No Flow	4/14											
No Flow	4/21											
No Flow	4/28											
Nio Flow	5/5											
No Flow	5/19											
No Flow	6/10											
No Flow	6/25											
No Flow	6/30											
Sheet (6)			**HILO BAY WATERSHED WATER QUALITY DATA**									
Shown as	**2008**	**AM/PM**	**Number**	**Rain**	**F°**	**NTU**	**N ug/l**	**N ug/l**	**N ug/l**	**P ug/l**	**P ug/l**	**mg/l**
Waiakea Pond	**Date**	**Time**	**Bottle**	**7 DAY**	**Temp**	**Turbidity**	**TDN**	**NO3+NO2**	**NH4**	**PO4**	**TP**	**TSS**
(* No Test Preformed)												
Start	3/19	15:37	6	1.38	70°	0.15	512	487	nd	nd	nd	nd
	3/28	15:54	14	0.65	72°	0.08	591	414	13	*	8	nd
	3/31	12:40	27	0.37	74°	0.12	572	380	26	*	7	nd
	4/14	12:50	8	3.36	73°	0.13	444	464	nd	*	3	nd
	4/21	13:55	5	2.19	76°	0.13	445	433	nd	*	2	0.02
	4/28	07:23	18	0.16	72°	0.11	457	462	nd	*	3	nd
	5/19	9:30	20	0.29	74°	0.08	416	461	4	nd	3	*
	6/10	9;00	3	0.35	72°	0.23	390	379	14	nd	nd	*
	6/25	14:40	22	0.77	74°	0.14	449	463	nd	*	nd	*
	6/30	12:30	27	0.31	76°	0.59	445	431	nd	*	nd	*
	7/7	10:05	6BR	0.50	75°	0.38	419	436	nd	*	1	*

APPENDIX A - RAW DATA

Sheet (7)			HILO BAY WATERSHED WATER QUALITY DATA									
Shown as	**2008**	**AM/PM**	**Number**	**Rain**	**F°**	**NTU**	**N ug/l**	**N ug/l**	**N ug/l**	**P ug/l**	**P ug/l**	**mg/l**
Kaumana Spring	**Date**	**Time**	**Bottle**	**7 Day**	**Temp**	**Turbidity**	**TDN**	**NO3+NO2**	**NH4**	**PO4**	**TP**	**TSS**
(* No Test Preformed)												
Start	3/7	12:31	11	T	68°	0.08	490	352	nd	0.004	13	nd
	3/17	13:00	3	0.76	71°	0.55	350	330	nd	*	7	0.04
	3/28	09:20	4	0.65	72°	0.21	438	227	nd	*	5	nd
	3/31	09:10	12	0.37	71°	0.08	424	161	9	*	5	nd
	4/14	08:30	16	3.36	73	0.1	282	265	nd	*	nd	nd
	4/21	08:55	24	2.19	72°	0.14	296	292	nd	*	4	nd
	4/28	09:20	4	0.16	72°	0.09	312	316	nd	*	4	nd
	6/10	10:15	1	0.35	72°	0.08	313	247	23	nd	nd	*
	6/25	15:00	24	0.77	74°	0.09	255	281	nd	*	3	*
	6/30	14:30	26	0.31	74°	0.13	262	276	nd	*	nd	*
	7/7	10:44	BR28	0.50	74°	0.11	258	273	nd	*	nd	*
Sheet (8)			**HILO BAY WATERSHED WATER QUALITY DATA**									
Shown as	**2008**	**AM/PM**	**Number**	**Rain**	**F°**	**NTU**	**N ug/l**	**N ug/l**	**N ug/l**	**P ug/l**	**P ug/l**	**mg/l**
Ainako Stream Middle	**Date**	**Time**	**Bottle**	**7Day**	**Temp**	**Turbidity**	**TDN**	**NO3+NO2**	**NH4**	**PO4**	**TP**	**TSS**
Pung Pasture												
(* No Test Preformed)	3/7	12:11	12	T	67°	0.7	334	206	nd	3	1	1.04
	3/17	13:00	22	0.76	70°	0.55	29	181	6	*	18	1.62
	3/28	09:00	7	0.65	70°	0.82	27	6	nd	*	4	1.42
	3/31	08:35	10	0.37	70°	0.79	252	101	nd	*	4	1.16
Discontinue	4/14											

APPENDIX A - RAW DATA

Sheet (9)			HILO BAY WATERSHED WATER QUALITY DATA									
Shown as	**2008**	**AM/PM**	**Number**	**Rain**	**F°**	**NTU**	**N ug/l**	**N ug/l**	**N ug/l**	**P ug/l**	**P ug/l**	**mg/l**
Ainako Stream Upper	**Date**	**Time**	**Bottle**	**7Day**	**Temp**	**Turbidity**	**TDN**	**NO3+NO2**	**NH4**	**PO4**	**TP**	**TSS**
Ainako Drive												
Start	3/7	13:21	3	T	70°	57	64	55	nd	nd	nd	0.42
(*No Test Preformed)	3/17	13:53	9	0.76	70°	73	79	54	0	*	4	0.96
	3/28	10:29	23	0.65	71°	91	107	54	nd	*	2	0.66
	3/31	09:27	18	0.37	60°	77	86	35	8	*	4	0.46
	4/14	08:06	2	3.36	69°	73	74	53	nd	*	nd	0.76
	4/21	09:15	9	2.19	68°	69	79	48	nd	*	nd	0.56
	4/28	09:45	12	0.16	71°	41	82	53	nd	*	nd	0.66
Sheet (10)			**HILO BAY WATERSHED WATER QUALITY DATA**									
Shown as	**2008**	**AM/PM**	**Number**	**Rain**	**F°**	**NTU**	**N ug/l**	**N ug/l**	**N ug/l**	**P ug/l**	**P ug/l**	**mg/l**
Wailuku River Lower	**Date**	**Time**	**Bottle**	**7Day**	**Temp**	**Turbidity**	**TDN**	**NO3+NO2**	**NH4**	**PO4**	**TP**	**TSS**
(* No Test Preformed)	2/13	10:27	19	8.02	*	0.88	94	48	nd	nd	nd	0.72
	3/7	09:13	9	T	66°	0.73	104	83	nd	3	15	0.54
	3/17	15:28	12	0.76	69°	0.98	102	39	nd	*	4	1.16
	3/28	13:00	19	0.65	70°	1.22	92	29	nd	*	2	0.16
	3/31	11.02	13	0.37	70°	0.82	135	13	nd	*	4	0.58
	4/14	09:57	10	3.36	72°	0.93	113	37	nd	*	3	1.12
	4/21	10:45	3	2.19	70°	2.06	134	22	nd	*	nd	1.38
	4/28	13:05	15	0.16	72°	4.89	112	39	11	*	11	4.18

APPENDIX A - RAW DATA

Sheet (11)			HILO BAY WATERSHED WATER QUALITY DATA									
Shown as	**2008**	**AM/PM**	**Number**	**Rain**	**F°**	**NTU**	**N ug/l**	**N ug/l**	**N ug/l**	**P ug/l**	**P ug/l**	**mg/l**
Chong Bridge	**Date**	**Time**	**Bottle**	**7 Day**	**Temp**	**Turbidity**	**TDN**	**NO3+NO2**	**NH4**	**PO4**	**TP**	**TSS**
	2/11	11:25	22	15.58	68°	1.35	194	130	nd	nd	nd	2.24
No Flow	3/7											
	3/17	14:53	0	0.76	0	0	0	0	0	0	0	0
Combined Waipahoehoe	3/28	11:45	11	0.65	69°	1.01	221	94	nd	*	3	0.16
and Kaluiiki Streams	3/31	10:13	20	0.37	68°	0.57	208	53	nd	*	4	0.42
(* No Test Preformed)	4/14	07:16	7	3.36	70°	0.45	122	97	nd	*	nd	0.26
	4/21	10:05	14	2.19	69°	0.78	124	93	nd	*	3	0.2
	4/28	10:30	19	0.16	70°	0.49	139	92	nd	*	nd	0.52

Sheet (12)			HILO BAY WATERSHED WATER QUALITY DATA									
Shown as	**2008**	**AM/PM**	**Number**	**Rain**	**F°**	**NTU**	**N ug/l**	**N ug/l**	**N ug/l**	**P ug/l**	**P ug/l**	**mg/l**
Akolea Road	**Date**	**Time**	**Bottle**	**7 Day**	**Temp**	**Turbidity**	**TDN**	**NO3+NO2**	**NH4**	**PO4**	**TP**	**TSS**
Kaluiiki Branch	2/11	12:06	7	15.58	68°	0.45	137	122	13	nd	nd	0.56
of Waipahoehoe Stream	3/7	13:17	1	T	72°	0.28	107	95	nd	0	nd	0.1
(* No Test Performed)	3/17	14:35	18	0.76	78°	1.51	166	66	nd	*	3	0.76
	3/28	11:25	17	0.65	72°	0.75	326	167	nd	*	nd	0.18
	3/31	09:59	5	0.37	69°	0.83	282	173	14	*	6	0.34
	4/14	7:29	17	3.36	71°	0.53	120	96	nd	*	nd	0.1
	4/21	9:45	BR9	2.19	72°	0.49	184	160	nd	*	nd	0.12
	4/28	10:16	11	0.16	75°	0.3	197	184	nd	*	nd	0.52

APPENDIX A - RAW DATA

Sheet (13)			HILO BAY WATERSHED WATER QUALITY DATA									
Shown as	**2008**	**AM/PM**	**Number**	**Rain**	**F°**	**NTU**	**N ug/l**	**N ug/l**	**N ug/l**	**P ug/l**	**P ug/l**	**mg/l**
Pukihae Stream Lower	**Date**	**Time**	**Bottle**	**7 Day**	**Temp**	**Turbidity**	**TDN**	**NO3+NO2**	**NH4**	**PO4**	**TP**	**TSS**
(* No Test Performed)	2/13	11:12	6	8.02		2.3	89	53	nd	nd	2	1.04
	3/7	10:01	16	T	70°	0.53	77	18	nd	0	nd	0.04
	3/17	15:30	5	0.76	72°	1.33	114	3	nd	*	5	4.88
	3/28	15:20	2	0.65	72°	1.8	66	2	14	*	8	2.14
	3/31	11:11	9	0.37	71°	1.17	70	2	nd	*	2	0.92
	4/14	10:10	11	3.36	72°	0.94	62	6	nd	*	2	2.1
	4/21	11:00	29	2.19	72°	4.16	54	2	nd	*	4	3.98
	4/28	13:16	7	0.16	74°	1.19	76	2	nd	*	nd	1.86

Sheet (14)			HILO BAY WATERSHED WATER QUALITY DATA									
Shown as	**2008**	**AM/PM**	**Number**	**Rain**	**F°**	**NTU**	**N ug/l**	**N ug/l**	**N ug/l**	**P ug/l**	**P ug/l**	**mg/l**
Maile Stream Upper	**Date**	**Time**	**Bottle**	**7 Day**	**Temp**	**Turbidity**	**TDN**	**NO3+NO2**	**NH4**	**PO4**	**TP**	**TSS**
(* No Test Performed)	2/13	16:12	17	8.02	*	1.72	74	24	nd	nd	nd	1.2
	3/7	10:27	24	T	64°	0.5	44	12	nd	nd	nd	0.52
	3/17	15:45	13	0.76	70°	1.23	91	4	2	*	3	0.9
	3/28	13:16	1	0.65	69°	1.99	49	4	nd	*	3	1.02
	3/31	11:25	22	0.37	68°	1.4	55	2	nd	*	2	0.92
	4/14	10:30	19	3.36	70°	1.57	57	2	nd	*	nd	2.72
	4/21	11:15	27	2.19	69°	5.54	62	3	nd	*	5	3.36
	4/28	13:32	16	0.16	72°	1.88	47	5	nd	*	nd	2.3

APPENDIX A - RAW DATA

Sheet (15)			HILO BAY WATERSHED WATER QUALITY DATA									
Shown as	2008	AM/PM	Number	Rain	F°	NTU	N ug/l	N ug/l	N ug/l	P ug/l	P ug/l	mg/l
Maile Stream Lower	Date	Time	Bottle	7 Day	Temp	Turbidity	TDN	NO3+NO2	NH4	PO4	TP	TSS
(* No Test Performed)	2/13	15:36	2	8.02		1.62	295	95	14	2	9	0.98
	3/7	11:36	5	T	68°	0.55	241	78	16	3	2	0.82
	3/17	16:13	8	0.76	70°	0.88	118	45	9	*	3	0.94
	3/28	13:58	24	0.65	71°	1.77	111	21	15	*	3	2.46
	3/31	11:40	26	0.37	72°	1.2	122	18	9	*	9	2.04
	4/14	11:04	6	3.36	74°	1.63	74	18	nd	*	4	2.04
	4/21	12:00	26	2.19	72°	5.03	79	22	nd	*	7	3.62
	4/28	14:10	21	0.16	74°	2.14	122	28	30	*	5	3.58
Sheet (16)			HILO BAY WATERSHED WATER QUALITY DATA									
Shown as	2008	AM/PM	Number	Rain	F°	NTU	N ug/l	N ug/l	N ug/l	P ug/l	P ug/l	mg/l
Honolii stream Lower	Date	Time	Bottle	7 Day	Temp	Turbidity	TDN	NO3+NO2	NH4	PO4	TP	TSS
(* No test Performed)	2/13	15:20	15	8.02		1.25	91	32	13	nd	nd	1.48
	3/7	11:05	18	T	70°	0.61	68	7	nd	nd	nd	0.26
	3/17	15:51	2	0.76	70°	2.36	58	3	12	*	5	1.88
	3/28	13:39	15	0.65	69°	2.98	88	3	11	*	4	1.68
	3/31	11:44	3	0.37	70°	1.32	101	3	nd	*	6	1.1
	4/14	10:51	21	3.36	72°	1.91	68	2	nd	*	nd	1.76
	4/21	11:48	28	2.19	70°	6.26	67	nd	nd	*	nd	2.7
	4/28	14:00	17	0.16	74°	3.82	90	4	14	*	nd	2.66

APPENDIX A - RAW DATA

Sheet (17)			HILO BAY WATERSHED WATER QUALITY DATA									
Shown as	**2008**	**AM/PM**	**Number**	**Rainfall**	**F°**	**NTU**	**N mg/l**	**N mg/l**	**N mg/l**	**P mg/l**	**P mg/l**	**mg/l**
Waiolama Spring	**Date**	**Time**	**Bottle**	**7 Day**	**Temp**	**Turbidity**	**TDN**	**NO3+NO2**	**NH4**	**PO4**	**TP**	**TSS**
(* No Test Performed)												
First Sample	4/14	11:25	23	3.36	74°	0.39	858	785	nd	*	4	1.76
	4/21	13:20	22	2.19	76°	0.21	805	850	11	*	nd	nd
	4/28	14:30	8	0.16	74°	0.08	764	718	11	*	nd	0.3
	5/19	9:12	5	0.29	74°	0.11	758	750	nd	nd	3	*
	6/10	8:37	13	0.35	74°	0.1	598	489	nd	nd	nd	*
	6/25	13:50	22	0.77	74°	0.08	603	564	nd	*	nd	*
	6/30	11:45	29	0.31	76°	0.97	595	609	nd	*	nd	*
	7/7	9:45	BR14A	0.50	74°	0.11	585	613	nd	*	nd	*
Sheet (18)			**HILO BAY WATERSHED WATER QUALITY DATA**									
Shown as	**2008**	**AM/PM**	**Number**	**Rain**	**F°**	**NTU**	**N ug/l**	**N ug/l**	**N ug/l**	**P ug/l**	**P ug/l**	**mg/l**
Ainako Stream Lower	**Date**	**Time**	**Bottle**	**7 Day**	**Temp**	**Turbidity**	**TDN**	**NO3+NO2**	**NH4**	**PO4**	**TP**	**TSS**
Wainuenue Ave												
First Sample	3/7	13:42	10	T	69°	1.13	267	220	nd	nd	2	1.4
(* No Test Performed)	3/17	15:05	14	0.76	70°	1.49	230	188	nd	*	5	2.62
	3/28	15:07	6	0.65	72°	1.87	302	159	nd	*	4	2.1
	3/31	10:24	8	0.37	71°	1.43	281	101	nd	*	6	1.78
	4/14	09:10	4	3.36	71°	0.82	209	118	nd	*	nd	1.22
	4/21	10:24	BR14	2.19	71°	0.95	165	144	nd	*	7	1.22
	4/28	10:50	23	0.16	72°	1.21	212	151	nd	*	9	2.71

APPENDIX B - FINANCIAL DATA

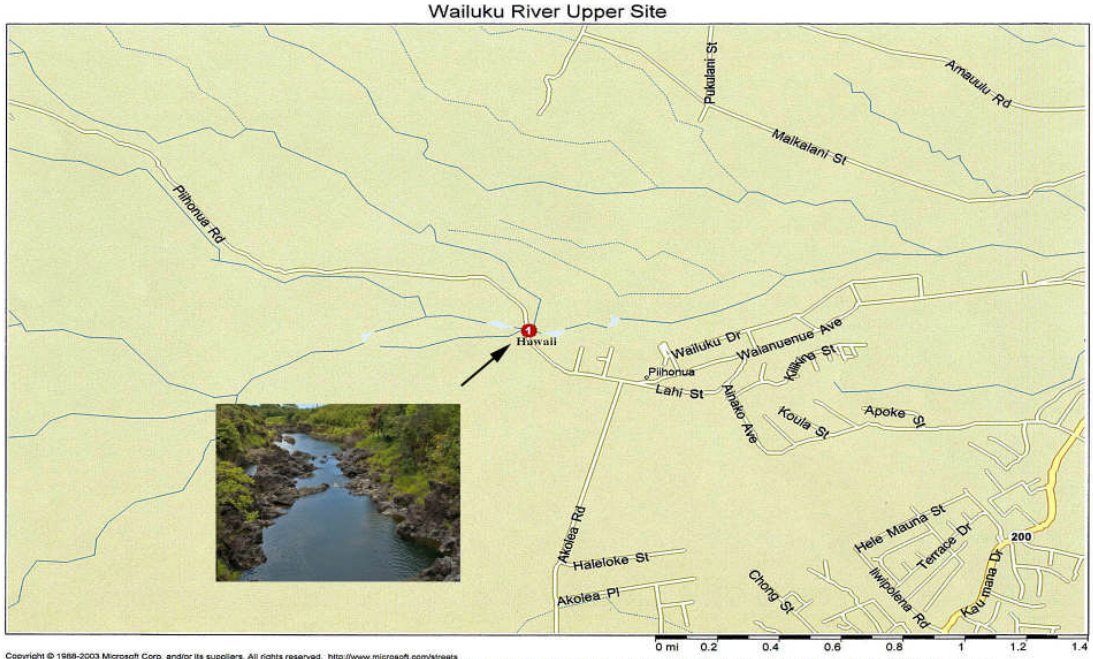
HBWAG water monitoring project budget vs. actual thru June 2008

	Budgeted	Actual to date	Over/under	% over
ORMP Grant				
Turbidity equipment	880	1001.55	121.55	13.8%
Sample bottles	80	78	-2	-2.5%
UHH analyses	3600	3530	-70	-1.9%
March		390		
April		1560		
May		1280		
June		300		
BIRC&D Admin fee	460	502	42	9.1%
ORMP Grant Subtotal	5020	5111.55	91.55	1.8%
Match				
Planning staff	1227.20	836.51		
HBWAG volunteers	4428.00	4723.20		
Match subtotal	5655.20	5559.71		

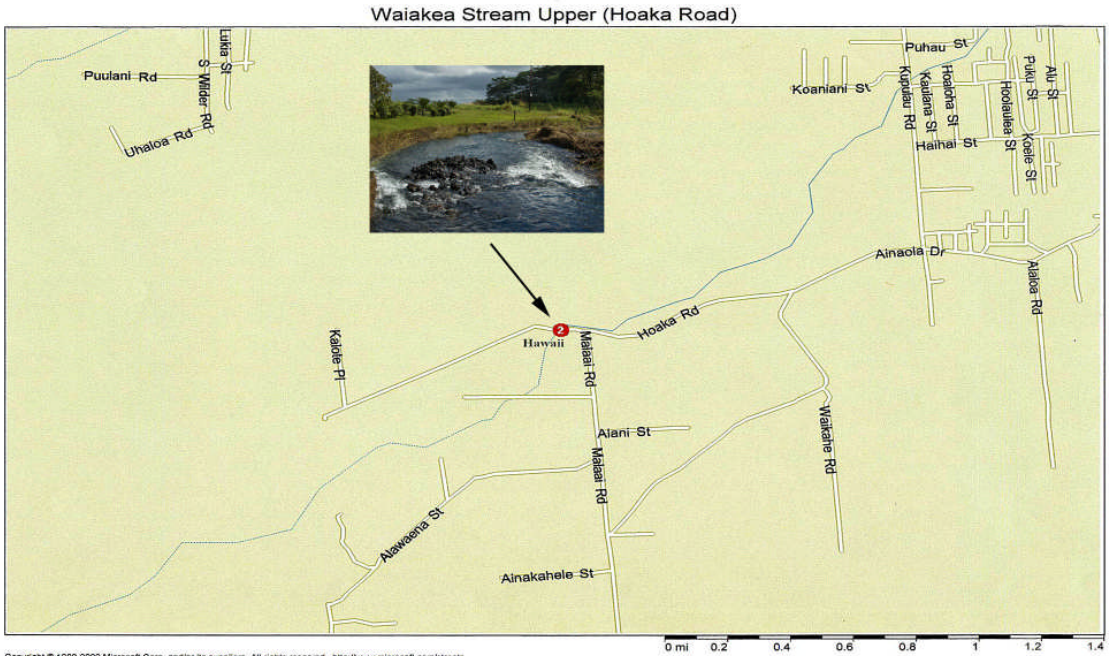
Note: Over 400 miles were driven in executing this project

APPENDIX C - SITE MAPS

Wailuku River Upper Site

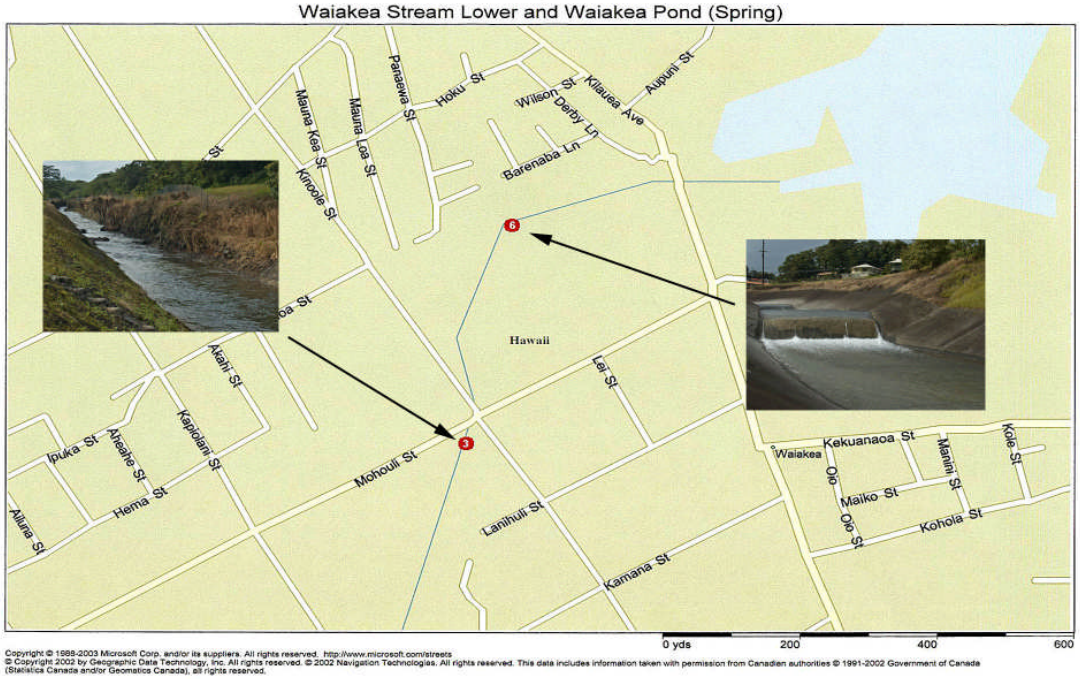


Waiakea Stream Upper (Hoaka Road)

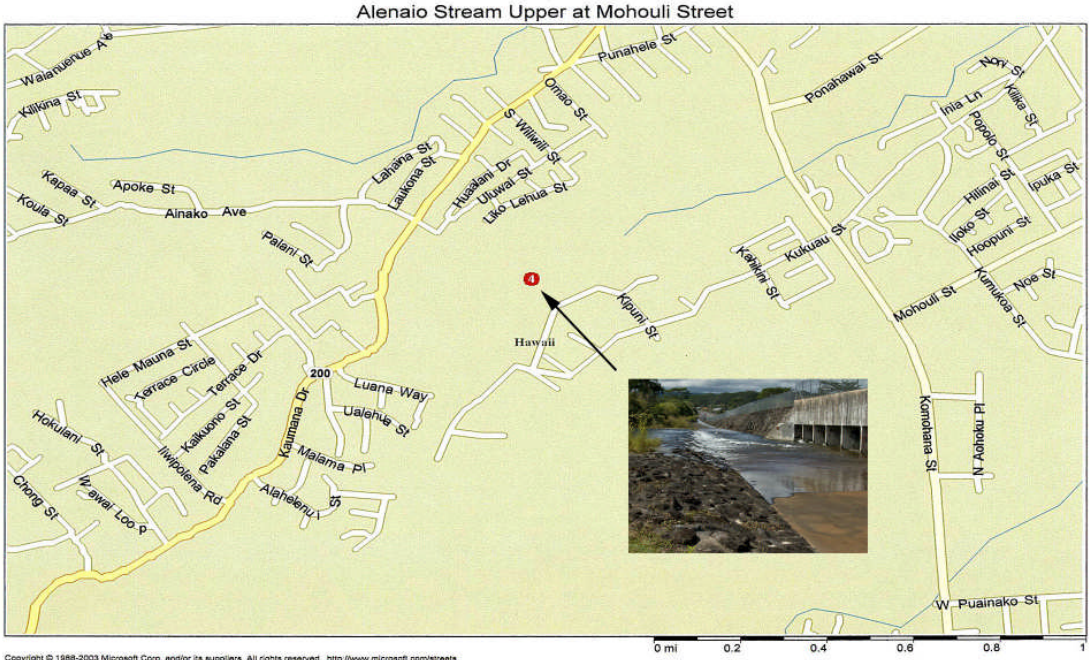


APPENDIX C - SITE MAPS

Waiakea Stream Lower and Waiakea Pond (Spring)

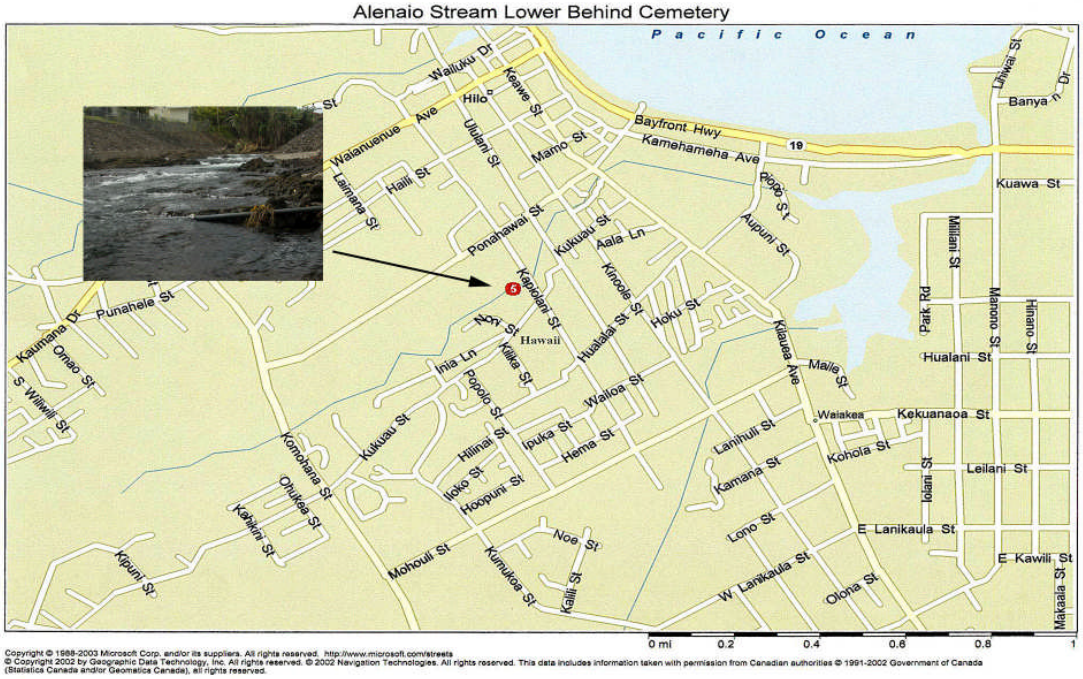


Alenaio Stream Upper at Mohouli Street

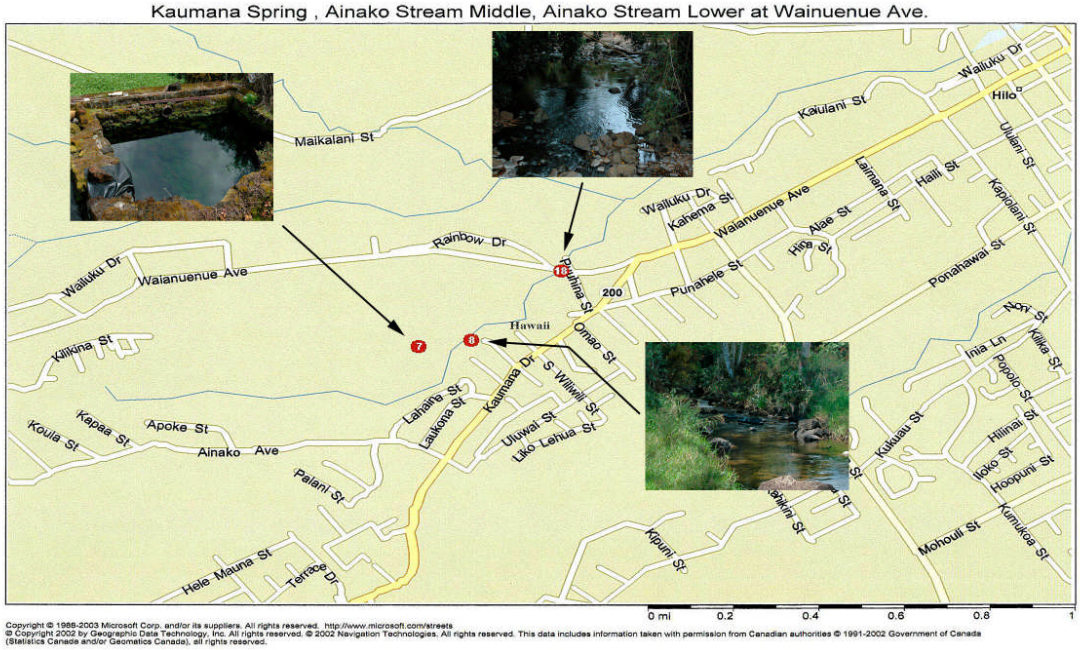


APPENDIX C - SITE MAPS

Alenaio Stream Lower Behind Cemetery

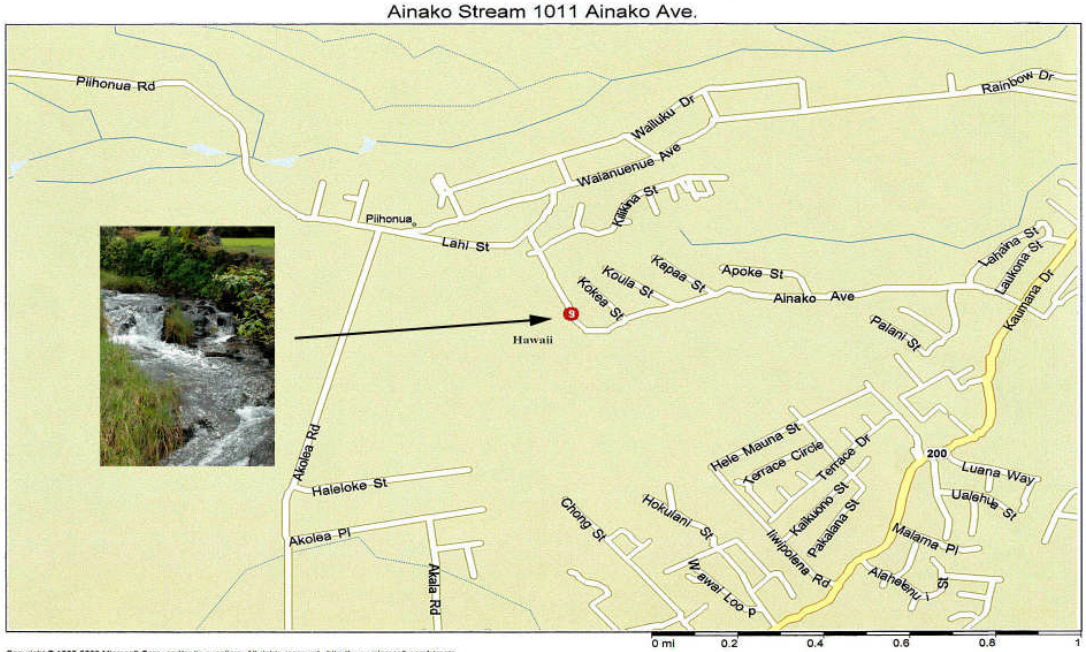


Kaumana Spring , Ainako Stream Middle, Ainako Stream Lower at Wainuenue Ave.

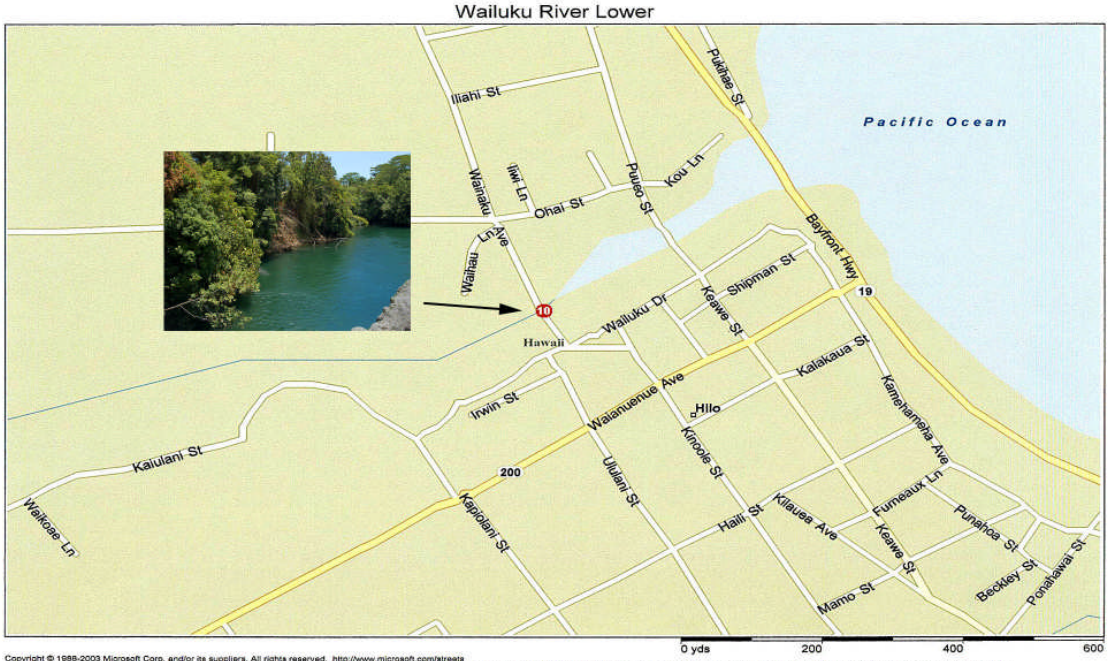


APPENDIX C - SITE MAPS

Ainako Stream 1011 Ainako Ave.



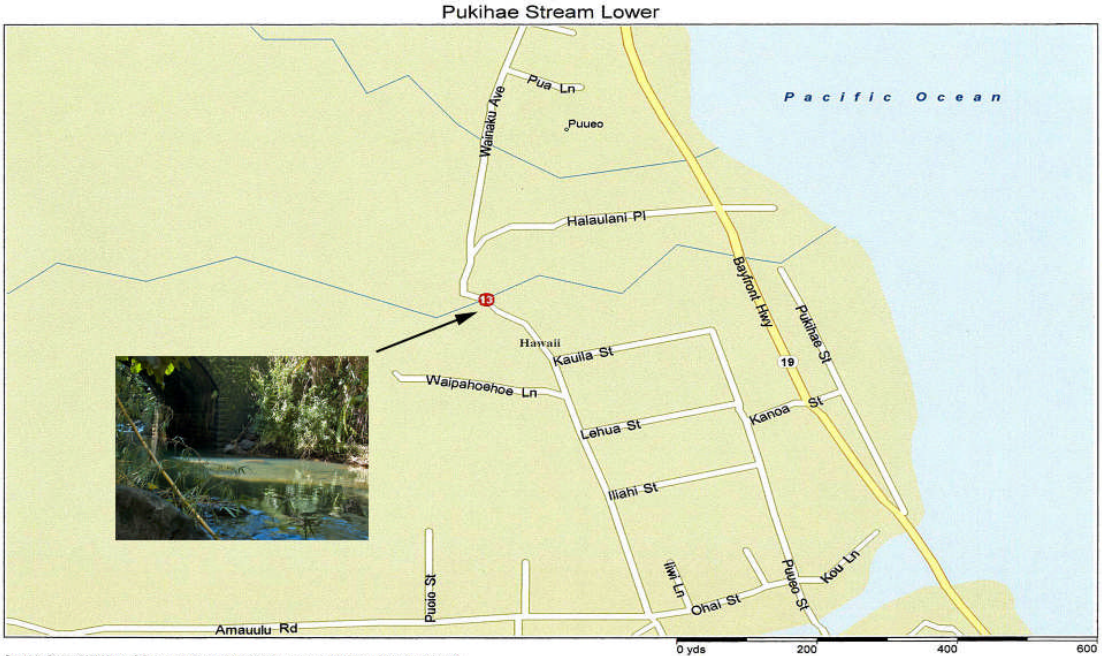
Wailuku River Lower



APPENDIX C - SITE MAPS

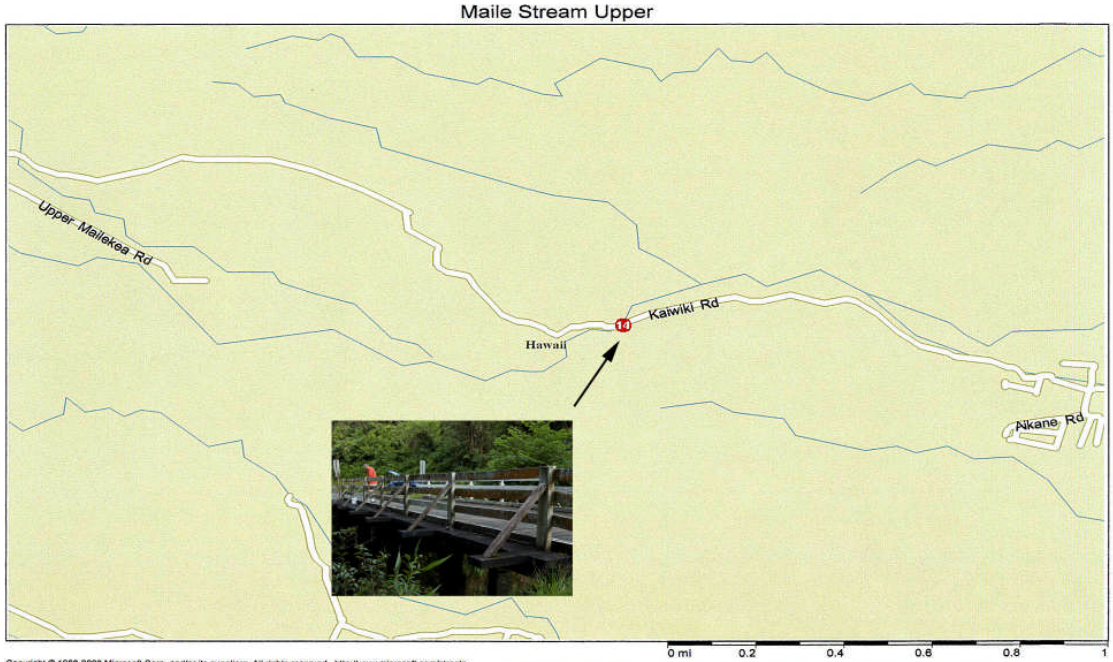
Kaluiiki Branch (Akolea Road) and Waipahoehoe Stream (Chong Bridge)

Pukihae Stream Lower

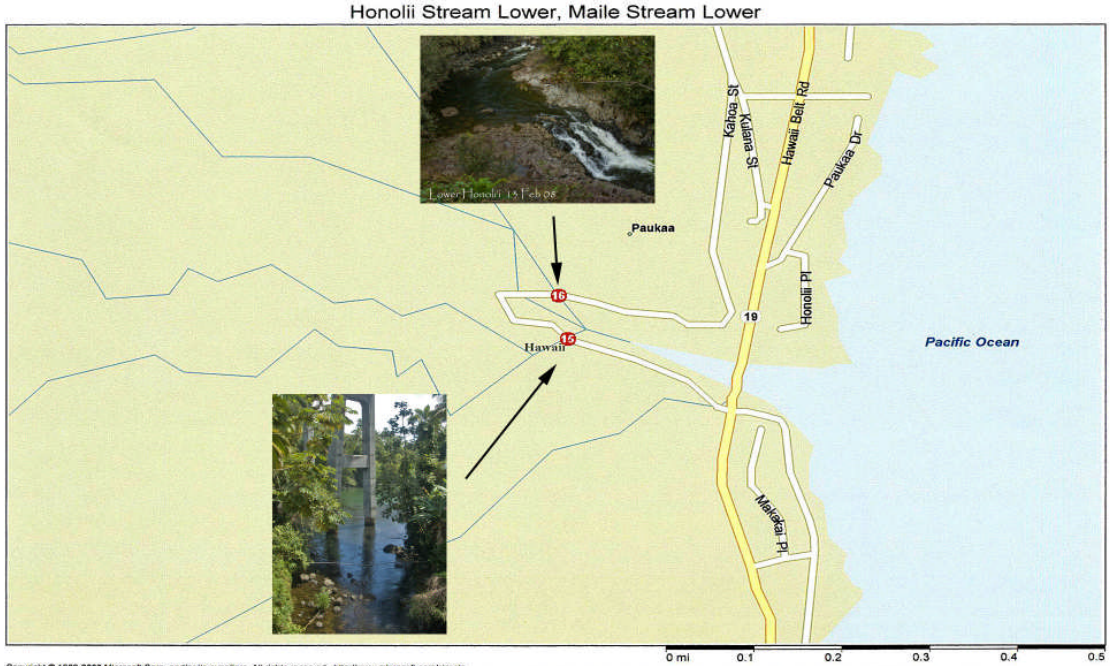


APPENDIX C - SITE MAPS

Maile Stream Upper



Honolii Stream Lower, Maile Stream Lower



APPENDIX C - SITE MAPS