STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT
P.O. BOX 621
HONOLULU, HAWAII 96809

STAFF SUBMITTAL

For the meeting of the
COMMISSION ON WATER RESOURCE MANAGEMENT

May 25, 2010
Paia, Maui

Petitions to Amend the Interim Instream Flow Standards
For the Surface Water Hydrologic Units of
Waikamoi (6047), Puohokamoa (6048), Haipuaena (6049), Punalau (6050),
Honomanu (6051), Nuaailua (6052), Ohia (6054), West Wailuaiki (6057),
East Wailuaiki (6058), Kopiliula (6059), Waiohue (6060), Paakea (6061),
Waiaaka (6062), Kapaula (6063), Hanawi (6064), and Makapipi (6065), Maui

PETITIONER:

Na Moku Aupuni O Koolau Hui
c/o Native Hawaiian Legal Corp.
1164 Bishop Street
Honolulu, HI 96813

LOCATION MAP: See Figure 1

SUMMARY OF REQUEST:

Staff is requesting that the Commission consider the recommendations for 19 Petitions to Amend the Interim Instream Flow Standards (Interim IFS) for streams contained within the following 16 surface water hydrologic units in the region of east Maui (See Figure 1).

WAIKAMOI (6047): Waikamoi Stream, Alo Stream, and Wahinepee Stream
PUOHOKAMOA (6048): Puohokamoa Stream
HAIPUAENA (6049): Haipuaena Stream
PUNALAU (6050): Punalau/Kolea Stream
HONOMANU (6051): Honomanu Stream
NUAAILUA (6052): Nuaailua Stream
OHIA (6054): Ohia (Waianu) Stream
WEST WAILUAIKI (6057): West Wailuaiki Stream

EAST WAILUAIKI (6058): East Wailuaiki Stream
KOPILIULA (6059): Kopiliula Stream and Puakaa Stream
WAIOHUE (6060): Waiohue Stream
PAAKEA (6061): Paakea Stream
WAIAAKA (6062): Waiaaka Stream
KAPAULA (6063): Kapaula Stream
HANAWI (6064): Hanawi Stream
MAKAPIPI (6065): Makapipi Stream

BACKGROUND:

On May 24, 2001, Native Hawaiian Legal Corporation (NHLC), on behalf of Na Moku Aupuni O Koolau Hui (Na Moku), Beatrice Kepani Kekahuna, Marjorie Wallett, and Elizabeth Lehua Lapenia[1], filed 27 Petitions to Amend the Interim Instream Flow Standards for 27 East Maui streams.

On July 23, 2001, NHLC met with Commission staff to discuss the handling of the 27 petitions. Agreement was reached that efforts would focus on Honopou, Hanehoi, Waiokamilo, Kualani, Piinaau, Palauhulu, and Wailuanui Streams. Subsequent efforts by the Commission to adopt surface water hydrologic units for the purpose of improving surface water resource management resulted in the grouping of the eight petitioned streams into five hydrologic units. The State Water Code (Code), Chapter 174C, Hawaii Revised Statutes (HRS), provides that the Commission may adopt interim IFS on a stream-by-stream basis or a general IFS applicable to all streams within a specified area. This submittal seeks to address the remaining 19 petitions, grouped into 16 hydrologic units, as petitioned by NHLC.

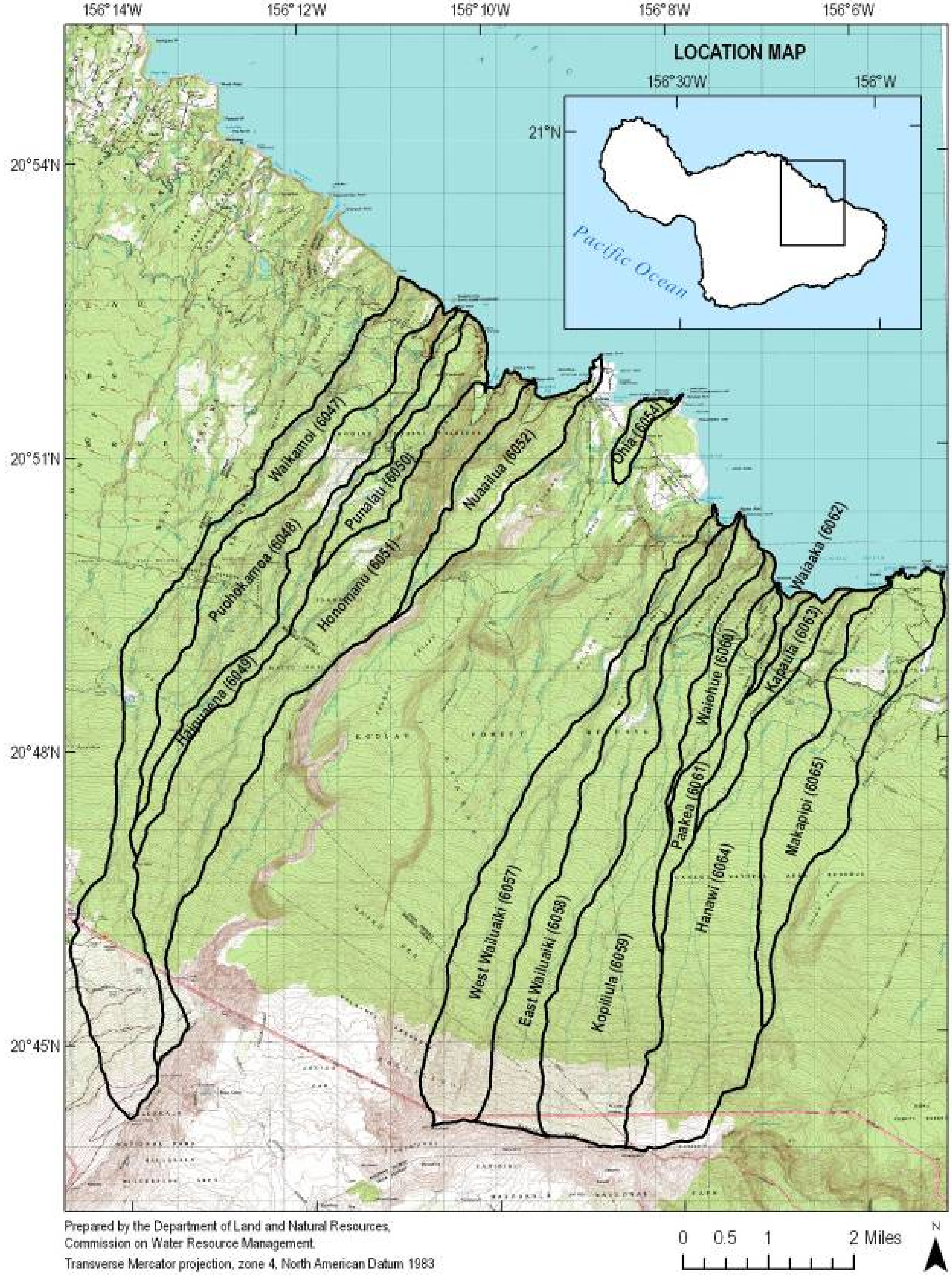
The current interim instream flow standard (interim IFS) for the streams being considered were established by way of Hawaii Administrative Rules (HAR) §13-169-44, which, in pertinent part, reads as follows:

> Interim instream flow standard for East Maui. The Interim Instream Flow Standard for all streams on East Maui, as adopted by the commission on water resource management on June 15, 1988, shall be that amount of water flowing in each stream on the effective date of this standard, and as that flow may naturally vary throughout the year and from year to year without further amounts of water being diverted offstream through new or expanded diversions, and under the stream conditions existing on the effective date of the standard.

The current interim IFS became effective on October 8, 1988. Thus, the status quo interim IFS, in effect, grandfathered all existing diversions that were registered with the Commission in subsequent years. Following the initial registration of stream diversions works, any new or modified stream diversion works structure requires a permit for construction.

[1] The Commission was notified by letter on May 10, 2007, that NHLC "no longer represent Ms. Lapenia and are, therefore, no longer authorized to advance the claim with respect to the parcel identified as TMK: 2-9-008:31 or LCAw-S-1 Claimant: Naoo on her behalf."

Figure 1: Location map of Waikamoi, Puohokamoa, Haipuaena, Punalau, Honomanu, Nuaailua, Ohia, West Wailuaiki, East Wailuaiki, Kopiliula, Waiohue, Paakea, Waiaaka, Kapaula, Hanawi, and Makapipi Surface Water Hydrologic Units, Maui.



Under the Code, the Commission has the responsibility of establishing IFS on a stream-by-stream basis whenever necessary to protect the public interest in the waters of the State. In the Waiahole Ditch Contested Case Decision and Order (Waiahole), the Hawaii Supreme Court emphasized that "instream flow standards serve as the primary mechanism by which the Commission is to discharge its duty to protect and promote the entire range of public trust purposes dependent upon instream flows."

The Code defines an instream flow standard as a "quantity or flow of water or depth of water which is required to be present at a specific location in a stream system at certain specified times of the year to protect fishery, wildlife, recreational, aesthetic, scenic, and other beneficial instream uses. In considering a petition to amend an interim instream flow standard, the Code directs the Commission to "weigh the importance of the present or potential instream values with the importance of the present or potential uses of water for noninstream purposes, including the economic impact of restricting such uses."

"Instream use" means beneficial uses of stream water for significant purposes which are located in the stream and which are achieved by leaving the water in the stream. Instream uses (listed in no particular order) include, but are not limited to:

1) Maintenance of fish and wildlife habitats;
2) Outdoor recreational activities;
3) Maintenance of ecosystems such as estuaries, wetlands, and stream vegetation;
4) Aesthetic values such as waterfalls and scenic waterways;
5) Navigation;
6) Instream hydropower generation;
7) Maintenance of water quality;
8) The conveyance of irrigation and domestic water supplies to downstream points of diversion; and
9) The protection of traditional and customary Hawaiian rights.

"Noninstream use" means the use of stream water that is diverted or removed from its stream channel and includes the use of stream water outside of the channel for domestic, agricultural, and industrial purposes.

On September 25, 2008, the Commission approved, with amendments, the recommendations to amend the interim IFS for five of the 21 total surface water hydrologic units covered by the 27 east Maui petitions. The combined streamflow restoration the Commission approved amounted to a combined estimate of 7 cfs (4.5 mgd).

Various events leading up to and following the Commission action on September 25, 2008 are provided in Exhibit 2, Staff Submittal for the Meeting of the Commission on Water Resource Management, December 16, 2010, Paia, Maui, Petitions to Amend the Interim Instream Flow Standards for the Surface Water Hydrologic Units of Waikamoi (6047), Puohokamoa (6048), Haipuaena (6049), Punalau (6050), Honomanu (6051), Nuaailua (6052), Ohia (6054), West Wailuaiki (6057), East Wailuaiki (6058), Kopiliula (6059), Waiohue (6060), Paakea (6061), Waiaaka (6062), Kapaula (6063), Hanawi (6064), and Makapipi (6065), Maui.

On December 16-17, 2009, Commission staff presented its submittal to address the interim instream standards for the remaining 16 surface water hydrologic units. Following considerable testimony and discussions with various stakeholders, the Commission deferred action on the submittal and directed staff to collect additional information from key stakeholders in the categories of short term, mid term, and long term issues.

The additional data submitted, as requested by the Commission, is provided in Exhibit 3 as the Compilation of Data Submissions, Part II, PR-2010-01. This staff submittal specifically addresses the key points that the Commission sought clarification on and provides two streamflow restoration approaches (seasonal and annual) to address the needs of native stream organisms and cultural gathering practices.

ISSUES/ANALYSIS:

This section of the submittal begins with general considerations of issues that broadly apply to the development of interim IFS for the 16 surface water hydrologic units (Figure 1). The analysis presented is based on additional information that was collected following the December 16-17, 2009 Commission meeting, and should be considered together with the analysis presented in the December 2009 submittal (Exhibit 2). Data summary sheets for each specific hydrologic unit and stream are provided in Exhibit 1.

System Loss Considerations. The 75-mile long East Maui Irrigation Co. (EMI) System consists of approximately 50 miles of tunnel and 25 miles of open ditch, which collect and transport surface water from Nahiku to Maliko Gulch at which point it enters the Hawaiian Commercial and Sugar (HC&S) plantation. Roughly 50 miles of the system is lined to reduce seepage and evaporative losses in the tunnels are essentially eliminated due to the non-exposure to sunlight or wind. While an exact system loss figure cannot be determined, HC&S cites an American Water Works Association survey that indicates municipal water systems (closed pipe systems) typically experience between 10- to 15-percent of unaccounted water loss. In their data submission, HC&S offers two options for determining system loss which range from an inexpensive system classification approach to a very costly (~$15 million) and accurate gaging approach. Regardless, EMI does conduct regular inspection and repair/maintenance of the entire system to minimize losses. These efforts are aided by 12 telemetry stations which enable remote monitoring of the entire ditch system.

Once at the HC&S plantation, east Maui water is used in conjunction with 36 reservoirs that serve the plantation and range in size from 1 million to 80 million gallons. Of these 36 reservoirs, 31 are unlined. HC&S was unable to provide current studies documenting system loss from the reservoirs. However, they did provide data from seepage runs conducted in the 1960s which estimated loss at 23 to 31 mgd. Those studies were conducted when HC&S utilized furrow irrigation and all reservoirs were storing water for longer periods. Current operations geared towards drip-irrigation use the reservoirs mainly as collection points where water is only stored for short periods and conveyed to the plant as soon as possible, thereby limiting water loss to less than the average amount of 23 to 31 mgd. HC&S believes that most of the current water loss (due to increased infiltration) occurs during high rainfall periods when water levels in the reservoirs are higher and water is stored for a greater length of time.

HC&S notes that the reservoirs are a carry-over from furrow irrigation practices when they were constructed to fill and store water overnight for watering adjacent fields the next morning. The amount of water lost can vary with reservoir size, underlying geology, and operational practices. The maximum storage capacity, normal operating capacity, lining, and range of estimated water loss for each reservoir are provided in Exhibit 3, Section 2.0. HC&S estimates the cost to line all 31 unlined reservoirs with polypropylene at $43.5 million.

Maui County Department of Water Supply (Maui DWS) estimates their system loss for the Upcountry Maui systems to be approximately 14-percent. An on-going leak detection program surveyed 14.1 miles of pipe (of a total 270 miles) in the Upcountry system during Fiscal Year (FY) 2009. The survey rate is expected to increase considerably by FY 2011.

Of particular concern are the system losses from the wooden Waikamoi Flume, which Maui DWS indicates cannot be accurately determined at this time. EMI personnel assist with inspection of the flume system and stream intakes on a regular basis, and in turn report leaks to Maui DWS to perform repairs. Periodic inspections are also performed by Maui DWS crews. Rehabilitation of the wooden Waikamoi Flume that serves the Maui DWS' Olinda Water Treatment Facility could undoubtedly increase available surface water supplies.

Maui DWS asserts that they do intend to consult with Commission staff to establish a monitoring program of system losses, and $500,000 has also been committed to the Waikamoi Flume Rehabilitation Design project in the current fiscal year. As of March 8, 2010, a design consultant was selected and has conducted a site inspection to prepare a proposal for the county. The Commission staff believes that rehabilitation of the Waikamoi Flume is of utmost importance in providing a more reliable source of water from existing surface water diversions and may help to maintain water levels in the existing Waikamoi and Kahakapao Reservoirs.

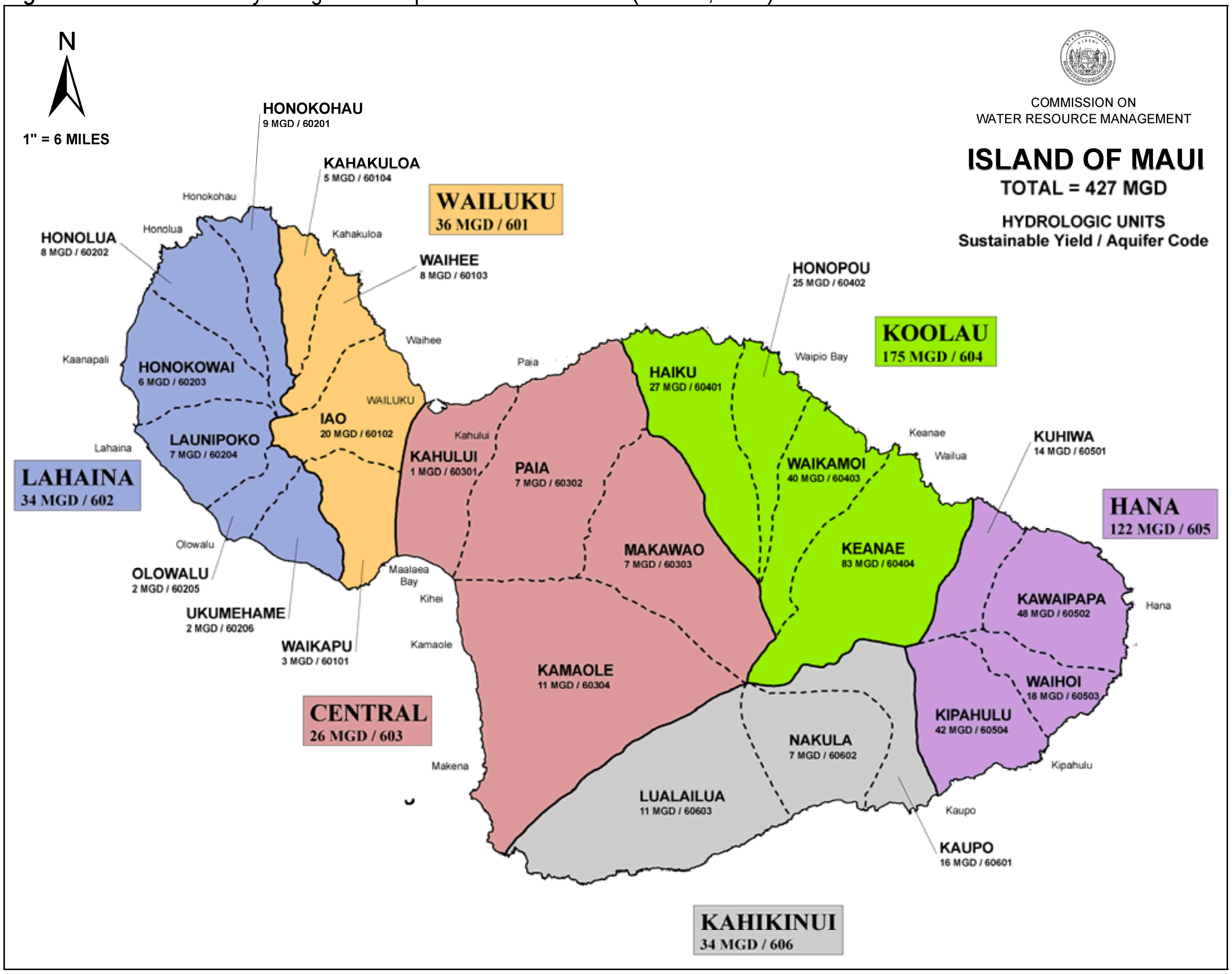
Ground Water Considerations. Based on water use data, the Commission is aware that ground water pumpage regularly exceeds the estimated ranges of sustainable yields in the Paia and Kahului Aquifer System Areas. Table 1 provides the 12-month moving average (12-MAV) of reported ground water pumpage as of December 2008 in comparison to the sustainable yields of each aquifer system in the Central sector (See Figure 2 for map of Maui ground water hydrologic units).

Table 1. Sustainable yields and reported 12-MAV pumpage rates for the Central Aquifer Sector as of December 2008. [mgd = million gallons per day]

Aquifer Code	Aquifer System	Sustainable Yield Range (mgd)	12-MAV Pumpage (mgd)
60301	Kahului	1 - 11	26.22
60302	Paia	7 - 25	33.55
60303	Makawao	7 - 18	0.78
60304	Kamaole	11 - 14	1.33

The Commission has officially adopted the minimums of the ranges as the sustainable yields due to lack of deep monitoring wells in those areas and the potential effects of drought without agricultural return irrigation (i.e. no importation of East Maui surface water).

Figure 2. Ground water hydrologic unit map of the Island of Maui (CWRM, 2008).



The current contribution of return irrigation recharge to the aquifer system areas from large-scale plantations and leakage from reservoirs and ditches[2] are represented in the upper range of the sustainable yields. This is supported by US Geological Survey's (USGS) study on the *Effects of Agricultural Land-Use and Rainfall on Ground-Water Recharge, Central and West Maui 1926-2004*[3]. Spillover from the Makawao Aquifer System Area to down-gradient aquifer system areas, as in the case of Paia, may help to explain why pumpage exceeds the range of sustainable yields without the drastic salinity problems one would expect. The Commission is currently working with USGS to further explore this issue specifically for the Paia and Kahului Aquifer System Areas.

In response to the Commission's request for additional information, HC&S provided summaries of their 16 brackish water wells used to irrigate the plantation. Based on data from 1986-2009, total pumpage from the 16 wells averaged 72 million gallons per day (mgd) and ranged from a

[2] State of Hawaii, Commission on Water Resource Management. (2008). Hawaii Water Plan: Water Resource Protection Plan. Department of Land and Natural Resources, Commission on Water Resource Management, 556 p.
[3] Engott, J.A., and Vana, T.T. (2007). Effects of Agricultural Land-Use Changes and Rainfall on Ground-Water Recharge in Central and West Maui, Hawaiʻi, 1926–2004: U.S. Geological Survey Scientific Investigations Report 2007–5103, 56 p.

January average of 27 mgd to an October average of 112 mgd. The pump capacity and estimated costs per million gallons pumped for each well is provided in Exhibit 3, Section 2.0.

In the case of Maui DWS, the Commission had specifically asked the County to consider a plan for shifting Upcountry Maui reliance on surface water from 85-percent to a more even balance between surface water and ground water. The Draft County Water Use and Development Plan outlines five strategies to meet anticipated Upcountry demands. The first strategy, referred to as the “Reference Strategy” calls for incremental basal well development as needed. Using the “Reference Strategy” as a baseline, Maui DWS explained that developing more ground water sources to reduce surface water demands would cost over $117 million over a 25-year planning period, $85 million of which could be attributed to electricity costs. All five strategies, including: a) Incremental basal well development; b) Expansion of raw water storage capacity; c) Drought proof full basal well backup; d) Improved Kamole Water Treatment Plant Capacity; and e) Limited growth with extensive conservation measures; are presented by Maui DWS in Exhibit 3, Section 3.0.

Based on the information presented, it appears that increasing reliance on ground water while simultaneously reducing surface water supplies may not be a feasible alternative. For Maui DWS, additional water is available from the Makawao aquifer system; however, the high cost of pumping to meet Upcountry demands may be financially burdensome on Maui’s limited customer base. Maui DWS should continue to explore water source development alternatives as technology advances.

Conversely, ground water resources currently available to HC&S are already being overpumped and it would be difficult for HC&S to sustain, or even increase, their use of brackish ground water resources should surface water for irrigation be considerably reduced. The current reported pumpages from the Paia and Kahului Aquifer Systems far exceed the sustainable yields, and is largely attributable to irrigation recharge by east Maui surface water.

Alternative Water Source Considerations. Both Maui DWS and HC&S provided the Commission with summaries of potential alternative water sources. Maui DWS identified four alternatives including the exchange of Hamakuapoko Well water for Wailoa Ditch water for municipal use, use of recycled water from wastewater treatment plants on the Upcountry system (does not currently exist), use of reclaimed stormwater (currently being studied by the U.S. Department of Agriculture’s Natural Resources Conservation Service), and various strategies outlined in the County Water Use and Development Plan to meet increasing Upcountry demands.

HC&S identified six alternatives consisting of wastewater reclamation, catchment, stormwater reclamation, desalination, development of new wells, and weather modification. Each alternative was determined to be of limited value either due to lack of infrastructure, high development costs, ineffectiveness, or a combination thereof. Exhibit 3 includes details for each of the alternatives presented by both HC&S (Section 2.0) and Maui DWS (Section 3.0).

Interim IFS Approach Considerations. As directed by the Commission, staff considered two different approaches to establish and implement interim IFS in the subject east Maui streams. The annual approach seeks to maintain a measurable flow standard in the stream year round, while the seasonal approach considers seasonal rainfall patterns in central Maui resulting in lower offstream needs for surface water during the wet season. The Code definition for IFS as a "quantity or flow of water or depth of water which is required to be present at a specific location in a stream system at certain specified times of the year…", supports both annual and seasonal approaches. A comparison of the annual interim IFS approach and the seasonal interim IFS approach is provided below.

Annual approach

Similar to the interim IFS staff recommendations adopted in the September 2008 Commission decision, the annual approach is to establish and implement a single measurable flow standard that remains in the stream year-round, unless the natural flow is less in which case the interim IFS is the natural flow of the stream.

Increased streamflow is commonly believed to occur in the winter season when rainfall is high. However, rainfall in east Maui follows a different pattern. Rain gage stations in Puohokamoa, Keanae, Paakea, and Kailua[4] show that high rainfall occurs throughout the year and does not follow the typical wet winter - dry summer trend (Figure 3). Streamflow records for the east Maui streams also show a similar monthly pattern. Figure 4 illustrates the monthly streamflow trends for Puohokamoa (USGS station 16545000), West Wailuaiki (USGS station 16518000), Paakea (USGS station 16514000), and Hanawi Streams (USGS 16508000). All four streamflow trends show lack of a seasonal flow pattern and that high streamflow generally occurs in the months of March, April, May, July August, and December.

Under the annual approach, an amount of flow set by the interim IFS would be released downstream in the high streamflow periods that are observed on average 6 months out of the year (Figure 4). During the dry periods when streamflow is low, available flow in the stream would flow downstream. From a streams perspective, the annual approach would restore streamflow to its natural streamflow pattern for the full year that is characteristic of east Maui streams. This pattern is not of a well-defined seasonal trend, but one that varies throughout the year.

The annual interim IFS approach would also help to restore the natural life cycle of the native stream biota in east Maui. Native amphidromous species respond to the natural flow regime in which increased streamflow triggers spawning, recruitment, upstream and downstream migration. In the drier periods, these animals can only exist in shallow pools without major growth and reproduction. According to the Division of Aquatic Resources (DAR), management actions that mimic natural flow patterns with both high and low flows are likely to sustain suitable instream habitats and amphidromous animal populations (see PR-2009-19 Revised, Section 20.0). DAR has calculated the minimum flow to maintain minimum viable habitat for stream animals (H_{min}) in the wet season and minimum flows to maintain minimum connectivity for animals to survive in suitable habitats (C_{min}). Under the annual approach, an annual interim IFS may adapt the H_{min} flow rates for the full year, which could support long-term growth and reproduction of native stream animals year-round.

[4] Western Regional Climate Center. (2009). Western U.S. Historical Climate Summaries. Retrieved May 2010, from the Western Regional Climate Center Web site: http://www.wrcc.dri.edu/.

Figure 3. Monthly mean rainfall trends for selected rain gages in east Maui, Hawaii.

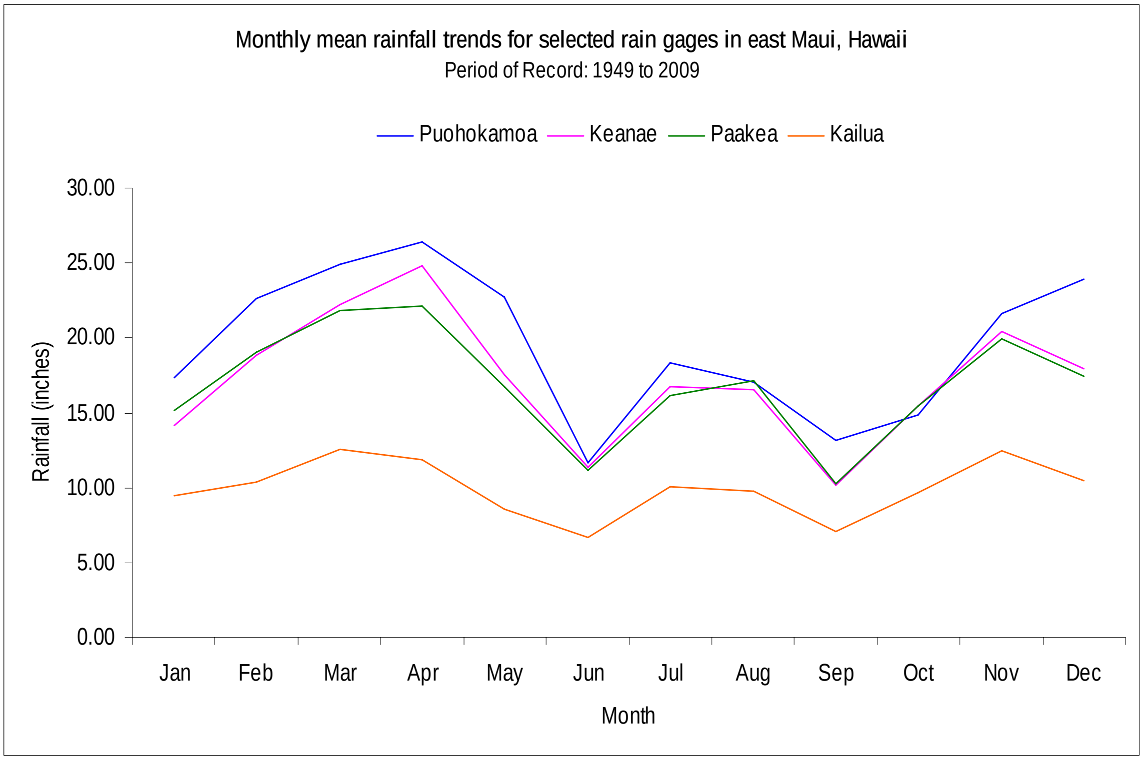
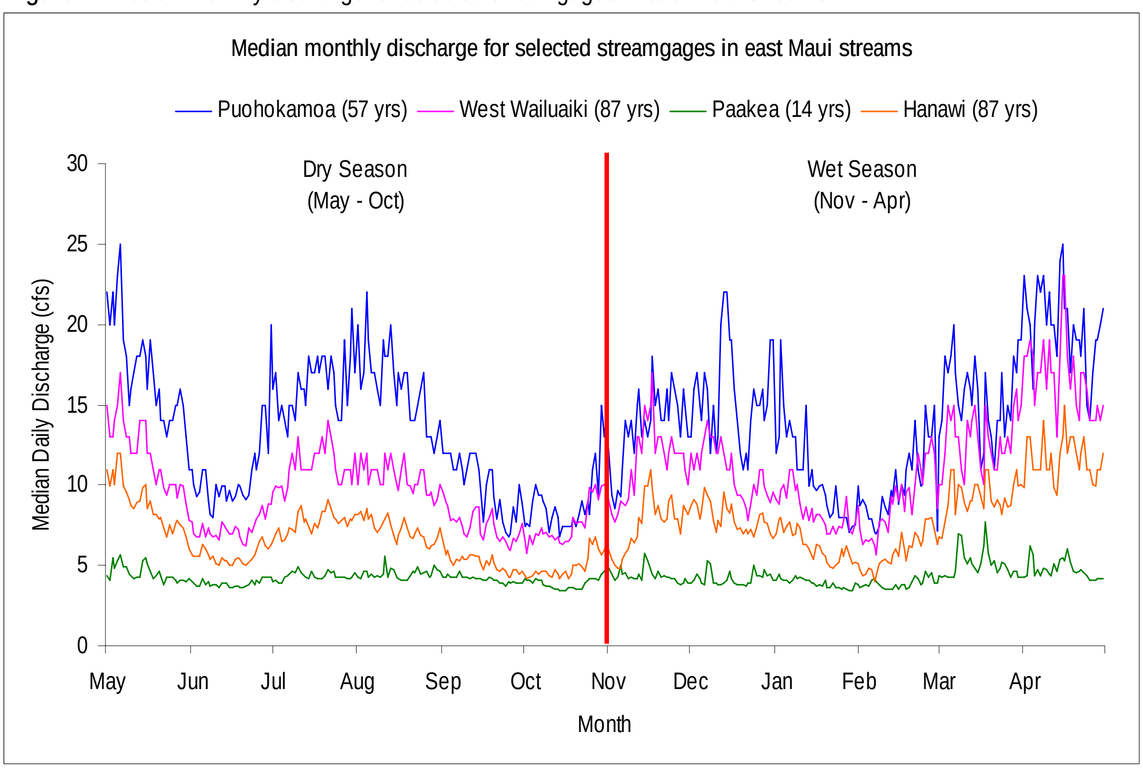


Figure 4. Median monthly discharge for selected streamgages in east Maui Streams.



Seasonal approach

The seasonal interim IFS approach was first discussed at the December 2009 Commission meeting. This approach recognizes the seasonal rainfall patterns in central Maui which translate to lower demands for surface water in the wet season. Accordingly, in the rainy season (November to April), offstream users could be mandated to restore some streamflow, while being permitted to divert some streamflow during the dry season (May to October). Obviously, the Commission needs to consider and weigh all instream values and offstream uses to determine if diversions from a stream should be authorized in establishing any interim IFS, seasonal or annual.

The first question in considering a seasonal IFS is whether that approach protects instream values. DAR has calculated minimum flows to maintain minimum viable habitat for native stream animals (H_{min}) and the minimum flows to maintain minimum connectivity for animals to survive in suitable habitats (C_{min}). Accordingly, a seasonal IFS may adapt H_{min} flow rates during the wet season and C_{min} flow rates during the dry season, which could support most ecological functions required by the stream animals. DAR cautions that the C_{min} flow rates are too low to expect suitable long-term growth and reproduction of native stream animals. Staff also notes that the seasonal approach may not be effective in streams where adjacent landowners are seeking to grow taro, as those uses require water on a regular basis. However, with the exception of Makapipi Stream, the streams at issue in this matter do not include applicants for taro cultivation at this time, but instead focuses on cultural gathering.

Agricultural crops generally need more water in the summer months to compensate for higher evapotranspiration rates and decreased rainfall contribution to irrigation. Contrary to the rainfall pattern in east Maui, rainfall in central Maui where a majority of the end water use is located, exhibit a strong seasonal pattern of wet winters and dry summers. Figure 5 plots the monthly mean rainfall for selected rain gages in central Maui[5]. All four trends show significantly lower rainfall amounts in the months of June to September. This seasonal rainfall pattern, with clearly defined winter and summer seasons, is characteristic of the Leeward coastal areas and areas with lower rainfall[6].

As expected from the streamflow trends, EMI ditch flows recorded at Honopou did not exhibit seasonal variations for a period of 65 years selected between 1922 and 2007. This is clearly illustrated in Figure 6, which shows the flow duration curves for wet season, dry season, and total annual ditch flows. A flow duration curve plots the relationship between flow and the percentage of time that the flow is exceeded. The median or Q_{50} flow has an exceedence probability of 50 percent, that is, the ditch flow is higher than the median flow half the time over the course of 65 years. The EMI ditch flow duration curves for wet and dry seasons are similar, meaning ditch flows behaved similarly in the wet and dry seasons. Figure 7 shows the 65-year median ditch flow for each day of the year. The higher daily median flows were not seasonally dependent as they occurred throughout the year. Similar to that of the east Maui streamflow, ditch flow trends show lack of a seasonal flow pattern. Cumulative ditch flow in the wet season contributes to over half of the annual total ditch flow for 42 out of 63 years (Figure 8). The

[5] Western Regional Climate Center. (2009).

[6] Giambelluca, T.W., Nullet, M.A., and Schroeder, T.A. (1986). Rainfall atlas of Hawaii: State of Hawaii, Department of Land and Natural Resources, Report R76, 59 p.

average wet season contribution to annual total ditch flow is 51 percent and for dry season 49 percent, which is another indication that ditch flows did not vary seasonally.

Figure 5. Monthly mean rainfall trends for selected rain gages in central Maui, Hawaii.

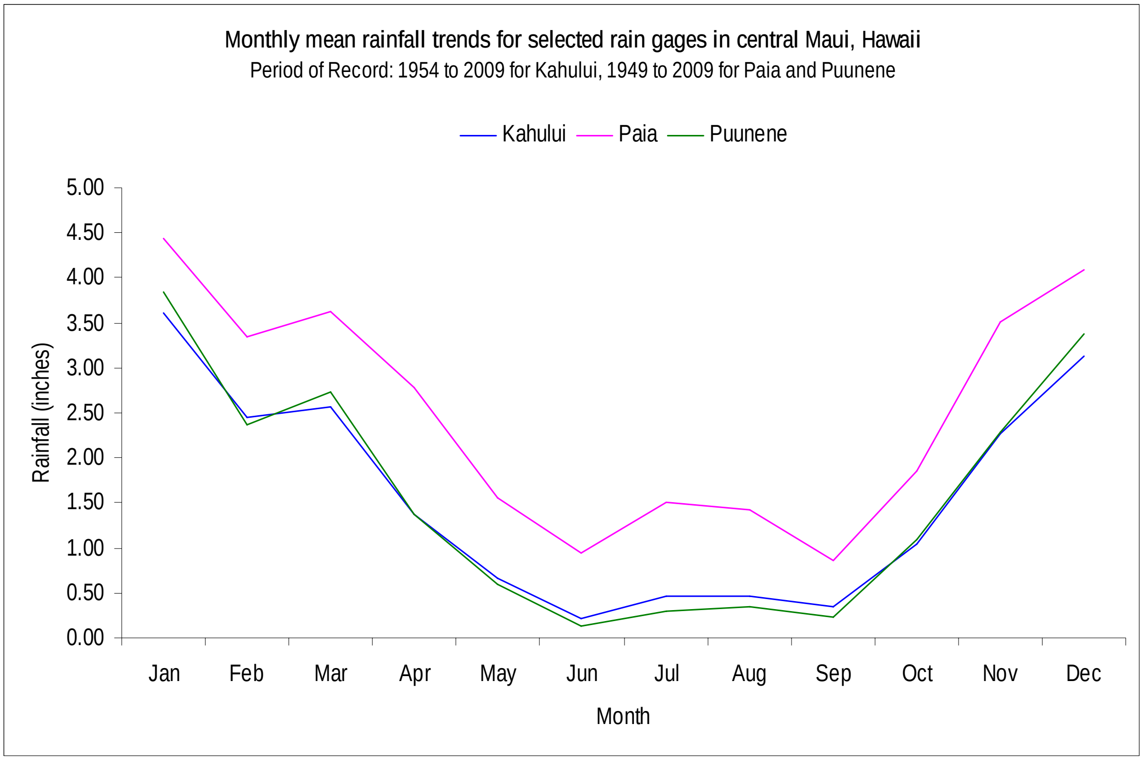


Figure 6. Flow duration for annual total and seasonal ditch flow at Honopou for over 65 years.

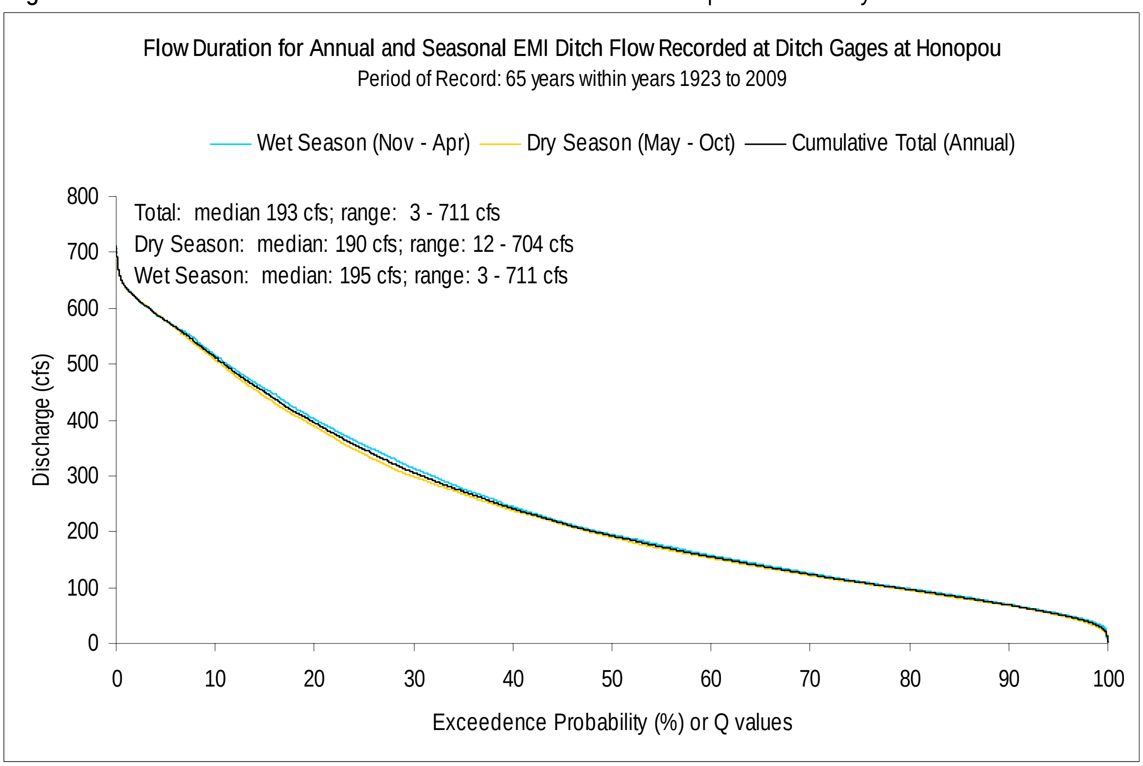


Figure 7. 65-year median daily EMI ditch flow at Honopou.

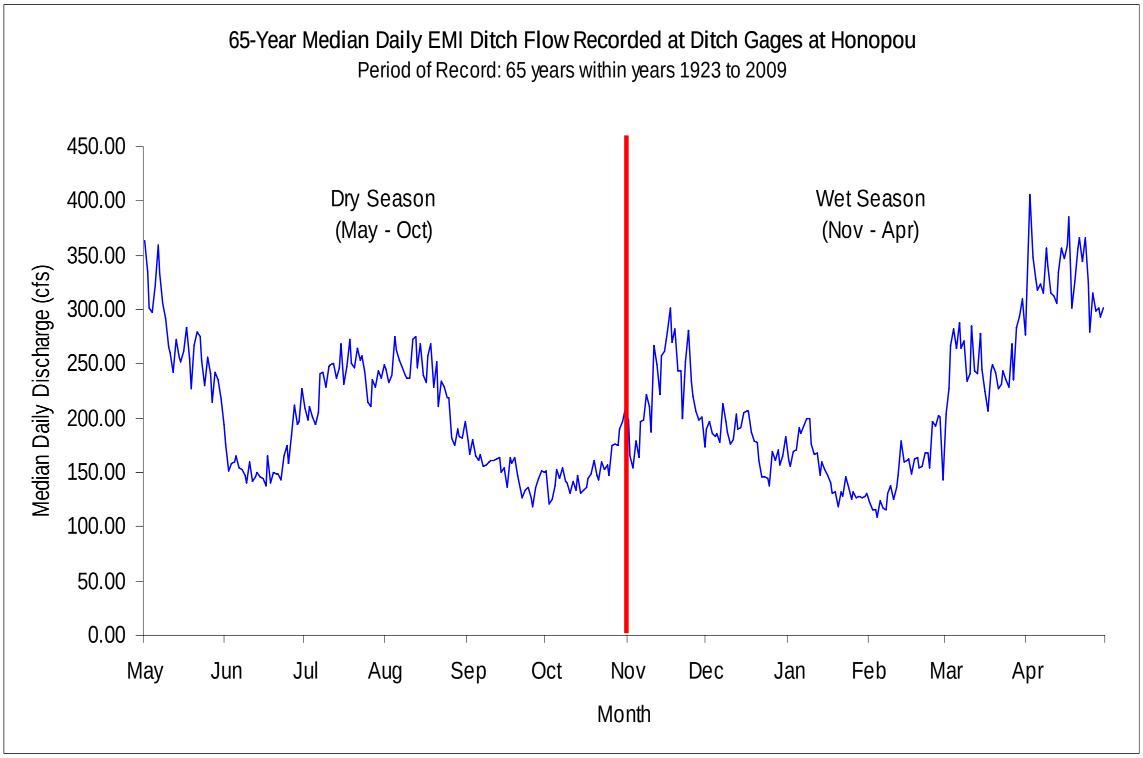
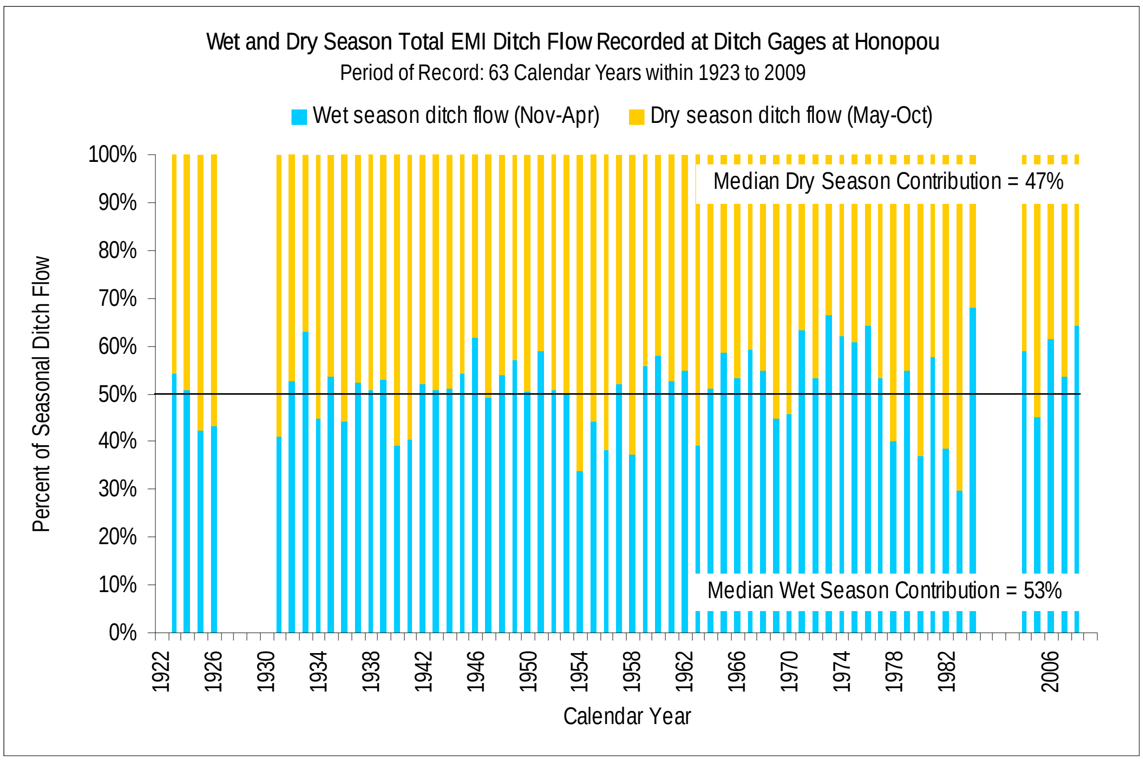


Figure 8. Wet and dry season total EMI ditch flow at Honopou for 63 calendar years.



Comparison between the two approaches

To summarize the information presented above, table 2 compares the annual and seasonal approaches from the instream and noninstream use perspectives.

Table 2. Comparison between the annual and seasonal interim IFS approaches.

	Annual Interim IFS Approach	Seasonal Interim IFS Approach
Instream Use Considerations	▪ Helps restore the east Maui streams to their natural flow pattern for the full year, one that is not seasonally varied, which using H_{min} flow rates could support long-term growth and reproduction of native stream animals year-round ▪ Results in greater biological benefit than the seasonal IFS as the higher levels support annual growth and reproduction of native stream animals	▪ Helps restore the east Maui streams to their natural flow pattern for a portion of the year, which using the H_{min}/C_{min} flow rates, supports most ecological functions required by the stream animals ▪ Results in semi-annual growth and reproduction of native stream animals with recruitment and survival during the alternate six months
Noninstream Use Considerations	▪ Less surface water is available for noninstream agricultural and domestic needs in the summer when demands are high ▪ One-time diversion modification needed for stable IFS	▪ Streamflows would provide water for agricultural and domestic needs in the summer season when surface water demands are higher than in the winter season ▪ More complex diversion modifications needed for flexible IFS and oversight of semi-annual modifications required

Diversion Modification Considerations. Physical modifications, if any, to existing diversion structures are somewhat independent of both proposed interim IFS approaches. The main purpose of a diversion modification in this context is to ensure sufficient streamflow for instream uses downstream of the diversion structure. To maximize the potential flow restoration, the diversion should be modified in such a way that best satisfies downstream uses. In this case, the major issues are: 1) releasing sufficient flow to support a healthy stream animal population downstream of the diversion structure; 2) increasing upstream migration and reducing downstream entrainment of native stream animals across the diversion structure; and 3) ensuring opportunities for traditional gathering. Therefore, any diversion modification should be designed to increase downstream flow in addition to providing connectivity for native stream animals. Designs for each recommended diversion modification should be developed on a stream-by-stream basis and in collaboration with biologists and engineers to ensure that the structural integrity of the diversions is not compromised.

The burden to modify the diversion to suit these objectives in a timely manner is upon the diverter. In addition, diverters should be obligated to install gages alongside such modifications in order to provide the Commission with accurate and timely data of the diversions and streamflows.

Water needs of HC&S. The question has been raised whether HC&S has been diverting more water than what the plantation needs. Based on HC&S' data submission, HC&S has been operating on 85 percent of its water need for the past 24 years (1986 to 2009). At an average need of 270 mgd, the plantation water demands are not met 10 months out of the year. Only during the winter months of November and December are the water needs of the plantation satisfied with the available water (Exhibit 3, Section 2.0). On average, streamflow provides 167 mgd of water to the plantation with an additional 72 mgd from ground water sources. Evidently, the plantation's water needs greatly exceed available surface water sources otherwise HC&S would not expend the cost to pump water from its brackish water wells to supplement surface water sources. Pumping costs can range from $32 to $290 per million gallons (see Exhibit 3, Section 2.0). With decreasing trends in streamflow[7], east Maui streams will continue to be an insufficient supply of surface water needs for the plantation regardless of interim IFS adoption.

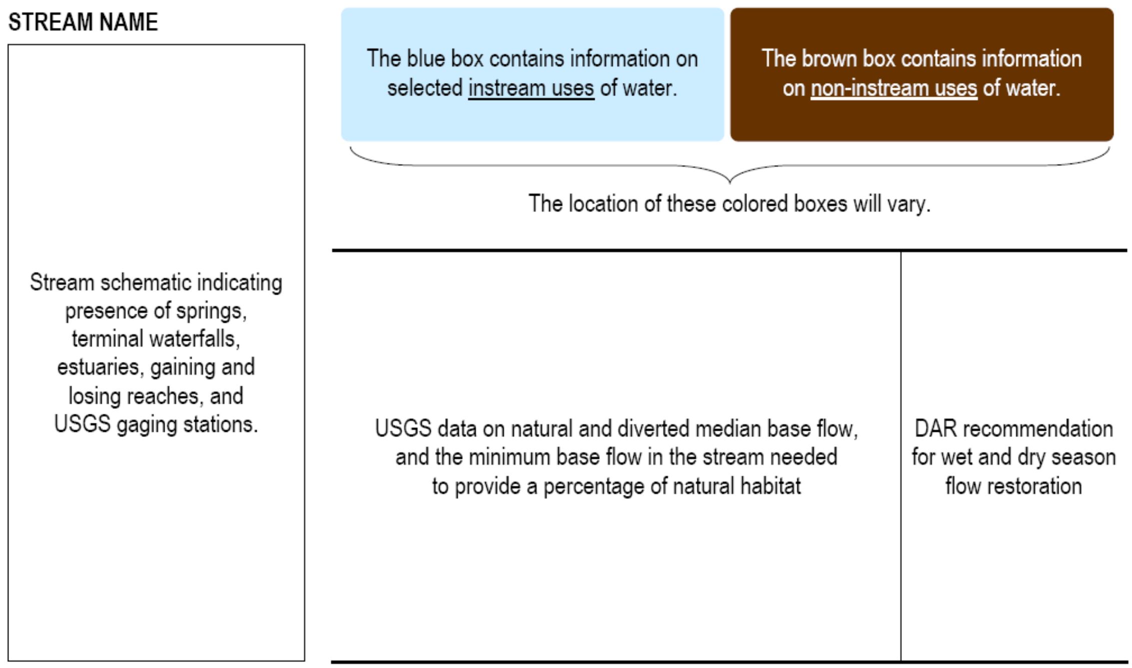
Additionally, on April 7, 2010, the U.S. Department of Agriculture (USDA) announced a partnership between its Agricultural Research Service, the Natural Resources Conservation Service, the Department of the Navy's Office of Naval Research, and the University of Hawaii, in working collaboration with HC&S, to assess the potential for commercial production of advanced biofuels and other renewable energy systems from sugarcane and other biomass crops grown in Hawaii. The energy produced is intended for use by the Department of the Navy which is providing $2 million per year through 2015 to support USDA's research efforts.[8] With few details available at this time, this information is provided for reference only.

[7] Oki, D. (2004). Trends in Streamflow Characteristics at Long-Term Gaging Stations, Hawaii. U.S. Geological Survey, Scientific Investigations Report 2004-5080, 120 p.

[8] U.S. Department of Agriculture. (2010). USDA Announces Partnership in Hawaii to Help Navy Achieve its Biofuel and Other Renewable Energy Goals. Retrieved May 2010, from http://www.usda.gov/wps/portal/usda/

Data Summaries. Exhibit 1 contains data summaries for each of the 19 east Maui streams. These are created to consolidate the available hydrologic, biologic, instream and noninstream use data specific for the streams. Each hydrologic unit has a data summary that is organized into two pages, with the exception of the Waikamoi hydrologic unit which has a 4-page data summary. The first page has the general format illustrated in Figure 9 with slight variations in the order of the colored boxes. The second page contains information on and photos of the major diversion structures present in the hydrologic unit.

Figure 9. First page of a data summary.



Interim IFS Rationale. Surface water is a precious resource, especially on Maui, which has become the most surface water dependent island in the state. The difficulty in establishing interim IFS for the subject east Maui streams lies in the complexity of the EMI ditch system and that HC&S, the largest diverter of east Maui streams, also supplies water for domestic needs. While the major diverters could quantify the economic impacts of flow restoration, the impact to native stream animals since the stream diversion were first constructed cannot be overlooked. Keeping water in the stream for the purposes such as ecosystem maintenance and aesthetics are intrinsic values that, unfortunately, are difficult to measure. Lastly, the traditional practices of taro cultivation and gathering have obviously been negatively impacted by diminishing streamflow, largely caused by upstream diversions.

The following is the rationale for staff's recommendation that is organized into four sections: 1) Interim IFS approach (annual versus seasonal); 2) Streams recommended for flow restoration; 3) Streams not recommended for flow restoration; and 4) Method of calculating the amount of flow restored. Stream names are in *italics* for ease of locating the rationale for specific streams.

<u>Interim IFS approach (annual versus seasonal)</u>
Compared to the existing diverted conditions, both annual and seasonal approaches provide for biological benefit. The annual interim IFS approach would result in greater stream habitat

restoration for building a healthy stream animal population, improving overall stream health, and increasing opportunities for traditional gathering. The seasonal interim IFS approach would provide biological benefit, mandate noninstream users to restore streamflow and increase system efficiency during the wet season, and provide for noninstream uses during the dry seasons.

Staff recommends adopting an annual interim IFS, subject to conditional release, for Makapipi Stream due to the potential for taro cultivation and other instream uses expressed in this community. The Commission should weigh the various values and uses to determine whether to adopt a seasonal or annual interim IFS for the remaining 18 streams.

<u>Method of calculating amount of flow restored</u>
DAR recommends 64-percent of median base flow (BFQ_{50}) in the stream to provide the minimum amount of viable habitat (H_{min}) during the wet season and 20-percent of BFQ_{50} in the dry season to provide minimum viable connectivity (C_{min}). DAR has also provided the minimum amount of median baseflow that is needed to maintain 50-percent (H_{50}) and 70-percent (H_{70}) of the habitat, but does not believe that these flow rates are viable flow rates for the protection of native aquatic biota. DAR cautions that the habitat availability study by USGS[9] did not consider all life history requirements of the stream animals; therefore, DAR does not believe there is linear relationship between the amount of viable habitat and the number of animals in the stream. According to DAR, the flow rate at H_{70} does not produce 20-percent fewer animals than the flow rate at H_{90}. DAR did not provide data on the difference between the volume of animals produced with 20-percent less viable habitat.

In any event, staff recommends that the Commission selects the level of natural habitat to remain in the stream that would apply to both annual and seasonal interim IFS approaches. In the event the Commission adopts the annual interim IFS approach, staff recommends the baseflow needed to maintain the selected natural habitat level to remain in the stream for the full year. In the event the Commission adopts the seasonal interim IFS approach, staff recommends the baseflow needed to maintain the selected natural habitat level to remain in the stream for the wet season and to maintain 20-percent of the natural median baseflow (C_{min} flow rate) during the dry season. Tables 3 and 4 includes the various flow rates needed to provide H_{min} and C_{min} discussed here.

The flow rates to provide H_{min} calculated by Commission staff are similar but not the same as DAR's recommended flows in the wet season. DAR calculated the flow values from natural median baseflow in the middle and lower reaches, whereas the interim IFS are based on natural median baseflow near the potential monitoring locations. Streamflow in the middle reaches include ground water gains from below the ditch. According to USGS data[10], ground water gains can be as high as 1 cfs in the selected streams. The monitoring sites are mostly established near Hana Highway and relatively close to the diversions such that ground water gains reflected at the monitoring locations are minimal. A majority of the ground water gains are observed below the monitoring sites. Therefore, the interim IFS are calculated from the natural median baseflow in the upper reaches upstream from the diversions.

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[9] Gingerich, S.B., and Wolff, R.H. (2005). Effects of Surface-Water Diversions on Habitat Availability for Native Macrofauna, Northeast Maui, Hawaii. U.S. Geological Survey, Scientific Investigations Report 2005-5213, 93 p.
[10] Gingerich, S.B. (2005). Median and Low-Flow Characteristics for Streams under Natural and Diverted Conditions, Northeast Maui, Hawaii. U.S. Geological Survey, Scientific Investigations Report 2004-5262, 72 p.

Table 3. Minimum flows provided by DAR for nine streams under the seasonal approach for restoring the minimum amount of water that is needed in the stream to provide minimum viable habitat in the wet season and minimum viable connectivity in the dry season.

[cfs is cubic feet per second; values in italics are not recommended by DAR but provided for comparison purposes; the first value for Kopiliula Stream corresponds to the flow needed in the middle reach and the second value corresponds to the flow needed in the lower reach.]

Stream	Rank	Wet Season			Dry Season
		Minimum flow in cfs [17% natural median base flow] needed in stream to provide 50 percent of natural habitat	Minimum flow in cfs [36% natural median base flow] needed in stream to provide 70 percent of natural habitat	Minimum flow in cfs [64% natural median base flow] needed in stream to provide 90 percent of natural habitat	Minimum flow in cfs to provide minimum connectivity
East Wailuaiki	1	1.2	2.6	4.5	1.4
West Wailuaiki	2	1.2	2.6	3.5	1.4
Puohokamoa	3	1.8	3.9	7.4	2.3
Waikamoi	4	1.2	2.5	4.2	1.3
Kopiliula	5	1.4	3.0	4.2 / 5.8	1.3 / 2.9
Puakaa				No change	1.2
Haipuaena	6	0.9	1.9	3.3	0.9
Waiohue	7	1.1	2.5	4.4	1.3
Hanawi	8	No change	No change	No change	0.1
Total flow returned		1.4	10.06	22.7*	1.4
Percent of total flow returned to average EMI delivery		0.5%	3.9%	8.8%	0.5%

* The total amount of flow restored in the wet season under the DAR recommendation is 22.7 cfs, which is slightly lower than the original data submission due to minor transcription errors recognized by DAR.

Table 4. Minimum flows needed to provide H_{50}, H_{70}, and H_{90} in the wet season, and the minimum flows needed to provide C_{min} for six streams using staff's method of calculating the interim IFS based upon the upper reach flow estimates.

[cfs is cubic feet per second; EMI delivery is 258 cfs or 167 mgd based on HC&S' data submission.]

Stream	Wet Season			Dry Season
	Minimum flow in cfs [17% natural median base flow] needed in stream to provide 50 percent of natural habitat	Minimum flow in cfs [36% natural median base flow] needed in stream to provide 70 percent of natural habitat	Minimum flow in cfs [64% natural median base flow] needed in stream to provide 90 percent of natural habitat	Minimum flow in cfs to provide minimum connectivity
East Wailuaiki	0.99	2.10	3.70	1.2
West Wailuaiki	1.00	2.20	3.80	1.2
Waikamoi	1.10	2.40	4.30	1.3
Waiohue	0.85	1.80	3.20	1
Hanawi	0.10 (to create a wetted pathway)			
Makapipi	0.93 (conditional flow release)			
Total flow returned	4.77	9.33	15.83	4.7
Percent of total flow returned to average EMI delivery	1.8%	3.6%	6.1%	1.8%

Streams recommended for flow restoration

Commission staff assessed available hydrologic, biologic, instream and noninstream use data for the 19 subject east Maui Streams. From these streams, DAR has recommended nine streams that they believed would produce the most biological return from flow restoration. Table 3 shows DAR's recommendation for nine streams under the seasonal flow restoration. Commission staff is recommending flow restoration for five of the nine streams from the DAR recommendation, and one stream that is not recommended by DAR. Staff recommends flow restoration in the following streams for reasons stated hereafter: Waikamoi, West Wailuaiki, East Wailuaiki, Waiohue, Hanawi, and Makapipi Streams.

Waikamoi Stream is recommended for flow restoration because staff supports DAR's position of a geographic approach to flow restoration. A geographic approach means restoring flow to streams both east and west of Keanae valley. Benefits of this approach include biological diversity in the east Maui area, and regional diversity in traditional gathering opportunities. Staff recommends flow restoration in Waikamoi Stream because it is the only stream out of the three DAR recommended streams located west of Keanae Valley that is not used for conveyance on its main reach. Many area residents also expressed interests in gathering native animals from this stream (See Exhibit 3, Section 5.0).

Staff recommends flow restoration for *West Wailuaiki Stream* and *East Wailuaiki Stream* because these streams would result in the most biological return from additional flow. The presence of an estuary in both streams further enhances the biological diversity of the stream. In addition, flow restoration provides increased opportunities for traditional gathering that area residents currently want to practice (See Exhibit 3, Section 5.0).

Waiohue Stream is also proposed for flow restoration for similar reasons that East and West Wailuaiki Streams were selected. The presence of an estuary further enhances the biological diversity of the stream. Based on NHLC's data, 25 residents testified to gathering vegetation and stream animals in Waiohue Stream (Exhibit 3, Section 5.0).

Staff proposed flow restoration for *Hanawi Stream* because minimal flow is needed to achieve the desired biological diversity and impacts to HC&S would be negligible. Modification of the diversion would serve mainly to create a wetted pathway for stream animal connectivity from the diversion to the ocean. The interim IFS for Hanawi Stream is an exception to the staff's approach of calculating the interim IFS because the stream has adequate flow to sustain a viable biota population. As recommended by DAR, the biological health of the stream could be further improved simply by providing connectivity in the dry reach immediately below the diversion. For this reason, staff established the monitoring site directly below the ditch at an interim IFS of 0.1 cfs to ensure a wetted pathway.

Apart from DAR's priority streams, staff recommends flow restoration for *Makapipi Stream* because the Nahiku community relies heavily on the stream for cultural practices, recreation, and other instream uses. With the uncertainty of gaining and losing reaches along most of the stream's course to the ocean, it is not known whether restored flow would result in continuous streamflow from the headwaters to the stream mouth. A coordinated study of a short-term release of water past the one major EMI diversion should be sufficient to determine the sustainability of the proposed standard. The interim IFS for Makapipi Stream is an exception to the staff's approach of calculating the interim IFS because flow restoration is proposed mainly for the purpose of taro cultivation. The interim IFS for Makapipi Stream is the estimated TFQ_{70} flow at USGS station 16507000 located just upstream of Hana Highway.

Table 4 shows the minimum flows needed to provide H_{50}, H_{70}, and H_{90} in the wet season, and the minimum flows needed to provide C_{min} for six streams using staff's method of calculating the interim IFS based upon the upper reach flow estimates.

<u>Streams not recommended for flow restoration</u>
Among the DAR priority streams, staff is not recommending flow restoration for Puohokamoa Stream, Haipuaena Stream, Kopiliula Stream, and Puakaa Stream. *Puohokamoa, Haipuaena, and Kopiliula Streams* are not proposed for flow restoration because these streams are used for conveyance. At this time, flow restoration is not recommended for streams that are used to convey water from one ditch to another, as more water may exist in the portion of stream used for conveyance than would naturally occur. Commingled water exists for a considerable distance upstream of the diversion structures on both streams. Staff believes that any interim IFS should be based solely on the surface water available within the given hydrologic unit. Any modification to the existing diversion infrastructure on these streams could result in more water being released than naturally occurs.

While a minimal flow restoration to provide connectivity is proposed for Hanawi Stream, staff does not recommend the same for *Puakaa Stream*. According to DAR (see Exhibit B, Section 1.0), the amount of habitat unit gain in Puakaa Stream is only 300 meters compared to over 1,200 meters in Hanawi Stream. Staff feels that the cost and effort to modify the diversion to allow for connectivity is better spent in Hanawi Stream than Puakaa Stream.

For the remaining nine streams – *Alo, Wahinepee, Punalau, Honomanu, Nuaailua, Ohia, Paakea, Waiaaka, and Kapaula Streams*, flow restoration is not recommended because these streams would not result in significant biological return from additional flow. Instead, staff recommends establishing measurable status quo flows at specific locations along each stream.

RECOMMENDATION:
Recommendations are presented in order of the hydrologic units codes, from west to east.

WAIKAMOI (6047) RECOMMENDATIONS:
Waikamoi and Alo Streams: In the matter of the Petition to Amend the Interim Instream Flow Standard for Waikamoi and Alo Streams, staff recommends that one measurable instream IFS be established for Waikamoi Stream below the confluence with Alo Stream. The proposed interim IFS for Waikamoi Stream below all EMI diversions and just above Hana Highway, near an altitude of 550 feet, shall be established at an estimated flow of 4.3 cubic feet per second (2.8 million gallons per day).

Wahinepee Stream: In the matter of the Petition to Amend the Interim Instream Flow Standard for Wahinepee Stream, staff recommends that one measurable interim IFS be established for this stream. The interim IFS below all EMI diversions and just above Hana Highway, near an altitude of 575 feet, shall remain as designated on October 8, 1988. This is equivalent to an estimated flow of 0.5 cubic feet per second (0.32 million gallons per day) cfs based on USGS estimates of total flow at Q_{95} (TFQ_{95}).

PUOHOKAMOA (6048) RECOMMENDATIONS:
Puohokamoa Stream: In the matter of the Petition to Amend the Interim Instream Flow Standard for Puohokamoa Stream, staff recommends that one measurable interim IFS be established for this stream. The interim IFS below all EMI diversions and just above Hana Highway, near an altitude of 565 feet, shall remain as designated on October 8, 1988. This is equivalent to an estimated flow of 0.4 cubic feet per second (0.26 million gallons per day) based on USGS estimates of total flow at Q_{95} (TFQ_{95}).

HAIPUAENA (6049) RECOMMENDATIONS:
Haipuaena Stream: In the matter of the Petition to Amend the Interim Instream Flow Standard for Haipuaena Stream, staff recommends that one measurable interim IFS be established for this stream. The interim IFS below all EMI diversions and just above Hana Highway, near an altitude of 510 feet, shall remain as designated on October 8, 1988. This is equivalent to an estimated flow of 0.1 cubic feet per second (0.07 million gallons per day) based on USGS estimates of total flow at Q_{95} (TFQ_{95}).

PUNALAU (6050) RECOMMENDATIONS:
Punalau/Kolea Stream: In the matter of the Petition to Amend the Interim Instream Flow Standard for Punalau/Kolea Stream, staff recommends that one measurable interim IFS be established for this stream. The interim IFS below all EMI diversions and just above Hana Highway, near an altitude of 40 feet, shall remain as designated on October 8, 1988. This is equivalent to an estimated flow of 0.2 cubic feet per second (1.36 million gallons per day) based on USGS estimates of total flow at Q_{95} (TFQ_{95}).

HONOMANU (6051) RECOMMENDATIONS:
Honomanu Stream: In the matter of the Petition to Amend the Interim Instream Flow Standard for Honomanu Stream, staff recommends that one measurable interim IFS be established for this stream. The interim IFS below all EMI diversions and just above Hana Highway, near an altitude of 20 feet, shall remain as designated on October 8, 1988. This is equivalent to an estimated flow of 0 based on USGS estimates of total flow at Q_{95} (TFQ_{95}).

NUAAILUA (6052) RECOMMENDATIONS:
Nuaailua Stream: In the matter of the Petition to Amend the Interim Instream Flow Standard for Nuaailua Stream, staff recommends that one measurable interim IFS be established for this stream. The interim IFS below all EMI diversions and just above Hana Highway, near an altitude of 110 feet, shall remain as designated on October 8, 1988. This is equivalent to an estimated flow of 3.1 cubic feet per second (2 million gallons per day) based on USGS estimates of total flow at Q_{95} (TFQ_{95}).

OHIA (6054) RECOMMENDATIONS:
Ohia Stream: In the matter of the Petition to Amend the Interim Instream Flow Standard for Ohia (Waianu) Stream, staff recommends that one measurable interim IFS be established for this stream. The interim IFS below all EMI diversions and just above Hana Highway, near an altitude of 195 feet, shall remain as designated on October 8, 1988. This is equivalent to an estimated flow of 4.6 cubic feet per second (2.00 million gallons per day) based on USGS estimates of total flow at Q_{95} (TFQ_{95}).

WEST WAILUAIKI (6057) RECOMMENDATIONS:
West Wailuaiki Stream: In the matter of the Petition to Amend the Interim Instream Flow Standard for West Wailuaiki Stream, staff recommends that one measurable instream IFS be established for this stream. The proposed interim IFS for West Wailuaiki Stream below all EMI diversions and just above Hana Highway, near an altitude of 1,235 feet, shall be established at an estimated flow of 3.8 cubic feet per second (2.5 million gallons per day).

EAST WAILUAIKI (6058) RECOMMENDATIONS:
East Wailuaiki Stream: In the matter of the Petition to Amend the Interim Instream Flow Standard for East Wailuaiki Stream, staff recommends that one measurable instream IFS be established for this stream. The proposed interim IFS for East Wailuaiki Stream below all EMI diversions and just above Hana Highway, near an altitude of 1,235 feet, shall be established at an estimated flow of 3.7 cubic feet per second (2.4 million gallons per day).

KOPILIULA (6059) RECOMMENDATIONS:
Kopiliula Stream: In the matter of the Petition to Amend the Interim Instream Flow Standard for Kopiliula Stream, staff recommends that one measurable instream IFS be established for this stream. The proposed interim IFS for Kopiliula Stream below all EMI diversions and just above Hana Highway, near an altitude of 1,270 feet, shall remain as designated on October 8, 1988. This is equivalent to an estimated flow of 0.5 cubic feet per second (0.32 million gallons per day) based on USGS estimates of total flow at Q_{95} (TFQ_{95}).

Puakaa Stream: In the matter of the Petition to Amend the Interim Instream Flow Standard for Puakaa Stream, staff recommends that one measurable interim IFS be established for this stream. The interim IFS below all EMI diversions and just above Hana Highway, near an altitude of 1,235 feet, shall remain as designated on October 8, 1988. This is equivalent to an estimated flow of 0.6 cubic feet per second (0.39 million gallons per day) based on USGS estimates of total flow at Q_{95} (TFQ_{95}).

WAIOHUE (6060) RECOMMENDATIONS:

Waiohue Stream: In the matter of the Petition to Amend the Interim Instream Flow Standard for Waiohue Stream, staff recommends that one measurable instream IFS be established for this stream. The proposed interim IFS for Waiohue Stream below all EMI diversions and just above Hana Highway, near an altitude of 1,195 feet, shall be established at an estimated flow of 3.2 cubic feet per second (2.1 million gallons per day).

PAAKEA (6061) RECOMMENDATIONS:

Paakea Stream: In the matter of the Petition to Amend the Interim Instream Flow Standard for Paakea Stream, staff recommends that one measurable interim IFS be established for this stream. The interim IFS below all EMI diversions and just above Hana Highway, near an altitude of 1,265 feet, shall remain as designated on October 8, 1988. This is equivalent to an estimated flow of 1.5 cubic feet per second (1 million gallons per day).

WAIAAKA (6062) RECOMMENDATIONS:

Waiaaka Stream: In the matter of the Petition to Amend the Interim Instream Flow Standard for Waiaaka Stream, staff recommends that one measurable interim IFS be established for this stream. The interim IFS below all EMI diversions and at Hana Highway, near an altitude of 1,235 feet, shall remain as designated on October 8, 1988. This is equivalent to an estimated flow of 0.

KAPAULA (6063) RECOMMENDATIONS:

Kapaula Stream: In the matter of the Petition to Amend the Interim Instream Flow Standard for Kapaula Stream, staff recommends that one measurable interim IFS be established for this stream. The interim IFS below all EMI diversions and just above Hana Highway, near an altitude of 1,194 feet, shall remain as designated on October 8, 1988. This is equivalent to an estimated flow of 0.2 cubic feet per second (0.1 million gallons per day).

HANAWI (6064) RECOMMENDATIONS:

Hanawi Stream: In the matter of the Petition to Amend the Interim Instream Flow Standard for Hanawi Stream, staff recommends that one measurable instream IFS be established for this stream. The proposed interim IFS for Hanawi Stream immediately below the EMI diversion, near an altitude of 1,300 feet, shall be established at an estimated flow of 0.1 cubic feet per second (0.06 million gallons per day). This proposed interim IFS aims to create a wetted pathway directly below the EMI diversion to provide connectivity for stream biota.

MAKAPIPI (6065) RECOMMENDATIONS:

The balance of instream and noninstream uses for Makapipi Stream considers both the importance of diverted streamflow for the EMI System and the Nahiku community which relies on the stream for cultural practices, recreation, and other instream uses. With the uncertainty of gaining and losing reaches along most of the stream’s course to the ocean, it is not known whether restored flow would result in continuous streamflow from the headwaters to the stream mouth. A coordinated study of a short-term release of water past the one major EMI diversion should be sufficient to determine the sustainability of the proposed standard.

Makapipi Stream: In the matter of the Petition to Amend the Interim Instream Flow Standard for Makapipi Stream, staff recommends that one measurable interim IFS be established for this stream. The proposed interim IFS below all EMI diversions and just above Hana Highway, near an altitude of 935 feet, shall be established at an estimated flow of 0.93 cubic feet per second (0.6 million gallons per day) based on USGS estimates of total flow at Q_{70} (TFQ_{70}). Due to the uncertainty of existing hydrogeologic conditions of Makapipi Stream, this interim IFS will be subject to a conditional release of water by EMI and monitoring by Commission staff. Should an estimated flow of 0.93 cubic feet per second be unattainable, the interim IFS may be revised by a future Commission action.

GENERAL RECOMMENDATIONS:
Staff recommends approval of the following adaptive management strategies for all sixteen of the hydrologic units being considered:

IMPLEMENTATION

GENERAL ACTIONS

- Staff shall seek to enforce the provisions of the State Water Code should any unauthorized, non-registered or non-permitted diversions be discovered in the course of its fieldwork. Staff recommends that all owners of unauthorized diversion works structures contact staff to file the necessary applications to seek compliance with all permitting requirements set forth by the Code.
- Staff shall coordinate with EMI to identify and determine appropriate actions with regard to attaining the proposed interim IFS values downstream of existing diversion structures.
- Staff shall continue to assess existing conditions and the status of all EMI diversions, in coordination with EMI and the DAR, to develop the necessary modifications to improve habitat conditions for stream biota.
- Any party diverting water from a stream shall be responsible to maintain system efficiencies, minimize offstream water losses, and minimize impacts to the natural stream resource.

Staff is recommending flow restoration for six streams, and that the implementation of the interim IFS to follow a tiered approach. The tiered approach consists of implementation actions that can be achieved in the short-term, mid-term, and long-term. Each of the six streams is placed in the appropriate tier based on the potential difficulty of implementing the interim IFS. This approach allows the staff and stakeholders to evaluate the effectiveness of a particular implementation action, and whether that action can be repeated for the streams in the next tier.

SHORT-TERM ACTIONS:
The short-term recommendations represent interim IFS that shall be implemented in a period of one (1) year from the date of adoption.

- East Wailuaiki Stream: The proposed interim IFS for East Wailuaiki Stream below all EMI diversions and just above Hana Highway, near an altitude of 1,235 feet, shall be established at an estimated flow of 3.7 cubic feet per second (2.4 million gallons per day).
- West Wailuaiki Stream: The proposed interim IFS for West Wailuaiki Stream below all EMI diversions and just above Hana Highway, near an altitude of 1,235 feet, shall be established at an estimated flow of 3.8 cubic feet per second (2.5 million gallons per day).

- Hanawi Stream: The proposed interim IFS for Hanawi Stream immediately below the EMI diversion, near an altitude of 1,300 feet, shall be established at an estimated flow of 0.1 cubic feet per second (0.06 million gallons per day). This proposed interim IFS aims to create a wetted pathway directly below the EMI diversion to provide connectivity for stream biota.
- Makapipi Stream: The proposed interim IFS for Makapipi Stream below all EMI diversions and just above Hana Highway, near an altitude of 935 feet, shall be established at an estimated flow of 0.93 cubic feet per second (0.6 million gallons per day). Due to the uncertainty of existing hydrogeologic conditions of Makapipi Stream, this interim IFS will be subject to a conditional release of water by EMI and monitoring by Commission staff. Should an estimated flow of 0.93 cubic feet per second be unattainable, the interim IFS may be revised by a future Commission action. Adjustments to ground water development tunnels will not be required.

MID-TERM ACTIONS:

The mid-term recommendations represent interim IFS that shall be implemented in a period of one (1) year after the implementation of the short-term recommendations.

- Waikamoi Stream: The proposed interim IFS for Waikamoi Stream below all EMI diversions and just above Hana Highway, near an altitude of 550 feet, shall be established at an estimated flow of 4.3 cubic feet per second (2.8 million gallons per day).
- Waiohue Stream: The proposed interim IFS for Waiohue Stream below all EMI diversions and just above Hana Highway, near an altitude of 1,195 feet, shall be established at an estimated flow of 3.2 cubic feet per second (2.1 million gallons per day).

LONG-TERM ACTIONS

The long-term recommendations represent implementation actions that shall be achieved within a three (3) year time frame from the date of adoption.

- Maui DWS initiate rehabilitation and construction on the Waikamoi Flume within three (3) years. The reconstruction of the extremely leaky Waikamoi Flume is the least expensive alternative water source for Maui DWS Upcountry customers. Maui County is required to reduce waste and system loss. If action is not taken to initiate construction in this time period, then the Commission shall be obligated by law to reduce Maui DWS' diversions due to waste.

MONITORING

- HC&S currently reports monthly water use for four stations in its telemetry system. Upon approval of these recommendations, HC&S shall begin reporting water use for the other four stations in its system that are also continuously recorded (Wailoa Ditch at Opana, Kauhikoa Ditch at Maliko, Lowrie Ditch at Maliko, Haiku Ditch at Maliko). If EMI is unable to provide monthly water use reports, sufficient justification should be provided to Commission staff.
- There are currently four gaging stations in the EMI telemetry system that do not continuously record data. EMI, in coordination with Commission staff, shall identify and install continuous recorders at these four gaging stations within one year. If EMI is

unable to install a recorder, sufficient justification should be provided to Commission staff.

- EMI, in coordination with the Commission and USGS, shall seek to cooperatively fund and undertake a system efficiency study to accurately determine EMI system losses and/or gains. Should such an effort not be possible, Commission staff shall report back to the Commission.
- HC&S, in coordination with the Commission and USGS, shall undertake a system efficiency study to accurately determine HC&S reservoir system losses.
- Maui DWS, in consultation with Commission staff, shall regularly report monthly water use or related monitoring data (e.g., ditch flow, reservoir levels, pumpage amounts, etc.) on forms provided by the Commission.
- Staff shall monitor streamflow by taking periodic flow measurements, subject to available funding, at the proposed interim IFS locations, as weather permits. These will be point-in-time measurements; however, the installation of stream gaging stations remains an option for long-term management.
- Periodic biological surveys shall be conducted, subject to available funding, to monitor the response of stream biota to post-interim IFS implementation.
- Any party claiming to be negatively impacted as a result of the adopted interim IFS shall monitor and document, in cooperation with staff, the impact upon instream or noninstream uses, including economic impacts. Data shall be provided to staff to substantiate any claims.
- Likewise, any party claiming that negative impacts are a direct result of actions (i.e., diverting too much water, violating the interim IFS) caused by another party, shall monitor and document the impact upon instream or noninstream uses, including economic impacts. Data shall be provided to staff to substantiate any claims.
- All claimants shall cooperate with staff in conducting appropriate investigations and studies, particularly with regard to granting access to stream channels and private property related to such investigations, subject to the provisions of the State Water Code, Chapter 174C, HRS.

<u>EVALUATION</u>

- Within one year from the date of adoption of an interim IFS, staff shall report to the Commission on the progress of implementing the interim IFS and the application of the adaptive management strategies outlined above, and the impacts of the interim IFS upon instream and noninstream uses.
- Within one year, HC&S/EMI shall report to the Commission on the status and implementation of the proposed interim IFS.
- Within one year, Maui DWS shall report to the Commission on the status of efforts to rehabilitate the Waikamoi Flume and other steps being taken to improve system inefficiencies.
- Staff shall assess the implementation of these strategies on an as-needed basis, as may be necessary upon consultation with the affected parties.
- Staff shall continue to provide quarterly updates to the Commission during the course of the year.
- Should there be changes to the operational status of HC&S, changes to the current water uses declared by HC&S, and/or any substantial changes in water needs as determined by

the Commission or Commission staff, staff shall reassess the interim IFS for streams affected by the EMI System.

REPORTING

- Maui DWS shall submit annual reports to the Commission at a regular Commission meeting detailing the progress of the Waikamoi Flume design and construction until that rehabilitation construction is completed.
- HC&S shall submit annual reports to the Commission detailing the end use of water originating from east Maui streams. HC&S shall obtain agreements and/or provide existing agreements with any entity that receives water from the HC&S/EMI water delivery system to provide data on the ultimate end use of such water in these annual reports. HC&S shall work with Commission staff and present a draft report format to the Commission for review no later than September 2010.

Respectfully submitted,

KEN C. KAWAHARA, P.E.
Deputy Director

Note: Exhibit 3 is provided electronically on an accompanying CD and all exhibits are available from the Commission website at http://hawaii.gov/dlnr/cwrm/currentissues_Petition27EastMaui.htm.

Exhibit 1	Data Summaries
Exhibit 2	Staff Submittal for the Meeting of the Commission on Water Resource Management, December 16, 2010, Paia, Maui, Petitions to Amend the Interim Instream Flow Standards for the Surface Water Hydrologic Units of Waikamoi (6047), Puohokamoa (6048), Haipuaena (6049), Punalau (6050), Honomanu (6051), Nuaailua (6052), Ohia (6054), West Wailuaiki (6057), East Wailuaiki (6058), Kopiliula (6059), Waiohue (6060), Paakea (6061), Waiaaka (6062), Kapaula (6063), Hanawi (6064), and Makapipi (6065), Maui.
Exhibit 3	Compilation of Data Submissions, Part II, PR-2010-01

APPROVED FOR SUBMITTAL:

LAURA H. THIELEN
Chairperson

EXHIBIT 1
DATA SUMMARIES

WAIKAMOI & ALO STREAM

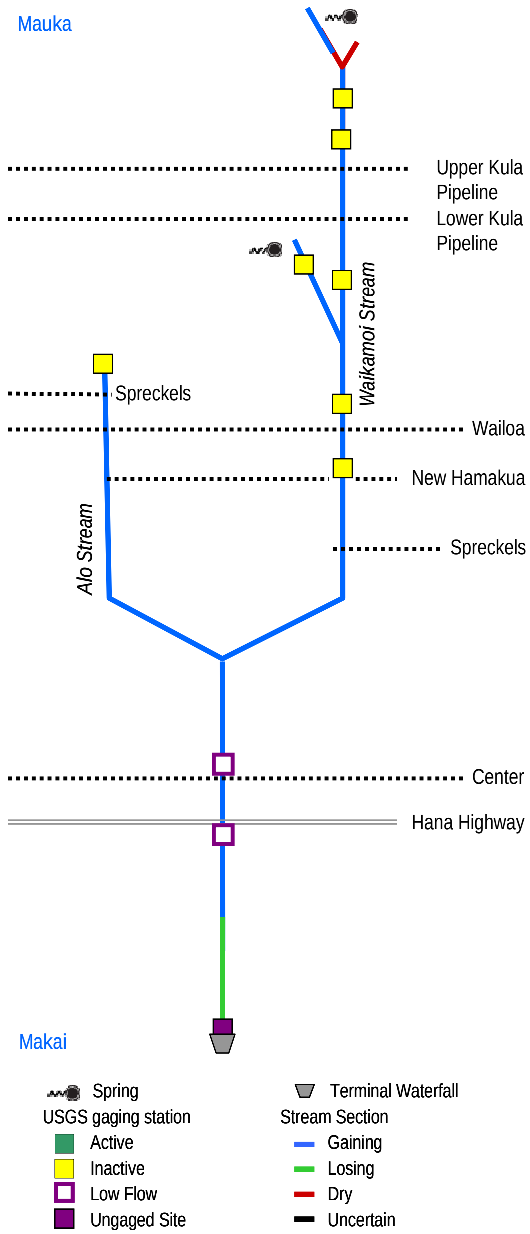

DIAGRAM NOT TO SCALE

[Data in black correspond to Waikamoi Stream, data in blue corresponds specifically to tributary Alo Stream]

Reach	Median base flow, BFQ_{50} (cfs): Natural condition	Median base flow, BFQ_{50} (cfs): Diverted condition	Minimum flow, a percentage of natural BFQ_{50}, needed in the stream to provide a percentage of natural habitat (cfs): 17% of BFQ_{50} for H_{50}	25% of BFQ_{50} for H_{60}	36% of BFQ_{50} for H_{70}	48% of BFQ_{50} for H_{80}	64% of BFQ_{50} for H_{90}	DAR Recommendation [RANK 4]: Wet season H_{min} (cfs)	Dry season C_{min} (cfs)	Habitat units restored (m)
Upper	3.5 1.5	Above diversion	0.60 0.26	0.88 0.38	1.30 0.54	1.70 0.72	2.20 0.96	No change	No change	526
Diversion	Diverting all flow		Wailoa Ditch intake (W-1): ☑ dam / weir ☑ control gate ☑ onstream sluice ☑ conveyance (S-8, Haipuaena) Wailoa Ditch intake (W-2): ☑ dam / weir ☑ control gate ☑ ~~onstream~~ sluice ☐ conveyance					DAR recommends restoration at the Wailoa Ditch intake (W-2)		
Diversion	Diverting all flow		New Hamakua Ditch intake (NH-1): ☑ dam / weir ☑ control gate ☑ onstream sluice ☑ conveyance (overflow)					DAR does not recommend any restoration action for Alo Stream		
Diversion	Diverting all flow		Spreckels Ditch intake (S-10, Skimming Dam): ☑ dam / weir ☑ control gate ☐ sluice gate ☐ conveyance					DAR recommends restoration at the Spreckels Ditch intake (S-10)		
Middle-Upper	6.6	1.6	1.10	1.70	2.40	3.20	4.20	3.6 (+ 2.0)	1.7 (+ 0.1)	556
Diversion	Diverting all flow		Center Ditch intake (C-1): ☑ dam / weir ☐ control gate ☑ onstream sluice ☐ conveyance					DAR recommends restoration at the Center Ditch intake (C-1)		
Middle-Lower	6.7	0.2	1.10	1.70	2.40	3.20	4.30	4.2 (+ 0.6)	1.3 (- 0.4)	1,005
Lower	7	0.2	1.20	1.80	2.50	3.40	4.50			

H_{min} = minimum flow, defined as 64% of BFQ_{50}, to provide 90% of natural instream habitat.
C_{min} = minimum flow, defined as 20% of BFQ_{50}, to provide connectivity between ocean and stream habitats.
Habitat units restored = total amount of habitat restored at H_{90} for the native species of oopu, hihiwai, and opae at 64% of BFQ_{50}.

Total HU: 7,080 m Restored: 2,087 m
*Action would restore 30% of total HU, or 30% of HU lost to diversions.

INSTREAM USES

Traditional: 13 testified potential gatherers of vegetation and fish
Ecosystem: Native species dominance
Recreation: Substantial (HSA rating)
Water Quality: Impaired
Hydropower Potential: No

NONINSTREAM USES

Traditional: No taro cultivation
Diversions: EMI - 5 major, 5 minor; MDWS - 4 major, 8 minor

- EMI diverts 6.6 cfs (dry times) to 13.3 cfs (normal times) of water, 6-13% of Huelo Lic and 2-5% of East Maui Lic water yield

Wailoa Ditch intake (W-1) on Alo Stream

Diversion structure consists of a 36 feet (L) x 8 feet (H) dam. The intake grate (8 x 10 feet) spans across the stream channel and is about 6.5 feet above the stream. The control gate, gravel basin, and two sluice gates (3 x 3 feet, W x H) are situated on the left stream bank. This section of Alo Stream is used to convey water from Spreckels Ditch to the Wailoa Ditch.

New Hamakua Ditch intake (NH-1) on Alo Stream

Diversion structure consists of a 10 feet tall curved dam, about 26 feet from the intake to the sluice gate. The dividing wall (43 feet in length) and the intake (5 x 2.2 feet, W x H) are situated on the left bank. The sluice gate (3 x 4.4 feet, W x H) is on the right bank. During normal flows, much of the water from Alo Stream is diverted in the Wailoa Ditch. During high flows when the Wailoa Ditch is full, excess water is diverted into New Hamakua Ditch via this intake. Alo Stream continues as a waterfall if flow was present.

Wailoa Ditch intake (W-2) on Waikamoi Stream

Diversion structure consists of a 50 feet (L) x 4 feet (H) dam. The dividing wall, about 41 feet in length and 2.1 feet in height, is on the left stream bank. Water flows into two inlets and is transported to the Wailoa Ditch further downstream (by the swinging bridge). A minor diversion is located on the right stream bank. At the Wailoa Ditch by the swinging bridge, the radio gate (with float chamber) controls the water entering the New Hamakua Ditch (via a cross-tunnel) when Wailoa Ditch is full. The two sluice gates are 4 x 4 feet (W x H).

Spreckels Ditch intake (S-10) on Waikamoi Stream

Diversion structure consists of a 31 feet (L) x 4.7 feet (H) dam. The dividing wall is 41 feet (L) x 1.8 feet (H) and has one opening that is 3 inches wide. The intake (6.8 x 4 feet, W x H) is located on the left stream bank, with no sluice gate. This diversion diverts excess water from Waikamoi to Kolea Stream.

Center Ditch intake (C-1) on Waikamoi Stream

Diversion structure consists of a 80 feet (L) x 6 feet (H) dam. Intake and sluice gate (3.8 x 4.7 feet, W x H) situate on the left stream bank. The dividing wall is 50 feet (L) x 3 feet (H), and has three openings with diameter of 0.6 feet. This section of the Waikamoi Stream is used for conveying water from the Manuel Luis Ditch to the Center Ditch. Downstream from the diversion, Waikamoi Stream continue as a waterfall when there is flow.

WAHINEPEE STREAM

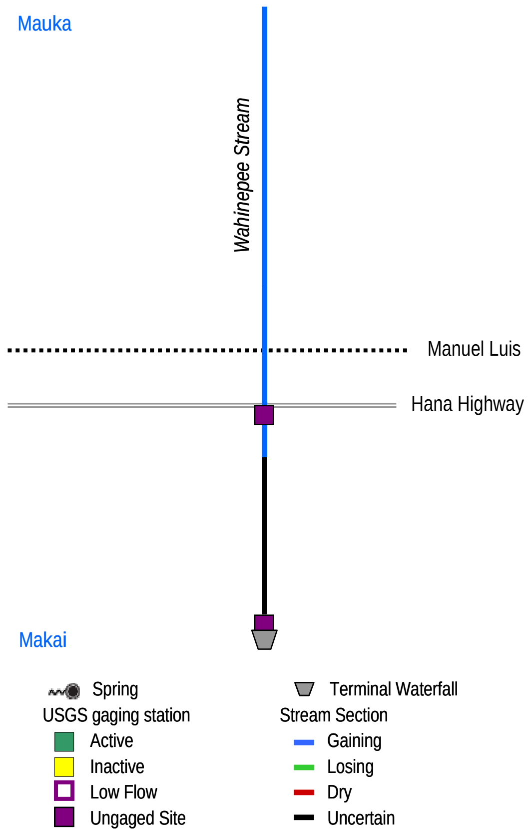

DIAGRAM NOT TO SCALE

Reach	Median base flow, BFQ_{50} (cfs)		Minimum flow , a percentage of natural BFQ_{50}, needed in the stream to provide a percentage of natural habitat (cfs)					DAR Recommendation		
	Natural condition	Diverted condition	17% of BFQ_{50} for H_{50}	25% of BFQ_{50} for H_{60}	36% of BFQ_{50} for H_{70}	48% of BFQ_{50} for H_{80}	64% of BFQ_{50} for H_{90}	Wet season H_{min} (cfs)	Dry season C_{min} (cfs)	Habitat units restored (m)
Upper	--	--	--	--	--	--	--			
Diversion	Diverting all flow		Manuel Luis Ditch intake (ML-5) ☑ dam / weir ☐ control gate ☐ sluice gate ☐ conveyance					DAR does not recommend any restoration action for Wahinepee Stream		
Middle	0.9	0.9	0.15	0.23	0.32	0.43	0.58			
Lower	0.9	1.8	0.31	0.45	0.65	0.86	1.20			

H_{min} = minimum flow, defined as 64% of BFQ_{50}, to provide 90% of natural instream habitat.
C_{min} = minimum flow, defined as 20% of BFQ_{50}, to provide connectivity between ocean and stream habitats.
Habitat units restored = total amount of habitat restored at H_{90} for the native species of oopu, hihiwai, and opae at 64% of BFQ_{50}.

INSTREAM USES

Traditional: 0 testified potential gatherers of vegetation and fish
Ecosystem: Native species dominance
Recreation: Substantial (HSA rating)
Water Quality: No information
Hydropower Potential: No

NONINSTREAM USES

Traditional: No taro cultivation
Diversions: EMI - 1 major, 9 minor; 1 for Puohokamoa Farm

- EMI diverts minimal amounts of water from Wahinepee Stream

PUOHOKAMOA STREAM

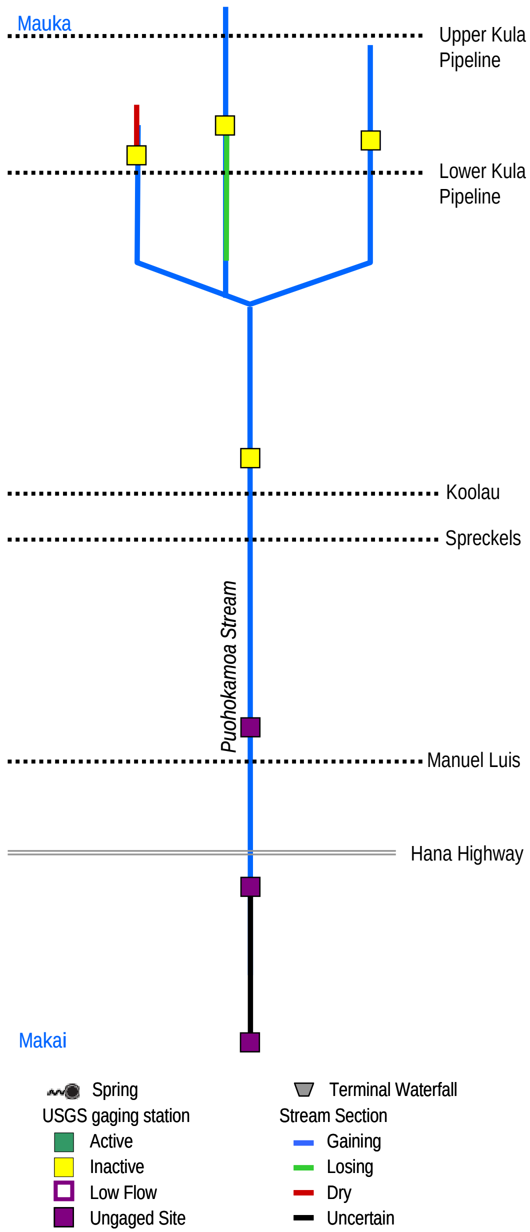

DIAGRAM NOT TO SCALE

Reach	Median base flow, BFQ_{50} (cfs)		Minimum flow, a percentage of natural BFQ_{50}, needed in the stream to provide a percentage of natural habitat (cfs)					DAR Recommendation [RANK 3]		
	Natural condition	Diverted condition	17% of BFQ_{50} for H_{50}	25% of BFQ_{50} for H_{60}	36% of BFQ_{50} for H_{70}	48% of BFQ_{50} for H_{80}	64% of BFQ_{50} for H_{90}	Wet season H_{min} (cfs)	Dry season C_{min} (cfs)	Habitat units restored (m)
Upper	6.4	Above diversion	1.10	1.60	2.30	3.10	4.10	No change	No change	668
Diversion	Diverting all flow		Koolau Ditch intake (K-33) ☑ dam / weir ☑ control gate ☐ sluice gate ☐ conveyance					DAR recommends restoration at the Koolau Ditch intake (K-33)		
Diversion	Diverting all flow		Spreckels Ditch intake (S-9) ☑ dam / weir ☑ control gate ☑ sluice gate ☑ conveyance (overflow)					DAR recommends restoration at the Spreckels Ditch intake (S-9)		
Middle-Upper	8.4	2	1.40	2.10	3.00	4.00	5.40	5.4 (+ 3.4)	2.1 (+ 0.1)	635
Diversion	Diverting all flow		Manual Luis Ditch intake (ML-3) ☑ dam / weir ☐ control gate ☐ sluice gate ☑ conveyance (??)					DAR recommends restoration at the Manuel Luis Ditch intake (ML-3)		
Middle-Lower	10	1.1	1.70	2.50	3.60	4.80	6.40	7.4 (+ 2.0)	2.3 (+ 0.2)	1,498
Lower	11	2.1	1.90	2.80	4.00	5.30	7.00			

H_{min} = minimum flow, defined as 64% of BFQ_{50}, to provide 90% of natural instream habitat.
C_{min} = minimum flow, defined as 20% of BFQ_{50}, to provide connectivity between ocean and stream habitats.
Habitat units restored = total amount of habitat restored at H_{90} for the native species of oopu, hihiwai, and opae at 64% of BFQ_{50}.

Total HU: 11,955 m Restored: 2,801 m
*Action would restore 33% of total HU, or 29% of HU lost to diversions.

INSTREAM USES

Traditional: 0 testified potential gatherers of vegetation and fish
Ecosystem: Native species dominance
Recreation: Substantial (HSA rating)
Water Quality: Impaired
Hydropower Potential: No

NONINSTREAM USES

Traditional: No taro cultivation
Diversions: EMI - 4 major, 3 minor; MDWS - 4 major, 9 minor
- EMI diverts 8.4 cfs (dry times) to 16 cfs (normal times) of water, 8-15% of Huelo Lic and 3-6% of East Maui Lic water yield

Koolau Ditch intake (K-33) on Puohokamoa Stream

Diversion structure consists of a 41 feet (L) x 3.2 feet (H) dam. Intake (10 x 5 feet, W x H) is on the left stream bank, with no sluice gate. The control (radio) gate is connected to a float in the Koolau Ditch. When the ditch is full, the float rises and the control gate shuts to allow water flow downstream to the next ditch level, i.e., Spreckels Ditch. The Koolau and Spreckels Ditch are situated at different elevations. The intakes on Puohokamoa Stream into these two ditches are about 200 feet apart, with the Koolau Ditch intake upstream from the Spreckels Ditch intake.

Spreckels Ditch intake (S-9) on Puohokamoa Stream

Diversion structure consists of 37 feet (L) x 3.5 feet (H) dam. The intake (4 x 2 feet, W x H) is on the left stream bank. Water from Puohokamoa Stream flows past the gravel basin, into the Spreckels Ditch, and eventually ends up in Alo Stream (tributary of Waikamoi Stream). The Koolau Ditch by Puohokamoa Stream has a lower capacity. Therefore, the excess water captured by the Spreckels Ditch will continue to Alo Stream, where the Koolau Ditch has a higher capacity.

Manuel Luis Ditch intake (ML-3) on Puohokamoa Stream

Puohokamoa Stream drops directly into Manuel Luis Ditch. The diversion structure does not have a sluice gate or gravel basin. The diversion dam is 30 feet in length and 6 feet high.

HAIPUAENA STREAM

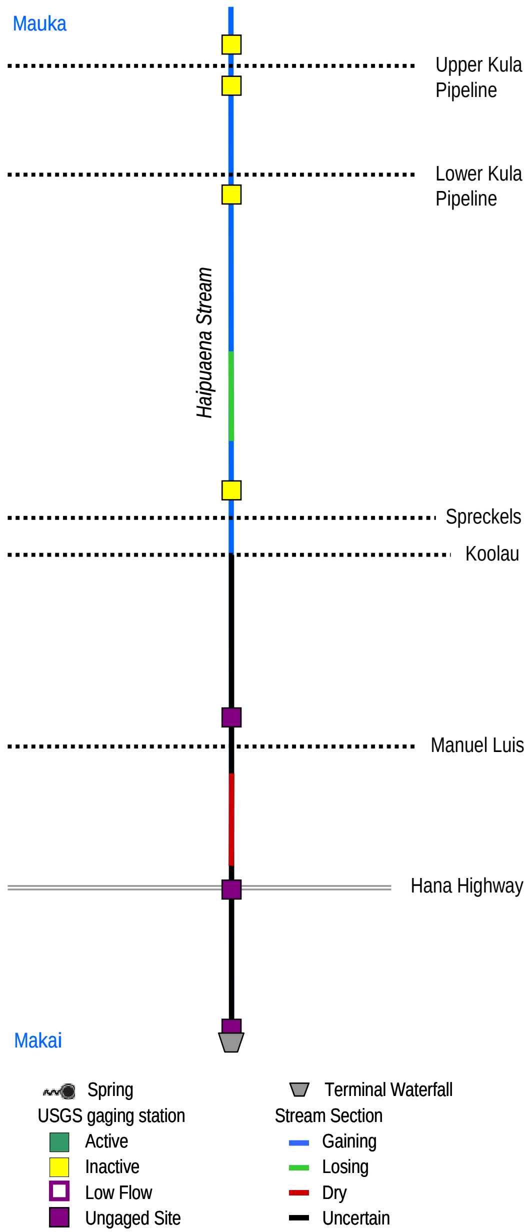

DIAGRAM NOT TO SCALE

INSTREAM USES

Traditional: 12 testified potential gatherers of vegetation and fish
Ecosystem: Native species dominance
Recreation: Moderate (HSA rating)
Water Quality: Impaired
Hydropower Potential: No

NONINSTREAM USES

Traditional: No taro cultivation
Diversions: EMI - 2 major, 7 minor; MDWS - 2 major, 9 minor; 1 State Parks

- EMI diverts 4.4 cfs (dry times) to 6.5 cfs (normal times) of water, 10-18% of Honomanu Lic and 2-3% of East Maui Lic water yield

Reach	Median base flow, BFQ_{50} (cfs)		Minimum flow, a percentage of natural BFQ_{50}, needed in the stream to provide a percentage of natural habitat (cfs)					DAR Recommendation [RANK 6]		
	Natural condition	Diverted condition	17% of BFQ_{50} for H_{50}	25% of BFQ_{50} for H_{60}	36% of BFQ_{50} for H_{70}	48% of BFQ_{50} for H_{80}	64% of BFQ_{50} for H_{90}	Wet season H_{min} (cfs)	Dry season C_{min} (cfs)	Habitat units restored (m)
Upper	3.6	Above diversion	0.61	0.90	1.30	1.70	2.30	No change	No change	0
Diversion	Diverting all flow		Spreckels Ditch intake (S-8) ☑ dam / weir ☑ control gate ☐ sluice gate ☑ conveyance (S-7, Punalau)					DAR recommends restoration at the Spreckels Ditch intake (S-8)		
Middle-upper	4.3	0.8	0.73	1.10	1.50	2.10	2.80	2.8 (+ 2)	0.8 (+ 0)	548
Diversion	Diverting all flow		Manuel Luis Ditch intake (ML-2) ☑ dam / weir ☐ control gate ☐ sluice gate ☐ conveyance					DAR recommends restoration at the Manuel Luis Ditch intake (ML-2)		
Middle-lower	4.9	0.5	0.83	1.20	1.80	2.40	3.10	3.3 (+ 0.5)	0.9 (+ 0.12)	951
Lower	5.5	1.1	0.94	1.40	2.00	2.60	3.50			

H_{min} = minimum flow, defined as 64% of BFQ_{50}, to provide 90% of natural instream habitat.
C_{min} = minimum flow, defined as 20% of BFQ_{50}, to provide connectivity between ocean and stream habitats.
Habitat units restored = total amount of habitat restored at H_{90} for the native species of oopu, hihiwai, and opae at 64% of BFQ_{50}.

Total HU: 5,968 m Restored: 1,499 m
*Action would restore 25% of total HU, or 29% of HU lost to diversions.

Spreckels Ditch intake (S-8) on Haipuaena Stream

Haipuaena Stream drops directly into Spreckels Ditch. The diversion dam is 63 feet in length, and the control gate at the intake 5 feet wide.

Manuel Luis Ditch intake (ML-2) on Haipuaena Stream

Haipuaena Stream drops directly into Manuel Luis Ditch. The diversion dam is located on the opposite side of the EMI access road, and it is 36 feet in length and 6 feet high.

PUNALAU / KOLEA STREAM

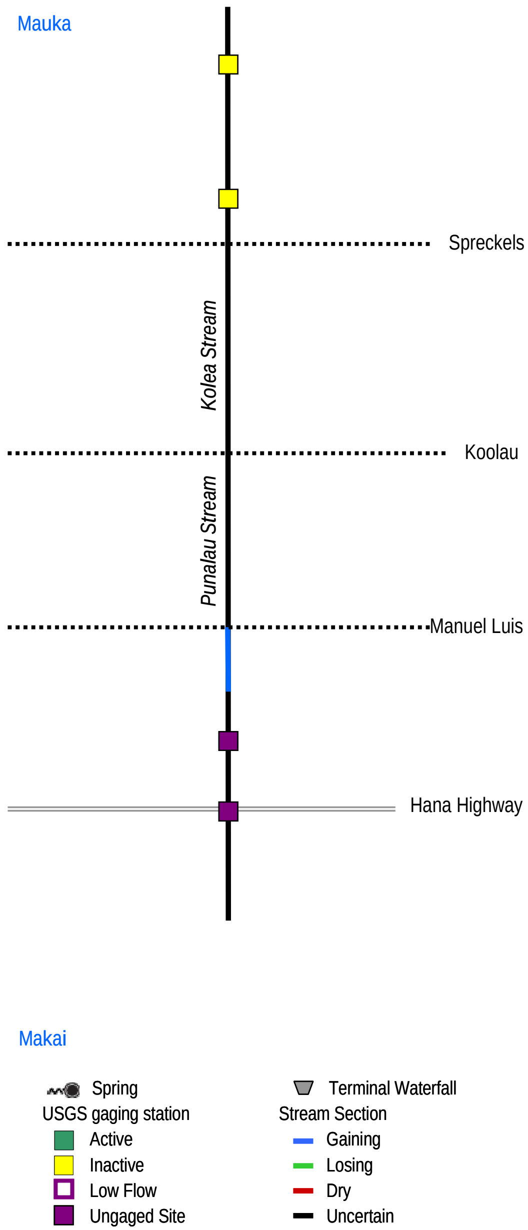

DIAGRAM NOT TO SCALE

Reach	Median base flow, BFQ_{50} (cfs)		Minimum flow , a percentage of natural BFQ_{50}, needed in the stream to provide a percentage of natural habitat (cfs)					DAR Recommendation		
	Natural condition	Diverted condition	17% of BFQ_{50} for H_{50}	25% of BFQ_{50} for H_{60}	36% of BFQ_{50} for H_{70}	48% of BFQ_{50} for H_{80}	64% of BFQ_{50} for H_{90}	Wet season H_{min} (cfs)	Dry season C_{min} (cfs)	Habitat units restored (m)
Upper	3.9	Above diversion	0.66	1.00	1.40	1.90	2.50			
Diversion	Diverting all flow		Spreckels Ditch intake (S-7) ☑ dam / weir ☑ control gate ☑ onstream sluice ☑ conveyance (S-6, Honomanu)							
Middle-Upper										
Diversion	Diverting all flow		Koolau Ditch intake (K-32) ☑ dam / weir ☑ control gate ☑ ~~onstream~~ sluice ☐ conveyance					DAR does not recommend any restoration action for Punalau / Kolea Stream		
Middle-Lower										
Diversion	Diverting all flow		Manual Luis Ditch intake (ML-1) ☑ dam / weir ☑ control gate ☑ onstream sluice ☐ conveyance							
Lower	4.5	0.6	0.77	1.10	1.60	2.20	2.90			

H_{min} = minimum flow, defined as 64% of BFQ_{50}, to provide 90% of natural instream habitat.
C_{min} = minimum flow, defined as 20% of BFQ_{50}, to provide connectivity between ocean and stream habitats.
Habitat units restored = total amount of habitat restored at H_{90} for the native species of oopu, hihiwai, and opae at 64% of BFQ_{50}.

INSTREAM USES

Traditional: 12 testified potential gatherers of vegetation and fish
Ecosystem: Alien and native same
Recreation: No HSA rating
Water Quality: Impaired
Hydropower Potential: No

NONINSTREAM USES

Traditional: No taro cultivation
Diversions: EMI - 3 major, 8 minor
- EMI diverts 4.4 cfs (dry times) to 6.5 cfs (normal times) of water, 9-13% of Honomanu Lic and 2% of East Maui Lic water yield

Spreckels Ditch intake (S-7) on Kolea Stream

Diversion structure consists of a 35 x 6 feet (W x H) dam with a valve (0.4 feet ID) that returns water to the stream. The intake (8 feet wide) is on the left stream bank.

Koolau Ditch intake (K-32) on Kolea Stream

Diversion structure consists of a 50 feet (L) x 13 feet (H) dam with the intake grate (17 x 28 feet), control gate (9.5 x 1.3 feet, W x H), dividing wall, and gravel basin on the left stream bank. There are two sluice gates on the left stream bank, each 3.6 feet wide x 5 feet high. The power house is no longer in operation.

Manuel Luis Ditch intake (ML-1) on Punalau Stream

Diversion structure consists of a 39 feet (L) x 4.6 feet (H) dam, with the intake (4 x 1.8 feet, W x H) and sluice gate (3.8 x 4 feet, W x H) on the left stream bank. The dividing wall is 27 feet in length and 3.3 feet high with one opening for water to flow from the gravel basin to the intake.

HONOMANU STREAM

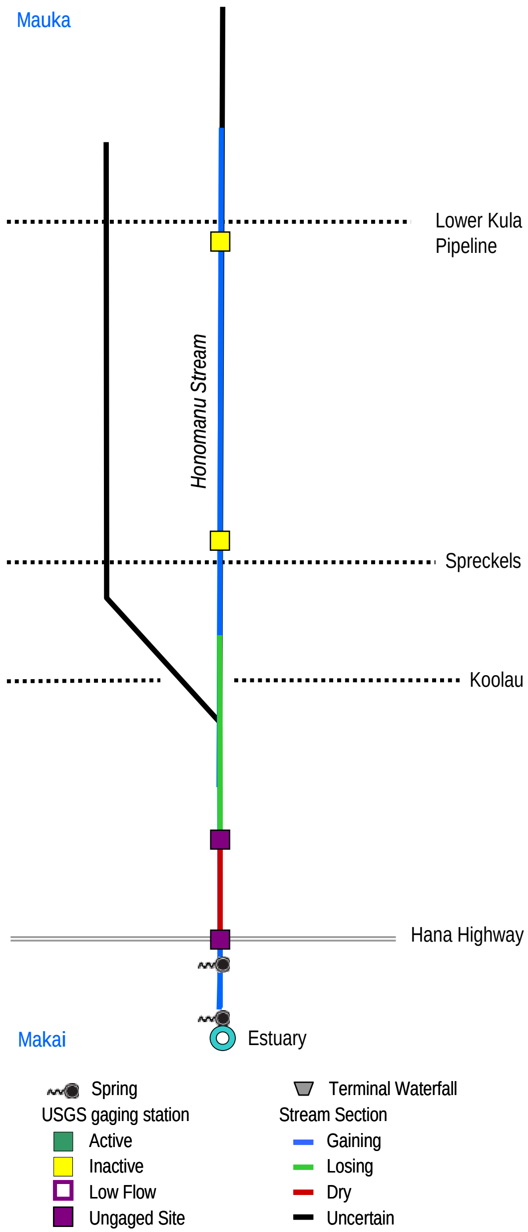

DIAGRAM NOT TO SCALE

INSTREAM USES

Traditional: 26 testified potential gatherers of vegetation and fish
Ecosystem: Native species dominance
Recreation: Outstanding (HSA rating)
Water Quality: Impaired
Hydropower Potential: No

NONINSTREAM USES

Traditional: No taro cultivation
Diversions: EMI - 5 major, 5 minor; MDWS - 1 major; 2 Haleakala Ranch
- EMI diverts 3 cfs (dry times) to 6 cfs (normal times) of water, 6-14% of Honomanu Lic and 1-2% of East Maui Lic water yield

Reach	Median base flow, BFQ_{50} (cfs)		Minimum flow, a percentage of natural BFQ_{50}, needed in the stream to provide a percentage of natural habitat (cfs)					DAR Recommendation		
	Natural condition	Diverted condition	17% of BFQ_{50} for H_{50}	25% of BFQ_{50} for H_{60}	36% of BFQ_{50} for H_{70}	48% of BFQ_{50} for H_{80}	64% of BFQ_{50} for H_{90}	Wet season H_{min} (cfs)	Dry season C_{min} (cfs)	Habitat units restored (m)
Upper	2.8	Above diversion	0.48	0.70	1.00	1.30	1.80			
Diversion	Diverting all flow		Spreckels Ditch intake (S-2, S-4): ☑ dam / weir ☐ control gate ☑ onstream sluice ☐ conveyance Spreckels Ditch intake (S-6): ☑ dam / weir ☐ control gate ☑ ~~onstream~~ sluice ☐ conveyance					DAR does not recommend any restoration action for Honomanu Stream		
Middle	6.7	3.8	1.10	1.70	2.40	3.20	4.30			
Lower	9	0	1.50	2.30	3.20	4.30	5.80			

H_{min} = minimum flow, defined as 64% of BFQ_{50}, to provide 90% of natural instream habitat.
C_{min} = minimum flow, defined as 20% of BFQ_{50}, to provide connectivity between ocean and stream habitats.
Habitat units restored = total amount of habitat restored at H_{90} for the native species of oopu, hihiwai, and opae at 64% of BFQ_{50}.

Spreckels Ditch intake (S-2) on Honomanu Stream

Diversion structure consists of a 16 feet (L) x 2.7 feet (H) dam. Intake (2.3 x 3.3 feet, W x H) and sluice gate (2.5 x 2.7 feet, W x H) situate on the left bank. The dividing wall has a height of 3.2 feet. Honomanu Stream continues as a waterfall downstream from the diversion.

Spreckels Ditch intake (S-4) on Honomanu Stream

Diversion structure consists of a curved dam about 66 feet in length. Intake (4 x 3 feet, W x H) and sluice gate (4 x 3 feet, W x H) situate on the left bank. The dividing wall is 37 feet in length. Honomanu Stream continues as a waterfall downstream from the diversion.

Spreckels Ditch intake (S-6) on Honomanu Stream

Diversion structure consists of an intake grate (11 x 4 feet) that spans the entire stream channel. Gravel basin and the sluice gate (2 x 4 feet, W x H) situate on the left stream bank. The dividing wall is about 5.5 feet in height.

NUAAILUA STREAM

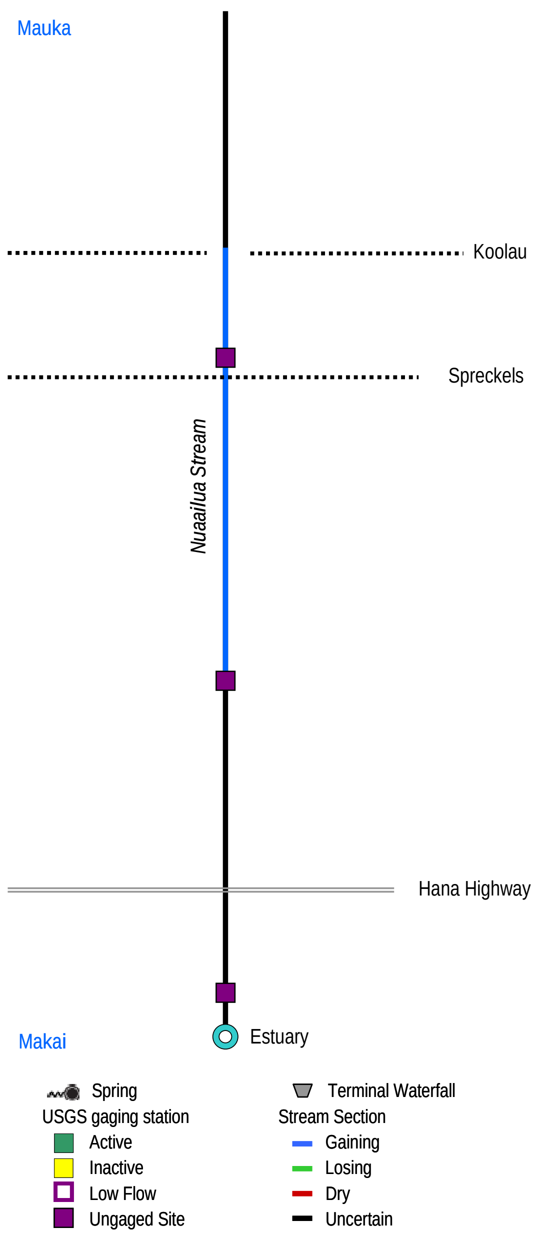

DIAGRAM NOT TO SCALE

Reach	Median base flow, BFQ_{50} (cfs)		Minimum flow , a percentage of natural BFQ_{50}, needed in the stream to provide a percentage of natural habitat (cfs)					DAR Recommendation		
	Natural condition	Diverted condition	17% of BFQ_{50} for H_{50}	25% of BFQ_{50} for H_{60}	36% of BFQ_{50} for H_{70}	48% of BFQ_{50} for H_{80}	64% of BFQ_{50} for H_{90}	Wet season H_{min} (cfs)	Dry season C_{min} (cfs)	Habitat units restored (m)
Upper	0.28	Above diversion	0.05	0.07	0.10	0.13	0.18			
Diversion	Diverting all flow		Spreckels Ditch intake (S-1) ☑ dam / weir ☑ control gate ☐ sluice gate ☐ conveyance					DAR does not recommend any restoration action for Nuaailua Stream		
Middle	2.5	2.2	0.43	0.63	0.90	1.20	1.60			
Lower	7.4	7.1	1.30	1.90	2.70	3.60	4.70			

H_{min} = minimum flow, defined as 64% of BFQ_{50}, to provide 90% of natural instream habitat.
C_{min} = minimum flow, defined as 20% of BFQ_{50}, to provide connectivity between ocean and stream habitats.
Habitat units restored = total amount of habitat restored at H_{90} for the native species of oopu, hihiwai, and opae at 64% of BFQ_{50}.

INSTREAM USES

Traditional: 25 testified potential gatherers of vegetation and fish
Ecosystem: Alien and native same
Recreation: No HSA rating
Water Quality: Not impaired
Hydropower Potential: No

NONINSTREAM USES

Traditional: No taro cultivation
Diversions: EMI - 1 major, 3 minor
- EMI diverts <1 cfs of water, 1% of Honomanu Lic and 0.2% of East Maui Lic water yield

Spreckels Ditch intake (S-1) on Nuaailua Stream

Diversion structure consists of a 25 feet (L) x 3.3 feet (H) dam. Intake (1.7 x 2.32 feet, W x H) situate on the left bank without a sluice gate. Two minor diversion pipes sit adjacent to the diversion dam, with diameters 0.62 feet and 0.5 feet. Nuaailua Stream marks the start of the Spreckels Ditch.

OHIA STREAM

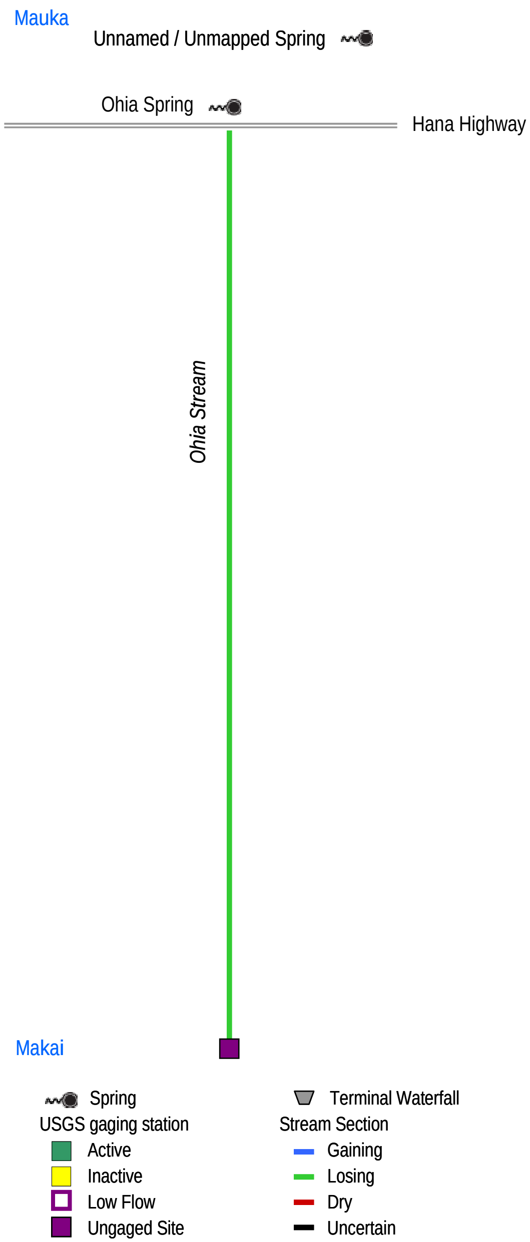

DIAGRAM NOT TO SCALE

INSTREAM USES

Traditional: 28 testified potential gatherers of vegetation and fish
Ecosystem: Alien species dominant
Recreation: Substantial (HSA rating)
Water Quality: Impaired
Hydropower Potential: No

NONINSTREAM USES

Traditional: One active taro cultivation

- Diversions: EMI does not divert from Ohia stream.

Reach	Median base flow, BFQ_{50} (cfs)		Minimum flow , a percentage of natural BFQ_{50}, needed in the stream to provide a percentage of natural habitat (cfs)					DAR Recommendation		
	Natural condition	Diverted condition	17% of BFQ_{50} for H_{50}	25% of BFQ_{50} for H_{60}	36% of BFQ_{50} for H_{70}	48% of BFQ_{50} for H_{80}	64% of BFQ_{50} for H_{90}	Wet season H_{min} (cfs)	Dry season C_{min} (cfs)	Habitat units restored (m)
Upper										
Middle								DAR does not recommend any restoration action for Ohia Stream		
Lower	4.7	4.7	0.80	1.20	1.70	2.30	3.00			

H_{min} = minimum flow, defined as 64% of BFQ_{50}, to provide 90% of natural instream habitat.
C_{min} = minimum flow, defined as 20% of BFQ_{50}, to provide connectivity between ocean and stream habitats.
Habitat units restored = total amount of habitat restored at H_{90} for the native species of oopu, hihiwai, and opae at 64% of BFQ_{50}.

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WEST WAILUAIKI STREAM

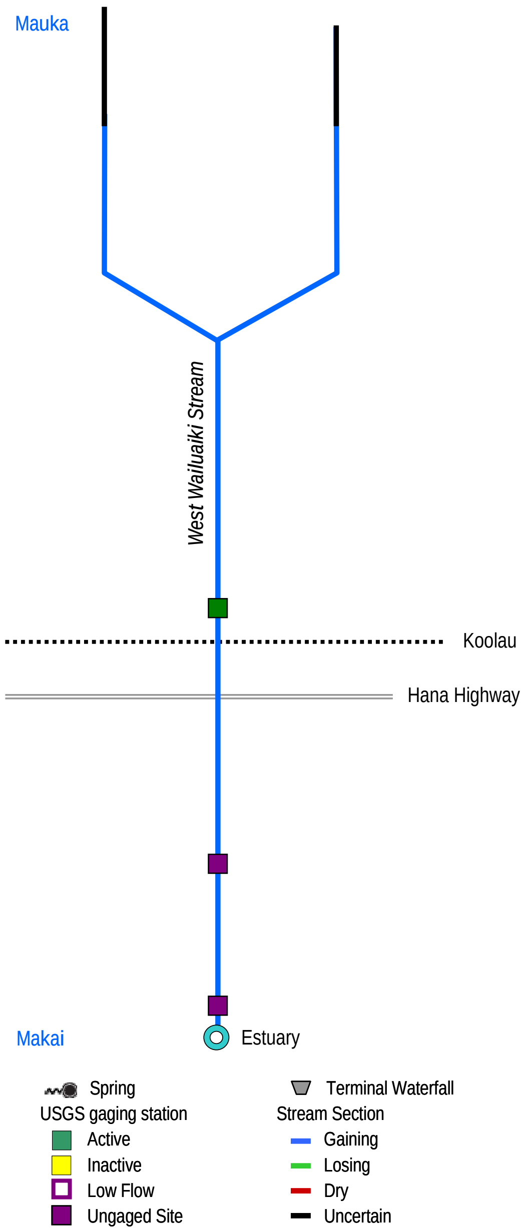

DIAGRAM NOT TO SCALE

INSTREAM USES

Traditional: 25 testified potential gatherers of vegetation and fish
Ecosystem: Native species dominance
Recreation: Outstanding (HSA rating)
Water Quality: Impaired
Hydropower Potential: Yes

NONINSTREAM USES

Traditional: No taro cultivation
Diversions: 1 EMI major, 5 EMI minor
- EMI diverts 6 cfs (dry times) to 10 cfs (normal times) of water, 9-15% of Keanae Lic and 2-4% of East Maui Lic water yield

Reach	Median base flow, BFQ_{50} (cfs)		Minimum flow, a percentage of natural BFQ_{50}, needed in the stream to provide a percentage of natural habitat (cfs)					DAR Recommendation [RANK 2]		
	Natural condition	Diverted condition	17% of BFQ_{50} for H_{50}	25% of BFQ_{50} for H_{60}	36% of BFQ_{50} for H_{70}	48% of BFQ_{50} for H_{80}	64% of BFQ_{50} for H_{90}	Wet season H_{min} (cfs)	Dry season C_{min} (cfs)	Habitat units restored (m)
Upper	6	Above diversion	1.00	1.50	2.20	2.90	3.80	No change	No change	886
Diversion	Diverting all flow		Koolau Ditch intake (K-17) ☑ dam / weir ☑ control gate ☑ onstream sluice ☐ conveyance					DAR recommends restoration at the Koolau Ditch intake (K-17)		
Middle	6.8	0.8	1.20	1.70	2.40	3.30	4.40	4.5 (+ 3.5)	1.4 (+ 0.4)	1,331
Lower	7.2	1.2	1.20	1.80	2.60	3.50	4.60			

H_{min} = minimum flow, defined as 64% of BFQ_{50}, to provide 90% of natural instream habitat.
C_{min} = minimum flow, defined as 20% of BFQ_{50}, to provide connectivity between ocean and stream habitats.
Habitat units restored = total amount of habitat restored at H_{90} for the native species of oopu, hihiwai, and opae at 64% of BFQ_{50}.

Total HU: 5,703 m Restored: 2,218 m
*Action would restore 39% of total HU, or 55% of HU lost to diversions.

Koolau Ditch intake (K-17) on West Wailuaiki Stream

Diversion structure consists of a 30 feet (L) x 2 feet (H) dam. Intake (4.5 x 3 feet, W x H) and sluice gate (5.5 x 3 feet, W x H) situate on the right bank. The dividing wall between the gravel basin and the ditch is 33.5 feet in length. Water flows down a waterfall into a tunnel that runs further downstream into the intake and sluice structures. Past the diversion, water flows down a waterfall.

EAST WAILUAIKI STREAM

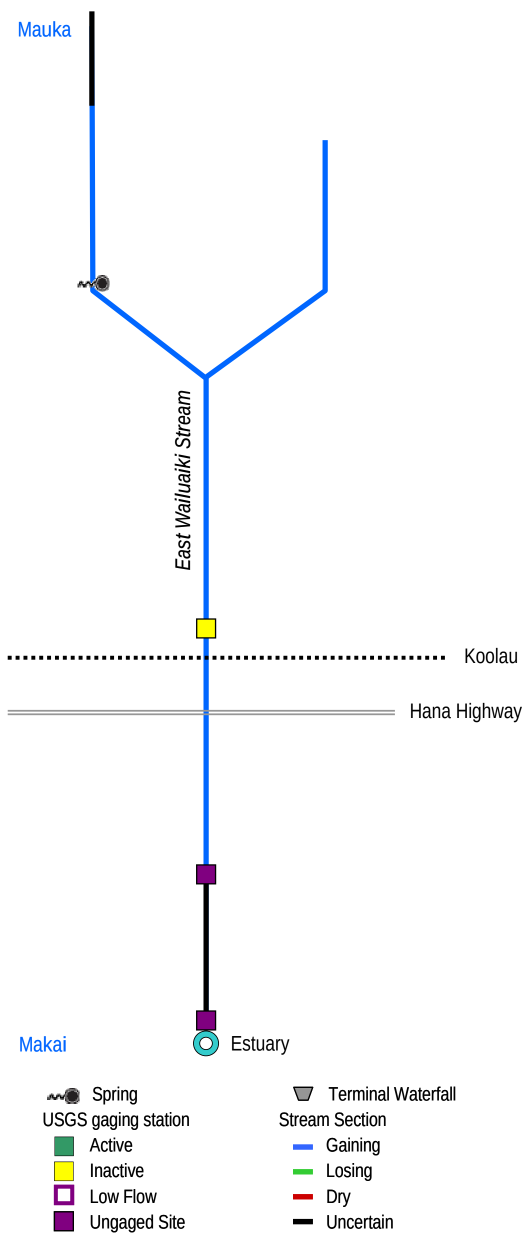

DIAGRAM NOT TO SCALE

INSTREAM USES

Traditional: 25 testified potential gatherers of vegetation and fish
Ecosystem: Native species dominance
Recreation: Outstanding (HSA rating)
Water Quality: Impaired
Hydropower Potential: Yes

NONINSTREAM USES

Traditional: No taro cultivation
Diversions: 1 EMI major, 3 EMI minor
- EMI diverts 5.8 cfs (dry times) to 10 cfs (normal times) of water, 9-15% of Keanae Lic and 2-4% of East Maui Lic water yield

Reach	Median base flow, BFQ_{50} (cfs)		Minimum flow , a percentage of natural BFQ_{50}, needed in the stream to provide a percentage of natural habitat (cfs)					DAR Recommendation [RANK 1]		
	Natural condition	Diverted condition	17% of BFQ_{50} for H_{50}	25% of BFQ_{50} for H_{60}	36% of BFQ_{50} for H_{70}	48% of BFQ_{50} for H_{80}	64% of BFQ_{50} for H_{90}	Wet season H_{min} (cfs)	Dry season C_{min} (cfs)	Habitat units (HU) restored (m)
Upper	5.8	Above diversion	0.99	1.50	2.10	2.80	3.70	No change	No change	951
Diversion	Diverting all flow		Koolau Ditch intake (K-16) ☑ dam / weir ☑ control gate ☑ onstream sluice ☐ conveyance					DAR recommends restoration at the Koolau Ditch intake (K-16)		
Middle	6.8	1	1.20	1.70	2.40	3.30	4.40	4.5 (+ 3.2)	1.4 (+ 0.2)	1,452
Lower	7.2	1.5	1.20	1.80	2.60	3.50	4.60			

H_{min} = minimum flow, defined as 64% of BFQ_{50}, to provide 90% of natural instream habitat.
C_{min} = minimum flow, defined as 20% of BFQ_{50}, to provide connectivity between ocean and stream.
Habitat units restored = total amount of habitat restored at H_{90} for the native species of oopu, hihiwai, and opae at 64% of BFQ_{50}.

Total HU: 6,528 m Restored: 2,402 m
*Action would restore 37% of total HU, or 55% of HU lost to diversions.

Koolau Ditch intake (K-16) on East Wailuaiki Stream

Diversion dam consists of two walls, one man-made dam (34 feet – L, 4.4 feet – H), and a natural dam (61 feet – L, 5.5 feet – H). Intake (5 x 4 feet, W x H) and sluice gate (3 x 2 feet, W x H) situate on the left bank. The dividing wall between the gravel basin and the ditch is 42 feet (L) x 5 feet (H) and has two openings.

KOPILIULA & PUAKAA STREAMS

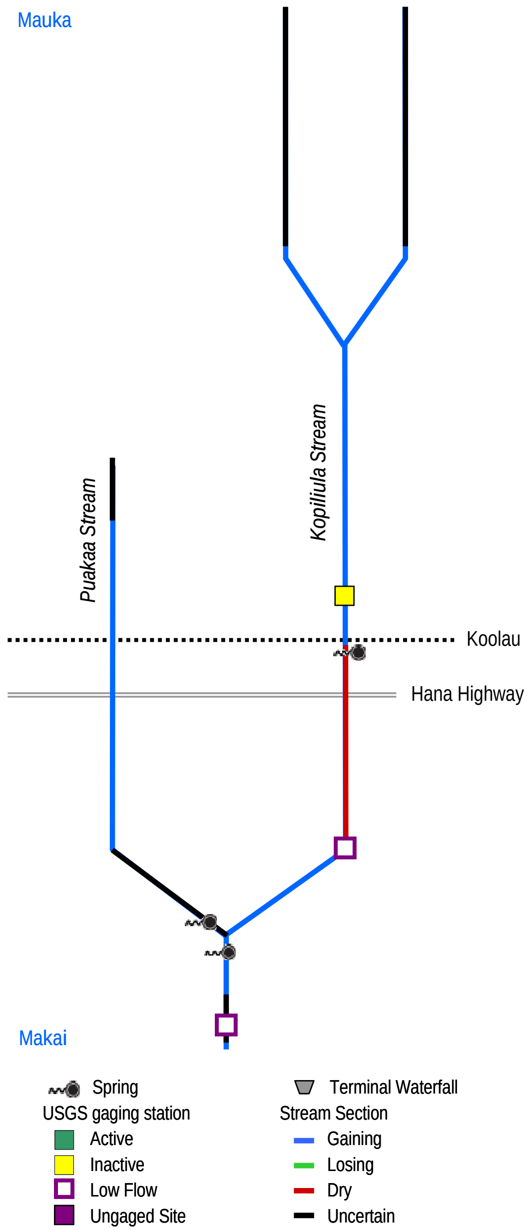

DIAGRAM NOT TO SCALE

INSTREAM USES

Traditional: 0 testified potential gatherers of vegetation and fish
Ecosystem: Native species dominance
Recreation: Substantial (HSA rating)
Water Quality: Impaired
Hydropower Potential: No

NONINSTREAM USES

Traditional: No taro cultivation
Diversions: 1 EMI major per stream, 8 EMI minor (7 on Kopiliula)
- EMI diverts 6 cfs (dry times) to 11 cfs (normal times) of water, 15-26% of Nahiku Lic and 2-4% of East Maui Lic water yield

[Data in black correspond to Kopiliula Stream, data in blue corresponds specially to Puakaa Stream]

Reach	Median base flow, BFQ_{50} (cfs)		Minimum flow , a percentage of natural BFQ_{50}, needed in the stream to provide a percentage of natural habitat (cfs)					DAR Recommendation [RANK 5]		
	Natural condition	Diverted condition	17% of BFQ_{50} for H_{50}	25% of BFQ_{50} for H_{60}	36% of BFQ_{50} for H_{70}	48% of BFQ_{50} for H_{80}	64% of BFQ_{50} for H_{90}	Wet season H_{min} (cfs)	Dry season C_{min} (cfs)	Habitat units restored (m)
Upper	5 1.1	Above diversion	0.85 0.19	1.30 0.28	1.80 0.40	2.40 0.53	3.20 0.7	No change	No change	901 300
Diversion	Diverting all flow		Koolau Ditch intake (K-14) ☑ dam / weir ☑ control gate ☑ ~~onstream~~ sluice ☐ conveyance			Koolau Ditch intake (K-15) ☑ dam / weir ☑ control gate ☑ onstream sluice ☑ conveyance (ditch)		DAR recommends restoration at both Koolau Ditch intakes (K-14 and K-15)		
Middle	6.5 2.2	1.2 1.1	1.10 0.37	1.60 0.55	2.30 0.79	3.10 1.10	4.20 1.40	4.2 (+ 3) no change	1.3 (+ 0.2) + 0.1	805 0
Lower	9.5	2.8	1.60	2.40	3.40	4.60	6.10	5.8 (+ 0)	2.9 (+ 0)	

H_{min} = minimum flow, defined as 64% of BFQ_{50}, to provide 90% of natural instream habitat.
C_{min} = minimum flow, defined as 20% of BFQ_{50}, to provide connectivity between ocean and stream habitats.
Habitat units restored = total amount of habitat restored at H_{90} for the native species of oopu, hihiwai, and opae at 64% of BFQ_{50}.

Total HU: 9,257 m Restored: 2,007 m
*Action would restore 22% of total HU, or 39% of HU lost to diversions.

Koolau Ditch intake (K-14) on Puakaa Stream

Diversion structure consists of a 46 feet (L) x 2.3 feet (H) dam. Intake (5.7 x 5.2 feet, W x H) and sluice gate (2 x 4 feet, W x H) situate on the left bank, with the sluice gate further downstream from the intake. The dividing wall between the gravel basin and the ditch has an opening with diameter of 1.6 feet.

Koolau Ditch intake (K-15) on Kopiliula Stream

Diversion structure is located by Hana Highway and consists of a 25.5 feet (L) x 2 feet (H) dam. Intake and sluice gate situate on the left bank. Water from Kopiliula flows downstream and co-mingles with the ditch water (diverted from Makapipi, Hanawi, Kapaula, Waiaaka, Paakea, Waiohue, and Puakaa Streams) in the gravel basin and then flows back into the Koolau Ditch (tunnel) on the left bank.

WAIOHUE STREAM

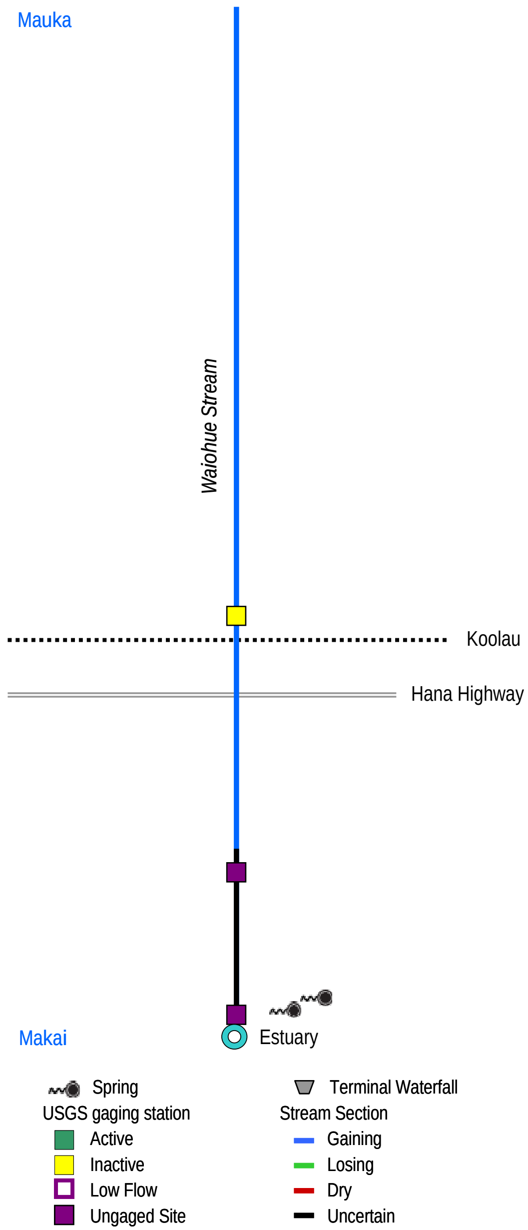

DIAGRAM NOT TO SCALE

INSTREAM USES

Traditional: 25 testified potential gatherers of vegetation and fish
Ecosystem: Native species dominance
Recreation: Outstanding (HSA rating)
Water Quality: Not impaired
Hydropower Potential: No

NONINSTREAM USES

Traditional: No taro cultivation
Diversions: 2 EMI major, 5 EMI minor

- EMI diverts 5 cfs (dry times) to 6.5 cfs (normal times) of water, 14-19% of Nahiku Lic and 2-3% of East Maui Lic water yield

Reach	Median base flow, BFQ_{50} (cfs)		Minimum flow, a percentage of natural BFQ_{50}, needed in the stream to provide a percentage of natural habitat (cfs)					DAR Recommendation [RANK 7]		
	Natural condition	Diverted condition	17% of BFQ_{50} for H_{50}	25% of BFQ_{50} for H_{60}	36% of BFQ_{50} for H_{70}	48% of BFQ_{50} for H_{80}	64% of BFQ_{50} for H_{90}	Wet season H_{min} (cfs)	Dry season C_{min} (cfs)	Habitat units restored (m)
Upper	5	Above diversion	0.85	1.30	1.80	2.40	3.20	No change	No change	562
Diversion	Diverting all flow		Koolau Ditch intake (K-13) ☐ dam / weir ☑ control gate ☑ ~~onstream~~ sluice ☐ conveyance					DAR recommends restoration at the Koolau Ditch intake (K-13)		
Middle	6	1	1.00	1.50	2.20	2.90	3.80	4.4 (+ 2.7)	1.3 (+ 0.1)	932
Lower	7.5	2.1	1.30	1.90	2.70	3.60	4.80			

H_{min} = minimum flow, defined as 64% of BFQ_{50}, to provide 90% of natural instream habitat.
C_{min} = minimum flow, defined as 20% of BFQ_{50}, to provide connectivity between ocean and stream habitats.
Habitat units restored = total amount of habitat restored at H_{90} for the native species of oopu, hihiwai, and opae at 64% of BFQ_{50}.

Total HU: 4,428 m Restored: 1,494 m
*Action would restore 34% of total HU, or 55% of HU lost to diversions.

Koolau Ditch intake (K-13) on Waiohue Stream

The intake (2.4 x 2.1 feet, W x H) is further upstream from the sluice gate (1.4 x 5.9 feet, W x H). Water flows from a waterfall into the plunge pool, where it is diverted into the intake grate and then through a short tunnel into the gravel basin downstream from the intake. The dividing wall of the diversion structure has two openings with diameters 1.3 feet and 0.8 feet diameter.

PAAKEA STREAM

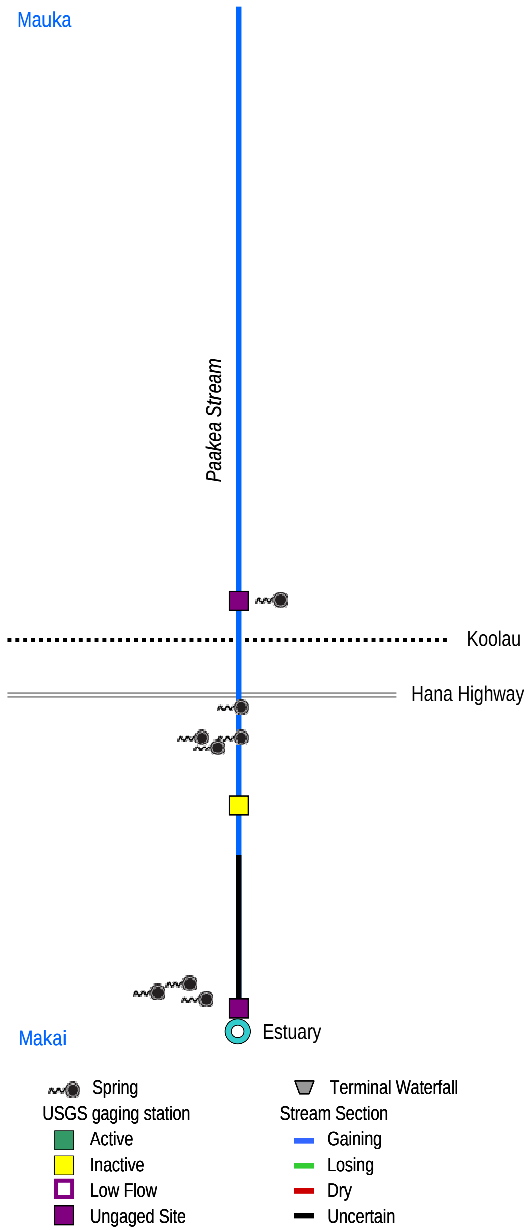

DIAGRAM NOT TO SCALE

INSTREAM USES

Traditional: 25 testified potential gatherers of vegetation and fish
Ecosystem: Native species dominance
Recreation: Substantial (HSA rating)
Water Quality: Not impaired
Hydropower Potential: No

NONINSTREAM USES

Traditional: No taro cultivation
Diversions: 2 EMI major, 3 EMI minor

- EMI diverts 1 cfs (dry times) to 1.5 cfs (normal times) of water, 2.6-4% of Nahiku Lic and 0.3-0.6% of East Maui Lic water yield

Reach	Median base flow, BFQ_{50} (cfs)		Minimum flow , a percentage of natural BFQ_{50}, needed in the stream to provide a percentage of natural habitat (cfs)					DAR Recommendation		
	Natural condition	Diverted condition	17% of BFQ_{50} for H_{50}	25% of BFQ_{50} for H_{60}	36% of BFQ_{50} for H_{70}	48% of BFQ_{50} for H_{80}	64% of BFQ_{50} for H_{90}	Wet season H_{min} (cfs)	Dry season C_{min} (cfs)	Habitat units restored (m)
Upper	0.9	Above diversion	0.15	0.23	0.32	0.43	0.58			
Diversion	Diverting all flow		Koolau Ditch intake (K-10) ☑ dam / weir ☑ control gate ☑ ~~onstream~~ sluice ☐ conveyance					DAR does not recommend any restoration action for Paakea Stream		
Middle	4.7	3.8	0.80	1.20	1.70	2.30	3.00			
Lower	5.5	4.6	0.94	1.40	2.00	2.60	3.50			

H_{min} = minimum flow, defined as 64% of BFQ_{50}, to provide 90% of natural instream habitat.
C_{min} = minimum flow, defined as 20% of BFQ_{50}, to provide connectivity between ocean and stream habitats.
Habitat units restored = total amount of habitat restored at H_{90} for the native species of oopu, hihiwai, and opae at 64% of BFQ_{50}.

Koolau Ditch intake (K-10) on Paakea Stream

Diversion structure consists of a 24 feet (L) x 3.6 feet (H) dam. Intake (2.7 x 1.05 feet, W x H) and sluice gate (3.1 x 2.5 feet, W x H) situate on the left bank. The dividing wall between the gravel basin and the ditch has an opening with diameter of 0.7 feet.

WAIAAKA STREAM

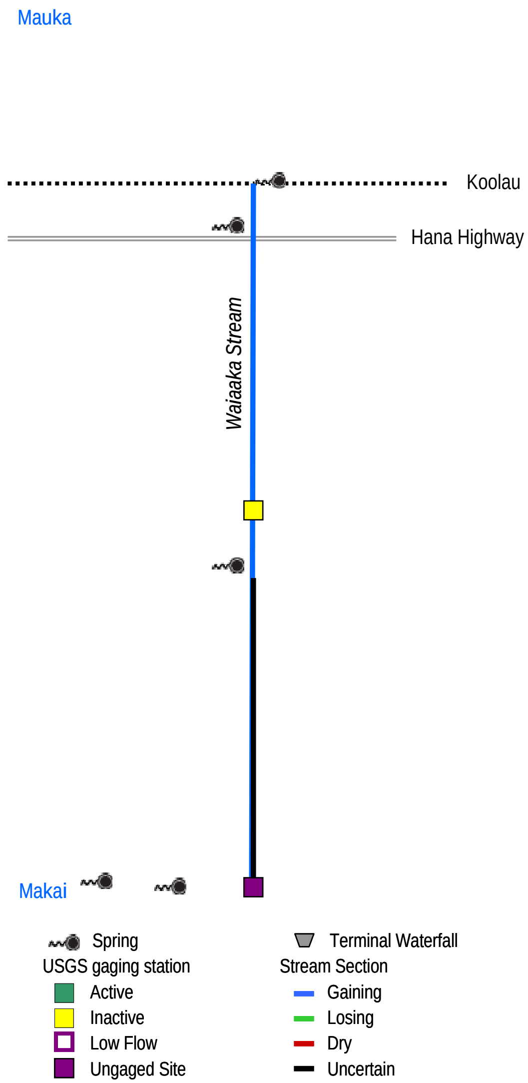

DIAGRAM NOT TO SCALE

Reach	Median base flow, BFQ_{50} (cfs)		Minimum flow, a percentage of natural BFQ_{50}, needed in the stream to provide a percentage of natural habitat (cfs)					DAR Recommendation		
	Natural condition	Diverted condition	17% of BFQ_{50} for H_{50}	25% of BFQ_{50} for H_{60}	36% of BFQ_{50} for H_{70}	48% of BFQ_{50} for H_{80}	64% of BFQ_{50} for H_{90}	Wet season H_{min} (cfs)	Dry season C_{min} (cfs)	Habitat units restored (m)
Diversion	Diverting all flow		Koolau Ditch intake (K-9) ☐ dam / weir ☐ control gate ☑ onstream sluice ☑ conveyance					DAR does not recommend any restoration action for Waiaaka Stream		
Middle	0.77	0.77	0.13	0.19	0.28	0.37	0.49			
Lower	1.1	1.1	0.19	0.28	0.40	0.53	0.70			

H_{min} = minimum flow, defined as 64% of BFQ_{50}, to provide 90% of natural instream habitat.
C_{min} = minimum flow, defined as 20% of BFQ_{50}, to provide connectivity between ocean and stream habitats.
Habitat units restored = total amount of habitat restored at H_{90} for the native species of oopu, hihiwai, and opae at 64% of BFQ_{50}.

INSTREAM USES

Traditional: 0 testified potential gatherers of vegetation and fish
Ecosystem: Alien species dominance
Recreation: Substantial (HSA rating)
Water Quality: Not impaired
Hydropower Potential: No

NONINSTREAM USES

Traditional: No taro cultivation
Diversions: 1 EMI major

- EMI diverts minimal amounts of water from Waiaaka Stream.
- The stream is used to convey water from a development tunnel to the ditch.

Koolau Ditch intake (K-9) on Waiaaka Stream

Waiaaka Stream is used to convey water from a development tunnel into the Koolau Ditch. The stream was dry downstream from the diversion. No physical measurements were recorded.

KAPAULA STREAM

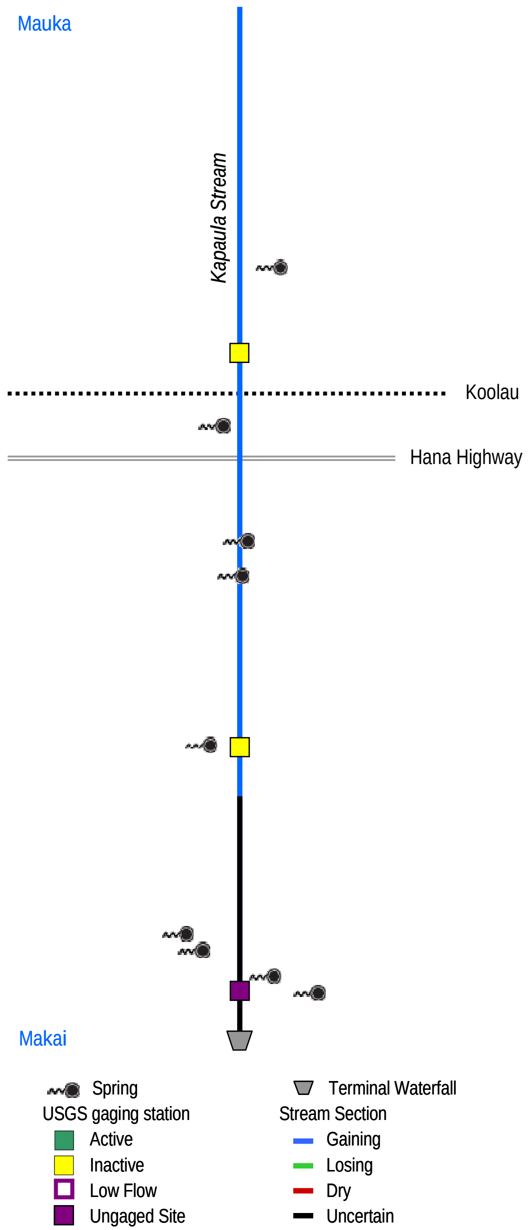

DIAGRAM NOT TO SCALE

Reach	Median base flow, BFQ_{50} (cfs)		Minimum flow , a percentage of natural BFQ_{50}, needed in the stream to provide a percentage of natural habitat (cfs)					DAR Recommendation		
	Natural condition	Diverted condition	17% of BFQ_{50} for H_{50}	25% of BFQ_{50} for H_{60}	36% of BFQ_{50} for H_{70}	48% of BFQ_{50} for H_{80}	64% of BFQ_{50} for H_{90}	Wet season H_{min} (cfs)	Dry season C_{min} (cfs)	Habitat units restored (m)
Upper	2.8	Above diversion	0.48	0.70	1.00	1.30	1.80			
Diversion	Diverting all flow		Koolau Ditch intake (K-7) ☑ dam / weir ☐ control gate ☐ sluice gate ☐ conveyance					DAR does not recommend any restoration action for Kapaula Stream		
Middle	5.1	2.1	0.87	1.30	1.80	2.40	3.30			
Lower	5.7	2.6	0.97	1.40	2.10	2.70	3.60			

H_{min} = minimum flow, defined as 64% of BFQ_{50}, to provide 90% of natural instream habitat.
C_{min} = minimum flow, defined as 20% of BFQ_{50}, to provide connectivity between ocean and stream habitats.
Habitat units restored = total amount of habitat restored at H_{90} for the native species of oopu, hihiwai, and opae at 64% of BFQ_{50}.

INSTREAM USES

Traditional: 26 testified potential gatherers of vegetation and fish
Ecosystem: Alien and native species same dominance
Recreation: Substantial (HSA rating)
Water Quality: Not impaired
Hydropower Potential: No

NONINSTREAM USES

Traditional: No taro cultivation
Diversions: 2 EMI major, 5 EMI minor

- EMI diverts 3 cfs (dry times) to 5.2 cfs (normal times) of water, 8-15% of Nahiku Lic and 1-2% of East Maui Lic water yield

Koolau Ditch intake (K-7) on Kapaula Stream

Diversion structure consists of a 19.5 feet (L) x 2.7 feet (H) dam. Intake grate (3 x 19 feet, W x L) situates on the right bank with no sluice gate. Water flows down a small cascading waterfall before reaching the diversion. Downstream of the diversion appears to have an existing diversion dam. According to Garret Hew, the stream is losing upstream of the old dam. Therefore, the diversion dam was moved further upstream from the losing section.

HANAWI STREAM

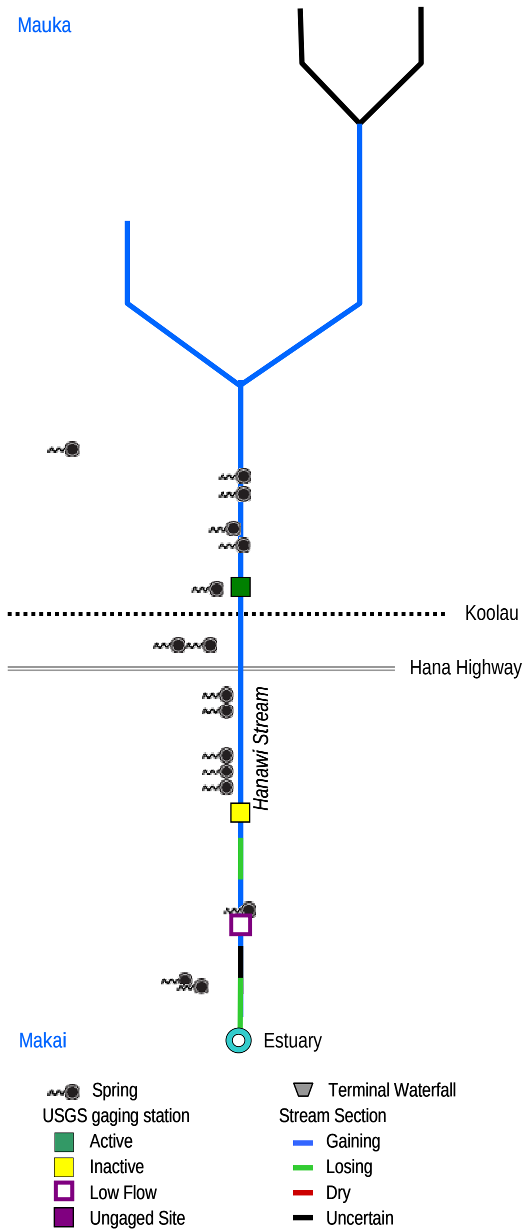

DIAGRAM NOT TO SCALE

INSTREAM USES

Traditional: 30 testified gatherers of vegetation and fish
Ecosystem: Native species dominance
Recreation: Outstanding (HSA rating)
Water Quality: Impaired
Hydropower Potential: Yes

NONINSTREAM USES

Traditional: No taro cultivation
Diversions: 5 EMI major, 11 EMI minor, 1 MLP – Nahiku Pump

- EMI diverts 4.6 cfs (dry times) to 7 cfs (normal times) of water, 13-20% of Nahiku Lic and 2-3% of East Maui Lic water yield

Reach	Median base flow, BFQ_{50} (cfs)		Minimum flow, a percentage of natural BFQ_{50}, needed in the stream to provide a percentage of natural habitat (cfs)					DAR Recommendation [RANK 8]		
	Natural condition	Diverted condition	17% of BFQ_{50} for H_{50}	25% of BFQ_{50} for H_{60}	36% of BFQ_{50} for H_{70}	48% of BFQ_{50} for H_{80}	64% of BFQ_{50} for H_{90}	Wet season H_{min} (cfs)	Dry season C_{min} (cfs)	Habitat units restored (m)
Upper	4.6	Above diversion	0.78	1.20	1.70	2.20	2.90	No change	No change	1,296
Diversion	Diverting all flow		Koolau Ditch intake (K-4) ☑ dam / weir ☐ control gate ☑ onstream sluice ☐ conveyance					DAR recommends restoration at the Koolau Ditch intake (K-4)		
Middle	24	19	4.10	6.00	8.60	12.00	15.00	No change	(+ 0.1) Wetted pathway	0
Lower	26	21	4.40	6.50	9.40	12.00	17.00			

H_{min} = minimum flow, defined as 64% of BFQ_{50}, to provide 90% of natural instream habitat.
C_{min} = minimum flow, defined as 20% of BFQ_{50}, to provide connectivity between ocean and stream habitats.
Habitat units restored = total amount of habitat restored at H_{90} for the native species of oopu, hihiwai, and opae at 64% of BFQ_{50}.

Total HU: 7,585 m Restored: 1,296 m
*Action would restore 17% of total HU, or 38% of HU lost to diversions.

Koolau Ditch intake (K-4) on Hanawi Stream

Diversion structure consists of a 38 feet (L) dam. Intake and sluice gate (2.97 x 4 feet, W x H) situate on the right bank, with the intake grate about 30 feet upstream of the sluice gate. Minor diversion on the right bank consists of 2 white pipes that transmit seepage flow into the gravel basin. Water flows down a waterfall before reaching the diversion.

MAKAPIPI STREAM

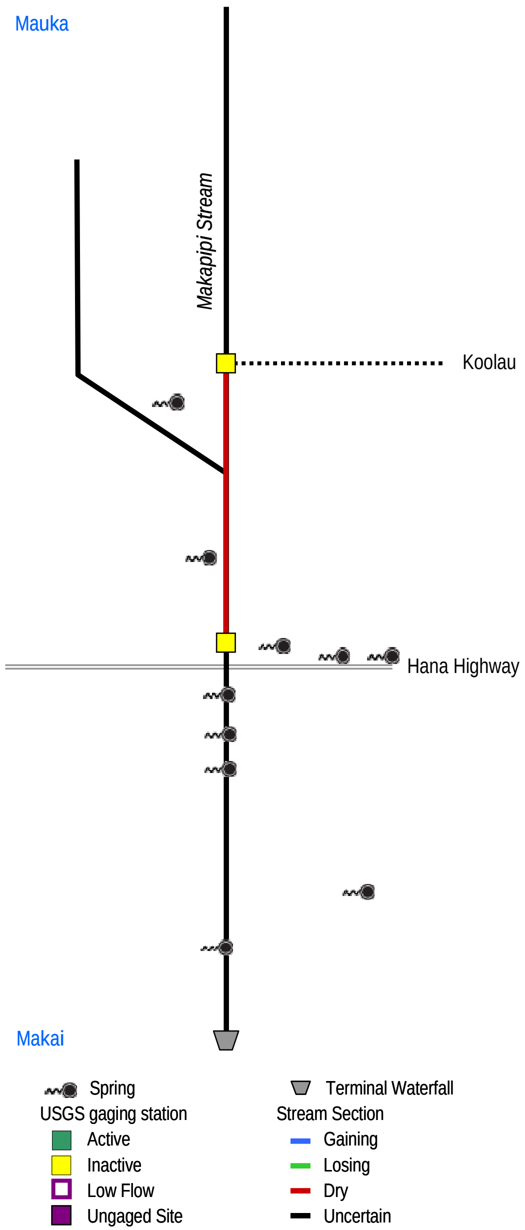

DIAGRAM NOT TO SCALE

Reach	Median base flow, BFQ_{50} (cfs)		Minimum flow , a percentage of natural BFQ_{50}, needed in the stream to provide a percentage of natural habitat (cfs)					DAR Recommendation		
	Natural condition	Diverted condition	17% of BFQ_{50} for H_{50}	25% of BFQ_{50} for H_{60}	36% of BFQ_{50} for H_{70}	48% of BFQ_{50} for H_{80}	64% of BFQ_{50} for H_{90}	Wet season H_{min} (cfs)	Dry season C_{min} (cfs)	Habitat units restored (m)
Upper	1.3	Above diversion	0.22	0.33	0.47	0.62	0.83			
Diversion	Diverting all flow		Koolau Ditch intake (K-1) ☑ dam / weir ☐ control gate ☑ onstream sluice ☐ conveyance					DAR does not recommend any restoration action for Makapipi Stream		
Middle	--	--	--	--	--	--	--			
Lower	--	--	--	--	--	--	--			

H_{min} = minimum flow, defined as 64% of $BFQ_{50,}$ to provide 90% of natural instream habitat.
C_{min} = minimum flow, defined as 20% of BFQ_{50}, to provide connectivity between ocean and stream habitats.
Habitat units restored = total amount of habitat restored at H_{90} for the native species of oopu, hihiwai, and opae at 64% of BFQ_{50}.

INSTREAM USES

Traditional: 31 testified potential gatherers of vegetation and fish
Ecosystem: Alien and native species same dominance
Recreation: Substantial (HSA rating)
Water Quality: Not impaired
Hydropower Potential: No

NONINSTREAM USES

Traditional: Existing taro cultivation
Diversions: 1 EMI major, 2 EMI minor; 2 for domestic

- EMI diverts 1.3 cfs (dry times) to 4.4 cfs (normal times) of water, 4-13% of Nahiku Lic and 1-2% of East Maui Lic water yield

Koolau Ditch intake (K-1) on Makapipi Stream

Diversion structure consists of a 15 feet (L) x 5 feet (H) dam. Intake and sluice gate (3 x 1.83 feet, W x H) situate on the left bank. Water flows down a small waterfall before reaching the diversion.

Civil No. 19-1-0019-01 (JPC)

Defendant A&B/EMI's Exhibit AB-133

FOR IDENTIFICATION ____________________

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CLERK _________________________________