COMMISSION ON WATER RESOURCE MANAGEMENT

STATE OF HAWAII

`Īao Ground Water Management Area	)	Case No. CCH-MA06-01
High-Level Source Water Use	)	
Permit Applications and	)	
Petition to Amend Interim Instream	)	
Flow Standards of Waihe`e, Waiehu,	)	
`Īao, & Waikapū Streams	)	
Contested Case Hearing	)	
______________________________	)	

HEARINGS OFFICER'S

PROPOSED FINDINGS OF FACT, CONCLUSIONS OF LAW, AND DECISION AND ORDER

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HEARINGS OFFICER'S

PROPOSED FINDINGS OF FACT, CONCLUSIONS OF LAW, AND DECISION AND ORDER

For nearly 150 years, the waters of Nā Wai `Ehā—Waihe`e River, North and South Waiehu, `Īao, and Waikapū Streams—have been diverted, primarily to irrigate sugar cane but also for kuleana lands, other agricultural purposes and domestic uses. Under the prevailing laws at the time when the ditch systems were built and sugar was the dominant industry, water was treated as private property and streams were diverted to such an extent that practically all of their dry-weather flows were diverted. Following statehood and a state court system whose judges and justices were not federally appointed as in the days when Hawai`i was a territory, in 1973 the Hawai`i Supreme Court ruled that title to water was not intended to be and was not transferred to an awardee by the Great Mahele, and that water in streams and rivers (and all freshwater resources, including underground aquifers) were held in trust by the state for the common good of its citizens. The constitutional amendments of 1978 and the State Water Code of 1987 further confirmed and solidified that the freshwater resources of the state were held in trust for its citizens.

This "public trust doctrine" embodies a dual purpose: 1) protection, and 2) maximum reasonable and beneficial use. In short, the objective is not maximum consumptive use, but rather the most equitable, reasonable, and beneficial allocation of state water resources, with full recognition that protection also constitutes use.

The Court has identified four trust purposes: 1) maintenance of waters in their natural state; 2) domestic water use of the general public; 3) Native Hawaiian and traditional and customary rights, including kuleana water rights; and 4) reservations of water for Hawaiian home lands. For those seeking private, commercial uses of water, there is a higher level of scrutiny. In practical terms, this means that the burden ultimately lies with those seeking or approving such uses to justify them in light of the purposes protected by the trust.

The Commission is to weigh competing public and private water uses on a case-by-case basis, accommodating both instream and offstream uses where feasible, and must consider the cumulative impact of existing and proposed diversions on trust purposes and to implement reasonable measures to mitigate this impact, including using alternative resources.

This contested case hearing addresses a petition to restore flows to the Nā Wai `Ehā streams, as well as applications for water use permits from the diked, high-level water enclosed in the mountains above these streams, which is also the source of the headwaters of these four streams. The applications for water use permits were a consequence of the designation of the `Īao Aquifer System as a ground water management area, which includes basal, caprock, and high-level dike sources. Applications for permits from the basal and caprock sources were previously addressed by the Commission.

During this contested case hearing, the Commission designated the four Nā Wai `Ehā streams as a surface water management area, with an effective date of designation of April 30, 2008. Existing-use permits had to be filed within one year of the date of designation, or by April 30, 2009. Applications for new-use permits may be filed at any time. These permit applications can be accommodated only to the extent that stream waters for offstream uses are available. That amount will be determined in this contested case hearing, because the amended instream flow standards will determine how much water must remain in Waihe`e River, North and South Waiehu Streams, `Īao Stream, and Waikapū Stream, and those standards will in turn determine how much water will be available for offstream uses.

The hearings officer makes the following Findings of Fact (hereinafter, "FOF"), Conclusions of Law (hereinafter, "COL"), and Decision and Order (hereinafter, "D&O"), based on the records maintained by the Commission on Water Resource Management (hereinafter, "Commission") and the witness testimonies and exhibits presented and accepted into evidence.

If any statement denominated a COL is more properly considered a FOF, then it should be treated as a FOF; and conversely, if any statement denominated a FOF is more properly considered a COL, then it should be treated as a COL.

FOF not incorporated in this D&O have been excluded because they may be duplicative, not relevant, not material, taken out of context, contrary (in whole or in part) to the found facts, an opinion (in whole or in part), contradicted by other evidence, or contrary to law. Proposed FOF that have been incorporated may have modifications or corrections that do not substantially alter the meaning of the original findings.

I. FINDINGS OF FACT

A. BACKGROUND

1. On July 9, 2001, a petition was filed to designate the `Īao and Waihe`e Aquifer System Areas as ground water management areas. Following numerous reviews, hearings, and meetings and its Findings of Fact, the Commission denied immediate designation but imposed triggers to automatically cause designation. One of these triggers was pumping greater than 90 percent of the aquifer's sustainable yield, based on a 12-month moving average (hereinafter, "12-MAV").

2. In June 2003, the 12-MAV for the `Īao Aquifer System Area exceeded the Commission's designated trigger, and on July 21, 2003, `Īao was officially designated a Ground Water Management Area upon publication of the public notice declaring designation and describing the water management area regulations. Ground water in the `Īao Aquifer System includes basal, caprock, and high-level dike sources.

3. On June 25, 2004, Hui o Nā Wai `Ehā and Maui Tomorrow Foundation, Inc. (hereinafter, "Hui/MTF"), through Earthjustice, filed a "Petition to Amend the Interim Instream Flow Standards for Waihe`e, North & South Waiehu, `Īao, and Waikapū Streams and Their Tributaries."

4. By July 21, 2004, some existing users had not met the one-year deadline for filing water use permit applications (hereinafter, "WUPAs"), and all WUPAs were the subject of objections. On September 22, 2004, the Commission authorized a subcommittee to convene a public hearing on Maui to hear objections to and clarifications of the WUPAs. Existing and new-use WUPAs were to be addressed in separate sessions but on the same day, and the public hearing was to remain open to allow the public time to request a contested case hearing. Commissioners James Frazier and Lawrence Miike were appointed to the subcommittee.

5. On October 19, 2004, Hui/MTF, who had filed the June 25, 2004, petition to amend the interim instream flow standards (hereinafter, "IIFS") for Waihe`e, North & South Waiehu, `Īao and Waikapū Streams and their tributaries, also filed a Waste Complaint and a Petition for Declaratory Order against Wailuku Water Company ("hereinafter, "WWC"), then known as Wailuku Agribusiness Co., Inc., and Hawaiian Commercial & Sugar Company (hereinafter, "HC&S").

6. On October 28, 2004, the subcommittee conducted the first session of the public hearing.

7. On April 22, 2005, a second session of the public hearing was held on Maui. The hearing remained open for subsequent information gathering. On July 11, 2005, an information-sharing meeting was held on Maui by Commission staff, where the parties attending reported on meetings between themselves to resolve some issues to avoid a possible contested case hearing.

8. On September 7, 2005, the next session of the public hearing was held on Maui. This session was limited to basal and caprock wells, and it was announced that the public hearing would be closed at the end of the meeting for these wells. Prior to the close of the hearing, several requests were made for a contested case hearing (hereinafter, "CCH") concerning various basal well sources, and timely written requests were submitted by two applicants, Maui Department of Water Supply (hereinafter, "MDWS") and Kehalani Mauka (hereinafter, "KM"), and three organizations: Hui o Nā Wai `Ehā and Maui Meadows Association, both represented by Earthjustice, and the Office of Hawaiian Affairs (hereinafter, "OHA"). MDWS requested a CCH for all eight of its WUPAs and for KM's competing application for the Shaft 33 battery of wells; KM requested a CCH for its and MDWS's competing application for the Shaft 33 battery of wells; and Hui o Nā Wai `Ehā/Maui Meadows Association and OHA requested a CCH for all eight of MDWS's WUPAs.

9. On October 5, 2005, Commissioner Lawrence Miike was appointed the hearings officer.

10. On October 17, 2005, standing was granted to all five requesting parties. On December 16, 2005, Hui o Nā Wai `Ehā/Maui Meadows Association and OHA withdrew their objections and request for a CCH regarding MDWS's WUPAs, stating that they had reached a resolution with MDWS. MDWS's request for a contested case on all eight of its WUPAs had been conditioned on another party requesting a CCH, leaving only the competing applications for Shaft 33 between MDWS and KM as the subject of the CCH.

11. On April 7, 2006, KM filed a motion for declaratory ruling that its application for Shaft 33 was for an existing use.

12. On April 19, 2006, the CCH was held on Maui, at which time the hearings officer also heard and denied KM's motion for declaratory ruling.

13. Closing oral arguments were held on May 24, 2006, in Honolulu, and Proposed Findings of Fact, Conclusions of Law, and Decision and Order were submitted to the Hearings Officer on July 28, 2006.

14. The hearings officer issued his proposed Decision and Order on August 11, 2006, and on January 31, 2007, the Commission issued its final Decision and Order. MDWS was issued a water use permit for 5.771 mgd under WUPA No. 702 from Wailuku Shaft 33, State Well No. 5330-05, and KM was issued a water use permit for 0.691 mgd under WUPA No. 707 from Wailuku Shaft 33, State Well No. 5330-05. Under the Decision and Order, KM could apply for a modification of its permit for: 1) a change in the quantity of water currently awarded if it deems the amount insufficient to meet its reasonable and beneficial needs under actual use conditions; and/or 2) the 1,060 units projected to be completed between 2011-2014 in whole or in part within the four-year statutory window of use/nonuse. HRS§174C-57. The Commission also recognized that KM was currently obtaining all of its water from MDWS and that they were in negotiations for the continued use of Shaft 33 by MDWS. If the parties agree that MDWS will continue to provide water to KM, the Water Code provides for the transfer of KM's permit for 0.691 mgd, in whole or in part to MDWS. HRS §§174C-59 and 174C-57(c). On February 8, 2007, MDWS filed a Motion for Reconsideration of the Commission's D&O. On March 21, 2007, the Commission denied the Motion.

15. The WUPAs from caprock sources were approved on October 25, 2005. The WUPAs from the basal aquifer that were not the subject of the CCH between MDWS and KM (the other seven MDWS WUPAs and a new-use application from the Living Waters Land Foundation) were approved on February 15, 2006.

16. Diked, high-level well and tunnel sources were not part of the September 7, 2005, hearing, and the public hearing remained open for those WUPAs. On February 2, 2006, the final session of the public hearing for WUPAs from these sources was held on Maui. Prior to the close of the hearing, verbal requests were made by various parties for a CCH on all WUPAs from diked, high-level sources. Written requests were submitted by: 1) MDWS; 2) WWC; 3) HC&S; 4) OHA; 5) Hui/MTF; and 6) Ka Aha O Nā Wai `Ehā Ku Moku O Mauiloa.

17. The WUPAs that were the subject of the February 2, 2006, public hearing were: 1) MDWS's Well No. 5332-05 (Kepaniwai Well) for 1.042 mgd; 2) MDWS's Well No. 5332-02 (`Īao Tunnel [Kepaniwai]) for 1.359 mgd; 3) HC&S's Well No. 5330-02 (`Īao Tunnel [Puako]) for 0.100 mgd; and 4) five wells for unknown amounts of water: WWC's Wells No. 5132-01 (Waikapū Tunnel 1), No. 5132-02 (Waikapū Tunnel 2), No. 5332-01 (Black Gorge Tunnel), No. 5333-01 (`Īao Needle Tunnel 1), and No. 5333-02 (`Īao Needle Tunnel 2). The WUPAs for

Waikapū Tunnels 1 and 2 were subsequently excluded, because they were not subject to the `Īao ground water management area designation. Chumbley, WRT 10/29/07, p. 8; Chumbley, WST 11/19/07, p. 3. WWC FOF 802.

18. On February 15, 2006, the Commission initiated a CCH for the `Īao high-level WUPAs and specified that the petition to amend the IIFS of the four streams would be included in the CCH. The Commission further directed that mediation for the waste complaint be initiated prior to the CCH. On March 17, 2006, the Commission clarified its intent by ordering that two CCHs be held, one for the petition to amend the IIFS and the `Īao high-level WUPAs (CCH-MA06-01) and a separate CCH for the waste complaint (CCH-MA06-02). On June 19, 2006, standing was granted in these two CCHs to the same five parties: 1) MDWS; 2) WWC; 3) HC&S; 4) OHA; and 5) Hui/MTF. Ka Aha O Nā Wai `Ehā Ku Moku O Mauiloa had not applied to be a party in the CCH on the waste complaint and had withdrawn its request to be a party in the CCH on the high-level WUPAs.

19. Commissioner Lawrence Miike was again appointed hearings officer for both CCHs.

20. Peter Adler was appointed the mediator for the waste complaint on June 28, 2006, and mediation was held from August 21, 2006, through October 6, 2006. On October 11, 2006, Mr. Adler reported to Hearings Officer Miike that no agreement was reached.

21. On February 20, 2007, Hui/MTF filed a motion and petition to disqualify Yvonne Izu, Esq., former Deputy Director of the Commission, from representing HC&S in both contested cases.

22. On April 5, 2007, Yvonne Izu voluntarily withdrew as counsel for HC&S in both contested cases.

23. On May 14, 2007, Hui/MTF withdrew its waste complaint and on May 31, 2007, CCH-MA06-02 was dismissed without prejudice.

24. On June 14, 2007, a prehearing conference was held for CCH-MA06-01 (IIFS/permit applications), at which a schedule for filing of documents was established, with the contested case to begin on December 3, 2007.

25. The contested case evidentiary hearing was held on Maui over 23 days, commencing on December 3, 2007, and concluding on March 4, 2008. Due to the large volume of transcripts that had to be prepared and then made available to and reviewed by the parties, the deadline for the

parties' proposed Findings of Fact, Conclusions of Law, and Decision and Order was established as September 26, 2008.

26. On March 13, 2008, the Commission designated the four streams of Nā Wai `Ehā as a surface water management area. The effective date of designation was April 30, 2008, when the Public Notice was published. Applications for existing-use permits had to be filed within a period of one year from the effective date of designation, or no later than April 30, 2009.

27. On July 18, 2008, HC&S filed a motion to reopen evidence and offer of proof of a study that HC&S had commissioned but which had not been completed at the time the evidentiary hearings were concluded on March 4, 2008. On July 25, 2008, WWC filed a memorandum in support of HC&S's motion; and on August 19, 2008, memoranda in opposition were filed by Hui/MTF, OHA, and MDWS.

28. On August 21, 2008, a hearing on HC&S's motion to reopen the evidence and offer of proof was held, at which time the motion was approved. The September 26, 2008, deadline for the parties to submit their proposed Findings of Fact, Conclusions of Law, and Decision and Order was also vacated.

29. On August 25, 2008, OHA filed a motion to supplement the record with a portion of the Environmental Impact Statement Preparation Notice for the Proposed Wai`ale Water Treatment Facility that was published in the Office of Environmental Quality Control's Environmental Notice on July 8, 2008.

30. On October 14, 2008, the hearing on HC&S's study and on OHA's motion to supplement the record was held on Oahu, with video connection to Maui with the consent of all the parties. The hearing concluded with an evening session on the same day, with telephone connection to Maui, again with the consent of all parties. At the hearing, the exhibit that was the subject of OHA's motion to supplement the record and an additional exhibit offered by OHA, were entered into evidence on the stipulation of all parties.

31. By the end of the evidentiary phase of the hearing, the testimony of 77 witnesses was heard and over 600 exhibits were accepted into evidence.

32. On December 5, 2008, Hui/MTF, WWC, HC&S, and MDWS submitted their Proposed FOF, COL, and D&O to the hearings officer. OHA filed a joinder to Hui/MTF, and only Hui/MTF submitted a closing brief.

33. On April 9, 2009, hearings officer Miike submitted his Proposed FOF, COL, and D&O to the Commission.

B. <u>Traditional and Customary Practices in Nā Wai `Ehā</u>

34. Due to the profusion of fresh-flowing water in ancient times, Nā Wai `Ehā supported one of the largest populations and was considered the most abundant area on Maui; it also figured centrally in Hawaiian history and culture in general. (Exh. C-2, p. 19; Akana, WDT 9/14/07, ¶ 12.) Hui/MTF FOF A-11.[1]

35. The abundance of water in Nā Wai `Ehā enabled extensive lo`i kalo (wetland kalo) complexes, including varieties favored for poi-making such as "throat-moistening lehua poi." (Exh. C-2, p. 7 (citing Kahā`ulelio 2006); Tr. 12/4/07, p. 19, l. 19 to p. 20, l. 3.) Hui/MTF FOF A-12.

36. The four ahupua`a of Nā Wai `Ehā and their streams comprised the largest continuous area of wetland taro cultivation in the islands. (Exh. C-2, pp. 1, 17 (citing Handy and Handy 1972, p. 496); Tengan, Tr. 12/4/07, p. 20, l. 19 to p. 21, l. 7; Holt-Padilla, WDT 9/14/07, ¶ 9.) Hui/MTF FOF A-13.

37. `Īao Valley was known for its two famous `auwai called the Kama`auwai and Kalani`auwai, which fed many kuleana lands. (Exh. C-2, p. 9.) Hui/MTF FOF A-16.

38. Numerous springs feeding lo`i kalo existed in the district of Wailuku in ancient days. (Exh. C-2, p. 9.) Hui/MTF FOF A-17.

39. "All indications are that Waihe`e Valley was traditionally a rich, fertile valley supporting a substantial population. Hawaiians constructed extensive lo`i (irrigated taro terraces) and elaborate `auwai systems to provide water for the lo`i . . . Many lo`i can be seen today, although most are not in use." (Exh. C-2, p. 10 (quoting Kelly & Hee 1987).) Hui/MTF FOF A-18.

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[1] References to the record are enclosed in parentheses, followed by a party's proposed Finding of Fact ("FOF"), if accepted. "Exh." refers to exhibits accompanying written or oral testimony, followed by the exhibit number. Written testimony is referred to as follows: name of the witness, the type and date of the written testimony, and the page and line numbers, or paragraph, of that testimony. "Decl." means written declaration; "WDT," written direct testimony; "WRT," written rebuttal testimony; and "WST," written surrebuttal testimony. Oral testimony is referred to as follows: name of the witness, the date of the transcript ("Tr."), and the page and line numbers. For example, this Finding of Fact is referenced to Exhibit C-2, page 19; and Akana's written direct testimony of 9/14/-7, paragraph 12. This Finding of Fact was proposed by Hui/MTF as their FOF A-11, which was accepted.

40. In addition to extensive agricultural production, traditional and customary practices thrived in Nā Wai `Ehā, including the gathering of upland resources, such as thatch and ti, and protein sources from the streams, including `o`opu, `ōpae, and hihiwai. (Tengan, Tr. 12/4/07, p. 21, ll. 15-21.) Hui/MTF FOF A-19.

41. In Nā Wai `Ehā, the gathering of certain species of `o`opu was sometimes kapu (reserved) for the chiefs. The name of the famous kili`o`opu wind of Waihe`e means faint odors of the `o`opu, in reference to "the appetizing fragrance" of the `o`opu cooking in ti leaves, which "wafted down by the wind to the chief's door." Maka`āinana from this area developed a method to hide the scent of the cooking `o`opu by wrapping it in `olena leaves so the aroma could not escape. (Exh. C-2, pp. 14-15 (quoting Rebecca Nu`uhiwa's oral history).) Hui/MTF FOF A-20.

42. In the ahupua`a of `Īao, "the waters of the region provided for a diet which 'consisted mainly of fish (napili and nakea), opae, hihi-wai (all obtained from `Īao Stream), and lehua (red) taro which was grown in lo`i (irrigated terraces) lining the banks of the stream.'" (Exh. C-2, p. 14 (citing Connolly 1974).) Hui/MTF FOF A-21.

43. The waters of Nā Wai `Ehā were renowned for the traditional and customary practice of hiding the piko, or the naval cord of newborn babies. (Tengan, Tr. 12/4/07, p. 22, ll. 2-12.) "[T]he spring Eleile contained an underwater cave where the people of the area would hide the piko (umbilical cords) of their babies after birth. . . . The location of where one buries or hides the piko is a traditional custom that represents Native Hawaiian cultural beliefs about an individual's connection to the land." (Exh. C-2, pp. 4-5 (citing Bishop Museum Archives Audio Collection, HAW 84.2.3).) Hui/MTF FOF A-23.

44. Upper `Īao Valley contained the royal residences of chiefs in both life and the afterlife. (Exh. C-2, pp. 11-12.) In a secret underwater cave, Native Hawaiians hid the bones of "all the ruling chiefs who had mana and strength, and the kupua, and all those attached to the ruling chiefs who were famous for their marvelous achievements. There were several hundred in all who were buried there." Thus, the burial of sacred chiefs required a deep freshwater body to ensure the utmost protection of their bones. (<u>Id.</u> at p. 13 (quoting <u>Ke Au Okoa</u> 1870); Tengan, Tr. 12/4/07, p. 22, ll. 13-21.) Hui/MTF FOF A-24.

45. Nā Wai `Ehā is home to several important heiau. Of particular significance are Haleki`i and Pihana Heiau, located between Waiehu and `Īao Streams. (Sites of Maui 64, Elspeth Sterling ed., Bishop Museum Press 1998). These heiau were re-consecrated in 1776 as an offering before

the famous battle between Hawai`i and Maui. Id. It is said that Kalanikaukooluaole, a high chiefess and daughter of Kamehamehanui, bathed in the stream water near the heiau, before she entered the heiau. (Id. at 76.) Hui/MTF FOF A-25.

46. The presence of heiau (places of worship, temples) in a windward environment indicates large populations and agricultural pursuits. In Nā Wai `Ehā, there are a total of 36 documented heiau, which is the largest number of heiau among all Maui island communities and underscores the cultural, historical, and political importance of this region. (Exh. C-2, p. 10 (citing Walker 1931, Thrum 1909, Bruce 1973, Stokes 1918, Cordy 1978).) Hui/MTF FOF A-26.

47. Nā Wai `Ehā's water resources sustained "the second largest population on the island of Maui." (Exh. C-2, p. 9 (citations omitted).) "In 1831-32, 827 people resided in the Waihe`e ahupua`a, representing a very large population" that was surpassed only by the population in `Īao (or Wailuku) (Id.) Hui/MTF FOF A-27.

48. Nā Wai `Ehā's abundant water resources served as a base of political and economic power for the region in ancient times. (Tengan, Tr. 12/4/07, p. 20, l. 23 to p. 21, l. 11.) Hui/MTF FOF A-29.

49. Cultural experts and community witnesses provided uncontroverted testimony regarding limitations on Native Hawaiians' ability to exercise traditional and customary rights and practices in the greater Nā Wai `Ehā area due to the lack of freshwater flowing in Nā Wai `Ehā's streams and into the nearshore marine waters. (See, e.g., Kekona, Tr. 12/4/07, p. 214, ll. 9-15; Pellegrino, WDT 9/14/07, ¶ 33.) Hui/MTF FOF A-40.

50. "`O`opu must once have been plentiful in Nā Wai `Ehā streams; the wind in Waihe`e is called ka makani kili`o`opu, which means the wind that brings the faint odors of the `o`opu." Today, however, "[i]t is very difficult to find `ōpae, hihiwai, and `o`opu in the streams of Nā Wai `Ehā, large portions of which are frequently dry." (Holt-Padilla, WDT 9/14/07, ¶ 22.) Hui/MTF FOF A-42.

51. Despite significant challenges, some Native Hawaiian practitioners in Nā Wai `Ehā continue to exercise traditional and customary rights and practices, including "gathering stream life such as hihiwai, `ōpae, `o`opu, and limu for subsistence and medicinal purposes," as well as "cultivating taro for religious and ceremonial uses, gathering materials for hula, lua (ancient Hawaiian martial arts), and art forms." (Akana, WDT 9/14/07, ¶ 16.) Hui/MTF FOF A-45.

52. In Nā Wai `Ehā, it is a traditional Native Hawaiian practice for cultural practitioners to gather in the ahupua`a in which she lives; an ahupua`a in which she has ancestral ties, even if no family member then resides there; or an ahupua`a that "contains certain resources of value to her as a member of a Hawaiian cultural group such as traditional Hawaiian healers, who may use a specific area to gather lā`au lapa`au (native plants for medicine); hālau hula, whose chants and dances may honor deities associated with a specific natural resource area, and which may need to gather certain native plants from these areas; and fishermen, hunters, and gatherers who have accessed and used the ahupua`a for subsistence." (Holt-Padilla, WDT 9/14/07, ¶ 17.) Hui/MTF FOF A-46.

53. Kumu hula Akoni Akana gathers materials such as hau, palapalai, la`ī, and laua`e from Waihe`e and Waiehu for hula ceremonies and performances. (Akana, WDT 9/14/07, ¶ 6.) "As part of the protocol for gathering these items, we always soak the leaves we gather in the stream flow nearby. This practice necessitates a flowing stream." (Id.) Hui/MTF FOF A-47.

54 T.he spiritual practice of hi`uwai, also known as kapu kai, often occurred around the time of makahiki, when individuals "would go into the rivers or into the ocean in order to do a cleansing for the new year[.]" (Holt-Padilla, Tr. 12/4/07, p. 192, l. 22 to p. 193, l. 8.) This type of cleansing, which required immersion in the water, was also conducted "before you start or end certain ceremonies[.]" (Id. p. 193, ll. 3-8, 21-23.) For ceremonies dedicated to Kāne, "having a hi`uwai in a stream magnifies the mana[.]" (Id. p. 193, ll. 11-20.) Hui/MTF FOF A-51.

55. Other practitioners would like to expand the scope of their traditional and customary practices and plan to do so if water is returned to the streams. For example, Hōkūlani Holt-Padilla testified that "[m]any families seek to reestablish the tradition of growing kalo" in Nā Wai `Ehā. (Holt-Padilla, Tr. 12/4/07, p. 190, ll. 9-13.) Hui/MTF FOF A-52.

56. A subsistence lifestyle can be maintained in today's cash economy, but with "different demands upon subsistence growers. In the old days, you could pay taxes to chiefs with taro. Those in-kind of tax payments are no longer allowable, so even subsistence farmers would inevitably have to sell some of their taro for cash in order to pay taxes." (Tengan, Tr. 12/4/07, p. 26, ll. 10-22.) Hui/MTF FOF A-54.

57. "Nā Wai `Ehā continues to hold the potential to once again support enhanced traditional and customary rights and practices if sufficient water is restored." (Exh. C-2, p. 19.) Restoring streamflow to Nā Wai `Ehā "would enormously benefit" Native Hawaiians and other

communities who seek to reconnect with their culture and live a self-sustaining lifestyle, and more people would be able to engage in traditional and customary practices with more water. (Tengan, Tr. 12/4/07, p. 25, l. 21 to p. 26, l. 9.) Hui/MTF FOF A-56.

58. "Restoration of mauka to makai flow to the streams is critical to the perpetuation and practice of Hawaiian culture in Nā Wai `Ehā." "If we are not able to maintain our connection to the land and water and teach future generations our cultural traditions, we lose who we are as a people." (Holt-Padilla, WDT 9/14/07, ¶ 25.) Hui/MTF FOF A-57.

59. "The return of the waters of Nā Wai `Ehā to levels that can sustain the rights of native Hawaiians and Hawaiians to practice their culture will result in the betterment of the conditions of native Hawaiians and Hawaiians by restoring spiritual well-being and a state of 'pono' (goodness, righteousness, balance) to the people and communities of Nā Wai `Ehā." (Apoliona, WDT 9/14/07, ¶ 11.) Hui/MTF FOF A-59.

60. In particular, cold, free-flowing water is essential for kalo cultivation, which in turn is integral to the well-being, sustenance, and cultural and religious practices of native Hawaiians and Hawaiians. Kalo cultivation provides not only a source of food, but also spiritual sustenance, promotes community awareness and a connection to the land, and supports physical fitness and mental well-being. (Apoliona, WDT 9/14/07, ¶¶ 6-7.) Hui/MTF FOF A-66.

61. In Hawaiian culture, "[o]ur ancestor was the kalo itself." Hōkūlani Holt-Padilla explained:

> The first born child of Wākea (Sky father) and Ho`ohōkūkalani (daughter of Papa, the Earth mother) was stillborn. Shortly after being buried, his body reemerged from the ground in the form of a kalo plant, which Wākea named Hāloanakalaukapalili (long stem, trembling leaf). Their next child was a healthy boy whom they named Hāloa after his deceased older sibling. Hāloa grew to be a strong man and became the ancestor of all Hawaiians.

(Holt-Padilla, WDT 9/14/07, ¶ 11; Holt-Padilla, Tr. 12/4/07, p. 189, l. 11 to p. 190, l. 7.) See also Tengan, Tr. 12/4/07, p. 17, l. 22 to p. 18, l. 8 (recounting the history of Hāloa). Hui/MTF FOF A-67.

62. The story of Hāloa acknowledges Native Hawaiians' familial relationship with kalo as an elder sibling, and the resulting cultural significance of cultivating kalo in a traditional manner. (Tengan, Tr. 12/4/07, p. 17, l. 22 to p. 18, l. 8.) Hui/MTF FOF A-68.

C. **Maintenance of Fish and Wildlife Habitats**

63. Out of the 376 perennial streams it identified in Hawai`i, the Commission has designated only 44 streams statewide as "Candidate Streams for Protection." Hawai`i Stream Assessment 5, 272 (1990) (hereinafter, "HSA"). Each of the Nā Wai `Ehā streams earned this designation among only nine streams selected from the entire island of Maui. Id. at 276. The Commission also designated the Nā Wai `Ehā streams as "Blue Ribbon Resources," meaning that they featured the "few very best resources" in their respective resource areas. Id. at 272. Hui/MTF FOF C-1.

64. The native amphidromous fauna of Hawaiian streams consists of five species of goboid fishes: *Awaous guamensis* ('o'opu nākea), *Sicyopterus stimpsoni* ('o'opu nōpili), *Lentipes concolor* ('o'opu alamo'o), *Stenogobius hawaiiensis* ('o'opu naniha), and the eleotrid *Eleotris sandwicensis* ('o'opu akupa). Native amphidromous invertebrates include two gastropods, *Neritina granosa* (hihiwai) and the estuarine *Neritina vespertina* (hapawai); and the decapods, *Atyoida bisulcata* ('opae kala'ole) and *Macrobrachium grandimanus* ('opae 'oeha'a). (Ford, WDT 10/26/07, ¶ 31.) HC&S FOF 44.

65. The term "amphidromous" describes fishes that undergo regular, obligatory migration between freshwaters and the sea at some stage in their life cycle other than the breeding period (Myers 1949). All native Hawaiian amphidromous species exhibit "freshwater amphidromy" where spawning takes place in freshwater, and the newly hatched larvae are swept into the sea by stream currents. While in the marine environment, the larvae undergo development as zooplankton before returning to freshwater to grow to maturity. An important ecological characteristic of the amphidromous fauna is the ability to move upstream, surmounting riffles and small falls, and for some species even very high waterfalls (Ford & Kinzie 1982, Radtke & Kinzie 1996). (Ford, WDT 10/26/07, ¶ 30.) HC&S FOF 45.

66. The life history of amphidromous stream macrofauna can be divided into three phases: recruitment into the stream, adult population biology and instream habitat use, and reproductive output. All of these must be operative for a population in a particular stream to be considered successful. (Exhibit E-53, p. 39 (§ 7.5.1).) HC&S FOF 46.

67. The five native Hawaiian amphidromous species have no distinct breeding season. (Lindstrom, Tr. 10/18/08, p. 46, ll. 12-15.) HC&S FOF 47.

68. An overriding factor impairing the biological and ecological integrity of diverted Central Maui streams, compared to their non-diverted counterparts, is the disruption of natural flow via large-scale offstream diversions. (Benbow, WDT 9/14/07, ¶ 8.) Hui/MTF C-7.

69. Diversions of streamflow harm stream life by degrading or destroying habitat, diminishing food availability, and disturbing species interactions and food web processes. Particularly during low flow or drought conditions, the diversions exaggerate the negative impact of low flows and can eliminate most stream life and habitat below the diversions and leave the streams barren of recruitment. (Benbow, WDT 9/14/07, ¶¶ 9, 32.) Hui/MTF FOF C-8.

70. Stream diversions have been found to dampen the natural seasonal discharge cycle, exacerbate natural low flow conditions, and increase the likelihood of prolonged periods of extremely low flow. (Exh. A-221, p. 53.) Hui/MTF FOF C-9.

71. Diversions particularly compromise the life cycles of native amphidromous species in numerous ways that compound the negative impacts on their overall populations from mauka to makai. (Benbow, WDT 9/14/07, ¶ 12.) Hui/MTF FOF C-10.

72. Diversions diminish larval drift by capturing eggs and larvae. (Benbow, WDT 9/14/07, ¶ 11; Payne, Tr. 12/12/07, p. 74, l. 24 to p. 75, l. 5; p. 75, ll. 21-24.) Hui/MTF FOF C-11.

73. Diversions also impair flows necessary to transport larvae to the ocean. Any factor that hinders flow or increases retention time in a stream will delay the transport of larvae to the marine environment and negatively impact and possibly kill larvae. (Exh. A-220, p. 55; Lindstrom, Tr. 10/14/08, p. 59, ll. 8-11; p. 19, ll. 2-10.) Hui/MTF FOF C-12

74. Terminal discharge at the stream mouth into the ocean of sufficient duration and volume is necessary to attract and accommodate upstream migration of post-larval fishes, mollusks, and crustaceans. (Ford WDT 10/26/07, ¶ 55.) Hui/MTF FOF C-15.

75. There is a direct correlation between streamflow volume under non-freshet conditions and postlarval recruitment in Central Maui streams, such that increased streamflow correlates with increased recruitment at the stream mouth. (Benbow, WDT 9/14/07, ¶ 37; Benbow, Tr. 12/10/07, p. 21, ll. 9-12.) Hui/MTF FOF C-36.

76. Hui/MTF's expert witness maintains that "the amphidromous life cycle requires continuous flow to link biologically the mountains (mauka) to the ocean (makai)." Benbow, WDT 9/14/07, ¶ 10.) Hui/MTF FOF C-4.

77. HC&S's expert witness states that "(i)t has not been definitively established that the life cycle of native Hawaiian amphidromous species absolutely depends on continuous mauka to makai flow. There are naturally interrupted and intermittent streams in Hawai'i that host amphidromous organisms. Statewide surveys conducted by the Division of Aquatic Resources ("DAR") have found an abundance of 'o'opu alamo'o and 'opae in the upper reaches of leeward streams that were assumed to be dry year round. Standing pools in the mid-reaches of such streams provide ecologically important habitat for native amphidromous species during baseflow and drought conditions. (Ford, WDT 10/26/07, ¶ 8; Ford, Tr. 12/10/07, p. 213, ll. 11-22, p. 214, l. 21 to p. 215, l. 3.) HC&S FOF 48.

78. HC&S's expert witness thus distinguishes between "ecological" and "physical" connectivity: "Ecological connectivity in a stream is more important than physical connectivity for purposes of sustaining the biological integrity of the stream. Ecological connectivity exists if stream flows of sufficient volume and frequency allow the normal distribution of native amphidromous species within a given watershed. Physical connectivity exists if there is uninterrupted flow of surface waters between the headwaters of a stream and its mouth. Ecological connectivity could exist irrespective of whether there is physical connectivity. (Ford, Tr., 12/10/07, p. 219, l. 24 to p. 221, l. 7; Exhibit E-53 at 4, n.1 (§ 1.0), and 43 (§ 8.0))

79. Ultimately, the precise volume and duration of stream flow needed to sustain the life cycle of amphidromous organisms is not known. (Benbow, Tr. 12/10/07, p. 76, l. 18 to p. 77, l. 16.) HC&S FOF 48.

D. <u>The Nā Wai `Ehā Streams</u>

80. Nā Wai `Ehā, or "the four great waters of Maui," refers to the Waihe`e River and Waiehu, `Īao, and Waikapū Streams. (Exh. E-53, p. 4, Exh. C-2, p. 1; Oki WDT 9/14/07, ¶ 5.) WWC FOF 31.

81. The Waihe`e River is the northern-most of the four waters. Flowing in a long, deep, narrow valley, it drains the northeast slopes of the West Maui Mountains. Running a distance of about 26,585 feet, its watershed covers an area of about 4,500 acres. It is the principal source of water in the Nā Wai `Ehā area. ((Exh. E-2; Exh. A-3, p. 22; Exh. E-53, fig. 1 and 11.) WWC FOF 46-49.

82. Waiehu Stream is formed by the confluence of the North and South Waiehu Streams. Running a distance of about 23,700 feet, its watershed covers an area of about 6,600 acres. ((Exh. A-3, p. 21; Exh. E-53, fig. 1 and 12.) WWC FOF 50-51.

83. `Īao Stream is the second largest in Nā Wai `Ehā. Draining a large amphitheater-headed valley, it runs for a distance of about 38,000 feet. Its watershed covers an area of about 14,500 acres. A significant portion of its lower reaches was channelized and the stream bed and banks hardened with concrete by the United States Army Corps of Engineers for flood control and drainage. (Exh. A-3, p. 20; Exh. E-53, p. 8, fig. 1, and fig. 13.) WWC FOF 52-55.

84. Waikapū Stream is the southern-most stream. The longest of the four streams, it is about 63,500 feet in length, with a watershed (Waikapū Valley) that covers about 9,000 acres. (Exh. E-2; Exh. A-3, p. 20; Exh. E-53, fig. 1 and 14.) WWC FOF56-58.

85. There are three types of ground water systems in the Nā Wai `Ehā area: (1) dike impounded; (2) the basal freshwater lens; and (3) perched. (Oki, WDT 9/14/07, ¶ 7.) WWC FOF 36.

86. Dike-impounded ground waters occur at high elevations; basal freshwater lenses and perched waters occur at lower elevations closer to the coast. (Oki, WDT 9/14/07, ¶ 7.) WWC FOF 37.

87. Gaining reaches of streams are those in which ground water contributes to the streamflow by a breaching of the ground water system by the stream. (Oki, WDT 9/14/07, ¶ 10.) WWC FOF 40.

88. Losing reaches of streams are where the channel bottoms are above the water table and an unsaturated zone exists between the stream and water table. (Oki, WDT 9/14/07, ¶ 12.) WWC FOF 41.

89. In the upper reaches of the Nā Wai `Ehā area, the stream channels intersect the dike-impounded ground waters, which results in a contribution of ground water to the stream, making the streams gaining in the upper reaches. (Oki, WDT 9/14/07, ¶ 10.) WWC FOF 42.

90. In the lower reaches of the Nā Wai `Ehā area, the stream channels overlie the basal freshwater lenses, allowing stream waters to migrate from the stream bed to the basal lenses, making the streams losing in the lower reaches. (Oki, WDT 9/14/07, ¶ 12.) WWC FOF 43.

91. At the mouths of the streams in the Nā Wai `Ehā area, some of the stream channels intersect the basal freshwater lenses, making those streams gaining in that area. (Oki WDT 9/14/07, ¶ 13.) WWC FOF 44.

92. The Nā Wai `Eha streams are generally gaining streams above the existing diversions (described *infra*) and losing streams below the diversions. (Oki, Tr., 12/6/07, p. 57, ll. 14-16.) WWC FOF 45.

93. The loss rate in a stream is expected to increase as flow increases because: 1) the potential streambed area through which infiltration of water can occur increases with flow; and 2) the increased water level in the stream creates a large vertical hydraulic gradient, which controls the rate of subsurface flow. In addition, loss rates change as a function of the permeability of the streambed sediments, which may vary over different stream reaches. (Oki, WDT 9/14/07, ¶ 54.)

94. A USGS study of stream flows in Hawai`i concluded that flows had decreased significantly over a 90-year period. (Exh. E-53, p. 16.) WWC FOF 445.

95. While USGS has not observed any significant trends in median flows in the Waihe`e River over the period, 1984 to 2005, (Oki, Tr. 12/6/07, p. 78, ll. 7-21) WWC FOF 446, USGS data also show that average (or mean) monthly total stream flows for the Waihe`e River and `Īao Stream for the three 8-year periods 1984-1991, 1992-1999, and 2000-2007, decreased by about 25 percent and 10 percent, respectively. For Waihe`e Stream, the monthly flows averaged 1639.1 mgd, 1436.0 mgd, and 1236.6 mgd, respectively, for these eight-year periods. These monthly averages translate into daily averages of 54.64 mgd for 1984-1991, 47.87 mgd for 1992-1999, and 41.22 mgd in 2000-2007. (Exh. D-45, p. 17-18; Suzuki, Tr. 12/14/07, p. 83, ll. 4-9 and 13-17.) WWC FOF 453-454, 586-587. (**<u>See</u>** FOF 97, *infra,* for a description of median flow.)

1. <u>Stream Flows</u>

96. One of the most useful ways to summarize stream-flow data is through the use of flow-duration curves. A flow-duration curve shows the percentage of time that specified stream flows were equaled or exceeded during a given period of record. (Oki, WDT 9/14/07, ¶ 21.) Hui/MTF FOF B-51-52.

97. The Q_{50} flow, or median flow, is the flow that is equaled or exceeded 50 percent of the time and is "reflective of typical flow conditions." (Oki, WDT 9/14/07, ¶ 21; Oki, Tr. 12/6/07, p.

78, ll. 17-21.) Hui/MTF FOF B-52-53. For example, a Q_{50} of 25 mgd means that the flow of the specified stream was 25 mgd or more for half of the measurements of stream flow and less than 25 mgd for the other half of the measurements during the specified period of time; e.g., "the Q_{50} for stream X was 25 mgd for the period 1985-2000."

98. Stream flow consists of: (1) direct runoff, or overland flow and subsurface storm flow (or interflow) that rapidly returns infiltrated water to the stream following a period of rainfall; (2) ground water discharge, or base flow, where the stream intersects the water table; (3) water returned from stream bank storage; (4) rain that falls directly on streams; and (5) any additional water, including excess irrigation water, discharged to the stream by humans. (Oki, WDT 9/14/07, ¶ 19; Oki, Tr. 12/6/07, p. 126, l. 14 to p. 127, l. 2; Exh. A-201.) Hui/MTF FOFB-42.

99. Because ground water levels vary over time, base flow also varies: base flow is higher during periods when the ground water level is high; lower during periods when the ground water level is low; and may cease if the ground water level is lowered below the water level in the stream. (Oki, WDT 9/14/07, ¶ 20; Oki, WDT 2/20/08, ¶ 3; Oki, Tr. 2/21/08, p. 27, ll. 8-25; Exh. A-201; Exh. A-202.) Hui/MTF FOF B-47.

100. Although measurement of flow in a stream on any given day will reflect the total flow in the stream, separating base flow from total flow is helpful to indicate the ground water contribution to a stream. (Oki, WDT 9/14/07, ¶ 20; Oki, Tr. 2/21/08, p. 55, ll. 14-18.) Hui/MTF FOF B-46.

101. For stream flows where more than ground water discharge is contributing to stream flow, the United States Geological Survey ("USGS") uses a computerized base-flow separation method: 1) to estimate the percent of total flow that comes from ground water discharge as total flow varies; and 2) averages these variations to estimate mean base flow. USGS has concluded that mean base flow of perennial streams in Hawai`i generally is between the Q_{60} to Q_{80} flows. (Oki, WDT 9/14/07, ¶ 21; Oki, WDT 2/20/08, ¶ 6; Exh. A-7; Exh. A-201.) Hui/MTF FOF B-54.

102. Thus, USGS has concluded that in general, the Q_{70} discharge could be an appropriate estimate of mean base flow for Hawai`i streams. (Oki, WDT 9/14/07, ¶ 21; Oki, Tr. 12/6/07, p. 29, l. 25 to p. 30, l. 1.) Hui/MTF FOF B-58. USGS did not apply its model specifically to the Nā Wai `Ehā streams. (Oki, Tr. 2/21/08, p. 39, ll. 16-19.)

103. In dry periods, the model assumes that the base and total flow are the same. In wetter periods, the model uses criteria designed to take away the rain, runoff, and seepage components

of stream flow to try to estimate the average base flow at all times when the stream is flowing. Although it has been tested against some form of data, ultimately there is no solid way of validating the model and its results. (Oki, Tr. 2/21/08, p. 38, l. 17 to p. 39, l. 15, p. 71, l. 24 to p. 73, l. 2.)

104. The Q_{90} flow is commonly used to characterize low flows in a stream. In Hawai`i, Q_{90} flows may range from near zero for ephemeral streams in areas that receive little rainfall, to tens of cubic feet per second in areas that receive significant rainfall or ground water discharge. (Exh. A-201, p. 3.) (The Q_{100} flow represents the lowest flow recorded in the stream, which is most likely all from ground water discharge.)

105. USGS does not calculate base flow for water management purposes; instead, base flows are calculated for other purposes, such as extracting the direct runoff components of total stream flow for estimating water budgets (underestimating base flow results in overestimating direct runoff), identifying the raw component of rainfall when estimating recharge, and surveying how conditions such as base flow may have changed over time. (Oki, Tr. 2/21/08, p. 55, ll. 4-13; p. 32, ll. 9-25.) Hui/MTF FOF B-59, B-61.

2. **Waihe`e River**

106. Waihe`e River and its main diversions are shown in Figure 1.

107. In the period of climate years 1984-2005 (a climate year begins on April 1 and is designated by the calendar year in which it begins) at USGS stream-gaging station 16614000 on Waihe'e River near an altitude of about 605 feet upstream of all diversions, the minimum daily mean flow (Q_{100}) was 14 mgd (this minimum flow occurred on only 6 days over 22 years, an average of about 0.3 days per year). The Q_{90} flow was 24 mgd; the Q_{70} flow was 29 mgd; and the Q_{50} flow was 34 mgd. (Oki, WDT 9/14/07, ¶¶ 23 and 53.) HC&S FOF 1.

108. The two main diversions are Waihe`e Ditch near an altitude of about 600 feet, and Spreckels Ditch, near an altitude of about 400 feet and about 0.6 miles downstream from the Waihe`e Ditch. (Oki, WDT 9/14/07, ¶ 53.)

109. Estimated stream flow losses in Waihe`e River downstream of the Spreckels Ditch may range from 2.1 to at least 5.9 mgd. Although actual losses may vary as a function of streamflow, because data are limited, a constant loss of 4 mgd is assumed by USGS. (Oki, WDT 9/14/07, ¶ 56.)

110. Water also returns to the River in the form of return flows and leakage from ditches at several locations downstream of the diversions. In some places, the return flows enter the River in well-defined channels, whereas in other places the return flows enter as diffuse flows. (Oki WDT 9/14/07, ¶¶ 38.)

111. Waihe`e and Spreckels Ditches are capable of diverting all of the dry-weather flow available at the intakes. However, stream flow immediately downstream of the intakes may exist because of leakage through or subsurface flow beneath the dams at these sites. Estimated dry-weather flow immediately downstream of the Waihe`e and Spreckels Ditch intakes commonly is on the order of about 0.1 mgd, but the stream may not have continuous surface flow from mauka to makai. (Oki WDT 9/14/07, ¶ 44.)

3. <u>Waiehu Stream</u>

112. North Waiehu Stream and its main diversion are shown in Figure 2.

113. Low-flow characteristics for North Waiehu Stream during the 1984-2005 climate years were estimated using record-extension techniques and available historical data during 1911-1917 from discontinued USGS gaging stations 16608000, 16609000, and 16609500. The minimum discharge (Q_{100}) measured at gaging station 16608000 at an altitude of 880 feet was 1.6 mgd during March 1915. The estimated Q_{90} discharge ranges from 1.4 to 2.7 mgd for 1984-2005; the estimated Q_{70} discharge ranges from 2.3 to 2.7 mgd; and the estimated Q_{50} discharge ranges from 3.1 to 3.6 mgd. (Oki, WDT 9/14/07, ¶¶ 24 and 57.) HC&S FOF 2.

114. Water is diverted by the North Waiehu Ditch near an altitude of about 860 feet. (Oki, WDT 9/14/07, ¶ 57.)

115. USGS estimates that the stream loses 1.3 mgd between the North Waiehu Ditch and the confluence of North and South Waiehu Streams. (Oki, WDT 9/14/07, ¶ 60.)

116. The North Waiehu Ditch generally diverts most of the water available at the diversion structure, but leakage from the North Waiehu Ditch may sometimes return to the stream. (Oki, WDT 9/14/07, ¶ 39, 44.)

117. South Waiehu Stream and its main diversion are also shown in Figure 2.

118. Regarding the "Cerizos Kuleana Ditch" shown in Figure 2, in identifying the kuleana ditches and their stream sources, WWC identifies South Waiehu Stream as the source of the Cerizos Kuleana Ditch. (Exh. D-7; also citing Cerizo's WDT of 9/14/07.) WWC FOF 152. But

Cerizos testified that he recently bought kuleana land on Waikapū Stream, (Cerizo, WDT 9/14/07, ¶¶ 1-2, 4-5; Exh. A-23; Exh. A-194D) Hui/MTF FOF 365, so it is unclear whether this ditch is misnamed.

119. Low-flow characteristics for South Waiehu Stream for the 1984-2005 climate years were estimated using record-extension techniques and available historical data during 1911-1917 from discontinued USGS gaging station 16610000. The minimum discharge (Q_{100}) measured at gaging station 16610000 at an altitude of 870 feet was 1.5 mgd during July 1913. Near gaging station 16610000 at an altitude of 870 feet, the estimated Q_{90} discharge ranges from 1.3 to 2.0 mgd for 1984-2005; the estimated Q_{70} discharge ranges from 1.9 to 2.8 mgd; and the estimated Q_{50} discharge ranges from 2.4 to 4.2 mgd. (Oki, WDT 9/14/07, ¶¶ 25 and 57.) HC&S FOF 3.

120. Water is currently diverted from South Waiehu Stream by the Spreckels Ditch and two kuleana ditches farther upstream. The main diversion is the Spreckels Ditch, near an altitude of about 270 feet and about 1000 feet upstream from the confluence of North and South Waiehu Streams. (Oki, WDT 9/14/07, ¶¶ 40, 57.)

121. No information is available on estimated losses in South Waiehu Stream, but USGS estimates that the loss in Waiehu Stream itself, between the confluence of North and South Waiehu Streams and the mouth, is 0.6 mgd. (Oki, WDT 9/14/07, ¶ 60.)

122. Return flows and leakage from the kuleana ditches have been observed entering South Waiehu Stream. In addition, overflow or releases from the Waihe`e and Spreckels Ditches may sometimes enter South Waiehu Stream. (Oki, WDT 9/14/07, ¶ 40.)

123. Spreckels Ditch is commonly capable of diverting all of the flow of South Waiehu Stream during dry-weather conditions, although stream flow immediately downstream of the intake may exist because of leakage through or subsurface flow beneath the dam at the intake. Waiehu Stream is commonly dry farther downstream near Lower Waiehu Beach Road, and therefore, Waiehu Stream does not flow continuously from mauka to makai. (Oki, WDT 9/14/07, ¶ 46.)

124. There is extensive channel erosion below the Spreckels Ditch on South Waiehu Stream, with a 12-foot drop in the elevation of the stream just below the diversion, and there is a vertical concrete apron located just below the highway culverts in lower Waiehu Stream. (Exh. E-53, pp. 29, 44.) WWC 629, 650.

4. `Īao Stream

125. `Īao Stream and its main diversions are shown in Figure 3.

126. On the basis of 22 years of complete records (climate years 1984-2005) at USGS stream-gaging station 16604500 on 'Īao Stream near an altitude of about 780 feet and above all diversions, the minimum daily mean flow (Q_{100}) was 7.1 mgd (the minimum flow occurred on 29 days over 22 years, an average of about 1.3 days per year); the Q_{90} flow was 13 mgd; the Q_{70} flow was 18 mgd; and the Q_{50} flow was 25 mgd. (Oki, WDT 9/14/07, ¶¶ 26 and 61.) HC&S FOF 4.

127. The two main diversions are `Īao-Waikapū and `Īao-Maniania Ditches near an altitude of about 780 feet (there is also a small privately owned pipe farther downstream), and the Spreckels Ditch, near an altitude of about 260 feet and about 2.4 miles downstream from the `Īao-Waikapū and `Īao-Maniania Ditches. (Oki, WDT 9/14/07, ¶¶ 41, 61.)

128. The `Īao Flood Control Project starts about 2.5 miles above the mouth of `Īao Stream and consists of a debris basin, a concrete channel that runs from the debris basin to just downstream of North Market Street, a 20-foot vertical drop, a broadened but unlined channel running to Waiehu Beach Road, and concrete wing walls running about one-half of the distance from the Waiehu Beach Road to the mouth of the stream. (Exh. E-53, p. 8.) WWC FOF 496. In 2008, a $30 million project was advertised to line the remaining Control Project channel and raise existing levees to eliminate future flooding and levee failure. (Exh. E-53, p. 8.) WWC FOF 497.

129. USGS estimates that `Īao Stream loses 6.3 mgd in reaches that are not lined with concrete and that are downstream of the `Īao-Maniania Ditch diversion (which is at about 780 feet elevation), or 3.00 miles from about 595 feet elevation down to 35 feet elevation. (Oki, WDT 9/14/07, ¶¶ 62-64.)

130. Water that overflows or leaks from the ditch systems or that is discharged through gates in the systems sometimes returns to `Īao Stream downstream of the diversions. (Oki, WDT 9/14/07, ¶ 41.)

131. In the absence of ditch return flows and runoff during and following periods of rainfall, `Īao Stream remains dry in some reaches downstream of the main diversion intake for the `Īao-Maniania and `Īao-Waikapū Ditches and does not flow continuously from mauka to makai. (Oki, WDT 9/14/07, ¶ 47.)

5. **Waikapū Stream**

132. Waikapū Stream and its main diversions are shown in Figure 4.

133. On the basis of record extension techniques applied by USGS to the historical data from Waikapū Stream near gaging station 16650000 near an altitude of about 880 feet, the estimated Q_{90} flow was from 3.3 mgd to 4.6 mgd during climate years 1984-2005; the estimated Q_{70} flow was 3.9 mgd to 5.2 mgd, and the estimated Q_{50} flow ranged from 4.8 mgd to 6.3 mgd. The lowest recorded flow was 3.3 mgd in October 1912. (Oki, WDT 9/14/07, ¶ 27.) HC&S FOF 5.

134. The record extension techniques applied to the historical data to estimate the natural flow near gaging station 16650000 combined 1910-1917 historical data from gaging station 16650000, flows in the South Side Waikapū Ditch near an altitude of about 1,120 feet, and flows in the Everett Ditch near an altitude of about 900 feet. (Oki, WDT 9/14/07, ¶ 27.) While the Everett Ditch is no longer active, the South Side Waikapū Ditch is. The estimates of natural flow assume no gains, losses, or return flows between the South Side Waikapū Ditch diversion and station 16650000 during the period when the gaging stations were operated. Recent USGS seepage-run data from 2004 indicate no significant net gain or loss between the South Side Waikapū Ditch diversion and station 16650000. (Oki, WDT 9/14/07, ¶ 27.) Thus, the estimated natural flows just above the South Side Waikapū Ditch diversion should be the same as those estimated at station 16650000, while the actual flows at gaging station 16650000 for climate years 1984-2005 should be lower than the estimated natural flow for climate years 1984-2005 by an amount currently diverted at the South Side Waikapū Ditch.

135. Active diversions on Waikapū Stream include the South Side Waikapū Ditch near an altitude of about 1,120 feet, an intake on the Waihe`e Ditch (elevation not specified), and the Reservoir 6 Ditch (elevation not specified). (**See** Figure 5.)

136. Numerous return flows have been observed in Waikapū Stream downstream of the diversions. (Oki, WDT 9/14/07, ¶ 42.)0

137. Diversions in Waikapū Stream may not cause the stream to be dry immediately downstream of the diversions, although it is commonly dry downstream of all diversions because of infiltration losses into the streambed, and the stream does not flow continuously from mauka to makai. (Oki. WDT 9/14/07, ¶ 48.)

E. **Withdrawals and Diversions**

1. **Kepaniwai Well**

138. MDWS's Kepaniwai Well (Well No. 5332-05) draws dike-impounded ground water. (Eng, Dec. 9/14/07, ¶ 10.) MDWS FOF 10.

139. Water from the Kepaniwai Well is piped to MDWS's `Īao Tank, which in turn ties into the County's water system. (Eng., Dec., ¶ 18.) MDWS FOF 13.

140. MDWS has a WUPA for 1.042 mgd. (**See** FOF 17, *supra.*)

2. **Tunnels**

141. Twelve tunnels were known to be excavated in Nā Wai `Ehā between 1900 and 1926. (Oki, WDT 9/14/07, ¶ 16 (citing Stearns and Macdonald, 1942); Exh. A-5, p. 23.) Hui/MTF FOF B-29.

142. Eight tunnels were excavated in Nā Wai `Ehā's dike complex and tap dike-impounded ground water. (Oki, WDT 9/14/07, ¶ 16; Exh. A-5, p. 23.) Hui/MTF FOF B-30.

143. The other four tunnels were excavated beneath `Īao and Waiehu Streams and collect water from beneath the streams in the valley-floor alluvium. (Oki, WDT 9/14/07, ¶ 16; Exh. A-5, p. 23.) Hui/MTF FOF B-31.

144. About nine mgd of dike-impounded ground water was developed by tunnels, although most of the water (7.5 mgd) may have discharged naturally to streams below the level of the tunnels had it not been intercepted by the tunnels. (Oki, WDT 9/14/07, ¶ 16 (citing Stearns and Macdonald, 1942); Exh. A-3, p. 29; Exh. A-5, p. 23.) Hui/MTF FOF B-32.

145. The tunnels that discharge directly into the streams include the five tunnels for which WWC submitted WUPAs—Black Gorge Tunnel, `Īao Needle Tunnels No. 1 and No. 2, and Waikapū Tunnels No. 1 and No. 2 (FOF 17, *supra.*)

146. Waikapū Tunnel No. 1 flows into a tributary that joins Waikapū Stream below the diversion for the South Side Waikapū Ditch (**See** Figure 4), but its estimated yield is less than 0.01 mgd. (Exh. E-2; Exh. A-3, p. 30.) WWC FOF 776-777.

147. Waikapū Tunnel No. 2 flows into Waikapū Stream above the South Side Waikapū Ditch (**See** Figure 4) and has an estimated yield of 1.0 mgd. (Exh. A-3, p. 30.) WWC FOF 776.

148. Black Gorge Tunnel and `Īao Needle Tunnels No. 1 and No. 2 discharge into `Īao Stream above all diversions (**See** Figure 3). Development of the `Īao Tunnel (MDWS/WWC's Well No. 5332-02, *infra*) caused the Black Gorge Tunnel to go dry. (Oki, WDT 9/14/07, ¶ 26, citing Yamanaka and Huxel, 1970.) There is no information available to quantify the effects of `Īao Needle Tunnels No. 1 and No. 2 on `Īao Stream's total flow. (Oki, WDT 9/14/07, ¶ 26.) WWC FOF 562.

149. Waihe`e North and Waihe`e South Tunnels (**See** Figure 1), built in 1909, may have contributed to the total flow of Waihe`e River for a period of time after their construction, but it is not likely that they presently contribute appreciably to the total flow. (Oki, WDT 9/14/07, ¶ 23.) WWC FOF 431-432.

150. The County of Maui and WWC built the `Īao Tunnel (Well No. 5332-02) in 1937. (Exh. D-8(a), D-8(b), D-8(c); Ex. B-4; Eng, WDT, p. 5; Exh. D-37.) WWC FOF 808-809, 811-813.

151. Water from the `Īao Tunnel is first directed to MDWS's water treatment plant, and the remainder enters the ditch at WWC's `Īao Stream diversion. (**See** Figure 3.)

152. Under an agreement between WWC and MDWS, MDWS uses 1.074 mgd, with WWC having the use for the amounts over 1.074 mgd. MDWS pays WWC a delivery fee for any amounts in excess of 1.074 mgd. (Chumbley, WRT 10/29/07, ¶ 10; Chumbley, Tr. 1/15/08, p. 10, ll. 48-50; Chumbley, Tr. 1/16/08, pp. 85, 88-89.) WWC FOF 815-817.

153. MDWS has a WUPA for 1.359 mgd (**See** FOF 17, *supra*), and WWC has been using between 0.25 to 0.35 mgd. (Exh. D-32; Chumbley, WST 11/19/07, pp. 5, 7-8; Chumbley, Tr. 1/15/08, pp. 10-11, 53-54 and 127.) MDWS FOF 61, WWC FOF 832.

154. HC&S has a separate `Īao Tunnel (Well No. 5330-02), for which it has a WUPA for 0.1 mgd. (**See** FOF 17, *supra*.)

155. HC&S's `Īao Tunnel discharges into the Spreckels Ditch between HC&S's intakes on South Waiehu and `Īao Streams. (Hew, WDT 1/29/08, ¶ 11D.) HC&S FOF 88D. (*For the description of the Spreckels Ditch, **see** FOF 184-192, infra.*)

3. Ditches

156. There are two primary and two secondary systems that distribute the waters diverted from the Nā Wai `Ehā streams. (Suzuki, WDT 9/12/07, pp. 1-16.) WWC FOF 59.

157. The primary distribution systems are the WWC ditch system and the HC&S reservoir/ditch system. (Suzuki, WDT 9/12/07, pp. 1-16.) WWC FOF 60.

158. The secondary distribution systems are the "kuleana" ditches/pipes that either have an intake directly in a stream or that receive waters from the primary systems, and the MDWS water treatment plants. (Suzuki, WDT 9/12/07, p. 15.) WWC FOF 61.

159. Almost all of the kuleana distribution systems receive water by delivery from ditches or reservoirs that are a part of the primary distribution systems. (Suzuki, WDT 9/12/07, p. 15; Exh. D-99.) WWC FOF 62.

160. These distribution systems and the end users are called "kuleana" because they were not charged for water delivery. They may or may not have appurtenant or riparian rights. (Chumbley, WDT 9/12/07, p. 10.) WWC FOF 63.

F. <u>The Primary Distribution Systems</u>

161. The primary distribution systems receive stream waters via nine active diversions, two on Waihe`e River, one on North Waiehu Stream, one on South Waiehu Stream, two on `Īao Stream and three on Waikapū Stream. (Exh. D-99.) WWC FOF 64.

162. Historically, there were three additional diversions, one on Waihe`e which is presently sealed (Field 1 intake), one on `Īao that no longer exists (Kama Ditch), and one on Waikapū that is presently sealed (Everett Ditch). (Exh. D-99.) WWC FOF 65.

163. In addition, there are three kuleana intakes directly on the streams, one each in South Waiehu, `Īao, and Waikapū Streams. (Exh. D-99; Cerizo WDT 9/14/07; Pellegrino, WDT 9/14/07; Duey WDT 9/14/07.) WWC FOF 153.

164. WWC and its predecessors used the system to divert water from the streams and deliver it to users for agricultural (crops and animals), industrial (commerce and stores), and domestic (camps, villages and towns) purposes. (Exh. D-9, p. 28; Suzuki, WDT 9/12/07, p. 8; Chumbley, WDT 9/12/07, pp. 3, 4; Exh. C-85, p. 7:12-14.) WWC FOF 73.

165. In 1862, WWC's predecessor was formed and started cultivation of fields to grow sugar cane. (Exh. D-48; Chumbley, Tr. 1/15/08, p.19, ll. 4-20.) WWC FOF 68.

166. Ditches to deliver water diverted from the streams to irrigate the sugar cane were first used in 1862. (Exh. D-48; Chumbley, Tr. 1/15/08, p. 19, ll. 4-20.) WWC FOF 69.

167. In 1882, construction of the Spreckels Ditch started. (Exh. D-48; Chumbley, Tr. 1/15/08, p. 24, ll. 17-24.) WWC FOF 70.

168. Around 1900, construction of the `Īao and Waiehu ditch systems was started. (Exh. D-48; Chumbley, Tr. 1/15/08, p. 24, l. 25 to p. 26, l. 8). WWC FOF 71.

169. Construction of the Waihe`e Ditch started in 1905 and was completed in two years. (Exh. D-48; Chumbley, Tr. 1/15/08, p. 25, ll. 17-25.) WWC FOF 72.

170. The WWC distribution system involves 11 registered stream diversions, 2 major ditches, 7 minor ditches, and 16 reservoirs. (Suzuki, WDT 9/12/07, pp. 2-3; Exh. D-1(A); Exh. D-1(B); Chumbley, WDT 9/12/07, p. 3; Exh. C-85, pp. 9:12 -10:10.) WWC FOF 75.

171. In addition to sharing in the cost and maintenance of the portions of the system operated by WWC, HC&S operates a diversion intake on South Waiehu Stream at the Spreckels Ditch, a diversion intake on `Īao Stream at the Spreckels Ditch, and the Spreckels Ditch from Reservoir 25 to its terminus at HC&s's Reservoir No. 73 (the "Waiale Reservoir"). (Hew, WDT 1/29/08.) HC&S FOF 7.

172. The distribution system from the Nā Wai `Ehā streams, including intakes, reservoirs, connectors, kuleana systems and gauging stations, is depicted in Figure 5, which combines Figures 1-4 and, while generally correct, has some inaccuracies in placements of reservoirs and kuleana systems. (Exh. D-99.) WWC FOF 78.

173. WWC distributes water to three major user groups: agricultural, kuleana systems, and domestic. (Chumbley, WDT 9/12/07, pp. 6-7.) WWC FOF 77.

174. WWC's system is divided into northern and southern sections. (Suzuki, WDT 9/12/07, p. 3.) WWC FOF 79.

175. The northern sector of the system includes the Waihe`e, Spreckels, North Waiehu, and `Īao-Maniania ditches, which receive water from the Waihe`e, North Waiehu, and `Īao Streams. (Suzuki, WDT 9/12/07, p. 3.) WWC FOF 81.

176. The southern section of the system includes the South Waikapū, Reservoir No. 6, and `Īao-Waikapū Ditches, which divert water from the Waikapū and `Īao Streams. (Suzuki, WDT 9/12/07, p. 3; Chumbley, Tr. 1/14/08, p. 32, l. 22 to p. 33, l. 2; Suzuki, Tr. 12/14/07, p. 79, l. 25; Exh. D-99B.) WWC FOF 80. HC&S FOF 25.

177. There are two major ditches in the system: the Waihe`e and Spreckels Ditches. (Suzuki, WDT 9/12/07, pp. 2-4; Exh. D-1A; Exh. D-99.) WWC FOF 82.

1. **Waihe`e Ditch**

178. The Waihe`e Ditch begins at the Waihe`e Ditch Diversion in Waihe`e Stream and terminates at Reservoir 9. (Suzuki WDT 9/12/07, pp. 3-4; Exh.. D-1(A); Exh. D-99; Exh. D-45). WWC FOF 83.

179. The Waihe`e Ditch diversion on Waihe`e Stream is at approximately 620 feet elevation and consists of two concrete structures that direct stream flow over metal grates that drop water into the intake. (Exh. E-53, p. 23.) WWC FOF 103.

180. The Waihe`e Ditch Intake has a design capacity of 60 mgd but is set to divert 40 mgd. (Suzuki, WDT 9/12/07, p. 4.) WWC FOF 26. HC&S FOF 10.

181. There is an additional intake into the Waihe`e Ditch at Waikapū Stream. (Chumbley, Tr. 1/15/08, p. 29, l. 10-14, p. 30, l. 6-10; Exh. D-99B.) HC&S FOF 11.

182. Water from the Waihe`e Ditch can be transferred to the Spreckels Ditch in two places: 1) a "drop" ditch in Waihe`e Valley located north of all reservoirs, which transfers approximately 6 mgd into the Spreckels Ditch (Suzuki, WDT 9/12/07, p. 3, ll. 20-21.) HC&S FOF 12; and 2) through the Hopoi Chute located near `Īao Stream, which transfers water into the Spreckels Ditch at its terminus at Waiale Reservoir.

183. Water can also be added to the Waihe`e Ditch from North Waiehu Stream via the North Waiehu Ditch and from `Īao Stream via the `Īao-Maniania and `Īao-Waikapu Ditches. (**See** FOF 194, 197, 198, *infra.*)

2. **Spreckels Ditch**

184. The Spreckels Ditch starts at its intake on Waihe`e Stream at 420 feet elevation (downstream from the Waihe`e Ditch intake), crosses North Waiehu Stream, South Waiehu Stream, and `Īao Stream, and terminates at the point where the Hopoi chute drops water from the Waihe`e Ditch to HC&S's Waiale Reservoir. (Chumbley, Tr. 1/15/08, p. 30, ll. 11-18; Suzuki, WDT 9/12/07, pp. 3-5; Exh. D-99B; Exh. E-53, p. 4.) WWC FOF 108. HC&S FOF 13.

185. The Spreckels Ditch intake at Waihe`e Stream has a design capacity of 30 mgd, but the gate is typically set at 12 mgd. The intake is controlled by WWC. (Chumbley, Tr. 1/15/08, p. 30, ll. 11-18; Suzuki, WDT 9/12/07, p. 5, ll. 6-7; Suzuki, Tr. 12/14/07, p. 74, ll. 14-16; Exh. D-99B.) HC&S FOF 14.

186. The Spreckels Ditch also has intakes at South Waiehu Stream and `Īao Stream, which are controlled by HC&S. (Chumbley, Tr. 1/15/08, p. 31, ll. 2-11; Exh. D-99B.) HC&S FOF 15.

187. HC&S's intakes are not metered, but HC&S estimates that the intake on South Waiehu Stream ranges from a low of 2-3 mgd during dry periods to a maximum of 10-15 mgd during wet periods. There is also a kuleana intake via a pipe that takes water from the ditch that connects the diversion to Spreckels Ditch, which HC&S estimates takes approximately 0.25 mgd. (Hew, WDT, 1/29/08, ¶ 11C; Hew, Tr. 1/28/08, p. 32, l. 8 to p. 33, l. 9.) HC&S FOF 88C.

188. The intake on `Īao Stream is also not metered, but HC&S estimates that the amount diverted ranges from a low of 3-4 mgd during dry periods to a high of about 20 mgd during wet periods. (Hew, WDT 1/29/08, ¶ 11E.) HC&S FOF 88E.

189. HC&S's `Īao Tunnel (Well No. 5330-02), for which it has a WUPA for 0.1 mgd, enters the Spreckels Ditch between the intakes from South Waiehu and `Īao Streams. (Hew, WDT 1/29/08, ¶ 11D.) HC&S FOF 88D.

190. HC&S measures the aggregate water flow in the Spreckels Ditch at its Wailuku gauging station located downstream of the South Waiehu Diversion, the intake pipe from the HC&S `Īao Tunnel, and the `Īao Stream intake, none of which is separately gauged. In addition to these three sources, the gauged amount includes water diverted by WWC from Waihe`e River via two ditches: 1) the Waihe`e Ditch via the drop ditch to Spreckels Ditch; and 2) the Spreckels Ditch, downstream from the Waihe`e Ditch diversion. (Hew, WDT 1/29/08, ¶ 11F.) HC&S FOF 88F.

191. As described under the Waihe`e Ditch, water can be transferred from the Waihe`e Ditch to the Spreckels Ditch through a drop ditch and the Hopoi Chute. (<u>**See**</u> FOF 182, 184, *supra*).

192. WWC controls the Spreckels Ditch from its intake on Waihe`e Stream to HC&S's intake at South Waiehu Stream, and HC&S controls the Ditch from South Waiehu to its terminus at Waiale Reservoir. (<u>**See**</u> FOF 171, *supra*.)

3. <u>North Waiehu Ditch</u>

193. The North Waiehu Ditch on North Waiehu Stream has a capacity of 5 mgd, but the control gate is currently set at 1.5 mgd. (Chumbley, Tr. 1/14/08, p. 32, ll. 14-17; Suzuki, WDT 9/12/07, p. 4, ll. 9-10 and p. 5, ll. 11-12.) HC&S FOF 22.

194. The North Waiehu Ditch diverts water to the north and can drop water into the Waihe`e Ditch. (Chumbley, Tr. 1/14/08, p. 32, ll. 14-17; Suzuki, Tr. 12/14/07, p. 76, ll. 7-11.) HC&S FOF 23.

4. **`Īao Ditch**

195. The ʻĪao Ditch starts with an intake at ʻĪao Stream, which is rated at 60 mgd, but the intake is set to divert at most 20 mgd. (Suzuki, WDT 9/12/07, p. 4, ll. 3-8, and p. 5, ll. 8-9; Chumbley, Tr., 1/14/08, p. 31, ll. 16-22.) HC&S FOF 19.

196. A control gate after the intake controls the amount of water that is released into the remainder of the Ditch. The water can be diverted north to the ʻĪao-Maniania Ditch or south to the ʻĪao-Waikapū Ditch. Any water beyond the gate settings for the ʻĪao-Maniania and the ʻĪao-Waikapū ditches is returned to ʻĪao Stream about 1000 feet below the intake. The settings for this control gate vary according to needs, and are changed as often as weekly. HC&S gives WWC a weekly plan of their irrigation needs by day and reservoirs so that WWC can adjust the control gate accordingly. (Suzuki, WDT 9/12/07, p. 4, ll. 3-8, p. 5, ll. 8-9, p. 41, ll. 3-8; Suzuki, Tr. 12/14/07, p. 77, ll. 21-25, and p. 174, l. 18 to p. 175, l. 12; Chumbley, Tr. 1/14/08, p. 31, ll. 16-22; Chumbley, Tr. 1/16/08, p. 134, ll. 2-17 and p. 190, l. 9 to p. 191, l. 18; Exhibit D-99B.) HC&S FOF 19. MDWS FOF 80.

197. The ʻĪao-Maniania Ditch is an unlined ditch of about 2.07 miles in length. It has a rated capacity of 30 mgd, but its control gate is currently set to receive 2 mgd of flow from the main ʻĪao Ditch. The ʻĪao-Maniania Ditch can deliver water back north and deposit water back into the Waihe'e Ditch. (Chumbley, Tr. 1/14/08, p. 31, ll. 23-24 and p. 32, ll. 7-8; Suzuki, Tr. 12/14/07, p. 7, ll. 1-4; Suzuki, WDT 9/12/07, p. 5, ll. 9-10; Exh. D-99B.) HC&S FOF 20.

198. The ʻĪao-Waikapū Ditch is approximately 70 to 80 percent lined and is 2.95 miles in length. It has a rated capacity of 30 mgd, but its control gate is currently set to receive 18 mgd of flow from the main ʻĪao Ditch. The ʻĪao-Waikapū ditch can send water south to service the Waikapū region and the area from ʻĪao Valley Road back to the south. (Chumbley, Tr. 1/14/08, p. 31, ll. 16-22, and p. 32, ll. 1-10; Suzuki, WDT 9/12/07, p 5, ll. 9-10; Suzuki, Tr. 12/14/07, p. 78, ll. 5-7; Exh. D-99B.) HC&S FOF 21. Any water remaining in the `Īao-Waikapū Ditch is put into the Waihe`e Ditch downstream of the Hopoi Chute. (Hew, WDT 1/29/08, ¶ 10C.) HC&S FOF 87C.

5. Waikapū Ditch

199. The Waikapū Ditch is located off of the top intake on Waikapū Stream (the other two intakes on Waikapū Stream are at the Waihe`e Ditch (**See** FOF 181, *supra*) and at the Reservoir No. 6 Ditch (**See** FOF 200, *infra*). The intake to the ditch has a rated capacity of 5 mgd, but the control gate is currently set at 3 mgd. The ditch delivers water to Reservoir No. 1. (Chumbley, Tr. 1/14/08, p. 32, ll. 18-21; Suzuki, WDT 9/12/07, p. 4, ll. 11-12 and p. 5, ll. 10-11; Exhibit D-99B.) HC&S FOF 24.

6. Reservoir No. 6 Ditch

200. The Reservoir No. 6 Ditch delivers water from the lowest Waikapū Stream intake and delivers it back north to Reservoir No. 6, located just below Honoapiilani Highway. (Chumbley, Tr. 1/14/08, p. 32, l. 22 to p. 33, l. 2; Suzuki, Tr. 12/14/07, p. 79, l. 25; Exhibit D-99B.) HC&S FOF 25.

7. Inactive Ditches

201. The Kama Ditch, Everett Ditch, and Field One intake are inactive ditches. (Chumbley, Tr. 1/14/08, p. 33, ll. 7-12; Suzuki, Tr., 12/14/07, p. 74, ll. 16-17, p. 77, l. 25, and p. 79, l. 23; Exh. D-99B.) HC&S FOF 26.

8. Monitoring Practices

202. WWC maintains a "storm setting" practice when heavy rains are forecasted. (Suzuki, WDT 9/12/07, pp. 11-12.) WWC FOF 117.

203. At storm settings the Waihe`e Ditch Gate on Waihe`e Stream will be reduced to 20 mgd from the normal setting of 40 mgd, and the `Īao-Waikapū Ditch Gate will be reduced to 10 mgd from 18 mgd. (Suzuki, WDT 9/12/07, pp. 11-12.) WWC FOF 119.

204. The primary intakes of the Waihe`e, Spreckels, `Īao-Maniania, and `Īao-Waikapū ditches have 24-hour gauging stations to measure the ditch flow. In addition, ditch flows at five other stations along the six ditches operated by WWC are read and recorded daily. (Suzuki, WDT 9/12/07, p. 4.) WWC FOF 94, 95.

205. The waters that enter the distribution system travel by gravity flow in primary ditches through uplands into reservoirs that in turn deliver the water into smaller ditches for end use.

Because the flows of the streams vary daily, reservoirs were made a part of the system to allow for a more constant delivery of water to end users. (Suzuki, WDT 9/12/07, pp. 5-8.) WWC FOF 120, 121.

206. WWC built and presently maintains 16 reservoirs that were designed to hold about 79 million gallons, but due to siltation, the reservoirs have a current capacity between 55 and 60 million gallons. (Suzuki, WDT 9/12/07, pp. 5-6.) WWC FOF 122, 123.

207. Each reservoir has a water meter to measure the flow from the reservoir. (Suzuki, WDT 9/12/07, p. 6.) WWC FOF 125.

208. In addition to their stream diversions, both WWC and HC&S add or may augment stream waters with other sources. WWC adds water from its and MDWS's `Īao Tunnel at the `Īao Stream intake (**See** Figure 3), and HC&S adds water from its `Īao Tunnel into the portion of the Spreckels Ditch that it controls (**See** FOF 189, *supra).* In the past, HC&S has also used its Well No. 7 to pump ground water from the Kahului aquifer to irrigate some of its fields. (Volner, WDT 9/14/07, p. 2; Volner, Tr. 1/29/08, pp. 175-177.) WWC FOF 149.

G. Users

209. Historically, an average of about 67 mgd was diverted from the four streams for sugar cane irrigation: 40 mgd from Waihe`e, 3 mgd from North Waiehu, 3 mgd from South Waiehu, 18 mgd from `Īao, and 3 mgd from Waikapū. (Oki, WDT 9/14/07, ¶ 18; Exh. A-5, p. 8; Exh. A-3, p. 13.)

210. Currently, from 70 to 90 percent of the annual total flow of Waihe`e River is diverted by WWC. (Suzuki, WDT 9/12/07, p. 10.) WWC FOF 408. WWC estimates that the amount of water diverted averaged 37.09 mgd in 2005 and 29.72 mgd in 2006. (Exh. A-138.) WWC FOF 412.

211. Currently, from 40 to 60 percent of the annual total flow of North Waiehu Stream is diverted by WWC. (Suzuki, WDT 9/12/07, p. 10.) WWC FOF 653. WWC estimates that the amount it diverts averaged 1.41 mgd in 2005 and 1.38 mgd in 2006. (Exh. A-138; Exh. A-213.) WWC FOF 655. In addition, HC&S estimates that the amount it diverts at its intake on South Waiehu Stream into the Spreckels Ditch ranges from a low of 2-3 mgd during dry periods to a maximum of 10-15 mgd during wet periods. (Hew, WDT, 1/29/08, ¶ 11C; Hew, Tr. 1/28/08, p. 32, l. 8 to p. 33, l. 9.) HC&S FOF 88C.

212. Currently, from 30 to 50 percent of the annual total flow of ʻĪao Stream is diverted by WWC. (Suzuki, WDT 9/12/07, p. 10.) WWC FOF 536. WWC estimates that the amount of water diverted averaged 13.68 mgd in 2005 and 13.53 mgd in 2006. (Exh. A-138.) WWC FOF 542. In addition, HC&S estimates that the amount it diverts at the Spreckels Ditch ranges from a low of 3-4 mgd during dry periods to a high of about 20 mgd during wet periods. (Hew, WDT 1/29/08, ¶ 11E.) HC&S FOF 88E.

213. Currently, from 60 to 80 percent of the annual total flow of Waikapū Stream is diverted. (Suzuki, WDT 9/12/07, p. 10.) WWC FOF 754. WWC estimates that the amount of water diverted averaged 4.32 mgd in 2005 and 4.31 mgd in 2006. (Exh. D-7; Exh. A-138.) WWC FOF 758.

1. <u>The Kuleana Systems</u>

214. Before the 1980s, delivery of water to most kuleana systems only occurred during periods when water was delivered for agricultural operations through the ditches and reservoirs to which the kuleana systems were connected. (Suzuki, Tr. 12/14/07, p. 89; Chumbley, Tr. 1/15/08, pp. 39- 40.) WWC FOF 154.

215. In the 1980s, as WWC shifted from furrow irrigation to drip irrigation, WWC changed its delivery system by installing pipes to replace ditches, which made deliveries more reliable and consistent. (Suzuki, Tr. 12/14/07, p. 89; Chumbley, Tr. 1/16/08, p. 142.) WWC FOF 155.

216. During plantation operations, HC&S and WWC frequently provided the maintenance of the kuleana systems when their workers maintained the ditch systems used to provide irrigation for agricultural operations of those companies. (Chumbley, Tr. 1/15/08, pp. 39-40.) WWC FOF 157.

217. After the installation of drip irrigation in the 1980s, users of the kuleana systems which received water through the WWC distribution system were expected to maintain their own systems. (Chumbley, Tr. 1/15/08, pp. 39-40.) WWC FOF 158.

218. WWC's practice since that time has been and remains that it will maintain its ditches to the point of delivery of water into the kuleana ditch or pipe system. (Suzuki, WRT 10/29/07, p. 9.) WWC FOF 159.

219. Maintenance of the kuleana ditches and pipes by the present users has been inconsistent, with some users maintaining limited portions of some of the systems and other systems receiving

no maintenance from the users. (Suzuki, Tr. 12/14/07, p. 142; Miyashiro, Tr. 2/21/08, pp. 189-192). WWC FOF 161.

220. Seventeen kuleana ditch/pipe systems were identified (but there may be 18; **see** FOF 225, *infra*). (Exh. D-99.) WWC FOF 151.

221. Table 1 lists each kuleana ditch/pipe system and the source of water for the system. Fourteen systems are connected to one of the primary distribution systems, and three divert water directly from a stream. (Exh. D-7; Cerizo WDT 9/14/07; Pellegrino WDT9/14/07; Duey WDT9/14/07; Exh. D-99.) WWC FOF 152.222.

222. Table 2 lists the amount of water delivered to each of the kuleana ditches/pipes that receive water through the WWC distribution system in 2006. (Exh. D-7, Exh. A-213.) WWC FOF 413, 543, 657, 759.

223. WWC states that the Field 31 Pipe off the Spreckels Ditch is not metered and therefore provided no figures. (Exh. D-7; Exh. A-213.) WWC FOF 657.

224. Hui/MTF claims that there is a branch `auwai to Waihe`e Valley North `auwai, and that the 0.95 mgd measurement does not include 0.43 mgd measured in this branch in September 2007. (Ellis, WDT 10/26/07, ¶ 6.) Hui/MTF FOF D-27.

225. As described earlier, at HC&S's diversion on South Waiehu Stream, there is also a kuleana intake via a pipe that takes water from the ditch that connects the diversion to Spreckels Ditch, which HD&S estimates takes approximately 0.25 mgd. (Hew, WDT, 1/29/08, ¶ 11C; Hew, Tr. 1/28/08, p. 32, l. 8 to p. 33, l. 9.) HC&S FOF 88C. This kuleana pipe diversion is very close to the Field 31 Pipe off the Spreckels Ditch (**See** Figure 2), and both HC&S and WWC may be referring to the same ditch. If so, then the Field 31 pipe diverts about 0.25 mgd; if not, then the amount diverted by the Field 31 pipe remains unknown and there are at least 15, not 14, kuleana ditch/pipe systems in addition to the three diversions that have been identified as diverting water directly off South Waiehu, `Īao, and Waikapū streams.

226. The three diversions on the streams are not measured. (Duey, Tr. 12/3/07, p. 66; Cerizo, Tr. 12/7/07, pp. 69-84; Pellegrino, Tr. 12/6/07, p. 266, ll. 10-15.) WWC FOF 539, 622.

227. The total identified amount of water diverted for kuleana use is therefore probably 6.84 mgd, 0.68 mgd more than the 6.16 mgd reported by WWC in Table 2. The 6.84 mgd does not include the amount diverted by the Field 31 pipe and the amounts diverted directly from South

Waiehu, `Īao, and Waikapū Streams by the three known diversions and other, unknown diversions.

228. WWC does not measure amounts of water delivered to or collect data on the individual users from kuleana systems on a parcel-by-parcel basis. (Chumbley, WDT 9/12/07, p. 10.) WWC FOF 173.

229. Table 3 identifies persons receiving water from a kuleana distribution system that delivers Waihe`e River water. (Exh. D-7.) WWC FOF 414.

230. Table 4 identifies persons receiving water from a kuleana distribution system that delivers North Waiehu Stream water. (Exh. D-7; Hoopi, Tr. 12/4/07, pp. 196-207; Singer, Tr. 12/13/07, p. 29.). WWC FOF 658.

231. Table 5 identifies persons receiving water from a kuleana distribution system that delivers `Īao Stream water. (Exh. D-7; Brito, Tr 12/7/07, pp. 29-38.) WWC FOF 544.

232. Table 6 identifies persons receiving water from a kuleana distribution system that delivers Waikapū Stream water. (Exh. D-7; Exh. A-194.). WWC FOF 761.

233. Nearly 50 persons testified at the CCH, including many identified in Tables 3-6 and others who wished to receive Na Wai `Ehā waters. Approximately 135 acres were involved, of which about 45 acres were or were intended to be cultivated, primarily in wetland kalo but also for vegetables, trees, and plants for subsistence and cultural purposes. (<u>See</u> Hui/MTF FOF D-1 to D-458).

234. Persons who were receiving water testified that the amounts currently delivered were insufficient (e.g., Pellegrino, WDT 9/14/07, ¶¶ 17-18; Hui/MTF FOF D-389, D-398) and nearly all also wished to increase their land under cultivation (e.g., Soong, WDT 11/16/07, ¶¶ 4-5; Hui/MTF FOF D-379-D-380). Most of those not receiving water intended to resume or start cultivation of a portion of their land (e.g., Ornellas, WDT 9/14/07, ¶¶ 8, 16) Hui/MTF FOF D-308, but several asked only for stream restoration for cultural and recreational purposes (e.g., Higashino, WDT 9/14/07, ¶¶ 6-7; Higashino, Tr. 12/13/07, p. 8, ll. 10-19, p. 9, ll. 7-12) Hui/MTF FOF D-156, D-157.

235. Most of those testifying had lands under 5 acres, but some had larger parcels; e.g., Duey, on `Īao Stream with 18.146 acres, of which he currently has only 0.08 acres in kalo lo`i but intended to reopen all 1.5 acres of ancient lo`i if water were available (J. Duey, WDT 9/14/07, ¶¶ 3, 11-12, 14), Hui/MTF FOF D-284, D-288, D-289; Horcajo, with 49.5 acres, of which he would

start with 3 acres of kalo lo`i and 4 acres of native plants (Horcajo, WDT 9/14/07, ¶¶ 5, 12, 14), Hui/MTF FOF D-313, D.316, D-317.

236. At least one person leased lands for commercial growing of kalo; Ho`opi`i, with 3.94 acres, of which 3.5 acres has been leased to Aloha Poi for over 50 years. (Ho`opi`i WDT 10/26/07, ¶¶ 4, 16.) Hui/MTF FOF D-180, D-185.

237. In addition to the mostly small parcels of land that comprised the approximately 135 acres, North Shore at Waiehu, with 64 acres of land along the shore near Waiehu and `Īao Streams, requested stream flow restoration so that springs would revive and help restore the wetlands that previously comprised about one-third of the property. (Ivy, WDT 3/7/08, ¶¶ 1-2, 9-10, 17-18.) Hui/MTF FOF D-358, D-364.

2. MDWS

238. In addition to water from the `Īao Tunnel (Well No. 5332-02), MDWS receives water from the `Īao-Waikapū Ditch, which is treated at its `Īao Water Treatment Facility for domestic use. (Eng, Dec. 9/14/07, p. 8.) WWC FOF 190.

239. In 2004 MDWS and WWC entered into an agreement until November 30, 2010, allowing MDWS to receive up to 3.2 mgd from the `Īao-Waikapū Ditch whenever the total flow in `Īao Stream exceeds 55 mgd at the USGS gauging station above the WWC `Īao Ditch Diversion (which then splits into the `Īao-Maniania and `Īao-Waikapū Ditches). (Chumbley, WDT 9/12/07, p. 9; Exh. D-8(i); Exh. D-93.) WWC FOF 192, 194.

3. WWC Delivery Agreements

240. WWC has water-delivery agreements with 34 entities in addition to its agreement with MDWS and HC&S. (Exh. D-96.)

241. WWC's table of customers does not identify the nature of the water uses, except to label them generally as either "agriculture" or "irrigation." Under WWC's terminology, "irrigation" is "agriculture," but on a shorter-term basis and also includes dust control. (Exh. D-96; Chumbley, Tr. 1/24/08, p. 64, l. 21 to p. 65, l. 13.) Hui/MTF FOF E-31.

242. WWC's table of customers also did not provide information on any acreages cultivated. (Exh. D-96.) Hui/MTF FOF E-32.

243. Several of WWC's customers provided testimony at the CCH:

244. Maui Cattle Company ("MCC"), with a maximum delivery agreement of 0.750 mgd (Exh. D-96), previously irrigated pasture for cattle on an experimental basis, using up to 0.9 to 1 mgd to spray water into the air over dry pasture. (Franco, Tr. 1/14/08, p. 174, ll. 22-24, p. 176, ll. 17-19, and p. 188, ll. 23-25.) Hui/MTF FOF E-40, E-41, E-42.

245. The irrigated area subsequently was decreased from 240 to 25 acres, the number of cattle decreased from a high of 375 to 60, and the amount of water decreased to about 0.029 mgd by 2007. (Franco, Tr. 1/14/08, p. 176, l. 4, p. 186, ll. 8-11 and 19-22, p. 192, ll. 6-14.) Hui/MTF FOF E-48, E-49.

246. MMK Maui ("MMK"), with a maximum delivery agreement of 4 mgd (Exh. D-96), used 1.198 mgd for 36 holes in 2006, its first full year of irrigation. (Dooge, Tr. 1/14/08 p. 136, ll. 9-13 and p. 160, ll. 9-22.) Hui/MTF FOF E-59.

247. Wailuku Country Estates ("WCE"), with a maximum delivery agreement of 1 mgd (Exh. D-96), was represented by a single lot owner, who did not identify the total current use by WCE. WCE limits each lot owner to a daily average of 2,200 gallons ("gpd") and imposes an extra charge for any excess over the allowable use. (Irani, Tr. 1/14/08, p. 18, ll. 10-15, p. 91, l. 25 to p. 92, l. 3; Exh A-214, p. 1.) Hui/MTF FOF E-85, E-86.

248. WCE lots also receive up to 540 gpd from the county water system.

249. WCE also claimed a maximum amount of 0.1 mgd for its community park and roadside community areas (acreage not specified) but on cross-examination stated that actual use was less than half of the stated maximum. (Irani, Dec. 9/14/07, ¶ 7; Irani, Tr. 1/14/08, p. 55, l. 22 to p. 56, l. 1 and p. 55, ll. 2-3.) Hui/MTF FOF E-91, E-92.

250. Koolau Cattle Company ("KCC"), a 10-lot, 72-acre agricultural development with a maximum delivery agreement of 0.1 mgd (Exh. D-96), provided no details on acreages or water usages. (Betsill, Tr. 1/25/08, p.210, ll. 18-23.) Hui/MTF FOF E-99.

251. Each lot in KCC also receives up to 1,000 gpd from the county system. (Betsill, Tr. 1/25/08, p. 204, l. 24 to p. 205, l. 5.) Hui/MTF FOF E-98.

252. Atherton and his partners ("Atherton et al.") own several entities, including Ma`alaea Properties, Waikapū Properties, and Maui Tropical Plantation ("MTP"). MTP has a maximum delivery agreement of 0.5 mgd. (Exh. D-96.) Ma`alaea Properties and Waikapū Properties each have maximum delivery agreements of 0.050 mgd. (Exh. C-71, p. 2, §§ 1.09, 3.01; Exh. C-72, p.

2, §§ 1.09, 3.01; Atherton, Tr. 2/21/08, p. 165, l. 8 to p. 166, l. 12; Exh. D-96.) Hui/MTF FOF E-131.

253. Maui Tropical Plantation used 0.114 mgd for 59 acres over the period 2001 through 2007. (Ex. A-140, p. 20; D-97; Atherton, Tr. 2/21/08, p. 180, ll. 1-11.) Hui/MTF E-124.

254. The Ma`alaea development project is still "a long ways" away and "all proposed…not fact." (Atherton, Tr. 2/21/08, p. 134, ll. 15-20 and p. 143, ll. 11-17.) Hui/MTF FOF E-117.

255. A coffee plantation is proposed for the Waikapū Properties. (Atherton, Tr. 2/21/08, p. 168, l. 23 to p. 169, l. 15; p. 171, ll. 1-4; p. 203, ll. 19-22; p. 169, ll. 18-20.) Hui/MTF FOF E-120.

256. The maximum delivery agreements derived from Exh. D-96 and D-99 total 11.188 mgd (not including MDWS, which has a maximum-use agreement of 3.2 mgd (**See** FOF 239, *supra*.) However, other evidence introduced at the CCH (**See** FOF 252, *supra*) show that Ma`alaea and Waikapū Properties each have maximum delivery agreements of 0.05 mgd, not 1.0 mgd as shown for Ma`alaea Properties and 2.0 mgd as shown for Waikapū Properties in Exh. D-96. (**See also** WWC FOF 421, 553, 767, which are derived from Exh. D-96 and Exh. D-99.)

257. Therefore, the maximum delivery agreements that WWC has with 34 entities total 8.288 mgd, not 11.188 mgd (11.188 – 0.95 – 1.95 = 8.288).

258. The total amounts of water used under the 34 water-delivery agreements were 1.42 mgd in 2005 and 2.37 mgd in 2006. (Exh. E-3; Exh. E-4; Exh. A-138.) WWC FOF 270.

4. HC&S

259. In addition to water from its diversions on South Waiehu and `Īao Streams and from the `Īao Tunnel that feed into the Spreckels Ditch, HC&S receives water from WWC through the Spreckels Ditch (from Waihe`e River), the Waihe`e Ditch via the drop ditch into Spreckels Ditch (also from Waihe`e River), and the Hopoi Chute into the terminus of the Spreckels Ditch (from Waihe`e River and North Waiehu and `Īao Streams). (Hew, WDT 1/29/08, pp. 4-6.) WWC FOF 148.

260. The portion of HC&S' plantation that is irrigated with Nā Wai 'Ehā stream water consists of two groups of fields: 1) the Waihe'e-Hopoi Fields, and the `Īao-Waikapū fields. (Exh. E-1.)

261. The Waihe'e-Hopoi Fields consist of 3,950 acres, excluding Fields 921 and 922, which in recent years have been irrigated exclusively with wastewater from Maui Land and Pine ("MLP"). HC&S anticipates that, due to the shutdown of MLP's cannery operation, MLP mill wastewater

will only be able to supply approximately half of the irrigation requirements of Fields 921 and 922 in the future. HC&S owns the Waihe'e-Hopoi Fields. (Exh. E-1); Hew, WDT 1/29/08, ¶ 5; Volner, WDT 9/14/07, ¶¶ 3, 5; Volner, Tr. 1/29/08, p. 163, ll. 1-16 and p. 174, l. 2 to p. 175, l.14.) HC&S FOF 79.

262. These fields are currently irrigated with Nā Wai 'Ehā stream water transported to Waiale Reservoir, from where it is distributed by gravity flow via pipes and ditches to sand filter stations for removal of impurities and then applied to the fields through drip tubes. (Volner, WDT 9/14/07, ¶ 11; Hew, WDT 1/29/08, ¶ 5.) In addition, HC&S Well No. 7, which is the only one of HC&S's 16 brackish water wells on the plantation that is situated so as to be able to introduce water into HC&S's internal ditch system and direct it by gravity flow, can also be used to irrigate the Waihe'e-Hopoi fields with the exception of Field 715. (Volner, WDT 9/14/07, ¶ 6.) HC&S FOF 80.

263. HC&S has minimized the use of Well No. 7 ever since Brewer ceased its sugar operations and the Waihe`e and Spreckels Ditch flows previously used by Brewer to irrigate its cane fields were allowed to flow uninterrupted into the Waiale Reservoir 24 hours a day rather than being substantially reduced during the day, as was previously the case under the sharing arrangement between HC&S and Brewer. (Volner, WDT 9/14/07, ¶ 7.) HC&S FOF 80.

264. The `Īao-Waikapū fields (also known as the "Leased Fields") consist of 1,350 acres. HC&S leases all of these fields except Field 920, which HC&S owns. Historically, the 'Īao-Waikapū Fields were cultivated by C. Brewer and successor entities. After C. Brewer terminated its sugar operations, HC&S took over cultivation of these fields by taking back Field 920 and leasing the remaining fields from C. Brewer. HC&S currently leases the fields from the Atherton Group. (Hew, WDT 1/29/08, ¶ 6; Hew, Tr. 1/29/08, p. 115, ll. 20-23; Volner, WDT 9/14/07, ¶ 3; Holaday, Tr. 1/31/08, p. 68, l. 21 to p. 69, l. 9; Exh. E-1; Exh. C-67.) HC&S FOF 81.

265. The Atherton Group consists of LODI Development, Inc., Michael W. Atherton, William S. Fillios, as trustee of the William Fillios Separate Property Trust dated April 3, 2000, and Boyce Holdings, Inc. Michael Atherton testified that he intends to renew the six-year lease with HC&S for the portions of the 'Īao-Waikapū Fields owned by the Atherton Group. (Atherton, Tr. 2/21/08, p. 208, ll. 17-22.) HC&S FOF 81.

266. The 'Īao-Waikapū Fields are all above the Waiale Reservoir, and thus, beyond the reach of HC&S' gravity-based irrigation system, including Well No. 7. These fields are irrigated with

water from WWC's Reservoir 6, which can receive water from ʻĪao-Waikapū Ditch via the Waiheʻe Ditch, the Waiheʻe Ditch below the Hopoi chute, and the South Waikapū Ditch. Water to irrigate the ʻĪao-Waikapū Fields comes principally from ʻĪao Stream via the ʻĪao-Waikapū Ditch and Waikapū Stream via the South Waikapū Ditch and Waiheʻe Ditch, all of which are operated by WWC. If necessary, water in the Waiheʻe Ditch can be kept in the ditch past the Hopoi chute to supplement the flow from the ʻĪao-Waikapū Ditch. Field 735, however, because of its elevation, can only be irrigated with water from the South Waikapū Ditch. (Hew WDT 1/29/08, ¶¶ 6-8; Hew, Tr. 1/29/08, p. 89, ll. 18-22.) HC&S FOF 82.

267. HC&S intended to cultivate Field 767, a former Wailuku Sugar Company field that is shown on Exhibit E-1 but not color coded. Rick W. Volner, Jr., HC&S' Senior-Vice President of Agricultural Operations, and G. Stephen Holaday, president of A&B's Agricultural Group, testified in January 2008, that HC&S intended to begin cultivation of the field within the next two to three weeks. The source of irrigation water for Field 767 would be the same as the ʻĪao-Waikapū Fields. (Volner, Tr. 1/30/08, p. 197, l. 10 to p. 198, l. 1, p. 198, ll. 6-13; Holaday, Tr. 1/31/08, p. 51, l. 21 to p. 52, l 17.) HC&S FOF 83.

268. Waiale Reservoir receives water from the Waiheʻe Ditch as follows:

269. Waiheʻe Ditch diverts Waiheʻe Stream via a stream diversion. WWC then drops an amount of water determined by WWC to be necessary to service kuleanas in Waiheʻe Valley to the Spreckels Ditch, from which it can be directed into the ditch that services the kuleanas. (Hew, WDT 1/29/08, ¶ 10A.) HC&S FOF 87A.

270. North Waiehu Ditch diverts the northern tributary of Waiehu Stream. Water from the North Waiehu Ditch is withdrawn by various kuleanas served by WWC. Any excess water remaining in the ditch is fed into the Waiheʻe Ditch. (Hew, WDT 1/29/08, ¶ 10B.) HC&S FOF 87B.

271. WWC's diversion at ʻIao Stream channels water into the ʻĪao-Maniania Ditch to the north and the ʻĪao-Waikapū Ditch to the south. WWC, via the ʻĪao-Maniania Ditch, services various kuleanas and the Wailuku Country Estates subdivision. Any excess water remaining in the ʻĪao-Maniania Ditch is put into the Waiheʻe Ditch. WWC, via the ʻĪao-Waikapū Ditch, services various kuleanas, the Maui Department of Water Supply, and various licensees. Any excess water remaining in the ʻĪao-Waikapū Ditch is put into the Waiheʻe Ditch downstream of the Hopoi chute (and thus not available to Waiale Reservoir, because the Hopoi chute drops water at

the terminus of the Spreckels Ditch into Waiale Reservoir). (Hew, WDT 1/29/08, ¶ 10C.) HC&S FOF 87C.

272. Water in the Waihe'e Ditch is measured by HC&S at a gaging station at "Field 63" (this is a former Brewer field designation) in Hopoi. The flow at the Hopoi gaging station represents the aggregate of the remaining water in the ditch at that point collected in the Waihe'e Ditch from (a) Waihe'e Stream; (b) any excess water passed from the North Waiehu Ditch; and (c) any excess water passed from the 'Īao-Maniania Ditch. The average flow measured at the Hopoi gaging station between 1993 and 2007 was approximately 20.51 mgd. Approximately 100 yards downstream of the gauging station, a control gate allows water in the Waihe'e Ditch to be diverted to the Hopoi chute Ditch and into the Waiale Reservoir. WWC operates and controls the control gate. Pursuant to agreement with HC&S, WWC operates the control gate to divert some or all of the Waihe'e Ditch water into the Hopoi chute Ditch. Any water not diverted into the Hopoi chute Ditch remains in the Waihe'e Ditch. Water passing the Hopoi chute Ditch and remaining in the Waihe'e Ditch is under the control of WWC, and can be used to irrigate HC&S' leased 'Īao-Waikapū fields, Maui Tropical Plantation, and the golf course. (Hew, WDT 1/29/08, ¶ 10D; Hew, Tr. 1/29/08, p. 120, ll. 8-13.) HC&S FOF 87D.

273. From approximately 1924 until Brewer stopped cultivating sugar in 1988, the Waihe'e Ditch water, which was comprised principally of water from Waihe'e Stream, was shared by agreement between Brewer and HC&S, 7/12 to Brewer and 5/12 to HC&S. From at least the mid 1980's, this was administered by Brewer opening the gate to the Hopoi chute Ditch from 7:00 p.m. to 5:00 a.m. and closing it from 5:00 a.m. to 7:00 p.m. daily. However, after 1988, when Brewer no longer needed the Waihe'e Stream water downstream of the Hopoi chute, WWC has generally left the gate open and the water formerly used by Brewer has flowed down into the Waiale Reservoir for use by HC&S. (Hew, WDT 1/29/08, ¶ 10E.) HC&S FOF 87E.

274. Water delivered by WWC to HC&S's Waiale Reservoir through the Hopoi Chute is measured at the Waihe`e Hopoi gauging station. As the Hopoi Chute is approximately 100 yards downstream of the gauging station (**<u>See</u>** FOF 272, *supra*), the amount reported as delivered to Waiale Reservoir includes water flowing past the Hopoi Chute in the Waihe`e Ditch if there are irrigation needs further down the ditch, such as filling Reservoirs 90, 92, 97, or 9 and used to irrigate HC&S' leased 'Īao-Waikapū fields, Maui Tropical Plantation and the golf course. (Exh.

E-3; Hew, Tr. 1/29/08, p. 27, ll. 17-23, p. 28, ll. 9-13, p. 153, ll. 11-20; Chumbley, Tr. 1/24/08, p. 140, ll. 19-25.) HC&S FOF 89.

275. Waiale Reservoir receives water from the Spreckels Ditch as follows:

276. Spreckels Ditch diverts Waihe'e Stream via a stream diversion that is located below the diversion that feeds the Waihe'e Ditch. At a point downstream of the diversion of Waihe'e Stream into Spreckels Ditch, WWC drops an amount of water from the Waihe`e Ditch determined by WWC to be necessary to service kuleanas in Waihe'e Valley into the Spreckels Ditch from which it can be directed into the ditch servicing the kuleanas. (**See** FOF 269, *supra*.)

277. From approximately 1924 until Brewer stopped cultivating sugar in 1988, the Waihe'e Stream water collected in the Spreckels Ditch, after satisfying kuleana users, was shared by agreement between Brewer and HC&S, 1/2 to Brewer and 1/2 to HC&S down to South Waiehu Stream. From at least the mid-1980's, this was administered by Brewer closing its intakes off of the ditch that fed its reservoirs and fields below the Spreckels Ditch from 7:00 p.m. to 7:00 a.m. daily. However, after 1988, the water previously taken by WWC and not delivered to kuleana or other users has flowed down into the Waiale Reservoir for use by HC&S. (Hew, WDT 1/29/08, ¶ 11B.) HC&S FOF 88B.

278. HC&S, at the Spreckels Ditch, diverts South Waiehu Stream via a stream diversion and short ditch that transports the diverted water into the Spreckels Ditch. (Hew, WDT 1/29/08, ¶ 11C; Hew, Tr. 1/28/08, p. 32, l. 8 to p. 33, l. 9.) HC&S FOF 88C.

279. Downstream in the Spreckels Ditch from the South Waiehu intake, approximately 0.1 mgd of ground water from a water development tunnel (HC&S's 'Īao Tunnel) is also deposited into the Spreckels Ditch via an underground network of pipes and tunnels. (Hew, WDT 1/29/08, ¶ 11D.) HC&S FOF 88D.

280. Further downstream in the Spreckels Ditch, HC&S diverts 'Īao Stream water into the Spreckels Ditch. (Hew, WDT 1/29/08, ¶ 11E.) HC&S FOF 88E.

281. HC&S measures the aggregate water flow in the Spreckels Ditch at its Wailuku gauging station, located downstream of the South Waiehu diversion, the intake pipe from the HC&S 'Īao Tunnel, and the 'Īao Stream intake, none of which is separately gauged (but for which HC&S has provided estimates –**See** FOF 187-190, *supra*). The gauged amount, therefore, includes water diverted by WWC from Waihe'e Stream (and separately reported by WWC to CWRM) as well

as water diverted by HC&S from South Waiehu Stream, the HC&S ʻIao Tunnel and ʻIao Stream. (Hew, WDT 1/29/08, ¶ 11F.) HC&S FOF 88F.

282. From March 2006, HC&S began receiving monthly reports from WWC indicating the amount of water sent past the Hopoi chute. (Hew, Tr. 1/29/08, p. 27, ll. 14 to p. 28, l 2.) HC&S FOF 89.

283. For HC&S's Waihe`e-Hopoi Fields, the average amount of water delivered to the Waiale Reservoir between 1993 and July 2007, as calculated by combining the flows measured at the Wailuku gauging station at the Spreckels Ditch and the Hopoi gauging station at the Waiheʻe Ditch, was approximately 39 mgd. (Hew, WDT 1/29/08, ¶ 12.) HC&S FOF 93.

284. The average water delivery from the Spreckels Ditch to Waiale Reservoir during this period was approximately 18.39 mgd, with the remainder of approximately 20.61 mgd delivered from Waihe`e Ditch through the Hopoi Chute. (Exh. E-4; Hew, Tr. 1/29/08, p. 37, ll. 16-23.) HC&S FOF 90.

285. To illustrate the year-to-year variability, water delivered to the Waiale Reservoir for 2005 and 2006 were: 1) for 2005, 40.11 mgd—23.43 mgd from the Spreckels Ditch and 16.68 mgd from the Waihe`e Ditch; and 2) for 2006, 31.04 mgd—16.72 mgd from the Spreckels Ditch and 14.32 mgd from the Waihe`e Ditch. (Exh. E-3, Exh. E-4, Exh, A-138.) WWC FOF 261.

286. For HC&S's `Iao-Waikapū Fields ("Leased Fields"), WWC reported providing 9.98 mgd during 2005 and 10.88 mgd during 2006. (Exh. E-3; Exh. E-4.)

287. WWC states that the water delivered to HC&S's `Īao-Waikapū Fields is metered or otherwise measured. (Hew, WDT 1/29/08, p. 7.) WWC FOF 259.

288. However, HC&S states that the reports of water deliveries to HC&S submitted by WWC to the Commission are not based on meter readings. Instead, WWC calculates the number of gallons delivered to users other than HC&S, and then attributes the balance to HC&S. As a result, water that was not actually delivered to HC&S could be counted as delivered to HC&S. (Chumbley, Tr., 1/24/08, p. 136, l. 14 to p. 138, l. 23; Exh. A-140, p. 47.) HC&S FOF 91.

289. The `Īao-Waikapū Fields are irrigated with water from WWC's Reservoir 6, which can receive water from ʻĪao-Waikapū Ditch via the Waiheʻe Ditch, the Waiheʻe Ditch below the Hopoi chute, and the South Waikapū Ditch. Water to irrigate the ʻĪao-Waikapū Fields comes principally from ʻĪao Stream via the ʻĪao-Waikapū Ditch and Waikapū Stream via the South Waikapū Ditch and Waiheʻe Ditch, all of which are operated by WWC. If necessary, water in the

Waihe'e Ditch can be kept in the ditch past the Hopoi chute to supplement the flow from the 'Īao-Waikapū Ditch. Field 735, however, because of its elevation, can only be irrigated with water from the South Waikapū Ditch. (**See** FOF 266, *supra*.)

5. **Summary of Uses**

290. Table 7 summarizes water deliveries for 2005 and 2006: totaling 60.65 mgd in 2005 and 53.97 mgd in 2006. These totals include: 1) waters diverted by HC&S from South Waiehu and `Īao Streams into the Spreckels Ditch, because HC&S measures the aggregate water flow in the Spreckels Ditch at its Wailuku gauging station, located downstream of the South Waiehu diversion, the intake pipe from the HC&S 'Īao Tunnel (which contributes an estimated 0.1 mgd), and the 'Īao Stream intake, none of which is separately gauged; and 2) waters from MDWS's `Īao Tunnel (1.59 mgd in 2005 and 1.76 mgd in 2006) and waters not diverted by MDWS to its Water Treatment Facility, which enter the `Īao Ditch at its division into the `Īao-Maniania and `Īao-Waikapū Ditches, which WWC estimates at 0.25-0.35 mgd (**See** FOF 153, *supra*). If we subtract these ground water sources from total use, total use of waters diverted from the four streams would be 58.66 mgd in 2005 and 51.81 mgd in 2006. Adding WWC's estimate of system losses at 7.34 percent, results in 62.97 mgd in 2005 and 55.61 mgd in 2006.

291. Table 8 summarizes the amounts of water diverted from the four streams in the same periods. Estimates were that 56.50 mgd were diverted by WWC in 2005 and 48.94 mgd in 2006, compared to 62.97 mgd in 2005 and 55.61 mgd in 2006 of deliveries, including losses. There is some double-counting of deliveries, because the Hopoi Chute is approximately 100 yards downstream of the gauging station, and the amount reported as delivered to Waiale Reservoir includes water flowing past the Hopoi Chute in the Waihe`e Ditch if there are irrigation needs further down the ditch, such as filling Reservoirs 90, 92, 97, or 9 and used to irrigate HC&S' leased 'Īao-Waikapū fields. FOF 272, 274, *supra*. Most of the difference, however, is from HC&S's diversions on South Waiehu and `Īao Streams, which are included in Table 7's deliveries to Waiale Reservoir. As described in the previous FOF, HC&S measures the aggregate water flow in the Spreckels Ditch at its Wailuku gauging station, located downstream of the South Waiehu diversion, the intake pipe from the HC&S 'Īao Tunnel, and the 'Īao Stream intake, none of which is separately gauged. The gauged amount, therefore, includes water diverted by WWC from Waihe'e Stream and separately reported by WWC to CWRM, as well as water

diverted by HC&S from South Waiehu Stream, the HC&S 'Iao Tunnel and 'Iao Stream. FOF 281, *supra*.

292. Based on the numbers in Table 8 and including both WWC's and HC&S's diversions, each of the four streams contributed the following percentages of diverted water: 1) Waihe`e River: 58 percent in 2005 and 53 percent in 2006; 2) Waiehu Stream: seven percent in 2005 and eight percent in 2006; 3) `Īao Stream: 28 percent in 2005 and 31 percent in 2006; and 4) Waikapū Stream: seven percent in 2005 and eight percent in 2006.

H. Future Uses

1. Kuleana Lands and Wetlands Restoration

293. About 6.84 mgd is currently delivered to kuleana lands. (Table 7.)

294. Nearly 50 persons testified at the CCH, including many identified in Tables 3-6 and others who wished to receive Na Wai `Ehā waters. Approximately 135 acres were involved, of which about 45 acres were or were intended to be cultivated, primarily in wetland kalo but also for vegetables, trees, and plants for subsistence and cultural purposes. (**See** Hui/MTF FOF D-1 to D-458).

295. In contrast, HC&S identified 39 individuals or organizations that testified at the CCH, seeking water for approximately 59.3 acres, of which approximately 51.8 acres would consist of lo`i kalo. (**See** HC&S FOF 162B,172F, 174I, and 176G.)

296. Persons who were receiving water testified that the amounts currently delivered were insufficient, and nearly all also wished to increase their land under cultivation. Most of those not receiving water intended to resume or start cultivation of a portion of their lands. (**See** Hui/MTF FOF D-1 to D-458.)

297. Reppun, Hui/MTF's expert witness, stated that "(w)etland kalo requires cool water flowing over its roots to ensure the health and productivity of the crop. Irrigation, therefore, needs to provide more water than just what is consumed in the lo`i through evaporation from open water, transpiration through the kalo leaves, and percolation through the lo`i bottom and sides." (Exh. A-12, p. 2.) Hui/MTF FOF D-463.

298. Reppun concluded that an average wetland taro complex requires between 100,000 to 300,000 gallons per acre per day (gad) of water to maintain water temperatures at or below 77°F

(27°C) and therefore prevent crop failure due to rot and pests. (Reppun, WDT 9/14/07, ¶¶ 4-5; Reppun, Tr. 12/3/07, p. 114, ll. 21-25; Exh. A-176, pp. 16-17. Hui/MTF FOF D-468.

299. Kalo farmers don't consume water in the same way that offstream water users do. Instead kalo farmers borrow water from the river then return that water so it can serve other functions. (Reppun, Tr. 12/3/07, p. 135, ll. 5-10.) Hui/MTF FOF D-465.

300. Reppun also claims that the Watson study's conclusion that 15,000 to 40,000 gad was a sufficient gross application amount to allow for sufficient outflow to assure good circulation actually represented the amount of water consumed by the lo`i kalo and not the amount necessary for throughflow. (Reppun, Tr. 12/3/07, p. 145, l. 19 to p. 146, l. 23; p. 147, l. 13 top. 148, l. 7.) **<u>See also</u>** Exh. A-176, p. 30 (interpreting Watson's 15,000 to 40,000 gad as the consumption amount.) Hui/MTF FOF D-474.

301. In addition to the mostly small parcels of land that comprised the approximately 135 acres, North Shore at Waiehu, with 64 acres of land along the shore near Waiehu and `Īao Streams, requested stream flow restoration so that springs would revive and help restore the wetlands that previously comprised about one-third of the property. (**<u>See</u>** FOF 237, *supra.*) No estimates were provided for the amounts required, and such restoration would not require a noninstream water use permit, as revival of the springs might result from enhanced stream flow at the mouths of Waiehu and `Īao Streams.

302. Maui Coastal Land Trust ("MCLT") owns the 277-acre Waihe`e Coastal Dunes and Wetlands Refuge along the coast and along the mouth and southern edge of Waihe`e River, at the base of Waihe`e Valley and extending across about 75 percent of the coastal portion of the ahupua`a of Waihe`e. (Fisher, WDT 9/14/07, ¶ 3.) Hui/MTF FOF C-123.

303. MCLT seeks to restore stream flows to Waihe`e River to support: 1) 27 acres of what it described as palustrine (marsh) wetlands habitat (known as the Kapoho or Waihe`e Wetlands) and associated cultural resources including the loko kalo i`a (Hawaiian dual fishpond and taro field) located in the wetlands; and 2) ten acres of riparian and estuarine wetlands habitat along Waihe`e River, and associated cultural resources including over 20 ancient lo`i totaling about 1.7 acres. (Fisher, WDT 9/14/07, ¶¶ 4-8, 19, 22-23.) Hui/MTF FOF C-124, C-125.

304. Schwarm, MCLT's expert witness, recommended providing a flow of 1.5 mgd to 2.5 mgd from Waihe`e River, estimated at less than 25 percent of the likely historical `auwai flow. (Fisher, WDT 9/14/07, ¶ 20; Exh. A-43, pp. 1, 4-5.) This amount includes 0.75 mgd to 1.00 mgd

to raise the water levels by 18 inches to create standing habitat and 0.75 mgd to 1.50 mgd to restore the ancient fishpond. (Exh. A-43, p. 1.) Hui/MTF FOF C-140.

2. **MDWS**

305. MDWS plans to increase the current capacity of the `Īao Water Treatment Facility from 3.2 mgd to 4.0 mgd. The increase in capacity will require an additional 0.8 mgd delivery from the `Īao Stream. (Chumbley WDT, p. 9; Exh. D-93.) WWC FOF 273-274.

306. MDWS, in conjunction with A&B, parent company of HC&S, plans to construct a surface water treatment plant requiring up to 9 mgd from Waihe`e and `Īao Streams. (Eng, Dec. 9/14/07, pp. 8-9; Eng, Tr. 12/13/07, pp. 123-125, 154-161, and 206-211; Eng, Tr. 12/14/07, pp. 6-7, 9-11; Volner, Tr. 1/30/08, pp. 175-178.) WWC FOF 275. Details of the plant operations, including delivery charges for A&B and allocation of water source credits, have not been agreed upon. (Kuriyama, Tr. 2/22/08, pp. 18-21.) WWC FOF 277.

3. **WWC Delivery Agreements**

307. The maximum delivery agreements that WWC has with 34 entities total 8.288 mgd, and the total amounts of water used under these agreements were 1.42 mgd in 2005 and 2.37 mgd in 2006. (**See** FOF 257-258, *supra.*)

308. Three end users that have delivery agreements with WWC indicated a desire for additional water in the future to be used for agricultural, domestic and industrial purposes (Irani, Dec. 9/17/07, pp. 3-4; Franco, Tr1/14/08, pp. 174-176, 206, and 208; Betsill, Tr. 1/25/08, pp. 120-121) WWC FOF 280, but the amount of additional water desired by the existing delivery agreement end users is unknown. (Exh. D-96.) WWC FOF 281.

309. Three persons who are not presently end users indicated a desire to enter into water delivery agreements and receive waters from Nā Wai `Ehā streams. (Schwarm, Tr. 1/24/08, pp. 180 and 183-185;Hamamoto, Tr. 1/25/08, p. 32; Hamamoto, WDT 10/29/07, p. 3; Atherton, WDT 9/17/07, p. 3) WWC FOF 282, and the total amount of water requested was approximately 4 mgd. (Schwarm, Tr. 1/24/08, pp. 180 and 183-185); Hamamoto, Tr. 1/25/08, p. 32; Hamamoto, WDT 10/29/07, p. 3; Atherton, WDT 9/17/07, p. 3.) WWC FOF 283.

4. **HC&S**

310. HC&S plans to add, or has added, a portion of Field 767 to its lease with the Atherton Hui of the `Īao-Waikapū Fields. (Volner, Tr. 1/30/08, p. 207, ll. 5-18; p, 213, ll. 8-16.) Of the 129 or 130 acres in Field 767, just over 40 acres will be added to the existing lease; 89 acres "will not be guaranteed any specific land lease term as development plans in this area are in progress." (Exh. A-212, p. 3; Chumbley, Tr. 3/3/08, p. 97, ll. 18-22; p. 100, ll. 2 to p. 101, l. 14.) Hui/MTF FOF F-122, F-123.

311. HC&S felt it would be prudent to cultivate Field 767 because it is not cultivating Field 920. (Volner, Tr. 1/30/08, p. 213, l. 23 to p. 214, l. 3; Holady, Tr. 1/31/08, p. 108, l. 23 to p. 109, l. 4.) Hui/MTF FOF F-124.

312. HC&S expects that water will be available from WWC on the same flat rate per acre per year terms as with the other leased fields, for use on Field 767, and WWC confirmed that that is the verbal understanding between WWC and HC&S. (Exh. A-212, p. 3; Chumbley, Tr. 3/3/08, p. 102, ll. 2-6.) Hui/MTF FOF F-125.

313. Sometime between 1995 and 1997, HC&S entered into an agreement with Maui Land and Pine ("MLP") under which HC&S's Fields 921 and 922, 300 acres which were "pasture land" with "[q]uite a bit of kiawe trees," would be cleared and planted in seed cane and watered by wastewater from MLP's cannery in Kahului. (Volner, Tr. 1/30/08, p. 161, l. 23 to p. 162, l. 16; Volner, Tr. 1/30/08, p. 27, ll. 21 to p. 28, l. 4.) Hui/MTF FOF F-126.

314. Fields 921 and 922, like neighboring Field 920, are sandy "scrub land"; Ms. Nakahata explained that "for years HC&S had not farmed those fields because we thought it was sandy." (Santiago, Tr. 2/22/08, p. 130, ll. 7-19; Nakahata, Tr. 2/20/08, p. 25, ll. 18-23.) Mr. Volner was not aware of any plans to cultivate that area prior to the agreement with MLP. (Volner, Tr. 1/30/08, p. 137, l. 16 to p. 138, l. 1.) Hui/MTF FOF F-127.

315. MLP built a pipeline to deliver wastewater several miles from its Kahului cannery to the vicinity of Fields 921 and 922. (Volner, Tr. 1/30/08, p. 29, l. 16 to p. 30, l. 21; Exh. C-77.) Deliveries of MLP wastewater averaged between 1.5 to 2.4 mgd in the years 2000 through 2005, and dropped to an average of 0.78 mgd in 2006. (Exh. A-200; Exh. C-82, p. 3.) Hui/MTF FOF F-128, F-129.

316. The volume of wastewater delivered by MLP was sufficient from 2004 through 2007 (Volner, Tr. 1/30/08, p. 139, ll. 18-23), but HC&S is "under the assumption" that the volume will

decrease although it has not "seen the numbers to validate that yet" and could not say whether there would be a decrease in volume or how much that decrease would be. (Volner, Tr. 1/30/08, p. 138, ll. 14-25). Hui/MTF FOF F-130.

317. HC&S anticipates that if the volume of wastewater from MLP decreases to where it is no longer sufficient, it would look to use Nā Wai `Ehā water on Fields 921 and 922. (Volner, Tr. 1/29/08, p. 138, l. 24 to p. 139, l. 2.) Hui/MTF FOF F-131.

I. Reasonable Uses, Losses, and Alternative Sources

1. Kuleana Lands and Wetlands Restoration

a. Kuleana Lands

318. Several people residing on kuleana lands testified that they used "kuleana" ditch/pipe or stream waters for domestic uses (e.g., Brito, WDT 10/26/07, ¶¶ 7-8; Hui/MTF FOF D-241; Kamaunu, WDT 10/26/07, ¶¶ 2, 5-7; Kamaunu, Tr. 12/13/07, p. 45, ll. 4-17; Hui/MTF FOF D-102).

319. MDWS's "average typical residential customer" uses 400 to 600 gallons per day ("gpd") of combined indoor and outdoor use and 1,500 to 2,000 gpd for customers irrigating "lush tropical landscape treatment" in the island's most arid areas (e.g., Maui Meadows or Kihei). (Eng, Tr. 12/13/07, p. 191, l. 7 to p. 192, l. 5; Eng, Tr. 12/14/07, p. 4, ll. 9-22.) Hui/MTF FOF E-75.

320. As described earlier, Reppun, Hui/MTF's expert witness, concluded that an average wetland taro complex requires between 100,000 to 300,000 gad to maintain water temperatures at or below 77°F (27°C) and therefore prevent crop failure due to rot and pests. (**See** FOF 298, *supra.*)

321. Reppun also claimed that the Watson study's conclusion that 15,000 to 40,000 gad was a sufficient gross application amount to allow for sufficient outflow to assure good circulation actually represented the amount of water consumed by the lo`i kalo and not the amount necessary for throughflow. (**See** FOF 300, *supra.*)

322. Reppun further claimed that a study by de La Pena measured only the total amount of water flowing into the lo`i and that therefore de La Pena's 30,000 gad kalo water duty likely also represented net consumption. (Reppun, Tr. 12/3/07, p. 143, ll. 19-20.) Hui/MTF FOF D-475.

323. Finally, Reppun also cited a USGS report on Water Use in Wetland Kalo Cultivation in Hawai`i, which provided "baseline information on wetland kalo irrigation practices for a variety of geographical settings in the Hawaiian Islands." (Exh. A-12, pp. 2-3.) Hui/MTF FOF D-476.

324. USGS reported that "(t)he water need for kalo varies depending on the crop stage. To ensure that flow and temperature data collected at different lo`i reflected similar irrigation conditions (continuous flooding of a mature crop), only lo`i with crops near the harvesting stage were selected for data collection. Data were collected during the dry season (June-October), when water requirements for cooling kalo approach upper limits. Flow measurements generally were made during the warmest part of the day and temperature measurements were made every 15 minutes at each site for about a two-month period." (Oki, WDT 9/14/07, ¶¶ 70-71.)

325. "The average (mean) inflow for all lo`i complexes was 260,000 gad and the median inflow was 150,000 gad. At the individual lo`i level, inflow averaged 350,000 for all sites. In Waihe`e, lo`i complex inflows ranged from 110,000 to 160,000 gad. The measured inflows for Waihe`e lo`i complexes were less than the average inflow for the Island of Maui (230,000 gad) and the average inflow for all sites in the State (260,000 gad), although the median value for the State (150,000 gad) was within the range of measured inflows for the Waihe`e lo`i complexes." (Oki, WDT 9/14/07, ¶¶ 75-76.)

326. "Of the 17 lo`i complexes where water inflow temperature was measured, only 3 lo`i complexes had inflow temperature values greater than 27°C for more than 0.05 percent of the time. A water temperature of 27°C is considered the threshold temperature above which wetland kalo is more susceptible to fungi and associated rotting diseases (Gingerich and others, 2007). In the Waihe`e Maui upper lo`i complex, inflow temperature did not exceed 27°C during the study period, and the mean inflow temperature was 21.6°C. In the Waihe`e Maui lower lo`i complex, inflow temperature exceeded 27°C about 25 percent of the time which is more frequent than for any other lo`i complex studied. In addition, the lower Waihe`e lo`i complex recorded the warmest mean inflow temperature (24.9°C) and the most variable inflow temperature value (7.6°C mean daily range) of all the lo`i complexes where temperature was measured in this study." (Oki, WDT 9/14/07, ¶ 77.)

327. "During field visits, the USGS also interviewed farmers about their irrigation practices and about their perceptions of their water supply. In general, most farmers believed that their

supply of irrigation water was insufficient for proper kalo cultivation. (Gingerich and others, 2007.)" (Oki, WDT 9/14/07, ¶ 78.)

328. From these findings and Reppun's observation that the outflow water temperature often exceeded the threshold for root fungus (27°C), he concluded that 300,000 gad must be consistently available to satisfy current demand for water to grow healthy kalo. (Reppun, WDT 9/14/07, ¶ 13; Reppun, Tr. 12/3/07, p. 131, ll. 1-6.) Hui/MTF FOF D-484.

329. However, the USGS study was intentionally designed for continuous flooding of a mature crop during the dry season (June-October), when water requirements for cooling kalo approach upper limits, and covered only a two-month period at the end of the kalo crop cycle, when plants were near the harvesting stage. (**See** FOF 324, *supra.*) Yet, Reppun extrapolated these maximum requirements for water inflow into kalo lo`i to conclude that 300,000 gad was the daily requirement for the entire growing cycle.

330. In de La Pena's study, the crop cycle was 14 months. (Exh. A-174, p. 99.) Watson and Grance assumed that "as a general average throughout Hawaii no water is required to enter patches approximately 40 to 50 per cent of the time, either because of cultural practices including planned resting or fallowing of patches." (Exh. A-171, App. A.)

331. The number of future "kuleana" users beyond those identified at the CCH is unknown.

332. Taking the approximately 45 acres mostly in or intending to be cultivated in wetland kalo by those testifying at the CCH (**See** FOF 294, *supra*) and dividing the 6.84 mgd currently delivered to "kuleana" lands (**See** Table 7), current average inflow would be 152,000 gad. These 45 acres include parcels not currently served (**See** FOF 294, *supra*), so the per acre water delivery would be higher for those currently receiving water. This would be the average amount of water delivered daily.

333. If HC&S's estimate of 51.8 acres (**See** FOF 295, *supra*) in or intending to be cultivated in wetland kalo were used instead of 45 acres, the 6.84 mgd would average 132,000 gad. As in the 45-acre estimate, the per acre water delivery would be higher for those currently served.

334. During the dry season (June-October) when water requirements for cooling kalo approach upper limits, the average inflow for all lo`i complexes in the USGS study was 260,000 gad, and the average inflow for the Waihe`e lo`i complexes ranged from 110,000 to 160,000 gad. While the water temperature of these inflow rates were below the threshold temperature of 27°C for susceptibility to rotting diseases in 95 percent of the lo`i complexes in the USGS study, in

general, most of the kalo farmers still believed their supply of irrigation water was insufficient for proper kalo cultivation. (**See** FOF 327, *supra*).

335. WWC kuleana users who testified at the CCH also complained of inadequate water (**See** FOF 296, *supra*), even at the current estimated daily inflow rate of more than 150,000 gad, an average daily rate over the entire crop cycle that includes periods when water requirements for cooling kalo approach upper limits of at least twice the average.

336. However, USGS's Nā Wai `Ehā study observed numerous return flows and leakages from the ditches into all four streams (Oki, WDT 9/14/07, ¶¶ 38, 40-42), so substantial losses through the ditches are likely occurring.

337. A substantial amount of water is needed for inflow above what is consumed by the lo`i themselves for proper kalo cultivation. This large amount of inflow and outflow would result in substantial losses, unless as much of the outflow as practical is channeled back into the streams.

338. Cox noted that in addition to the net loss in the irrigation of the lo`i (i.e., consumption), "a considerably greater amount would have to be diverted in order to successfully grow taro with proper circulation of water. This excess water in the upper areas would be returned to the stream and be subject to rediversion lower down…That used on the areas adjacent to the estuary and below the lowest diversion ditch could not be rediverted and would be an increase in necessary water consumption." (Exh. A-172, Letter of Submittal, p. 2.)

339. Moreover, Reppun identified lo`i water consumption as consisting of evaporation from open water, transpiration through the kalo leaves, and percolation through the lo`i bottom and sides (**See** FOF 297, *supra*). Watson also observed numerous leakages in the sides of the lo`i in his study. Exh. A-171, Memorandum of June 24, 1964. Thus, most of the water "consumption" by kalo lo`i is most likely through leakage, and minimally through evaporation and transpiration.

b. <u>Maui Coastal Land Trust ("MCLT")</u>

340. MCLT seeks water to restore 27 acres of what it describes as "prime palustrine" Kapoho wetlands and associated cultural resources, including a seven-acre loko kalo i'a fishpond-taro field system to create a more consistent standing wetland habitat for native plants and animals, including endangered bird species. (Fisher, WDT 9/14/07, ¶¶ 4-8, 19 Fisher, Tr. 12/04/07, p. 57, ll. 2-11.) MCLT seeks to restore freshwater to the Kapoho wetlands habitat and loko kalo i'a by

restoring application of stream flow from Waiheʻe River. (Fisher, WDT 9/14/07, ¶ 6, 19.) HC&S FOF 165. Hui/MTF FOF C-124, C-136, C-138.

341. Various kuleana parcels are located around the outer portion of the wetlands, and the documentation at the time of the Māhele described "kalo," "lo`i," "pond," and "fishponds," confirming that water flowed to the Kapoho Wetlands at the time of the Māhele. (Fisher, WDT 9/14/07, ¶¶ 9, 11; Exh. A-40, p. 23; Exh. A-42.) In acquiring the Refuge lands, MCLT received three of these parcels totaling 2.17 acres via quitclaim deed with "all the rights, easements, privileges and appurtenances thereto belonging or appertaining." (Fisher, WDT 9/14/07, ¶ 11; Exh. A-41, pp. 0012, 0014.) Hui/MTF FOF C-137.

342. MCLT also seeks more water flowing to the mouth of Waiheʻe River to increase ground water seepage into the wetland habitat to support ten acres of riparian and estuarine wetlands habitat along Waihe`e River, and associated cultural resources including over 20 ancient lo`i totaling about 1.7 acres. (Fisher, WDT 9/14/07, ¶¶ 6, 22-23; Fisher, Tr. 12/04/07, p. 55, ll. 15-16; p. 62, l. 22 to p. 63, l. 6; p. 63, ll. 22-24.) Hui/MTF FOF C-125. HC&S FOF 165.

343. Schwarm, who was qualified as an expert civil engineer (Tr. 12/4/07, p. 132, ll. 14-17), prepared a Preliminary Water Budget Evaluation for MCLT. (Fisher WDT 9/14/07, ¶ 20; Exh. A-43; Schwarm, Tr. 12/4/07, p. 133, ll. 10-17.) Schwarm explained that civil engineering includes hydrology as a "normal part of our work," and that the work he conducted for MCLT is normal civil engineering within the scope of his expertise. (Schwarm, Tr. 12/4/07, p. 132, ll. 10-13; p. 133, ll. 4-9.) Hui/MTF FOF C-139.

344. Schwarm acknowledged that his experience in development of ground water resources is very limited, and he does not consider himself an expert in the field of ground water resources. (Schwarm, Tr. 12/4/07, p. 153, ll. 10-12.) HC&S FOF 165.

345. To accomplish MCLT's ecological and cultural restoration goals, Schwarm recommended providing a flow of 1.5 mgd to 2.5 mgd from Waihe`e River, or less than 25 percent of the likely historical `auwai flow. (Fisher, WDT 9/14/07, ¶ 20; Exh. A-43, pp. 1, 4-5.) This amount includes 0.75 mgd to 1.00 mgd to raise the water table elevations between 12 and 18 inches, which Schwarm believes is sufficient to provide the consistent water necessary for restoring habitat within the Kapoho wetland (Exhibit A-43 at 1), and running 0.75 mgd to 1.50 mgd of fresh water through the fishpond, which should be sufficient to restore favorable

aquaculture conditions within the ancient fishpond limits. (Exh. A-43, p. 1.) Hui/MTF FOF C-140. HC&S FOF 165.

346. Schwarm conducted these calculations as a best estimate, based on available data on topography, soil types, and reported current water levels, and subject to revision once flow is restored. (Schwarm, WDT 11/16/07, ¶¶ 9, 2; Tr. 12/4/07, p. 176, ll. 15-18; p. 132, ll. 2-9; p. 134, l. 11 to p. 136, l. 5; 134, ll. 11-18.) No one, including Nance, HC&S's consultant, provided any contrary calculations. Hui/MTF FOF C-141.

347. Schwarm also opined that restoration of flows of Waihe`e River, in themselves, would help to replenish the underlying aquifer and raise water levels in the wetlands. (Exh. A-43, pp. 5-6; Schwarm, Tr. 12/4/07, p. 168, ll. 6-11.) **See also** Exh. A-223, p. 6 (stating that the wetlands are "sustained mostly by the Waihee Stream"). Hui/MTF FOF C-142.

348. Schwarm's recommendation that the water table be elevated up to 18 inches was based solely on his professional judgment that the target habitat restoration goals were analogous to a rise in water levels of 18 inches. That conclusion was in turn premised on the working assumption, based on reports from others, that water levels were typically 18 inches below grade in the area where MCLT intended to restore wetland habitat during non-drought conditions. (Schwarm, Tr. 12/4/07, p. 147, l. 10 to p. 148, l. 19, p. 157, ll. 6-9.) However, there is no reliable way of measuring whether the target water levels are reached, given variations in (a) the elevation levels across the wetlands and (b) the stratified permeability of the substrate of the wetlands, which is not known. (Schwarm, Tr. 12/04/07, p. 158, l. 13 to p. 159, l. 9; Nance, Dec. 10/26/07, ¶ 11.) HC&S FOF 166.

349. Schwarm's water budget also assumed that ground water levels remain constant over time. He acknowledged that ground water levels vary with rainfall and tide, but his calculations assumed that that tide levels remain constant. (Schwarm, Tr. 12/4/07, p. 159, l. 10 to p. 160, l. 11.) HC&S FOF 166.

350. The flow levels recommended in Schwarm's water budget were not based on scientific knowledge of the water requirements of the bird species within the Kapoho wetlands. (Schwarm, Tr. 12/4/07, p. 157, ll. 6-9.) No evidence of the specific water requirements for the species was presented. Although one of the recovery actions listed in the Draft Revised Recovery Plan for Hawaiian Waterbirds prepared by the U.S. Fish & Wildlife Service is "secure water sources and manage water levels to maximize nesting success, brood survival, food availability, and

recruitment of waterbirds," the recovery plan does not specify the amount of water that should be secured at the Kapoho wetlands. (Duvall, Tr. 12/4/07, p. 12, ll. 7-24; Exh. A-38C, pp. 80, 136.) Duvall, a wildlife biologist with the Department of Land and Natural Resources, Division of Forestry and Wildlife in Maui District, was unable to identify the quantity of water needed to support recovery of endangered waterbirds in the Kapoho wetlands. (Duvall, Tr. 12/4/07, p. 107, ll. 17-22, p. 114, l. 25 to p. 115, l. 4.) Duvall recommended restoration of the water level in the wetlands to the extent he observed in 1990, but he could not quantify what that amount was. (Duvall, Tr. 12/4/07, p. 115, ll. 19-24, p. 116, ll. 11-13.) He further acknowledged that the water requirement differs for each species. (Duvall, Tr. 12/4/07, p. 115, ll. 15-18.) HC&S FOF 167.

351. Nance, a civil engineer and hydrologist testifying on behalf of HC&S, disputed MCLT's characterization of the Kapoho wetlands as "palustrine," which he characterizes as a nontidal wetland where the salinity level due to ocean-derived salts is below 0.5 parts per thousand ("ppt"). Palustrine wetlands are typically inland. (Nance, Tr. 12/11/07, p. 151, ll. 11-16, p. 170, ll. 10-13.) Nance's opinion was that the Kapoho wetlands are not palustrine, because they are situated in a near-shore environment, are tidally influenced, and their salinity level has been measured at between 1.68 ppt to 2.25 ppt, well above the threshold for classification as a palustrine wetland. (Nance, Tr. 12/11/07, p. 152, l. 10 to 153, l. 5; Exh. A-162.) HC&S FOF 168.

352. Nance also described the basal ground water body underlying the wetlands as located in the volcanic formation at depth, not in the sedimentary sand and alluvium in which the wetland is located. This generally less permeable sedimentary caprock overlies the volcanics. At least in part, ground water in this overlying formation may have originated as upward leakage from the basal aquifer in the volcanics at depth, but it is otherwise hydrologically a distinct ground water body that is generally more saline and limited in aerial extent. Under completely natural conditions, the wetland would be an exposure of the brackish to saline ground water in the sedimentary formation. Thus, the Kapoho wetlands cannot be characterized as "palustrine." (Nance, Dec. 10/27/07, ¶ 8.) HC&S FOF 168.

353. Nance opined that to the extent that artificially raising the water level in the wetland to create bird habitat is MCLT's objective, a reasonable alternative to a diversion from the Waihe'e River would be to drill a well into the underlying basal aquifer in the volcanics. If the basal head is not adequate for gravity delivery, only low head pumping at quite modest expense would be required. As an example, Well 5327-10 with low head pumping of basal ground water has been

the source of supply for the Kanaha Pond for decades. (Nance, Dec. 10/27/07, p. ¶ 12.) HC&S FOF 170.

354. Duvall, who has managed Kanahā Pond since 1996 (Duvall, Tr. 12/04/07, p. 102, ll. 12-13), maintained that pumping merely attempts to maintain water levels for the short term, but in and of itself has not allowed Kanahā Pond over the long term to maintain water in areas that used to be wet. (Id. p. 124, ll. 10-20; p. 111, ll. 15-24.)

355. Schwarm and Duvall were of the opinion that attempting to maintain water levels by circulating ground water to the surface where it evaporates simply places further demands on an already diminished ground water source. (Schwarm WDT 11/16/07, ¶ 10; Duvall, Tr. 12/04/07, p. 110, ll. 15-24.) Duvall and Schwarm also stated that pumping ground water to raise wetlands water levels is analogous to the operation of a table-top fountain, and equivalent to "chas[ing] your tail." (Duvall, Tr. 12/04/07, p. 123, ll. 18-21; p. 110, ll. 18-20; Scharm, Tr. 12/04/07, p. 177, ll. 12.) They were of the opinion that it is "terribly inefficient," "not sustainable," and "does not provide a good long-term solution." (Scharm, Tr. 12/04/07, p. 177, ll. 1-13; Fisher, Tr. 12/04/07, p. 69, ll. 5-11; Duvall, Tr. 12/04/07, p. 112, ll. 10-13.) Hui/MTF FOF C-147.

356. Both Schwarm (a civil engineer without expertise in the field of ground water resources) and especially Duvall (a biologist), were not qualified to testify as expert witnesses on ground water resources, and had no expertise to conclude that pumping basal ground water to raise wetlands water levels was analogous to a table-top fountain, in which they presumably assumed that the wetlands water would then leak back through the caprock into the underlying volcanic basal aquifer. Nance, an expert in hydrology and ground water, had stated that ground water in the overlying formation may have originated as upward leakage from the basal aquifer in the volcanics at depth, but it is otherwise hydrologically a distinct ground water body that is generally more saline and limited in aerial extent.

357. Schwarm also concluded that ground water pumping poses a real risk of drawing salt water into the wetlands and causing irreparable harm. (Schwarm, Tr. 12/04/07, p. 177, l. 14 to p. 178, l. 4.), because the ground water near the coastline forms a convex lens that thins out closer to the shore, increasing the risk of a well drawing seawater. (Id. p. 182, ll. 7-15.) Hui/MTF FOF 148. However, in addition to Schwarm not being an expert in ground water resources, he did not explain why a well that might draw seawater would not quickly be capped if that event were to occur.

358. MCLT also seeks more water flowing to the mouth of Waihe'e River to increase ground water seepage into the Kapoho wetlands. (Fisher, WDT 9/14/07, ¶ 21.) The Kapoho Wetlands were historically sustained by both water percolating from underground, and stream water flowing from Waihe`e River via the `auwai. (Fisher, WDT 9/14/07, ¶¶ 7-8.) The ground water source has diminished, however, because of factors such as the development of the former wetlands on the opposite side of the dune, (Id. ¶ 13; Exh. A-43, p. 4.) Hui/MTF FOF C-144, an event that happened long after the flow at the mouth of Waihe`e River diminished to its present state.

359. Nance opined that there is no support for the assumption that seepage from Waihe`e River has a direct connection to ground water in the sedimentary caprock and water levels in the wetland. His view was that it is far more likely that there is a hydrologic disconnect between the ground water body and the wetlands, and that there would be no increase in the water level in the wetlands in response to increased seepage from Waihe`e River. Thus, elevating the water level of the wetlands would have to be accomplished by a direct delivery of water, either conveyed from Waihe'e River in a ditch or pipe or pumped in from a well. (Nance, Dec. 10/27/07, ¶ 10) The presence of the ancient 'auwai tends to support this view. HC&S FOF 169.

2. MDWS

360. On February 15, 2006, CWRM approved the Water Use Permit Applications for existing uses in the basal portion of the `Īao aquifer submitted by MDWS, totaling 11.227 mgd. (Minutes of the February 15, 2005 CWRM Meeting; **see also** Findings of Fact, Conclusions of Law, and Decision and Order "In the Matter of Water Use Permit Applications for the `Īao Ground Water Management Area Basal Source Contested Case Hearing" (CCH-MA05-1) issued January 31, 2007, p. 4, ¶ 2.) MDWS FOF 4.

361. In issuing Water Use Permits to MDWS for seven of its basal sources, CWRM was required to determine, and did determine, that MDWS's Water Use Permits met all statutory criteria under Hawaii Revised Statutes ("H.R.S.") § 174C-49. (Minutes of the February 15, 2005 CWRM Meeting; **see also** Findings of Fact, Conclusions of Law, and Decision and Order "In the Matter of Water Use Permit Applications for the `Īao Ground Water Management Area Basal Source Contested Case Hearing" (CCH-MA05-1) issued January 31, 2007, ¶¶ 33 – 50; "MDWS's water use permit [for Shaft 33] also meets all of the Code's requirements." (Id., ¶ 9.)

MDWS FOF 5.

362. CWRM's findings with respect to MDWS's basal sources and Shaft 33 (also known as the "Wailuku Shaft") also apply to MDWS's Water Use Permits at issue in this proceeding, because all of MDWS sources are part of its integrated Central Maui System. (Eng, Dec. 9/14/07, ¶¶ 7, 9, 13, 15.) MDWS FOF 6.

363. The County of Maui relies on water from its two high level sources, Kepaniwai Well and MDWS's `Īao Tunnel, to supply a total of 2.401 mgd to the people and businesses served by the County's Central Maui System. (Eng, Dec. 9/14/07, ¶ 6.) MDWS FOF 8.

364. The two applications filed by MDWS are for the same purposes as the water use permits granted to MDWS for Shaft 33 and seven other previously filed applications, and those were all found to be consistent with applicable plans, land use classifications, and land use policies. (Staff submittal for the CWRM meeting of Feb. 15, 2006, p. 7, and Findings of Fact, Conclusions of Law, and Decision and Order "In the Matter of Water Use Permit Applications for the `Īao Ground Water Management Area Basal Source Contested Case Hearing" (CCH-MA05-1) issued January 31, 2007, ¶ 46.) MDWS FOF 39.

365. OHA does not object to MDWS's Water Use Permit Applications for MDWS's Īao Tunnel and Kepaniwai Well. (Apoliona, WDT 12/3/07, p. 16, ll. 7 – 24.) MDWS FOF 34.

366. The 2.401 mgd sought by MDWS in its Water Use Permit Applications will not interfere with the rights of the Department of Hawaiian Home Lands ("DHHL"). MDWS's Central Maui system serves homes built by DHHL. (Eng, Dec. 9/14/07, ¶ 50.) MDWS FOF 40.

367. DHHL has not objected to MDWS's Water Use Permit Applications and has not requested party status in this contested case. (Eng, Dec. 9/14/07, ¶ 50.) MDWS FOF 41.

368. Through an agreement with WWC, MDWS receives up to 3.2 mgd of surface water from the `Īao-Waikapū Ditch. (<u>See</u> FOF 239, *supra*.)

369. MDWS also has had discussions with A&B concerning the potential for a surface water treatment plant to be located near the Waiale reservoir. While these discussions are still in a preliminary phase, MDWS hopes that by the end of 2009, it will be able to obtain up to 9.0 mgd of surface water treated in this plant to augment the municipal water supply for Central and South Maui in order to avoid over-pumping the `Īao Aquifer. (Eng, Suppl. Dec., ¶ 15.) MDWS FOF 50.

370. MDWS has considered drilling new wells in the Waihe`e and Kahakuloa aquifers, but

CWRM has asked MDWS to limit its withdrawals from the Waihe`e aquifer, and USGS has indicated that new wells there may not be as productive or cost-effective as hoped. (Eng, Dec. 9/14/07, ¶ 27.) MDWS FOF 34.

371. USGS has indicated that Waikapū aquifer may be a possible source of new water supply, but the current sustainable yield of that aquifer is 2 mgd (Exh. B-13), and MDWS expects competition from private landowners for the available water in this aquifer. (Eng, Dec. 9/14/07, ¶ 27.) MDWS FOF 46.

372. The ability of MDWS to utilize water sources from East Maui is restricted by a consent decree in the case of <u>Coalition to Protect East Maui Water Resources v. Board of Water Supply, County of Maui</u>, Civ. No. 03-1-0008(3), December 2003.

373. That consent decree requires that "(b)efore any new project is planned by the County of Maui to develop ground water in the agreed-upon portion of the East Maui Region, the County will vigorously investigate and pursue the availability of surface water from the Waikapū (60101), `Īao (60102) and/or Waihe`e (60103) hydrologic units for public use by preparing a report which shall include a rigorous analysis of the costs and benefits of making these water resources part of Maui's public water system." (Exh. B-10, ¶ 4.3.) MDWS FOF 47.

3. <u>WWC Water Delivery Agreements</u>

374. WWC estimated the amount of losses from its ditch system as a set percentage of 7.34 percent, based primarily on a 20-year old report, Exh. D-4A. (Suzuki, Tr. 12/14/07, p. 164, l. 11 to p. 165, l. 23.) Hui/MTF FOF E.35.

375. The great majority of WWC's ditches are open and unlined. (Suzuki, Tr. 12/14/07, p. 159, ll. 11-13; pp. 159-62.) All of WWC's reservoirs are unlined. (<u>Id.</u> p. 162, l. 25 to p. 164, l. 10; Santiago, Tr. 2/22/08, p. 135, ll. 13-15.) Hui/MTF FOF E-36.

376. WWC did not address the feasibility of minimizing the losses from its system except to state that it "may . . . in the future" have plans to line the unlined portions of their system. (Suzuki, Tr. 12/14/07, p. 268, ll. 21-25.) Hui/MTF FOF E-39.

377. WWC has water-delivery agreements with 34 entities in addition to its agreement with MDWS and HC&S. Its table of customers does not provide information on any acreages cultivated and does not identify the nature of the water uses, except to label them generally as

either "agriculture" or "irrigation." Under WWC's terminology, "irrigation" is "agriculture," but on a shorter-term basis and also includes dust control. (<u>**See**</u> FOF 241, *supra.*)

378. Only a few of the 34 entities provided information of their current and/or future uses.

379. Maui Cattle Company ("MCC") used water to irrigate its 240-acre pasture for cattle in Ma`alaea, starting around March 2006 and eventually using at its peak 0.99 mgd to 1 mgd. (Franco, Tr. 1/14/08, p. 174, ll. 22-24; p. 176, ll. 17-19.) Hui/MTF FOF E-40.

380. The irrigated area has shrunk from 240 acres to 25 acres (Franco, Tr. 1/14/08, p. 192, ll. 6-14), and the number of cattle has decreased from a high of 375 to only 60 animals (<u>id.</u> p. 176, l. 4; p. 186, ll. 8-11). Hui/MTF FOF E-48. 381.

381. According to WWC's records, MCC's water use has decreased to only 8.84 mg from January to October 2007, or about 29,000 gpd (1,160 gad). (Exh. C-70 (TMK No. 3-6-01:018).) MCC stated that this amount is "sufficient." (Franco, Tr. 1/14/08, p. 186, ll. 19-22.) Hui/MTF FOF E-49.

382. MCC has indicated no plans to continue even its reduced use. MCC's landowner seeks to develop the property. (Atherton, Dec. 9/14/07, ¶ 15.) <u>**See also**</u> Franco, Tr. 1/14/08, p. 184, ll. 2-18 (both lease and water license mutually terminable with 30-days notice). MCC stated that "if" it were to re-lease the property, it would simply "graze it on a seasonable basis and without major irrigation." (<u>Id.</u> p. 181, l. 23 to p. 182, l. 6.) Hui/MTF FOF E-50.

383. Michael Atherton, along with various partners, own several entities that have acquired former Wailuku plantation lands, including Ma`alaea Properties, Waikapū Properties, and Maui Tropical Plantation (collectively, "Atherton et al."). Mr. Atherton's partners provide equity and are "mainly in the development business," and Mr. Atherton is also in the real estate development business. (Atherton, Tr. 2/21/08, p. 128, l. 24 to p. 129, l. 1.)Hui/MTF FOF E-110, E-111.

384. Atherton et al. seek to develop the Ma`alaea pasture currently occupied by Maui Cattle Company, TMK No. 3-6-01:18. (Atherton, Dec. 9/14/07, ¶ 15.) Hui/MTF FOF E-115.

385. Atherton et al. stated that the Ma`alaea development project and its potential alternatives for water use are still "a long ways" away and "all proposed . . . not fact." (Atherton, Tr. 2/21/08, p. 134, ll. 15-20; p. 143, ll. 11-17.) Among other approvals, the project still must seek state and county rezoning out of agriculture. (<u>Id.</u> p. 212, l. 5 to p. 213, l. 2.) Hui/MTF FOF E-117.

386. An alternative water source of approximately 620,000 gpd of wastewater the development project would generate could be reclaimed in an onsite facility. (Atherton, Tr. 2/21/08, p. 132, ll. 13-23.) Hui/MTF FOF E-118.

387. Aside from the possible alternative source of reclaimed water from its own contemplated treatment plant, Atherton et al. have had no discussions with the County about reclaimed water and hopes to reserve water from their five existing and planned wells for off-site transport to their desired development. (Atherton, Tr. 2/21/08, p. 194, l. 24 to p. 195, l. 13.) Hui/MTF FOF E-125, E-126.

388. Atherton et al. also proposed a coffee plantation on TMK Nos. 3-6-004:003 and 3-6-004:006, claiming water usage of 10,000 gad on more than 200 acres. (Exh. D-94, p. 1.) Mr. Atherton based the figure on 120 to 130 inches a year, but he has conducted no research on water use for coffee in different locations, notwithstanding his acknowledgement that water use "depends on the area" and "the factors at a specific location," and "[e]very area is different." (Atherton, Tr. 2/21/08, p. 168, l. 23 to p. 169, l. 15; p. 171, ll. 1-4; p. 203, ll. 19-22; p. 169, ll. 18-20.) Hui/MTF FOF E-120.

389. Atherton operates a coffee plantation in Kualapu`u, Moloka`i on about 300 acres. (Atherton, Tr. 2/21/08, p. 114, l. 23 to p. 115, l. 5.) For two years, that plantation did not irrigate at all, and in the last two years, it used an annual amount of 100 to 300 million gallons, or up to 2,739 gad. (Id. p. 168, ll. 3-9.) Now, the plantation "actually [is] in the black," and "[t]he last few years have been good." (Id. p. 119, ll. 4-10; p. 122, ll. 5-13.) Hui/MTF FOF E-121.

390. For Maui Tropical Plantation, the usage stated in WWC's water use reports and subpoenaed invoices indicate that MTP's water use over the period of 2001 through 2007 has averaged 114,313 gpd (1,938 gad over the 59 acres). (Exh. A-140, p. 20; Exh. D-97; Atherton, Tr. 2/21/08, p. 180, ll. 1-11.) Hui/MTF FOF E-124.

391. MMK Maui ("MMK"), owner of the Kahili Golf Course and King Kamehameha Golf Club has stated that "(t)he amount of water necessary to irrigate the golf course, given its climate and location, varies from approximately 1.6 to 2.2 million gallons per day." (Dooge Dec. 9/14/07, ¶ 12.) WWC states a maximum contract amount of 4 mgd. (Exh. D-96, p. 4.) Hui/MTF FOF E-57.

392. The 2.2 mgd figure came from a single month, October 2005, based on measurements at the pump station (Dooge, Tr. 1/14/08, p. 152, ll. 8-21), which is less accurate than the meter at

the ditch intake that MMK normally uses, and which MMK "used to sometimes" consult only "if the [ditch intake] meter was down." (Id. p. 147, ll. 12-23; p. 148, ll. 15-18.) October 2005 fell within the period toward the end of 2005 and continuing into 2006, during which MMK was growing in the turf on both courses and thus "throwing out a lot of water on the golf courses, more than we would normally." (Id. p. 134, l. 20 to p. 135, l. 1.) MMK measured no other month of such use (id. p. 152, l. 22 to p. 153, l. 2) and has never even projected the potential of such use (id. p. 155, ll. 6-12). Hui/MTF FOF E-58.

393. MMK testified that 2006 would be the first year in which records would show a full year of irrigation on all 36 holes. (Dooge, Tr. 1/14/08, p. 136, ll. 9-13.) Based on its subpoenaed records, MMK used 1.2 (1.198) mgd in 2006 for 36 holes. (Id. p. 160, ll. 9-22; Exh. C-61.) Hui/MTF FOF E-59.

394. MMK did not open both golf courses until May 2006 (Dooge, Tr. 1/14/08, p. 134, ll. 9-12), and thus for the first several months of 2006 was "throwing a lot of water down," "more than normal," "growing in part of the nine holes at Kahili, growing in the upper [Kamehameha] course too." (Id. p. 135, l. 22 to p. 136, l. 8.) Hui/MTF FOF E-60.

395. The 1.2 mgd figure paralleled the State of Hawai`i Office of State Planning's ("OSP") reported figure of 0.6 mgd each for the "Waikapu" and "Waikapu Slwd" courses, which are the predecessors of the current courses. (Exh. C-49.) See Tr. 1/14/08 p. 132, ll. 4-11 (background of prior course names). Although MMK first applied the figure for the "Maui Lani" course (Dooge, Dec. 11/16/07, ¶¶ 8-9), it later admitted that the predecessor courses offered a more accurate comparison than Maui Lani or other general figures, and that OSP's reported figure of 1.2 mgd was accurate. (Dooge, Tr. 1/14/08, p. 144, l. 2 to p. 145, l. 22.) Moreover, MMK has installed a new irrigation and monitoring system, resulting in "greater efficiency in the use of water" and lower use rates than before. (Id. p. 122, ll. 12-15; p. 168, ll. 9-20.) Hui/MTF FOF E-61.

396. MMK's claim that Mr. Parabicoli of Maui County advised it that reclaimed water is "not feasible for irrigation of golf courses" (Dooge, Dec. 11/16/07, ¶ 18), is belied by the many years of reclaimed water use on golf courses on Maui and throughout the state, from both public and private plants. (Parabicoli, Tr. 1/25/08, p. 137, l. 13 to p. 138, l. 10.) Contrary to MMK's claim that Mr. Parabicoli advised that there was "no way" MMK could obtain reclaimed water (Tr. 1/14/08, p. 127, ll. 5-6), Mr. Parabicoli has never been approached by any MMK representative

about using water from any reclamation facilities. (Parabicoli, Tr. 1/25/08, p. 140, ll. 2-7.) Hui/MTF, FOF.

397. "Farm plans" for Wailuku Country Estates ("WCE") do not require agriculture, but alternatively allow "conservation," which involves landscaping activities like planting trees and grass. (Irani, Tr. 1/14/08, p. 87, ll. 14-25; p. 24, ll. 10-11.) Hui/MTF FOF E-70.

398. WWC's contract with WCE states a maximum delivery of 1 mgd to WCE (Exh. D-96, p. 6; Exh. D-92, § 1.7), which would amount to 5,435 gad for 184 lots. Hui/MTF FOF E-81.

399. Like other WWC customers, WCE pays a quarterly "minimum charge" for water, regardless of what it actually uses. WCE automatically pays for 0.5 mgd a month. (Exh. D-92, §§ 1.8, 1.7.) Hui/MTF FOF E-82.

400. WCE limits each lot owner to a daily average use of 2,200 gallons, which it stated is "adequate." (Irani, Tr. 1/14/08, p. 18, ll. 10-15; p. 92, ll. 1-2.). WCE "penalize[s]" lot owners who exceed their "allotment" by imposing an extra charge for "any excess over the allowable use." (Irani, Tr. 1/14/08, p. 91, l. 25 to p. 92, l. 3; Exh. A-214, p. 1.) Hui/MTF FOF E-85, E-86.

401. In addition to water received from WWC, WCE lots receive up to 540 gpd from the county system. (Irani, Tr. 1/14/08, p. 17, ll. 5-9.) Hui/MTF FOF E-84.

402. The County has accommodated agricultural development lots with 600 to 1,200 gpd, but limits further allocations so as not to provide excessive amounts of water to developments not engaged in bona fide agriculture. (Tr. 12/14/07 (Eng), p. 189, l. 13 to p. 190, l. 2; Tr. 12/14/07, p. 4, l. 25 to p. 5, l. 12.) Hui/MTF FOF E-74.

403. The County does not have a policy to encourage new subdivisions to use surface water for irrigation, and Director Eng of the Maui County Department of Water Supply has made it clear to his department not to encourage such use. (Eng, Tr. 12/14/07, p. 147, l. 24 to p. 148, l. 5.) Hui/MTF FOF E-73.

404. WCE's allocation of 2,200 gpd, plus the County's 540 gpd, equals 2,740 gpd, higher than the 600 to 1,200 gpd the County provides to agricultural development lots.WCE claimed a maximum amount of 100,000 gpd for its community park and roadside community areas, but actual use was "a lot less," not "even half as much," because of the use of drought tolerant grass. (Irani, Tr. 1/14/08, p. 55, l. 22 to p. 56, l. 1; p. 55, ll. 2-3; p. 53, l. 11 to p. 54, l. 3; p. 54, ll. 11-14.). Hui/MTF FOF E-91, E-92, E-93.

405. Apart from the recycled water alternative discussed above, WCE recognizes it may petition the County to use its municipal system as an "alternative source of water for WCE irrigation purposes" and observes that "[s]ince the County of Maui allows other agricultural property in central Maui to use [county] water, it is unlikely the County would deny such a petition." (Irani, Dec. 11/16/07, ¶ 20.) Hui/MTF FOF E-94.

406. Koolau Cattle Company ("KCC") is another agricultural development, a 10-lot, 72-acre subdivision called "Malaihi Ag" on Kahekili Highway in Waihe`e. (See Subpoena Duces Tecum to Dwayne Betsill of KCC.) KCC is one of "about 40 companies" owned by the Betsill brothers, who are in the business of construction and development. (Betsill, Tr. 1/25/08, p. 110, l. 22 to p. 111, l. 3; Betsill, Tr. 1/14/08, p. 201, ll. 11-20.) Hui/MTF FOF E-95, E-96.

407. WWC states a maximum contract amount for KCC of 100,000 gpd. (Exh. D-96, p. 4.) KCC stated it had an agreement for 200,000 gpd: 100,000 on the Malaihi Ag. parcel, TMK No. 3-2-13-15; and 100,000 for a separate 113-acre parcel, TMK No. 3-2-9-1. (Betsill, Tr. 1/14/08, p. 210, ll. 1-11.) See also Exh. D-86, Exh A; Tr. 1/25/08, p. 107, ll. 16-25 (TMK numbers). But KCC's agreement contemplates a maximum of 100,000 gpd for both parcels. See Exh. D-86, § 4.06 (defining "Property" as both parcels for water use purposes). Hui/MTF FOF E-97.Apart from any water supplied by WWC, each lot in the Malaihi Ag. subdivision receives up to 1,000 gpd from the county system. (Betsill, Tr. 1/14/08, p. 204, l. 24 to p. 205, l. 5.) Hui/MTF FOF E-98.

408. KCC substantiated only limited water uses on both parcels and provided no details on acreages or water usages, even though each lot is supposedly metered. (Betsill, Tr. 1/14/08, p. 210, ll. 18-23.) Hui/MTF FOF E-99.KCC also has about eight acres of dryland taro on the 113-acre parcel, as well as 17 to 21 cattle. (Betsill, Tr. 1/14/08, p. 203, l. 21 to p. 204, l. 2.) The 113-acre parcel also contains remnant macadamia nut trees from the former Wailuku plantation, none of which has been watered. (Id. p. 224, ll. 10-17.) KCC's dryland taro uses "minimal water" through a drip system. (Id., p. 215, ll. 6-8.) KCC stated its water use on its total 9.25 acres of dryland taro on both parcels as 15,000 to 20,000 gpd. (Id. p. 207, ll. 13-17.) Hui/MTF FOF E-104, E-105. KCC noted a desire to develop the 113-acre parcel, but it has not proposed anything yet after being turned down by the county because of a zoning "problem." (Betsill, Tr. 1/25/08, p. 107, ll. 4-13.) Hui/MTF FOF E-106.

409. Kihei Gardens & Landscaping ("KGL") cultivates landscaping plants on 15 to 18 acres of a 25.4 acre parcel in Waikapū (Waiale Road). (Okamura, Tr. 1/24/08, pp. 157-58.) WWC's records indicate average usage between 37,924 to 44,002 gpd (around 2,500 gad) from 2005 to 2007. (Exh. A-215.) KGL's usage is projected to decrease as more and more native plants and less water-consuming plants are being used. (Okamura, Tr. 1/24/08, p. 180, ll. 7-18.) Hui/MTF FOF E-132, E-133, E-134.

410. KGL has "never considered" or looked into using county water. (Okamura, Tr. 1/24/08, p. 160, ll. 3-5; p. 175, ll. 13-14), assuming this alternative would increase costs, because it thought it buys water at a lower rate than county water. (Id. p. 160, ll. 20-23.) However, KGL pays WWC $0.85 per 1000 gallons (Exh. D-76, § 9), which is identical to the county rate as of 2006 (Exh. D-90, § 1.12.) Hui/MTF FOF E-135.

411. KGL has also only "thought about," but never looked into, installing a well on its property. (Okamura, Tr. 1/24/08, p. 160, ll. 9-16; p. 175, ll. 15-19.) Hui/MTF FOF E-136.

412. Melia Orchids ("MO") is a orchid distribution business in Waikapū (Waiko Road) cultivating10 acres in Waikapū and 10 acres in Kula using another water source. (Schenk, Tr. 1/25/08, pp. 82-83, p. 88, l. 21 to p. 90, l. 3.) Hui/MTF FOF E-140, E-141.

413. WWC's records indicate an average use of 8,185 to 8,585 gpd (about 840 gad) from 2005 to 2007. (Exh. A-216.) Hui/MTF FOF E-142.

414. MO has only a 30-day lease on the Waikapū parcel from the owner, A&B Properties, with the understanding that the land is slated for development and a long-term lease would mean the "rent would go way up." (Schenk, Tr. 1/25/08, p. 98, l. 19 to p. 99, l. 4.) Hui/MTF FOF E-144.

415. Various entities, including THP Associates and Waikapū Mauka Partners (collectively, "THP/WMP"), which are represented by Howard Hamamoto, own 270 acres of land formerly connected to the Waikapū golf courses. (Hamamoto, WDT 10/26/07, ¶ 4.) Hui/MTF FOF E-145.

416. THP/WMP's development plans on the land remain in the "schematic," "conceptual" phase and involve "just tossing ideas around at this point." (Hamamoto, Tr. 1/25/08, p. 33, ll. 6-20.) Any development would require numerous state and county approvals, but THP/WMP have not begun the first step of applying to the state Land Use Commission. (Hamamoto, Tr. 1/25/08, p. 33, l. 6 to p. 34, l. 8.) Hui/MTF FOF E-146, E-147.

4. **HC&S**

417. Approximately 5,300 acres of HC&S's sugar plantation, or about 15 percent of the roughly 35,000 acres HC&S uses for sugar cane cultivation, are located in HC&S's "West Maui Fields," which are within the "Maalaea Farm." (Volner, Dec. 9/14/07, ¶ 3; Hew, Dec. 9/14/07, ¶ 4; Holaday, Dec. 9/14/07, ¶ 4.) Hui/MTF FOF F-1.

418. The West Maui Fields consist of two groups of fields – the Waihe`e-Hopoi Fields and the `Īao-Waikapū Fields. (Hew, Dec. 9/14/07, ¶¶ 4-6; Exh. E-1; Volner, Dec. 9/14/07, ¶ 3.) Hui/MTF FOF F-2.

419. The Waihe`e-Hopoi Fields, which are owned by HC&S, are irrigated with water diverted from Waihe`e River and Waiehu and `Īao Streams that is delivered to Waiale Reservoir by the Spreckels Ditch and the Waihe`e Ditch via the Hopoi Chute. (Hew Dec. 9/14/07, ¶¶ 5, 10, 11, 12.) Hui/MTF FOF F-3.

420. The average amount of water delivered to the Waiale Reservoir between 1993 and July 2007, as calculated by combining the flows measured at the Wailuku gauging station at the Spreckels Ditch and the Hopoi gauging station at the Waihe'e Ditch minus whatever water was determined to have passed by the Hopoi Ditch, was approximately 39 mgd. This does not include any water separately delivered by WWC to the 'Īao-Waikapū Fields. (Hew, WDT 1/29/08, ¶ 12.) HC&S FOF 93.

421. HC&S received an average of 40.11 mgd in 2005 and 31.04 mgd in 2006 at Waiale Reservoir. (Exh. E-3; Exh. E-4.) WWC FOF 255.

422. Of the amounts received at Waiale Reservoir, WWC estimates that it provided 29.14 mgd of the 40.11 mgd in 2005 and 17.55 mgd of the 31.04 mgd in 2006. (Exh. A-138.) WWC FOF 256, 260.

a. **System Losses**

423. HC&S estimates that it loses 6-8 mgd through seepage from the Waiale reservoir, depending on the level of the reservoir. Seepage throughout the rest of the HC&S ditch and reservoir system is estimated to be 3-4 mgd. (Volner, WDT 9/14/07, ¶ 16.) HC&S FOF 96.

424. HC&S' policy is to try to keep reservoir levels as low as possible and tries to maintain the water level in Waiale Reservoir at a relatively constant level of approximately 12 feet, or 36 million gallons ("mg"). This level is not too close to the point where a sudden rain event would

cause the reservoir to overflow, but stores a reasonable amount of water to act as a buffer for days when the ditch flows are low. HC&S tries to avoid letting the level drop below 9 feet, or 20 mg, because when the level is low, there is a greater risk of silt entering the irrigation system and clogging the sand filters and irrigation tubes. Irrigation volume is therefore set as much as possible to match outflows to inflows on a daily basis, adjusting for seepage and system losses. (Volner, WDT 9/14/07, ¶ 12; Volner, Tr. 1/30/08, p. 58, ll. 7-17.) HC&S FOF 97.

425. HC&S acknowledges that "high density polyethylene lining could negate much of the seepage, not all of it" and that concrete lining "is obviously another option." (Volner, Tr. 1/30/08, p. 58, ll. 18-25; see also Exh. E-45, p. 2.) HC&S has no estimates of the cost to line Waiale Reservoir or the other reservoirs and ditches and has undertaken no engineering or financial analysis of what it would take to reduce the losses (Volner, Tr. 1/30/08, p. 59, ll. 6-17; Holaday, Tr. 1/31/08, p. 135, l. 16 to p. 136, l. 14). Hui/MTF FOF F-116.

426. WWC estimated the losses from its ditch system as a set percentage of 7.34 percent, based primarily on a 20-year old report, Exh. D-4A. (Suzuki, Tr. 12/14/07, p. 164, l. 11 to p. 165, l. 23.) Hui/MTF FOF E-35.

b. Irrigation Practices

427. According to HC&S, the Waihe`e-Hopoi Fields comprise approximately 3,950 acres. (Hew, Dec. 9/14/07, ¶ 5.) Although Fields 921 and 922 are within the geographical area of the Waihe`e-Hopoi Fields, the approximately 300 acres included in Fields 921 and 922 are not included in the 3,950-acres of the Waihe`e-Hopoi Fields because Fields 921 and 922 were watered exclusively with wastewater from Maui Land and Pine ("MLP") and did not use water diverted from Nā Wai `Ehā streams during 2004 through 2006 except for flushing the drip lines. (Volner, Tr. 1/30/08, p. 27, l. 21 to p. 28, l. 12; p. 28, l. 24 to p. 28, l. 6.) Hui/MTF FOF F-4.

428. Of the 3,950-acre Waihe`e-Hopoi Fields, HC&S currently leases 600.2 acres to Monsanto: 114.6 acres in Field 913; 240.1 acres in Field 904; and 245.5 acres in Field 908. (Exh. A-197 (Exh. A); Exh. A-198, pp. HC&S 02021-02022, (Exhs. A, B); Exh. A-199; Holaday, Tr. 1/31/08, p. 57, l. 8 to p. 58, l. 2; p. 60, l. 10 to p. 62, l. 2; p. 62, l. 23 to p. 64, l. 2.) Hui/MTF FOF F-5.

429. Subtracting the land leased to Monsanto, the acreage of the Waihe`e-Hopoi Fields on which HC&S grows sugar cane irrigated with water diverted from Nä Wai `Ehä streams is approximately 3,350 acres. Hui/MTF FOF F-6.

The other group of West Maui Fields is the `Īao-Waikapū Fields, which include Field 920, an HC&S-owned field of which about 250 acres have been used for sugar cane cultivation, and another thirteen fields, comprising 1080 acres (sometimes herein, the "leased fields"), that HC&S leases from entities associated with Atherton, et al. for a total of approximately 1330 acres. (Hew, Dec. 9/14/07, ¶ 6; Volner, Tr. 1/30/08, p. 12, l. 4 to p. 13, l. 11; Exh. C-67 (Exh. A).) Hui/MTF FOF F-7.

430. In December, 2007, HC&S entered a verbal agreement with the Atherton Hui, through Mr. Chumbley, to lease Field 767, consisting of approximately 129 acres, as though it had been part of the existing 1080-acre lease. (Volner, Tr. 1/30/08, p. 211, ll. 11-18; p. 212, l. 19 to p. 213, l. 17.) Hu/MTF FOF F-8.

431. The `Īao-Waikapū Fields are above Waiale Reservoir and beyond the reach of HC&S's irrigation system. (Hew, Dec. 9/14/07, p. 3; Volner WDT 9/14/07, p. 2; Tr. XVI 89, 180-181.) WWC FOF 241.

432. The `Īao-Waikapū Fields can receive stream water from several sources: `Īao Stream via the `Īao-Waikapū Ditch; Waikapū Stream via the South Waikapū Ditch; and Waihe`e River, and Waiehu and `Īao Streams via the Waihe`e Ditch past the Hopoi Chute. (Hew Dec. 9/14/07, ¶¶ 6-8.) Hui/MTF FOF F-9.

433. HC&S pays WWC a flat fee per acre for water used on the `Īao-Waikapū Fields, regardless of how much water is used; in 2005 that fee was $300/acre/year. (Tr. 1/30/08 (Volner), p. 26, ll. 3-7; Exh. D-56, p. 4; Chumbley, Tr. 1/24/07, p. 41, ll. 3-18.) Hui/MTF FOF F-10.

434. For HC&S's `Iao-Waikapū Fields ("Leased Fields"), WWC reported providing 9.98 mgd during 2005 and 10.88 mgd during 2006. (Exh. A-138.) WWC FOF 260.

435. The reports of water deliveries to HC&S submitted by WWC to the Commission are not based on meter readings. Instead, WWC calculates the number of gallons delivered to users other than HC&S, and then attributes the balance to HC&S. As a result, water that was not actually delivered to HC&S could be counted as delivered to HC&S. (Chumbley, Tr., 1/24/08, p. 136, l. 14 to p. 138, l. 23; Exh. A-140, p. 47.) HC&S FOF 91.

436. Excluding a little over 100 acres leased to third-party lessee whose average usage is estimated at 1-2 mgd, HC&S used an average of 6,828 gad or 22.19 mgd for the remaining 3,250 acres of the Waihe'e-Hopoi Fields during 2004-2006. While there are periods of time when the irrigation needs of these fields are fully satisfied, the fields are typically at a substantial moisture deficit during the summer months, when solar radiation is greater and ditch flows are low. (Volner, WDT 9/14/07, ¶¶ 13-14, 16; Volner, Tr. 1/30/08, p. 66, ll. 7-20; Exh. E-5.) HC&S FOF 94.

437. HC&S does not regularly calculate and use gad in managing its operations, because averages can misstate actual irrigation requirements. For example, HC&S could apply twice the amount of water needed in the winter months and half the amount of water needed in the summer months, and the average would indicate that an adequate amount of water is applied on an annual basis. Yet, the sugarcane plant will not respond well, and the yields will be off. (Volner, Tr. 1/29/08, p. 196, l. 5 to p. 197, l. 5.) HC&S FOF 94 (footnote 1).

438. Usage was computed by using HC&S's water balance database for all the fields in the Waihe'e Hopoi system, determining how many irrigations hours were charged to the fields, and then multiplying it by the application rate. The figure was not based off of meter readings. (Volner, WDT 9/14/07, ¶ 17.) HC&S FOF 94(D).

439. The irrigated acres also could fluctuate yearly, because HC&S could add acres that were not in production previously and may take in more lands as it surveys field boundaries to determine the actual boundaries of its fields. (Volner, Tr. 1/29/08, p. 198, l. 19 to p. 199, l. 1.) HC&S FOF 94(A).

440. HC&S does not perform an accounting of deliveries versus usage on a daily basis in the normal course of its business. (Volner, Tr. 1/29/08, p. 201, ll. 9-12.) HC&S FOF 94(E).

441. For 2004-2006, HC&S used an average of 7,716 gad for the 'Īao-Waikapū Fields or an average of about 10.26 mgd for 1330 acres for the years 2004 -2006. (Volner, WDT 9/14/07, ¶¶ 17-18; Exh. E-6.) HC&S FOF 95.

442. Use was calculated from HC&S records by multiplying the flow rates in the drip irrigation system by the hours of operation. There is no significant issue of system losses other than the assumed 80% delivery rate to the plants inherent in the drip system, since the water for these fields is delivered by WWC directly to the fields rather than going through Waiale Reservoir and HC&S' internal ditch system. (Volner, WDT 9/14/07, ¶ 17)

443. The figure is skewed somewhat, however, by the inclusion of Field 920, which has very sandy soil and has consumed more water that the other fields because of its porosity and also because of its use for seed cane. (Volner, WDT 9/14/07, ¶ 18; Volner, Tr. 1/29/08, p. 204, l. 18 to p. 205, l. 5.) Excluding Field 920, HC&S used an average of 7,098 gad for the ʻĪao Waikapū Fields for 2004, 2005, and 2006. (Volner, WDT 9/14/07, ¶ 19; Exhibit E-7.) HC&S FOF 95(B), 95(C).

444. HC&S is able to satisfy the irrigation requirement for the ʻĪao-Waikapū Fields more consistently, because the available water for these fields per acre is greater than it is for the Waiheʻe-Hopoi Fields. As a result, historically these were among the highest yielding fields on the plantation. (Volner, WDT 9/14/07, ¶ 19.) HC&S FOF 95(D). However, starting in about 2003, even though the ʻĪao Waikapū Fields receive more water on a per-acre basis than the Waihe`e-Hopoi Fields, the extra water does not result in a higher yield. (Volner, Tr. 1/30/08, p. 99, ll. 10-16.) Hui/MTF FOF F-100.

445. In 1986, HC&S installed a drip irrigation system in its fields at a total cost of approximately $30 million. Irrigating fields with drip tubes reduces water loss due to evaporation and helps ensure that water applied to a field is actually delivered to the sugar cane plant. Under drip irrigation, it is assumed that 80% of the water applied is delivered to the sugar cane plant. This is a uniformity factor, not an efficiency factor. The uniformity factor allows one to assume with a degree of confidence that 80% of all water is applied to all the sugarcane plants at the same rate. It does not mean that 80% of the water is used by the plant, or that 20% of the water is lost. (Volner, WDT 9/14/07, ¶ 10A; Volner, Tr. 1/29/08, p. 195, l. 6 to p. 196, l. 1.) HC&S FOF 99.

446. Water in the ditch passes into a takeoff and through a screen to filter out debris. The water then gravity flows into a pipe or multiple pipes to sand media filters. Sand media filters are pressurized vessels containing a bed of sand. Water is percolated through the sand under pressure, filtering any impurities that are too large to be passed through drip emitters. Water then flows through the outlet of the sand filters, generally into large main lines and then distributed throughout the fields. (Volner, Tr. 1/29/08, p. 178, l. 7 to p. 179, l. 2.) Occasionally, the sand filters need to be "back flushed" with water to remove collected debris. Where possible, HC&S uses the discharged back flush water for irrigation, either by returning it to the irrigation ditches

or by applying it to cultivated fields through perforated plastic pipes. (Volner, WDT 9/14/07, ¶ 10C; Volner, Tr. 1/29/08, p. 201, l. 23 to p. 202, l. 24.) HC&S FOF 100.

447. Agricultural water meters are installed to allow HC&S to check instantaneous flows. At each acre in the field there is a pressure regulator and a control valve. If a break occurs in that one acre section, HC&S can isolate that section and continue to run the rest of the field. The water then enters drip tubing, which generally has an emitter every 36 inches. Water is discharged from emitters at the rate of 0.6 gallons per hour. (Volner, Tr. 1/29/08, p. 179, ll. 3-16.) HC&S FOF 101.

448. Because HC&S does not have the capacity to irrigate all of its fields simultaneously, available irrigation water is applied in "rounds" to different fields in accordance with priorities that are assigned to them by the farm managers. The highest priority is given to fields that are being planted, the second priority to fields that are ripening, and the third priority to all other fields (routine irrigation). A round of irrigation can consist of anywhere from 24 hours up to 72 hours of continuous irrigation. Sometimes it can be longer, as in germinating cane, or shorter, as in fertilizing. At any given time, only a fraction of the fields are actually receiving water (Volner, WDT 9/14/07 written direct testimony, ¶ 10B; Volner, Tr. 1/29/08, p. 183, ll. 11-24, p. 190, ll. 19-21, p. 191, ll. 17-24, p. 192, ll. 2-4.) HC&S FOF 102.

449. Sugarcane is cultivated by HC&S in accordance with a two-year crop cycle. The two-year crop cycle helps HC&S reduce costs and maximize yields. The sugarcane plant requires water throughout the crop cycle, but during the last six months before harvesting, the amount of water applied to the plant is purposely reduced to induce the plant to accumulate sucrose. To facilitate the entry of machinery into the fields for harvesting, the fields are usually not irrigated at all approximately 40-60 days before harvest. (Volner, WDT 9/14/07, ¶ 8; Volner, Tr. 1/29/08, p. 186, l. 1 to p. 187, l. 2.) HC&S FOF 103.

450. HC&S uses slightly more water on a newly planted seed cane field than on a crop field to ensure one hundred percent germination. In addition, it takes longer for the water to move to the seed piece in the sandier soils. (Volner, Tr. 1/30/08, p. 196, ll. 2-9.) Fares, called by Petitioners as an expert in irrigation management, stated that under his water budget model, seed cane requires 13 percent more water than crop cane, assuming three crop cycles of eight months running consecutively across a 24-month period. (Fares, Tr. 2/15/08, p. 21, ll. 20-21 and p. 65, l. 21 to p. 67, l. 9.) HC&S FOF 104.

451. HC&S determines the irrigation needs by the daily evapo-transpiration rate, which is defined as the loss of water from the soil both by evaporation and by transpiration from the plants growing in the soil. The evapo-transpiration rate varies during the year, depending on weather conditions, solar insulation, temperatures, humidity, and wind speed. In order to maintain sugar yields, the sum of available rainfall plus irrigation water applied to the fields must approach the evapo-transpiration rate to promote efficient growth. The evapo-transpiration rate tends to be the highest during the months of May through September, which are the peak growing, planting, and harvesting periods for the plantation. Adequately meeting evapo-transpiration rates is directly correlated with crop yield potential. (Volner, WDT 9/14/07, ¶ 9.) HC&S FOF 105.

452. HC&S employs a computerized water balance model to determine the irrigation requirements of its fields. The water balance model essentially calculates a water budget that accounts for "deposits" of water in the form of rainfall and irrigation and "withdrawals" in the form of evapo-transpiration. HC&S uses its water balance model as a managerial prioritization tool to determine what needs to be irrigated. It also tracks what is applied to the field. (Nakahata, WDT 11/16/07, ¶ 3; Volner, Tr. 1/29/08, p. 185, ll. 23-25; Nakahata, Tr. 2/15/08, p. 168, ll. 3-10.) HC&S FOF 106.

453. On a daily basis, HC&S collects evaporation data from fifteen major weather stations situated across the plantation and rainfall data from rainfall stations. HC&S personnel input the evaporation and rainfall data into the water balance model along with data on the soil moisture storage for the fields and the number of irrigation hours applied. The model then applies the data to a modified Penman equation. The result is the water status for each field. The model then prioritizes the field based on which field should receive water next. (Volner, Tr. 1/29/08, p. 189, l. 25 to p. 190, l. 12; Nakahata, Tr. 2/15/08, p. 169, l. 7 to p. 170, l. 15.) HC&S FOF 107.

454. Fares, Hui/MTF's expert witness, calculated the optimal irrigation requirements for sugar cane grown on HC&S's fields using a computerized daily water budget model. (Fares, WDT 10/26/07, ¶¶ 1-5; Fares, Tr. 2/15/08 p. 20, ll. 6-9, p. 29, ll. 3-5; exh. A-80.) Hui/MTF FOF F-13.

455. Fares' model accounts for water going into the plantation system, and water leaving the system as evapo-transpiration, overflow, runoff, excess due to drainage; and the storage capability of the soil. The purpose of the model is to calculate the optimal irrigation requirements for sugarcane grown in Central Maui. Fares explained that the optimal irrigation requirement is

the amount of irrigation water needed to keep the soil moisture level above the allowable water deficit ("AWD"), which is a given percent of the soil moisture level at which the sugarcane plant wilts and can no longer take water from the soil. Fares' model assumes that the AWD is 65 percent of the available soil water holding capacity ("ASWHC"). (Exh. A-80; Fares, Tr. 2/15/08, p. 30, l. 11 to p. 31, l. 2 and p. 59, l. 18 to p. 60, l 2.1) The model is not intended to determine how much irrigation water to apply on a daily basis. (Fares, Tr. 2/15/08, p. 31, ll. 3-24.) HC&S FOF 108.

456. The computer program Fares used for his water budget methodology requires, as inputs, historical rainfall data, evapotranspiration or pan evaporation data for as long a period as available from the location in which the crop will be grown, and data regarding the soil characteristics and crop parameters. (Fares, Tr. 2/15/08, p. 31, l. 25 to p. 32, l. 20.) The program then calculates, over the historical period covered by the rainfall data, how much irrigation water would have been required to grow the crop. (Fares, Tr. 2/15/08, p. 34, l. 20 to p. 35, l. 9.) The results are statistically analyzed to determine, inter alia, average daily amount of irrigation water needed in the wettest year (xmin) and the driest year (xmax) in the period of record, as well as the amount of irrigation water that would have supplied the irrigation requirements 80 percent of the time, or four out of five years. (Exh. A-80, pp. 5-7; Fares, Tr. 2/15/08, p. 35, ll. 10-23.) Hui/MTF FOF F-16.

457. Fares used an 80 percent probability for satisfying the crop's irrigation requirements, because it is the industry standard for calculating crop water duties in both the government and private sectors, including the Hawai`i Natural Resource Conservation Service of the United States Department of Agriculture. (Exh. A-80, pp. 5-7; Fares, Tr. 2/15/08, p. 35, ll. 10-23.) Hui/MTF FOF F-17.

458. The data on soil characteristics that Fares used in his model were from the State of Hawai`i Soil Survey published by the United States Department of Agriculture. (Exh. A-80, p. 3.) The crop parameters Fares used, including the crop coefficient for sugar cane, the wilting point, and the root depth, were obtained from literature. (Fares, Tr. 2/15/08, p. 75, ll. 12-22.) Hui/MTF FOF F-18.

459. Fares used 54 years of daily rainfall data from a NOAA National Climatic Data Center weather station located in the direct vicinity of the fields in question. (Exh. A-80, p. 2; Exh. A-80A; Exh. A-80B; Fares, Tr. 2/15/08, p. 35, l. 24 to p. 37, l. 20.) To account for the spatial

variability of the rainfall, Fares adjusted the rainfall data according to isohytes, or contour lines demarcating spatial rainfall gradients, which were developed as part of the Hawai`i Rainfall Atlas. (Fares, Tr. 2/15/08, p. 37, l. 25 to p. 40, l. 6; Exh. A-80C.) Hui/MTF FOF F-19.

460. Evapotranspiration ("ET") can be calculated, in the absence of direct measurements, by evaporation of water from an open pan with certain characteristics (pan evaporation, or PE), which can then be correlated to the water demands of the specific crop. (Fares, Tr. 2/15/08, p. 41, l. 18 to p. 42, l. 21; p. 80, l. 21to p. 81, l. 8.) Hui/MTF FOF F-20.

461. Fares used site-specific historical pan evaporation data spanning almost a century, from 1894 to 1983, collected by the sugar industry and published in a Department of Land and Natural Resources ("DLNR") report prepared by Ekern and Chang, which reported historical monthly mean pan evaporation values. (Exh. A-80, p. 2; Fares, Tr. 2/15/08, p. 47, l. 1 to p. 48, l. 23.) Hui/MTF FOF F-21.

462. To calculate the crop evapotranspiration (ET_c) from the measured pan evaporation, the two-step methodology employed by Dr. Fares uses a reference crop, in this case a grass 15 cm above ground that is not stressed and has no diseases. The potential, or reference, ET (ET_o) is calculated using the equation $ET_o = PE \times K_p$, where PE is the measured pan evaporation and K_p is the pan coefficient for the reference crop. The crop ET (ET_c) is then calculated using the equation $ET_c = K_c \times ET_o$, where K_c is a crop coefficient specific to the crop being grown, in this case, sugar cane, that varies over the growth cycle of the crop, and is available from peer-reviewed literature. (Fares, Tr. 2/15/08, p. 43, l. 8 to p. 44, l. 7; p. 45, l. 4 to p. 46, l. 25; Exh. A-80, p. 2.) Hui/MTF FOF F-22.

463. Fares ran his water budget program on each of the four TMK parcels comprising HC&S's `Īao-Waikapū Fields and the three TMK parcels comprising HC&S's Waihe`e-Hopoi Fields. (Exh. A-80, pp. 6-7.) Given that HC&S plants sugar cane year-round, Fares accounted for variations in the optimal irrigation requirements based on the month in which a crop was planted by running the model 12 times for each TMK, to simulate a crop planted in each month of the year, and averaging the results. (Exh. A-80, p. 5.) Hui/MTF FOF F-26.

464. For the Waihe`e-Hopoi Fields, Fares's water budget program calculated that the optimal irrigation requirement over the 54-year period of rainfall data ranged between 4,211 gad (xmin) in the wettest year during that period and 6,005 gad (xmax) in the driest year, and that 5,674 gad

would satisfy the optimal irrigation requirements for sugar cane grown in the Waihe`e-Hopoi Fields in 80% of those 54 years. (Exh. A-80, p. 6.) Hui/MTF FOF F-27.

465. For the `Īao-Waikapū Fields, Fares's methodology calculated that the optimal irrigation requirements over the same 54-year period of record ranged between 3,648 gad (xmin) in the wettest year during that period and 5,558 gad (xmax) in the driest year, and that 5,150 gad would satisfy the optimal irrigation requirements for sugar cane grown in the `Īao-Waikapū Fields in 80% of those 54 years. (Exh. A-80, p. 7.) Hui/MTF FOF F-28.

466. Fares also divided his calculations of the optimal irrigation requirements for the `Īao-Waikapū Fields into Field 920 and the leased fields. For Field 920 (TMK No. (2) 3-8-5-23), the optimal irrigation requirements over the 54-year period of record ranged between 4,443 gad (xmin) in the wettest year and 6,109 gad (xmax) in the driest year; and 5,752 gad would satisfy the optimal irrigation requirements for sugar cane grown in Field 920 in 80% of those 54 years. (Exh. A-80, p. 7.) Hui/MTF FOF F-29.

467. When the weighted averages for the `Īao-Waikapū Fields are recalculated to exclude Field 920, the optimal irrigation needs of the leased fields over the period of record range between 3,483 gad (xmin) in the wettest year and 5,444 (xmax) in the driest year; and 5,026 gad would satisfy the optimal irrigation requirements 80% of the time. (Exh. A-80, p. 7.) Hui/MTF FOF F-30.

468. HC&S experts were of the opinion that the Fares model is conceptually similar to HC&S' water balance model, but different in significant respects. (Nakahata, Dec. 11/16/07, ¶ 5.) For the input of rainfall, Fares used 54 years of rainfall data collected from the Pohakea Bridge Station 307.2 operated by the National Climatic Data Center, and adjusted the data to account for spatial variability of rainfall in the specific geographic area where the model is being applied. To perform the adjustment, Fares multiplied the data by the ratio between the isohyets going through Station 307.2 and the isohyets going through the midpoint of the subject property. Fares then took the mean and median of the historical rainfall data. (Exh. A-80, pp. 2, 5; Exh. A-80A; Exh. A-80C; Fares, Tr. 2/15/08, p. 35, l. 24 to p. 39, l. 12.) Ogoshi, an Associate Agronomist at the University of Hawai'i at Manoa, Department of Tropical Plant and Soil Sciences and a colleague of Fares, testified that Fares' method of interpolating data to approximate local conditions has not been tested for accuracy. (Ogoshi, Tr. 2/20/08, p. 165, l. 22 to p. 166, l. 17.) HC&S FOF 109.

469. Unlike the Fares model, HC&S relies on real-time data collected at its weather stations to determine its daily irrigation requirements. HC&S collects data from its 41 rain stations and 15 evaporation stations located throughout the plantation; four of the rain stations and two of the evaporation stations are located in the West Maui Fields. (Nakahata, Dec. 11/16/07, ¶ 7.) Real-time data is more reliable than long-term daily averages in helping to determine, on any given day, the amount of moisture replacement the soils need in order to optimize the growth of the sugarcane. For example, a daily average over the course of a month in which it rained very heavily for just a few days would lead to under irrigating for the majority of the month. Further, during extended periods of low rainfall, relying on historic averages would result in under irrigating for most of the year. (Nakahata, Dec. 11/16/07, ¶ 6; Ogoshi, Dec. 11/16/07, ¶ 5.) HC&S FOF 110.

470. For the input of evaporation, the Fares model engages in a two-step process. The first step is to calculate the reference evapo-transpiration (ET_O), which is the evapo-transpiration rate for a reference crop. The reference crop is grass with 15 centimeters above the ground when water is not stressed. The ET_O is calculated by multiplying pan evaporation (PE) by a pan coefficient for the reference crop (K_P). (Exh. A-80, p. 2, Fares, Tr. 2/15/08, p. 43, l. 8 to p. 45, l. 3.) Fares selected a pan coefficient of 0.8 because it is between the range of 0.5 to 0.85 reported in the literature. As such, the pan coefficient used by Fares is a postulated, not calculated, value. The second step in the process is to multiply the ET_O by a crop coefficient (K_C) for the subject crop, here sugarcane. HC&S FOF 111.

471. Unlike the Fares model, HC&S' water balance model does not apply a pan coefficient, but rather, applies the crop coefficient directly to the pan evaporation value. (Nakahata, Tr. 2/15/08, p. 171, ll. 11-25; Nakahata, Tr. 2/20/08, p. 33, ll. 18-19.) HC&S based its method on studies done within the sugarcane growers industry, such as:

A. Ekern & Chang, Pan Evaporation: State of Hawai'i, 1894-1983 (1985) (Exh. E-35, pp. 49-50; Nakahata, Tr. 2/15/08, p. 171, ll. 11-25; Nakahata, Tr. 2/20/08, p. 33, ll. 18-19);

B. Cornelison & Humbert, Irrigation Interval Control in the Hawaiian Sugar Industry (1960) (Exh. E-36; Nakahata, Tr. 2/15/08, p. 175, ll. 1-25; Nakahata, Tr. 2/20/08, p. 43, l. 12 to p. 43, l. 18);

C. Santo & Bosshart, Amounts of Water Versus Yield Relationships of Drip-Irrigated Sugarcane (1982) (Exh. E-38, p. 6, Figure 1; Nakahata, Tr. 2/15/08, p. 178, ll. 14-23);

D. Santo & Beminzer, Effects of Irrigation and Nitrogen on Yields of Drip-Irrigated Sugarcane (Exh. E-39, Nakahata, Tr. 2/15/08, p. 181, l. 15 to p. 182, l. 13);

E. Chang, Campbell, Brodie, & Baver, Evapotranspiration Research at the HSPA Experiment Station (Exh. E-42, p. 13);

F. Jones, A Review of Evapotranspiration Studies in Irrigated Sugarcane in Hawaii (1980) (Exh. E-32, p. 198)

HC&S calculates the crop coefficient using a leaf area index curve developed by a researcher at the Hawaii Sugar Planters Association it retained in the late 1980's. (Nakahata, Tr. 2/5/08, p. 170, l. 16 to p. 171, l. 10, p. 172, ll. 1-4.) HC&S FOF 112.

472. Fares relied on evaporation data reported in Ekern & Chang (1985), which only go up until 1983. (Exh. E-35.) Because Fares calculated outputs from his model up to 2004, it appears that the evaporation figures he used for 1983 to 2004 are monthly means calculated from data prior to 1983. However, using monthly means might not accurately reflect inter-annual variations in rainfall which in turn correlate with variations in pan evaporation. (Ogoshi, Tr. 2/20/08, p. 168, l. 19 to p. 169, l. 23.) HC&S FOF 113.

473. In calculating the gross daily optimal irrigation requirement, the Fares model assumes irrigation efficiency of 85% for drip irrigation. Fares defined irrigation efficiency as the percentage of water that will be delivered to the plant. Thus, irrigation efficiency of 85% assumes that of 100 gallons pumped, 85 gallons will be delivered to the plant. According to Fares, 85% irrigation efficiency is the industry standard. (Fares, Tr. 2/15/08, p. 51, l. 17 to p. 53, l. 6.) Fares had no opinion on whether HC&S's irrigation practices are efficient or inefficient. (Fares, Tr. 2/15/08, p. 146, ll. 13-16.) HC&S also takes into account the different types of tubing used in the field, the length of the tubes, and variations in topography. Therefore, HC&S uses an 80% efficiency factor. (Nakahata, Tr. 2/15/08, p. 191, l. 18 to p. 192, l. 11 and p. 196, l. 10 to p. 197, l. 8.) HC&S FOF 114.

474. One of the parameters used in the Fares model is crop growth stage. (Exh. A-80, p. 3; Fares, Tr. 2/15/08, p. 87, ll. 17-24.) For this parameter, Fares relied on values coinciding with those reported for sugarcane in FAO Irrigation and Drainage Paper No. 56, Crop

Evapotranspiration. ("FAO Paper No. 56"), Table 11 (Exh. E-31, p. 107, Table 11; Fares, Tr. 2/15/08, p. 93, ll. 5-21.) FAO Paper No. 56 cautions that the values in Table 11 are to be used as guides, and should be checked against local conditions:

> "[t]he values in Table 11 are useful only as a general guide and for comparison purposes. The listed lengths of growth stages are average lengths for the regions and periods specified and are intended to serve only as examples. Local observations of the specific plant stage development should be used, wherever possible, to incorporate effects of plant variety, climate and cultural practices. Local information can be obtained by interviewing farmers, ranchers, agricultural extension agents and local researchers, by conducting local surveys, or by remote sensing. When determining stage dates from local observations, the guidelines and visual descriptions may be helpful.

(Exhibit E-31 at 108.) HC&S FOF 115.

475. Fares reviewed literature relating to growing sugarcane in Hawai'i. He did not, however, observe or study the conditions specific to HC&S's fields. (Fares, Tr. 2/15/08, p. 23, ll. 19-22, p. 141, l. 24 to p. 143, l. 12, p. 102, l. 17 to p. 104, l. 2.) HC&S FOF 116.

476. Fares has not personally visited the fields or inspected HC&S' irrigation system. He has never done any field work concerning the irrigation of sugarcane nor has he studied the actual usage of water for sugarcane. (Fares, Tr. 2/15/08, p. 23, ll. 19-22, p. 28, ll. 2-10, 21-24, p. 141, l. 24 to p. 143, l. 12.) HC&S stressed the importance of basing water management on conditions in the field rather than on models. (Volner, Tr. 1/29/08, p. 211, l. 14 to p. 213, l. 22, p. 214, l. 23 to p. 216, l. 10.) HC&S FOF 117.

477. Fares' model and the generalizations drawn from it do not necessarily track actual conditions and practices in HC&S's West Maui Fields. For example, Fares' model does not account for water that must be run through the irrigation system to detect leaks. (Nakahata, Tr. 2/15/08, p. 202, l. 9 to p. 203, l. 7.) The model also fails to account for irrigation water "lost" because it is applied just before it rains. (Nakahata, Tr. 2/15/08, p. 203, ll. 8-23.) HC&S FOF 118.

478. Fares' model assumes it is always practical for a sugarcane grower to apply irrigation water to a field to restore its soil moisture storage level to 100 percent once it depletes to 65 percent. (Fares, Tr. 2/15/08, p. 132, ll. 15-25.) In practice, irrigation water may not necessarily be available at the point the soil moisture level reaches 65 percent. Especially in the dry summer

months, fields could go for weeks without being irrigated. (Nakahata, Tr. 2/15/08, p. 187, ll. 4-22.) Moreover, because HC&S does not operate 24 hours a day, it may not necessarily have enough personnel on hand to shut water off to fields precisely at the point when the soil moisture reaches 100 percent. (Nakahata, Tr. 2/15/08, p. 189, l. 22 to p. 191, l. 7.) Therefore, if significant flows in the ditches are available, HC&S might intentionally irrigate in excess of the amount needed to restore the soil moisture level to 100 percent to create a reserve of water that can be tapped by the deeper part of the root zone in times of drought. (Nakahata, Tr. 2/20/08, p. 20, ll. 9-22.) HC&S FOF 119.

479. HC&S's water balance model considers the root zone to be where the majority of the roots are, which is at the approximate depth of two feet, but the roots could actually extend as deep as six feet. Nakahata testified about her observations of experiments conducted on HC&S Fields 921 and 922 in which lysimeters were installed at six feet depth and did not receive any water. Thus, although the water balance model would consider water going beyond the majority root zone to be "lost," it could still be available to the plant. This is the case even in fields with sandier soils, because moisture-retaining soil (such as loam) could lie beneath the sandy soil surface where the majority root zone resides. (Nakahata, Tr. 2/15/08, p. 21, ll. 11-14, p. 24, l. 14 to p. 26, l. 17, p. 29, l. 7 to p. 30, l. 24, p. 31, ll. 16-19.) HC&S FOF 119 (footnote).

480. HC&S will deviate from its water balance model as dictated by field conditions and other practical requirements. For example, HC&S does not rely strictly on the crop coefficient in the initial phase of crop growth. When a field is first planted, the primary objective is to keep the seed piece moist so as to ensure germination. (Volner, Tr. 1/29/08, p. 192, l. 21 to p. 193, l.6; Nakahata, Tr. 2/15/08, p. 185, ll. 14-18.) Water also needs to be applied constantly in the initial stage of growth to keep away the lesser cornstalk borer (*elasmopalpus lignosellus*) from boring into the shoots. (Nakahata, Tr. 2/15/08, p. 185, l. 19 to p. 186, l. 7; Nakahata, Tr. 2/20/08, p. 91, ll. 15-23.) Therefore, in the first six weeks to two months of a crop, HC&S might irrigate above the amount correlated to the 0.4 crop coefficient that its water balance model uses for the initial stage of a crop. (Nakahata, Tr. 2/15/08, p. 186, ll. 8-12.) Once a crop reaches the ripening state, the amount of water applied is no longer determined by evapo-transpiration. Instead, HC&S takes cane samples to determine when to irrigate the field. (Nakahata, Tr. 2/15/08, p. 184, ll. 6-14; Volner, Tr. 1/29/08, p. 192, ll. 14-20.) Other reasons for applying water to the fields besides

replacing moisture lost to evapotranspiration include application of fertilizer and herbicides. (Volner, Tr. 1/29/08, p. 193, ll. 12-17, p. 193, l. 22 to p. 194, l. 15.) HC&S FOF 120.

481. Fares has attempted to validate his model by comparing the optimal irrigation requirements calculated using the model to water duties for Hawai'i crops recommended by the National Resources and Conservation Services ("NRCS") of the U.S. Department of Agriculture. (Fares, Tr. 2/15/08, p. 133, l. 18 to p. 136, l. 13.) The NRCS recommendations are not published or peer reviewed. (Fares, Tr. 2/15/08, p. 137, ll. 3-11.) Moreover, the NRCS recommendations do not report data taken from the field. Thus, attempting to validate a model with the NRCS recommendations amounts to comparing one modeling methodology to another. (Fares, Tr. 2/15/08, p. 137, l. 15 to p. 138, l. 1.) Proper validation of a model requires comparison to an independent data set based on sugarcane grown in the field. (Fares, Tr. 2/20/08, p. 163, l. 16 to p. 164, l. 19.) HC&S FOF 121.

482. HC&S' actual water usage for the West Maui Fields in 2004 through 2006 is higher than the optimal irrigation requirements computed by Fares under his model. (Exh. A-80, pp. 6-7.) However, Fares declined to opine that HC&S is over-irrigating its fields. Fares would only say that under his model, the optimal irrigation requirement is less than what HC&S actually used in 2004 through 2006. (Fares, Tr. 2/15/008, p. 143, l. 20 to p. 144, l. 9.) HC&S FOF 122.

483. 2004 to 2006 were low rainfall years. (Exh. E-52.) Thus, it is plausible for 2004 to 2006 data to lie outside the probabilities generated from 1930-1983, which is the period of the data set that Fares relied on for the rainfall input of his model. (Ogoshi, Dec. 11/16/07, ¶ 6; Ogoshi, Tr. 2/20/08, p. 202, l. 23 to p. 203, l. 17.) HC&S FOF 122 (footnote).

484. Although Fares's and HC&S's water budget programs use different methods for determining evapotranspiration, those methods lead to the same result for a large part of the growth cycle of the sugar cane crop, because during the peak growth period the product of Dr. Fares's pan coefficient (0.8) and crop coefficient (1.25) is the same as HC&S's crop coefficient (1.0). In the rest of the growth cycle, HC&S's method would apply slightly more water in the initial growth stages for crops planted in the summer, but HC&S does not use its water balance model during ripening, which starts six months before harvest, during which the cane uses "very, very little water," and drying, which begins forty to sixty days before harvest, when HC&S does not apply any water at all. Fares's method decreases the irrigation linearly for the six months before harvest, and would continue applying irrigation water during drying. (Exh. C-80;

Nakahata, Tr. 2/20/08, p. 54, l. 4 to p. 55, l. 2; p. 68, l. 24 to p. 72, l. 7; Hew, Tr. 1/29/08, p. 84, ll. 8-10; Exh. C-78 (Exh. F), p. 2.) Hui/MTF FOF F-34.

485. In response to Ogoshi's criticism that real-time weather data is superior to historical long term data (Ogoshi, Dec. 11/16/07, ¶ 5) and his suggestion that using HC&S's 2004 through 2006 weather data may result in a higher optimal irrigation requirement for those years, Fares compared HC&S's evaporation and rainfall data from 2004 through 2006 with the long term data, and determined that on both the Waihe`e-Hopoi Fields and the `Īao-Waikapū Fields, the mean rainfall for 2004 through 2006 was actually higher than the mean rainfall over the 54-year period of record and the mean evaporation was lower. (Fares, Tr. 2/15/08, p. 40, ll. 7-23; p. 49, l. 25 to p. 51, l. 16; Exh. A-80D; Exh. A-80E.) Accordingly, Fares's water balance program calculated a lower optimal irrigation requirement for the Waihe`e-Hopoi Fields using HC&S 2004 through 2006 weather data than it did using the long-term weather data. (Exh. A-80F; Fares, Tr. 2/15/08, p. 58, l. 18 to p. 59, l. 7.) Hui/MTF FOF F-39.

486. Another difference between Fares and HC&S, which also results in Fares's model calculating a higher optimal irrigation requirement than HC&S's model, is depth of the root zone irrigated. Fares's calculations are based on irrigating a root zone which is initially 18 inches deep at planting, increases to 36 inches deep by the end of the first year, and remains at 36 inches deep throughout the second year. (Exh. A-80, p. 3.) (Fares' model overstates irrigation needs in the early growth stages by calculating the irrigation requirements to a depth of 18 inches, because at planting, the seed pieces have no roots.) HC&S calculates irrigation need for a root zone that is a maximum of two feet deep. During the initial crop growth stages, HC&S reduces that depth by applying the crop coefficient. (Nakahata, Tr. 2/20/08, p. 32, ll. 11-16; p. 18, l. 8 to p. 19, l. 6.) Hui/MTF FOF F-41.

487. Ogoshi, HC&S's expert, did not analyze HC&S's water balance model or irrigation records, and so, notwithstanding his disagreement with Fares's results to the extent they indicated that HC&S had overirrigated the Waihe`e-Hopoi Fields and `Īao-Waikapū Fields in 2004 through 2006, Ogoshi did not reach any conclusion that HC&S did not overirrigate those fields during that period; he did not know one way or the other. (Ogoshi, Tr. 2/20/08, p. 178, ll. 15-25.) Hui/MTF FOF F-52.

488. Fares concluded that the only difference that results in his model calculating lower optimal irrigation requirements than HC&S's is the choice of irrigation efficiency. (Fares, Tr.

2/15/08, p. 51, l. 17 to p. 52, l. 9; p. 128, ll. 7-9; Nakahata, Tr. 2/20/08, p. 72, l. 8 to p. 74, l. 7.) In running his program, Fares selected 85 percent for the irrigation efficiency. (Exh. A-80, p. 3 (Table 1); Fares, Tr. 2/15/08, p. 127, ll. 21-24.) Although drip irrigation can have irrigation efficiency greater than 90 percent, Fares selected 85 percent because it is the irrigation industry standard and the minimum efficiency for which drip irrigation systems are designed. (Tr. 2/15/08 (Fares), p. 52, l. 10 to p. 53, l. 6; p. 127, ll. 21 to p. 128, l. 3; p. 132, ll. 1-11.) For the purpose of its water balance program, HC&S assumes that "under drip irrigation . . . 80 percent of the water applied gets to the cane plant." (Exh. C-78 (Exh. F), p. 1; Volner, Dec. 9/14/07, ¶ 10.A.) Hui/MTF FOF F-42, F-43, F-44.

489. According to Nakahata, the 80 percent irrigation efficiency assumption was provided by HC&S's engineers. (Nakahata, Tr. 2/15/08, p. 198, ll. 18-24.) Volner and Nakahata agreed that the 80 percent efficiency (or uniformity) assumption has been used since before either of them started with HC&S; neither is aware of any actual measurements or studies conducted by HC&S to verify the assumption. (Nakahata, Tr. 2/20/08, p. 74, ll. 8-11, p. 76, ll. 21 to p. 77, l. 1; Volner, Tr. 1/30/08, p. 84, l. 22 to p. 85, l. 3; p. 88, ll. 1-4.) Hui/MTF FOF F-48.

490. The evidence HC&S provided of its actual water requirements, as opposed to its water use, was not from its water balance model. Volner testified that, by "historical daily requirement," he meant "the historical evapotranspiration for the Waihe`e-Hopoi fields which is based on historical records of Field 906. . . . It is what was actually required by the weather conditions." (Volner, Tr. 1/30/08, p. 67, ll. 2-6, p. 68, ll. 5-6.) The data from HC&S's weather stations, including the station at Field 906, is evaporation data, not a measurement of evapotranspiration (which is calculated by applying a crop coefficient to the evaporation). (Exh. A-80E; Nakahata, Dec. 11/16/07, ¶ 7; Nakahata, Tr. 2/20/08, p. 78, l. 24 to p. 79, l. 11; p. 83, l. 18 to p. 84, l. 19; Nakahata, Tr. 2/15/08, p. 166, ll. 11-13; p. 173, ll. 4-9; Volner, Dec. 9/14/07, ¶ 9.) Hui/MTF FOF F-54.

491. To calculate the "historical daily requirement of 6,826 gad" for the Waihe`e-Hopoi Fields, Volner testified that HC&S used 0.25 inches as the average of the historical evaporation measured at Field 906, multiplied it by 27,152 to convert it to gallons, and then divided by the acreage. (Volner, Tr. 1/30/08, p. 67, ll. 7-12.) 6,826 gad is HC&S's conversion of the historical daily evaporation at Field 906, which is measured in inches, into gallons per acre. (Volner, Tr. 1/30/08, p. 174, ll. 8-12.) Hui/MTF FOF F-55.

492. HC&S's calculation does not account for rainfall but assumes that all of the water lost through evapotranspiration must be replaced by irrigation. (Volner, Tr. 1/30/08, p. 67, ll. 16.) Efficient growth and sugar yields are maintained when the sum of the available rainwater plus irrigation water approach the evapotranspiration rate. (Volner, Dec. 9/14/07, ¶9.) Hui/MTF FOF F-56.

493. Using the daily average evaporation as a measure of water need also does not take into consideration the growth stage of the crop (both Fares' and HC&S's models use a crop coefficient to calculate the evapotranspiration) and thus overestimates irrigation requirements by assuming that, at any given time, all of the Waihe`e-Hopoi Fields are in the maximum growth stage in which evapotranspiration is roughly equal to pan evaporation. Use of daily average evaporation as a measurement of need does not account for fields that use less than the evaporation rate because they are in the initial growth stage, ripening, or drying (See Exh. C-80), or fields that are not using water because they are between harvest and planting, a period that can range from several weeks to several months (Volner, Tr. 1/30/08, p. 23, l. 13 to p. 24, l. 10.) Hui/MTF FOF F-57.

c. Alternative Water Sources

494. **HC&S's Well No. 7.** From 1927 until additional Nā Wai `Ehā water became available in the 1980s, HC&S's primary source of irrigation water for its Waihe`e-Hopoi Fields was Well No. 7 (USGS No. 16), a brackish water well. (Volner, Tr. 1/30/08, p. 107, ll. 6-12; Exh. A-143, pp. 127, 156 (map), ¶ 4.) Hui/MTF FOF F142.

495. Between 1927 and 1985, HC&S pumped an average of about 21 mgd from Well No. 7. (Exh. A-148, pp. 1-2, 5.) Since the additional Nā Wai `Ehā flows became available, HC&S has minimized its use of Well No. 7. (Volner, Dec. 9/14/07, ¶ 7) but continued to use heavily on occasion; e.g., for the six-month period from June through November of 1996, an average of 25 mgd was pumped (Exh. A-148, p. 3); and for the six-month period from May through October of 2000, an average of 18.9 mgd was pumped. (Exh. A-148, p. 3). Hui/MTF FOF F-143.

496. Well No. 7 is currently configured with three pumps: pumps 7A and 7B are at water level and can each pump 17.5 mgd to ground level, and pump 7C is a booster pump at ground level which can pump 14 mgd from pump 7A up to HC&S's Waihe`e Ditch, from which the water can be distributed to all of the Waihe`e-Hopoi Fields except for the 175-acre Field 715.

(Volner, Tr. 1/29/08, p. 176, ll. 1-25; Volner, Tr. 1/30/08, p. 180, ll. 7-8.) Without using pump 7C, water from Well No. 7 can reach Fields 904, 908, and 909, which total approximately 800 acres. (Tr. Volner, 1/30/08, p. 35, ll. 4-12.) Hui/MTF FOF F-144. HC&S FOF 132.

497. According to HC&S, as currently configured, Well No. 7 can supply only 14 mgd to the Waihe`e-Hopoi Fields, with the exception of Field 715. (Volner, Dec. 11/16/07, ¶ 3.) However, HC&S's records do not indicate that Well. No. 7 was ever configured differently than its current configuration (Volner, Tr. 1/30/08, p. 35, ll. 13-22). Hui/MTF FOF F-145.

498. HC&S estimates that it would cost approximately $525,000 to add another booster pump and additional distribution pipeline to increase the volume that can be pumped from Well No. 7 to HC&S's Waihe`e Ditch from 14 mgd to 28 mgd; and the cost of an additional pipeline to reach Field 715 would be $475,000. (Volner Dec. 11/16/07, ¶¶ 5, 7.) Hui/MTF FOF F-146, F-147. HC&S FOF 132.

499. HC&S also claims that it does not have adequate electrical power to run the pumps for Well No. 7 on a consistent and sustained basis because of its power contract with Maui Electric Company ("MECO") and limitations of its capacity to generate electricity through its system of burning bagasse and other supplemental fuels in its power plant and the operation of its hydro power turbines on its ditch system which are supplied by East Maui water (Nā Wai `Ehā stream waters comprise its West Maui ditch system). (Volner, WDT 9/14/07, ¶¶ 20, 20A, 20B,20C, 22; Volner, WDT 10/26/07, ¶¶ 7-10; Volner, Tr. 1/29/08, p. 184, ll. 1-25, p. 206, l. 21 to p. 207, l. 22; Exh. C-27; Holady, Tr. 1/31/08, p. 14, l. 23 to p. 15, l. 1.) HC&S FOF 133-139.

500. HC&S also claims that any increased pumping of water from the Kahului aquifer to replace surface water being imported from the West Maui Ditch System would both exacerbate the degree to which the sustainable yield is already being exceeded and reduce the recharge from imported surface water that sustains the aquifer. (Eng, Tr. 12/14/07, p. 11, ll. 20-22, p. 47, l. 19 to p. 48, l. 3; Exh. C-90, p. 2; Exh. A-185, pp. 2-3; Exh. B-13; Exh. C-90.) HC&S FOF 141-143.

501. **Recycled County Wastewater.** Reclaimed water resources on Maui include at least five mgd available from the County of Maui's Wailuku/Kahului wastewater treatment plant, which currently is unused and disposed of via underground injection. (Parabicoli, Tr. 1/25/08, p. 152, ll. 11-18.) Several hundred thousand gallons a day of reclaimed water are also produced by private treatment plants in Ma`alaea, but are also unused and disposed of. (Parabicoli, Tr. 1/25/08, p. 139, l. 11 to 140, l. 1.) Hui/MTF FOF E-161, E-163.

502. It was suggested that wastewater produced by the County of Maui could be used by HC&S. However, the County currently has no existing infrastructure to deliver recycled wastewater to HC&S' fields. (Parabicoli, Tr. 1/25/08, p. 159, ll. 1-14.) HC&S FOF 145

503. None of the parties in this case ever approached the county about any use of reclaimed water. (Parabicoli, Tr. 1/25/08, pp. 144-47; p. 148, ll. 19-24.) Hui/MTF FOF E-174.

504. Parabicoli, the county official in charge of reclaimed water use (Parabicoli, Tr. 1/25/08, p. 135, l. 8 to p. 136, l. 17), agreed that private parties could construct their own pipeline to the plant. (Id. p. 153, l. 15 to p. 154, l. 9.) Hui/MTF FOF E-171.

505. **Recycled Wastewater from HC&S's Puunene Mill.** HC&S already utilizes wastewater from its Puunene Mill. In 1997, HC&S developed a project to use reclaimed wastewater from the Puunene mill for certain fields in Puunene and Paia via drip irrigation. The project presented challenges in the form of difficulty filtering the water to the level suitable for drip irrigation; the high nitrogen content of the water, which interfered with ripening of the cane; high cost of maintenance and repairs; and declining yields. Due to these problems, HC&S had to convert the drip irrigation system for these fields to overhead sprinklers. Fields 710, 711, 712, 713, 714 are fields that are actively or were actively irrigated with the overhead sprinkler system. (Volner, Tr., 1/29/08, p. 160, l. 14 to p. 161, l. 14; Exhibit E-1.) HC&S FOF 146.

506. **Recycled Wastewater from MLP.** Between 1995 and 1997, MLP injected their wastewater into an injection well in Kahului at their cannery facility. Methane buildup in the well caused an explosion. Therefore, MLP entered into an agreement with HC&S to transport wastewater from their cannery facility to HC&S Fields 921 and 922, which was pasture land at the time. (Volner, Tr. 1/29/08, p. 161, l. 23 to p. 162, l. 16; Exhibit C-77.) Fields 921 and 922 are currently irrigated with Nā Wai 'Ehā surface water. (Volner, Tr. 1/30/08, p. 179, ll. 16-19.) The shutdown of the canning operation will reduce the amount of wastewater available in the future by approximately one half. HC&S FOF 147.

J. Economic Impact on Non-Instream Uses

507. The current and potential non-instream uses include all users of diverted stream waters: 1) the kuleana landowners and MCLT, who seek restoration to benefit their lands; 2) MDWS, who favors restoration of the Nā Wai `Ehā streams while also preserving and even expanding its use of those surface waters; 3) WWC's Water Delivery Contractees; 4) even WWC, who uses no

water directly but is in the business of delivering stream waters to non-instream users; and 5) HC&S, the major user.

508. No information was presented at the CCH concerning the positive economic impact on kuleana landowners and MCLT, although general testimony was presented on the kinds of crops and activities they would be able to engage in if they were to receive more stream waters.

509. Information on MDWS was focused on the role of stream waters as part of its integrated water supply system and the benefit to its public users.

510. Information was presented on some of WWC's Water Delivery Contractees' water uses, which included the availability of MDWS water for at least some of them.

511. Some information was presented on WWC's water delivery charges, which presumably would be impacted if stream diversions were to be reduced.

512. According to a prospectus sent to shareholders on October 3, 2005, WWC stated that it charges its customers "between $0.20 and $2.40 per thousand gallons delivered." (Exh. B-5, p. 3.) MDWS FOF 76.

513. The contracts provided by WWC indicate that most of its customers pay a rate equivalent or approximate to the county rate for agricultural water, or about $0.85 or $0.90 per thousand gallons. (**See**, e.g., Exh. D-90, § 1.12). Hui/MTF FOF E-44.

514. Many of WWC's contracts do not involve any actual present use of water, but rather allow WWC to collect a minimum charge, regardless of any actual use, based on a percentage of the stipulated maximum delivery. **See**, e.g., Exh. D-87, § 1.05; Chumbley, Tr. 1/24/08, p. 91, l. 13 to p. 92, l. 9.) Hui/MTF FOF E-15.

515. The state Public Utilities Commission ("PUC") has taken action to regulate WWC based on the understanding that "WWC is and has been operating as a public utility without proper authority." (Exh. C-25, p. 18.) In its February 8, 2008 application to the PUC for a Certificate of Public Convenience and Necessity ("CPCN") and approval of its proposed tariff, WWC stated that it has created a new utility company, Wailuku Water Distribution Company, LLC ('WWDC"), of which WWC is the sole member, and from which WWC proposes to exact lease payments to use the watershed land and ditch system. (Chumbley, Tr. 3/3/08, p. 117, ll. 11-18; Exh. C-87, Exh. 2.) Hui/MTF FOF E-16.

516. WWC proposes to the PUC a tariff rate of $0.90 per 1,000 gallons, while acknowledging PUC precedent declaring preexisting rate contracts unenforceable and unlawful. (Exh. C-85, p. 11, ll. 1-20.) Hui/MTF FOF E-17.

517. WWC requested the PUC to approve a 10 percent profit rate. (Exh. C-85, p. 16, ll. 12-20.) In contrast, WWC made a 14.59 and 13.85 percent profit in 2006 and 2007. (Chumbley, Tr. 1/16/08, p. 58, ll. 7-16; Chumbley, WDT 9/14/07, p. 15, l. 5.) Hui/MTF FOF E-18.

518. WWC also receives a delivery fee for the amount taken in excess of 1.074 mgd from its and MDWS's `Īao Tunnel (Well No. 5332-02). (Tr. XI, pp. 48-50; Tr. XII, pp. 88-89.) WWC FOF 817. The amount of this fee was not introduced into evidence.

519. As previously noted, in 2004 MDWS and WWC entered into an agreement until November 30, 2010, allowing MDWS to receive up to 3.2 mgd from the `Īao-Waikapū Ditch whenever the total flow in `Īao Stream exceeds 55 mgd at the USGS gauging station above the WWC `Īao Ditch Diversion (which then splits into the `Īao-Maniania and `Īao-Waikapū Ditches). (Chumbley, WDT 9/12/07, p. 9; Exh. D-8(i); Exh. D-93.) WWC FOF 192, 194. No evidence was introduced on whether or not there is a delivery fee.

520. As previously noted, WWC does not charge the kuleana users for deliveries. FOF 160, *supra.* As previously noted, HC&S pays WWC a flat fee per acre for water used on the `Īao-Waikapū Fields, regardless of how much water is used; in 2005 that fee was $300/acre/year. (Tr. 1/30/08 (Volner), p. 26, ll. 3-7; Exh. D-56, p. 4; Chumbley, Tr. 1/24/07, p. 41, ll. 3-18.) Hui/MTF FOF F-10.

521. The focus at the CCH on the economic impact on non-instream uses was on HC&S.

522. HC&S has concluded that, in addition to the technical issues associated with pumping a substantial amount of water from Well No. 7 to replace ditch waters, it would: 1) incur estimated costs of $1 million to install new pipelines and pumps (Volner, WDT 9/14/07, ¶¶ 6-7; Volner, WDT 11/16/07, ¶¶ 3,5;Volner, Tr. 1/29/08, p. 176, ll. 19-25, p. 177, ll. 3-25) HC&S FOF 132; 2) incur costs of $777,650, in addition to the $1 million, because MECO would require upgrades to its pumps and related electrical equipment to MECO's standards for servicing such equipment (Volner, WDT 11/16/073, ¶ 7; Exh. E-21) HC&S FOF 139; 3) cost an additional $310 per MWH, or $7,440 per day, to run Well No. 7 (Volner, WDT 11/16/07, ¶ 9) HC&S FOF 139) and 4) lose $1.8 million in annual revenues under its contract with MECO as well as a decrease in HC&S's

avoided cost rate and penalties three times the power rate for power it does not deliver (Holaday, Tr. 1/31/08, p. 15, l. 10 to p. 16, l. 19). HC&S FOF 134.

523. A key factor in HC&S' ability to sustain itself is the economies of scale it can apply to the approximately 35,000 contiguous acres it cultivates on Maui, of which the West Maui Fields comprise about 5,300 acres. (Holaday WDT 9/14/07, pp. 2-3; Volner, Tr. 1/30/08, p. 200, Exh. E-28). WWC FOF 197-198.

524. The West Maui Fields provide the most productive yields of all of HC&S's cultivated lands, making the West Maui Fields critical to the viability of HC&S. (Holaday, WDT 9/14/07, pp. 2-3; Holaday, Tr. 1/31/08, p. 65; Volner, Tr. 1/30/08, p. 200.) WWC FOF 199.

525. In 2006, HC&S grew 81 percent of Hawai`i's raw cane sugar crop. (Holaday, WDT 9/14/07, p. 2.) WWC FOF 200..

526. HC&S employs about 800 full-time workers and EMI employs about 17 workers on Maui. (Holaday WDT 9/14/07, p. 5; Holaday, Tr. 1/31/08, p. 11; Hew, Tr 1/29/08, pp. 9, 165-168; Exh. E-28.) WWC FOF 202.

527. HC&S forecast that it generates approximately $250,000,000 annually to the County of Maui and State of Hawai`i economies (using a multiplier of 2.5 to the $100,000,000 plus HC&S expenditure on Maui each year). (Holaday WDT 9/14/07, p. 5.) WWC FOF 203.

528. HC&S' sustainability is to some extent a result of its ability to spread its fixed costs of mill and related facilities operations over the revenues generated from farming the extensive acreage. (Holaday WDT 9/14/07, p. 2; Holaday, Tr. 1/31/08, p. 13; Holaday, Tr. 1/30/08, pp. 201-202.) WWC FOF 204.

529. One method of spreading costs is to generate revenues from the by-products of farming sugar cane and production of raw sugar. (Holaday, WDT 9/14/07, pp. 2-7.) WWC FOF 205.

530. One revenue source, energy sales, comes from the burning of bagasse, a by-product of sugar cane production, and from hydro power, a by-product of operation of a water delivery system. (Holaday, WDT 9/14/07, p. 2-3.) HC&S's business success depends on its ability to receive significant revenues from selling the electric power it generates to Maui Electric Company under long term contracts. (Holaday WDT 9/14/07, pp. 2 - 3; Holaday, Tr. 1/31/08, pp. 13-20; Holaday, Tr. 1/30/08, pp. 190, 200-201.) Revenues from energy sales make up about 20 percent of the total revenues generated by the agribusiness companies compared to about 5

percent of the total revenues from a decade before. (Holaday, WDT 9/14/07, pp. 2 - 3; Holaday, Tr. 1/31/08, pp. 19-20, 140-142; Holaday, Tr. 1/30/08, p. 201.) WWC FOF 206-208.

531. HC&S diversified its product line by increasing production of foodgrade raw sugar, which returns a higher margin than commodity sugar. (Holaday WDT 9/14/07, pp. 3-4; Holaday, Tr. 1/31/08, pp. 12-13, 19-20.) WWC FOF 211.

532. In the last four years, HC&S made capital investments of up to $20,000,000 supporting its efforts to diversify product lines, reduce costs of production, and increase revenues from other sources. (Holaday, WDT 9/14/07, p. 4; Holaday, Tr. 1/31/08, pp. 19-21.) WWC FOF 212.

533. HC&S states that, if reductions in HC&S' use of Nā Wai 'Ehā stream water were of such a magnitude as to force HC&S not to cultivate the 5,300 acres that comprise the West Maui fields, HC&S would not be a viable plantation. (Volner, Tr., 1/30/08, p. 200, ll. 17-21; Holaday, Tr. 1/31/08, p. 143, ll. 9-14.) In addition to the immediate impacts in terms of lost jobs and in excess of $100,000,000 of spending on Maui, closure of HC&S will have a deleterious effect on efforts to promote agriculture and curb urbanization in Hawai'i. The withdrawal of HC&S' 35,000 acres of prime agricultural lands from sugar would vastly increase the agricultural lands in the State of Hawai'i and on Maui that are idle. Past experience with closure of other plantations has demonstrated the difficulty of returning former plantation lands into agriculture, especially if reliable access to irrigation water is curtailed. This increases the pressure to urbanize these lands instead of keeping them in agricultural use. (Holaday, WDT 9/14/07, ¶ 18; Kennison, Tr. 1/25/08, p. 55, l. 19 to p. 56, l. 6.) Idling of HC&S' lands will also result in the deterioration of existing irrigation systems and infrastructure that would be extremely expensive to replace. (Holaday, WDT 9/14/07, ¶ 18.) HC&S FOF 123-124.

534. Generally, remaining economically viable involves achieving targets in terms of sugar yields and maintaining a reasonable cost structure. Small reductions of water for irrigation on any given day might have little or no negative impact, depending on weather conditions, location, and crop cycle. Larger, persistent reductions, with no corresponding mitigation of impacts, especially if combined with reductions in the amounts that HC&S will be permitted to continue to divert in East Maui, will likely render HC&S unviable. (Holaday, WDT 10/26/07, ¶ 4.) HC&S FOF 126.

535. The key agronomic driver in determining sugar production is per acre yields, which is measured in tons of sugar per acre ("TSA"). HC&S has determined that, on a long term basis,

sustainable yields should be between 13 and 14 TSA per crop cycle, which would translate into over 200,000 tons of sugar per year given the acreage that HC&S has in cultivation. HC&S needs to achieve yields in this range to remain viable, i.e., to generate sufficient revenues to carry its fixed and variable costs and return a reasonable profit to its shareholders. One of the most important variables determining yields is water. (Holaday, WDT 9/14/07, ¶ 12; Holaday, Tr. 2/22/08, p. 116, ll. 15-21.) As a rule of thumb, HC&S needs to harvest about 400,000 acre-months of cane growth per year to be viable. That translates into approximately 200,000 tons of sugar. (Holaday, Tr. 1/31/08, p. 44, l. 22 to p. 45, l. 3.) Reduction of water deliveries to Waiale Reservoir, especially during periods of low ditch flows, will force HC&S to try to replace that water to the extent possible by pumping water from Well No. 7 at the expense of pumping from other wells. However, power limitations restrict the amount of water that HC&S can ultimately pump, which affects sugar yields. (Holaday, WDT 9/14/07, ¶ 13.) HC&S FOF 127.

536. Prolonged drought conditions, such as HC&S has experienced for much of the last 15 years, can cause a reduction in average crop age by delaying the replanting of harvested fields and prompting the premature harvesting of fields whose growth potential is compromised by lack of water. Disease and other operating conditions can also cause a reduction in average crop age. In addition, during water-short periods, the cane does not grow; hence the physical age of the cane is greater than the growth age. (Holaday, WDT 11/16/07, ¶ 7.) HC&S FOF 128.

537. The average crop age of harvested acres at HC&S has dropped from 2003 to 2006 due to the combined effects of drought and HC&S's 2001 closure of its Paia Mill, which was done to reduce costs and increase efficiency by centralizing all sugar processing at the Puunene Mill. In 2001, total acres harvested were approximately 2000 less than the prior year, because the Puunene Mill was initially unable to absorb all of the lost capacity from the Paia Mill closure. Harvesting fewer acres increased the average crop age of the unharvested acres. As capacity was added to the Puunene Mill and HC&S gained more experience in the reconfigured operation, harvested acres increased again, resulting in a lower average crop age and lower yields. (Holaday, WDT 11/16/07, ¶ 7.) HC&S FOF 129.

538. Given the currently reduced crop age of HC&S' fields, HC&S expects to reduce its rate of harvesting into 2008 and 2009 to allow for an increase in crop age so as to improve yields, and then return to harvesting at its historic rate of approximately 16,000 to 17,000 acres per year that maximizes the acreage that can be served with currently available irrigation water as well as the

current processing capacity of the Puunene Mill. The short-term result will be diminished revenues both from reduced sugar production and reduced production of bagasse to fuel the power plant. The hoped for longer term result will be increased yields which, together with increased revenues from the production and sale of specialty sugars and further expansion of energy related sales, will allow HC&S to remain economically viable. This will only be possible, however, if HC&S's continued access to irrigation water is not unduly compromised. (Holaday, WDT 11/16/07, ¶ 11.) HC&S FOF 130.

539. Chan-Halbrendt, OHA's expert witness, determined that HC&S "provided no economic analysis of the impacts of decreasing its use of Nā Wai `Ehā water," and "made no apparent attempt to substantiate and quantify the impact, even though I believe many of the essential data for such analysis are within HC&S's possession." (Exh. C-46, p. 1.) Hui/MTF FOF F-188.

540. Referring to Alexander & Baldwin's ("A&B") form 10-K filings (Exh. C-47) Chan-Halbrendt remarked that, "looking at this data, it makes you also wonder how they could make these statements." (Chan-Halbrendt, Tr. 2/22/08, p. 65, ll. 11-17.) She cited the following examples:

a. HC&S claimed that, in order to remain economically viable, it needed to achieve a yield of 13 to 14 tons of sugar per acre ("TSA") on a sustainable, long-term basis. (Holaday, Dec. 9/14/07, ¶ 12.) The data from A&B's 10-K filings indicate that HC&S had obtained those yields in only four of the fifteen years from 1992 to 2006, and that there was only a weak correlation, if any, between the TSA and HC&S's profits. (Exh. C-46, p. 3; Exh. C-47; Chan-Halbrendt, Tr. 2/22/08, p. 65, l. 18 to p. 66, l. 5.)

b. HC&S claimed that it had "benefitted" from the acreage it leased in the `Īao-Waikapū Fields and the additional Nā Wai `Ehā water it gained access to when WWC's predecessor abandoned sugar cultivation. (Holaday, Dec. 9/14/07, ¶ 8.) The data from A&B's 10-K filings indicates that HC&S's raw sugar production was lower in the ten years after 1994, when it leased the additional acreage in the `Īao-Waikapū Fields, than it was in the ten years before, and the profitability of the agribusiness sector, of which HC&S is a part, actually decreased after 1988, when HC&S gained access to the additional Nā Wai `Ehā stream water. (Exh. C-46, p. 3; Exh. C-47; Chan-Halbrendt, Tr. 2/22/08, p. 66, l. 6 to p. 67, l. 1.)

c. HC&S claimed that maintaining the number of acres it has in sugar cultivation is necessary to remain economically viable (Holaday, Dec. 9/14/07, ¶ 6; see also Holaday, Tr. 1/31/08, p. 54, ll. 2-5.) A&B's 10-K filings, though, indicate that, from 2000 through 2005, HC&S decreased its cultivated acreage by more than 2000 acres, which increased only slightly in 2006. (Exh. C-47; Exh. C-46, p. 4.) Moreover, A&B has development plans that would remove almost 3,500 additional acres from cultivation. (Exhs. A-204 to A-209.)

Chan-Halbrendt concluded that the discrepancy between HC&S's broad conclusions about economic impact and the limited available data highlights the need for economic analysis, rather than unsubstantiated assumptions, to support reasoned decision-making. (Exh. C-46, p. 2.) Hui/MTF FOF F-189.

541. HC&S has also claimed that its survival hinges on the `Īao-Waikapū Fields and having sufficient Nā Wai `Ehā water to irrigate them (Holaday, Dec. 10/26/07, ¶ 7), but it made no apparent attempt to acquire those lands when they became available (Volner, Tr. 1/30/08, p. 186, l. 17 to p. 187, l. 3). HC&S had no written agreement with WWC after July 2003, when WWC refused to extend the land lease and announced HC&S was "no longer entitled to any water allocation pursuant to that Temporary Water Agreement." (Exh. A-212, pp. 1-2; Chumbley, Tr. 3/3/08, p. 96, l. 9 to p. 97, l. 17.) This continued until July 2005 (after the IIFS petition was filed), when Atherton et al. began acquiring the land and HC&S and WWC settled on their present terms for water in a one-page letter. (Exh. D-56, p. 4.) Hui/MTF FOF F-190.

542. To assess whether reducing the Nā Wai `Ehā water available to HC&S on 15 percent of its cultivated acreage would have impacts that extend to the economies of the County of Maui and the State of Hawai`i would require, initially, a partial equilibrium analysis to determine the impacts on HC&S, which would then feed into a general equilibrium analysis which would consider inter-sectoral, employment, and income impacts and may include the economic values and opportunity costs of alternative uses of water, including instream uses. (Exh. C-46, pp. 1-2; Chan-Halbrendt, Tr. 2/22/08, p. 67, l. 21 to p. 68, l. 8.) Such an analysis, had HC&S performed

one, may potentially have revealed "not only a mitigation of adverse impact, but also an overall increase in economic and social welfare" because, among other things, "reallocation of water can facilitate its efficient and equitable distribution to higher valued uses, both within agriculture as well as in other sectors." (Exh. C-46, pp. 4-5; see also Chan-Halbrendt, Tr. 2/22/08, p. 67, ll. 4-17; p. 68, ll. 9-17.) Hui/MTF FOF F-191.

543. Chan-Halbrendt, commenting on HC&S's description of the impacts of shutting down its sugar operations entirely, concluded that "the relevant issue requiring analysis is the economic impact of decreasing the supply, or increasing the cost, of water to approximately 15 percent of HC&S's fields. Absent that analysis, there is no reason to suppose that cessation of all sugar cultivation would be an economically rational response." (Exh. C-46, p. 4.) Hui/MTF FOF F-192.

544. A&B's practice is to shut down an operating company if the losses incurred in operating the company are greater than the costs of not operating the company. Consistent with its past practice, Holaday believes that A&B would shut HC&S down if and when the operating costs of HC&S exceeded the holding costs that would be incurred in shutting the company down, such as real property taxes, insurance, security, and other holding costs, "things like that that you project what those costs are," as well as the social costs. (Holaday, Tr. 1/31/08, p. 115, l. 10 to p. 116, l. 24.) Hui/MTF FOF F-193.

545. Chan-Halbrendt commented that one such cost would be significantly increased real property taxes; for example, in 2007, the County of Maui assessed the value of HC&S's agricultural lands in TMKs (2) 3-8-5-3, (2) 3-8-5-2, (2) 3-8-6-3, and (2) 3-8-5-23 alone (those TMKs comprise the Waihe`e-Hopoi Fields and Field 920), at $60,892,600, but, because the land was in agriculture, HC&S paid real property taxes on a net taxable land value of only $2,388,400.00 for those TMKs, less than five percent of the total assessed land value. (Exhs. C-52A – C-52D.) Almost twenty years ago, the state Department of Business and Economic Development recognized that one of the incentives for a sugar company to continue operations despite lack of profitability was "banking land for future development while continuing to pay low property taxes afforded by the favorable tax assessments on agricultural land (i.e., profits are made instead on the annual appreciation of the land)." (Exh. C-46, p. 7.) Hui/MTF FOF F-194.

546. HC&S had not "done any economic analysis on how a reduction of available surface water in this case would force HC&S to shut down"; Mr. Holiday "[could not] say yes or no" when asked whether shifting 9 mgd of Nā Wai `Ehā surface water to another purpose would

prevent HC&S from being viable, but testified that HC&S is "assuming" that impact "for planning purposes." (Holaday, Tr. 1/31/08, p. 114, l. 10 to p. 115, l. 15; p. 78, l. 25 to p. 79, l. 13.) Hui/MTF FOF F-195.

547. Chan-Halbrendt concluded that an assessment of the economic effect, if any, of incremental reductions of available Nā Wai `Ehā water could be done through a partial equilibrium analysis, which could be very simple and would rely on data that HC&S should have available; it is the type of analysis HC&S claims that it routinely employs for planning purposes, although it did not in this case. (Exh. C-46, p. 1; Chan-Halbrendt, Tr. 2/22/08, p.106, l. 20 to p. 107, l. 6; Holaday, Tr. 2/22/08, p. 110, l. 16 to p. 111. l. 13.) Hui/MTF FOF F-198.

548. A partial equilibrium analysis could examine the impact on HC&S's profitability under several scenarios, such as: use of pumped ground water or conservation measures to compensate for incremental reductions of Nā Wai `Ehā water; projected change in yield caused by varying increments of water reduction; incremental shifts in cultivated acreage in response to incremental reduction in available water; or a combination of such factors. (Exh. C-46, p. 1.) Hui/MTF FOF F-199.

549. Chan-Halbrendt stated that the scenarios identified for analysis in a partial equilibrium analysis are substantially the same as those identified by HC&S as available options in the event its access to Nä Wai `Ehä is restricted. HC&S's estimate of electrical costs of pumping Well No. 7, without any information about the costs or benefits of the other options, might be a factor in an economic analysis, but does not substitute for the analysis. (Chan-Halbrendt, Tr. 2/22/08, p. 88, l. 25 to p. 90, l. 3.) HC&S has not analyzed the economic impact of increased water costs on its business (Holaday, Tr. 1/31/08, p. 80, l. 23 to p. 81, l. 2) and has done no financial analysis of the impact of having to pay for water at the agricultural rate that other farmers pay (Holaday, Tr. 1/31/08, p. 131, ll. 16-20; p. 132, ll. 10-21). Hui/MTF FOF F-200, F-201, F-202.

550. Chan-Halbrendt was asked to evaluate the economic analysis undertaken by HC&S, not perform an independent economic analysis of the impact of stream water reductions to HC&S. (Chan-Halbrendt, Tr. 2/22/08, p. 65, ll. 5-10, p. 76, ll. 17-23.) HC&S FOF 156.

551. According to Chan-Halbrendt, "the lack of any economic analysis, or the data required to conduct such an analysis, prevents anyone, including this Commission, from evaluating HC&S's claims of economic impact." (Exhibit C-46, p. 1) By economic analysis, Chan-Halbrendt refers to an appropriate tool or framework to study economic performance under certain conditions.

(Chan-Halbrendt, Tr., 2/22/08, p. 60, ll. 2-8.) Specifically, she advises conducting a general equilibrium analysis and partial equilibrium analysis. General equilibrium analysis analyzes how an industry affects other sectors' economy, while partial equilibrium analysis analyzes the impact of changes on economic performance on the industry itself. (Chan-Halbrendt, Tr. 2/22/08, p. 60, l. 22 to p. 61, l. 2.) HC&S FOF 157.

552. Chan-Halbrendt did not review Volner's testimony or the testimony and evidence received at the hearings, which would contain information relevant to an economic analysis. (Chan-Halbrendt, Tr. 2/22/08, p. 85, l. 13 to p. 87, l. 8, p. 89, ll. 8-15.)

553. Chan-Halbrendt also criticized HC&S's claim that it needs to produce 13-14 TSA per crop cycle to remain economically viable. She noted that A&B's Form 10-K filings show that since the 1980's, HC&S has achieved the yield of 13-14 TSA only four out of 15 years, and yet, in that period, HC&S failed to make a profit only three out of five years. (Chan-Halbrendt, Tr. 2/22/08, p. 65, l. 11 to p. 66, l. 5; Exhibit C-46, p, 3.) In addition, she opined that the Form 10-K filings do not support HC&S's claim that its operations benefited from leasing additional acreage and receiving additional water from WWC after the closure of Wailuku Sugar Co., because the filings show that production was higher on average before HC&S leased the additional land than afterwards. (Chan-Halbrendt., Tr.,2/22/08, p. 66, l. 9 to p. 67, l. 1; Exhibit C-46 at 3-4.) HC&S FOF 159.

554. HC&S's response is that financial information about the A&B Agribusiness Group reported in the Form 10-K filings is meant only to provide a general view of the performance of the group. The filings do not account for revenues not based directly on sugar production, such as power sales to MECO. The filings also do not account for increased costs, declines in sugar prices, the effects of disease and drought, the effects of federal disaster relief payments received by HC&S for drought conditions, the inclusion of C&H in the financial reports of the Agribusiness Group from 1993 through 1998, the addition of specialty sugars sales in later years, and other factors that influence the profitability of HC&S. (Holaday, WDT 11/16/07, ¶ 4.) Holaday testified that given HC&S' cost structure, which in 2008 totaled approximately $104 million, HC&S needs to generate revenue based on 13-14 TSA to remain viable going forward. (Holaday, Tr. 2/22/08, p. 109, l. 13 to p. 110, l. 9, p. 112, ll. 14-15.) HC&S FOF 160.

555. Second, Chan-Halbrendt did not focus on crop age and acres harvested. There is a very high correlation between average crop age per acre harvested and TSA. All other things being

equal, the greater the age of the cane at the time of harvest, the greater the yield and the resulting sugar revenues over which to spread the average cost of preparing, planting, and harvesting each acre during a given two-year cycle as well as the fixed costs of operating and maintaining HC&S' mill and other facilities. All other things being equal, producing more sugar per acre harvested in turn results in more net sugar revenues, and harvesting more acres results in the production and sale of more sugar. (Holaday, WDT 11/16/07, ¶¶ 5, 6, 10; Holaday, Tr. 2/22/08, p. 118, l. 21 to p. 119, l. 17; Exh. E-22.) HC&S FOF 161.

K. <u>Interim Instream Flow Standards ("IIFS")</u>

556. Benbow, Hui/MTF's expert witness, concluded that "(p)ending firmer scientific information from further studies, flow restoration should uphold two guiding principles. First, the flow amounts must create enough quality habitat to support sustainable, reproductive instream biological communities, taking into account public uses such as Native Hawaiian gathering practices. Second, the flow amounts must maintain enough continuous flow from mauka to makai to enable the streams to serve their natural ecological functions, including sustaining the life cycles of the native amphidromous species. (Benbow, Tr. 12/10/07, p. 22, ll. 7-21; Benbow, WDT 9/14/07, ¶ 22.) Hui/MTF FOF C-48.

557. Ford, HC&S's expert witness, disagreed that continuous flow from mauka to makai is necessary to enable the streams to serve their natural ecological functions and distinguishes between physical connectivity versus ecological connectivity (stream flows of sufficient volume and frequency to allow the normal distribution of native amphidromous species within a given watershed). (Ford, Tr. 12/10/07, p. 219, l. 24 to p. 221, l. 7; Exh. E-53, p. 41, § 1.0 and p. 43, § 8.0.) HC&S FOF 50.

558. The diversion structures consisting of grates spanning the entire stream channel are potentially the worst possible configuration from a biological perspective because they sever the mauka to makai flow continuum and impose a physical barrier and trap, preventing passage of native amphidromous stream life between upstream habitats and the ocean. (Benbow, WDT 9/14/07, ¶ 16; Payne, Tr. 12/12/07, p. 103, ll. 1-22.) Hui/MTF FOF C-28.

559. HC&S's consultants expressed the desire to explore ways that might lead to improved migration over the dam. There would be various mechanisms available to provide water, and these particular structures could be modified in some ways to provide a flow, including blocking

off some of the grated areas. (Ford, Tr. 12/11/07, p. 131, l. 16 to p. 132, p. 23; Payne, Tr. 12/12/07, p. 104, ll. 4-16.) Hui/MTF FOF C-67.

560. Particularly in Waihe`e River and `Īao Stream, the diversions take almost all (more than 90 percent and sometimes up to 100 percent) of their total low flows, leaving stream beds dry for extended lengths and without connection to the ocean. Habitat above the diversions is characterized by high flow, numerous riffles, and cascades, while habitat below the diversions, where existing at all, is characterized by low flow, infrequent riffles, and small shallow pools. (Benbow, WDT 9/14/07, ¶ 15.) Hui/MTF FOF C-26.

561. Benbow, Hui/MTF's expert witness, has conducted multi-year studies of Central Maui streams and found that the largest migrations of native stream species occur in streams with minimal or no diversions, and the greatest reductions in recruitment during drought occur in diverted streams such as Waihe`e River. (Benbow, WDT 9/14/07, ¶¶ 11, 36.) Hui/MTF FOF C-16.

562. SWCA Environmental Consultants ("SWCA") was retained by HC&S to evaluate amphidromous species in the four Nā Wai 'Ehā streams, conducting the studies in 2007 and early 2008. A series of larval drift sampling was also performed in Waihe'e Stream, Waiehu Stream, and Waikapū Stream, and in ditch discharges diverted from 'Īao Stream. Larval drift sampling was conducted to evaluate whether amphidromous species are reproducing within the Nā Wai 'Ehā streams. The larval drift sampling employed methods developed by Lindstrom (1998a,b). (Exhibit E-53 at 22 (§ 6.4).) HC&S FOF 51.

563. SWCA described its findings in Waihe`e River as normal patterns of migration, species and size distribution, and reproduction throughout the stream under diverted conditions, with its larval drift sampling indicating that Waihe`e River is the only stream that appears to have significant reproductive populations of native amphidromous species. (Exh. E-53, p. 44, § 9.0.) HC&S FOF 53.

564. SWCA observed low numbers of adult amphidromous species in Waiehu Stream. No larvae were found in the downstream drift samples collected from the stream. Waiehu Stream does not appear to have significant reproductive populations of these species. However, there is evidence of ecological activity in Waiehu Stream because at least two species of 'o'opu and amphidromous prawns were found in the upper reaches of that stream, and recruits were found

on the mauka side of the culverts under Kahekili Highway. (Ford, Tr. 10/18/08, p. 226, ll. 5-14.) HC&S FOF 59.

565. Only a few large adult ‘o‘opu alamo‘o, ‘o‘opu nōpili, and ‘o‘opu nākea were observed by SWCA within ‘Īao Stream, and no juvenile or post-larval recruits were found in the stream above the channelized section. (Exh. E-53, p. 4, § 8.0.) Benbow testified that both he and DAR biologist Skippy Hau have artificially planted ‘o‘opu and hihiwai post-larvae above the diversions in ‘Īao Stream. (Benbow, Tr. 12/10/07, p. 114, ll. 16-23.) It is likely that the ‘o‘opu observed by SWCA in ‘Īao Stream were those introduced by Hau and/or Benbow. The endemic shrimp *Atyoida bisulcata* (‘opae kala‘ole) was highly abundant, although it is unknown whether they are maintained by recruitment from the sea up to the ‘Īao channel, or from populations of shrimp within the Waihe‘e and Spreckels Ditches. (Exh. E-53, p. 4, § 8.0.) No larval fishes or crustaceans were represented in the drift samples collected from ‘Īao Stream. (Exh. E-53, p. 43, § 8.0.) HC&S FOF 61-62.

566. The only amphidromous species observed in Waikapū Stream in the SWCA study was ‘opae kala‘ole, and only large adults were found. No recruitment of post-larval ‘opae into the stream or reproduction (as indicated by the larval drift samples) was observed in the studies. Some ‘opae were found, but these may have been planted or entered via the ditches rather than recruiting naturally from the ocean. (Exh. E-53, p. 44, §§ 8.0, 9.0.) HC&S FOF 64.

567. It is conceivable that the ’opae are moving from stream to stream, because in order for them to recruit into Waikapū Stream naturally, they would have to come up via Kealia Pond. However, Waikapū Stream does not have physical connectivity to the sea through Kealia Pond except during prolonged intense flooding events. (Ford, Tr. 12/10/07, p. 225, l. 6 to p. 226, l. 3; Exh. E-53, p. 44, § 9.0.) When there is flow from Waikapū Stream to Kealia Pond, the water does not travel via a continuous channel through the pond and into the ocean, but instead, fans out into a big delta. (Ford, Tr. 12/10/07, p. 241, l. 15 to p. 242, l. 15.) HC&S FOF 65.

568. On the basis of these findings, SWCA concluded that what it calls “ecological connectivity” exists under diverted conditions in Waihe‘e River and Waiehu Stream. Although adult ‘opae kala‘ole were found in upper ‘Īao and Waikapū Streams, SWCA believes these may have been introduced to the stream by DAR biologists. SWCA did not find larval, post-larval, or juvenile amphidromous species in either ‘Īao or Waikapū streams. (Exhibit E-53 at 4 (§ 1.0).) HC&S FOF 52.

569. However, based on the field work up to December 2007, SWCA was not "able to come to any conclusion regarding the number of animals there." (Ford, Tr. 12/11/07, p. 83, ll. 12-21.) Hui/MTF FOF C-84.

570. Moreover, SWCA's larval drift survey lasted one week in total, including one day each in Waiehu and Waikapū Streams and the Spreckels Ditch diversion of `Īao Stream. (Exh. E-53, pp. 41-42.) In contrast, other previous studies spanned an entire year or multiple years. (Ford, Tr. 10/14/08, p. 178, ll. 4-10.) Hui/MTF FOF C-87a.

571. SWCA initially intended to sample larval drift at different locations in the stream, not just at the mouth (Ford, Tr. 12/11/07, p. 107, l. 22 to p. 108, l. 6), and other studies sampled at multiple locations (Ford, Tr. 10/14/08, p. 177, l. 13 to p. 178, l. 3). SWCA sampled only at one point below the diversions for each stream. (Tr. 10/14/08, p. 21, l. 5 to p. 22, l. 17.) Hui/MTF FOF C-87b.

572. SWCA did not measure the sample volumes and calculate larval densities, which is the "established methodology" in the previous studies (Ford, Tr. 10/14/08, p. 178, l. 22 to p. 279, l. 15), so it is unknown how the samples compared more broadly. (Lindstrom, Tr. 10/14/08, p. 33, l. 13 to p. 34, l. 8.) Hui/MTF FOF 87d.

573. SWCA's larval drift survey was "just a snapshot" that did not allow "broad extrapolations over time" or "to other streams." (Lindstrom, Tr. 10/14/08, p. 55, ll. 11-21.) Hui/MTF FOF C-88.

574. Given these limitations, the larval drift survey could only observe that there was "something" in Waihe`e River and nothing in the other streams at that particular time. (Lindstrom, Tr. 10/14/08, p. 33, ll. 3-17.) It is unknown whether Waihe`e River hit a "larval jackpot," or if the other streams had a larval "bust" on the day of sampling. (Id. p. 27, ll. 18-21; p. 28, ll. 15-19.) Hui/MTF FOF C-89.

575. No study has correlated larval drift with upstream abundance. (Ford, Tr. 10/14/08, p. 182, l. 2 to p. 183, l. 20.) Given that o`opu can lay tens or hundreds of thousands or even over a million at a time, it is unknown how many animals contributed to SWCA's sampled larvae. (Lindstrom, Tr. 10/14/08, p. 35, l. 8 to p. 36, l. 5.) Hui/MTF FOF C-91

576. Lindstrom, HC&S's expert witness, agreed that it would be "fairly essential" to compare larval densities between Waihe`e River and another relatively undiverted or naturally flowing

stream before making any kind of conclusions about the quality or normality of Waihe`e River's reproductive output. (Lindstrom, Tr. 10/14/08, p. 34, ll. 9-20.) Hui/MTF FOF C-94.

577. Benbow, Hui/MTF's expert witness, concluded that, "(s)hort of restoration of 100 percent of natural flows, the working presumption should be that the streams of Nā Wai `Ehā need no less than 75 percent of annual median flow to maintain their overall biological and ecological integrity over the short and long term." (Benbow, WDT 9/14/07, ¶ 24.) Hui/MTF FOF C-53.

578. Benbow uses the median to measure total streamflow (Tr. 12/10/07, p. 23, ll. 13-15), which is the "preferred measure of typical flow conditions" instead of mean (or "average") flow (Exh. A-7, pp. 12-13). The median is synonymous with Q_{50}, or the flow equaled or exceeded 50 percent of the time. (Oki, WDT 9/14/07, ¶ 21; Payne, Tr. 12/11/07, p. 249, ll. 20-21.) Hui/MTF FOF C-50.

579. Benbow's recommendation of releases of 75 percent of the annual Q_{50} of the Nā Wai 'Ehā streams computes to flow values approximately between the Q_{65} and Q_{85} of the streams. These duration values mean that 15 to 35 percent of the time streamflows will be naturally lower even without any diversions. (Payne, WDT, at ¶ 11; Payne, Tr. 12/11/07, p. 251, ll. 20-24.) HC&S FOF 35A.

580. Benbow's recommendation nearly matches the Q_{70} level, or what USGS theorizes is the mean base flow component of total flow; however, Benbow stated that he did not rely on that fact for his recommendation. (Benbow, Tr. 12/10/07, p. 174, ll. 7-13.) Hui/MTF FOF C-51.

581. Benbow states that "(t)he 75 percent of median recommendation is less than optimal, but incorporates a margin of safety to compensate for natural or other variations in streamflow (Benbow, Ph.D. WDT 9/14/07, ¶ 27), which may include long-term drought if a moving median is adopted (Tr. 12/10/07 (Dr. Benbow), p. 23, l. 22 to p. 24, l. 2). The margin of safety accounts also for the absence of more detailed scientific information on the necessary flow amounts. (Benbow, Ph.D. WDT 9/14/07, ¶ 27.) Lesser amounts would foreclose benefits to stream life and ecology and the opportunity for the necessary studies to determine whether our best estimates of the minimum flows should be maintained or modified." (Id.) Hui/MTF FOF C-56.

582. When asked to clarify how "annual median flow" would be calculated, Benbow stated that a "starting place" would be the historical median flow for the period between 1984 to 2005. (Benbow, Tr. 12/10/07, p. 38, l. 25 to p. 39, l. 12.) However, Benbow proposed that the 75 percent figure be adjusted periodically. For example, every six months, the median flow for the

previous year would be calculated, and 75 percent of that flow would be released. (Benbow, Tr., 12/10/07, at 133:23 to 134:14)

583. The 75 percent figure is supposed to represent a "null hypothesis." (Benbow, Tr. 12/10/07, p. 30, l. 24 to p. 31, l. 3.) However, Payne, HC&S's expert witness, stated that varying the 75 percent figure every six months would defeat the purpose of testing if a control flow has any effect on the stream. It would be impossible to isolate test variables if the control flow were adjusted over the test period. (Payne, Tr. 12/12/07, p. 24, l. 17 to p. 25, l. 24.) HC&S FOF 35C.

584. Payne testified that the technique of using flow duration curves to derive instream flow recommendations is well established in the scientific literature. The Tennant Method (Tennant 1976), has as a basis various percentages of the mean annual flow. The New England Base Flow Method (Larsen 1981) uses the median August flow to set a minimum flow value. Many others (e.g. Hoppe Method, Northern Great Plains Resource Program Method, Lyon's Method, Arkansas Method, Texas Method) select specific flow duration values (e.g., Q_{40}, Q_{80}, 40% of Q_{50}, etc.) by either season or month (Instream Flow Council 2004). None of these methods, however, specify 75 percent of the Q_{50} as does Dr. Benbow. Typically, when a hydrograph is used to set flow, the flow will be based on a specific flow duration value (e.g., Q_{70} or Q_{90}) rather than a variable percentage of a flow duration value. Payne is unaware that Benbow's approach has ever been applied or tested on Hawaiian or any other streams. Therefore, Payne concluded that the argument that 75 percent of the Q_{50} is required to accomplish his stated objectives appears to be based on Benbow's personal judgment and opinion, is unsupported by published literature, and is without implementation history or precedent. (Payne, WDT 10/26/07, ¶ 12, Payne, Tr. 12/12/07, p. 25, l. 25 to p. 26, l. 16.) HC&S FOF 36A.

585. Benbow testified that the 75 percent figure is an "informed guess." (Benbow, Tr. 12/10/07, p. 172, ll. 2-10.) He also conceded that the amount of flow needed could be less. (Benbow, Tr. 12/10/07, p. 130, l. 19 to p. 131, l. 12.) HC&S FOF 36B.

586. Benbow is unaware if any member of the working group at the USGS stakeholder meeting has endorsed recommending to the Commission that the appropriate instream flow standard should be 75 percent of the annual median flow. (Benbow, Tr. 12/10/07, p. 129, ll. 13-18.) HC&S FOF 36C.

587. The flow rate recommended by Benbow cannot be sustained because it could exceed the natural flow of the stream. For instance, the Q_{75} of Waihe'e Stream is between 20 to 30 mgd

(USGS historical data indicate that the Q_{70} flow of Waihe'e Stream is 29 mgd). Yet, the flow of Waihe'e Stream is frequently less than 20-30 mgd even under undiverted conditions. (Oki, WDT 9/14/07, ¶ 53; Benbow, Tr. 12/10/07, p. 132, l. 12 to p. 133, l. 12.) HC&S FOF 37.

588. The releases proposed by Benbow for a period of at least five years is his personal opinion and based in part on the lack of scientific understanding about biological communities in the Nā Wai 'Ehā streams. (Benbow, Tr. 12/10/07, p. 62, l. 4 to p. 63, l. 11.) HC&S FOF 39.

589. Contrary to Benbow's suggestion that a large volume of flow be restored and sustained for a long period of time, Ford, HC&S's expert witness, recommended that restoration of flows, if any, should begin at a low level and increased incrementally over time. Starting with a low level of releases helps in determining the incremental contributions of flow and their significance. Adequate time should be allowed to study both changes in habitat and biological responses to the releases at each increment. (Ford, Tr. 12/10/07, p. 228, l. 5 to p. 230, l. 12; Ford, Tr. 12/11/07, p. 137, l. 6 to p. 139, l. 4.) Starting with low increases in flows quickly result in a large benefit in terms of increasing the wetted habitat area of a stream. At higher flows, the increase in wetted habitat area from increasing flows becomes much less dramatic. (Payne, Tr. 12/12/07, p. 16, l. 13 to p. 20, l. 25.) HC&S FOF 41.

590. HC&S's expert witnesses recommended that the addition of flow to Waihe'e River and Waiehu Streams would yield the most benefit in terms of increasing populations of native amphidromous species in the Nā Wai 'Ehā area. (Ford, Tr. 12/10/07, p. 211, ll. 13-16, p. 227, l. 24 to p. 228, l. 4; Payne, Tr. 12/12/07, p. 15, l. 23 to p. 16, l. 25; Ford, Tr. 10/18/08, p. 236, ll. 13-17.) The key is to place flow in streams in which existing alterations of habitat are minimal. (Ford, Tr. 12/10/07, p. 210, ll. 7-10.) Waihe'e River provides significant habitat for all life stages of native amphidromous species. Waiehu Stream, while not an ideal candidate for restoration due to its narrow channel and cultural disturbances in the middle reaches, nevertheless showed signs of ecological connectivity. By comparison, it is highly questionable whether increased flows in 'Īao Stream would mitigate the impediment to recruitment posed by the channelization of the stream. There is also no definitive evidence that Waikapū Stream ever carried uninterrupted surface waters to the sea. (Exh. E-53, p. 43, § 8.0.) HC&S FOF 66.

591. However, in its initial written testimony, SWCA stated "it is possible" that the channelized portion of 'Īao Stream plays a "far greater role" than the lack of water, "though this suggestion must be verified by quantitative study." (Ford, WDT 10/26/07, ¶ 19.) In its final

report, SWCA stated it was "our firm belief" that the channel "is the primary factor." (Exh. E-53, p. 44.) Hui/MTF FOF C-103.

592. SWCA also admitted that neither the Timbol and Maciolek study it cited, nor any data or study that it knew of, demonstrated that channelization is more important. (Ford, Tr. 12/11/07, p. 113, l. 17 to p. 115, l. 7; p. 39, ll. 12-17; Ford, Tr. 10/14/08, p. 151, ll. 9-13.) SWCA's final report claimed the larval drift survey results reinforced this hypothesis, but SWCA admitted that the survey did not address the issue of the relative importance of channelization versus lack of flow. (Ford, Tr. 10/14/08, p. 143, l. 19 to p. 144, l. 6.) Hui/MTF FOF C-104.

593. The Division of Aquatic Resources' ("DAR") ongoing biological surveys and monitoring have documented amphidromous recruitment in the channelized section in `Īao Stream during intermittent flows. (Polhemus, Tr. 12/12/07, p. 190, l. 22 to p. 191, l. 4; Exh. C-96 (letter from Mr. Hau, DAR.) Hui/MTF FOF C-109.

594. Benbow's studies in `Īao Stream also documented substantial amphidromous migration when flow connected to the ocean for more than three or four days (Benbow, WDT 9/14/07, ¶ 5) and thus anticipated that with continuous flow, amphidromous species would reestablish into the upper reaches of `Īao Stream. (Benbow, Tr. 12/10/07, p. 169, ll. 10-11.) Hui/MTF FOF C-110.

595. Benbow's opinion is that no amount of mitigation of other factors such as channelization can compensate for a lack of streamflows; on the other hand, increased streamflows can go a long way to mitigate the adverse effects of other factors. (Benbow, WDT 11/16/07, ¶ 10.) Hui/MTF FOF C-112.

596. SWCA also acknowledged that, ultimately, restoration of flow would answer whether Waikapū Stream flows mauka to makai. (Ford, Tr. 12/11/07, p. 117, l. 18 to p. 118, l. 2.) **See also** Oki, WDT 9/14/07, ¶ 48; Oki, Tr. 12/6/07, p. 45, ll. 1-8.

597. HC&S's expert witnesses concluded further that the contributions of one healthy stream to the populations of amphidromous species in neighboring streams cannot be overlooked. The larval drift sampling conducted by SWCA found large numbers of 'o'opu larvae in Waihe'e Stream and none in the three other streams. This suggests that Waihe'e Stream contributes thousands of 'o'opu larvae to the oceanic pool. On a regional basis, this tends to compensate for the absence of significant reproducing populations in the other three Nā Wai 'Ehā Streams. (Lindstrom, Tr. 10/18/08, p. 45, ll. 12-20; Exh. E-53, p. 42 and Table 7 (§ 7.5.2), and 44 (§ 9.0).) HC&S FOF 67.

598. On the other hand, Benbow was of the opinion that each stream is a natural system, and differences in the characteristics of the streams and their watersheds should be taken into account. (Benbow, WDT 9/14/07, ¶ 23), Hui/MTF FOF C-102.

599. In federal fiscal year 2006, the USGS initiated a study, which included: (1) compiling and analyzing existing information relevant to the Waihe`e River, and Waiehu, `Īao, and Waikapū Streams, (2) conducting baseline reconnaissance surveys of the streams to identify sites of diversion and return flow and significant gaining and losing reaches, (3) establishing low-flow partial-record stations in reaches with flowing water to characterize natural and current diverted flows in Nā Wai `Ehā streams, (4) establishing temperature-monitoring sites in reaches with flowing water to provide information on temperature variations for diverted and undiverted conditions, (5) monitoring the frequency of dry days in selected reaches of the diverted streams to establish the number of days during which continuous mauka to makai flow is available for the upstream movement of native species, (6) surveying the presence or absence of native and non-native aquatic species in selected stream reaches to provide baseline data for assessing effects of streamflow restoration, (7) collecting macrohabitat, microhabitat, and channel-geometry information in selected study reaches downstream from existing diversions to characterize the effects of diversions on habitat for native stream macrofauna, and (8) analyzing data and producing a report summarizing the study findings. (Oki, WDT 9/14/07, ¶¶ 28-36; Oki, Tr. 12/6/07, p. 39, l. 25 to p. 52, l. 25.) Hui/MTF FOF B-116.

600. The USGS's cooperative study of Nā Wai `Ehā streams is funded by a consortium of county, state, and federal partners, including this Commission. (Oki, Tr. 12/6/07, p. 137, ll. 6-9.) Hui/MTF FOF B-117.

601. USGS collected qualitative flow information at selected sites downstream of diversions on Waihe`e River (3), Waiehu Stream (2), `Īao Stream (3), and Waikapū Stream (2). (Oki, WDT 9/14/07, ¶ 43.) Hui/MTF FOF B-120.

602. Photographic information from cameras mounted at three selected sites downstream of all diversions established that from September 2006 to July 2007 North Waiehu Stream was dry about 79 percent of the time, `Īao Stream was dry about 70 percent of the time, and Waikapū Stream was dry about 37 percent of the time. (Oki, WDT 9/14/07, ¶ 43.) Hui/MTF FOF B-120 . Waihe`e and Spreckels Ditches on Waihe`e River are capable of diverting all of the dry-weather flow available at the intakes. However, streamflow immediately downstream of the intakes may

exist because of leakage through or subsurface flow beneath the dams at these sites. Estimated dry-weather flow immediately downstream of the Waihe`e and Spreckels Ditch intakes commonly is on the order of about 0.1 mgd, but the stream may not have continuous surface flow from mauka to makai. (Oki, WDT 9/14/07, ¶ 44.)

603. For the USGS's Nā Wai `Ehā study, data are being collected to evaluate the effects of diversions on physical habitat for native aquatic species. (Oki, WDT 9/14/07, ¶ 49.) Although data are not yet available to fully describe the relation between physical habitat and streamflow for Waihe`e River and Waiehu, `Īao, and Waikapū Streams, in general, for low-flow conditions (less than median flow), the availability of suitable physical habitat generally increases as streamflow increases. (Id.) Hui/MTF FOF B-122.

604. A critical component of the USGS study is the need to partially or fully restore flow to create streams that flow along their entire length during the period of study. Controlled releases have been and continue to be requested to allow measurements of streamflow, infiltration (loss of water into the underlying stream bed), and physical habitat (and possibly recruitment and larval drift) for different flow conditions in sections of the stream that commonly are dry under diverted conditions. (Oki, WDT 9/14/07, ¶ 50.)

605. The controlled releases are not designed to predict the abundance of native aquatic species for different streamflow conditions. (Oki, WDT 9/14/07, ¶ 49.) It is intended to study the effect of different flow conditions on habitat, not to predict the biological response of the stream to the flow conditions. (Oki, WDT 9/14/-07, ¶ 5.) Population abundance is only indirectly inferred, without any direct quantification or prediction of individual species numbers or density. (Oki, Tr. 12/6/07, p. 158, l. 15 to p. 159, l. 17.)

606. "The results are intended to be used along with other biological and hydrological information in development, negotiations, or mediated settlements for instream flow requirements (Gingerich and Wolff, 2005)." (Payne, WDT 10/26/07, ¶ 10.) HC&S FOF 32C.

607. Payne, HC&S's expert witness, recommends use of the Demonstration Flow Assessment (DFA) method in place of the method used by USGS to modify interim instream flow standards. DFA relies on direct observation of stream characteristics rather than complex computations of hydraulics and habitat suitability. Persons representing the various instream flow needs identified for assessment (e.g., fish habitat, recreation, aesthetics, native Hawaiian values, cultivation, etc.) observe and objectively evaluate conditions and develop a consensus rating of different flows

through collaborative discussion. (Payne, WDT 10/26/07, ¶ 13.) While the DFA still requires interpretation, it can be subject to negotiation and vests all parties with direct knowledge of stream conditions under various flow alternatives. (Payne, WDT 10/26/07, ¶ 14.) DFA can be done concurrently with USGS's method at no additional cost of water or time. The same study sites can be evaluated (if appropriate) with the two methods at the same flow levels over the same one-to-three day time frame. (Payne, WDT, ¶ 15.) HC&S FOF 33.

608. USGS has proposed a series of controlled releases into Waihe'e River, Waiehu Stream, and 'Īao Stream to allow measurements of streamflow, infiltration, and physical habitat under different flow conditions. No controlled releases were proposed for Waikapū Stream. The releases would be done in three stages, with each stage involving a flow rate higher than the last. The higher streamflow-restoration rates could be refined as additional information becomes available to better estimate loss rates. Each restoration condition should be maintained for a period of time sufficient to allow flow conditions to stabilize and measured loss rates in a reach to vary by less than 10 percent on three different days. (Oki, WDT 9/14/07, ¶¶ 50, 51, 56, 60, 64, Table 1.) HC&S FOF 30.

609. The controlled releases would be simultaneous for all three streams, but to minimize disruption to regular ditch operations, a phased approach was proposed, starting first at Waihe`e River, then Waiehu Stream, and finally `Īao Stream. (Oki, Tr. 12/6/07, p. 165, ll. 21-24; Oki, WDT 9/14/07, ¶ 51.)

610. USGS stated that control releases would be helpful to resolve whether or not Waikapū Stream flowed continuously to the ocean under natural conditions and that a schedule of controlled releases for Waikapū Stream could be developed in the future. (Oki, WDT 9/14/07, ¶ 51.)

611. For Waihe'e Stream, USGS proposed maintaining flows near the coast of about 6.5 mgd, 13 mgd, and 26 mgd, which USGS estimates would require flows just downstream of the Spreckels Ditch diversion of 10 mgd, 17 mgd, and 30 mgd, respectively, assuming a constant streamflow loss of 4 mgd downstream of the Spreckels Ditch diversion. (Oki, WDT 9/14/07, ¶ 56, Table 1.) HC&S FOF 30A.

612. Flows of 10 mgd, 17 mgd, and 30 mgd just upstream of the first diversion at the Waihe`e Ditch are less than the minimum, Q_{99}, and Q_{68} flows, respectively. (Oki, WDT 9/14/07, ¶ 56.)

613. For North and South Waiehu Streams, USGS proposed maintaining flows near the coast of 0.6 mgd, 1.6 mgd, and 2.6 mgd, which USGS estimates would require flows of: 1) 1.6 mgd at the North Waiehu Ditch on North Waiehu Stream plus 0.9 mgd at Spreckels Ditch on South Waiehu Stream; 2) 2.2 mgd at the North Waiehu Ditch on North Waiehu Stream plus 1.3 mgd at Spreckels Ditch on South Waiehu Stream; and 3) 2.9 mgd at the North Waiehu Ditch on North Waiehu Stream plus 1.6 mgd at Spreckels Ditch on South Waiehu Stream. This assumes: 1) an estimated streamflow loss in North Waiehu Stream between the North Waiehu Ditch and the confluence of North and South Waiehu Stream of about 1.3 mgd, and 2) an estimated streamflow loss in Waiehu Stream between the confluence of North and South Waiehu Stream and the coast of 0.6 mgd. (Oki, WDT 9/14/07, ¶ 60.) HC&S FOF 30B.

614. For North Waiehu Stream, flows of 1.6 mgd, 2.2 mgd, and 2.9 mgd upstream of all diversions are equal to the minimum, Q_{90}, and between the Q_{70} and Q_{50} flows, respectively. (Oki, WDT 9/14/07, ¶ 24.) For South Waiehu Stream upstream of most diversions (a small kalo ditch diverted about 0.06 mgd to 0.2 mgd upstream of the stream-gaging station): a flow of 0.9 mgd is less than the minimum measurement of 1.5 mgd, and flows of 1.3 mgd and 1.6 mgd is within the range of the Q_{90} of 1.3 mgd to 2.0 mgd. (Oki, WDT 9/14/07, ¶ 25.)

615. For ʻĪao Stream, USGS proposed maintaining flows near the coast of about 3.2 mgd, 9.7 mgd, and 16 mgd, which USGS estimates would require flows just downstream of the ʻĪao-Maniania Ditch diversion of 9.5 mgd, 16 mgd, and 22 mgd, respectively, based on an estimated loss of 6.3 mgd. (Oki, WDT 9/14/07, ¶ 64.) HC&S FOF 30C.

616. Flows of 9.5 mgd, 16 mgd, and 22 mgd upstream of all diversions represent the Q_{97}, Q_{75}, and Q_{56} flows, respectively.

617. While controlled releases for Waikapū Stream were deferred, the USGS estimates for streamflow above all diversions were 4.8 mgd to 6.3 mgd for Q_{50}, 3.9 mgd to 5.2 mgd for Q_{70}, and 3.3 mgd to 4.6 mgd for Q_{90}. However, gaging station 16650000, at altitude of about 880 feet, is located <u>below</u> the South Side Waikapū Ditch, at an altitude of about 1,120 feet, but these estimates include water diverted by that Ditch. Thus, the <u>actual</u> flow should be less than the historical natural flow at gaging station 16650000 by the amount still being diverted by the South Side Waikapū Ditch. However, the record-extension estimates of flows in climate years 1984 to 2005 for gaging station 1665000 should be the same for the flows above the South Side Waikapū Ditch, because USGS's estimates of natural flow assume no gains, losses, or return flows

between the South Side Waikapū Ditch diversion and station 16650000 during the period when the gaging stations were operated. (**See** FOF 134, *supra*.)

II. CONCLUSIONS OF LAW

A. OVERVIEW OF APPLICABLE LAW

1. Instream Flow Standards

1. "'Instream flow standard' means a quantity 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." HRS §174C-3.

2. "'Interim instream flow standard' means a temporary instream flow standard of immediate applicability, adopted by the commission without the necessity of a public hearing, and terminating upon the establishment of an instream flow standard." HRS §174C-3.

3. The (instream flow standard) is the surface water corollary to the ground water "sustainable yield" in that both perform the function of guiding water planning and regulation by prescribing responsible limits to the development and use of public water resources. In re Water Permit Applications, 94 Haw. 97, at 148; 9 P.3d 409, at 460 (2000) ("**Waiāhole I**").

4. "Any person with the proper standing may petition the commission to adopt an interim instream flow standard for streams in order to protect the public interest, pending the establishment of a permanent instream flow standard…A petition…shall set forth data and information concerning the need to protect and conserve beneficial instream uses of water and any other relevant and reasonable information required by the commission. In considering a petition to adopt an interim instream flow standard, the commission shall 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." HRS §174C-71(2); HAR §13-169-40.

5. "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 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.

HRS §174C-3.

6. "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. HRS §174C-3.

2. <u>Water Use Permit Applications ("WUPAs")</u>

7. Each WUPA must demonstrate that the proposed use of water (1) can be accommodated with the available water source, (2) is a reasonable-beneficial use, (3) will not interfere with any existing legal use of water, (4) is consistent with the public interest, (5) is consistent with state and county general plans and land use designations, (6) is consistent with county land use plans and general policies, and (7) will not interfere with the rights of the Department of Hawaiian Home Lands. HRS §174C-49(a).

8. "Reasonable-beneficial use" is the use of water in such a quantity as is necessary for economic and efficient utilization, for a purpose, and in a manner which is both reasonable and consistent with the state and county land use plans and the public interest."HRS § 174C-3.

9. In addition to meeting the constitutionally mandated standard of reasonable-beneficial use, an applicant for a water use permit must affirmatively demonstrate that its proposed use satisfies all the other criteria set forth in Haw. Rev. Stat. § 174C-49(a). **<u>Waiāhole I</u>**, 94 Haw. at 160-61, 9 P.3d at 472-73; **<u>Waiāhole II</u>**, 105 Haw. at 15-16, 93 P.3d at 657-58.

3. **Water as a Public Trust**

10. Under article XI, sections 1 and 7 of the Hawaii Constitution, the public trust doctrine applies to all water resources without exception or distinction. **Waiāhole I**, 94 Haw. at 133; 9 P.3d at 445.

11. The public trust mandate is to conserve and protect water resources as well as to use and develop them in a reasonable and beneficial manner. "(T)he State…shall conserve and protect Hawaii's…water… and shall promote the development and utilization of these resources in a manner consistent with their conservation and in furtherance of the self-sufficiency of the State." Hawaii State Constitution, Article XI, §1. "The state water resources trust thus embodies a dual mandate of 1) protection and 2) maximum reasonable and beneficial use." **Waiāhole I**, 94 Haw. at 139; 9 P.3d at 451. "In short, the object is not maximum consumptive use, but rather the most equitable, reasonable, and beneficial allocation of state water resources, with full recognition that resource protection also constitutes 'use.'" **Waiāhole I**, 94 Haw. at 140; 9 P.3d at 452.

12. Each offstream user must prove that each specific use is reasonable-beneficial by providing details on "acres to be used, the crops to be planted, and the water needed as to each group." In re Waiāhole Ditch Combined Contested Case Hr'g, 105 Haw. 1, at 25, 93 P.3d 643, at 667 (2004) ("**Waiāhole II**"). Absent such basic information, an offstream user cannot meet its legal burden. Id. at 26, 93 P.3d at 668.

13. The purposes of the water resources trust are: 1) maintenance of waters in their natural state; 2) domestic water use of the general public; 3) Native Hawaiian and traditional and customary rights, including appurtenant rights; and 4) reservations of water for Hawaiian home lands. **Waiāhole I**, 94 Haw. at 136-138; 9 P.3d at 448-450. In re Wai`ola o Moloka`i, Inc., 103 Haw. 401, at 429, 431, 83 P.3d 664, at 692, 694 (2004) ("**Wai`ola**").

14. There are no absolute priorities among these trust purposes; i.e., protection of the resource is not a "categorical imperative." **Waiāhole I**, 94 Haw. at 142, 9 P.3d at 454.

15. "(I)nsofar as the public trust, by nature and definition, establishes use consistent with trust purposes as the norm or 'default' condition…it effectively prescribes a 'higher level of scrutiny' for private commercial uses…In practical terms, this means that the

burden ultimately lies with those seeking or approving such uses to justify them in light of the purposes protected by the trust." **<u>Waiāhole I</u>**, 94 Haw. at 142; 9 P.3d at 454.

16. The Commission is to "weigh competing public and private water uses on a case-by-case basis, according to any appropriate standards provided by law" and "accommodating both instream and offstream uses where feasible." **<u>Waiāhole I</u>**, 94 Haw. at 142; 9 P.3d at 454.

17. "(T)he public trust compels the state duly to consider the cumulative impact of existing and proposed diversions on trust purposes and to implement reasonable measures to mitigate this impact, including using alternative resources." **<u>Waiāhole I</u>**, 94 Haw. at 143; 9 P.3d at 455.

18. After an IIFS has been established, water available over the amount that must remain in the stream is available for offstream uses. However, water not actually put to reasonable-beneficial use would be wasted and must remain in the streams. **<u>Waiāhole I</u>**, 94 Haw. at 118, 156, 9 P.3d at 430, 468.

4. <u>Traditional and Customary Rights</u>

19. In addition to appurtenant rights when practiced for subsistence, cultural and religious purposes, traditional and customary rights include, but are not limited to, kuleana water for domestic purposes, kalo cultivation, and other irrigation purposes, and the gathering of hihiwai, opae, o`opu, limu, thatch, ti leaf, aho cord, and medicinal plants for subsistence, cultural, and religious purposes. Haw. Rev. Stat. § 174C-101(c). **<u>Waiāhole I</u>**, 94 Haw. at 137, 9 P.3d at 449.

20. Traditional and customary rights cannot be abandoned, and are guaranteed even if the practice has not been continually practiced in an area. <u>Public Access Shoreline Haw. v. Hawai`i Planning Comm'n</u>, 79 Haw. 425, at 450, 903 P.2d 1246, at 1271 (1995) ("**<u>Pash</u>**").

5. <u>Appurtenant rights</u>

21. "The trust's protection of traditional and customary rights also extends to the appurtenant rights recognized in *Peck.*" **<u>Waiahole I</u>**, 94 Haw. at 137 n. 34; 9 P.3d at 449, n. 34. However, *Peck* had concluded that an appurtenant right may be used for any

purpose: "(O)riginally the water was wanted mainly for the cultivation of kalo and more recently for cane. If land has a water right, it will not be contended that the water shall be used forever for the same crop, be it kalo or cane. It may be used for any purpose which the owner may deem for his interest, always taking care that any change does not affect injuriously the rights of others." **Peck v Bailey**, 8 Haw. 658, at 665 (1867).

22. By including appurtenant rights within Native Hawaiian and traditional and customary rights, the Court presumably has limited that inclusion to appurtenant rights that are exercised for subsistence, cultural or religious purposes. "The State reaffirms and shall protect all rights, customarily and traditionally exercised for subsistence, cultural and religious purposes and possessed by ahupua`a tenants who are descendants of native Hawaiians who inhabited the Hawaiian Islands prior to 1778, subject to the right of the State to regulate such rights." Hawaii State Constitution, Article XII, §7. "(W)hile the state water resources trust acknowledges that private use for 'economic development' may produce important public benefits and that such benefits must figure into any balancing of competing interests in water, it stops short of embracing private commercial use as a protected 'trust purpose'...(I)f the public trust is to retain any meaning and effect, it must recognize enduring public rights in trust resources separate from, and superior to, the prevailing private interests in the resource at any given time." **Waiahole I**, 94 Haw. at 138; 9 P.3d at 450.

23. However, the Constitution and the State Water Code preserve appurtenant rights, whether being exercised or not at the time the area in which those rights pertain to is designated a water management area. Hawaii State Constitution, Article XI, §7; State Water Code, HRS §174C-63, §174C-27, §174C-101(d). "The Code contains no comparable provisions preserving riparian (surface water) and correlative (ground water) 'rights'." **Waiahole I**, 94 Haw. at 179; 9 P.3d at 491. Thus, only riparian and correlative rights that were being exercised on April 30, 2008, the time of water management area designation, qualify for existing-use water permits. FOF 26. Future uses no longer are based on riparian or correlative rights, which are extinguished as of the date of water management area designation, and have no priority over other permit applicants.

24. Under the State Water Code, not only is the exercise of an appurtenant right preserved, but the exercise of that right has priority over other uses in the issuance of a

water use permit: "Appurtenant rights are preserved. Nothing in this part shall be construed to deny the exercise of an appurtenant right by the holder thereof at any time. A permit for water use based on an existing appurtenant right shall be issued upon application. Such permit shall be subject to sections 174C-26 and 174C-27 and 174C-58 to 174C-62." HRS §174C-63.

25. The Code does subject water uses under appurtenant rights to the shortage provisions of section 174C-62: The Commission may impose restrictions "as may be necessary to protect the water resources of the area from serious harm and to restore them to their previous condition…including but not limited to apportioning, rotating, limiting, or prohibiting the use of the water resources of the area."

26. However, whether intentionally or inadvertently, HRS §174C-63 does not subject the exercise of appurtenant rights to section 174C-49, the "Conditions for a permit" section of the Code, which includes a requirement that the proposed use of water "(i)s a reasonable-beneficial use as defined in section 174C-3." But the public trust mandate is to conserve and protect water resources as well as to use and develop them in a reasonable and beneficial manner. COL 11, *supra*. Thus, appurtenant uses must also be undertaken for reasonable-beneficial uses.

27. "[T]he right to the use of water acquired as appurtenant rights may only be used in connection with that particular parcel of land to which the right is appurtenant[.]" McBryde Sugar Co. v. Robinson, 54 Haw. 174, at 191, 504 P.2d 1330, at 1341 (1973); *affd on rehearing*, 55 Haw. 260, 517 P.2d 26 (1973); *appeal dismissed for want of jurisdiction and cert. denied*, 417 U.S. 962 (1974) ("**McBryde**").

28. "(A)ppurtenant water right(s) to taro land attached to the land when title was confirmed by the Land Commission Award and title conveyed by the issuance of Royal Patent." **McBryde**, 54 Haw. at 190, 504 P.2d at 1340; **see also** Territory v. Gay, 31 Haw. 376, at 383 (1930); *aff'd*, 52 F.2d 356 (9th Cir. 1931); *cert. denied*, 284 U.S. 677 (1931) (" **Territory v Gay**").

29. "(W)hile the proper measure of those rights is indeed the quantum of water utilized at the time of the Mahele, requiring too great a degree of precision in proof would make it all but impossible to ever establish such rights." When "the same parcel of land is being utilized to cultivate traditional products by means approximating those

utilized at the time of the Mahele, there is sufficient evidence to give rise to a presumption that the amount of water diverted for such cultivation sufficiently approximates the quantity of the appurtenant water rights to which that land is entitled." Reppun v. Board of Water Supply, 65 Haw. 531, at 554, 656 P.2d 57, at 72 (1982) ("**Reppun**").

30. Appurtenant rights must be recognized, the amounts of water accompanying those rights must be determined, and the Commission is the authority for doing so: "(The Commission) (s)hall determine appurtenant water rights, including quantification of the amount of water entitled to by that right." HRS §174C-5(14).

6. Alternative Sources

31. An alternative is practicable if it is available and capable of being used after taking into consideration cost, existing technology, and logistics. **Waiāhole II**, 105 Haw. at 19, 93 P.3d at 661.

32. An applicant's inability to afford an alternative source of water, standing alone, does not render that alternative impracticable. **Waiāhole II**, 105 Haw. at 19, 93 P.3d at 661.

33. An alternative source of water is not rendered impracticable simply because an offstream user does not own or control the source. **Waiāhole II**, 105 Haw. at 17, 93 P.3d at 659.

34. The Commission "is not obliged to ensure that any particular user enjoys a subsidy or guaranteed access to less expensive water sources when alternatives are available and public values are at stake." **Waiāhole I,** 94 Haw. at 165, 9 P.3d at 477.

7. Losses

35. Offstream users have the burden to prove that any system losses are reasonable-beneficial by establishing the lack of practicable mitigation measures, including repairs, maintenance, and lining of ditches and reservoirs. **Waiāhole I**, 94 Haw. at 172-73, 9 P.3d at 484-85; **Waiāhole II**, 105 Haw. at 27, 93 P.3d at 669.

36. Whether or not a permit is required for system losses, offstream users, and ultimately the Commission, must account for water lost or missing by adopting

"provisions that encourage system repairs and limit losses." **Waiāhole II**, 105 Haw. at 27, 93 P.3d at 669.

8. Surface Water Diversions: The WUPA Process Versus This CCH

37. "(B)esides advocating the social and economic utility of their proposed uses, permit applicants (in the WUPA or water use permit application proceedings) must also demonstrate the absence of practical mitigating measures, including the use of alternative water sources. Such a requirement is intrinsic to the public trust, the statutory instream-use protection scheme, and the definition of 'reasonable-beneficial' use, and is an essential part of any balancing between competing interests." **Waiahole I**, 94 Haw. at 161; 9 P.3d at 473.

38. Permits for noninstream uses can be issued only to the extent that stream flows in excess of the amended IIFS are available. COL 3, *supra.* But in establishing the IIFS in the first place, the Commission must 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. COL 4, *supra.*

39. In WUPAs, permit applicants must show that their uses are reasonable and beneficial and that there are no practical alternative resources. COL 12, *supra.* The Nā Wai `Ehā streams were designated as a surface water management area, with an effective date of designation of April 30, 2008. Applicants for existing–use permits had to be filed within a period of one year from the effective date of designation, or no later than April 30, 2009. FOF 26; HRS §174C-50(c). New uses may be filed at any time and will be considered after the existing use determinations have been made. HRS §§174C-49 and 174C-51.

40. This CCH is limited to the `Īao high-level ground water WUPAs and the petition to amend the IIFS. FOF 18. Thus, it cannot make the final determination of the amounts of noninstream uses that would meet the statutory requirements for water use permits for existing and future uses of diverted surface waters.

41. However, in determining the IIFS, many of the same noninstream existing and future uses of water must still have to be evaluated in this CCH. COL 4, *supra.* Thus, the

Commission must make a collective finding on these noninstream uses in order to meet its duty of finding a balance between instream and noninstream uses to establish the IIFS.

42. In its assessment of noninstream uses in this CCH, the Commission must also determine whether or not the amounts of water being diverted for noninstream purposes are justifiable—i.e., reasonable uses—in order to evaluate "the importance of the present or potential uses of water for noninstream purposes, including the economic impact of restricting such uses." COL 4, *supra*. The importance of such uses cannot apply to water that may be used in an unreasonable manner and/or amount, which would be contrary to the public trust's duty of both protection and maximum reasonable and beneficial use, COL 11, *supra*, and the Commission's duty to uphold that trust.

43. In amending the IIFS, the costs of available alternative water sources for noninstream uses would be included in the economic impact of restricting such uses. COL 4, *supra*. For a water use permit application, the costs of alternative sources would be considered only in the determination of the practicability of those alternative sources. COL 17, 31, *supra*.

B. <u>PRESENT OR POTENTIAL INSTREAM VALUES</u>

"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. COL 5, *supra*.

In this CCH, such beneficial uses include:

44. maintenance of fish and wildlife habitats, FOF 40, 42, 50, 556;

45. outdoor recreational activities, FOF 234;

46. maintenance of ecosystems such as estuaries, wetlands, and stream vegetation, FOF 63-79, 234, 237, 303;

47. aesthetic values such as waterfalls and scenic waterways, FOF 38, 237, 303;

48. conveyance of irrigation and domestic water supplies to downstream points of diversion, FOF 60, 214-236; and

49. protection of traditional and customary Hawaiian rights, FOF 35-37, 39-43, 47, 49, 51-59, 234, 556. These are rights that are located in the streams and achieved by leaving/restoring water in the streams. COL 5, *supra*. They are distinct from the

traditional and customary rights that are included in noninstream purposes; i.e., appurtenant rights exercised through traditional and customary methods, discussed *infra*.

The amounts of stream waters to be restored to address these instream purposes are discussed in section G on Interim Instream Flow Standards ("IIFS").

C. PRESENT OR POTENTIAL USES FOR NON-INSTREAM PURPOSES

"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. COL 6, *supra*.

In this CCH, noninstream uses include:

50. domestic purposes, FOF 233, 238-239;
51. agricultural purposes, FOF 233, 238-239, 241, 244, 250, 253, 255, 260-289, 363; and
52. industrial purposes, 238-239, 363.

In this CCH, the Commission makes a collective finding on the reasonableness of these noninstream uses in order to meet its duty of weighing instream and noninstream uses to establish the IIFS; the Commission does not make the final determination of the amounts of noninstream uses that would meet the statutory requirements for water use permits, which will be addressed through the WUPA process for Nā Wai `Ehā as a surface water management area. FOF 26. COL 40-42, *supra*.

1. Kuleana Lands and Maui Coastal Land Trust ("MCLT")

53. As of the close of the evidentiary phase of this CCH, there were no petitions to the Commission from kuleana landowners for appurtenant rights and the amounts of water that such rights would be entitled to from the Nā Wai `Ehā streams, as required by law. COL 30, *supra*.

54. Even without recognized appurtenant rights, current users of Nā Wai `Ehā waters qualify as existing uses if their WUPAs are filed with and accepted by the Commission by April 30, 2009. FOF 26. Current users that do not file for existing-use permits by the deadline may file after the deadline as new uses, and kuleana landowners who successfully petition for recognition of their claimed appurtenant rights may subsequently

submit WUPAs for the amounts of water recognized as accompanying those rights. COL 23, *supra*.

54. A reasonable amount for consumptive use by kalo lo`i (evaporation, transpiration, and percolation through the bottoms and leakage through the banks) is between 15,000 to 40,000, FOF 321-322, and most of the net loss between lo`i inflow and outflow is percolation and leakage, FOF 339.

55. For proper kalo cultivation, a substantially greater amount of water is needed for inflow above what is consumed, FOF 337. At times of peak use, at least 260,000 gad mean (average) flow or 150,000 gad median (50 percent of flows above, and 50 percent below 150,000 gad) flow is needed, FOF 325. However, during a crop cycle of 14 months, no water is required to enter the lo`i approximately 40 to 50 percent of the time, either because of cultural practices including planned resting or fallowing of patches. FOF 330.

56. The Commission estimates that current kuleana lands receive more than 130,000 to 150,000 gad for their kalo lo`i, FOF 332-333, translating to about 260,000 to 300,000 gad when adjusted for the 50 percent of time that no water is needed to flow into the lo`i, FOF 330. These amounts would be sufficient for proper kalo cultivation and even meet Reppun's estimate of sufficient flow, FOF 328.

57. However, kuleana users testified that their water deliveries were inadequate, FOF 335, and together with observations of numerous leakages from the ditches, FOF 336, the Commission further concludes that much of the water reported by WWC as being delivered to the kuleana lands is being lost between the kuleana lands and WWC's ditches and reservoirs from which the kuleana ditches/pipes emanate. These losses are addressed, in Section E on Losses, *infra*.

58. The large amounts of inflow and outflow required for proper kalo cultivation would result in substantial losses, so as much of the outflow as practical must be channeled back into the streams. FOF 337.

59. The Commission concludes that water use permits are the proper approach to account for the consumptive use, but not for the larger amounts needed to flow through the lo`i for proper cultivation. While the large amounts of flow-through are reasonable for proper kalo cultivation, water use permits effectively remove those large amounts from

all other uses; i.e., maintaining/restoring stream flows and other reasonable-beneficial offstream uses. Whether or not a permit is required, the Commission must account for water losses by adopting provisions that limit such losses. COL 36, *supra*. Those provisions are presented in Section E on Losses, *infra*.

60. Kuleana lands also use stream waters for domestic and other uses (vegetables, trees, and plants). FOF 233. MDWS has allocated up to 540 gpd for households and 600 to 1,200 gpd for agricultural development lots, FOF 401-402, which are reasonable amounts for kuleana lands for those purposes. The kalo lo`i reasonable use at between 15,000 to 40,000 gad, however, is by far the dominant use.

61. MCLT seeks 1.5 to 2.5 mgd to restore its wetlands by raising the water table elevation between 12 to 18 inches and running freshwater through its fishpond to restore aquaculture conditions within the ancient fishpond limits. FOF 345. There was no testimony against these amounts being reasonable for the stated purposes, with the testimony focused on whether or not the underlying basal aquifer was a practical alternative to water from the Waihe`e River. FOF 353.

2. <u>MDWS</u>

62. All of MDWS's basal and high-level water sources in the `Īao Ground Water Management Area and its surface water sources from Nā Wai `Ehā are part of its integrated Central Maui System. FOF 362. In issuing water use permits to MDWS for its seven basal sources and for Shaft 33 in CCH-MA05-1 of January 31, 2007, the Commission found that MDWS's use met all of the requirements of HRS §174C-49(a), including that the uses were reasonable-beneficial. Therefore, if its existing, FOF 239, 368, and proposed, FOF 369, uses of surface waters are for the same purposes, the amounts of those uses would be reasonable.

3. <u>WWC Water Delivery Agreements</u>

63. Of the 34 entities in addition to MDWS and HC&S who have water-delivery agreements with WWC, except for testimony provided by some of these entities, only the total actual uses and general descriptions of these uses were identified. FOF 240-241,

256-258, 377. Out of maximum delivery agreements of 8.288 mgd, total use for the 34 entities were 1.42 mgd in 2005 and 2.37 mgd in 2006. FOF 257-258.

64. Of those testifying, MDWS is an alternative source for several, and there is the possibility that recycled water could be available. (**See** Section D on Alternative Water Sources, *infra.*) These include at least two agricultural developments, FOF 397, 406, and two housing developments, both of which are only in the conceptual stage, FOF 385, 416.

65. For two of the larger current or future users, reasonable amounts are 1.2 mgd or less for two golf courses, FOF 391, 395, and 2,730 gad for a proposed coffee farm of about 300 acres, FOF 388-389.

4. HC&S

66. HC&S calculated that it used an average of 6,828 gad or 22.19 mgd on 3,250 acres of its Waihe`e-Hopoi Fields and 7,716 gad or about 10.26 mgd on 1330 acres of its `Īao-Waikapū Fields during 2004-2006. Excluding Field 920 from the `Īao-Waikapū Fields because it has consumed more water because of the porosity of its sandy soil and its use for seed cane, there was an average use of 7,098 gad. FOF 436-437, 441.

67. HC&S is able to satisfy the irrigation requirements for the `Īao-Waikapū Fields more consistently, because the available water for these fields per acre is greater than it is for the Waihe`e-Hopoi Fields. FOF 444.

68. For the Waihe`e-Hopoi Fields, the fields are typically at a substantial moisture deficit during the summer months, when solar radiation is greater and ditch flows are low. FOF 436

69. The rates reported in gad (gallons per acre per day) were not based on meter readings. HC&S does not regularly calculate and use gad in managing its operations, because averages can misstate actual irrigation requirements. FOF 437. Usage is computed through its water balance database, determining how many irrigation hours were charged to the fields and then multiplying by the application rate. FOF 438. Furthermore, the irrigated acres could fluctuate yearly, because acres could be added that were not in production previously and may take in more lands as HC&S surveys field boundaries to determine the actual boundaries of its fields. FOF 439.

70. HC&S's computerized water balance model essentially calculates a water budget that accounts for "deposits" of water in the form of rainfall and irrigation and "withdrawals" in the form of evapo-transpiration, which is defined as the loss of water from the soil both by evaporation and by transpiration from the plants growing in the soil. The evapo-transpiration rate varies during the year, depending on weather conditions, solar insulation, temperatures, humidity, and wind speed. In order to maintain sugar yields, the sum of available rainfall plus irrigation water applied to the fields must approach the evapo-transpiration rate to promote efficient growth. The evapo-transpiration rate tends to be the highest during the months of May through September, which are the peak growing, planting, and harvesting periods. Adequately meeting evapo-transpiration rates is directly correlated with crop yield potential. The model is used as a managerial tool to decide what fields need to be irrigated and also tracks what is applied to the fields. FOF 451-452.

71. Fares also calculated irrigation requirements using a computerized water budget model, FOF 454-463, which, in the opinion of HC&S's experts, was similar to HC&S's model although different in significant respects. FOF 468-475, 486.

72. Fares's model accounts for water going into the plantation system and water leaving the system as evapo-transpiration, overflow, runoff, excess due to drainage, and the storage capability of the soil. The purpose of the model is to calculate the irrigation requirements to keep the soil moisture level above the allowable water deficit, which is a given percent of the soil moisture level at which the sugarcane plant wilts and can no longer take water from the soil. His model assumes that the allowable water deficit is 65 percent of the available soil water holding capacity. FOF 455.

73. Fares's model is not intended to determine how much irrigation water to apply on a daily basis. FOF 455.

74. Fares used an 80 percent probability for satisfying the crop's irrigation requirements—that water sufficient to meet the irrigation requirements would be available four out of five days—because it is the industry standard for calculating crop water duties in both the government and private sectors. FOF 457. This was not specifically identified by HC&S's expert witnesses as one of the factors that was

different in HC&S's model, but HC&S uses real-time data in its model to identify daily irrigation requirements, not the average over a period of time. FOF 469.

75. Fares estimated that 5,674 gad would have satisfied the irrigation requirements for the Waihe`e-Hopoi Fields in 80 percent of the 54 years of rainfall data up to 2004 that was incorporated into his model, and that the comparable requirement for the `Īao-Waikapū Fields was 5,150 gad. FOF 464-465. For the latter fields, when Field 920 is excluded, irrigation requirements would be 5,026 gad, and for Field 920, 5,752 gad. FOF 466-467. **Compare to** HC&S's 6,828 gad for its Waihe`e-Hopoi Fields and 7,716 gad for its `Īao-Waikapū Fields including Field 920 and 7,098 gad when Field 920 is excluded, during 2004-2006. COL 66, *supra*, FOF 436, 441. HC&S's numbers are based on acres irrigated during the time period (2004-2006), which are determined by how many irrigation hours were charged to the fields and then multiplying by the application rate, COL 68, *supra*, FOF 438. In other words, HC&S's numbers are the actual irrigation rates, which were determined through its water balance model that calculates what the water requirements were for the days that those irrigation rates were applied, modified by the amounts of water that were actually available for irrigation. COL 67-68, *supra*.

76. Fares concluded that the only difference that results in his model calculating lower irrigation requirements than HC&S's is his choice of irrigation efficiency of 85 percent versus HC&S's 80 percent. FOF 488-489. Fares defined irrigation efficiency as the percentage of water that will be delivered to the plant. Thus, an irrigation efficiency of 85 percent assumes that of 100 gallons pumped into the drip irrigation lines, 85 gallons will be delivered to the plant. FOF 473.

77. Fares chose 85 percent irrigation efficiency because he concluded that it is the irrigation standard and the minimum efficiency for which drip irrigation systems are designed. FOF 488.

78. HC&S's witnesses agreed that HC&S's 80 percent efficiency assumption had been used since before either of them started with HC&S; neither was aware of any actual measurements or studies conducted by HC&S to verify the assumption. FOF 489.

79. However, HC&S's witnesses concluded that Fares's model and the generalizations drawn from it do not necessarily track actual conditions and practices in HC&S's West Maui Fields. FOF 477. For example: Fares's model: 1) does not account

for water that must be run through the irrigation system to detect leaks, FOF 477; 2) fails to account for irrigation water "lost" because it is applied just before it rains, FOF 477; and 3) assumes it is always practical for a sugarcane grower to apply irrigation water to a field to restore its soil moisture storage level to 100 percent once it depletes to 65 percent, when in practice irrigation water may not necessarily be available at the point the soil moisture level reaches 65 percent, FOF 478. Furthermore, a round of irrigation can consist of anywhere from 24 hours up to 72 hours of continuous irrigation. And at any given time, only a fraction of the fields are actually receiving water. FOF 448. HC&S also will deviate from its water balance model as dictated by field conditions and other practical requirements. For example, HC&S does not rely strictly on the crop coefficient in the initial phase of growth; when a field is first planted, the primary objective is to keep the seed piece moist as to ensure germination. FOF 480. Water also needs to be applied constantly in the initial stage of growth to keep away the lesser cornstalk borer from boring into the shoots. FOF 480. Other reasons for applying water to the fields besides replacing moisture lost to evapotranspiration include application of fertilizers and herbicides. FOF 480.

80. These differences between the ideal conditions of a model and field-level management and use of water could account for the difference between Fares's use of 85 percent versus HC&S's use of 80 percent irrigation efficiency.

81. However, the evidence provided by HC&S of its actual water requirements, as opposed to its water use, was not from the water balance model. **See** COL 72, *supra*. "Historical daily requirement" was calculated by replacing the historical evaporation rate, converted into gad, but the calculation did not account for rainfall and assumed that all of the water lost through evapotranspiration must be replaced by irrigation. FOF 490-492. Thus, the water requirements calculated by HC&S overstate the requirements by the amount offset by rainfall.

82. A model of irrigation requirements, such as Fares's, should be the starting point for determining actual irrigation requirements, i.e., the requirements for successful crops as actually grown and managed by HC&S. But the burden is on HC&S to avoid the model as the default requirement. HC&S has met that burden in part, and there are still

uncertainties remaining on what are reasonable irrigation requirements for HC&S's Waihe`e-Hopoi and `Īao-Waikapū Fields.

83. First, if we accept Fares's conclusion that the only difference between his results and HC&S's water balance model is his use of an 85 percent efficiency factor versus HC&S's 80 percent, in the real-world conditions in which HC&S operates, the Commission then concludes that an 80 percent efficiency factor is reasonable. **See** COL 79-80, *supra*.

84. Fares estimated that 5,674 gad would have satisfied the irrigation requirements for the Waihe`e-Hopoi Fields in 80 percent of the 54 years of rainfall data up to 2004 that was incorporated into his model, and that the comparable requirement for the `Īao-Waikapū Fields was 5,150 gad when Field 920 was included. COL 75, *supra*. FOF 464-465. 85 percent of 5,674 gad is 4,823 gad, and 4,823 gad is 80 percent of 6,028 gad. Similarly, Fares's estimate for the `Īao-Waikapū Fields was 5,150 gad, of which 85 percent would be 4,378 gad, which in turn would be 80 percent of 5,472 gad. Thus, the irrigation requirements under these assumptions would be: 1) 6,028 gad for the Waihe`e-Hopoi Fields, compared to Fares's model of 5,674 gad and the 6,828 gad of actual use calculated by HC&S; and 2) 5,472 gad for the `Īao-Waikapū Fields, compared to Fares's model of 5,150 gad and the 7,716 gad of actual use calculated by HC&S.

85. If the higher requirement of Field 920 is discounted and all acres in the `Īao-Waikapū Fields were assumed to require 5,026 gad instead of 5,150 gad in the Fares model, COL 75, *supra*, FOF 466-467, then Fares's irrigation requirement at 80 instead of 85 percent efficiency would be 5,340 gad instead of 5,472 gad.

86. Similar comparisons of total use over irrigated acres would be: 1) on the 3,250 acres of the Waihe`e-Hopoi Fields, 19.59 mgd versus 18.44 mgd for Fares's model and 22.19 mgd for the calculations by HC&S; and 2) on the 1330 acres of the `Īao-Waikapū Fields: a) when Field 720's higher irrigation requirement is included, 7.28 mgd versus 6.85 mgd for Fares's model, and 10.26 mgd for the calculations by HC&S; and b) when Field 720's irrigation requirement is assumed to be the same as the rest of the fields, 7.10 mgd versus 6.68 mgd for Fares's model, and 10.26 mgd for the calculations by HC&S.

87. A further consideration is the assumption in Fares's model of an 80 percent probability for satisfying the crop's irrigation requirements—that water sufficient to meet

the irrigation requirements would be available four out of five days over the 54-year period of his model. COL 74, *supra.* FOF 457. On the other hand, HC&S uses real-time data in its model to identify daily irrigation requirements, not the average over a period of time. COL 74, *supra*. FOF 469. While it is not explicitly stated whether or not HC&S's model also uses an 80 percent probability, its model is used to calculate and apply water use requirements on a daily basis and not on long-term averages. FOF 437, 451, 453. If HC&S water requirements are daily requirements—i.e., not the probability that water will be needed four out of five days but instead needed every day—then the water requirements would increase from four to five days, or by 25 percent.

88. For the Waihe`e-Hopoi Fields, an increase of 25 percent of 6,028 gad would be 7,535 gad, more than the 6,828 gad calculated as actually used in 2004-2006. However, HC&S is able to supply water to these fields less consistently than it is able to for the `Īao-Waikapū Fields, COL 67, *supra*, FOF 444, and these fields are typically at a substantial moisture deficit during the summer months, COL 68, *supra*, FOF 436.

89. For the `Īao-Waikapū Fields, an increase of 25 percent of 5,472 gad would be 6,840 gad, less than the 7,716 gad actually used in 2004-2006. If the Field 920 requirement is assumed to be the same as the rest of the fields, the 80 percent probability water requirement would be 5,340 gad instead of 5,472 gad, and an increase of 25 percent would be 6,675 gad.

90. Thus, there are two reasonable estimates of the water use requirements of HC&S's West Maui sugarcane fields: 1) using Fares's estimated requirements of water delivery four out of five days and at 80 percent instead of 85 percent efficiency: for the Waihe`e-Hopoi Fields, 6,028 gad or 19.59 mgd for 3,250 irrigated acres; and for the `Īao-Waikapū Fields, 5,340 gad to 5,472 gad or from 7.10 mgd to 7.28 mgd for 1,330 irrigated acres; and 2) increasing Fares's estimates by 25 percent so that water is delivered daily instead of four out of five days: for the Waihe`e-Hopoi Fields, 7,535 gad or 24.49 mgd for 3,250 irrigated acres; and for the `Īao-Waikapū Fields, 6,675 gad to 6,840 gad or from 8.88 mgd to 9.10 mgd for 1,330 irrigated acres.

91. For the Waihe`e-Hopoi Fields, the daily (7,535 gad) estimated requirements exceeded the actual daily use of 6,828 mgd, while the four-out-of-five days (6,028 gad) requirement was less than the actual daily use. For the `Īao-Waikapū Fields, the four-out-

of-five days (5,340 to 5,472 gad) and even the daily (6,675 to 6,840 gad) estimated requirements were less than the actual use of 7,716 mgd.

92. Thus, the Waihe`e-Hopoi Fields' water use requirements in 2004-2006 were 7,535 gad or 24.49 mgd for 3,250 irrigated acres, versus the actual use of 6,828 gad or 22.19 mgd, resulting in sub-optimal watering during those years.

93. The `Īao-Waikapū Fields's water use requirements in 2004-2006 were 6,675 gad to 6,840 gad or 8.88 mgd to 9.10 mgd for 1,330 irrigated acres, versus the actual use of 7,098 gad to 7,716 gad or 9.44 mgd to 10.26 mgd, resulting in over-watering during those years.

D. ALTERNATIVE WATER RESOURCES

An alternative is practicable if it is available and capable of being used after taking into consideration cost, existing technology, and logistics. COL 31.

1. Kuleana Lands and MCLT

a. Kuleana Lands

94. Appurtenant rights are preserved, COL 23, *supra*, and water use permits must be issued, subject to that use being reasonable-beneficial and limitations imposed in the event of a water shortage. COL 23-26, *supra*. The Code's definition of "reasonable-beneficial" does not include a requirement that there are no practical alternative water sources, COL 8, *supra*, but the Court has stated that the use of alternative water sources is "intrinsic to the public trust, the statutory instream-use protection scheme, and the definition of 'reasonable-beneficial' use." COL 37, *supra*. The Commission resolves this conflict in favor of not requiring appurtenant rights-holders to meet the practical alternatives test, because the Hawai`i Constitution and the State Water Code expressly preserves access to the specific surface waters that appurtenant lands had historically and culturally. COL 23, *supra*.

b. <u>MCLT</u>

95. MCLT requests a diversion of 1.5 to 2.5 mgd, an amount it estimates as less than 25 percent of the likely historical `auwai flow to restore 27 acres of wetlands. FOF 304, 345.

96. An alternative source is the basal aquifer underlying the wetlands. FOF 353.

2. <u>MDWS</u>

97. MDWS has WUPAs for Kepaniwai Well and `Īao Tunnel to supply a total of 2.401 mgd, FOF 8, 363; an agreement with WWC to receive up to 3.2 mgd of surface water from the `Īao-Waikapū Ditch, FOF 239, 368; and is engaged in discussions with WWC to obtain up to 9.0 mgd of surface water for a surface water treatment plant to be located near the Waiale reservoir, FOF 50, 369.

98. All of MDWS's sources, including the eight `Īao basal aquifer sources previously granted water use permits, FOF 362, are part of its integrated Central Maui System, FOF 362.

99. MDWS has considered various other sources in the Waihe`e, Kahakuloa, and Waikapū aquifers, but those sources have not been show to be practical. FOF 370, 371. MDWS has also entered into a consent decree that restricts its ability to utilize water sources from East Maui. FOF 372-373.

3. **WWC Delivery Agreements**

100. Information was provided at the CCH on only some of the Delivery Agreements. FOF 378-416.

101. Some of the WWC contractees were also using or may have access to MDWS water. FOF 401-403, 405, 410.

102. Wells, FOF 411, and recycled water, FOF 386, are possible but unexplored alternatives.

4. <u>HC&S</u>

103. <u>**Well No. 7**</u> was the primary source of irrigation water for the Waihe`e-Hopoi Fields, averaging about 21 mgd between 1927 and 1985, FOF 494-495, and as recently as May through October 2000, an average of 18.9 mgd was pumped, FOF 495. Each of the

two pumps at water level can pump 17.5 mgd each to reach approximately 800 acres of the 3,350 acres of the Waihe`e-Hopoi Fields, FOF 429, 496; and the booster pump at ground level can pump 14 mgd to the Waihe`e Ditch, from where it can reach all of the Fields except for the 175-acre Field 715, FOF 496.

104. HC&S states that as currently configured, Well No 7 can supply only 14 mgd to the Waihe`e-Hopoi Fields, with the exception of Field 715. FOF 497.

105. HC&S estimates that it would cost approximately $525,000 to add another booster pump and additional distribution pipeline to increase the volume that can be pumped into the Waihe`e Ditch from 14 mgd to 28 mgd, with the cost of an additional pipeline to reach Field 715 estimated at $475,000. FOF 498.

106. HC&S further states that it does not have adequate electrical power to run the pumps for Well No. 7 on a consistent and sustained basis because of its power contract with MECO. FOF 499.

107. **Recycled County Wastewater** include at least 5 mgd from Maui County's Wailuku/Kahului wastewater treatment plant, which is currently disposed of via underground injection; and several hundred thousand gallons a day are also produced by private treatment plants in Ma`alaea but unused and disposed of. FOF 501.

108. The County currently has no existing infrastructure to deliver recycled wastewater to HC&S's fields, FOF 502; but private parties could construct their own pipeline to the plant, FOF 504.

109. **Recycled Wastewater from HC&S's Puunene Mill** were or are still being used to irrigate with an overhead sprinkler system on Fields 710-715. FOF 505.

110. **Recycled Wastewater from MLP** was used to irrigate Fields 921 and 922, which was pasture at the time. They are currently irrigated with surface water for cane. The shutdown of the cannery operation will reduce the amount of wastewater by approximately half. FOF 506.

E. LOSSES

Offstream users have the burden to prove that any system losses are reasonable-beneficial by establishing the lack of practicable mitigation measures, including repairs, maintenance, and lining of ditches and reservoirs. COL 35.

Whether or not a permit is required for system losses, offstream users, and ultimately the Commission, must account for water lost or missing by adopting provisions that encourage system repairs and limit losses. COL 36.

1. **<u>Kuleana Lands</u>**

a. **<u>Kuleana Ditches</u>**

111. Many of the ditches have readily observable leaks, including the kuleana ditches. FOF 336. Furthermore, even at estimated inflow rates of 150,000 gad, kuleana users who testified at the CCH complained of inadequate water, FOF 296, 335. WWC measures the amount of water it delivers to each of the kuleana ditch/pipe system, FOF 222; but WWC does not measure amounts of water delivered to or collect data on the individual users from kuleana systems on a parcel-by-parcel basis, FOF 228. Thus, the kuleana ditches must be leaking to such an extent that water is inefficiently being delivered to the kuleanas.

112. WWC states that in the 1980s, it replaced ditches with pipes to make deliveries more reliable and consistent, FOF 215, but evidence on the extent of that replacement is lacking.

113. Even if access to stream water through an `auwai is part of the customary Hawaiian practice of growing kalo on kuleana lands under Haw. Rev. Stat. § 1-1, **<u>Reppun</u>**, 65 Haw. at 539, 656 P.2d at 63, if practicable measures are available to prevent or minimize waste of the surface water resource, they should be utilized. While resource preservation and traditional and customary Hawaiian practices are both trust purposes, COL 13, *supra*, there is no categorical imperative or absolute priorities among trust purposes, COL 14, *supra*. The <u>purpose</u> for transporting stream waters to kuleana lands for appurtenant uses, whether for traditional and customary Hawaiian practices or for other reasonable-beneficial uses, will still be achieved through practical, more efficient methods such as enclosed pipes instead of open and unlined `auwai. Thus, in order to prevent or minimize waste, kuleana ditches should be lined or enclosed pipes used in their place, absent a showing that it is unnecessary to prevent waste, or that it is not practical to do so.

b. Kalo Lo`i

114. Water "consumption" by kalo lo`i equals about 15,000 to 40,000 gad, FOF 300, and consists of evaporation from open water, transpiration through the kalo leaves, and percolation through the lo`i bottom and sides, and most of the loss is likely through leakage and minimally through evaporation and transpiration. FOF 339.

115. A typical solution for percolation/leakage losses through standing bodies of water such as reservoirs is to line the bottoms and sides with concrete or high-density polyethylene. FOF 425. However, such a "solution" for leakage from kalo lo`i would most likely be impractical; more importantly, it would be inimical to the very tradition and custom of wetland kalo and its place in the tradition and culture of Hawaiians, FOF 61-62.

116. Therefore, for losses through leakages from kalo lo`i, the Commission recognizes such losses as part of the water duty for growing wetland kalo.

c. Outflows From Kalo Lo`i

117. This CCH and the subsequent WUPAs for surface water permits are and will be the first instances in which this Commission addresses not only the consumption water-duty for wetland kalo but also the flow-through requirements for prevention/minimization of temperature-related rotting diseases that affect wetland kalo. Amounts far in excess of the consumptive amounts must be provided, FOF 337-338, but there will be large amounts of waste if outflows are not returned downstream of the diversions, and disruption of stream flows in the stretches between the diversion and return points.

118. Water for kalo lo`i is a noninstream use, COL 6, *supra*, and must show a lack of practicable mitigating measures for losses, COL 35. In the WUPA process for kalo lo`i, outflow waters will have to be returned to the stream, absent a showing that it is not practicable to do so. If it is not practicable, the Commission may adopt provisions to limit losses, including invoking its powers under the shortage provisions of the Code.

119. Another consequence of inflow/outflows that have to be well in excess of consumptive requirements is the "de-watering" of stream stretches between the diversion points and return points further downstream, even if all or most of the lo`i outflows can

practicably be returned to the stream. Those stretches cannot be allowed to go dry, and the WUPA process will have to address these circumstances.

2. WWC

120. The great majority of WWC's ditches are unlined, as are all of its reservoirs; and estimated losses from its ditch system are a set percentage of 7.34 percent. FOF 374-375.

121. WWC may in the future have plans to line the unlined portions of its system. FOF 376. Therefore, WWC has not established the lack of practicable mitigating measures to address these losses.

3. HC&S

122. HC&S estimates that it loses 6-8 mgd through seepage from the Waiale Reservoir, depending on the level of the reservoir, and estimates seepage throughout the rest of its ditch and reservoir system at 3-4 mgd. FOF 423.

123. HC&S has not undertaken studies nor estimated the costs to line Waiale Reservoir or the other reservoirs and ditches. FOF 425. Therefore, WWC has not established the lack of practicable mitigating measures to address these losses.

F. ECONOMIC IMPACT OF RESTRICTING NON-INSTREAM USES

124. Current and potential non-instream users include all users of diverted stream waters: 1) kuleana landowners and MCLT, who seek restoration to benefit their lands; 2) MDWS, who favors stream restoration while also preserving and even expanding its use of stream waters; 3) WWC's Water Delivery Contractees; 4) WWC itself, which uses no water directly but is in the business of delivering stream waters to non-instream users; and 5) HC&S, the major user. FOF 507.

125. No information was presented at the CCH concerning the positive economic impact on kuleana landowners and MCLT, although general testimony was presented on the kinds of crops and activities they would be able to engage in if they were to receive more stream waters. FOF 508.

126. Information on MDWS focused on the role of stream waters as part of its integrated water supply system and the benefits to its public users. FOF 509.

127. Information was presented on some of WWC's Water Delivery Contractees' water uses, which included the availability of MDWS water for at least some of them, FOF 510, and some information was presented on WWC's water delivery charges, which presumably would be impacted if stream diversions were to be reduced. FOF 511.

1. <u>WWC</u>

128. WWC charges between $0.20 and $2.40 per thousand gallons delivered, and the contracts introduced into evidence indicate that most of its customers pay a rate equivalent to the county rate for agricultural water of about $0.85 to $0.90 per thousand gallons. FOF 512-513.

129. However, many of WWC's water-delivery contracts do not involve any actual present use but allow WWC to collect a minimum charge, regardless of any use, based on a percentage of the stipulated maximum delivery. FOF 514. WWC has water-delivery agreements with 34 entities (in addition to MDWS and HC&S). FOF 240.

130. The maximum delivery agreements that WWC has with these 34 entities total 8.288 mgd, and the amount of water actually used under these agreements was 1.42 mgd in 2005 and 2.37 mgd in 2006. FOF 257-258. At the rate of $.85 to $0.90 per thousand gallons, WWC's income from the delivery agreements would have been $1,207 to $1,278 per day in 2005 and $2,015 to $2,133 per day in 2006. Income from the minimum charge would be additional but was not available.

131. In a filing with the state Public Utilities Commission ("PUC"), WWC proposed a tariff rate of $0.90 per thousand gallons, with a 10 percent profit rate. The PUC-approved rate would negate pre-existing rate contracts. FOF 516-517. At $0.90 per thousand gallons, WWC would have had income from the 1.42 mgd it delivered to its contractees in 2005 of $1,278 per day and in 2006 of $2,133 per day, with a profit rate of about $128 per day in 2005 and $213 in 2006.

132. WWC also receives an unspecified delivery fee from MDWS for the amount taken in excess of 1.074 mgd from its and MDWS's `Īao Tunnel (Well No 5332-02). FOF 518. However, the source of this water is high-level diked ground water and would not be affected by any reduction in diversion of stream waters.

133. WWC and MDWS also have an agreement allowing MDWS to receive up to 3.2

mgd from the `Īao-Waikapū Ditch whenever the total flow in `Īao Stream exceeds 55 mgd at the USGS gauging station above the `Īao Ditch diversion, but no evidence was introduced at the CCH on whether or not there is a delivery fee. FOF 519. This agreement could be affected by an amended IIFS for `Īao Stream even though the flow above the diversion would not be affected, because the amended IIFS may reduce WWC's ability to divert stream waters at its `Īao Ditch diversion and change the conditions under which WWC and MDWS entered into their agreement.

134. WWC does not charge kuleana users for deliveries. FOF 520. However, it is not legally obligated to continue providing water to kuleana lands through its system, except perhaps through those parts of its system that is built on or uses the `auwai that historically carried stream waters from the banks to the kuleana lands. If WWC ceases to provide water through its system and kuleana landowners want to continue their use, they would have to prove that they have easements accompanying their appurtenant rights (which also has to be recognized by the Commission) on the lands underlying WWC's ditch system.

135. HC&S pays WWC a flat fee for water used on the `Īao-Waikapū Fields, which was $300/acre/year in 2005. FOF 520. For the 1,330 acres irrigated in 2005, the fee would have been $399,000.

136. WWC also provides irrigation water to HC&S to its Waihe`e-Hopoi Fields, which are watered from HC&S's Waiale Reservoir. About half of the total amount is delivered to Waiale Reservoir from the Waihe`e Ditch through the Hopoi Chute, and about half from the Spreckels Ditch. However, the Spreckels Ditch also carries water from HC&S's diversions and tunnel, FOF 268-285, so it is difficult to identify how much comes from WWC's system. Even for water delivered by WWC from the Waihe`e Ditch, the amounts are not based on meter readings; instead, WWC calculates the number of gallons delivered to users other than HC&S and then attributes the balance to HC&S. FOF 288. HC&S's use of water from WWC's system traces back to 1924, when water from Waihe`e Stream was shared between Brewer and HC&S. After 1988, when Brewer no longer needed the Waihe`e Stream downstream of the Hopoi chute, WWC has generally left the gate open and the water formerly used by Brewer has flowed down into the Waiale Reservoir. FOF 273. No evidence was introduced that WWC charges HC&S for

this water.

2. <u>HC&S</u>

137. HC&S stated that a key factor in HC&S' ability to sustain itself is the economies of scale it can apply to the approximately 35,000 contiguous acres it cultivates on Maui, of which the West Maui Fields comprise about 5,300 acres. If reductions in HC&S's use of stream waters were of such a magnitude as to force HC&S not to cultivate the 5,300 acres that comprise its West Maui fields, HC&S would not be a viable plantation. FOF 523, 533. The West Maui Fields provide the most productive yields of all of HC&S's cultivated lands, making the West Maui Fields critical to the viability of HC&S. In 2006, HC&S grew 81 percent of Hawai`i's raw cane sugar crop. FOF 524-525.

138. HC&S employs about 800 full-time workers and EMI employs about 17 workers on Maui. FOF 526. The immediate impacts would include lost jobs and in excess of $100 million of spending on Maui, generating approximately $250,000,000 annually to the County of Maui and State of Hawai`i economies. Closure of HC&S would have a deleterious effect on efforts to promote agriculture and curb urbanization in Hawai`i. The withdrawal of HC&S's 35,000 acres of prime agricultural lands from sugar would vastly increase the agricultural lands in the State and on Maui that would be idle. Past experience with closure of other plantations has demonstrated the difficulty of returning former plantation lands into agriculture, especially if reliable access to irrigation water is curtailed. This increases the pressure to urbanize these lands instead of keeping them in agricultural use, and idling of HC&S's lands will also result in the deterioration of existing irrigation systems and infrastructure that would be extremely expensive to replace. FOF 527, 533.

139. Generally, remaining economically viable involves achieving targets in terms of sugar yields and maintaining a reasonable cost structure. Small reductions of water for irrigation on any given day might have little or no negative impact, depending on weather conditions, location, and crop cycle. Larger, persistent reductions, with no corresponding mitigation of impacts, especially if combined with reductions in the amounts that HC&S will be permitted to continue to divert in East Maui, will likely render HC&S unviable. FOF 534.

140. HC&S' sustainability is to some extent a result on its ability to spread its fixed costs of mill and related facilities operations over the revenues generated from farming the extensive acreage. One method of spreading costs is to generate revenues from the by-products of farming sugar cane and production of raw sugar. One revenue source, energy sales, comes from the burning of bagasse, a by-product of sugar cane production, and from hydro power, a by-product of operation of a water delivery system. HC&S's business success depends on its ability to receive significant revenues from selling the electric power it generates to Maui Electric Company under long term contracts. Revenues from energy sales make up about 20 percent of the total revenues generated by the agribusiness companies compared to about 5 percent of the total revenues from a decade before. HC&S diversified its product line by increasing production of foodgrade raw sugar, which returns a higher margin than commodity sugar. In the last four years, HC&S made capital investments of up to $20,000,000 supporting its efforts to diversify product lines, reduce costs of production, and increase revenues from other sources. FOF 528-532.

141. The key agronomic driver in determining sugar production is per acre yields, which is measured in tons of sugar per acre ("TSA"). HC&S has determined that, on a long term basis, sustainable yields should be between 13 and 14 TSA per crop cycle, which would translate into over 200,000 tons of sugar per year given the acreage that HC&S has in cultivation. HC&S needs to achieve yields in this range to remain viable, i.e., to generate sufficient revenues to carry its fixed and variable costs and return a reasonable profit to its shareholders. One of the most important variables determining yields is water. As a rule of thumb, HC&S needs to harvest about 400,000 acre-months of cane growth per year to be viable. That translates into approximately 200,000 tons of sugar. Reduction of water deliveries to Waiale Reservoir, especially during periods of low ditch flows, will force HC&S to try to replace that water to the extent possible by pumping water from Well No. 7 at the expense of pumping from other wells. However, power limitations restrict the amount of water that HC&S can ultimately pump, which affects sugar yields. FOF 535.

142. Prolonged drought conditions, such as HC&S has experienced for much of the last 15 years, can cause a reduction in average crop age by delaying the replanting of

harvested fields and prompting the premature harvesting of fields whose growth potential is compromised by lack of water. Disease and other operating conditions can also cause a reduction in average crop age. In addition, during water-short periods, the cane does not grow; hence the physical age of the cane is greater than the growth age. FOF 536. The average crop age of harvested acres at HC&S has dropped from 2003 to 2006 due to the combined effects of drought and HC&S's 2001 closure of its Paia Mill, which was done to reduce costs and increase efficiency by centralizing all sugar processing at the Puunene Mill. In 2001, total acres harvested were approximately 2000 less than the prior year, because the Puunene Mill was initially unable to absorb all of the lost capacity from the Paia Mill closure. Harvesting fewer acres increased the average crop age of the unharvested acres. As capacity was added to the Puunene Mill and HC&S gained more experience in the reconfigured operation, harvested acres increased again, resulting in a lower average crop age and lower yields. FOF 537. Given the currently reduced crop age of HC&S' fields, HC&S expects to reduce its rate of harvesting into 2008 and 2009 to allow for an increase in crop age so as to improve yields, and then return to harvesting at its historic rate of approximately 16,000 to 17,000 acres per year that maximizes the acreage that can be served with currently available irrigation water as well as the current processing capacity of the Puunene Mill. The short-term result will be diminished revenues both from reduced sugar production and reduced production of bagasse to fuel the power plant. The hoped for longer term result will be increased yields which, together with increased revenues from the production and sale of specialty sugars and further expansion of energy related sales, will allow HC&S to remain economically viable. This will be possible only if HC&S' continued access to irrigation water is not significantly reduced. FOF 538.

143. Chan-Halbrendt, OHA's expert witness, was asked to evaluate the economic analysis undertaken by HC&S, not perform an independent economic analysis of the impact of stream water reductions to HC&S. She concluded that HC&S "provided no economic analysis of the impacts of decreasing its use of Nā Wai `Ehā water," and "made no apparent attempt to substantiate and quantify the impact, even though I believe many of the essential data for such analysis are within HC&S's possession." FOF 539, 550.

144. As examples of unsubstantiated assumptions, Chan-Halbrendt provided the

following:

a. HC&S claimed that, in order to remain economically viable, it needed to achieve a yield of 13 to 14 tons of sugar per acre ("TSA") on a sustainable, long-term basis. The data from A&B's 10-K filings indicates that HC&S had obtained those yields in only four of the fifteen years from 1992 to 2006, and that there was only a weak correlation, if any, between the TSA and HC&S's profits. FOF 540.

b. HC&S claimed that it had "benefitted" from the acreage it leased in the `Īao-Waikapū Fields and the additional Nā Wai `Ehā water it gained access to when WWC's predecessor abandoned sugar cultivation. The data from A&B's 10-K filings indicates that HC&S's raw sugar production was lower in the ten years after 1994, when it leased the additional acreage in the `Īao-Waikapū Fields, than it was in the ten years before, and the profitability of the agribusiness sector, of which HC&S is a part, actually decreased after 1988, when HC&S gained access to the additional Nā Wai `Ehā stream water. FOF 540.

c. HC&S claimed that maintaining the number of acres it has in sugar cultivation is necessary to remain economically viable. A&B's 10-K filings, though, indicate that, from 2000 through 2005, HC&S decreased its cultivated acreage by more than 2000 acres, which increased only slightly in 2006. Moreover, A&B has development plans that would remove almost 3,500 additional acres from cultivation. FOF 540.

d. HC&S has also claimed that its survival hinges on the `Īao-Waikapū Fields and having sufficient Nā Wai `Ehā water to irrigate them, but it made no apparent attempt to acquire those lands when they became available. HC&S had no written agreement with WWC after July 2003, when WWC refused to extend the land lease and announced HC&S was "no longer entitled to any water allocation pursuant to that Temporary Water Agreement." This continued until July 2005 (after the IIFS petition was filed), when Atherton et al. began acquiring the land and HC&S and WWC settled on their present terms for water in a one-page letter. FOF 541.

145. In responses to these criticisms, HC&S stated that:

a. Financial information about the A&B Agribusiness Group reported in the Form 10-K filings is meant only to provide a general view of the performance of the group. The filings do not account for revenues not based directly on sugar production, such as power sales to MECO. The filings also do not account for increased costs, declines in sugar prices, the effects of disease and drought, the effects of federal disaster relief payments received by HC&S for drought conditions, the inclusion of C&H in the financial reports of the Agribusiness Group from 1993 through 1998, the addition of specialty sugars sales in later years, and other factors that influence the profitability of HC&S. Given HC&S's cost structure, which in 2008 totaled approximately $104 million, HC&S needs to generate revenue based on 13-14 TSA to remain viable going forward. FOF 554.

b. Chan-Halbrendt did not focus on crop age and acres harvested. There is a very high correlation between average crop age per acre harvested and TSA. All other things being equal, the greater the age of the cane at the time of harvest, the greater the yield and the resulting sugar revenues over which to spread the average cost of preparing, planting, and harvesting each acre during a given two-year cycle as well as the fixed costs of operating and maintaining HC&S' mill and other facilities. All other things being equal, producing more sugar per acre harvested in turn results in more net sugar revenues, and harvesting more acres results in the production and sale of more sugar. FOF 555.

146. In concluding that HC&S had not provided an economic analysis, Chan-Halbrendt advised conducting a general equilibrium analysis and partial equilibrium analysis. General equilibrium analysis analyzes how an industry affects other sectors' economy, while partial equilibrium analysis analyzes the impact of changes on economic performance on the industry itself. FOF 551.

147. Chan-Halbrendt was of the opinion that a partial equilibrium analysis could examine the impact on HC&S's profitability under several scenarios, such as: use of pumped ground water or conservation measures to compensate for incremental reductions of Nā Wai `Ehā water; projected change in yield caused by varying increments of water reduction; incremental shifts in cultivated acreage in response to incremental reduction in available water; or a combination of such factors. FOF 548.

148. Chan-Halbrendt was of the opinion that the scenarios identified for analysis in a partial equilibrium analysis are substantially the same as those identified by HC&S as available options in the event its access to Nā Wai `Ehā is restricted. HC&S's estimate of electrical costs of pumping Well No. 7, without any information about the costs or

benefits of the other options, might be a factor in an economic analysis, but does not substitute for the analysis. HC&S has not analyzed the economic impact of increased water costs on its business and has done no financial analysis of the impact of having to pay for water at the agricultural rate that other farmers pay. FOF 549.

149. According to Chan-Halbrendt, to assess whether reducing the Nā Wai `Ehā water available to HC&S on 15 percent of its cultivated acreage would have impacts that extend to the economies of the County of Maui and the State of Hawai`i would require, initially, a partial equilibrium analysis to determine the impacts on HC&S, which would then feed into a general equilibrium analysis which would consider inter-sectoral, employment, and income impacts and may include the economic values and opportunity costs of alternative uses of water, including instream uses. Such an analysis, had HC&S performed one, may potentially have revealed "not only a mitigation of adverse impact, but also an overall increase in economic and social welfare" because, among other things, "reallocation of water can facilitate its efficient and equitable distribution to higher valued uses, both within agriculture as well as in other sectors." FOF 542.

150. The Commission concludes that Chan-Halbrendt is substituting her approach to economic analysis for the balancing test that the Commission must perform between instream values and non-instream uses, because she includes instream uses among the economic values and opportunity costs of alternative uses of water. This is confirmed by her conclusion that "the lack of any economic analysis (i.e., a partial equilibrium analysis that feeds into a general equilibrium analysis), or the data required to conduct such an analysis, prevents anyone, including this Commission, from evaluating HC&S's claims of economic impact." FOF 551.

151. The Commission's duty in establishing the IIFS includes weighing the economic impact of restricting non-instream uses. COL 4, *supra*. The law does not prescribe a specific method for weighing that economic impact, and in insisting that the Commission is prevented from evaluating HC&S's claims of economic impact without following the dictates of her preferred method, Chan-Halbrendt is expressing a legal opinion, an area that is outside the realm of her qualifications as an expert witness.

152. As "the primary guardian of public rights under the trust," this Commission "must not relegate itself to the role of mere umpire passively calling balls and strikes for

adversaries appearing before it, but instead must take the initiative in considering, protecting, and advancing public rights in the resource at every stage of the planning and decisionmaking process." Waiāhole I, 94 Haw. at 143, 9 P.3d at 455. As a batter for team OHA, Chan-Halbrendt is not content to just swing at the pitches from HC&S but also insists that the Commission must disqualify HC&S's pitcher and not even call balls and strikes, because the game is not being played by her rules.

153. Analyses along the lines suggested by Chan-Halbrendt, COL 148, *supra*, would have been helpful, but the lack of such analyses does not prohibit the Commission from its duty of weighing instream values with non-instream uses.

154. Both HC&S and Chan-Halbrendt focused their analytical approach on the impact on HC&S's total sugar operations over 35,000 acres, if the 5,000 acres of the West Maui fields, 15 percent of the total, were shut down due to a lack of water. COL 137, 149, *supra*. FOF 523, 533, 542. It would have been more helpful to the Commission if either or both parties had provided information on incremental decreases in surface water to the 5,000 acres of West Maui Fields. The issue before the Commission in this CCH is a balancing of instream values and non-instream uses for the Nā Wai `Ehā waters and not an all-or-nothing choice between the two. The Supreme Court has declined to elevate any particular category of water use to the level of a "categorical imperative." Instead, the Commission is to "weigh competing public and private water uses on a case-by-case basis, according to any appropriate standards provided by law," and the Court has "indicated a preference for accommodating both instream and offstream uses where feasible." **Waiahole I**, 94 Haw. at 142, 9 P.3d at 454.

G. INTERIM INSTREAM FLOW STANDARDS (IIFS)

1. Diversions and Stream Flows

155. The current IIFS for the Nā Wai `Ehā streams are the flows that were in the streams on December 10, 1988: "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." HAR §13-169-48.

156. Gaining reaches of streams are those in which ground water contributes to the streamflow by a breaching of the ground water system by the stream. Losing reaches of streams are where the channel bottoms are above the water table and an unsaturated zone exists between the stream and water table. In the upper reaches of the Nā Wai `Ehā area, the stream channels intersect the dike-impounded ground waters, which results in a contribution of ground water to the stream, making the streams gaining in the upper reaches. In the lower reaches of the Nā Wai `Ehā area, the stream channels overlie the basal freshwater lenses, allowing stream waters to migrate from the stream bed to the basal lenses, making the streams losing in the lower reaches. At the mouths of the streams in the Nā Wai `Ehā area, some of the stream channels intersect the basal freshwater lenses, making those streams gaining in that area. The Nā Wai `Eha streams are generally gaining streams above the existing diversions and losing streams below the diversions. FOF 87-92.

157. For 1984-2005, USGS estimates the flow of Waihe`e River at 605 feet elevation, upstream of all diversions (Waihe`e Ditch at 600 feet elevation and Spreckels Ditch at 400 feet elevation), to be: Q_{90} flow was 24 mgd, Q_{70} flow was 29 mgd; and Q_{50} flow was 34 mgd. The lowest minimum daily flow recorded was 14 mgd. Estimated stream flow losses in Waihe`e River downstream of the Spreckels Ditch may range from 2.1 mgd to at least 5.9 mgd. Although actual losses may vary as a function of streamflow, because data are limited, a constant loss of 4 mgd is assumed by USGS. Waihe`e and Spreckels Ditches are capable of diverting all of the dry-weather flow available at the intakes, but stream flow immediately downstream of the intakes may exist because of leakage through or subsurface flow beneath the dams at these sites. Estimated dry-weather flow immediately downstream of the Waihe`e and Spreckels Ditch intakes commonly is on the order of about 0.1 mgd, but the stream may not have continuous surface flow from mauka to makai. FOF 108-109, 111.

158. Low-flow characteristics for North Waiehu Stream during the 1984-2005 climate years were estimated using record-extension techniques and available historical data during 1911-1917. The minimum discharge (Q_{100}) measured at gaging station 16608000

at an altitude of 880 feet was 1.6 mgd during March 1915. The estimated Q_{90} discharge ranges from 1.4 mgd to 2.7 mgd for 1984-2005; the estimated Q_{70} discharge ranges from 2.3 mgd to 2.7 mgd; and the estimated Q_{50} discharge ranges from 3.1 mgd to 3.6 mgd. Water is diverted by the North Waiehu Ditch near an altitude of about 860 feet and generally diverts most of the water available at the diversion structure, but leakage from the North Waiehu Ditch may sometimes return to the stream. USGS estimates that North Waiehu Stream loses 1.3 mgd between the North Waiehu Ditch and the confluence of North and South Waiehu Streams. Low-flow characteristics for South Waiehu Stream the 1984-2005 climate years were estimated using record-extension techniques and available historical data during 1911-1917 from discontinued USGS gaging station 16610000. The minimum discharge (Q_{100}) measured at gaging station 16610000 at an altitude of 870 feet was 1.5 mgd during July 1913. Near gaging station 16610000 at an altitude of 870 feet, the estimated Q_{90} discharge ranges from 1.3 mgd to 2.0 mgd for 1984-2005; the estimated Q_{70} discharge ranges from 1.9 mgd to 2.8 mgd; and the estimated Q_{50} discharge ranges from 2.4 mgd to 4.2 mgd. Water is currently diverted from South Waiehu Stream by the Spreckels Ditch and two kuleana ditches farther upstream. The main diversion is the Spreckels Ditch, near an altitude of about 270 feet and about 1000 feet upstream from the confluence of North and South Waiehu Streams. No information is available on estimated losses in South Waiehu Stream, but USGS estimates that the loss in Waiehu Stream itself, downstream of the confluence of North and South Waiehu Streams to the mouth of the stream, is 0.6 mgd. Return flows and leakage from the kuleana ditches have been observed entering South Waiehu Stream. In addition, overflow or releases from the Waihe`e and Spreckels Ditches may sometimes enter South Waiehu Stream. Spreckels Ditch is commonly capable of diverting all of the flow of South Waiehu Stream during dry-weather conditions, although stream flow immediately downstream of the intake may exist because of leakage through or subsurface flow beneath the dam at the intake. Waiehu Stream is commonly dry farther downstream near Lower Waiehu Beach Road, and therefore, Waiehu Stream does not flow continuously from mauka to makai. There is extensive channel erosion below the Spreckels Ditch on South Waiehu Stream, with a 12-foot drop in the elevation of the stream just below the diversion, and there is a vertical concrete apron located just below the highway culverts in lower Waiehu Stream. FOF 113-114, 116, 119-124.

159. On the basis of 22 years of complete records (climate years 1984-2005) at USGS stream-gaging station 16604500 on ʻĪao Stream near an altitude of about 780 feet and above all diversions, the minimum daily mean flow (Q_{100}) was 7.1 mgd; the Q_{90} flow was 13 mgd; the Q_{70} flow was 18 mgd; and the Q_{50} flow was 25 mgd. The two main diversions are ʻĪao-Waikapū and ʻĪao-Maniania Ditches near an altitude of about 780 feet (there is also a small privately owned pipe farther downstream), and the Spreckels Ditch, near an altitude of about 260 feet and about 2.4 miles downstream from the ʻĪao-Waikapū and ʻĪao-Maniania Ditches. The ʻĪao Flood Control Project starts about 2.5 miles above the mouth of ʻĪao Stream and consists of a debris basin, a concrete channel that runs from the debris basin to just downstream of North Market Street, a 20-foot vertical drop, a broadened but unlined channel running to Waiehu Beach Road, and concrete wing walls running about one-half of the distance from the Waiehu Beach Road to the mouth of the stream. In 2008, a $30 million project was advertised to line the remaining Control Project channel and raise existing levees to eliminate future flooding and levee failure. USGS estimates that ʻĪao Stream loses 6.3 mgd in reaches that are not lined with concrete and that are downstream of the ʻĪao-Maniania Ditch diversion (which is at about 780 feet elevation), or 3.00 miles from about 595 feet elevation down to 35 feet elevation. Water that overflows or leaks from the ditch systems or that is discharged through gates in the systems sometimes returns to ʻĪao Stream downstream of the diversions. In the absence of ditch return flows and runoff during and following periods of rainfall, ʻĪao Stream remains dry in some reaches downstream of the main diversion intake for the ʻĪao-Maniania and ʻĪao-Waikapū Ditches and does not flow continuously from mauka to makai. FOF 126-131.

160. On the basis of record extension techniques applied by USGS to the historical data from Waikapū Stream near gaging station 16650000 near an altitude of about 880 feet, the estimated Q_{90} flow was from 3.3 mgd to 4.6 mgd during climate years 1984-2005; the estimated Q_{70} flow was 3.9 mgd to 5.2 mgd, and the estimated Q_{50} flow ranged from 4.8 mgd to 6.3 mgd. The lowest recorded flow was 3.3 mgd in October 1912. The record extension techniques applied to the historical data to estimate the natural flow near

gaging station 16650000 combined 1910-1917 historical data from gaging station 16650000, flows in the South Side Waikapū Ditch near an altitude of about 1,120 feet, and flows in the Everett Ditch near an altitude of about 900 feet. (Oki, WDT 9/14/07, ¶ 27.) While the Everett Ditch is no longer active, the South Side Waikapū Ditch is. The estimates of natural flow assume no gains, losses, or return flows between the South Side Waikapū Ditch diversion and station 16650000 during the period when the gaging stations were operated. Recent USGS seepage-run data from 2004 indicate no significant net gain or loss between the South Side Waikapū Ditch diversion and station 16650000. (Oki, WDT 9/14/07, ¶ 27.) Thus, the estimated natural flows just above the South Side Waikapū Ditch diversion should be the same as those estimated at station 16650000. Active diversions on Waikapū Stream include the South Side Waikapū Ditch near an altitude of about 1,120 feet, an intake on the Waihe`e Ditch (elevation not specified), and the Reservoir 6 Ditch (elevation not specified). Numerous return flows have been observed in Waikapū Stream downstream of the diversions. Diversions in Waikapū Stream may not cause the stream to be dry immediately downstream of the diversions, although it is commonly dry downstream of all diversions because of infiltration losses into the streambed, and the stream does not flow continuously from mauka to makai. FOF 133-137.

161. Stream flows in Hawai`i have decreased significantly over a 90-year period. While USGS has not observed any significant trends in median flows in the Waihe`e River over the period, 1984 to 2005, the climate years upon which the USGS Q flows are based, average (or mean) monthly total stream flows for Waihe`e River for the three 8-year periods 1984-1991, 1992-1999, and 2000-2007, decreased by about 25 percent. The monthly flows averaged 1639.1 mgd, 1436.0 mgd, and 1236.6 mgd, and translate into daily averages of 54.64 mgd for 1984-1991, 47.87 mgd for 1992-1999, and 41.22 mgd in 2000-2007. In the same periods, `Īao Stream flows decreased by about 10 percent. FOF 94-95. Waiehu and Waikapū Streams are not gaged, FOF 113, 119, 133, but it would be reasonable to assume that the flows in those two streams have decreased by similar amounts; i.e., between 10 to 25 percent over the three eight-year periods from 1984 to 2007.

162. If we average the daily flows for the three eight-year periods in COL 161, *supra*, the average daily flow for Waihe`e River for 1984-2007 was 47.91 mgd, compared to the average daily flow for 2000-2007 of 41.22 mgd. Although USGS did not detect any significant trends in median flow (Q_{50}), the average flow in the years 2000-2007 was 86 percent of the average flow for the years 1984-2007. So even though USGS has concluded that there were no significant trends of the Q_{50} flow of 34 mgd for Waihe`e River, a decrease of 14 percent between the average flow from 1984-2007 versus from 2000-2007 means that there was less water in Waihe`e River for the last eight years of the 24-year period on which the USGS Q flows were calculated. This would also hold true for `Īao Stream, although the decrease there was less, at 10 percent, and for Waiehu and Waikapū Streams, although the extent of the decreases there are not known, because both streams are not currently gauged.

163. WWC diverts: 1) from 70 to 90 percent of the annual total flow of Waihe`e River; 2) from 40 to 60 percent of the annual total flow of North Waiehu Stream; 3) from 30 to 50 percent of the annual total flow of `Īao Stream; and 4) from 60 to 80 percent of the annual total flow of Waikapū Stream. FOF 210-213.

164. These diversions: 1) averaged 37.09 mgd in 2005 and 29.72 mgd in 2006 by WWC for Waihe`e River; 2) averaged 1.41 mgd in 2005 and 1.38 mgd in 2006 by WWC for North Waiehu Stream and ranged from a low of 2-3 mgd during dry periods to a maximum of 10-15 mgd during wet periods by HC&S for South Waiehu Stream; 3) averaged 13.68 mgd in 2005 and 13.53 mgd in 2006 by WWC and ranged from a low of 3-4 mgd during dry periods to a high of about 20 mgd during wet periods by HC&S for `Īao Stream; and 4) averaged 4.32 mgd in 2005 and 4.31 mgd in 2006 by WWC for Waikapū Stream. FOF 210-212. These diversions, plus the three kuleana diversions known to be present on South Waiehu, `Īao, and Waikapū Streams (**See** Table 1) divert all of the dry-weather flows of Waihe`e River and North and South Waiehu Streams. FOF 111, 116, 124. `Īao Stream remains dry in some reaches downstream of the diversions through a combination of diversions and infiltration losses into the stream bed, FOF 129-131, and although diversions may not cause Waikapū Stream to be dry immediately downstream of the diversions, it is commonly dry further downstream of all diversions because of infiltration losses into the streambed. FOF 137.

165. Table 9 compares the gate capacities and settings and the quantities of diverted waters for 2005 and 2006 with the Q_{90}, Q_{70}, and Q_{50} flows. All of the diverted amounts were less than the gate settings, except for Waikapū Stream, where the setting is at 3 mgd, but more than 4 mgd were diverted in both 2005 and 2006. However, the amounts diverted from Waikapū Stream are in the range between the Q_{90} and Q_{70} flows and therefore divert all of the stream waters up to about 30 percent of the time. For Waihe`e River, the diverted amounts range from the Q_{70} flows to more than the Q_{50} flows and therefore divert all of the stream waters more than 50 percent of the time. For Waiehu Stream, the diverted amounts range between the Q_{90} and Q_{70} flows and therefore divert all of the stream waters up to about 30 percent of the time. For `Īao Stream, the diverted amounts are in the range of the Q_{70} flows and therefore divert all of the stream waters about 30 percent of the time. These comparisons confirm USGS's observations that the diversions are capable of diverting all of the dry-weather flows available at the intakes. FOF 111, 116, 123, 131, 137. Furthermore, because there has been a reduction in average flows up to about 14 percent when the years 1984-2007 are compared to the years 2000-2007, the diverted amounts for 2005 and 2006 in Table 9 may result in higher percentages of the time when the diversions take all of the stream flows.

2. <u>Expert Opinions on Amending the IIFS</u>

166. Habitat above the diversions is characterized by high flow, numerous riffles, and cascades, while habitat below the diversions, where existing at all, is characterized by low flow, infrequent riffles, and small shallow pools. FOF 560.

167. Opposing opinions can be summarized as follows:

1) Benbow, Hui/MTF's expert witness, concluded that "(p)ending firmer scientific information from further studies, flow restoration should uphold two guiding principles. First, the flow amounts must create enough quality habitat to support sustainable, reproductive instream biological communities, taking into account public uses such as Native Hawaiian gathering practices. Second, the flow amounts must maintain enough continuous flow from mauka to makai to enable the streams to serve their natural ecological functions, including sustaining the life cycles of the native amphidromous species." FOF 556.

2) Ford, HC&S's expert witness, disagreed that continuous flow from mauka to makai is necessary to enable the streams to serve their natural ecological functions and distinguishes between physical connectivity versus ecological connectivity (stream flows of sufficient volume and frequency to allow the normal distribution of native amphidromous species within a given watershed). FOF 557.

3) Benbow's opinion is that no amount of mitigation of other factors can compensate for a lack of streamflows; on the other hand, increased streamflows can go a long way to mitigate the adverse effects of other factors. FOF 595.

4) Benbow's studies in `Īao Stream documented substantial amphidromous migration when flow connected to the ocean for more than three or four days and thus anticipated that with continuous flow, amphidromous species would reestablish into the upper reaches of `Īao Stream. FOF 594. The Division of Aquatic Resources' ongoing biological surveys and monitoring have also documented amphidromous recruitment in the channelized section in `Īao Stream during intermittent flows. FOF 593.

5) HC&S's expert witnesses concluded that the contributions of one healthy stream to the populations of amphidromous species in neighboring streams cannot be overlooked. On a regional basis, this tends to compensate for the absence of significant reproducing populations in the other streams. FOF 597.

6) Benbow was of the opinion that each stream is a natural system, and differences in the characteristics of the streams and their watersheds should be taken into account. FOF 598.

168. The approach to amending the IIFS of Benbow, Hui/MTF's expert witness, and the response of HC&S's expert witnesses were as follows:

1) "Short of restoration of 100 percent of natural flows, the working presumption should be that the streams of Nā Wai `Ehā need no less than 75 percent of annual median flow to maintain their overall biological and ecological integrity over the short and long term." FOF 577.

2) He uses the median to measure total streamflow, which, in his opinion, is the "preferred measure of typical flow conditions" instead of mean (or "average") flow. The median is synonymous with Q_{50}, or the flow equaled or exceeded 50 percent of the time. FOF 578.

3) His recommendation of releases of 75 percent of the annual Q_{50} of the Nā Wai ʻEhā streams computes to flow values approximately between the Q_{65} and Q_{85} of the streams. These duration values mean that 15 to 35 percent of the time, streamflows will be naturally lower even without any diversions. FOF 579.

4) His recommendation nearly matches the Q_{70} level, or what USGS theorizes is the mean base flow component of total flow; however, Benbow stated that he did not rely on that fact for his recommendation. FOF 580.

5) He stated that "(t)he 75 percent of median recommendation is less than optimal, but incorporates a margin of safety to compensate for natural or other variations in streamflow, which may include long-term drought if a moving median is adopted. The margin of safety accounts also for the absence of more detailed scientific information on the necessary flow amounts. Lesser amounts would foreclose benefits to stream life and ecology and the opportunity for the necessary studies to determine whether our best estimates of the minimum flows should be maintained or modified." FOF 581.

6) When asked to clarify how "annual median flow" would be calculated, he stated that a "starting place" would be the historical median flow for the period between 1984 to 2005. However, he also proposed that the 75 percent figure be adjusted periodically. For example, every six months, the median flow for the previous year would be calculated, and 75 percent of that flow would be released. FOF 582.

7) The 75 percent figure is supposed to represent a "null hypothesis." However, Payne, HC&S's expert witness, stated that varying the 75 percent figure every six months would defeat the purpose of testing if a control flow has any effect on the stream. It would be impossible to isolate test variables if the control flow were adjusted over the test period. FOF 583.

8) Benbow testified that the 75 percent figure is an "informed guess." He also conceded that the amount of flow needed could be less. FOF 585.

9) Benbow is unaware if any member of the working group at the USGS stakeholder meeting has endorsed recommending to the Commission that the appropriate instream flow standard should be 75 percent of the annual median flow. FOF 586.

10) Payne, one of HC&S's expert witnesses, testified that the technique of using flow duration curves to derive instream flow recommendations is well established

in the scientific literature. The Tennant Method has as a basis various percentages of the mean annual flow. The New England Base Flow Method uses the median August flow to set a minimum flow value. Many others select specific flow duration values by either season or month. None of these methods, however, specify 75 percent of the Q_{50}. Typically, when a hydrograph is used to set flow, the flow will be based on a specific flow duration value rather than a variable percentage of a flow duration value. Payne is unaware that Benbow's approach has ever been applied or tested on Hawaiian or any other streams. Therefore, Payne concluded that the argument that 75 percent of the Q_{50} is required to accomplish his stated objectives appears to be based on Benbow's personal judgment and opinion, is unsupported by published literature, and is without implementation history or precedent. FOF 584.

11) The flow rate recommended by Benbow cannot be sustained because it could exceed the natural flow of the stream. For instance, the Q_{75} of Waihe'e Stream is between 20 to 30 mgd (USGS historical data indicate that the Q_{70} flow of Waihe'e Stream is 29 mgd). Yet, the flow of Waihe'e Stream is frequently less than 20-30 mgd even under undiverted conditions. FOF 587.

12) The releases proposed by Benbow for a period of at least five years is his personal opinion. FOF 588.

169. The approach to amending the IIFS by HC&S's expert witnesses and the response of Benbow, Hui/MTF's expert witness, were as follows:

1) Contrary to Benbow's suggestion that a large volume of flow be restored and sustained for a long period of time, Ford, HC&S's expert witness, recommended that restoration of flows, if any, should begin at a low level and increased incrementally over time. Starting with a low level of releases helps in determining the incremental contributions of flow and their significance. Adequate time should be allowed to study both changes in habitat and biological responses to the releases at each increment. Starting with low increases in flows quickly results in a large benefit in terms of increasing the wetted habitat area of a stream. At higher flows, the increase in wetted habitat area from increasing flows becomes much less dramatic. FOF 589.

2) Benbow stated that his recommendation of much higher flows incorporates a margin of safety to compensate for natural or other variations in

streamflow. The margin of safety accounts also for the absence of more detailed scientific information on the necessary flow amounts. FOF 581.

3) HC&S's expert witnesses concluded that the contributions of one healthy stream to the populations of amphidromous species in neighboring streams cannot be overlooked. The larval drift sampling conducted by SWCA found large numbers of ‘o‘opu larvae in Waihe‘e Stream and none in the three other streams. This suggests that Waihe‘e Stream contributes thousands of ‘o‘opu larvae to the oceanic pool. On a regional basis, this tends to compensate for the absence of significant reproducing populations in the other three Nā Wai ‘Ehā Streams. FOF 596.

4) Benbow was of the opinion that each stream is a natural system, and differences in the characteristics of the streams and their watersheds should be taken into account. FOF 598.

5) HC&S's expert witnesses recommended that the addition of flow to Waihe‘e River and Waiehu Streams would yield the most benefit in terms of increasing populations of native amphidromous species in the Nā Wai ‘Ehā area. The key is to place flow in streams in which existing alterations of habitat are minimal. Waihe‘e River provides significant habitat for all life stages of native amphidromous species. Waiehu Stream, while not an ideal candidate for restoration due to its narrow channel and cultural disturbances in the middle reaches, nevertheless showed signs of ecological connectivity. By comparison, it is highly questionable whether increased flows in ‘Īao Stream would mitigate the impediment to recruitment posed by the channelization of the stream. There is also no definitive evidence that Waikapū Stream ever carried uninterrupted surface waters to the sea. FOF 590.

6) However, they admitted that the larval drift surveys they conducted did not address the issue of the relative importance of channelization versus lack of flow and that no data or study that they knew of demonstrated that channelization is more important. FOF 592.

7) On the question of whether or not Waikapū Stream flowed continuously to the ocean under uninterrupted conditions, they acknowledged that, ultimately, restoration of flow would answer whether Waikapū Stream flows mauka to makai. FOF 595.

3. **<u>The Parties' Proposed IIFS</u>**

170. On the basis of their expert witness, Hui/MTF, joined by OHA, recommended the following amended IIFS: 1) Waihe`e River: a) 25.5 mgd immediately downstream of the Waihe`e Ditch Diversion; b) 27.5 mgd immediately downstream of the Spreckels Ditch diversion; and c) at the mouth: the flow remaining in the stream after diversion of (1) up to 2.0 mgd to satisfy kuleana and T&C users downstream of the Spreckels Ditch diversion who take water directly from Waihe`e Stream and (2) up to 2.5 mgd for the uses of Maui Coastal Land Trust; 2) North Waiehu Stream: 2.5 mgd immediately below the North Waiehu diversion; 3) South Waiehu Stream: 2.5 mgd immediately below the South Waiehu diversion; 4) at the mouth of Waiehu Stream: the flow remaining after diversion of 0.07 mgd for the use of kuleana and T&C users; 5) `Īao Stream: a) 18.8 mgd immediately downstream of the `Īao intake; and b) at the mouth: the flow remaining after the diversion of up to 2.0 mgd to satisfy kuleana and T&C users who take water directly from the stream; 6) Waikapū Stream: a) 4.1 mgd immediately below the Reservoir 6 intake; b) at the mouth: the flow remaining after the diversion of up to 0.35 mgd for the uses of kuleana and T&C users who take water directly from the stream; and c) if Waikapū Stream flow has not reached Kealia Pond within 120 days from the effective date of the IIFS, then there shall be no IIFS at the mouth, and the IIFS immediately upstream of the Reservoir 6 intake shall be the amount remaining after the diversion of up to 0.35 mgd for the uses of kuleana and T&C users who take water directly from the stream. Hui/MTF Proposed D&O, Section II.A-D.

171. On the basis of their expert witnesses, HC&S recommended the following amended IIFS: 1) Waihe`e River: a minimum flow of 2 mgd to 3 mgd measured below the Spreckels Ditch intake; 2) North Waiehu Stream: a minimum flow of 0.15 mgd to 0.25 mgd below WWC's diversion on North Waiehu Stream; 3) South Waiehu Stream: a minimum flow of 0.15 mgd to 0.25 mgd below HC&S' diversion on South Waiehu Stream; and 4) 'Īao and Waikapū Streams: not viable candidates for restoration and therefore deny the requests for amendment of their IIFS. HC&S Proposed D&O, Section II.1.A-D.

172. WWC recommended the following amended IIFS: 1) Waihe`e River: 1.4 mgd below the Spreckels Ditch; 2) North Waiehu Stream: 0.5 mgd below the North Waiehu Ditch; 3) South Waiehu Stream: 0.5 mgd below the South Waiehu Ditch; 4) `Īao Stream: 4.2 mgd below WWC's `Īao Ditch and 1.4 mgd below HC&S's diversion into the Spreckels Ditch; and 5) Waikapū Stream: 1.1 mgd below the inactive Everett Ditch and 0.4 mgd below the Reservoir 6 Ditch. WWC Proposed D&O, Section XV.1.

173. MDWS recommended the following amended IIFS: after allocating sufficient water to meet existing kuleana needs; allocating up to 3.2 mgd to the County of Maui to meet its current needs for the municipal water supply; reserving an allocation of 9.0 mgd to meet the County of Maui's future needs for the municipal water supply; and allocating 6.1 mgd to HC&S to meet irrigation needs for HC&S's fields (other than Field 920) that cannot be irrigated by water from HC&S's Well No. 7, all remaining stream water currently diverted by Wailuku Water Company shall be returned to the streams. MDWS Proposed D&O, Section III.B.

4. <u>The Commission's Analysis and Conclusions</u>

a. <u>MDWS's Proposed IIFS</u>

174. MDWS would return all remaining waters into the streams after allocating sufficient water to meet the needs of what it had concluded were reasonable and beneficial offstream uses. COL 173, *supra.*

175. This approach would be in direct conflict with the Supreme Court's ruling in **<u>Waiāhole I</u>**: amending the IIFS comes first, and non-instream (offstream) uses are then met with the remainder. **<u>Waiāhole I</u>**, 94 Haw. at 153, 9 P.3d at 465.

b. <u>WWC's Proposed IIFS</u>

176. WWC's proposed amendments would do the following: 1) Waihe`e River: the proposed IIFS of 1.4 mgd would be less than even the lowest recorded flow (Q_{100}) of 14 mgd (Q_{90} of 24 mgd) above all diversions; 2) Waiehu Stream: the proposed IIFS of 0.5 mgd each for the North and South branches would be less than the lowest recorded flow (Q_{100}) for North Waiehu of 1.6 mgd (Q_{90} of 1.4-2.7 mgd) and for South Waiehu of 1.5

mgd (Q_{90} of 1.3 to 2.0 mgd) above all diversions; 3) `Īao Stream: the proposed IIFS of 4.2 mgd below WWC's `Īao Ditch and 1.4 mgd below HC&S's diversion into the Spreckels Ditch would both be below the lowest recorded flow (Q_{100}) of 7.1 mgd (Q_{90} of 13 mgd) above all diversions; and 4) Waikapū Stream: the proposed IIFS of 1.1 mgd below the inactive Everett Ditch and 0.4 mgd below the Reservoir 6 Ditch would both be below the lowest recorded flow (Q_{100}) of 3.3 mgd (Q_{90} of 3.3 to 4.6 mgd) above all diversions. COL 157-160, 172, *supra*.

177. The reasoning behind WWC's proposed IIFS is as follows:

a) Base flow reflects the amount of water in the stream in extended dry periods. WWC Proposed FOF 337.

b) If the amount of water necessary to satisfy instream and non-instream uses exceeds the base flow, the competing uses must be balanced to both protect the resource and provide for its beneficial use, citing HRS §174C-71(2)(D)). WWC Proposed FOF 338.

c) An IIFS that exceeds the base flow of a stream would not result in a weighing of instream and non-instream uses. WWC Proposed FOF 342.

d) An IIFS that does not apportion some of the base flow would not result in a balancing of the instream and non-instream uses. WWC Proposed FOF 343

e) Current non-instream use of each stream exceeds both the base flow and the duration curve data amounts suggested for adoption as an IIFS. WWC Proposed FOF 346.

f) WWC concludes that the lowest recorded stream flow represents base flow. WWC Proposed FOF 459, 592, 682, 702, 787.

178. WWC then determined what proportion of the lowest recorded flow, its definition of "base flow," should be returned to the stream, because "current non-instream use of each stream exceeds both the base flow and the duration curve data amounts suggested for adoption as an IIFS." COL 176(e), *supra*. In other words, because WWC has determined that current non-instream use is taking all of the base flow, some of it must be returned to the stream. However, because WWC also concluded that "(a)n IFFS that does not apportion some of the base flow would not result in a balancing of the instream and

non-instream uses, COL 176(d), *supra*, it reasoned that all of the base flow cannot be returned to the stream.

179. WWC did not explain why it concluded that such a small proportion of the lowest flows recorded should comprise the amended IIFS: 1) 1.4 of 14 mgd for Waihe`e River; 2) 0.5 of 1.6 mgd for North Waiehu Stream and 0.5 of 1.5 mgd for South Waiehu Stream; 3) 4.2 and, further downstream, 1.4 of 7.1 mgd for `Īao Stream; and 4) 1.1 and, further downstream, 0.4 of 3.3 mgd for Waikapū Stream. COL 175, *supra*.

180. Furthermore, through its method, while only a portion and not the whole of the lowest minimum flows are returned to the streams, non-instream uses have total access to all flows over the minimally record ones. In other words, while WWC would "give back" a minority portion of the minimally recorded flows that have been diverted, all other flows would be available for diversion.

181. WWC's reasoning is flawed. First, base flow does not only reflect the amount of water in the stream in extended dry periods. While base and total flow are nearly the same in dry periods, base flow varies with total stream flows. USGS's model estimates the fraction of total flows that represents the ground water contribution, and that model estimates that the ground water contribution rises with rising stream flows. FOF 98-103.

182. Second, neither the definition of "instream flow standard" nor the weighing of instream values with non-instream uses: 1) mentions base flow; 2) requires that the weighing must apportion only some of the base flow to the amended IIFS; or 3) prohibits establishing the IIFS above the base flow because that apportionment would not satisfy the Code's weighing of instream values with non-instream uses. HRS §§ 174C-3, 174C-71(2)(D).

183. Third, while the Supreme Court has concluded that "reason and necessity dictate that the public trust may have to accommodate offstream diversions inconsistent with the mandate of protection, to the unavoidable impairment of public instream uses and values," **Waiāhole I**, 94 Haw. At 141, 9 P.3d at 453, there is also a presumption in favor of the streams, whose maintenance in their natural states is a public trust purpose, and private commercial uses bear the burden of justifying their uses in light of the purposes protected by the trust. COL 15, *supra*. WWC reverses this presumption and burden of proof by allocating only a minor portion of the lowest recorded stream flows to make up

the entire amended IIFS, with the major portion and any flows above the lowest recorded stream flows available for offstream uses. And WWC advocates this course of action without explaining its "reason and necessity."

184. Fourth, even if WWC's reasoning was consistent with the law, none of WWC's proposed IIFS would result in continued mauka to makai flows. Waihe`e River loses 2.1 to 5.9 mgd (USGS assumes a constant loss of 4 mgd for planning purposes) downstream of the Spreckels Ditch. North Waiehu Stream loses an estimated 1.3 mgd between the North Waiehu Ditch and the confluence of North and South Waiehu Streams. Waiehu Stream loses an estimated 0.6 mgd between the confluence and the mouth. `Īao Stream loses an estimated 6.3 mgd from WWC's diversion to the mouth. Waikapū Stream has major infiltration losses downstream of all diversions so that it is unclear if even the entire natural flow would have reached the mouth. COL 157-160, FOF 109, 115, 121, 129, 137. All of WWC's proposed IIFS would infiltrate into the stream beds before they reached the mouth of the streams.

c. **Hui/MTF's and OHA's Proposed IIFS**

185. Hui/MTF, joined by OHA, proposed the following amended IIFS: 1) Waihe`e River: a) 25.5 mgd immediately downstream of the Waihe`e Ditch Diversion; b) 27.5 mgd immediately downstream of the Spreckels Ditch diversion; and c) at the mouth: the flow remaining in the stream after diversion of (1) up to 2.0 mgd to satisfy kuleana and T&C users downstream of the Spreckels Ditch diversion who take water directly from Waihe`e Stream and (2) up to 2.5 mgd for the uses of Maui Coastal Land Trust; 2) North Waiehu Stream: 2.5 mgd immediately below the North Waiehu diversion; 3) South Waiehu Stream: 2.5 mgd immediately below the South Waiehu diversion; 4) at the mouth of Waiehu Stream: the flow remaining after diversion of 0.07 mgd for the use of kuleana and T&C users; 5) `Īao Stream: a) 18.8 mgd immediately downstream of the `Īao intake; and b) at the mouth: the flow remaining after the diversion of up to 2.0 mgd to satisfy kuleana and T&C users who take water directly from the stream; 6) Waikapū Stream: a) 4.1 mgd immediately below the Reservoir 1 intake; b) at the mouth: the flow remaining after the diversion of up to 0.35 mgd for the uses of kuleana and T&C users who take water directly from the stream; and c) if Waikapū Stream flow has not reached Kealia

Pond within 120 days from the effective date of the IIFS, then there shall be no IIFS at the mouth, and the IIFS immediately upstream of the Reservoir 1 intake shall be the amount remaining after the diversion of up to 0.35 mgd for the uses of kuleana and T&C users who take water directly from the stream. COL 170, *supra*. (**Note**: Reservoir 1 receives water from the Waikapū Ditch, and Hui/MTF and OHA may be referring to Reservoir 6, which is further downstream, **see** Figure 4.)

186. These proposed IIFS are based on their expert witness's recommendation that the IIFS be established at 75 percent of "annual median flow." A "starting place" would be the historical median flow for the period between 1984 to 2005, and then adjusted periodically. For example, every six months, the median flow for the previous year would be calculated, and 75 percent of that flow would be released. COL 168(6), *supra*. FOF 582. However, their proposed IIFS are not adjusted yearly, as was recommended by their expert witness.

187. Their expert witness recommended 75 percent of the median (Q_{50}) flows to maintain overall biological and ecological integrity over the short- and long-term, COL 168(1), *supra*, FOF 577, but he did not explain further how this specific level for the IIFS, to be adopted for all four streams, would accomplish those purposes. For example, what does he mean by "short-term" biological and ecological integrity? Short-term effects could include indications of the "quality habitat," but whether these changes are able "to support sustainable, reproductive instream biological communities," COL 167(1), *supra*, FOF 556, can only be answered over the long-term.

188. Instead, their expert witness stated that the 75 percent of the median flow was "an informed guess" and that it could be less. COL 168(8), *supra*. FOF 585.

189. When queried whether his recommendation nearly matches the Q_{70} level, or what USGS theorizes is the mean base flow component of total flow, their expert witness stated that he did not rely on that fact for his recommendation. COL 168(4), *supra*. FOF 580. However, given that his reason was "an informed guess" without the reasons for why he chose that specific level and that he conceded that it could be less, the Commission concludes that it is more than coincidence that the 75 percent of mean (Q_{50}) flow, or Q_{65} to Q_{85}, closely coincides with the mean base flow component of total flow, or Q_{70}. Without any explanation beyond an informed guess, the Commission interprets

the expert witness's recommendation for the IIFS for all four streams as their mean base flows, a theoretical calculation that can never be empirically reproduced and which was not conceptualized as a means for establishing IIFS. FOF 101-103, 105.

190. The Commission is not categorically against using mean base flow or closely related flows to establish the IIFS, only that, in this case, there is insufficient support for the expert witness to choose that flow other than it is his "informed guess" without any more information of what he meant by "informed."

191. Even if the expert witness could have provided an adequate basis for choosing 75 percent of median flow, he would have had to provide sufficient reasons for each stream and not categorically apply it to all four. The expert witness himself was of the opinion that each stream is a natural system, and differences in the characteristics of the streams and their watersheds should be taken into account. COL 167(6) *supra*. FOF 598.

192. The proposed IIFS at the mouth of the four streams are also contrary to the law in the same manner as MDWS's proposed IIFS; i.e., amending the IIFS comes first, and non-instream (offstream) uses are then met with the remainder. **Waiāhole I**, 94 Haw. at 153, 9 P.3d at 465. COL 175, *supra*. In each of the four streams, the proposed IIFS at the stream mouth would be the flow remaining after diverting water for kuleana and traditional and customary users. COL 170, *supra*.

193. The proposed IIFS also do not strike a balance between instream values and offstream users. The proposed IIFS for `Īao and Waikapū Streams are arbitrary by denying, without explanation, the diversions by HC&S of `Īao Stream at the Spreckels Ditch and by WWC of Waikapū Stream at the Waihe`e Ditch, while allowing for all other of WWC's and HC&S's diversions. **Compare** FOF 181 and 186 with COL 170, *supra*.

194. The proposed IIFS, set between 65 and 85 percent of Q_{50}, **compare** COL 170, *supra*, and Table 9, would mean that all offstream uses, including kuleana and traditional and customary uses, would have no access to water 15 to 35 percent of the time. In addition, for those periods of time in which flows above the IIFS are less than the amount of offstream uses (to be determined in the water use permit application process under the designation of the four streams as a surface water management area) there will be insufficient water for those offstream users.

195. Unless the IIFS are established as the minimum flows ever recorded in each stream, there will unavoidably be periods when no water will be allowed to be diverted and periods when the water available for diversion will be insufficient. The Commission is not concluding that it must therefore establish the IIFS at the minimum recorded flows; only that a balancing of instream values with non-instream uses must consider these situations.

d. **<u>HC&S's Proposed IIFS</u>**

196. HC&S proposed the following amended IIFS: 1) Waihe`e River: a minimum flow of 2 mgd to 3 mgd measured below the Spreckels Ditch intake; 2) North Waiehu Stream: a minimum flow of 0.15 mgd to 0.25 mgd below WWC's diversion on North Waiehu Stream; 3) South Waiehu Stream: a minimum flow of 0.15 mgd to 0.25 mgd below HC&S' diversion on South Waiehu Stream; and 4) ʻĪao and Waikapū Streams: not viable candidates for restoration and therefore deny the requests for amendment of their IIFS. COL 171, *supra*.

197. The proposed IIFS were based on the following proposed Conclusion of Law: The currently available scientific evidence indicates that Waiheʻe Stream has significant reproducing populations of native Hawaiian amphidromous species and that ecological connectivity was also found in Waiehu Stream, although it is a less promising candidate for restoration than Waiheʻe Stream given its narrow stream channel and low flow volume under undiverted conditions, alterations to the stream caused by cultural disturbances, and the concrete apron below the culverts under Kahekili Highway. No ecological connectivity was found in ʻĪao and Waikapū Streams, and each of those streams present inherent challenges to the propagation of amphidromous species at various stages of their life cycle. In the case of ʻĪao Stream, channelization of the stream bed in the lower reaches impedes post-larval recruitment. The apparent lack of a direct connection between Waikapū Stream and the ocean interferes with migration and recruitment. Thus, it is unlikely that the addition of stream flow to ʻĪao and Waikapū Streams would result in the presence of reproductive populations of amphidromous organisms in those streams. HC&S's Proposed COL 6. As with WWC's proposed IIFS, the proposed IIFS for Waihe`e River and North and South Waiehu Streams are minority

fractions of the lowest recorded flows. <u>See</u> FOF 107, 113 and 119 for the minimum flows, and COL 179, *supra*.

198. In its Proposed Decision and Order, HC&S refers to restoring "a portion of the natural stream flow," HC&S's Proposed Decision and Order, II.1, and its proposed IIFS make it apparent that "natural stream flow" is equivalent to WWC's "base flow" and that both are equated to the lowest recorded flows.

199. Conclusions of Law 181-184 for WWC, *supra*, apply equally to HC&S's proposed IIFS for Waihe`e River and North and South Waiehu Streams, and HC&S's reasoning for its proposed IIFS for these streams is flawed.

200. As for `Īao Stream, experts differed on the significance of channelization on post-larval recruitment, and there have been observations of amphidromous recruitment in the channelized section when flow connected to the ocean. COL 167(4), *supra*, FOF 593. The larval drift surveys did not address the issue of the relative importance of channelization versus lack of flow and there are no data or study demonstrating that channelization is more important. COL 169(6), *supra*. FOF 592.

201. As for Waikapū Stream, ultimately, restoration of flow would answer whether it flows mauka to makai. COL 169(7), *supra*. FOF 595.

5. <u>The Commission's Analysis and Amendments to the IIFS</u>

a. <u>Analysis</u>

1. <u>Overview</u>

202. Construction of the Spreckels Ditch began in 1882, the `Īao and Waiehu ditch systems began around 1900, and the Waihe`e Ditch began in 1905. FOF 167-169. Starting with the very first water case addressed by the Hawaii Supreme Court and continuing until 1973, surface waters in Hawai`i could be treated as private property, and those with such "prescriptive" rights had superior rights to the common law "riparian" rights (for example, rights to stream waters by owners of land adjacent to the stream, in amounts that were not injurious to the rights of other owners of land adjacent to that

stream). The Court used the Hawaiian ahupua`a system as its rationale for ruling that the taking of water for other than use on riparian lands was the superior right:

> So if a riparian proprietor should interfere with an ancient auwai, by which other lands had been watered from time immemorial, he would be liable in damages, because this was clearly an easement for the benefit of those lands through which the ancient water course extended...(A) right to interfere with the natural right to make use of water belonging to another, when it is connected with the occupation of lands, constitutes an easement in favor of the latter, as the dominant estate. Peck v Bailey, 8 Haw. 658, at 661-662 (1867).

The Court continued to expand on the rights to own surface waters, ruling that it was not necessary for the water to be used on the land which had the prescriptive rights, Lonoaea v Wailuku Sugar Co., 9 Haw. 651 (1893), Horner v Kumuliilii, 10 Haw. 174 (1895), Wong Leong v Irwin, 10 Haw 265 (1896), thereby straying far away from its initial justification of ownership based on the ahupua`a system, and finally ruling in 1930 that:

> Riparian rights is not and ever has been the law in Hawaii. It is utterly inconsistent with the system which from time immemorial has been recognized and enforced in these Islands...Even the *kuleanas* awarded in 1845 or thereabouts to the common people, the poorer people, a great many, and perhaps most of them, were nonriparian and would never have been entitled and would not now be entitled under that system to any water from the streams. The system devised and wisely provided by the ancient kings and chiefs permitted of the construction and maintenance of a large network of artificial ditches...That system provided for every kuleana, ili and ahupuaa fed by those ditches more water and greater rights than those which would have been available under the riparian system, even as to those lands which were themselves riparian...There was no limitation to a "reasonable use" for the lands entitled to take from any of the ditches...There was no limitation in favor of lands within the same watershed or valley.**Territory v Gay**, 31 Haw. at 396-400.

203. Forty-three years after **Territory v Gay** completed the privatization of surface waters in Hawaii, the Court reversed course, ruling that: 1) title to water was not intended to be, could not be, and was not transferred to an awardee by the Great Mahele and subsequent Land Commission Award and issuance of Royal Patent; 2) the ownership in natural watercourses, streams, and rivers remained in the people of Hawai`i for their common good; 3) riparian rights exist and belong only to land adjoining a natural watercourse for its own use; and 4) appurtenant rights apply only in connection with the particular parcel of land to which the right is appurtenant. **McBryde**, 54 Haw. 174; 504

P.2d 1330 (1973). The intensity of the controversy surrounding this decision is reflected in the comments by Chief Justice Richardson: "In 1897, Hawaii was annexed by the United States and until 1959 was a territory with our judges and justices appointed by the President of the United States with the advice and consent of the United States Senate. In 1959, Hawaii became a state…While the decisions of the territorial courts were unquestionably binding upon the parties before it, we doubt whether those essentially federal courts could be said to have definitely established the common law of what is now a state. So long as the federal government was sovereign its authority to frame the law was unquestionable, but upon our assumption of statehood our own government assumed the whole of that responsibility, absent any explicit federal interest. And it is from our authority as a state that our present common law springs (emphasis in original)." **Robinson v Ariyoshi**, 65 Haw. 641, at 667, n. 25; 658 P.2d 287, at 306, n. 5 (1982).

204. In this CCH, the Commission must address the diversions that were constructed under the laws prevailing under COL 202, *supra*, and amend the IIFS under the present case laws, statutory laws, and the state Constitution under which water is a public trust resource, as initiated by **McBryde** in 1973. This duty fundamentally turns on its head the laws that were prevailing when the ditches were constructed and whose diversion practices continue to this day. Current practices are to serve offstream uses first, with the streams left with whatever flows that are not diverted on a day-to-day basis. But the flashy nature of Hawai`i's streams, with flows highly dependent on rainfall on even a day-to-day basis, makes management of offstream uses difficult even when such uses have first call on stream flows. Under current laws, the IIFS has to be determined first, and what water remains would be available for offstream uses, COL 18, *supra*, subject to the water use permits requirements. This means that management of offstream uses will still have to contend with the daily variations in stream flows but will also have to work with a quantity of water that will have been reduced by the amounts that must remain in the streams under the amended IIFS. Furthermore, unless the Commission decides on, or a variation of, WWC's or HC&S's proposed IIFS, under which only a portion of the lowest flows recorded will constitute the amended IIFS, there will be days when no water is available for offstream uses. But the Commission rejects this approach, based on its

analysis. COL 176-184, 196-201. The Commission also rejects the proposal of Hui/MTF, joined by OHA, for a number of reasons, one of which is that setting the IIFS at Q_{65-85} would mean that no water would be available for offstream use 15 to 35 percent of the time and insufficient water for a significant percentage more. COL 194, *supra*. In both cases—WWC and HC&S versus Hui/MTF joined by OHA—accepting those proposals would be tantamount to a "categorical imperative," COL 14, *supra*, for the offstream uses on one hand, and stream restoration on the other. Instead, the Commission "must weigh competing public and private uses on a case-by-case basis…accommodating both instream and offstream uses where feasible…consider(ing) the cumulative impact of existing and proposed diversions on trust purposes and to implement reasonable measures to mitigate this impact, including using alternative resources." COL 16-17, *supra*.

2. <u>The Restorative Potential of the Nā Wai `Ehā Streams</u>

205. Because of the amphidromous life cycle of Hawaiian streams' fish, mollusks, and crustaceans, FOF 65-67, if the currently degraded habitat of Nā Wai `Ehā streams are restored, recruitment and re-population are expected to occur. From the many expert opinions presented at the CCH, including often diametrically opposed opinions in part because of the adversial nature of the CCH process, the Commission reaches the following conclusions:

206. While continuous stream flow from the source in the mountains to the mouth at the ocean ("connectivity from mauka to makai") is perhaps a necessary condition for most of Hawai`i's perennial streams to sustain reproducing amphidromous populations at pre-diversion levels, FOF 556, there are streams that are naturally interrupted with healthy populations; i.e., with ecological instead of physical connectivity, or stream flows of sufficient volume and frequency to allow the normal distribution of native amphidromous species within a given watershed., FOF 557. These competing perspectives clashed on the viewpoint of the restorative potential of `Īao Stream in particular, where there has been extensive channelization with concrete in the lower reaches and plans to complete that channelization down to the mouth of the stream. FOF 128. One viewpoint is that it is the channelization, not interrupted flow, that prevents ecological connectivity; while the other viewpoint is that no amount of mitigation of

factors such as channelization can compensate for a lack of streamflow and that increased streamflows can go a long way to mitigate the adverse effects of other factors. FOF 590, 595.

207. The current balance between instream values and offstream uses, as represented by the status quo IIFS established on December 10, 1988, COL 155, *supra*, reflects the historical period when stream waters were considered private property. The Commission is required to retain more water in the streams under the IIFS process and concludes that restoring flows into `Īao Stream is the best available tool at its disposal for restoring the streams' amphidromous species.

208. However, a larger obstacle than the channelization of the stream in its lower reaches may be the 20-foot vertical drop in the channelized area, below the concrete channel above and the unlined channel below. FOF 128.

209. For Waikapū Stream, the principal issue is whether or not in dry weather, where actual flow is approximately equal to base flow, the non-diverted stream flowed continuously from mauka to makai or whether its natural flows infiltrated into the streambed before reaching the mouth. FOF 137.

210. An additional impediment for recruitment of amphidromous species into Waikapū Stream is that, when there is flow from Waikapū Stream to Kealia Pond during extensive periods of flooding, the water does not travel via a continuous channel through the pond and into the ocean, but instead, fans out into a big delta. FOF 567.

211. There is evidence of some ecological activity in Waiehu Stream, with low numbers of adult amphidromous species but no larvae in downstream drift samples collected from the stream. At least two species of ‘o‘opu and amphidromous prawns were found in the upper reaches of that stream, and recruits were found on the mauka side of the culverts. FOF 564. However, there is extensive channel erosion below the Spreckels Ditch on South Waiehu Stream, with a 12-foot drop in the elevation of the stream just below the diversion, and there is a vertical concrete apron located just below the highway culverts in lower Waiehu Stream. FOF 124.

212. In their present diverted states, Waihe`e River showed the most ecological activity. The study conducted by HC&S's expert witnesses described Waihe`e River as having normal patterns of migration, species and size distribution, and reproduction throughout

the stream under diverted conditions, with its larval drift sampling indicating that Waihe`e River is the only stream that appears to have significant reproductive populations of native amphidromous species. FOF 563. However, the study's many limitations included it being "just a snapshot" and no larval drift studies having been correlated with upstream abundance of the adults contributing the larvae, thereby limiting conclusions on the quality or normality of Waihe`e River's reproductive output. FOF 573-576.

213. All four streams are dry downstream of all diversions during dry-weather conditions. Minor flows are observed in the streams downstream of the diversions due to return flows and leakage from the ditches. Waihe`e River has a measurable flow of about 0.1 mgd immediately downstream of the Spreckels Ditch, but the River is estimated to lose from 2.1 to 5.9 mgd downstream of the Spreckels Ditch, so it also may not have continuous surface flow from mauka to makai. FOF 109-111, 116, 122-123, 130-131, 136-137.

214. Thus, the restorative potential is highest for Waihe`e River, which already exhibits reproductive activity, though the quality or normality of current reproductive output is not known. Higher flows in periods of rainfall, when streamflows are not fully diverted and/or rainfall and runoff downstream of the diversions result in flows that reach from mauka to makai, must result in recruitment, which in turn leads to some reproducing adults in the upper reaches of the River.

215. For Waiehu Stream, there is evidence that some recruitment has resulted in scarce populations of adult amphidromous species in the upper reaches of the stream. However, there are two significant physical impediments to restoring reproductive output: extensive channel erosion below the Spreckels Ditch on South Waiehu Stream, with a 12-foot drop in the elevation of the stream just below the diversion, and a vertical concrete apron located just below the highway culverts in lower Waiehu Stream.

216. For `Īao Stream, recruitment can occur through the channelized portion of the stream, but the most prohibitive obstacle to restoring reproductive output is the 20-foot vertical drop in the channelized area.

217. Waikapū Stream may not have flowed continuously mauka to makai prior to the diversions, because of extensive infiltration of streamflow into the streambed in its lower

reaches. Even if it did flow continuously mauka to makai, recruitment might not have occurred. When there is streamflow during extensive periods of flooding, it does not travel via a continuous channel through Kealia pond and into the ocean, but fans out into a big delta.

3. Reasonable Offstream Uses

218. In balancing instream values with offstream uses, the Commission will not recognize the economic impact on diverted water that is being used inefficiently, losses that could be prevented through practical actions, or waters that have practical alternatives. In this CCH, the purpose of estimating what are reasonable amounts of current offstream uses is to determine what might be the economic impact of restricting such uses, and is not determinative of the "reasonable-beneficial" requirement for WUPAs under the surface water management area designation of Nā Wai `Ehā. COL 37-43, *supra*. Thus, here, the Commission makes a general, collective assessment of reasonableness of offstream uses and not the WUPA-specific assessment with the burden of providing information on the parties seeking water use permits.

219. For kalo lo`i on kuleana lands, 130,000 to 150,000 gad, or about 260,000 to 300,000 gad when adjusted for the 50 percent of the time that no water is needed to flow into the lo`i, is sufficient for proper kalo cultivation. COL 56, *supra*. Consumption by the lo`i themselves comprises 15,000 to 40,000 gad, COL 54, *supra*, so the large amounts of inflow and outflow required to inhibit rotting diseases would result in substantial losses, so as much of the outflow as practical must be channeled back into the streams, and leakage from the inflow and outflow ditches must be reduced as much as practically possible, COL 57-58, *supra*.

220. The estimated 6.84 mgd delivered to kuleana lands, FOF 332, Table 7, is a reasonable amount to meet both the flow-through and consumptive requirements of their current and projected acreage in kalo lo`i. Only about 10 to 25 percent of this amount, however, would be consumed by the kalo lo`i and most of the rest available downstream if as much as practical of the outflows are diverted back into the streams. Therefore, the net consumptive use by the kalo lo`i would be on the order of 0.68 mgd to 1.71 mgd.

221. Some kuleana landowners also use stream waters for domestic and other uses (vegetables, trees, and plants). MDWS allocates up to 540 gpd for households and 600 to 1,200 gad for agricultural development lots, FOF 401-402, which are reasonable amounts for kuleana lands for these purposes, but the kalo lo`i use is by far the dominant use.

222. While none of the kuleana lands have yet to be confirmed as having appurtenant rights, if such rights are found to exist, there is no duty to meet the practical alternatives test. COL 94, *supra*.

223. Maui Coastal Land Trust is seeking 1.5-2.5 mgd for wetlands restoration and other related activities, which are reasonable, COL 61, *supra*, but there is also a reasonable alternative from ground water underlying the wetlands, FOF 353.

224. MDWS receives up to 3.2 mgd of surface water from the `Īao-Waikapū Ditch and is in discussions to obtain 9 mgd by the end of 2009 for a surface water treatment to be constructed near Waiale Reservoir. FOF 368-369. Both of these uses are reasonable. COL 62, *supra*.

225. WWC's system losses are estimated at 7.34 percent, or 4.31 mgd in 2005 and 3.80 mgd in 2006, averaging about 4.06 mgd over those two years. Table 7. Most of WWC's ditches are unlined, and all of its many small reservoirs (**See** Figure 5) are unlined. FOF 375. Assuming that losses could be halved by lining most of its reservoirs, reasonable losses would be about 2.0 mgd.

226. WWC's Water Delivery Agreements were 2.37 mgd in 2006, up from 1.42 mgd in 2005. Table 7. Although only some of the parties receiving water testified, most had alternative sources such as MDWS, or probable recycled water for future development projects. For two of the larger current or future users, reasonable amounts were 1.2 mgd or less for two golf courses, and 2,730 gad for a proposed coffee farm on about 300 acres, or 0.82 mgd. COL 64, *supra*.

227. The reasonable uses for HC&S is estimated at 24.49 mgd for the Waihe`e-Hopoi Fields and 8.88 mgd to 9.10 mgd for the `Īao-Waikapū Fields. COL 92-93, *supra*.

228. The 80 percent efficiency factor that is calculated into these estimates of reasonable uses is also a reasonable loss. Hui/MTF's expert witness himself used an efficiency factor—85 percent--but his estimates were not for water use on a daily basis,

COL 73, *supra*, and the application of his modeling results to actual field conditions could reasonably lead to an 80 percent efficiency, COL 79-80, 83, *supra*.

229. HC&S estimates that it loses 6 mgd to 8 mgd through seepage from the Waiale Reservoir, depending on the level of the reservoir, and estimates seepage throughout its ditch and reservoir system at 3 mgd to 4 mgd. It has not undertaken studies nor estimated the costs to line Waiale Reservoir or the other reservoirs and ditches. COL 122-123, *supra*. Given that HC&S has stated that "high density polyethylene lining could negate much of the seepage, not all of it" for Waiale Reservoir, FOF 425, the Commission estimates that it is practical to prevent 6-8 mgd of losses, or the seepage of the Waiale Reservoir.

230. Alternative sources for HC&S include Well No. 7 and recycled wastewater. Some of the wastewater sources were and are still being used, although at reduced levels. COL 103-110, *supra*. Fourteen mgd from Well No. 7 is a reasonable alternative for the Waihe`e-Hopoi Fields. The additional 14 mgd would incur costs of $1 million and constraints on the power to run the pumps on a consistent and sustained basis because of HC&S's power contract with MECO. COL 105-106, *supra*. HC&S also states that pumping from Well No. 7 will exacerbate the degree to which the sustainable yield of the Kahului aquifer is already being exceeded. FOF 500. The Commission's assumption is that about 16 mgd of alternative sources are practically available.

231. Therefore, for HC&S, total reasonable uses are estimated at 20.29 mgd to 21.59 mgd: 8.8 mgd to 9.10 mgd for the `Īao-Waikapū Fields, 8.49 mgd for the Waihe`e-Hopoi Fields after subtracting 16 mgd from alternative sources, and from 3 mgd to 4 mgd of system losses remaining after subtracting the 6 mgd to 8 mgd of losses from Waiale Reservoir.

232. Therefore, total reasonable current and future uses for all diverted stream waters are 37.19 mgd to 39.52 mgd: 1) 0.68 mgd to 1.71 mgd for consumptive use only by kalo lo`i; 2) 12.2 mgd for MDWS; 3) 2.02 mgd for WWC's Water Delivery Agreements; 4) 2 mgd for WWC's system losses; and 4) 20.29 mgd to 21.59 mgd for HC&S.

233. If the total flow-through requirements for kalo lo`i are substituted for the consumptive use (6.84 mgd in place of 0.68 mgd to 1.71 mgd), the total reasonable uses

would be 43.35 mgd to 44.65 mgd. Most of these additional amounts, however, would have to be returned into the streams downstream of the diversions to the lo`i.

234. In comparison, the estimated amounts of water diverted from the Nā Wai `Ehā streams were 63.50 mgd in 2005 and 55.94 mgd in 2006 (See Table 8), and total deliveries, including system losses, were 62.97 mgd in 2005 and 55.61 mgd in 2006 (See Table 7). These amounts were for actual diversions and uses, while the estimates for reasonable uses include about 11 mgd for future uses (MDWS and WWC Water Delivery Agreements, COL 224, 226, *supra*.

4. Economic Impacts

235. In order to assess the economic impacts on users of diverted waters, the flows that will be retained in the streams under the amended IIFS have to be identified first, then the amount of water available for offstream uses, then the shortfalls in those amounts compared to reasonable uses, and finally, the economic consequences of those shortfalls. However, the evidence at this CCH consisted primarily of "all-or-nothing" consequences; for example, if waters were not available for HC&S's sugar operations. Even OHA's expert witness, while faulting HC&S for not conducting a partial equilibrium analysis followed by a general equilibrium analysis, would have examined, through a partial equilibrium analysis, the effect of withdrawn water on HC&S's West Maui sugar fields in their 5,000-acre totality, and that effect on HC&S's entire 35,000 sugar fields. As stated earlier, a more useful analysis by either or both parties would have been the effects on the 5,000 acres of incremental reductions of Nā Wai `Ehā waters. Some of the considerations on the possible economic impacts are as follows:

236. All offstream users are subject to the inherent variability of daily stream flows. In extended dry periods, there may not be enough water to meet the needs of all offstream users, and in extremely wet periods, unrestrained diversions may even harm such uses through damage to the ditches and reservoirs and even the end uses. The daily variability of available water will continue, but management of the available water will become more complicated and at times perhaps even unmanageable, because under the current rule of law, the IIFS has to be established first, and only then will the remaining water be available for offstream uses. This means, for example, if there were 10 mgd flowing in

the stream, offstream users took all up to the 10 mgd, leaving the streams dry below the diversions most of the time and all of the time during dry periods, if the ground water contribution to stream flow was less than 10 mgd. Under the amended IIFS, if that IIFS were established at 5 mgd, offstream users would have that much less and none if the stream flow were 5 mgd or less.

237. Under the amended IIFS, if available water for offstream uses is less than the reasonable demand, when the WUPA process for the Nā Wai `Ehā surface water management area begins, the shortage provisions of the Code will come into effect. HRS §174C-62. Under that provision, the Commission "may impose such restrictions on one or more classes of permits as may be necessary." Because the amount of water available for offstream uses will have been determined by the establishment of the IIFS, would the consequence of water shortages compared to the amounts requested in the WUPAs be a result of establishing the amended IIFS, in which the Commission must weigh "the importance of the present or potential instream values with the importance of the present or potential uses of water for noninstream purposes," thereby requiring the Commission to include "the economic impact of restricting such uses," HRS §174C-71(2); HAR §13-169-40? Or does the consequence of a water shortage arising in the WUPA process after the IIFS have been amended not require the Commission to address those consequences under its duty to amend the IIFS?

238. Without resolving this "chicken or egg" situation, the Commission arrives at these conclusions on the economic impact of restricting offstream uses and provides further analysis in the following sections in which the amended IIFS are established.:

239. There will be economic consequences to kuleana lands, if the amended IIFS are established at such levels that existing uses and recognized appurtenant rights, whether exercised for traditional and customary or commercial purposes, cannot be practiced because of shortages in available water. But these consequences will not be apparent until the amended IIFS are established, and if they result in water shortages, how these kuleana lands will fare in the priority-setting among water use permittees under the shortage provisions. Traditional and customary practices, including appurtenant rights, are public trust purposes, and if appurtenant rights are not exercised for traditional and customary

purposes, the exercise of appurtenant rights still have a higher priority over private commercial uses. COL 21-24, *supra.*

240. The potential impact on MDWS's use of surface waters is similar to that on kuleana lands. At least the majority of MDWS's uses are for "domestic uses of the general public," another public trust purpose. COL 13, *supra.* An additional economic impact on MDWS might be the costs of acquiring the primary distribution systems of WWC (and HC&S's), if one of the consequences of the amended IIFS is that WWC decides to no longer continue its water distribution operations, and Maui County decides that it is in the public interest of the County's citizens to acquire and operate it.

241. The economic consequences for WWC's Water Delivery Agreements would primarily be the extra costs, if any, of having to use other delivery systems, such as MDWS's. Furthermore, the largest current and potential users may determine through financial analyses that the better option is to forego their operations (the golf courses) or plans (the coffee plantation), with lost-opportunity costs associated with those decisions. Finally, the Commission has the authority to treat golf-course irrigation as a non-agricultural use and apply different standards and conditions than to agricultural use, which would be of relevance if the Commission issues permits under shortage conditions. **Waiāhole I**, 94 Haw. at 169, 9 P.3d at 481.

242. The economic consequences on WWC itself would be a direct correlation between reductions of water available for offstream use and its revenues to deliver those waters. COL 128-133, 135, *supra.*

243. The economic consequences for HC&S are threats to its ability to apply economies of scale to its overall 35,000 acres of sugar operations, of which the 5,000 acres in West Maui are its most productive; retaining a reasonable cost structure; achieving target sugar yields of 13-14 tons per acre per crop cycle; and returning to historical rates of harvesting; all of which are dependent on a reliable water supply. COL 137-142, *supra.* Additional costs of $1 million and constraints on the power to run the pumps on a consistent and sustained basis because of HC&S's power contract with MECO would be incurred for replacing 14 mgd of surface waters by ground water from Pump No. 7. COL 105-106, *supra.*

b. Amendments to the IIFS

244. The current IIFS for the Nā Wai `Ehā streams are the flows that were in the streams on December 10, 1988: "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." HAR §13-169-48. COL 155, *supra.*

245. Those flows must be assigned specific numbers, and the problems inherent in that exercise have already been identified previously: i.e., actual measurements for only Waihe`e River and `Īao Stream, covering the period 1984 to 2005, and only estimates of the ungauged flows for Waiehu and Waikapū Streams through "record-extension techniques" from measurements of stream flows from 1911-1917 and 1910-1917, respectively. COL 157-160, *supra.* These are the only flow estimates above all diversions and the necessary starting points for amending the IIFS, but establishing IIFS at points below the diversions will incorporate any errors in the above-diversion estimates. Further complicating this task is that stream flows in Hawai`i have decreased significantly over the past 90 years, and over the period 1984 to 2007 (blanketing the period, 1984 to 2005, on which the USGS estimates of stream flow are based), there have been a 25 percent reduction of average stream flows in Waihe`e River, a 10 percent reduction in `Īao Stream, and presumed reductions of unknown percentages in the ungauged Waiehu and Waikapū Streams. COL 161, *supra.*

246. The Commission concludes that establishing continuous stream flow from mauka to makai provides the best conditions for re-establishing the ecological and biological health of the waters of Nā Wai `Ehā. The Commission also cautions that flow restoration cannot make up for the many factors that have affected these streams, but flow restoration is the instrument available to the Commission.

247. The Commission also notes that the first amounts of increased flow in dry or very low-flow streams quickly result in large increases in wetted habitat, and that the increase in wetted habitat from further increases in flows becomes less dramatic. FOF 589.

1. Waihe`e River

248. The amended IIFS is as follows:

1) above all diversions at gauging station 16614000 near an altitude of about 605 feet, the flow will remain as designated on December 10, 1988, estimated by USGS currently, based on data from 1984-2005, as Q_{90} of 24 mgd, Q_{70} of 29 mgd, and Q_{50} of 34 mgd, (**See** Table 9);

2) just downstream of the Spreckels Ditch diversion, the flow will be 14 mgd, unless the flow at about 605 feet is less than 14 mgd, at which time the flow will be the corresponding amount; and

3) at the mouth of the River, the flow will be the corresponding amount, estimated at 10 mgd when reduced by losses into the streambed. Losses are estimated at 4 mgd, ranging from 2.1 mgd to 5.9 mgd, between the Spreckels Ditch and the mouth.

249. 14 mgd is the minimum flow in Waihe`e River. In its current condition of essentially no flow during dry periods below the Spreckels Ditch, it still shows reproductive activity. Constant flow at the mouth, together with flows of 14 mgd just below the Spreckels Ditch and natural flows above all diversions, should greatly enhance the River's already proven ability to support reproductive activity.

250. Except for extremely dry periods when the flow above all diversions is near 14 mgd, some water will be available for offstream uses. However, because at least 14 mgd must remain in the stream past the diversions all of the time, the practice of diverting all the available flows first to meet offstream uses means that there will be less water available for offstream uses during lower flow periods. For example, referring to the Q flows in COL 248, *supra*, and subject to the accuracy of USGS's estimates, in the past, at least 24 mgd could be diverted 90 percent of the time, at least 29 mgd 70 percent of the time, and at least 34 mgd 50 percent of the time. These amounts will decrease to 10, 15, and 20 mgd, respectively, because at least 14 mgd must remain in the River. Applied to the amounts diverted from Waihe`e River in 2005 and 2006 (**See** Table 8) and assuming that more water was not available to be diverted, 23.09 mgd instead of 37.09 mgd would have been diverted in 2005 and 15.72 mgd instead of 29.72 mgd would have been diverted in 2006.

2. **<u>Waiehu Stream</u>**

251. The amended IIFS for North Waiehu Stream is as follows:

1) above all diversions near an altitude of 880 feet, estimated by USGS the flow will remain as designated on December 10, 1988, based on record extension techniques of 1911 to 1917 data projected to 1984-2005, as Q_{90} of 1.4 mgd to 2.7 mgd, Q_{70} of 2.3 mgd to 2.7 mgd, and Q_{50} of 3.1 mgd to 3.6 mgd (**<u>See</u>** Table 9); and

2) 2.2 mgd immediately below the North Waiehu Ditch diversion, unless the flow at altitude of 880 feet is less, at which time the flow will be the corresponding amount.

252. The amended IIFS for South Waiehu Stream is as follows:

1) above all diversions near an altitude of 870 feet, the flow will remain as designated on December 10, 1988, estimated by USGS currently, based on record extension techniques of 1910 to 1917 data projected to 1984-2008, as Q_{90} of 1.3 mgd to 2.0 mgd, Q_{70} of 1.9 mgd to 2.8 mgd, and Q_{50} of 2.4 mgd to 4.2 mgd (**<u>See</u>** Table 9); and

2) 1.3 mgd immediately below the Spreckels Ditch diversion, unless the flow at 870 feet is less, at which time the flow will be the corresponding amount.

253. The amended IIFS for the mouth of Waiehu Stream is as follows:

1. the corresponding amount, estimated at 1.6 mgd when reduced by estimated losses of 1.3 mgd between the North Waiehu Ditch and the confluence of North and South Waiehu Stream and an estimated loss of 0.6 mgd between the confluence of North and South Waiehu Stream and the mouth.

254. 2.2 mgd is near the upper range of the Q_{90} flow for North Waiehu Stream, and 1.3 mgd is at the lower range of the Q_{90} flow for South Waiehu Stream.

255. Compared to their Q flows, the amended IIFS just below the Spreckels Ditch on South Waiehu Stream has been set a little lower than the amended IIFS below the North Waiehu Ditch on North Waiehu Stream, COL 254, *supra*, because there is extensive channel erosion below the Spreckels Ditch on South Waiehu Stream, with a 12-foot drop in the elevation of the stream just below the diversion, COL 158, *supra*. This presents a

grave obstacle to recruitment further up South Waiehu Stream, and is the reason for setting the amended IIFS relatively lower below the Spreckels Ditch and relatively higher for the amended IIFS below the North Waiehu Ditch to create a constant flow at the mouth of the stream. However, the vertical concrete apron located just below the highway culverts in lower Waiehu Stream remains an obstacle to successful recruitment and reproductive activity upstream. COL 158, *supra.*

256. Comparing the amended IIFS below the diversions to the Q flows, for North Waiehu Stream, no diversions will be allowed about 10 percent of the time, diversions from about 0.5 mgd and higher will be allowed 70 percent of the time, and diversions from about 1 mgd and higher will be allowed about 50 percent of time. When diversions could take all stream flows, from 1.4 mgd to 2.7 mgd and higher could be taken 90 percent of the time, from 2.3 mgd to 2.7 mgd and higher 70 percent of the time, and from 3.1 mgd to 3.6 mgd and higher 50 percent of the time.

257. For South Waiehu Stream, diversions of zero to 0.7 mgd and higher will be allowed 90 percent of the time, between 0.6 mgd and 1.5 mgd and higher 70 percent of the time, and between 1.1 mgd and 2.9 mgd and higher 50 percent of the time. When diversions could take all stream flows, from 1.3 mgd to 2.0 mgd and higher could be diverted 90 percent of the time, from 1.9 mgd to 2.8 mgd and higher 70 percent of the time, and 2.4 mgd to 4.2 mgd and higher 50 percent of time.

258. The two amended IIFS below the diversions total 3.5 mgd, and when compared to the water diverted from Waiehu Stream in 2005 and 2006 (**See** Table 8), the diverted total of 4.41 mgd in 2005 would have been reduced to 0.91 mgd, and the total of 4.38 mgd in 2006 would have been reduced to 0.88 mgd, assuming that more water was not available to be diverted.

3. **`Īao Stream**

259. The amended IIFS for `Īao Stream is as follows:

1) above all diversions near an altitude of 780 feet, the flow will remain as designated on December 10, 1988, currently estimated by USGS, on the basis of 22 years of complete records (climate years 1984-2005), as a Q_{90} flow of 13 mgd; a Q_{70} flow of 18 mgd; and a Q_{50} flow of 25 mgd, (**See** Table 9);

2) 13 mgd below the `Īao-Waikapū and `Īao-Maniania Ditches, unless the flow at 780 feet elevation is less, at which time the flow will be the corresponding amount;

3) the flow associated with the 13 mgd, estimated at 8 mgd, below the Spreckels Ditch diversion; and

4) the flow associated with these two flows, estimated at 6.7 mgd at the mouth, when reduced by losses into the streambed.

260. 13 mgd is the Q_{90} flow. USGS estimates a loss of 6.3 mgd in reaches that are not lined with concrete and that are downstream of the `Īao-Waikapū and `Īao-Maniania Ditch diversion (which is at about 780 feet elevation), or 3.00 miles from about 595 feet elevation down to 35 feet elevation. COL 159, *supra*. The Spreckels Ditch is near an altitude of about 260 feet and about 2.4 miles downstream from the `Īao-Waikapū and `Īao-Maniania Ditches, FOF 127, which is above the concrete channelization near the mouth. Assuming that four-fifths of the loss occurs in the 2.4 mile stretch between the `Īao-Waikapū and `Īao-Maniania Ditches and HC&S's Spreckels Ditch intake, the loss in that 2.4-mile stretch would be about 5 mgd, and the loss below HC&S's intake would be about 1.3 mgd.

261. Thus, the 13 mgd flow just below the `Īao-Waikapū and `Īao-Maniania Ditch diversion would be about 8 mgd at the Spreckels Ditch diversion after losses into the streambed, and the flow at the mouth would be about 6.7 mgd after losses between the Spreckels Ditch diversion and the mouth.

262. For the IIFS at the Spreckels Ditch diversion, the actual flow will not be known until the 13 mgd flow above has stabilized. HC&S will be able to divert water only when the flow exceeds the IIFS, estimated at 8 mgd. If the lands associated with the Duey ditch between the two diversions (**See** Figure 3) are issued water use permits, those amounts will have to be added to the 13 mgd and count against the amounts available for offstream uses.

263. These continuous stream flows should enhance the recruitment of amphidromous species that have been observed in the channelized portion during intermittent flows lasting more than three to four days. FOF 593-594. However, there remains a serious obstacle for recruitment to continue past the channelized portion of the Flood Control

Project, which starts about 2.5 miles above the mouth of `Īao Stream and consists of a debris basin, a concrete channel that runs from the debris basin to just downstream of North Market Street, a 20-foot vertical drop, a broadened but unlined channel running to Waiehu Beach Road, and concrete wing walls running about one-half of the distance from the Waiehu Beach Road to the mouth of the stream. In 2008, a $30 million project was advertised to line the remaining Control Project channel and raise existing levees to eliminate future flooding and levee failure. Even if recruitment can continue when the unlined channel is lined with concrete, amphidromous recruits still face the obstacle of the 20-foot vertical drop. Thus, the difference in reproductive activity between Waihe`e River and `Īao Stream may not be the channelization, COL 169(5), *supra*, FOF 590, but the formidable obstacle of the 20-foot vertical drop.

264. With stream flow at 13 mgd, no diversions would be allowed 10 percent of the time, with some diversion allowed 90 percent of the time; 5 mgd or more diversions allowed 70 percent of the time, and 12 mgd or more allowed 50 percent of the time. When diversions could take all stream flows, 13 mgd and higher could be diverted 90 percent of the time, 18 mgd and higher 70 percent of the time, and 25 mgd and higher 50 percent of time.

265. When compared to the water diverted from `Īao Stream in 2005 and 2006 (<u>See</u> Table 8), the diverted total of 17.68 mgd in 2005 would have been reduced to 4.68 mgd, and the total of 17.53 mgd in 2006 would have been reduced to 4.53 mgd, assuming that more water was not available to be diverted.

4. <u>Waikapū Stream</u>

266. The amended IIFS for Waikapū Stream is as follows:

1) above all diversions near an altitude of 880 feet, the flow will remain as designated on December 10, 1988, estimated by USGS, based on record extension techniques of 1911 to 1917 data projected to 1984-2005, as Q_{90} of 3.3 mgd to 4.6 mgd, Q_{70} of 3.9 mgd to 5.2 mgd, and Q_{50} of 4.8 mgd to 6.3 mgd (<u>See</u> Table 9); and

2) 4 mgd below the Reservoir 6 Ditch diversion, unless the flow at 880 feet elevation is less, at which time the flow will be the corresponding amount;

3) if no flows reach Kealia Pond with a flow of 4 mgd at Reservoir 6, there will be no IIFS at Reservoir 6; and

4) if flows reach Kealia Pond, the IFFS below Reservoir 6 will be 4 mgd, and the IIFS at Kealia Pond will be the corresponding flow; except if flows reach Kealia Pond but surveys find no recruitment, there will be no IIFS below the Reservoir 6 Ditch diversion nor at Kealia Pond.

267. 4 mgd is near the average of the range of estimates of the Q_{90} flow and is the dry weather flow. This flow amount is to evaluate whether or not flows reached Kealia Pond under pre-diversion, dry-weather conditions.

268. Waikapū Stream is commonly dry downstream of all diversions because of infiltration losses into the streambed, COL 160, *supra*, and may not have flowed continuously mauka to makai prior to the diversions because of extensive infiltration of streamflow into the streambed in its lower reaches.

269. Even if it did flow continuously mauka to makai, recruitment might not have occurred. When there is streamflow during extensive periods of flooding, it does not travel via a continuous channel through Kealia pond and into the ocean, but fans out into a big delta. COL 217, *supra*.

270. If any water use permits are issued downstream of Reservoir 6, the flow at Reservoir 6 must be augmented by those amounts.

271. If stream flow reaches Kealia Pond and recruitment occurs, with stream flow at 4 mgd, hardly any diversions will be allowed 10 percent of the time, some diversions will be allowed 90 percent of the time; an average of about 0.5 mgd or more allowed 70 percent of the time, and an average of about 1.5 mgd or more allowed 50 percent of the time.

272. When diversions could take all stream flows, from 3.3 mgd to 4.6 mgd or more could be diverted 90 percent of the time, 3.9 mgd to 5.2 mgd or more 70 percent of the time, and 4.8 mgd to 6.3 mgd or more 50 percent of time.

273. When compared to the water diverted from Waikapū Stream in 2005 and 2006 (<u>See</u> Table 8), the diverted total of 4.32 mgd in 2005 would have been reduced to 0.32 mgd at an IIFS of 4 mgd, and the total of 4.31 mgd in 2006 would have been reduced to 0.31 mgd, assuming that more water was not available to be diverted.

c. **Conclusions**

274. In weighing "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," COL 4, *supra*, the Commission's amended IIFS were based on the following conclusions:

275. The IIFS below the diversions should be the dry-weather flows, because during dry weather, the actual flows are essentially equal to base flows, or the ground water contribution to stream flows. The Commission considered the dry-weather flows to be within the range of the lowest flows recorded (Q_{100}) to the Q_{90} flow, or the level at which only 10 percent of recorded flows are lower. With higher flows, the base-flow component will be higher, because as flows increase, base flows also increase. But the theoretical models designed to estimate the increases in base flow as total flow increases were never directed at determining how IIFS should be calculated. Moreover, Hawai`i's perennial streams have highly variable flows, rising and falling quickly from rainfall, runoff, and seepage into the streams. The rise and fall in the base flow component of these variable flows come on top of the dry-weather base flow, and are indistinguishable from the rise and fall of the total stream flow. To take the mean or average base flow, estimated (but never verifiable) as the Q_{70} flow, would result in establishing an IIFS that will always be higher than the total dry-weather flow and never attainable except with rainfall. To establish a floor for mauka to makai connectivity on which stream-flow variability would build, the Commission chose a relatively small range of flows, from the minimum recorded flows up to the Q_{90} flows. The Commission was hesitant to limit the IIFS to the minimum recorded flows, because those flows rarely occurred, raising questions on whether those flows would be favorable to recruitment and reproduction of amphidromous species if they were the dry-weather flow; i.e., for 10 percent of the time, or one day out of ten, instead of the minimum recorded flow's duration of less than one day a year.

276. Establishing the IIFS at Q_{90} instead of Q_{100} means that no diversions will be allowed 10 percent of the time, and that, for the other 90 percent of the time, the water available for diversion will be decreased by that amount, unless stream flows are in

excess of the sum of the IIFS and offstream uses that have been permitted. When diversions could take all of the water from the stream, the only constraint at low flows was the amount of flow. For example, if the demand for diverted water were 20 mgd, all of the water up to flows of 20 mgd would be taken. If the flow were 15 mgd, all would still be taken but would still fall short of demand by 5 mgd. For stream flows above 20 mgd, up to 20 mgd would be diverted and only the remainder would be left as flows. In contrast, if the IIFS were to be established at a Q_{90} of 5 mgd, only 15 mgd of a daily flow of 20 mgd could be taken to satisfy the demand of 20 mgd, leaving diversions 5 mgd "short" even when there is flow above the dry-weather flow.

277. The Commission was cognizant that, by establishing the IIFS near the Q_{90} flow, no water could be diverted 10 percent of the time, and that there would be additional periods of time when the amount to be diverted would not meet demand. Compared to ground water, using stream waters is already not wholly reliable, because of the highly variable nature of Hawai`i's short, steep, and flashy streams. There is no constant amount from which water can be withdrawn, even when diverters were free to take whatever was flowing in the stream. Retaining water in the streams further complicates the management of diverted water, but that is the price that must be paid for restoring instream values. The Commission determined that water unavailable for diversion one day out of ten could still serve the needs of offstream uses, although new management strategies will be necessary. To do less for stream restoration would tip the scales too far toward offstream uses, when the public trust assumption, at least for the commercial uses of diversions, is in favor of stream restoration.

278. The amended IIFS for the four streams were: 1) 14 mgd for Waihe`e River; 2) 3.5 mgd for Waiehu Stream; 3) 13 mgd for `Īao Stream; and 4) 4 mgd (if flow reaches Kealia Pond and recruitment occurs) for Waikapū Stream. If we assume that total stream flows equaled the amounts diverted, then water available for diversion would be decreased by 34.5 mgd.

279. Total diversions were 63.50 mgd in 2005 and 55.94 mgd 2006. <u>See</u> Table 8. Under the amended IIFS, diversions would have been reduced to 29.0 mgd in 2005 and 21.44 mgd in 2006. (The amount of diversions would likely have been higher, because this estimate assumes that all flows were being diverted, but there would have been times

when there was more water in the streams than needed for diversions. The fact that diversions were about 12 percent less in 2006 than 2005 also likely means that, even though there may have been days when stream flow was higher than the amount diverted, demand was higher than supply averaged over the year.)

280. Compared to actual use, reasonable current and future uses have been estimated at 37.19 mgd to 39.52 mgd, and if flow-through requirements were used instead of lo`i water consumption, the estimates were 43.35 mgd to 44.65 mgd. COL 232-233, *supra.* **Compare** with 29.0 mgd available in 2005 and 21.44 mgd in 2006 after reducing for the IIFS, COL 279, *supra.*

281. Future uses were 9 mgd for MDWS and 2 mgd for WWC's Water Use Agreements. COL 224, 226, *supra.* Without factoring in these future uses, reasonable uses for existing users and existing and future kuleana users would have been 26.19 mgd to 28.52 mgd. These uses are within the range of 29.0 mgd in 2005 and 21.44 mgd in 2006, COL 279, *supra*, the water available after retaining flows for the amended IIFS. If the flow-through requirements were used in place of consumptive use of the lo`i, reasonable uses would be 32.35 mgd to 33.35 mgd without including the future uses. Again, the amount of water available for diversion would likely be higher, because these comparisons assume that all of the flows were being diverted in 2005 and 2006. COL 279, *supra.*

282. Thus, under the amended IIFS, the amounts of water available for diversion would likely be sufficient for existing users, subject to the assumptions on system losses and alternative sources being confirmed. WUPAs for new uses would face the hurdle of showing that the proposed use of water can be accommodated with the available water source. HRS §174C-49(a)(1).

283. Finally, on the economic impact of restricting noninstream uses, the costs associated with reducing system losses and developing or renovating alternative sources, if required, will be costs incurred in order to be granted a permit under the WUPAs for the surface water management area. Therefore, the Commission does not consider such costs as part of the economic impact of restricting noninstream uses. WWC will also incur revenue losses with the reduction of diverted water, but those reductions will be

incurred primarily from reductions in actual use to reasonable use and only in minor part, if at all, from the retention of waters to meet the amended IIFS.

H. WATER USE PERMIT APPLICATIONS ("WUPAs")

284. The WUPAs in this CCH were for high-level diked ground waters: 1) MDWS's Well No. 5332-05 (Kepaniwai Well) for 1.042 mgd; 2) MDWS's Well No. 5332-02 (`Īao Tunnel [Kepaniwai]) for 1.359 mgd; 3) HC&S's Well No. 5330-02 (`Īao Tunnel [Puako]) for 0.100 mgd; and 4) five wells for unknown amounts of water: WWC's Wells No. 5132-01 (Waikapu Tunnel 1), No. 5132-02 (Waikapu Tunnel 2), No. 5332-01 (Black Gorge Tunnel), No. 5333-01 (`Īao Needle Tunnel 1), and No. 5333-02 (`Īao Needle Tunnel 2). WUPAs for Waikapū Tunnels 1 and 2 were subsequently excluded, because they were not subject to the `Īao ground water management area designation. FOF 17.

1. MDWS's WUPAs

285. MDWS's WUPAs for 1.042 mgd for the Kepaniwai Well (Well No. 5332-05) and 1.359 mgd for the `Īao Tunnel (Well No. 5332-02) meet all the criteria for a water use permit. FOF 360-367.

2. HC&S's WUPA

286. The application by HC&S for 0.1 mgd from 'Īao Tunnel (Well No. 5330-02) states as the method of measurement: "Water from the Iao Tunnel is measured at the HC&S Spreckels Ditch at Wailuku Gaging Station along with other stream water." HC&S's WUPA, dated February 25, 2004, and received by CWRM on February 27, 2004.

287. The Wailuku gauging station is located downstream of the South Waiehu Diversion, the intake pipe from HC&S's `Īao Tunnel, and the `Īao Stream intake, none of which is separately gauged. In addition to these three sources, the gauged amount includes water diverted by WWC from Waihe`e River via two Ditches: 1) the Waihe`e Ditch via the drop ditch to Spreckels Ditch; and 2) the Spreckels Ditch Diversion on Waihe`e River. FOF 190.

288. According to HRS §174C-50(e) Existing uses: "The commission shall also issue an interim permit for an estimated, initial allocation of water if the quantity of water consumed under the existing use is not immediately verifiable, but the existing use otherwise meets the conditions of subsection (b) for a permit of an interim permit. An interim permit is valid for such time period specified therein. The commission may issue successive interim permits of limited duration." Section 174C-50(g) continues as follows: "If an interim permit is issued pending verification of the actual quantity of water being consumed under the existing use, a final determination of that quantity shall be made within five years of the filing of the application to continue the existing use. In the final determination, the commission may increase or reduce the amount initially granted the permittee."

289. Subsection (b) of HRS §174C-50 requires that the existing use be reasonable and beneficial and refers to permits issued in accordance with sections 174C-51 Application for a permit, 174C-52 Notice, and 174C-53(b) Permit Issuance, regarding standing for persons filing objections.

290. Regarding the latter subsection on standing of persons filing objections, the parties in this CCH, except for one party that subsequently withdrew, had requested a CCH on all of the high-level, diked ground water sources, which has been combined with the petitions to amend the IIFS for the Nā Wai `Ehā streams. FOF 16-18.

291. On the requirement that the use be reasonable and beneficial and the conditions for a permit, HRS §174C-49(a):

a) The request can be accommodated with the available source of water. The other existing users, MDWS and WWC, continue to withdraw water and have not objected to HC&S's WUPA.

b) The request is for a reasonable-beneficial use. The estimated 0.100 mgd from this ground water source is intermingled with vastly larger amounts of surface water for irrigation of HC&S's Waihe`e-Hopoi Fields. The Code expressly recognizes agriculture as a beneficial use, HRS §174C-2(c), and, for the purpose of this CCH, the Commission has reached conclusions on what are reasonable, economic and efficient uses on these fields: 7,535 gad or 24.49 mgd for 3,250 irrigated acres, COL 92, *supra*. Whatever amounts of surface waters for which HC&S might be issued water use permits as existing uses by the Commission for these fields in its future actions on a WUPA under the surface water management area designation, such amounts would be reduced by the amount of the ground water from HC&S's `Īao Tunnel.

c) The proposed use does not interfere with any existing legal use of water. The other existing users, MDWS and WWC, continue to do so in the amounts they have been withdrawing prior and up to the designation of the `Īao aquifer as a ground water management area.

d) The proposed agricultural use is consistent with the public interest. Haw. Const. art. XI, § 3; HRS ī174C-2(c).

e) The lands irrigated by the water HC&S proposes to use are zoned agriculture in the state and county general plans and land use designation and therefore consistent with state and county general plans and land use designations. HRS § 205-4.5; Maui County Code chapters 19.04 and 19.06.

f) The proposed use will not interfere with the rights of DHHL, who has not objected to the proposed use.

292. Possible practical alternatives are the diverted surface waters that provide the great bulk of irrigation for HC&S's Waihe`e Hopoi Fields, as well as the possible alternatives to those surface waters, FOF 494-506. The diverted surface waters are also a public trust resource, and any future WUPAs for those sources would also require identifying possible practical alternatives. Thus, both are possible practical alternatives to each other and within the Commission's authority as a matter of law and policy to choose between the two. The high-level diked ground water is the common source for both HC&S's`Īao Tunnel and the base flows that compose the origins of the Nā Wai `Ehā streams, and it would be more practical to issue a permit for the `Īao Tunnel water and offset the amount of future permits for the surface waters, if any, by that amount, rather than to require HC&S to seal the tunnel and add the amount previously flowing into the Spreckels Ditch to any future permits for surface waters. As for the other possible alternatives identified in FOF 494-506, the final determination of whether they are practical or not will be made in the decisions on the surface water WUPAs. If some or all of those possible alternatives are found to be practical by the Commission, the amounts of surface waters that meet the conditions for a permit will be reduced by the amounts of

alternative sources that have been found to be practical alternatives.

3. <u>WWC's WUPAs</u>

293. WWC's WUPAs are for unknown amounts of water for No. 5332-01 (Black Gorge Tunnel), No. 5333-01 (ʻĪao Needle Tunnel 1), and No. 5333-02 (ʻĪao Needle Tunnel 2). FOF 17.

294. Black Gorge Tunnel and ʻĪao Needle Tunnels No. 1 and No. 2 discharge into ʻĪao Stream above all diversions (<u>See</u> Figure 3). Development of the ʻĪao Tunnel (Well No. 5332-02) caused the Black Gorge Tunnel to go dry. There is no information available to quantify the effects of ʻĪao Needle Tunnels No. 1 and No. 2 on ʻĪao Stream's total flow. FOF 148.

295. As with HC&S's WUPA for ʻĪao Tunnel (Well No. 5330-02), the Commission could entertain issuing an interim permit, but WWC describes the amounts as "current and historical amounts delivered from those tunnels to the Iao Stream," WWC Proposed FOF 880. For an interim permit, the Code requires "an estimated, initial allocation of water if the quantity of water consumed under the existing use is not immediately verifiable," and an interim permit is issued "pending verification of the actual quantity of water being consumed under the existing use." HRS §174C-50(e)&(e). The Commission interprets these provisions as requiring an estimation of the amount, not just a general statement as provided by WWC.

296. Furthermore, unlike HC&S's ʻĪao Tunnel, which discharges offstream into the Spreckels Ditch, WWC's three tunnels discharge into ʻĪao Stream upstream of all diversions, and whatever amounts of water they discharge have been incorporated into the current IIFS for ʻĪao Stream. Therefore, even if WWC were able to quantify the amounts discharged by the three tunnels, they are not being used by WWC as separate and distinct sources of water from WWC's surface water diversions of ʻĪao Stream and do not qualify for water use permits from the high-level, diked ground waters.

297. WWC's WUPA for its portion of the ʻĪao Tunnel (Well No 5332-02) that it shares with MDWS was not complete and not included in this CCH. During the CCH, WWC attempted to amend its WUPA to cover the amount in excess of that used by MDWS, or

0.227 mgd. WWC Proposed FOF 830, 878. WWC may file a new-use WUPA for that amount.

III. DECISION AND ORDER

A. THE AMENDED INTERIM INSTREAM FLOW STANDARDS

The current IIFS for Waihe`e River and Waiehu, `Īao, and Waikapū Streams are those adopted by the Commission on October 19, 1988, with an effective date of December 10, 1988, which "shall be the 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." HAR §13-169-48.

1. Waihe`e River

The amended IIFS is as follows:

1) above all diversions at gauging station 16614000 near an altitude of about 605 feet, the flow will remain as designated on December 10, 1988, currently estimated by USGS, based on data from 1984-2005, as Q_{90} of 24 mgd, Q_{70} of 29 mgd, and Q_{50} of 34 mgd;

2) just downstream of the Spreckels Ditch diversion, the flow will be 14 mgd, unless the flow at about 605 feet is less, at which time the flow will be the corresponding amount;

3) at the mouth of the River, the flow will be the corresponding amount, estimated at 10 mgd when reduced by losses into the streambed that are estimated as averaging 4 mgd, with estimates ranging from 2.1 to 5.9 mgd.

2. Waiehu Stream

The amended IIFS for North Waiehu Stream is as follows:

1) above all diversions near an altitude of 880 feet, the flow will remain as designated on December 10, 1988, currently estimated by USGS, based on record extension techniques of 1911 to 1917 data projected to

1984-2005, as Q_{90} of 1.4 mgd to 2.7 mgd, Q_{70} of 2.3 mgd to 2.7 mgd, and Q_{50} of 3.1 mgd to 3.6 mgd (**<u>See</u>** Table 9); and

2) 2.2 mgd immediately below the North Waiehu Ditch diversion, unless the flow at altitude 880 feet is less, at which time the flow will be the corresponding amount.

The amended IIFS for South Waiehu Stream is as follows:

1) above all diversions near an altitude of 870 feet, the flow will remain as designated on December 10, 1988, currently estimated by USGS, based on record extension techniques of 1910 to 1917 data projected to 1984-2008, as Q_{90} of 1.3 mgd to 2.0 mgd, Q_{70} of 1.9 mgd to 2.8 mgd, and Q_{50} of 2.4 mgd to 4.2 mgd (**<u>See</u>** Table 9); and

2) 1.3 mgd immediately below the Spreckels Ditch diversion, unless the flow at altitude 870 feet is less, at which time the flow will be the corresponding amount.

The amended IIFS for the mouth of Waiehu Stream is as follows:

1) the corresponding amount, estimated at 1.6 mgd when reduced by estimated losses of 1.3 mgd between the North Waiehu Ditch and the confluence of North and South Waiehu Stream and 0.6 mgd between the confluence of North and South Waiehu Stream and the mouth.

3. <u>`Īao Stream</u>

The amended IIFS for `Īao Stream is as follows:

1) above all diversions near an altitude of 780 feet, the flow will remain as designated on December 10, 1988, currently estimated by USGS, on the basis of 22 years of complete records (climate years 1984-2005), as a Q_{90} flow of 13 mgd; a Q_{70} flow of 18 mgd; and a Q_{50} flow of 25 mgd, (**<u>See</u>** Table 9);

2) 13 mgd below the `Īao-Waikapū and `Īao-Maniania Ditches, unless the flow at altitude 780 feet is less, at which time the flow will be the corresponding amount;

3) the flow associated with the 13 mgd, estimated at 8 mgd, below the Spreckels Ditch diversion; and

4) the flow associated with these flows, estimated at 6.7 mgd at the mouth, when reduced by losses into the streambed.

4. <u>Waikapū Stream</u>

The amended IIFS for Waikapū Stream is as follows:

1) above all diversions near an altitude of 880 feet, the flow will remain as designated on December 10, 1988, currently estimated by USGS, based on record extension techniques of 1911 to 1917 data projected to 1984-2005, as Q_{90} of 3.3 mgd to 4.6 mgd, Q_{70} of 3.9 mgd to 5.2 mgd, and Q_{50} of 4.8 mgd to 6.3 mgd (**<u>See</u>** Table 9);

2) 4 mgd below the Reservoir 6 ditch diversion for 120 days from the implementation of the amended IIFS, unless the flow at 880 feet elevation is less, at which time the flow will be the corresponding amount;

3) if no flows reach Kealia Pond with a flow of 4 mgd at Reservoir 6, there will be no IIFS at Reservoir 6; and

4) if flows reach Kealia Pond, the IFFS below Reservoir 6 will be 4 mgd, and the IIFS at Kealia Pond will be the corresponding flow; except if flows reach Kealia Pond but surveys find no recruitment, there will be no IIFS below the Reservoir 6 Ditch diversion nor at Kealia Pond.

5. <u>Implementation</u>

The existing diversions and gates were designed to divert stream flows and cannot control diversions so that specific flow rates remain in the streams. The Īao-Waikapū and `Īao-Maniania Ditch diversion also returns stream flow at a point downstream, thereby disrupting stream flows. New diversion infrastructures and new gauges will have to be provided to implement the amended IIFS.

The Commission staff shall confer with: 1) the parties to determine the necessary structural changes; and 2) with the parties and other relevant parties to determine the locations of stream-gauging stations and their estimated costs and possible sources of funding.

Commission staff shall also confer with the Division of Aquatic Resources, Maui County, and other parties to address the vertical impediments in the channelized portion of `Īao Stream, in South Waiehu Stream below the Spreckels Ditch diversion, and at the mouth of Waiehu Stream, in order to develop possible methods of allowing upstream migration to circumvent these obstacles.

From time to time, as determined by the Commission, staff and the parties shall report on the progress of and impediments to implementing the amended IIFS and their impacts on instream values and offstream uses. The deadine for existing-use WUPAs for surface water diversions in the Nā Wai `Ehā surface water management area was April 30, 2009, and the subsequent WUPA process should begin to identify the issues concerning the impacts on offstream uses.

The amended IIFS were based on the best-available estimates of stream flows, which, in the case of two streams, Waiehu and Waikapū Streams, were derived through record-extension techniques from actual data for the years 1910-1917. Stream flows in Hawai`i have decreased significantly over a 90-year period. Moreover, for Waihe`e River and `Īao Stream, while actual data from 1984-2005 were used, average (or mean) monthly total stream flows for Waihe`e River for the three 8-year periods 1984-1991, 1992-1999, and 2000-2007, have been observed to have decreased by about 25 percent. In this same period, `Īao Stream's average monthly stream flows have decreased by 10 percent. There are no data for Waiehu and Waikapū Streams during this time period, but it is reasonable to assume that comparable decreases have been occurring in those two streams.

"Interim instream flow standards are by their nature temporary and subject to change. Consequently, any reliance upon the interim standards shall be at the water user's own risk." HAR §13-169-43(b). The tenuous foundation of some of the information that the Commission has had to rely on to arrive at the amended IIFS, weighing their expected improvements in instream values and impacts on offstream uses, makes this "user beware" consequence a real possibility. But the Commission has addressed its duty to weigh these competing public and private water uses with a view to "accommodating both instream and offstream uses where feasible." **Waiāhole I**, 94 Haw. at 142; 9 P.3d at 454. In light of what will surely prove to be a long and complex implementation process, the Commission will likely have to decide whether it is feasible or not, or whether the IIFS established in this proceeding should be revisited.

B. WATER USE PERMIT APPLICATIONS FOR DIKED, HIGH-LEVEL WELL AND TUNNEL SOURCES

1. MDWS

MDWS is awarded water use permits for the existing use of 1.042 mgd for the Kepaniwai Well (Well No. 5332-05) and 1.359 mgd for the `Īao Tunnel (Well No. 5332-02), subject to the standard conditions for a ground water permit. (Attachment A.)

2. HC&S

HC&S is awarded a limited water use permit of 1-year duration for 0.1 mgd from 'Īao Tunnel (Well No. 5330-02), subject to the standard conditions for a ground water permit. (Attachment A.)

HC&S must verify the actual quantity of water being consumed under the existing use. The Commission may continue to issue successive one-year limited water use permits, if the current permits expire before the actual quantity of water being consumed is verified. A final determination shall be made within five years of the filing of HC&S's WUPA. In the final determination, the Commission may increase or reduce the amount initially granted to HC&S.

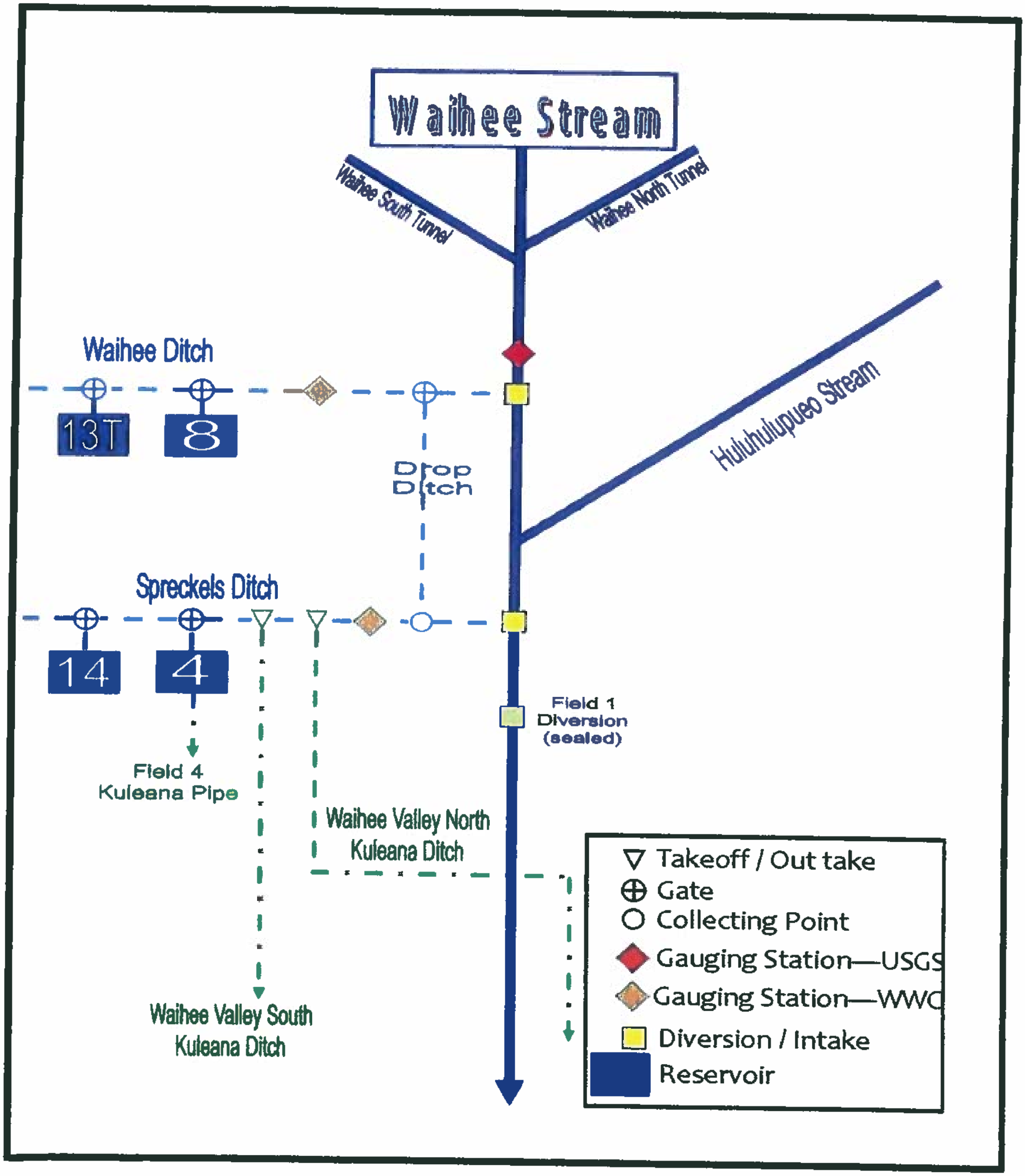
3. WWC

WWC's WUPAs No. 684 (Well No. 5333-01, `Īao Needle Tunnel 1), No. 686 (Well No. 5333-02, `Īao Needle Tunnel 2), and No. 685 (Well No. 5332-01, Black Gorge Tunnel) are denied.

These three tunnels discharge into `Īao Stream upstream of all diversions, and whatever amounts of water they discharge have been incorporated into the current IIFS for `Īao Stream. Therefore, even if WWC were able to quantify the amounts discharged by the three tunnels, they are not being used by WWC as separate and distinct sources of water from WWC's surface water diversions of `Īao Stream and do not qualify for water use permits from the high-level, diked ground waters.

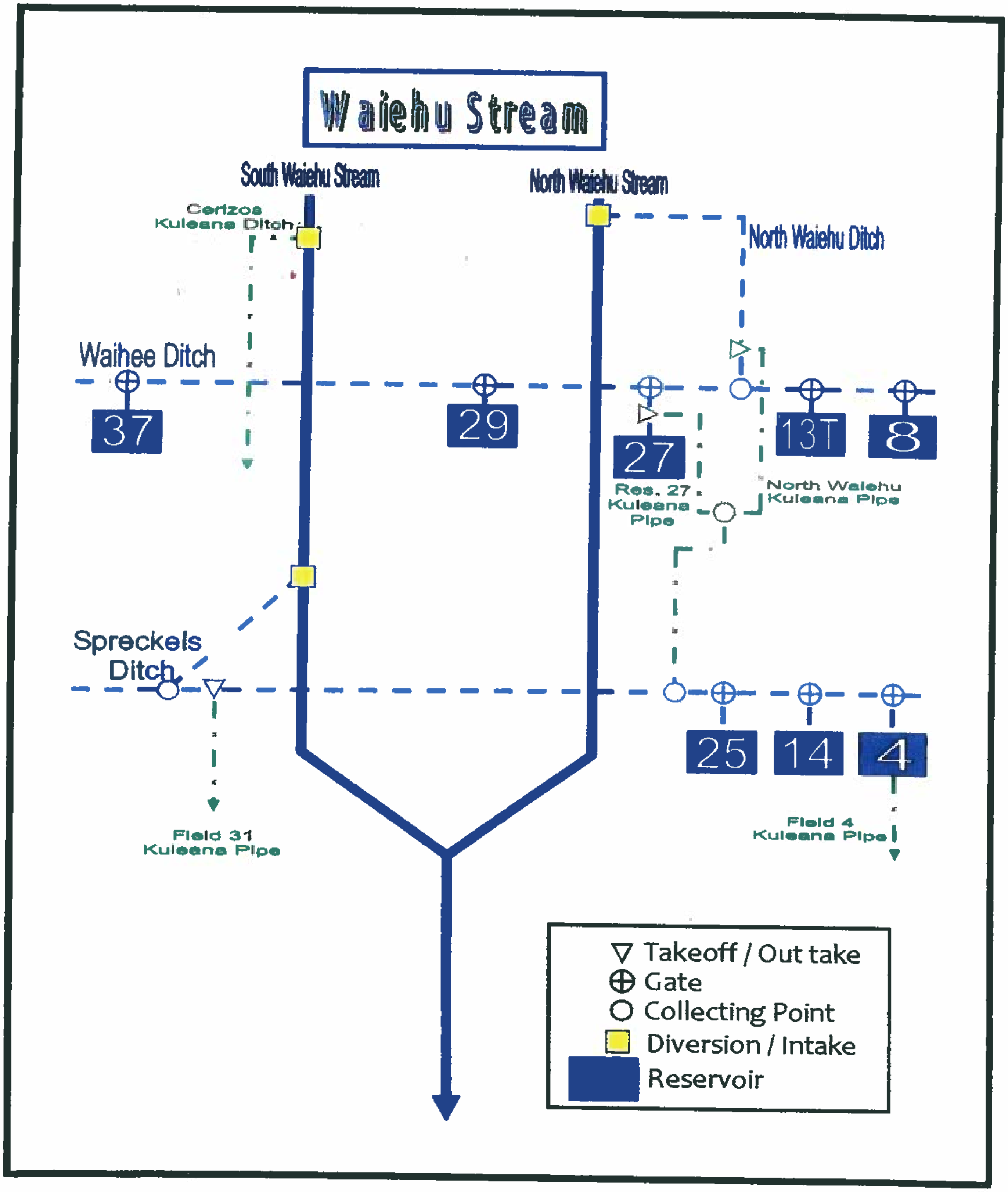
WWC's WUPA for its portion of the `Īao Tunnel (Well No 5332-02) that it shares with MDWS was not complete and not included in this CCH. During the CCH, WWC attempted to amend its WUPA to cover the amount in excess of that used by MDWS, or 0.227 mgd. WWC may file a new-use WUPA for that amount.

Figure 1: Waihee River and Diversions



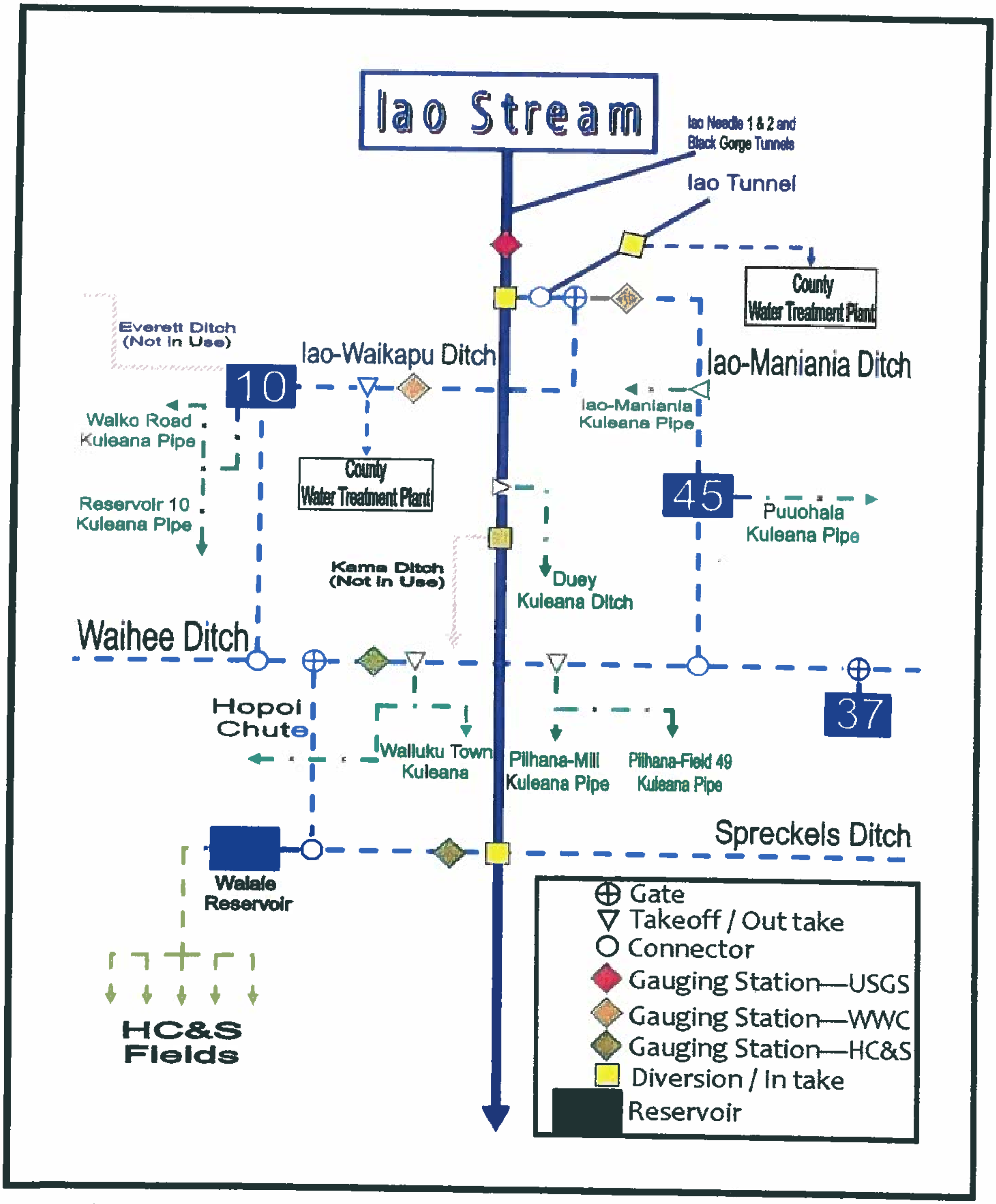
(WWC FOF 351)

Figure 2: Waiehu Stream and Diversions



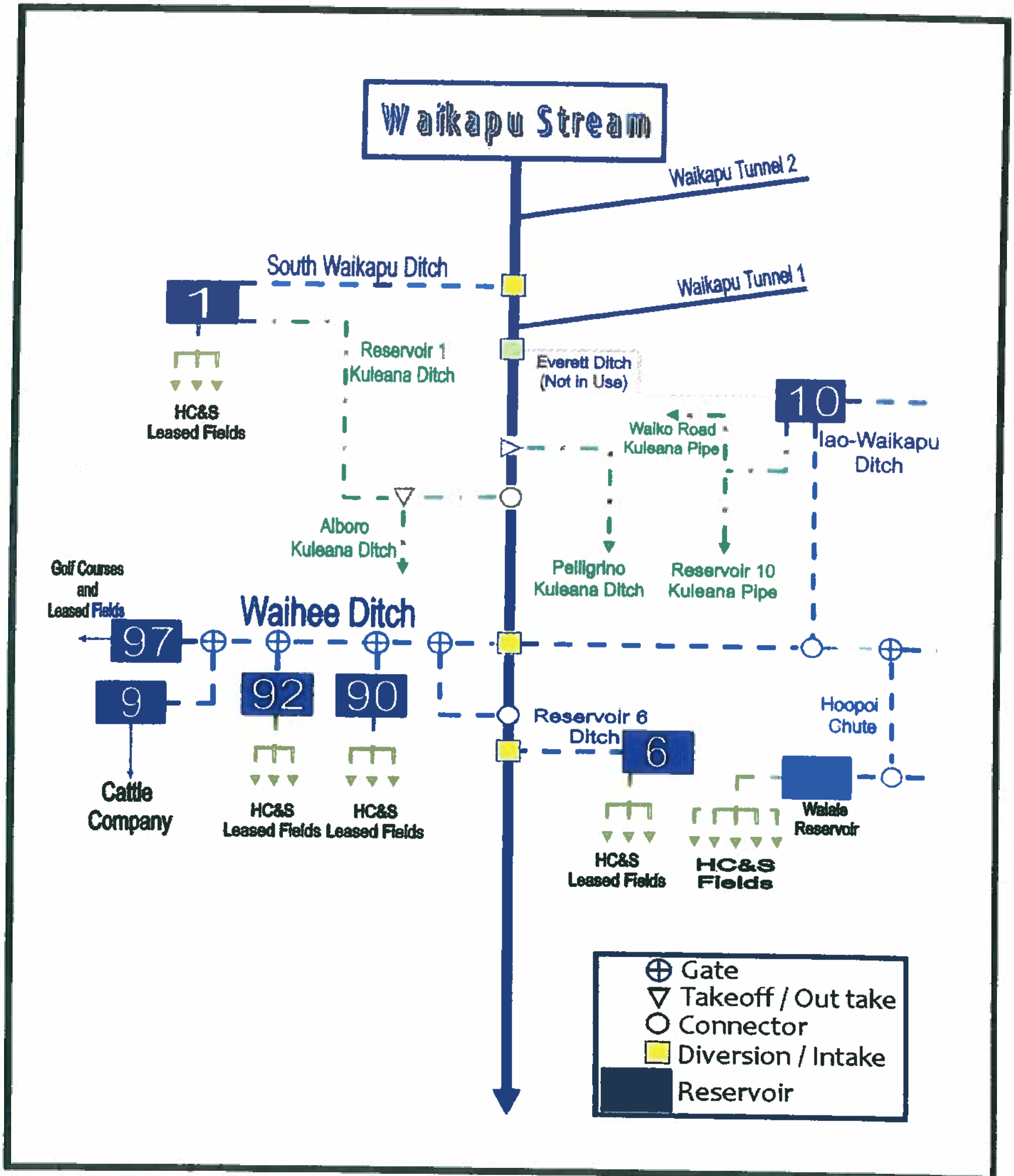
(WWC FOF 609)

Figure 3: Iao Stream and Diversions



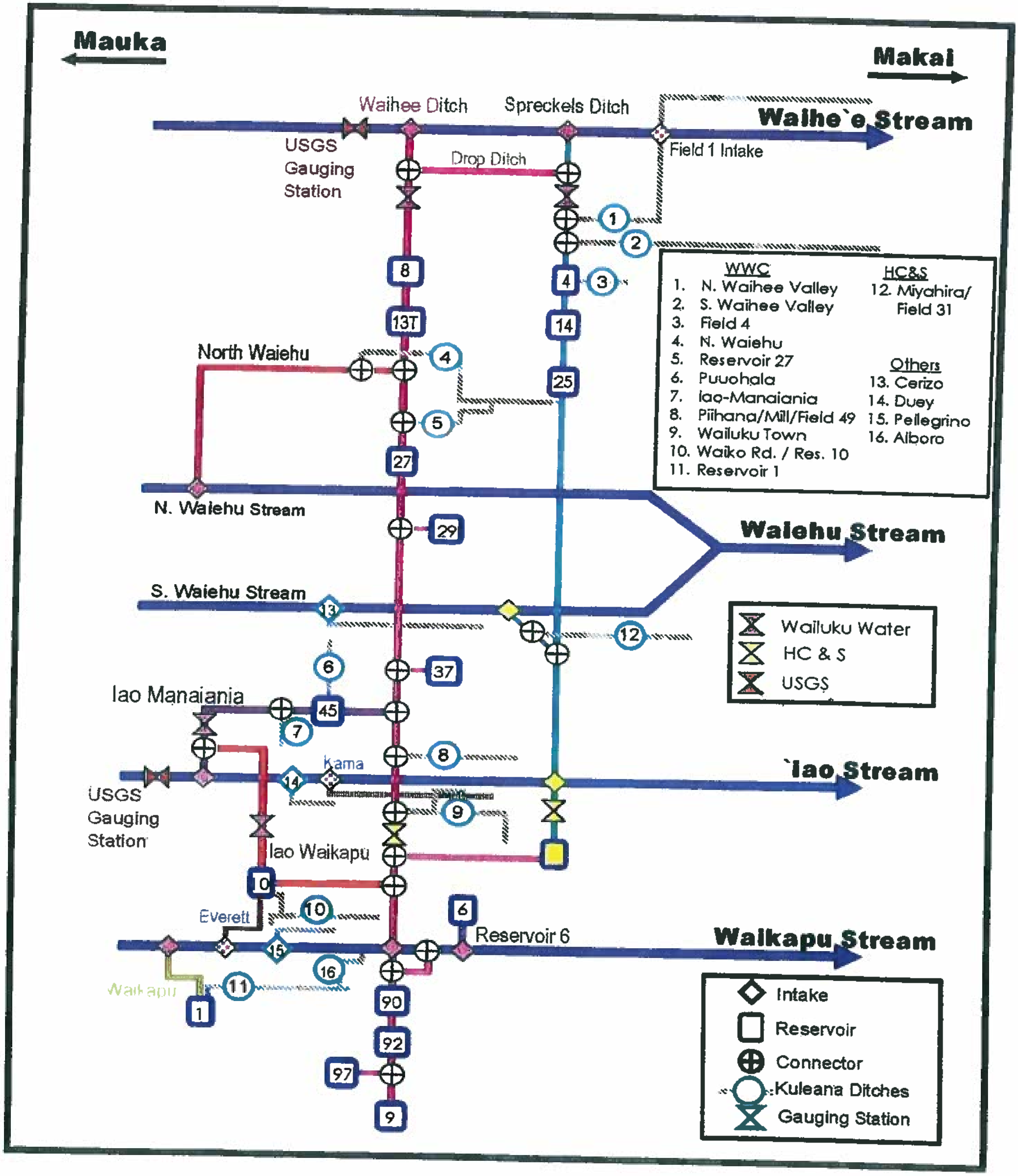
(WWC FOF 476)

Figure 4: Waikapu Stream and Diversions



(WWC FOF 709)

Figure 5: Na Wai Eha Streams and Diversions



(Exhibit D-99). (WWC FOF 78)

Table 1: Kuleana Ditch/Pipe by Stream Source

Kuleana System	Stream Source	Ditch Source	Reservoir Source
Waihe`e Valley North Ditch	Waihe`e	Spreckels	-
Waihe`e Valley South Ditch	Waihe`e	Spreckels	-
Field 4 Pipe	Waihe`e	Spreckels	4
North Waiehu Pipe	North Waiehu	North Waiehu	-
Reservoir 27 Pipe	Waihe`e	Waihe`e	27
Cerizos Ditch	South Waiehu	-	-
Field 31 Pipe	Waihe`e	Spreckels	-
Puuohala Pipe	`Īao	`Īao-Maniania	45
`Īao-Maniania Pipe	`Īao	`Īao-Maniania	-
Piihana-Mill Pipe	Waihe`e/`Īao	Waihe`e/`Īao-Maniania	-
Piihana-Field 49 Pipe	Waihe`e/`Īao	Waihe`e/`Īao-Maniania	-
Duey Ditch	`Īao	-	-
Wailuku Town Ditch	`Īao/Waihe`e	Waihe`e/Iao-Maniania	-
Reservoir 10 Pipe	`Īao	`Īao-Waikapū	10
Waiko Road Pipe	`Īao	`Īao-Waikapū	10
Pellegrino Ditch	Waikapū	-	-
Reservoir 1/Alboro Ditch	Waikapū	Waikapū	1

(Exh. D-7; **see also** Cerizo WDT 9/14/07, Pellegrino WDT 9/14/07, and Duey WDT 9/14/07; Exh. D-99). WWC FOF 152.

Table 2: Water Deliveries by Ditch System, 2006[1]

Kuleana System	Delivery Amount
Waihe`e Valley North Ditch	0.95 mgd
Waihe`e Valley South Ditch	2.60 mgd
Field 4 Pipe	0.09 mgd
North Waiehu Pipe	0.16 mgd
Reservoir 27 Pipe	1.35 mgd
Puuohala Pipe	0.01 mgd
`Īao-Maniania Pipe	0.06 mgd
Piihana-Mill Pipe	<0.01 mgd
Piihana-Field Pipe	<0.01 mgd
Wailuku Town Ditch	0.04 mgd
Reservoir 10 Pipe	0.06 mgd
Waiko Road Pipe	<0.01 mgd
Reservoir 1 Ditch/Alboro Ditch	0.84 mgd
Total Deliveries	6.16 mgd[2]

[1]Some of the numbers presented in WWC FOF 172 are incorrect, when compared to tables presented for each of the source streams; i.e., compare WWC FOF 172 with WWC FOF 413, 543, 657, and 759.

[2]Counting deliveries reported by HC&S and Hui/MTF, 6.84 mgd was delivered to kuleana lands. See footnote 2 in Table 7.

(Exh. D-7, Exh. A-213.) WWC FOF 413, 543, 657, 759.

Table 3: Waihe`e River Waters: Ditch and Kuleanas

Kuleana System	Type of Gauge	TMK	Name
Waihe`e Valley North Ditch	No Gauge	3-2-03:24	Majorie Barrett
		3-2-03:30	Lawrence Koki
		3-2-004:007	Dinnah K.L. Goo
		3-2-004:008	Dinnah K.L. Goo
		3-2-004:009	Dinnah K.L. Goo
		3-2-004:010	Dinnah K.L. Goo
		3-2-04:11	Richard Emoto/Roys Ellis
		3-2-004:012	Roys Ellis
		3-2-04:13	Julia & Stanley Faustino
		3-2-04:14	Nattie Kalanui
		3-2-004:015	Michael Rodrigues
		3-2-004:016	Michael Rodrigues
		3-2-04:017	Nathan Kanae/Michael Rodrigues
		3-2-002:037	William "Ka`u" Freitas
Waihe`e Valley South Ditch	Weir	3-2-004:002	Kenneth Kahalekai
		3-2-004:003	Kenneth Kahalekai
		3-2-004:018	Kaniloa Kamaunu
		3-2-004:019	Kenneth Kahalekai
		3-2-05:11	Burt Sakata
		3-2-05:15	Burt Sakata
		3-2-05:16	Ronald Nakata
		3-2-05:17	Peter Fritz/Burt Sakata
		3-2-05:20	Lorraine Anakalea
		3-2-05:21	Scott Linden
		3-2-05:22	James & Kenneth Kahalekai
		3-2-05:23	Nalia & Kenneth Kahalekai
		3-2-05:024	Kenneth Kahalekai

Table 3 (continued): Waihe`e River Waters: Ditch and Kuleanas

Kuleana System	Type of Gauge	TMK	Name
		3-2-05:025	Kenneth Kahalekai
		3-2-05:027:	Kenneth Kahalekai
		3-2-05:31	Thomas Texeira
		3-2-05:032	Thomas Texeira
		3-2-05:036	Kenneth Kahalekai
		3-2-05:039	Burt Sakata
		3-2-06:001	Charlene Kana
		3-2-06:04	D. Furukawa/Cordell Chang
		3-2-06:10	James Murakami
		3-2-06:18	Jacob & Charlene Kana
		3-2-07:10	Noel Texeira
		3-2-07:16	Bryan Sarasin
		3-2-11:06	Willie & Janet Goo/Dinnah K.L. Goo
		3-2-11:07	James & Barbara Goo/Dinnah K.L. Goo
		3-2-11:19	Jeffrey & Gale Goo/Dinnah K.L. Goo
		3-2-11:65	Lawrence & Diannah Goo/Dinnah K.L. Goo
		3-2-11:66	Joni Kawamura/Ester Goo/Dinnah K.L. Goo
		3-2-11:67	Joni Kawamura/Willie Goo/Dinnah K.L. Goo
Field 4 Pipe	1 ½ inch meter	3-2-07:17	Leonard Kaili/James Kaili, Jr.
		3-2-07:18	Merle Ideoka
		3-2-07:021	Donald Miyashiro/Waihe`e School
Reservoir 27	No Gauge	3-2-18:05	Alex Buttaro
		3-2-18:06	Heinrich Eisenburger
		3-2-18:07	Clarence & Magdalen Hoopi
		3-2-18:09	Donalee Singer
		3-2-18:14	William Morris

Table 3 (continued): Waihe`e River Waters: Ditch and Kuleanas

Kuleana System	Type of Gauge	TMK	Name
		3-2-18:16	Lester Nakama
		3-2-18:17	David & Donalee Singer
		3-2-18:44	Cook Trust
		3-2-18:45	Louis Silva/Magdalen Hoopi
		3-2-18:46	Louis Silva/Magdalen Hoopi
Piihana – Mill Pipe	3 inch meter	3-4-21:08	Elmer & Naone Ching
		3-4-21:09	Terumi Eya
		3-4-21:37	Robert Fujioka
		3-4-24:22	Alfred & Patricia De Mello/Alfred Santiago
		3-4-24:27	Alson & Vera De Mello Trust/Alfred Santiago
		3-4-25:42	Ronald Kim/Robert Kim
		3-4-33:14	Charles & Judy Dando
Piihana – Field 49 Pipe	1 ½ inch meter	3-4-31:08	Winifred L. Nakoa Cockett
		3-4-31:09	Annie Aola
		3-4-31:10	Gaznen Elizares
		3-4-31:11	Annie Aola
Wailuku Town Ditch/Pipe	4 inch meter	3-4-04:72	Jo Ann Howard
		3-4-04:78	Val & Lianne Ogata
		3-4-07:42	Anne & Vernon J.K. Bal

(Exh. D-7.) WWC FOF 414.

Table 4: North Waiehu Stream Waters: Ditch and Kuleanas

Kuleana System	Type of Gauge	TMK and Name	
North Waiehu Pipe	no gauge	3-2-018:21	William Robinson
		3-2-18:14	Donnalee Singer
		3-2-18:15	Donnalee Singer
		3-2-18:17	Donnalee Singer
		3-2-18:27	Magdalen Hoopii
		3-2-18:31	Magdalen Hoopii
		3-2-18:32	Magdalen Hoopii
		3-2-18:33	Magdalen Hoopii
		3-2-18:34	Donnalee Singer
		3-2-18:40	Kenneth Lee

(Exh. D-7, Hoopii, Tr. 12/4/07, pp. 196-207, Sinter, Tr. 12/13/07, p. 29.) WWC FOF 658.

Table 5: `Īao Stream Waters: Ditch and Kuleanas

Kuleana System	Type of Gauge	TMK and Name	
`Īao-Maniania Pipe	meter	3-3-02:17	Harold Graham
		3-3-02:18	Henry Ito's Orchid & Garden
Puuohala Pipe	meter	3-3-02:03	Valentine Haleakala
		3-3-02:25	Henry Kailiehu
		3-3-02:29	Gary & Evelyn Brito Trust
Waiko Road	meter	3-5-04:14	Avery Chumbley
		3-5-04:18	Avery Chumbley
		3-5-04:57	Glenn McClean
Reservoir 10	meter	3-5-04:38	Harumi Sanamura
		3-5-04:39	Roger Yamaoka
		3-5-04:41	Robert & Claire Pinto
		3-5-04:42	Royal & Earlette Vida
		3-5-04:44	Donald Vida
		3-5-04:51	Robert Pinto
		3-5-04:56	Leslie Vida
		3-5-04:91	Leslie Jr. & Michelle Vida
		3-5-04:100	Annie Vida

(Exh. D-7; Brito, Tr. 12/7/07, pp. 29-38.) WWC FOF 544.

Table 6: Waikapū Stream Waters: Ditch and Kuleanas

Kuleana System	Type of Gauge	TMK and Name	
Reservoir 1	no gauge	3-6-05:19	David Kaliponi/Alfred Santiago through Colin Kaliiponi
		3-6-06:01	Barbara Pawn
		3-6-06:09	Clayton Suzuki Trust
		3-6-06:13	Clayton Suzuki Trust
		3-6-06:17	Barbara Pawn
		3-6-06:21	Mae Balmores/Nadao Makimoto
		3-6-06:22	Sakae & Bernadette Inouye
		3-6-06:24	David Kaliponi/Alfred Santiago through Colin Kaliiponi
		3-6-06:25	Elaine Mullaney/Crystal Alboro
		3-6-06:27	Jinsei & Patricia Miyashiro
		3-6-06:29	Elaine Mullaney/Crystal Alboro
		3-6-06:33	Barbara Pawn
		3-6-06:42	Sharlee Dieguez

(Exh. D-7; Exh. A-194.) WWC FOF 761.

Table 7: Total Water Deliveries To All Users, 2005 and 2006

	2005	2006
HC&S:		
Waiale Reservoir (Waihe`e-Hopoi Fields)	40.11 mgd	31.04 mgd
Leased Fields (`Īao-Waikapū Fields)	9.98 mgd	10.88 mgd
MDWS:		
Surface water: `Īao-Waikapū Ditch	0.71 mgd	1.08 mgd
Groundwater: `Īao Tunnel	1.59 mgd	1.76 mgd
Kuleana System Users	6.84 mgd	6.84 mgd[1]
WWC Delivery Agreements	1.42 mgd	2.37 mgd
Total Use: All Users	60.65 mgd	53.97 mgd
Minus ground water contributions from:		
MDWS's `Īao Tunnel (Well No. 5332-02), and	-1.59 mgd	-1.76 mgd
`Īao Tunnels (Well Numbers 5332-02 and 5330-02)[2]	-0.4 mgd	-0.4 mgd
Total Surface Water Use: All Users	58.66 mgd	51.81 mgd
Plus WWC's estimated of 7.34 percent system losses[3]	4.31 mgd	3.80 mgd
Total Surface Water Deliveries, including system losses	62.97 mgd	55.61 mgd

[1]Compare with Table 2, with total deliveries of 6.16 mgd. Table 7's total of 6.84 mgd includes kuleana diversions not accounted for by WWC but reported by HC&S and Hui/MTF. FOF 227.

[2]Approximately 0.3 mgd added to the ditch system by WWC from MDWS's `Īao Tunnel (Well No. 5332-02) and 0.1 mgd from HC&S's `Īao Tunnel (Well No. 5330-02). FOF 153-154. **See also** text accompanying Table 7.

[3]FOF 374.

(Exh. E-3, E-4, and A-138, as modified by FOF 227 for the kuleana users.)

Table 8: Water Diverted by WWC (and HC&S) From Nā Wai `Ehā,

Estimates for 2005 and 2006[1]

Diversion Source	2005	2006
Waihe`e River	37.09 mgd	29.72 mgd
Waiehu Stream	1.41 (+3) mgd	1.38 (+3) mgd
`Īao Stream	13.68 (+4) mgd	13.53 (+4) mgd
Waikapū Stream	4.32 mgd	4.31 mgd
Total:[2]	56.50 (+7) mgd	48.94 (+7) mgd

[1]Excludes a low of 2-3 mgd during dry periods to a maximum of 10-15 mgd during wet periods diverted by HC&S for South Waiehu Stream; and a low of 3-4 mgd during dry periods to a high of about 20 mgd during wet periods diverted by HC&S for `Īao Stream.

[2] If we assume HC&S diverts an average of about 3 mgd from South Waiehu Stream and about 4 mgd from `Īao Stream, the total quantity of water diverted from the four streams, 63.50 mgd in 2005 and 55.94 mgd in 2006, approximates the total surface water deliveries, including losses, of 62.97 mgd in 2005 and 55.61 mgd in 2006 in Table 7.

(Exh. A-138, E-3, E-4.)

Table 9: Comparisons of Diversions versus Q Flows (mgd)

	Gate Capacity/Setting[1]	Diversions[2] 2005	Diversions[2] 2006	Q_{90}[3]	Q_{70}[3]	Q_{50}[3]
Waihe`e River	90 /52	37.09	29.72	24	29	34
Waiehu Stream						
North Waiehu	5/1.5	1.41	1.38	1.4-2.7	2.3-2.7	3.1-3.6
South Waiehu	no gauge[4]	3.00	3.00	1.3-2.0	1.9-2.8	2.4-4.2
Subtotal		4.41	4.38	2.7-4.7	4.2-5.5	5.5-7.8
`Īao Stream	60/20	13.68	13.53	13	18	25
	no gauge[5]	4.00	4.00			
Subtotal		17.68	17.53			
Waikapū Stream	5/3	4.32	4.31	3.3-4.6	3.9-5.2	4.8-6.3
Total:	160/76.5[6]	63.50	55.94	43-46.3	55.1-57.7	69.3-73.1

[1] FOF 180, 185, 186-187, 193, 195, 199.

[2] Table 8.

[3] FOF 107, 113, 119, 126, 133.

[4] Not gaged, but HC&S reports diverting 2-3 mgd during dry periods to a maximum of 10-15 mgd during wet periods. FOF 211.

[5] Not gaged, but HC&S reports diverting a low of 3-4 mgd during dry periods to a high of about 20 mgd during wet periods. FOF 212.

[6] Gate settings are increased by 35 mgd, because HC&S reports diverting a high of 15 mgd from South Waiehu and 20 mgd from `Īao Streams during wet periods. Therefore, maximum amounts of water that can be diverted by gate settings would be 111.5 mgd: 1) 52 mgd for Waihe`e River; 2) 16.5 mgd for Waiehu Stream; 3) 40 mgd for `Īao Stream; and 4) 3 mgd for Waikapū Stream.

STANDARD GROUND WATER USE PERMIT CONDITIONS

1. The water described in this water use permit may only be taken from the location described and used for the reasonable-beneficial use described at the location described above. Reasonable beneficial uses means "the use of water in such a quantity as is necessary for economic and efficient utilization which is both reasonable and consistent with State and County land use plans and the public interest." (HRS § 174C-3)

2. The right to use ground water is a shared use right.

3. The water use must at all times meet the requirements set forth in HRS § 174C-49(a), which means that it:
   a. Can be accommodated with the available water source;
   b. Is a reasonable-beneficial use as defined in HRS § 174C-3;
   c. Will not interfere with any existing legal use of water;
   d. Is consistent with the public interest;
   e. Is consistent with State and County general plans and land use designations;
   f. Is consistent with County land use plans and policies; and
   g. Will not interfere with the rights of the Department of Hawaiian Home Lands as provided in section 221 of the Hawaiian Homes Commission Act and HRS § 174C-101(a).

4. The ground water use here must not interfere with surface or other ground water rights or reservations.

5. The ground water use here must not interfere with interim or permanent instream flow standards. If it does, then:
   a. A separate water use permit for surface water must be obtained in the case an area is also designated as a surface water management area;
   b. The interim or permanent instream flow standard, as applicable, must be amended.

6. The water use authorized here is subject to the requirements of the Hawaiian Homes Commission Act, as amended, if applicable.

7. The water use permit application and submittal, as amended, approved by the Commission at its meeting are incorporated into this permit by reference.

8. Any modification of the permit terms, conditions, or uses may only be made with the express written consent of the Commission.

9. This permit may be modified by the Commission and the amount of water initially granted to the permittee may be reduced if the Commission determines it is necessary to:
   a. protect the water sources (quantity or quality);
   b. meet other legal obligations including other correlative rights;
   c. insure adequate conservation measures;
   d. require efficiency of water uses;
   e. reserve water for future uses, provided that all legal existing uses of water as of June, 1987 shall be protected;
   f. meet legal obligations to the Department of Hawaiian Home Lands, if applicable; or
   g. carry out such other necessary and proper exercise of the State's and the Commission's police powers under law as may be required.

ATTACHMENT A

Prior to any reduction, the Commission shall give notice of its proposed action to the permittee and provide the permittee an opportunity to be heard.

10. An approved flowmeter(s) must be installed to measure monthly withdrawals and a monthly record of withdrawals, salinity, temperature, and pumping times must be kept and reported to the Commission on Water Resource Management on forms provided by the Commission on a monthly basis (attached).

11. This permit shall be subject to the Commission's periodic review for the applicable Aquifer System Area's sustainable yield. The amount of water authorized by this permit may be reduced by the Commission if the sustainable yield of the applicable Aquifer System Area, or relevant modified aquifer(s), is reduced.

12. A permit may be transferred, in whole or in part, from the permittee to another, if:
    a. The conditions of use of the permit, including, but not limited to, place, quantity, and purpose of the use, remain the same; and
    b. The Commission is informed of the transfer within ninety days.

    Failure to inform the department of the transfer invalidates the transfer and constitutes a ground for revocation of the permit. A transfer, which involves a change in any condition of the permit, including a change in use covered in HRS § 174C-57, is also invalid and constitutes a ground for revocation.

13. The use(s) authorized by law and by this permit do not constitute ownership rights.

14. The permittee shall request modification of the permit as necessary to comply with all applicable laws, rules, and ordinances that will affect the permittee's water use.

15. The permittee understands that under HRS § 174C-58(4), that partial or total nonuse, for reasons other than conservation, of the water allowed by this permit for a period of four (4) continuous years or more may result in a permanent revocation as to the amount of water not in use. The Commission and the permittee may enter into a written agreement that, for reasons satisfactory to the Commission, any period of nonuse may not apply towards the four-year period. Any period of nonuse which is caused by a declaration of water shortage pursuant to section HRS § 174C-62 shall not apply towards the four-year period of forfeiture.

16. The permittee shall prepare and submit a water shortage plan within 30 days of the issuance of this permit as required by HAR § 13-171-42(c). The permittee's water shortage plan shall identify what the permittee is willing to do should the Commission declare a water shortage in the applicable Ground Water Management Area.

17. The water use permit shall be subject to the Commission's establishment of instream standards and policies relating to the Stream Protection and Management (SPAM) program, as well as legislative mandates to protect stream resources.

18. The permittee understands that any willful violation of any of the above conditions or any provisions of HRS § 174C or HAR § 13-171 may result in the suspension or revocation of this permit.

19. Special conditions in the attached cover transmittal letter are incorporated herein by reference.